CITY OF OAKLAND

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Public Works Agency
Environmental Services Divison

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March 1, 2011

Mr. Paresh Khatri
Hazardous Materials Specialist
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502

Subject: Human Health Risk Assessment and Ecological Screen for the City of Oakland Municipal Services Center (MSC) site
7101 Edgewater Drive, Oakland, California

Reference: ACEH Fuel Leak Case No. RO0000293, GeoTracker Global ID T0600100375

Dear Mr. Khatri:

The City of Oakland is pleased to submit the attached Risk Assessment report prepared by Arcadis Inc. (Arcadis). The City is submitting this report as part of the ongoing remediation and obtaining a "No Further Action" status to the above referenced site. Arcadis prepared this report as a consultant to the City.

Certification

I certify under penalty of law that this document and attachments are prepared under my direction or supervision in accordance with the system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing the violations.

If you have any questions, or comments, please contact me at (510) 238-6361.

Sincerely

Gopal Nair
Environmental Program Specialist

Human Health Risk Assessment and Ecological Screen for the City of Oakland Municipal Services Center, 7101 Edgewater Drive Oakland, California

LC010060.0007
March 1, 2011

Prepared For:
City of Oakland, Public Works Agency
Environmental Services Division
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ENVIRONMENT

Mr. Paresh Khatri
Hazardous Materials Specialist
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject:
Acceptance of the Health Risk Assessment Report "Human Health Risk Assessment and Ecological Screen for the City of Oakland Maintenance Service Center, 7101 Edgewater Drive, Oakland California," dated March 1, 2011

Date:
October 20, 2011

Contact:
Amy Goldberg Day

Phone:
(510) 652-4500

Email:
amy.goldbergday@arcadis-us.com

Our ref:
LC010060.0007

Dear Mr. Khatri:

The above referenced report was prepared by ARCADIS U.S., Inc. (ARCADIS) and submitted through the online uploading system.

However, it is our understanding that the report was rejected because it was not signed by a Professional Geologist or Professional Engineer. The report was written by a toxicologist and performed to both California and United States Environmental Protection Agencies' standard practice. The appropriate guidance documents were cited in the report. In addition, toxicology as a profession does not have a certification such as a Professional Geologist or Professional Engineer. The work in the report is highly specialized and is most appropriately performed by a toxicologist.

Therefore, ARCADIS is requesting that the health risk assessment report be accepted with a toxicologist's signature.

Sincerely,

ARCADIS U.S., Inc.

Amy Goldberg Day
Principal Toxicologist

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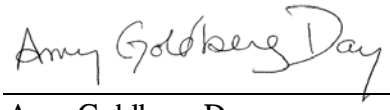
CERTIFICATION

The human health risk assessment was performed by a professional toxicologist. The work was conducted with the utmost care and to the industrial standard level of care for sites in California with state and local agency regulatory oversight. Currently, California does not offer a professional toxicologist certification. Therefore, no applicable professional stamp is available."



March 1, 2011

Amy Goldberg Day
Principal Toxicologist

Date

EXECUTIVE SUMMARY

On behalf of the City of Oakland, ARCADIS prepared this report presenting the results from a human health risk assessment (HHRA) and ecological screening evaluation for the Municipal Services Center located at 7101 Edgewater Drive in Oakland California ("the Site"; Figure 1).

The primary objective of this work was to perform a HHRA and an ecological screening evaluation for the Site. This included estimating human health risks for current site workers and potential future construction workers. In addition, ecological screening criteria were used to evaluate whether the estimated entrance concentrations of identified chemicals in groundwater flowing into the Oakland Harbor could be an ecological concern. The Regional Water Quality Control Board Environmental Screening Levels for the protection of marine habitat were selected as the screening ecological benchmarks.

The HHRA was performed in compliance with the both California and federal Environmental Protection Agency guidance documents. Potential risks and hazards to hypothetical commercial/industrial workers and construction workers were conservatively estimated using the soil and groundwater data collected during various investigations and consolidated into a database by Baseline Environmental Consulting ("Baseline"). Baseline submitted the database to the City of Oakland on February 19, 2008 in Microsoft Office Access format. This database contains the analytical results from samples collected during recent environmental investigations.

This assessment was performed to provide information for the risk management decision process only and does not represent actual exposure conditions. The estimated risks are compared to the California Department of Toxic Substances Control (DTSC) acceptable one in a million cancer risk (1×10^{-6}) and the hazard index (HI) of 1. Estimated cancer risks equal to and below the 1×10^{-6} and an estimated HI equal to and below 1 are not considered to be health concerns by the DTSC. In addition, the estimated risks and hazards were calculated based on historical fuel-related releases and chemicals of potential concern (COPCs) associated with the historical fill material. Specifically, the polycyclic aromatic hydrocarbons (PAHs) identified in soil could have been associated with the historical fill material. Therefore, the evaluation summarizes the risks associated with the PAHs in soil separately from the risk summary for the fuel-related compounds.

The results of the risk assessment, summarized below, indicate that concentrations of fuel-related compounds in soil and groundwater do not appear to be present at the Site at concentrations associated with increased estimated cancer risks and other health hazards considering the exposure scenarios evaluated in this report. Estimated cancer risks and health hazards to the construction worker and commercial/industrial worker were below the DTSC regulatory target of 1×10^{-6} for cancer risk or 1 for noncarcinogenic health hazard without the additive risks associated with the PAHs exposure. Estimated cancer risks and health hazards to the construction worker and commercial/industrial worker were equal to the DTSC regulatory target for cancer risk

for noncarcinogenic health hazard considering the additive risks associated with the PAHs exposure.

Summary of Estimated RME Risks

Exposure Scenario	Total Estimated Carcinogenic Risk without PAHs	Total Estimated Carcinogenic Hazard Index without PAHs	Total Estimated Cancer Risk with PAHs	Total Estimated Carcinogenic Hazard Index with PAHs
Construction Worker	3.E-07	7.E-01	1.E-06	7.E-01
Commercial/Industrial Worker	1.E-06	1.E-01	1.E-06	1.E-01

Note:
Bold = above regulatory target
RME = reasonable maximum exposure

Ecological risks were evaluated by screening the estimated entrance concentrations of COPCs in groundwater to the Oakland Harbor. The concentration in groundwater discharging to the harbor surface water was conservatively estimated by assuming a 10 times dilution attenuation factor from the representative COPC concentrations. The estimated entrance concentration for each COPC in groundwater was below both the protection of aquatic organisms in a marine habitat and the consumption of fish scenario.

LIMITATIONS STATEMENT

The opinions and recommendations presented in this report are based upon the scope of services, information obtained through the performance of the services, and the schedule as agreed upon by ARCADIS and the party for whom this report was originally prepared. This report is an instrument of professional service and was prepared in accordance with the generally accepted standards and level of skill and care under similar conditions and circumstances established by the environmental consulting industry. No representation, warranty or guarantee, express or implied, is intended or given. To the extent that ARCADIS relied upon any information prepared by other parties not under contract to ARCADIS, ARCADIS makes no representation as to the accuracy or completeness of such information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared for a particular purpose. Only the party for whom this report was originally prepared and/or other specifically named parties have the right to make use of and rely upon this report. Reuse of this report or any portion thereof for other than its intended purpose, or if modified, or if used by third parties, shall be at the user's sole risk.

Results of any investigations or testing and any findings presented in this report apply solely to conditions existing at the time when ARCADIS' investigative work was performed. It must be recognized that any such investigative or testing activities are inherently limited and do not represent a conclusive or complete characterization. Conditions in other parts of the Site may vary from those at the locations where data were collected. ARCADIS' ability to interpret investigation results is related to the availability of the data and the extent of the investigation activities. As such, 100% confidence in environmental investigation conclusions cannot reasonably be achieved.

ARCADIS, therefore, does not provide any guarantees, certifications, or warranties regarding any conclusions regarding environmental contamination of any such property. Furthermore, nothing contained in this document shall relieve any other party of its responsibility to abide by contract documents and applicable laws, codes, regulations, or standards.

1.0 INTRODUCTION AND OBJECTIVES

On behalf of the City of Oakland, ARCADIS prepared this report presenting results from a human health risk assessment (HHRA) and ecological screening evaluation for the Municipal Services Center (MSC) located at 7101 Edgewater drive in Oakland California ("the Site"; Figure 1).

The primary objective of this work was to perform a HHRA and an ecological screening evaluation for the Site. This included estimating human health risks for current site workers and potential future construction workers. In addition, ecological screening criteria were used to evaluate whether the estimated entrance concentrations of identified chemicals in groundwater flowing into the Oakland Harbor could be an ecological concern. The Regional Water Quality Control Board (RWQCB) Environmental Screening Levels (ESLs) for the protection of marine habitat were selected as the screening ecological benchmarks.

2.0 SITE SETTING AND BACKGROUND

The approximately 17-acre Site is currently owned by the Port of Oakland and is leased by the City of Oakland for use as a corporation yard. Prior to filling, the Site was originally part of a waterfront tidal marsh. The majority of the filling activities occurred between 1959 and 1971, when the MSC was constructed. A detailed site history was published by Baseline Environmental Consulting ("Baseline") in the report "Site History and Characterization," dated January 2001 (Baseline 2001). Figure 2 presents the current and the historical shoreline.

The Site has been the subject of numerous environmental investigations beginning in about 1989. The suspected sources of on-site contamination include releases from underground storage tanks (USTs), gasoline and diesel fuel hydrant systems, and the floor drain waste collection pits formerly located adjacent to Building No. 5. At one time there were 14 petroleum USTs reported at the Site. In addition, some or all of the material used to fill the Site may have been composed of waste material or contaminated fill. A comprehensive investigation conducted by Baseline in 2000 identified the existence of free-phase petroleum hydrocarbon product in four separate areas of the Site. These four areas are labeled Plumes A through D on Figure 3. Baseline's investigation is documented in the "Site History and Characterization Report" (Baseline 2001).

Groundwater monitoring was conducted quarterly from the fourth quarter of 1989 through the third quarter of 2002, and then semiannually to the present. Shallow groundwater levels vary between approximately 2 and 10 feet below ground surface (bgs), and are partially subject to tidal influence. Throughout much of the Site, shallow groundwater flows to the southwest - to the nearest shoreline along San Leandro Bay. In the northern portion of the Site, groundwater flows in a more northerly direction toward the curving shoreline and Damon Slough (LFR 2009).

Pilot-scale groundwater/soil-vapor dual-phase extraction (DPE) tests were conducted in 2002 to assess enhancing the removal of free-phase petroleum product from Plumes A through D. Extracted groundwater was treated on site through two 2,000-pound granular activated carbon units connected in series and discharged to the on-site storm drain in accordance with a National Pollutant Discharge Elimination System (NPDES) permit granted by the San Francisco Bay Regional Water Quality Control Board (NPDES Permit No. CAG912002). Based on the pilot test results, a full-scale product recovery and DPE system for Plumes C and D was installed and operated from May 2006 through December 2009. Chemical oxidation and enhanced bioremediation through periodic injections of hydrogen peroxide have been implemented at Plumes A and B since July 2004 (OTG 2010).

Work to date has emphasized site characterization and remediation. Soil and groundwater data generated through these efforts were compiled and entered into a Microsoft Office Access database. As part of evaluating whether the remedial efforts are sufficient and if the Site is appropriate for environmental closure, an HHRA and an ecological screening evaluation were performed. Therefore, relevant and appropriate data in the Microsoft Office Access database were used to assess for potential human health and ecological risks that could be associated with residual chemicals at this Site. The results will be used to evaluate whether the remediation has successfully reduced health and ecological concerns and the Site is appropriate for environmental closure.

3.0 RISK ASSESSMENT METHODOLOGY

The objectives of the risk evaluation were twofold. The first objective was to estimate human health risks to current site workers and potential future construction workers. The second objective was to perform an ecological screen with the estimated entrance concentration from the groundwater migrating to the harbor. The HHRA included the following specific tasks:

- Task 1: Data Evaluation, Data Validation, and Selecting the Chemicals of Potential Concern (COPCs)
- Task 2: Exposure Assessment
- Task 3: Toxicity Assessment
- Task 4: Risk Characterization

The HHRA was performed in compliance with the following guidelines:

- U.S. Environmental Protection Agency (U.S. EPA). 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Volume 1, Part A. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.
- California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC). 1996. Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.

State of California, Environmental Protection Agency, Department of Toxic Substances Control, Office of the Science Advisor. July.

- Cal-EPA. 2005. Guidance for the Evaluation and Migration of Subsurface Vapor Intrusion into Indoor Air. February.
- California Office of Environmental Health Hazard Assessment (OEHHA). 2009. California Cancer Potency Factors: Update. California Office of Environmental Health Hazard Assessment, Standards and Criteria Work Group. Sacramento, California. September.
- Cal-EPA DTSC. 2009. Interim Guidance, Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH).

4.0 DATA EVALUATION, DATA GAPS IDENTIFICATION, AND SELECTING THE CHEMICALS OF POTENTIAL CONCERN

ARCADIS used the relevant and appropriate data in the database generated by Baseline and provided to the City of Oakland on February19, 2008. These data consist of soil and groundwater results from environmental investigations conducted from 1995 through 2007. After ARCADIS received the electronic data, they were evaluated for quantitative assessment. Table 1a presents a summary of the organic soil data, Table 1b presents the metal results in soil, and Table 1c presents the groundwater quality data.

The soil data was initially considered for zero to 10 feet bgs for contact with construction workers and 0 to two feet bgs for contact with commercial workers. However, based on the data provided by the City of Oakland, only two soil samples were collected between 0 and 2 feet bgs. Therefore, for commercial/industrial receptors, soils were evaluated considering the 0 to 5 feet bgs depth. The 0 to 5 feet bgs data set provided sufficient representation.

Metals

The analytical results for metals in soil are presented in Table 1b. Metals are naturally occurring and are selected for risk evaluation if they are present at concentrations greater than their respective background concentrations. DTSC School Site Evaluation protocol for the determination of background metals was used to identify the metals potentially present at greater than background concentrations.

CAM 17 metals were selected as COPCs using the following methodology:

Step 1. The highest individual metal concentration detected on the Site was compared to the highest background concentration for the individual metal. Background concentrations were obtained from the document “Analysis of Background Distributions of Metals in the Soil at Lawrence Berkeley National Laboratory” published in 2009. If the site concentration was equal to or less than the background concentration for that metal, and if the highest site concentration was below the concentration associated with unacceptable risk or hazard, then the metal was

eliminated as a COPC. If the on-site maximum concentration for an individual metal was greater than the background maximum concentration for that metal, then further evaluation was performed as described below.

Each metal was eliminated at this step with the exception of barium, copper, lead, and zinc.

The evaluation for these four metals proceeded to Step 2.

Step 2. The site and background 90th percentile concentrations were compared. (Table 1b also presents background and 90th percentile concentrations.) If they were comparable, and if the highest site concentration was below the concentration associated with unacceptable risk or hazard, the metal was eliminated as a COPC. None of the metals were eliminated at this step. Barium, copper, lead, and zinc were evaluated to Step 3.

Step 3. For each of the remaining metals, log-transformed data are plotted against probability distribution that is expressed as standard deviation from the mean distribution. The probability of each data point is based on the rank order of the data and assumes the data is log-normally distributed. Best fit lines are drawn, based on the scatter plot. Each discernible line represents a distinct population. The lower concentration population is assumed to represent background, and the early line slope change is assumed to represent the separation between background concentration and an anthropogenic concentration. If the background concentrations were to include all the data and fit a log-normal distribution, this line would plot as a straight line with no inflection point. Therefore, the inflection point indicates a change in the distribution of the data. Based on the statistical plot, barium, copper, lead, and zinc appear to be at background concentrations. In addition, lead is below the 320 milligrams per kilogram level of concern for a commercial setting published by OEHHA in September 2009 (OEHHA 2009a). Metals were not selected as COPCs, therefore, additional evaluation considering metal in soil was not performed.

Organic Compounds

Initially, each detected analyte was considered to be a COPC. COPCs in soil were evaluated considering direct receptor contact and inhalation of airborne particulates. Groundwater was evaluated considering direct contact to construction workers, inhalation of volatile organic compounds (VOCs) via vapor transport from groundwater to commercial workers, and potential ecological impact. TPH was evaluated using the methods described in the DTSC document "Interim Guidance, Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH)," dated June 16, 2009. This involves evaluation of TPH toxicity according to specific detected carbon fractions. Each COPC in soil with greater than 5% detection frequency was selected for risk evaluation. The occurrence and distribution of the COPCs in soil are presented in Table 2. The following COPCs in soil were selected for the construction worker evaluation:

- 1,2,4-trimethylbenzene (1,2,4-TMB)

- 1,3,5-trimethylbenzene (1,3,5-TMB)
- 2-methylnaphthalene
- acetone
- benzene
- **benzo(a)anthracene**
- **benzo(a)pyrene**
- **chrysene**
- ethylbenzene
- **fluoranthene**
- **fluorene**
- isopropylbenzene
- methyl ethyl ketone
- methyl tertiary-butyl ether
- naphthalene
- n-butylbenzene
- n-propylbenzene
- **phenanthrene**
- **phenol**
- **pyrene**
- sec-butylbenzene
- toluene
- total xylenes
- TPH aliphatic and aromatic fractions

The COPCs in **bold** are PAHs. The source of these PAHs is likely associated with the imported fill material and does not appear to be related to the fueling operations. Accumulative estimated cancer risks and hazards were calculated considering exposures to fuel-related compounds and PAHs separately.

The following COPCs in soil were selected for the construction worker evaluation:

- benzene
- ethylbenzene
- **fluorene**
- naphthalene

- **phenanthrene**
- toluene
- total xylenes
- TPH aliphatic and aromatic fractions

The COPCs in **bold** are PAHs. The source of these PAHs is likely associated with the imported fill material and does not appear to be related to the fueling operations. Accumulative estimated cancer risks and hazards were calculated considering exposures to fuel-related compounds and PAHs separately.

Groundwater

Groundwater data collected in monitoring wells from 2004 until 2009 were used to represent current ambient groundwater conditions. In addition, data from recovery wells were not included in the statistical evaluation. The recovery wells are designed to extract groundwater as part of the groundwater remediation system. They are not necessarily designed for the collection of representative groundwater samples. Therefore, the analytical results from the groundwater wells designated for extraction could potentially bias the statistical evaluation and were not included in the groundwater representative concentrations.

Each COPC detected in groundwater samples collected from monitoring wells was included in the risk evaluation. Consistent with U.S. EPA and DTSC guidance, specific individual toxic and volatile components detected within petroleum were evaluated. Exposure to TPH (as a complex multi-component mixture) was evaluated per the methodology presented in "Interim Guidance, Evaluating Human Health Risks form Total Petroleum Hydrocarbons (TPH)" (DTSC 2009). The occurrence and distribution of the COPCs in groundwater are presented in Table 3. The following COPCs in groundwater were selected:

- benzene
- ethylbenzene
- methyl tertiary-butyl ether (MTBE)
- toluene
- total petroleum hydrocarbon as diesel (TPH-D)
- total petroleum hydrocarbon as gasoline (TPH-G)
- total petroleum hydrocarbon as kerosene (TPH-K)
- total petroleum hydrocarbon as motor oil (TPH-MO)
- total xylenes

Surface Water

To estimate potential risks associated with surface-water contact for the hypothetical ecological receptors, groundwater data were used in a dilution calculation to estimate entrance concentrations into the Oakland Harbor. A 10% mixing dilution attenuation factor (DAF) was considered. DAFs are commonly applied in evaluating groundwater discharge to surface water. The 10% DAF considers both mixing and biodegradation of the COPCs during transport from the wells to the harbor. The DAF of 10% is extremely conservative, as it is likely that additional mixing and dilution occurs within the vicinity of the harbor due to the observed tidal fluctuations.

5.0 EXPOSURE ASSESSMENT

The exposure assessment describes how receptors could potentially come into contact with COPCs. As previously stated, the evaluation will consider the potential source of the COPC. The objectives of the exposure assessment are to:

- identify and estimate potential exposure pathways to individuals who may come in contact with COPCs originating at the Site
- characterize potentially exposed populations
- estimate the extent of exposure
- estimate the exposure point concentration (EPC) for each COPC

The exposure assessment followed the U.S. EPA and DTSC risk assessment guidelines and methods. U.S. EPA guidance documents (U.S. EPA 1989) identify four primary tasks for an exposure assessment, as discussed below.

The first task of the exposure assessment was to identify potentially exposed human and aquatic populations that may come in contact with the COPCs. This required knowledge of (and/or making reasonable assumptions regarding) populations that may have access to or adjoin the Site in the future. The second task was to identify relevant exposure pathways for identified human and aquatic populations, by which potentially exposed populations may contact environmental media containing residual chemicals originating from the Site. The third task required estimation of EPCs at the points of potential human contact for all COPCs identified at the Site. EPCs are the concentrations used to represent the COPCs in the cancer and noncancer risk estimations.

The fourth task required estimating chronic daily intakes (CDIs) for exposure routes and potentially exposed populations. A CDI is a receptor's daily dose of a COPC averaged either over a lifetime for carcinogenic chemicals or over the exposure duration for noncancer causing chemicals. CDIs are calculated for each COPC under the exposure scenarios. The CDIs are derived using the EPC and reasonable maximum exposure (RME) assumptions regarding such variables as exposure duration, inhalation rate, and other parameters that describe human activities. The exposure assumptions

and methodologies for each task included in the exposure assessment are discussed below.

The RME is defined as "the highest exposure that is reasonably expected to occur at the site" (U.S. EPA 1989) and, as such, represents an upper-bound estimate of potential exposures. The RME case uses U.S. EPA and DTSC default exposure parameters (U.S. EPA 1989, 1997; DTSC 1996). The RME approach of assessing exposure relies upon "conservative" (i.e., a value well above the average but still within the range of possible values) or "reasonable worst case" assumptions for some or all of the exposure parameters. RMEs are estimated for each individual pathway. As a result of compounding high-end estimates for individual variables, this technique can also result in estimates that are much higher than would be expected for the potentially exposed populations.

5.1 Identification of Potentially Exposed Human Populations

Potentially exposed populations were identified based on consideration of the general land use as recommended in U.S. EPA and DTSC guidance (U.S. EPA 1989, DTSC 1996). The HHRA evaluated potential human health risks for the most sensitive potential receptors at the Site under current and reasonably foreseeable future land-use conditions, which includes scenarios for the following potential receptors:

- hypothetical construction workers
- future commercial/industrial worker

In addition, an ecological health screen was also performed for aquatic receptors potentially exposed to COPCs migrating off site and into the harbor. The benchmarks California Toxic Rule (CTR), the RWQCB ESL for the protection of estuaries, and the ESL for the protection of consuming fish were used for the screen.

Identification of Relevant Exposure Pathways

U.S. EPA and DTSC risk assessment guidance documents were used to identify relevant exposure pathways. The U.S. EPA describes exposure pathways consisting of four necessary elements (U.S. EPA 1989):

- a source and mechanism of chemical release
- a retention or transport medium (or media in cases involving media transfer)
- a point of potential human contact with the contaminated medium (referred to as an exposure point)
- an exposure route (for example, inhalation) at the exposure point

A pathway is considered "complete" only if these four conditions occur. The land use, affected media, and COPCs were used to identify the exposure pathways and receptors to evaluate in the HHRA. The complete exposure pathways for each identified receptor

are presented below:

Hypothetical construction worker:

(1) incidental soil ingestion
(2) dermal contact with soil
(3) inhalation of airborne particulates generated during soil intrusive activities
(4) direct contact with groundwater while performing subsurface intrusive activities

The hypothetical construction worker exposure assumptions are presented in Table 4a. The site conceptual model presenting the complete exposure pathways to the hypothetical construction worker are presented on Figure 4.

Commercial/industrial worker:

(1) incidental soil ingestion
(2) dermal contact with soil
(3) inhalation of airborne particulates generated during soil intrusive activities
(4) inhalation of vapors migrating from the subsurface

The hypothetical commercial/industrial worker exposure assumptions are presented in Table 4b. The site conceptual model presenting the complete exposure pathways to the hypothetical commercial/industrial worker are also presented on Figure 4.

Aquatic Organisms:

(1) acute and chronic contact with the estimated entrance concentration of groundwater migrating from the Site into the Oakland Harbor surface water

5.2 Statistical Evaluation

The data for soil and groundwater were evaluated to develop the EPC for each selected COPC. Statistical data distributions and the 95% upper confidence level (UCL) of the mean were calculated using the U.S. EPA public domain software ProUCL 4.00.2. As directed in the ProUCL guidance document, only the detected concentrations were used in the statistical evaluations. Duplicate samples were not included in the data set for each media. Also, per U.S. EPA guidance (U.S. EPA 1989), the lower of either the 95% UCL or the maximum concentration was selected as the soil EPC. In addition, COPCs with fewer than six detections were not evaluated statistically. Following U.S. EPA guidance, in these cases, maximum concentrations were used as the EPC. EPCs in this evaluation are presented in Tables 5a through 5e.

5.3 Estimating Chemical Intake

The dose of a COPC is quantified by estimating a CDI, which is defined as the mass of substance taken into the body per unit of body weight per unit of time. CDIs are

calculated using exposure parameters that represent the duration of exposure, frequency of exposure, and other factors that affect overall chemical dose. For any route of exposure, the calculated CDI is the product of the concentration (C) in media (e.g., soil vapor), the intake rate (IR), the exposure duration (ED), and the absorption efficiency (AE; fraction absorbed into the blood and tissue), divided by body weight (BW) and averaged exposure time (AT). This is expressed as follows:

$$CDI = \frac{(C) \times (IR) \times (ED) \times (AE)}{BW \times AT}$$

C refers to the EPC. EPCs were developed for each COPC quantitatively evaluated through the risk assessment process. The indoor air inhalation EPC was estimated using the U.S. EPA Advanced Johnson & Ettinger vapor transport model (U.S. EPA 2004). Groundwater data was used as the source concentration in the Johnson & Ettinger model.

IR refers to the intake rate; ED refers to exposure duration (the length of time the contact lasts; e.g., 25 years for the commercial scenario); BW is the body weight; and AT is the averaging time. This is 70 years for carcinogenic evaluation, and is equal to the exposure duration for the noncarcinogenic health hazard evaluation. Intake rates consider ingestion, dermal contact, and inhalation of affected media. For this evaluation, the affected media could include soil, harbor water, indoor air, and tissue from aquatic organisms.

The AE is the fraction of a COPC at an outer boundary of the human body that is likely to be absorbed into blood and tissue once contact occurs. To be conservative, absorption was assumed to be 100%.

5.3.1 Construction Worker

The construction worker receptors are assumed to work 8 hours per day, 250 days per year, for 1/2 year. Six months was selected as the exposure duration because the Site is currently developed as the primary maintenance and service yard for the City of Oakland. Based on conversations with City of Oakland employees, the MSC will keep its current function as it is essential to the City. Construction activities would only consist of improvements or maintenance. These type of activities would be likely complete within a few weeks, and at the most months. In addition, approximately 40 years ago, the City of Oakland entered into a 99-year lease for the property. This equates to the site use remaining unchanged for at least another 50 years. Therefore, the 6 month exposure duration is sufficiently conservative for the hypothetical construction worker.

The construction worker receptor is assumed to be exposed via direct contact with groundwater, incidental ingestion, direct dermal contact with soil, and inhalation of airborne particulate emissions. However, inhalation of VOCs sorbed to soils is assumed to be insignificant and is not quantitatively evaluated. An incidental soil

ingestion rate of 330 milligrams per day (mg/day) and an inhalation rate of 2.5 cubic meters per hour (m^3/hour) are assumed (DTSC 1996). A summary of the input parameters is also presented in Table 4a.

5.3.2 Commercial/Industrial Worker

The commercial/industrial worker receptor serves as a conservative model for the type of worker that may currently exist at the Site, including security guards. The on-site commercial/industrial worker receptors are assumed to work 8 hours per day, 250 days per year, for 25 years (DTSC 1996).

The commercial/industrial worker receptor is assumed to be exposed via incidental ingestion, direct dermal contact with soil, and inhalation of airborne particulate emissions. However, inhalation of VOCs sorbed to soils is assumed to be insignificant and is not quantitatively evaluated. An incidental soil ingestion rate of 50 mg/day and an inhalation rate of 1.7 m^3/hour for an 8-hour workday (14 m^3/workday) will be used (DTSC 2005). The average body weight of a commercial/industrial worker is assumed to be 70 kilograms (kg; DTSC 1996). The skin surface contact area for the worker is assumed to be 2,000 square centimeters per day (cm^2/day; DTSC 1996).

A summary of the input parameters is also presented in Table 4b.

5.4 Aquatic Organism Evaluation

Potential health risks to aquatic organisms were evaluated by comparing the estimated entrance concentrations to the screening criteria for the protection of marine habitat. The Bay Area Regional Water Quality Control Boards Environmental Screening Levels for "Marine Aquatic Habitat Goals presented in Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater" (RWQCB 2008), were used for this evaluation. The marine aquatic habitat goals were selected to be protective of marine organisms considering chronic exposures.

5.5 Adult Recreational Fishing

Estimated health risks to the adult recreational fishing receptor were evaluated by comparing the estimated entrance concentrations to the screening criteria for the protection of fish consumption. The CTR values were used as the screening criteria (40 CFR Part 131: Water Quality Standards; Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California: Federal Register, May 18, 2000). The CTR values were developed considering the potential accumulation of chemical in aquatic organisms and subsequent consumption by humans.

6.0 RISK CHARACTERIZATION

6.1 Consideration of Carcinogenic Endpoints

The hypothetical estimated cancer health risks will be calculated using standard exposure assumptions and DTSC-approved toxicity factors.

The following equation will be used to calculate the potential lifetime excess incremental cancer risk:

Lifetime Excess Cancer Risk = (CDI) × (CPF)

Cancer potency factors (CPFs), which are a measure of the potential for a chemical to produce a carcinogenic effect, will be obtained from the following source:

- California Cancer Potency Factors (OHHEA 2009, Table 6a)

Quantification of potential carcinogenic risk is expressed in terms of probability or the likelihood of an incremental cancer risk. For example, a potential incremental cancer risk of 1×10^{-6} represents a one-in-one-million probability of developing cancer. DTSC's residential exposure target risk is 1×10^{-6}. Estimated risks above this target threshold are considered to potentially pose an unacceptable health risk.

6.2 Consideration of Noncarcinogenic Endpoints

The hypothetical estimated noncancer health risks will be calculated using standard exposure assumptions and U.S. EPA-approved toxicity factors.

The following equation will be used to calculate noncancer adverse health effects (referred to as the hazard quotient [HQ]):

HQ = CDI/(RfD)

Reference doses (RfDs), which are a measure of the potential for a chemical to produce an adverse health effect other than cancer, were obtained from the following sources:

- California Reference Concentrations (OEHHA 2009b)
- U.S. EPA Regional Screening Levels (U.S. EPA 2009a)
- DTSC for TPH toxicity information (DTSC 2009)

The RfDs are presented in Tables 6b and 6c.

6.3 Vapor Intrusion Pathway to the Commercial Worker

The DTSC version of the Johnson & Ettinger model was used to estimate potential

vapor transport and intrusion at the Site. The Johnson & Ettinger model incorporates two primary transport mechanisms: (a) diffusion of VOCs from soil gas to an area near a building foundation, and (b) advective transport from the foundation into the building's interior. After the model estimates indoor air concentrations, it subsequently estimates health risks associated with exposure to the affected indoor air. Health risks to a future commercial/industrial population were evaluated and compared to the DTSC target health risk of one excess cancer case in a million or 1×10^{-6}.

Default soil physical parameters associated with sandy clay were used in the model. Building-specific defaults were incorporated into the modeling effort such as slab thickness and ventilation exchange rates. TPH-G was modeled using the chemical information provided in the DTSC TPH evaluation guidance manual (DTSC 2009).

The 95% UCL in groundwater was used as the source concentration in the modeling. An example of the Johnson & Ettinger model is presented in Appendix A.

6.4 Total Estimated Cancer Risk and Chronic Noncancer Health Hazard

The total estimated cancer risk is compared to the risk range that the U.S. EPA considers safe and protective of public health (one in one million to one in ten thousand excess cancer incidents; U.S. EPA 1989). In accordance with DTSC guidance (DTSC 1996), calculated risks for residential exposure scenarios are compared to the value of one in one million (1×10^{-6}). The chronic noncancer health hazard risks were compared to an acceptable noncancer risk threshold corresponding to a hazard index of 1. However, the cumulative risks and HI will also be evaluated.

The risk characterization section will also include a discussion of the uncertainties inherent to the HHRA process. Primary concern will be given to the impact of uncertainties identified from the noncarcinogenic HI and from cancer risk estimates.

7.0 RESULTS AND CONCLUSIONS

Potential risks and hazards to hypothetical commercial/industrial workers and construction workers were conservatively estimated using data provided by the City of Oakland in a database. This assessment was performed to provide information for the risk management decision process only and does not represent actual exposure conditions. A summary of the estimates on a receptor basis is presented in Tables 7a through 8b. Table 9 presents the overall results. The estimated risks are compared to the DTSC acceptable one in a million cancer risk (1×10^{-6}) and the hazard index of 1. Estimated cancer risks below the 1×10^{-6} and an estimated HI below 1 are not considered to be health concerns by DTSC.

7.1 Hypothetical Construction Worker

The estimated cancer risk and hazard index for the hypothetical construction worker are presented in Tables 7a and 7b and are summarized below. The construction

activities would not be associated with increased cancer risk and other adverse health effects to the hypothetical construction workers based on exposures to soil without the PAHs. However, construction activities would be associated with increased cancer risk and other adverse health effects to the hypothetical construction workers based on exposures to soil considering the contribution from the PAHs. Benzo(a)pyrene was the only PAH with an estimated risk above the regulatory target. Benzo(a)pyrene was only detected in two samples in the 22 samples analyzed. Based on risk assessment guidance, the maximum detected concentration is used in the risk assessment modeling. This is highly conservative and likely does not represent actual exposure conditions.

Estimated Risk and Hazard Index – Hypothetical Construction Worker

Exposure Scenario	Total Estimated Carcinogenic Risk without PAHs	Total Estimated Carcinogenic Hazard Index without PAHs	Total Estimated Cancer Risk with PAHs	Total Estimated Carcinogenic Hazard Index with PAHs
Construction Worker	3.E-07	7.E-01	1.E-06	7.E-01
Commercial/Industrial Worker	1.E-06	1.E-01	1.E-06	1.E-01

7.2 Commercial/Industrial Worker

The estimated cancer risk and hazard index for the hypothetical commercial/industrial worker are presented in Tables 8a and 8b and are summarized below. Exposures to residual COPCs by the commercial/industrial worker would not be associated with increased cancer risk and other adverse health effects considering soil with or without the PAHs. The commercial/industrial evaluation is highly conservative and likely does not represent actual exposure conditions. As previously mentioned, the commercial/industrial worker is not expected to come into contact with soils deeper than 5feet bgs. However, because the data set did not contain sufficient representation for the shallow soils, deeper soils were used in the evaluation.

Estimated Risk and Hazard Index – Hypothetical Commercial/Industrial Worker

Exposure Scenario	Estimated Cancer Risk	Estimated Hazard Index
Commercial/Industrial Worker Soil Contact without PAHs	1×10^{-6}	0.1
Commercial/Industrial Worker Soil Contact with PAHs	1×10^{-6}	0.1

7.3 Aquatic Organism Evaluation

Ecological risks were evaluated by screening the estimated entrance concentrations of COPCs in groundwater to the Oakland Harbor. The entrance concentration of the groundwater discharging to the harbor was conservatively estimated by assuming a 10 times DAF from the representative COPC concentrations. Mixing with the harbor water was not considered. The estimated entrance concentration for each COPC in groundwater was below both the protection of aquatic organisms in a marine habitat and the consumption of fish scenario.

7.4 Estimated Risk and Hazard Summary

This assessment was performed to provide information for the risk management decision process only and does not represent actual exposure conditions. The estimated risks are compared to the DTSC acceptable one in a million cancer risk (1×10^{-6}) and the hazard index of 1. Estimated cancer risks below the 1×10^{-6} and an estimated HI below 1 are not considered to be health concerns by DTSC. In addition, the estimated risks and hazards were calculated based on historical fuel-related releases and chemicals of potential concern associated with the historical fill material. Specifically, the PAHs identified in soil could have been associated with the historical fill material.

The results of the risk assessment, summarized below, indicate that concentrations of fuel-related compounds in soil and groundwater do not appear to be at concentrations associated with increased estimated cancer risks and other health hazards considering the exposure scenarios evaluated in this report. Estimated cancer risks and health hazards to the construction worker and commercial/industrial worker were below the DTSC regulatory target of 1×10^{-6} for cancer risk or an HI of 1 for noncarcinogenic health hazard without the additive risks associated with the PAHs exposure.

Summary of Estimated RME Risks

Exposure Scenario	Total Estimated Carcinogenic Risk without PAHs	Total Estimated Cancer Risk with PAHs
Construction Worker	3.E-07	1.E-06
Commercial/Industrial Worker	1.E-06	1.E-06

Notes:
Bold = above regulatory target

Ecological risks were evaluated by screening the estimated entrance concentrations of COPCs in groundwater to the Oakland Harbor. The concentration in groundwater discharging to the harbor surface water was conservatively estimated by assuming a 10 times DAF from the representative COPC concentrations. The estimated entrance concentration for each COPC in groundwater was below both the protection of aquatic

organisms in a marine habitat and the consumption of fish scenario.

8.0 UNCERTAINTIES ASSOCIATED WITH HUMAN HEALTH RISK ASSESSMENT

In the site characterization and this HHRA, assumptions are made regarding some of the gaps in our understanding of the physical aspects of a site and prediction of future exposures and consequent risks from those exposures. These assumptions must be reasonably conservative to be protective of human health but not so conservative as to be outside of the range of probability (DTSC 1996).

This section discusses site-specific topics where a potential lack of information resulted in an action or assumption that may have contributed to underestimating or overestimating the risks.

8.1 Uncertainties Related to the Fill Material

All available soil data collected historically at the Site were initially considered. Only results of unknown quality, outside the depth range of interest (maximum depth of 10.5 ft bgs), were omitted from the soil data set. This approach is conservative because it does not take into account the natural attenuation that has occurred since the samples were collected (some as early as 1987). Given the COPCs at this Site, using older data likely overestimates risk.

Only data collected from discrete sampling points were used for this evaluation. This means that only groundwater data generated from groundwater wells were considered.

8.2 Uncertainties Related to the Exposure Assessment

Soil data collected to 5ft bgs were included in the data set for the commercial/industrial worker, even though the commercial worker is unlikely to contact soil at this depth. Since this depth is deeper than soils typically used to characterize commercial worker exposure, including it overestimates risk to the commercial worker.

Predictions of chemical concentrations in the environment are required when conditions at the Site or other circumstances make it infeasible to collect environmental samples. Transport modeling was employed to estimate the potential for soil-vapor to move from groundwater to indoor air. Uncertainties are associated with the Johnson & Ettinger model. Default parameters used in models are often based on values that will produce a conservative estimate. The uncertainty introduced by the vapor transport model and the air dispersion models used in the risk assessment for the Site is considered to be high. These models are likely to have overestimated the overall risk.

Numerous conservative assumptions were made in selecting the exposure parameters employed in this assessment. In general, this approach was used as a health-conservative bias, particularly where uncertainty in the estimate may be greater than

satisfactory to characterize a given factor or parameter. Exposure factors such as exposure duration, exposure frequency, and breathing rate were intended to represent the average exposures that an individual may encounter at the Site, yet these values may never actually be realized. The magnitude of the effect of these uncertainties is considered moderate. Actual exposures are likely to be lower than assumed in this assessment.

8.3 Uncertainties in Toxicological Data

Several aspects of the toxicological data employed in this HHRA contain a high degree of uncertainty that may result in an overestimation of potential risk. These uncertainties arise from the following two primary areas.

First, the toxicity factors used in this assessment, which are established by state and federal policy, are deliberate overestimates of the potential dose-response. This means that actual risks are not likely to be higher than the potential risk estimates calculated in this assessment, but may be considerably lower.

Second, the results of animal studies are often used to predict the potential human health effects of a chemical. Extrapolation of toxicological data from animal tests is one of the largest sources of uncertainty. Because of these uncertainties, toxicological data parameters are usually very conservative to be more protective of human health. That conservative aspect has been incorporated into this HHRA. The uncertainties associated with intraspecies extrapolation are offset by safety factors the U.S. EPA uses when estimating toxicity values. The safety factors used by the U.S. EPA typically range from two to three orders of magnitude (100 to 1,000 times), depending on various aspects of the animal study.

8.4 Uncertainties in Risk Characterization

Chemical-specific risks are generally assumed to be additive (U.S. EPA 1989). Noncancer hazards are thought to be additive if they act on the same target organ. This oversimplifies the fact that some constituents may act synergistically ($1 + 1 > 2$) or antagonistically ($1 + 1 < 2$). The overall effect of these mechanisms on multi-chemical, multi-media risk estimates is difficult to determine, but the effects are usually assumed to balance.

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Table 1a
Organic Chemicals Detected in Soil
MSC, Oakland, California
all concentrations in milligrams per kilogram (mg/kg)

Analyte	Number of Samples	Number of Detections	Detection in Top 5 Feet BGS	Detection in 0 to 10 feet BGS	Maximum Detection in Top 5 Feet BGS	Maximum Detection in 0 to 10 Feet BGS
METHYLENE CHLORIDE	33	1	--	1	--	0.66
P-ISOPROPYLTOLUENE	29	1	--	1	--	0.012
2-CHLOROTOLUENE	29	1	--	1	--	0.033
DIBENZOFURAN	22	1	--	1	--	0.21
DIBENZ(A,H)ANTHRACENE	22	1	--	1	--	0.87
BENZO(K)FLUORANTHENE	22	1	--	1	--	2
BENZO(A)ANTHRACENE	22	1	--	1	--	2.5
BIS(2-ETHYLHEXYL) PHTHALATE	22	1	--	1	--	0.94
BENZO(G,H,I)PERYLENE	22	1	--	1	--	1.7
INDENO(1,2,3-C,D)PYRENE	22	1	--	1	--	1.6
TERT-BUTYL METHYL ETHER	167	10	1	9	0.016	8.7
CHRYSENE	22	2	--	2	--	4.1
BENZO(A)PYRENE	22	2	--	2	--	3.5
FLUORANTHENE	22	2	--	2	--	2.1
BENZO(B)FLUORANTHENE	22	2	--	2	--	2.9
PHENOL	9	1	--	1	--	0.11
N-BUTYLBENZENE	35	4	--	4	--	4.1
ISOPROPYLBENZENE	34	4	--	4	--	1.5
PYRENE	22	3	--	3	--	2.9
SEC-BUTYLBENZENE	34	5	--	5	--	0.33
1,3,5-TRIMETHYLBENZENE	35	6	--	6	--	15
FLUORENE	22	4	4	4	1.3	1.3
N-PROPYLBENZENE	35	7	--	7	--	6.7
1,2,4-TRIMETHYLBENZENE	31	7	--	7	--	62
METHYL ETHYL KETONE	29	7	--	7	--	0.26
BENZENE	178	47	12	45	110	110
PHENANTHRENE	22	6	5	6	2.1	2.1
NAPHTHALENE	54	15	4	15	4.4	8.6
TOLUENE	177	54	19	52	100	150
ACETONE	35	11	--	11	--	3.4
ETHYLBENZENE	177	68	20	67	470	470
TPH-K	57	25	4	25	9400	9400
2-METHYLNAPHTHALENE	22	10	5	10	2.1	8.6
TPH-G	148	81	26	80	3100	30000
XYLENES, TOTAL	113	65	24	63	220	992
TPH-MO	107	77	13	77	5200	13000
TPH-D	148	127	36	125	16000	16000

Notes:
BGS = below ground surface
TPH = total petroleum hydrocarbons
D = diesel
G = gasoline
K = kerosene
MO = motor oil

Table 1b
Summary of Metals Detected in Soil
MSC, Oakland, California
all concentrations in milligrams per kilogram (mg/kg)

Sample	ANTIMONY, TOTAL	ARSENIC, TOTAL	BARIUM, TOTAL	BERYLLIUM, TOTAL	CADMIUM, TOTAL	CHROMIUM, TOTAL	COBALT, TOTAL	COPPER, TOTAL	LEAD, TOTAL	MERCURY, TOTAL	MOLYBDENUM, TOTAL	NICKEL, TOTAL	SELENIUM, TOTAL	SILVER, TOTAL	THALLIUM, TOTAL	VANADIUM, TOTAL	ZINC, TOTAL
010597-2-4						38			12			50					80
FDP-100-4																	
MW-5-8		1.5				28.1		89.4	7.9			37.8					92.7
MW-6-7.5		2.1			0.3	43.4		26.3	94			43.4					79.5
MW-7-7		1.4				30.2		81.5	7.3			35.9					104
NCV-1-6	0.84	5.6	140	0.3		33	5.9	19	6.7	0.18	1	42				31	52
S-1-10									8.9								
S-2-10									92								
S-3-10									18								
S-4-10																	
S-5-10									8.1								
S-6-10									6.5								
S-7-8									12								
S-8-8									7.2								
SUMP-N-1-10		3.3	35	0.14	0.43	23	5.7	11	4.2	0.14		21				21	24
SUMP-N-1-5.5		4.5	220	0.39		29	16	74	7.3	0.048		32				67	70
SUMP-N-1A-12.5	1.2	8.2	290	0.47		22	20	150	18	0.7		62				60	150
SUMP-S-1-7	0.53	3.1	14			19	4.1	3.6	1.8			20				18	14
T-1-4									15								
T-2-4									10								
T-3-4									9.4								
T-4-4									8.4								
T-5-4									9.7								
T-6-4									10								
T-7-4									12								
UST7-1-10						26			10			31					84
UST7-1-5.5						41			19			41					68
UST7-2-10.5						50			42			40					67
UST7-2-6						31			7.3			31					33
WCP-E-1-7.5	3.9	3.3	130	0.35		33	7.5	18	10	0.29		35				28	41
WCP-E-2-11	5.5	8.8	400	0.47		17	19	89	19	0.32		45				59	110
WCP-E-3-7.5	9.1	4.1	400	0.49		27	17	65	8.7	0.16		31				45	88
WCP-E-4-7.5	7.7	6.7	360	0.54		29	21	77	11	0.24	0.82	41				47	150
WCP-E-5-7.5	7.5	5	240	0.46		25	14	61	7.4	0.14		33				38	83
WCP-N-B-12	1.6	5.2	130	0.26		31	9	38	130	0.29		33	0.94			62	92
WCP-N-E-7	0.58	9.4	140	0.62		38	12	31	9.9	0.058		37	0.74			44	58
WCP-N-N-7		7.2	230	0.48		26	18	73	11	0.21		35	1.2	0.41		43	100
WCP-N-S-7	0.69	6.2	83	0.42		33	10	26	7.9	0.12	0.45	40				35	51
WCP-N-W-7	0.5	6.6	160	0.56		37	9.6	32	9.9	0.066		35	0.66			41	61
WCP-S-B-7.5	2.8	7.8	450	0.5		27	14	64	7.2	0.19	0.5	29			0.6	44	87
WCP-S-E-6.5	2.6	16	400	0.48		27	18	77	11	0.25	0.9	40				45	87
WCP-S-N-6.5	2.2	6.7	410	0.47		26	17	85	16	0.19	1.4	39				42	97
WCP-S-S-6.5	1	3.1	9.7			24	3.8	4.3	14		3.4	21				15	14
WCP-S-W-6.5	2	7	190	0.5		32	12	41	7	0.14		34				43	64
WCP-W-B-10	1.9	7.4	260	0.42		21	12	48	6.7	0.17	0.56	22			0.61	31	70
WCP-W-E-6.5	1.6	5.8	180	0.54		50	12	35	14	0.14	0.38	55				38	62
WCP-W-N-6.5	2.1	4.6	160	0.43		36	9.3	29	12	0.13	0.33	34				49	48
WCP-W-S-6.5	1.2	3.9	180	0.35		36	7.4	22	6.4	0.1	0.38	35				33	37
WCP-W-W-6.5	1.5	6.1	110	0.52		35	8.1	22	8.3	0.063	0.54	34				37	47

Table 1b
Summary of Metals Detected in Soil
MSC, Oakland, California
all concentrations in milligrams per kilogram (mg/kg)

Sample	ANTIMONY, TOTAL	ARSENIC, TOTAL	BARIUM, TOTAL	BERYLLIUM, TOTAL	CADMIUM, TOTAL	CHROMIUM, TOTAL	COBALT, TOTAL	COPPER, TOTAL	LEAD, TOTAL	MERCURY, TOTAL	MOLYBDENUM, TOTAL	NICKEL, TOTAL	SELENIUM, TOTAL	SILVER, TOTAL	THALLIUM, TOTAL	VANADIUM, TOTAL	ZINC, TOTAL
Notes:																	
Maximum	9.1	16	450	0.62	0.43	50	21	150	130	0.7	3.4	62	1.2	0.41	0.61	67	150
Is max > bg	No	No	**Yes**	No	No	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No	**Yes**
Site Average Concentration			213					50	17								72
Background Average Concentration			130					32	7								64

blank = not analyzed
Background information from Lawrence Berkeley National Laboratory 2009

Table 1c
Resent Groudwater Analytical Results
MSC, Oakland, California
All Concentrations in Microgram per Liter (ugl)

Sample	BENZENE	ETHYL BENZENE	TERT-BUTYL METHYL ETHER	TOLUENE	TPH-D	TPH-G	TPH-K	TPH-MO	XYLENES, TOTAL
MW-10-04052006	2.1	ND	ND	ND	ND	ND	ND	ND	ND
MW-10-04282004	14	6.9	3.5	ND	ND	114	ND	ND	5.2
MW-10-09012005	2.4	ND	ND	ND	ND	110	ND	ND	0.7
MW-10-09062006	ND	ND	ND	ND	98	ND	ND	ND	ND
MW-10-10032007	30	ND	ND	ND	ND	ND	ND	ND	ND
MW-10-3/20/08	3.9	ND	ND	ND	ND	ND	ND	ND	ND
MW-10-11/21/08	11	ND	ND	ND	ND	ND	ND	ND	ND
MW-10-04/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10-10/30/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-1-04042006	470	7.8	ND	13	830	3700	1100	ND	6.3
MW-1-04052007	170	3.6	ND	7.2	500	1500	490	ND	5.7
MW-1-04282004	20	ND	ND	ND	ND	154	ND	ND	2.3
MW-1-09022005	6.6	ND	ND	1	140	350	170	ND	2.3
MW-1-09062006	4.2	ND	ND	1	3400	480	3100	400	1.9
MW-1-10032007	6.1	ND	ND	1.1	600	460	710	ND	1.2
MW-1-10292004	6.4	ND	ND	0.6	230	340	240	ND	1.4
MW-1-3/20/08	53	1.2	ND	4.1	1,000	1,600	960	ND	6.3
MW-1-11/21/08	2.4	ND	ND	0.52	110	210	87	ND	1.3
MW-1-04/01/09	79	2.9	<0.50	6.40	480	1,300	540	ND	5.1
MW-1-10/30/09	59	3.5	<0.50	9.40	810	1,800	820	ND	10.7
MW-1-04042006	ND	ND	ND	ND	58	ND	ND	ND	ND
MW-11-04042006	5.7	14	6.5	0.9	71	230	75	ND	7
MW-11-04052007	9.6	7.3	11	0.73	66	270	55	ND	2.4
MW-11-04282004	18	6.5	4	ND	ND	360	ND	ND	4.5
MW-11-09022005	ND	ND	4.5	ND	ND	85	ND	ND	ND

Table 1c
Resent Groudwater Analytical Results
MSC, Oakland, California
All Concentrations in Microgram per Liter (ugl)

Sample	BENZENE	ETHYL BENZENE	TERT-BUTYL METHYL ETHER	TOLUENE	TPH-D	TPH-G	TPH-K	TPH-MO	XYLENES, TOTAL
MW-11-3/20/08	3.5	5.4	13	ND	ND	160	ND	ND	ND
MW-11-04/01/09	0.98	2.9	13	ND	ND	94	ND	ND	ND
MW-12-04042006	ND	ND	ND	ND	110	110	110	ND	ND
MW-12-04052007	ND	ND	ND	ND	340	160	230	360	ND
MW-12-04282004	ND	ND	ND	ND	ND	ND	ND	1020	ND
MW-12-10022007	ND	ND	ND	ND	290	160	230	ND	ND
MW-12-10292004	ND	ND	ND	ND	240	170	180	460	ND
MW-12-3/20/08	ND	ND	ND	ND	620	130	430	340	ND
MW-12-11/21/08	ND	ND	ND	ND	170	59	120	ND	ND
MW-12-04/01/09	ND	ND	ND	ND	330	100	300	ND	ND
MW-12-10/30/09	ND	ND	ND	ND	280	160	220	ND	ND
MW-13-04052006	ND	ND	ND	ND	180	ND	ND	910	ND
MW-13-04282004	ND	ND	ND	ND	ND	ND	ND	799	ND
MW-13-09062006	ND	ND	ND	ND	150	ND	ND	730	ND
MW-13-10032007	ND	ND	ND	ND	120	ND	ND	460	ND
MW-13-3/20/08	ND	ND	ND	ND	53	ND	ND	ND	ND
MW-13-11/21/08	ND	ND	ND	ND	120	ND	ND	ND	ND
MW-13-04/01/09	ND	ND	ND	ND	110	ND	ND	ND	ND
MW-13-10/30/09	ND	ND	ND	ND	81	ND	ND	ND	ND
MW-14-04042007	ND	ND	ND	ND	100	ND	50	ND	ND
MW-14-04052006	1.7	ND	ND	ND	50	ND	ND	ND	ND
MW-14-04282004	1.4	ND	ND	ND	ND	241	ND	ND	ND
MW-14-09012005	6.7	ND	0.7	ND	ND	79	ND	ND	ND
MW-14-09062006	ND	ND	0.51	ND	140	60	79	ND	ND
MW-14-10032007	ND	ND	ND	ND	61	ND	ND	ND	ND

Table 1c
Resent Groudwater Analytical Results
MSC, Oakland, California
All Concentrations in Microgram per Liter (ugl)

Sample	BENZENE	ETHYL BENZENE	TERT-BUTYL METHYL ETHER	TOLUENE	TPH-D	TPH-G	TPH-K	TPH-MO	XYLENES, TOTAL
MW-14-10282004	3.5	ND	0.5	ND	ND	56	ND	ND	ND
MW-14-3/20/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-14-11/21/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-14-04/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-14-10/30/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-15-04032007	ND	ND	ND	ND	130	ND	63	ND	2.38
MW-15-04052006	ND	ND	ND	ND	300	ND	87	760	2.4
MW-15-04282004	ND	ND	2.8	ND	ND	ND	ND	567	ND
MW-15-09012005	ND	ND	ND	ND	420	55	120	ND	2
MW-15-09062006	ND	ND	ND	ND	220	ND	80	400	2.06
MW-15-10032007	ND	ND	ND	ND	150	55	ND	550	2
MW-15-10282004	ND	ND	ND	ND	ND	ND	ND	ND	2.2
MW-15-3/20/08	ND	ND	ND	ND	88	ND	ND	ND	2.02
MW-15-11/21/08	ND	ND	ND	ND	110	ND	ND	ND	1.78
MW-15-04/01/09	ND	ND	ND	ND	85	ND	ND	ND	0.82
MW-15-10/30/09	ND	ND	ND	ND	110	81	ND	ND	2.41
MW-16-04052006	ND	ND	ND	ND	95	ND	ND	420	ND
MW-16-04282004	150	46	ND	ND	ND	2000	ND	1030	ND
MW-16-10032007	31	4.5	ND	1.7	2300	480	1700	4300	1.6
MW-16-10282004	18	29	ND	1.7	450	1100	480	---	1.7
MW-16-11/21/08	21	2.7	ND	1.7	52,000	150	31,000	110,000	1.1
MW-16-04/01/09	ND	ND	ND	ND	---	59	---	---	ND
MW-16-10/30/09	59	3.1	ND	3.5	5,600	590	4,100	12,000	3.03
MW-17-04282004	ND	2.4	ND	ND	ND	ND	ND	ND	ND
MW-17-3/20/08	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 1c
Resent Groudwater Analytical Results
MSC, Oakland, California
All Concentrations in Microgram per Liter (ugl)

Sample	BENZENE	ETHYL BENZENE	TERT-BUTYL METHYL ETHER	TOLUENE	TPH-D	TPH-G	TPH-K	TPH-MO	XYLENES, TOTAL
MW-17-11/21/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-17-04/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-17-10/30/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2-04042006	2.1	ND	0.5	ND	ND	ND	ND	ND	0.5
MW-2-04052007	1.6	ND	ND	ND	ND	ND	ND	ND	ND
MW-2-04282004	--	ND	ND	ND	ND	ND	ND	ND	1.3
MW-2-09012005	2.8	ND	0.8	ND	ND	ND	ND	ND	ND
MW-2-3/20/08	1.5	ND	ND	ND	ND	ND	ND	ND	ND
MW-2-04/01/09	1.3	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-04052006	14	280	31	2.1	840	3400	850	ND	13
MW-5-04052007	9.3	230	38	ND	340	3100	310	ND	13
MW-5-04282004	34	560	47	ND	ND	4780	ND	ND	44
MW-5-09022005	13	55	92	1.4	510	1600	640	ND	8.6
MW-5-09062006	8.3	8.2	50	1.1	340	2000	400	ND	6.8
MW-5-10022007	11	100	46	1.4	400	3000	440	ND	6.8
MW-5-10292004	18	280	94	2.1	840	3000	940	ND	16.1
MW-5-3/20/08	8.4	270	23	1.7	1,400	4,100	1,400	ND	12
MW-5-11/21/08	11	240	20	1.7	660.00	2,600	690.00	ND	6.5
MW-5-04/01/09	8.8	380	15	2.5	730	4,800	840	ND	13.3
MW-5-10/30/09	5.2	200	23	ND	1,100	3,100	1,100Y	ND	8.1
MW-6-04042007	520	ND	4.5	ND	3300	1400	3000	ND	ND
MW-6-09062006	330	ND	4.8	3.9	180	1300	200	ND	3.7
MW-6-10022007	270	5.5	7.8	3.8	2400	890	2000	340	3
MW-6-3/20/08	500	5.9	7.7	3.5	7,200	1,100	5,900	820	3.1
MW-6-11/21/08	96	< 0.50	5.7	1.9	1,500	450	1,200	ND	1.2

Table 1c
Resent Groudwater Analytical Results
MSC, Oakland, California
All Concentrations in Microgram per Liter (ugl)

Sample	BENZENE	ETHYL BENZENE	TERT-BUTYL METHYL ETHER	TOLUENE	TPH-D	TPH-G	TPH-K	TPH-MO	XYLENES, TOTAL
MW-6-10/30/09	98	3.0	5.0	4.1	1,200	560	1,000	ND	4.76
MW-7-04052006	2.7	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-04052007	ND	ND	2.7	ND	ND	ND	ND	ND	ND
MW-7-04282004	1.6	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-09022005	ND	ND	3.2	ND	ND	ND	ND	ND	ND
MW-7-3/20/08	ND	ND	2.7	ND	ND	ND	ND	ND	ND
MW-7-10/30/09	ND	ND	1.3	ND	ND	ND	ND	ND	ND
MW-8-04052006	ND	ND	ND	ND	54	ND	ND	ND	ND
MW-8-3/20/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-11/21/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-04/01/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-10/30/09	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-9-04032007	27	ND	ND	4.2	180	240	140	ND	5.32
MW-9-04052006	140	ND	ND	5.2	140	160	64	320	4.1
MW-9-09062006	58	ND	ND	5.3	210	240	150	ND	5.68
MW-9-10032007	1	ND	ND	2.4	110	240	110	ND	3.53
MW-9-3/20/08	65	ND	ND	4.2	170	230	150	ND	5.13
MW-9-11/21/08	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-9-04/01/09	82	ND	ND	1.4	130	70	53	380	1.0
MW-9-10/30/09	ND	ND	ND	ND	220	ND	130	ND	0.61

notes:
TPH = total peteroleum hydrocarbon
D = diesel
G = gasoline
K = kerosene
MO = motor oil
ND = not detected above analytical reporting limit

Table 2
Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Soil
MSC, Oakland, California

COPC	Detection Frequency	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Maximum Detected Value Location	Selected as COPC	Rationale for Selection
Methylene Chloride	3%	<0.0017	0.66	MW-3-6.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
P-Isopropyltoluene	3%	<0.0041	0.012	WCP-W-N-6.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
2-Chlorotolune	3%	<0.03	0.033	WCP-W-N-6.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Dibenzofuran	5%	<0.03	0.21	10-W-3.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Dibenz(A,H)anthracne	5%	<0.03	0.87	11-S-9	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Benzo(k)fluoranthene	5%	<0.03	2	11-S-9	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Benzo(A)anthracene	5%	<0.03	2.5	11-S-9	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Bis(2-ethylhexyl)phthalate	5%	<0.03	0.94	11-E1-7.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Benzo(G,H,I)perylene	5%	<0.03	1.7	11-S-9	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
Indeno(,2,3-C,D)pyrene	5%	<0.03	1.6	11-S-9	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
tert Butyl-methyl ether	5%	<0.0041	8.7	2S-D-7.5	No	Sample Size ≥ 20 & Detection Frequency ≤ 5%
1,2,4-Trimethylbenzene	9%	<0.0017	62	B-15-5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
1,3,5-Trimethylbenzene	9%	<0.0017	15	B-15-5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
2-Methylnaphthalene	9%	<0.33	8.6	B-13-3.8	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Acetone	9%	<0.026	3.4	B-14-1	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Benzene	11%	<0.0017	110	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Benzo(a)pyrene	11%	<0.03	3.5	B-10-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Benzo(b)fluoranthene	12%	<0.03	2.9	B-13-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Chrysene	14%	<0.03	4.1	B-13-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Ethylbenzene	15%	<0.0017	470	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Fluoranthene	17%	<0.03	2.1	B-13-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Fluorene	18%	<0.03	1.3	B-12-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Isopropylbenzene (Cumene)	20%	<0.0017	1.5	B-15-5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Methyl Ethyl Ketone	23%	<0.0041	0.26	B-10-3.2	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Naphthalene	24%	<0.0045	8.6	B-15-5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
n-Butylbenzene	26%	<0.0041	4.1	B-13-3.8	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
n-Propylbenzene	27%	<0.0017	6.7	B-15-5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Phenanthrene	28%	<0.03	2.1	B-13-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Phenol	31%	<0.03	0.11	MW-1-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Pyrene	31%	<0.03	2.9	B-13-1.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
sec-Butylbenzene	38%	<0.0041	0.33	B-13-3.8	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Toluene	44%	<0.0017	150	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-D	45%	<4.2	16000	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-G	55%	<3.3	30000	B-13-3.8	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-K	58%	3.7	9400	B-11-3.0	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-MO	72%	<4.2	13000	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Xylenes, total	86%	<0.0033	992	B-16-5.5	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%

Table 2
Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Soil
MSC, Oakland, California

COPC	Detection Frequency	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Maximum Detected Value Location	Selected as COPC	Rationale for Selection

Notes:

COPC = chemical of potential concern

mg/kg = milligrams per kilogram

TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)

TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)

TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)

TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)

TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)

Table 3
Occurrence, Distribution, and Selection of
Chemicals of Potential Concern in Groundwater
MSC, Oakland, California

COPC	Detection Frequency	Minimum Detected Value (mg/l)	Maximum Detected Value (mg/l)	Maximum Detected Value Location	Selected as COPC	Rationale for Selection
Benzene	61%	<0.5	0.52	MW-6-04042007	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Ethylbenzene	32%	<0.5	0.56	MW-5-04282004	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Methyl tert-butyl ether (MTBE)	32%	<0.5	0.094	MW-5-10292004	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Toluene	36%	<0.5	0.013	MW-1-04042006	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-diesel	68%	<1.0	52	MW-16-11/21/08	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-gasoline	61%	<1.0	4.78	MW-5-04282004	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-K	53%	<1.0	31	MW-1-09062006	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
TPH-MO	29%	<1.0	110	MW-16-11/21/08	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%
Xylenes, total	55%	<0.5	0.044	MW-5-04282004	Yes	Sample Size ≥ 20 & Detection Frequency ≥ 5%

Notes:
COPC= Chemical of potential concern
mg/l= Millograms per liter
TPH-diesel= Total petroleum hydrocarbon- diesel (carbon 13-22 range)
TPH-oil= Total petroleum hydrocarbon- oil (carbon 22-40+ range)
TPH-purgeable= Total petroleum hydrocarbon- purgeable (carbon 4-13 range)

Table 4a
Exposure Assumptions for Calculation of Chronic Daily Intake
Construction Worker Scenario
MSC, Oakland, California

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Input Parameters and Model Equation
Ingestion of Soil	CS	Chemical Concentration in Soil	mg/kg	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x IR x CF1 x BF x EF x FT x ED x 1/BW x 1/AT
	IR-S	Ingestion Rate of Soil	mg/day	330	Assumes soil ingestion rate for construction worker (DTSC 1996)	
	CF1	Conversion Factor 1	kg/mg	1.0E-06	Mass conversion factor from milligrams to kilograms	
	BF	Bioavailability Factor	unitless	1	Professional judgment	
	EF	Exposure Frequency	days/year	250	DTSC recommendation	
	FT	Fraction of time in the day at Site	unitless	1	Assumes 8 hours of a 24-hour day	
	ED	Exposure Duration	years	0.5	Site Specific Conditions	
	BW	Body Weight	kg	70	DTSC default value (DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	250	ED times 250 days per year (LFR 2009)	
Ingestion of Groundwater	CS	Chemical Concentration in Surface Water	mg/l	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x IR x BF x ET x EF x ED x 1/BW x 1/AT
	IR-W	Ingestion Rate of Surface Water	l/hour	0.03	One half value for swimmer (EPA 1989)	
	BF	Bioavailability Factor	unitless	1	Professional judgment	
	ET	Exposure Time	hours/day	1	According to Work Plan (LFR 2009)	
	EF	Exposure Frequency	days/year	250	According to Work Plan (LFR 2009)	
	ED	Exposure Duration	years	0.5	Site Specific Conditions	
	BW	Body Weight	kg	70	DTSC default value (DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	250	ED times 250 days per year (LFR 2009)	
Dermal Contact with Soil	CS	Chemical Concentration in Soil	mg/kg	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x SA x CF1 x AF x ABS x EF x FT x ED x 1/BW x 1/AT
	SA	Skin Surface Area	cm^2/day	2000	EPA 1999a	
	CF1	Conversion Factor 1	kg/mg	1.0E-06	Mass conversion factor from milligrams to kilograms	
	AF	Soil-to-Skin Adherence Factor	mg/cm^2	0.1	(EPA 1999, DTSC 1999b)	
	ABS	Dermal Absorption Factor	unitless	0.1	Default value (EPA 1999a)	
	EF	Exposure Frequency	days/year	250	DTSC recommendation	
	FT	Fraction of time in the day at Site	unitless	1	Assumes 2 hours of a 24-hour day (Silvers et al. 1994)	
	ED	Exposure Duration	years	0.5	Site Specific Conditions	
	BW	Body Weight	kg	70	DTSC default value (DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	250	ED times 250 days per year (LFR 2009)	

Table 4a
Exposure Assumptions for Calculation of Chronic Daily Intake
Construction Worker Scenario
MSC, Oakland, California

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Input Parameters and Model Equation
Dermal Contact with Groundwater	CS	Chemical Concentration in Surface Water	mg/l	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x SA x CF2 x PC x ET x EF x ED x 1/BW x 1/AT
	SA	Skin Surface Area	cm^2	2000	DTSC default value (DTSC 1996)	
	CF2	Conversion Factor 2	l/cm^3	1.0E-03	Mass conversion factor from liters to cubic centimeters	
	PC	Dermal Permeability Constant	cm/hour	Chemical specific	DTSC 1999 and Johnson 1998	
	ET	Exposure Time	hours/day	1	According to Work Plan (LFR 2009)	
	EF	Exposure Frequency	days/year	250	According to Work Plan (LFR 2009)	
	ED	Exposure Duration	years	0.5	Site Specific Conditions	
	BW	Body Weight	kg	70	DTSC default value (DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	250	ED times 250 days per year (LFR 2009)	
Inhalation of Airborne Particulates	CA	Chemical Concentration in Vapors and Airborne Particulates	mg/m^3	EPC	Chemical-specific calculated value (see text)	CDI (mg/kg-day) = CA x IR x BF x ET x EF x FT x ED x 1/BW x 1/AT
	IR-A	Inhalation Rate of Air	m^3/hour	2.5	DTSC default value -assumes 20 m^3/day (DTSC 1996)	
	BF	Bioavailability Factor	unitless	1	DTSC default value (DTSC 1996)	
	ET	Exposure Time	hours/day	8	Assumes full work day	
	EF	Exposure Frequency	days/year	250	DTSC recommendation	
	FT	Fraction of time in the day at Site	unitless	1	Assumes 8 hours of a 24-hour day	
	ED	Exposure Duration	years	0.5	Site Specific Conditions	
	BW	Body Weight	kg	70	DTSC default value (DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	250	ED times 250 days per year (LFR 2009)	

Notes:

CDI = chronic daily intake
cm = centimeter
cm^2 = square centimeter
cm^3 = cubic centimeter
DTSC = Department of Toxic Substances Control
EPA = Environmental Protection Agency
EPC = exposure point concentration
kg = kilogram
l = liter
m^3 = cubic meter
mg = milligram
RME = reasonable maximum exposure
UCL = upper confidence limit of the mean

Table 4b
Exposure Assumptions for Calculation of Chronic Daily Intake
Commercial/Industrial Worker Scenario
MSC, Oakland, California

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Input Parameters and Model Equation
Ingestion of Soil	CS	Chemical Concentration in Soil	mg/kg	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x IR x CF1 x BF x EF x ED x 1/BW x 1/AT
	IR-S	Ingestion Rate of Soil	mg/day	50	Default value (EPA 1991, DTSC 1996)	
	CF1	Conversion Factor 1	kg/mg	1.0E-06	Mass conversion factor from milligrams to kilograms	
	BF	Bioavailability Factor	unitless	1	DTSC default value (DTSC 1996)	
	EF	Exposure Frequency	days/year	250	Default value (EPA 1991, DTSC 1996)	
	ED	Exposure Duration	years	25	Default value (EPA 1991, DTSC 1996)	
	BW	Body Weight	kg	70	Default value (EPA 1991, DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	9125	25-year value times 365 days per year (LFR 2009)	
Dermal Contact with Soil	CS	Chemical Concentration in Soil	mg/kg	EPC	95% UCL of mean or maximum detected value (use lesser value)	CDI (mg/kg-day) = CS x SA x CF1 x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Skin Surface Area	cm^2/d	2000	EPA 1999a	
	CF1	Conversion Factor 1	kg/mg	1.0E-06	Mass conversion factor from milligrams to kilograms	
	AF	Soil-to-Skin Adherence Factor	mg/cm^2	0.2	Default value for an adult worker (DTSC 1999)	
	ABS	Dermal Absorption Factor	unitless	0.1	Default value (EPA 1999a)	
	EF	Exposure Frequency	days/year	250	Default value (EPA 1991, DTSC 1996)	
	ED	Exposure Duration	years	25	Default value (EPA 1991, DTSC 1996)	
	BW	Body Weight	kg	70	Default value (EPA 1991, DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	9125	25-year value times 365 days per year (LFR 2009)	
Inhalation of Airborne Particulates	CA	Chemical Concentration in Vapors and Airborne Particulates	mg/m^3	EPC	Chemical-specific calculated value (see text)	CDI (mg/kg-day) = CA x IR x RF x BFx EF x ED x 1/BW x 1/AT
	IR-A	Inhalation Rate of Air	m^3/hour	1.7	14.7 m^3 per work day (DTSC 2005a)	
	RF	Respirable Fraction	unitless	1	DTSC default value (DTSC 1996)	
	BF	Bioavailability Factor	unitless	1	DTSC default value (DTSC 1996)	
	ET	Exposure Time	hours/day	8	EPA default value (EPA 1991)	
	EF	Exposure Frequency	days/year	250	Default value (EPA 1991, DTSC 1996)	
	ED	Exposure Duration	years	25	Default value (EPA 1991, DTSC 1996)	
	BW	Body Weight	kg	70	Default value (EPA 1991, DTSC 1996)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime default value times 365 days per year (EPA 1989)	
	AT-N	Averaging Time (Non-Cancer)	days	9125	25-year value times 365 days per year (LFR 2009)	

Table 4b
Exposure Assumptions for Calculation of Chronic Daily Intake
Commercial/Industrial Worker Scenario
MSC, Oakland, California

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Input Parameters and Model Equation

Notes:

CDI = chronic daily intake

cm^2 = square centimeter

DTSC = Department of Toxic Substances Control

EPA = Environmental Protection Agency

EPC = exposure point concentration

kg = kilogram

m^3 = cubic meter

mg = milligram

RME = reasonable maximum exposure

UCL = upper confidence limit of the mean

Table 5a
Exposure Point Concentrations for Chemicals of Potential Concern in Soil
MSC, Oakland, California

COPC	Data Distribution [a]	Maximum Detected Concentration (mg/kg)	95% UCL of Mean Concentration of Data 0 to 10 ft bgs (mg/kg) [a]	RME Exposure Point Construction Worker Concentration [b] (mg/kg)	95% UCL of Mean Concentration of Data 0 to 5 ft bgs (mg/kg) [a]	RME Exposure Point Industrial/ Commercial Worker Concentration [b] (mg/kg)
1,2,4-Trimethylbenzene	Gamma	62	168.70	62.00	--	--
1,3,5-Trimethylbenzene	Gamma	15	60.51	15.00	--	--
2-Methylnaphthalene	Normal	8.6	6.4	6.40	NA[1]	2.10
Acetone	Nonparametric	3.4	2.44	2.44	--	--
Benzene	Nonparametric	110	42.24	42.24	15.53	15.53
Benzo(a)pyrene	NA[1]	3.5	NA[1]	3.50	--	--
Benzo(b)fluoranthene	NA[1]	2.9	NA[1]	2.90	--	--
Chrysene	NA[1]	4.1	NA	4.10	--	--
Ethylbenzene	Nonparametric	470	125.30	125.30	128.70	128.70
Fluoranthene	NA[1]	2.1	NA[1]	2.10	--	--
Fluorene	NA[1]	1.3	NA[1]	1.30	NA[1]	1.30
Isopropylbenzene (Cumene)	Normal	1.5	1.30	1.30	--	--
Methyl Ethyl Ketone	Nonparametric	0.26	0.12	0.12	--	--
Naphthalene	Normal	8.6	3.61	3.61	4.68	4.68
n-Butylbenzene	Normal	4.1	3.81	3.81	--	--
n-Propylbenzene	Gamma	6.7	5.86	5.86	--	--
Phenanthrene	NA[1]	2.1	NA[1]	2.10	NA[1]	2.10
Phenol	NA[1]	0.11	NA[1]	0.11	--	--
Pyrene	NA[1]	2.9	NA[1]	2.90	--	--
sec-Butylbenzene	Normal	0.33	NA[1]	0.30	--	--
Toluene	Nonparametric	150	108.30	108.30	29.46	29.46
TPH-D	Lognormal	16000	3027.00	3027.00	3245.00	3245.00
TPH-G	Gamma	30000	1658.00	1658.00	1102.00	1102.00
TPH-K	Nonparametric	9400	5127.00	5127.00	8680.00	8680.00
TPH-MO	Lognormal	13000	1355.00	1355.00	2164.00	2164.00
Xylenes, total	Nonparametric	992	909.70	909.70	69.33	69.33

Notes:

a= Data distribution and 95% UCL are based on results of ProUCL 4.0

b= If the 95% UCL value exceeds the maximum detected concentration, the maximum detected concentration is used as the exposure point concentration

COPC= chemical of potential concern

mg/kg= milligrams per kilogram

NA[1] = not applicable; too few detected results for 95% UCL statistical analysis;

per ProUCL guidance, maximum detected value used for representative concentration

RME= reasonable maximum exposure

TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)

TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)

TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)

TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)

TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)

UCL= upper confidence limit of the mean

-- = not selected as a shallow soil COPC

Table 5b
Exposure Point Concentrations for Chemicals of Potential Concern in Groundwater
MSC, Oakland, California

COPC	Data Distribution [a]	Maximum Detected Concentration (mg/l)	95% UCL of Mean Concentration of Data (mg/l) [a]	RME Exposure Point Concentration [b] (mg/l)
Benzene	Lognormal	0.52	0.12	0.12
Ethylbenzene	Nonparametric	0.56	0.34	0.344
Methyl tert-butyl ether (MTBE)	Gamma	0.094	0.03	0.09
Toluene	Gamma	0.013	0.004	0.004
TPH-diesel	Nonparametric	52	5.90	5.90
TPH-gasoline	Nonparametric	4.78	1.99	1.99
TPH-K	Lognormal	31	1.61	1.61
TPH-MO	Nonparametric	110	27.91	27.91
Xylenes, total	Lognormal	0.044	0.01	0.01

a= Data distribution and 95% UCL are based on results of ProUCL 4.0

b= If the 95% UCL value exceeds the maximum detected concentration, the maximum detected concentration is used as the exposure point concentration

COPC= chemical of potential concern

mg/l= milligrams per liter

NA = not applicable; too few detected results for 95% UCL statistical analysis

RME= reasonable maximum exposure

TPH-diesel= total petroleum hydrocarbon- diesel (carbon 13-22 range)

TPH-oil= total petroleum hydrocarbon- oil (carbon 22-40+ range)

TPH-purgeable= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

UCL= upper confidence limit

Table 5c
Exposure Point Concentrations
in Outdoor Ambient Air Dispersed from Soil
MSC, Oakland, California

COPC	Outdoor Ambient Air Exposure Point Concentration (mg/m^3) [a]
1,2,4-Trimethylbenzene	NA
1,3,5-Trimethylbenzene	NA
2-Methylnaphthalene	4.8E-09
Acetone	NA
Benzene	NA
Benzo(a)pyrene	2.7E-09
Benzo(b)fluoranthene	2.2E-09
Chrysene	3.1E-09
Ethylbenzene	NA
Fluoranthene	1.6E-09
Fluorene	9.8E-10
Isopropylbenzene (Cumene)	NA
Methyl Ethyl Ketone	NA
Naphthalene	2.7E-09
n-Butylbenzene	NA
n-Propylbenzene	NA
Phenanthrene	1.6E-09
Phenol	8.3E-11
Pyrene	2.2E-09
sec-Butylbenzene	2.3E-10
Toluene	NA
TPH-D	2.3E-06
TPH-G	NA
TPH-K	3.9E-06
TPH-MO	1.0E-06

Notes:

a = Particulate Emission Factor (1/ 1.32 x 10^9 m^3/kg) is applied to RME EPC in soil to derive EPC in air
COPC= chemical of potential concern
EPC= exposure point concentration
NA = not applicable, only non-volatile compounds used
m^3/kg=cubic meters per kilogram
mg/m^3= milligrams per cubic meter
RME= reasonable maximum exposure
TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)

TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)

TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)

TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)

TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)

Table 5d
Exposure Point Concentrations for Chemicals of Potential Concern in Surface Water
MSC, Oakland, California
all concentrations in milligrams per liter (mg/l)

COPC	Surface-Water Exposure Point Concentration (mg/l) [a]	California Toxic Rule (mg/l)	ESL for Estuary Environment (mg/l)	Protection of Fish Consumption (mg/l)
Benzene	0.0121	0.071	0.046	0.71
Ethylbenzene	0.0344	29	0.043	29
Methyl tertiary-butyl ether (MTBE)	0.0094	NA	8	NA
Toluene	0.0004	200	0.13	200
TPH-diesel	0.5900	NA	0.21	NA
TPH-gasoline	0.1990	NA	0.21	NA
TPH-K	0.1610	NA	0.21	NA
TPH-MO	2.7910	NA	0.21	NA
Xylenes, total	0.0007	NA	0.1	NA

Notes:
a = Surface-water exposure point concentration (EPC) is derived by applying an attenuation factor (0.10) to the representative groundwater concentrations
COPC= chemical of potential concern
ESL = California Regional Water Quality Control Board Environmental Screening Level
mg/l= milligrams per liter
NA= no criteria available
TPH-diesel= total petroleum hydrocarbon- diesel (carbon 13-22 range)
TPH-oil= total petroleum hydrocarbon- oil (carbon 22-40+ range)
TPH-purgeable= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

Table 5e
Exposure Point Concentrations for Chemicals of Potential Concern in Indoor Air
MSC, Oakland, California

COPC	Data Distribution [a]	Maximum Detected Concentration (mg/l)	95% UCL of Mean Concentration of Data (mg/l)	RME Source Concentration [b] (mg/l)	Estimated Indoor Air Concentration [c] (mg/m^3)
Benzene	Lognormal	0.52	0.12	0.12	3.5E-07
Ethylbenzene	Nonparametric	0.56	0.34	0.344	9.0E-08
Methyl tert-butyl ether	Gamma	0.094	0.03	0.09	1.7E-07
Toluene	Gamma	0.013	0.004	0.004	1.1E-08
TPH-diesel	Nonparametric	52	5.90	5.90	NA
TPH-gasoline	Nonparametric	4.78	1.99	1.99	6.0E-06
TPH-K	Lognormal	31	1.61	1.61	NA
TPH-MO	Nonparametric	110	27.91	27.91	NA
Xylenes, total	Lognormal	0.044	0.01	0.01	2.8E-08

Notes:

a= Data distribution is based on results of ProUCL 4.0

b= If the 95% UCL value exceeds the maximum detected concentration, the maximum detected concentration is used as the source concentration for vapor intrusion modeling

c= Estimated indoor air concentration generated from Johnson & Ettinger Vapor Intrusion Model

COPC= chemical of potential concern

RME= reasonable maximum exposure

mg/l= milligrams per liter

UCL= upper confidence limit of the mean

mg/m^3= milligrams per cubic meter

NA = not applicable

Table 6a
Carcinogenic Toxicity Data - Oral and Inhalation
MSC, Oakland, California

COPC	Weight-of-Evidence Classification [a]	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ [b]	Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ [b]	Toxicity Data Reference Source
Groundwater				
Benzene	A	0.1	0.1	CalEPA - OEHHA
Ethylbenzene	B2	1.10E-02	8.70E-03	CalEPA
Methyl tertiary-butyl ether (MTBE)	-	1.80E-03	1.80E-03	CalEPA - OEHHA
Toluene	-			
TPH-diesel	-	-	-	-
TPH-gasoline	-	-	-	-
TPH-K	-	-	-	-
TPH-MO	-	-	-	-
Xylenes, total	-	-	-	-
Soil				
1,2,4-Trimethylbenzene	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-
2-Chlorotoluene	-	-	-	-
2-Methylnaphthalene	-	-	-	-
Acetone	-	-	-	-
Benzene	A	0.1	0.1	CalEPA - OEHHA
Benzo(a)pyrene	B2	12	3.9	CalEPA - OEHHA
Benzo(b)fluoranthene	B2	1.2	0.39	CalEPA - OEHHA
Chrysene	B2	0.12	0.039	CalEPA - OEHHA
Ethylbenzene	-	0.011	0.0087	CalEPA - OEHHA
Fluoranthene	D	-	-	IRIS
Fluorene	D	-	-	IRIS
Isopropylbenzene (Cumene)	D			IRIS
Methyl tertiary-butyl ether (MTBE)	-	0.0018	0.0018	CalEPA - OEHHA
Naphthalene	A	-	0.12	CalEPA - OEHHA
n-Butylbenzene	-	-	-	-
n-Propylbenzene	-	-	-	-
Phenanthrene	D	-	-	IRIS
Phenol	-	-	-	-
Pyrene	D	-	-	IRIS
sec-Butylbenzene	-	-	-	-
Toluene	-	-	-	-
TPH-D	-	-	-	-
TPH-G	-	-	-	-
TPH-K	-	-	-	-
TPH-MO	-	-	-	-
Xylenes, total	-	-	-	-

Notes:

"-" = data not available

a= Carcinogenic weight-of-evidence is a qualitative designation for potential carcinogens

EPA Weight of Evidence Groups:

A= Human carcinogen

B1= Probable human carcinogen - indicates that limited human data are available

Table 6a
Carcinogenic Toxicity Data - Oral and Inhalation
MSC, Oakland, California

COPC	Weight-of-Evidence Classification [a]	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ [b]	Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ [b]	Toxicity Data Reference Source

B2 = Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C = Possible human carcinogen
D = Not classifiable as to human carcinogenicity

b = Hierarchy of toxicity sources include (1) CalEPA - OEHHA (2003), (2) IRIS (EPA 2009a), and (3) RSL (EPA 2009b)
CalEPA = California Environmental Protection Agency
COPC = chemical of potential concern
IRIS = Integrated Risk Information System
mg/kg-day = milligrams per kilogram per day
OEHHA = Office of Environmental Health Hazard Assessment
RSL = Regional Screening Levels

TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)

TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)

TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)
TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)
TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)
TPH-diesel = total petroleum hydrocarbon- diesel (carbon 13-22 range)
TPH-oil = total petroleum hydrocarbon- oil (carbon 22-40+ range)
TPH-purgeable = total petroleum hydrocarbon- purgeable (carbon 4-13 range)

Table 6b
Noncarcinogenic Toxicity Data - Oral
MSC, Oakland, California

COPC	Oral RfD (mg/kg-day) [a]	Target Organ and Effects of Concern	Toxicity Data Reference Source
Groundwater			
Benzene	4.00E-03	Decreased lymphocyte count	IRIS
Ethylbenzene	1.00E-01	Liver and kidney toxicity	IRIS
Methyl tertiary-butyl ether (MTBE) [b]	8.57E-01	Increased liver and kidney weights, increased severity of spontaneous renal lesions, increased prostration, and swollen periocular tissue	IRIS
Toluene	8.00E-02	Increased kidney weight	IRIS
TPH-D [c, d]	1.00E-01	Lung toxicity	DTSC
TPH-G[e]	4.00E-02	Lung and kidney toxicity	DTSC
TPH-K [d]	1.00E-01	Change in liver weight	DTSC
TPH -MO [f]	2.00E+00	Lung and kidney toxicity	DTSC
Xylenes, total	2.00E-01	Decreased body weight and increased mortality	IRIS
Soil			
1,2,4-Trimethylbenzene [b]	2.00E-03	-	PPRTV/RSL
1,3,5-Trimethylbenzene	5.00E-02	-	PPRTV/RSL
2-Methylnaphthalene	4.00E-03	Pulmonary alveolar proteinosis	IRIS
Acetone	9.00E-01	Nephropathy	IRIS
Benzene [b]	4.00E-03	Decreased lymphocyte count	IRIS
Benzo(a)pyrene	-	-	-
Benzo(b)fluoranthene	-	-	-
Chrysene	-	-	-
Ethylbenzene	1.00E-01	Liver and kidney toxicity	IRIS
Fluoranthene	4.00E-02	Nephropathy, increased liver weights, hematological alterations, and clinical effects	IRIS
Fluorene	4.00E-02	Decreased red blood cells, packed cell volume, and hemoglobin	IRIS
Isopropylbenzene (Cumene)	1.00E-01	Increased average kidney weight	IRIS
Methyl tertiary-butyl ether (MTBE)	8.57E-01	Increased liver and kidney weights, increased severity of spontaneous renal lesions, increased prostration, and swollen periocular tissue	IRIS
Methyl Ethyl Ketone	6.00E-01	Nephropahty	IRIS
Naphthalene	2.00E-02	Decreased body weight	IRIS
n-Butylbenzene	2.00E-02	Liver and kidney toxicity	-
n-Propylbenzene	2.00E-02	Liver and kidney toxicity	-
Phenanthrene	-	-	-
Phenol	0.3		
Pyrene	3.00E-02	Kidney effects (renal tubular pathology, decreased kidney weights)	IRIS
sec-Butylbenzene	-	-	-
Toluene	8.00E-02	Increased kidney weight	IRIS
TPH-D [c, d]	1.00E-01	Lung toxicity	DTSC
TPH-G[e]	4.00E-02	Lung and kidney toxicity	DTSC
TPH-K [d]	1.00E-01	Changes in liver weight	DTSC
TPH -MO [f]	2.00E+00	Lung and kidney toxicity	DTSC
Xylenes, total	2.00E-01	Decreased body weight and increased mortality	IRIS

Notes:

"-" = data not available

a= Hierarchy of toxicity sources include (1) CalEPA - OEHHA (2003) or DTSC (2009), (2) IRIS (EPA 2009a), and (3)RSL (EPA 2009b)

b= Inhalation Reference Dose is used as surrogate for Oral Reference Dose

c= Diesel compositional assumptions are 60 percent of C11 to C22 aromatics and 40 percent of C9 to C18 aliphatics (Massachusetts DEP 2002)

d= 0.1 mg/kg-day, the criterion value corresponding to aliphatic C9-C18, was used (DTSC 2009b)

e= 0.04 mg/kg-day, the criterion value corresponding to aliphatic C5-C8, was used (DTSC 2009b)

f= 2 mg/kg-day, the criterion value corresponding to aliphatic C19-C32, was used (DTSC 2009b)

COPC= chemical of potential concern

DTSC= Department of Toxic Substance Control

IRIS= Integrated Risk Information System

mg/kg-day= milligrams per kilogram per day

PPRTV = Provisional Peer Reviewed Toxicity Values

RfD= reference dose

RSL = Regional Screening Levels

TPH-D= total petroleum hydrocarbon- diesel (carbon 13-22 range)

TPH-G= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

TPH-K = total petroleum hydrocarbon- Kerosene (carbon 19-32 range)

TPH-MO = total petroleum hydrocarbon- oil (carbon 22-40+ range)

Table 6c
Noncarcinogenic Toxicity Data - Inhalation
MSC, Oakland, California

COPC	Inhalation RfD (mg/kg-day) [a]	Target Organ and Effects of Concern	Toxicity Data Reference Source
Groundwater			
Benzene	1.71E-02	Hematopoietic, development, nervous, and immune systems	CalEPA - OEHHA
Ethylbenzene	5.71E-01	Liver and kidney and development, alimentary, endocrine and systems	CalEPA - OEHHA
Methyl tertiary-butyl ether (MTBE)	8.57E-01	Increased liver and kidney weights, increased severity of spontaneous renal lesions, increased prostration, and swollen periocular tissue	IRIS
Toluene	8.57E-02	Nervous, respiratory, and development systems	CalEPA - OEHHA
TPH-D [d]	8.60E-02	Liver, kidney, and body weight reduction	DTSC
TPH-G[e]	2.00E-01	Liver, kidney, and body weight reduction	DTSC
TPH-K [d]	8.57E-02	Change in blood chemistry and liver and body weights	DTSC
TPH -MO [f]	-	-	-
Xylenes, total	2.00E-01	Nervous and respiratory systems	CalEPA - OEHHA
Soil			
1,2,4-Trimethylbenzene	2.00E-03	-	PPRTV/RSL
1,3,5-Trimethylbenzene	1.71E-03	-	PPRTV/RSL
2-Methylnaphthalene	4.00E-03	Pulmonary alveolar proteinosis	IRIS
Acetone	8.86E+00	-	ATSDR/RSL
Benzene	1.71E-02	Hematopoietic, development, nervous, and immune systems	CalEPA - OEHHA
Benzo(a)pyrene	-	-	-
Benzo(b)fluoranthene	-	-	-
Chrysene	-	-	-
Ethylbenzene	5.71E-01	Liver and kidney and development, alimentary, and endocrine systems	CalEPA - OEHHA
Fluoranthene	4.00E-02	Nephropathy, increased liver weights, hematological alterations, and clinical effects	IRIS
Fluorene	4.00E-02	Decreased red blood cells, packed cell volume, and hemoglobin	IRIS
Isopropylbenzene (Cumene)	1.14E-01	Increased kidney weights and adrenal weights	IRIS
Methyl tertiary-butyl ether (MTBE) [c]	8.57E-01	Increased liver and kidney weights, increased severity of spontaneous renal lesions, increased prostration, and swollen periocular tissue	IRIS
Methyl Ethyl Ketone	1.40E+00	-	IRIS
Naphthalene [c]	2.57E-03	Respiratory system	CalEPA - OEHHA
n-Butylbenzene	2.00E-02	Liver and kidney toxicity	-
n-Propylbenzene	2.00E-02	Liver and kidney toxicity	-
Phenanthrene	-	-	-
Phenol	0.2		
Pyrene	3.00E-02	Kidney effects (renal tubular pathology, decreased kidney weights)	IRIS
sec-Butylbenzene [c]	-	-	-
Toluene [c]	8.57E-02	Nervous, respiratory, and development system	CalEPA - OEHHA
TPH-D [d]	8.60E-02	Lung toxicity	DTSC
TPH-G[e]	2.00E-01	Lung and kidney toxicity	DTSC
TPH-K [d]	8.57E-02	Changes in liver weight	DTSC
TPH -MO [f]	-	Lung and kidney toxicity	DTSC
Xylenes, total [c]	2.00E-01	Nervous and respiratory systems	CalEPA - OEHHA

Notes:

"-" = data not available

a= Hierarchy of toxicity sources include (1) CalEPA - OEHHA (2003) or DTSC, (2) IRIS (EPA 2009a), and (3) RSL (EPA 2009b)

b= Diesel compositional assumptions are 60 percent of C11 to C22 aromatics and 40 percent of C9 to C18 aliphatics (Massachusetts DEP 2002)

c= Oral Reference Dose is used as surrogate for Inhalation Reference Dose

d= 0.3 mg/m^3 (or 0.086 mg/kg-day), the criterion value corresponding to aliphatic C9-C18, was used (DTSC 2009b)

e= 0.7 mg/m^3 (or 0.2 mg/kg-day), the criterion value corresponding to aliphatic C5-C8, was used (DTSC 2009b)

f= Not developed due to low volatility and performing a quantitative evaluation for TPH C17+ bound to airborne dust is not recommended by DTSC because of significant uncertainties (DTSC 2009b)

ATSDR= Agency for Toxic Substances and Disease Registry

CalEPA = California Environmental Protection Agency

COPC= chemical of potential concern

DTSC= Department of Toxic Substance Control

IRIS= Integrated Risk Information System

mg/kg-day= milligrams per kilogram per day

OEHHA = Office of Environmental Health Hazard Assessment

PPRTV = Provisional Peer Reviewed Toxicity Values

RfD= reference dose

RSL = Regional Screening Levels

TPH-D= total petroleum hydrocarbon- diesel (carbon 13-22 range)

TPH-G= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

TPH-K = total petroleum hydrocarbon- Kerosene (carbon 19-32 range)

TPH-MO = total petroleum hydrocarbon- oil (carbon 22-40+ range)

Table 7a
Summary of Chronic Daily Intake and Risks for Carcinogens
Construction Worker Scenario
MSC, Oakland, California

COPC	Incidental Ingestion with Soil CDI (mg/kg-day)	Direct Dermal Contact with Soil CDI (mg/kg-day)	Incidental Ingestion with Groundwater CDI (mg/kg-day)	Dermal Permeability Constant (cm/h) [a]	Direct Dermal Contact with Groundwater CDI (mg/kg-day)	Inhalation Outdoor Air CDI (mg/kg-day)	Risk via Incidental Ingestion with Soil	Risk via Direct Dermal Contact with Soil	Risk via Incidental Ingestion with Groundwater	Risk via Direct Dermal Contact with Groundwater	Risk via Inhalation Outdoor Air	Total Risk for COPC
Soil												
Benzo(a)pyrene	8.1E-08	3.4E-09	NA	NA	NA	3.7E-12	9.7E-07	4.1E-08	NA	NA	1.4E-11	1.E-06
Benzo(b)fluoranthene	6.7E-08	2.8E-09	NA	NA	NA	3.1E-12	8.0E-08	3.4E-09	NA	NA	1.2E-12	8.E-08
Chrysene	9.5E-08	4.0E-09	NA	NA	NA	4.3E-12	1.1E-08	4.8E-10	NA	NA	1.7E-13	1.E-08
Naphthalene	8.3E-08	3.5E-09	NA	NA	NA	3.8E-12	1.0E-08	4.2E-10	NA	NA	4.6E-13	1.E-08
Soil and Groundwater												
Benzene	9.7E-07	4.1E-08	2.1E-07	2.1E-02	3.6E-07	NA	9.7E-08	4.1E-09	2.1E-08	3.6E-08	NA	2.E-07
Ethylbenzene	2.9E-06	1.2E-07	6.0E-07	7.4E-02	3.6E-06	NA	3.2E-08	1.3E-09	6.6E-09	3.9E-08	NA	8.E-08
Methyl tertiary-butyl ether (MTBE)	NA	NA	1.6E-07	6.0E-01	7.9E-06	NA	NA	NA	3.0E-10	1.4E-08	NA	1.E-08
											TOTAL RISK	1E-06

Notes:
a= Dermal Permeability Constants are from Preliminary Endangerment Assessment Guidance Manual (DTSC 1999) or Johnson 1998
CalEPA = California Environmental Protection Agency
CDI= chronic daily intake
cm/h= centimeters per hour
COPC= chemical of potential concern
DTSC= Department of Toxic Substance Control
mg/kg-day= milligrams per kilogram per day
NA= not applicable

Table 7b
Summary of Chronic Daily Intake and Hazards for Noncarcinogens
Construction Worker Scenario
MSC, Oakland, California

COPC	Incidental Ingestion with Soil CDI (mg/kg-day)	Direct Dermal Contact with Soil CDI (mg/kg-day)	Incidental Ingestion with Groundwater CDI (mg/kg-day)	Dermal Permeability Constant (cm/h) [a]	Direct Dermal Contact with Groundwater CDI (mg/kg-day)	Inhalation Outdoor Air CDI (mg/kg-day)	HQ via Incidental Ingestion with Soil	HQ via Direct Dermal Contact with Soil	HQ via Incidental Ingestion with Groundwater	HQ via Direct Dermal Contact with Groundwater	HQ via Inhalation Outdoor Air	Total HQ for COPC
Soil												
1,2,4-Trimethylbenzene	1.5E-04	6.2E-06	NA	NA	NA	NA	7.3E-02	3.1E-03	NA	NA	NA	7.6E-02
1,3,5-Trimethylbenzene	3.5E-05	1.5E-06	NA	NA	NA	NA	7.1E-04	3.0E-05	NA	NA	NA	7.4E-04
Acetone	5.8E-06	2.4E-07	NA	NA	NA	NA	6.4E-06	2.7E-07	NA	NA	NA	6.7E-06
Fluoranthene	5.0E-06	2.1E-07	NA	NA	NA	2.3E-10	1.2E-04	5.3E-06	NA	NA	5.7E-09	1.3E-04
Fluorene	3.1E-06	1.3E-07	NA	NA	NA	1.4E-10	7.7E-05	3.3E-06	NA	NA	3.5E-09	8.0E-05
Isopropylbenzene (Cumene)	3.1E-06	1.3E-07	NA	NA	NA	NA	3.1E-05	1.3E-06	NA	NA	NA	3.2E-05
Methyl Ethyl Ketone	2.8E-07	1.2E-08	NA	NA	NA	NA	4.7E-07	2.0E-08	NA	NA	NA	4.9E-07
Naphthalene	8.5E-06	3.6E-07	NA	NA	NA	3.9E-10	4.3E-04	1.8E-05	NA	NA	1.5E-07	4.4E-04
Phenol	2.6E-07	1.1E-08	NA	NA	NA	1.2E-11	8.6E-07	3.7E-08	NA	NA	4.0E-10	9.0E-07
Pyrene	6.8E-06	2.9E-07	NA	NA	NA	3.1E-10	2.3E-04	9.7E-06	NA	NA	2.2E-10	2.4E-04
2-Methylnaphthalene	1.5E-05	6.4E-07	NA	NA	NA	3.2E-11	3.8E-03	1.6E-04	NA	NA	8.1E-09	3.9E-03
N-Butybenzene	9.0E-06	3.8E-07	NA	NA	NA	NA	4.5E-04	1.9E-05	NA	NA	NA	4.7E-04
N=Propylbenzene	1.4E-05	5.9E-07	NA	NA	NA	NA	6.9E-04	2.9E-05	NA	NA	NA	7.2E-04
sec-Butylbenzene	7.1E-07	3.0E-08	NA	NA	NA	NA	3.5E-05	1.5E-06	NA	NA	NA	3.7E-05
Soil and Groundwater												
Benzene	1.0E-04	4.2E-06	2.2E-05	2.1E-02	3.6E-05	NA	2.5E-02	1.1E-03	5.4E-03	9.1E-03	NA	4.0E-02
Ethylbenzene	3.0E-04	1.3E-05	6.1E-05	7.4E-02	3.6E-04	NA	3.0E-03	1.3E-04	6.1E-04	3.6E-03	NA	7.3E-03
Methyl tertiary-butyl ether (MTBE)	NA	NA	1.7E-05	6.0E-01	8.1E-04	NA	NA	NA	2.0E-05	9.4E-04	NA	9.6E-04
TPH-D [b]	7.1E-03	3.0E-04	1.1E-03	7.4E-02	6.2E-03	3.3E-07	7.1E-02	3.0E-03	1.3E-02	7.8E-02	NA	1.7E-01
TPH-G [c]	3.9E-03	1.7E-04	3.6E-04	2.1E-02	6.0E-04	NA	9.8E-02	4.1E-03	3.6E-03	1.5E-02	NA	1.2E-01
TPH-K [c]	1.2E-02	5.1E-04	2.9E-04	2.2E-01	5.1E-03	5.5E-07	1.2E-01	5.1E-03	7.2E-03	5.1E-02	6.5E-06	1.8E-01
TPH-MO	3.2E-03	1.4E-04	5.0E-03	7.7E-03	3.1E-03	1.5E-07	1.6E-03	6.8E-05	5.0E-02	1.5E-03	NA	5.3E-02
Toluene	2.6E-04	1.1E-05	7.1E-07	8.0E-02	4.6E-06	NA	3.2E-03	1.4E-04	3.6E-07	5.3E-06	NA	3.3E-03
Xylenes, total [d]	2.1E-03	9.1E-05	1.3E-06	8.0E-02	8.0E-06	NA	1.1E-02	4.5E-04	6.3E-06	4.0E-05	NA	1.1E-02
											TOTAL HI	7E-01

Notes:
"-"= data not available
a= Dermal Permeability Constants are from Preliminary Endangerment Assessment Guidance Manual (DTSC 1999) or Johnson 1998
b= Hexane Dermal Permeability Constant was used for TPH Purgeable (Massachusetts DEP 2002)
c= Diesel compositional assumptions are 60 percent of C11 to C22 aromatics and 40 percent of C9 to C18 aliphatics (Massachusetts DEP 2002)
d= m-Xylene Dermal Permeability Constant used as surrogate for xylene, total
CDI= chronic daily intake
cm/h= centimeters per hour
COPC= chemical of potential concern
HI= hazard index
HQ= hazard quotient
mg/kg-day= milligrams per kilogram per day
NA= not applicable or not available
TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)
TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)
TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)
TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)
TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)
TPH-diesel= total petroleum hydrocarbon- diesel (carbon 13-22 range)
TPH-oil= total petroleum hydrocarbon- oil (carbon 22-40+ range)
TPH-purgeable= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

Table 8a
Summary of Chronic Daily Intake and Risks for Carcinogens
Commercial/Industrial Worker Scenario
MSC, Oakland, California

COPC	Incidental Ingestion with Soil CDI (mg/kg-day)	Direct Dermal Contact with Soil CDI (mg/kg-day)	Inhalation Indoor Air CDI (mg/kg-day)	Risk via Incidental Ingestion with Soil	Risk via Direct Dermal Contact with Soil	Risk via Indoor Air Inhalation	Total Risk for COPC
Soil							
Naphthalene	8.2E-07	5.0E-07	NA	9.8E-08	9.8E-08	NA	2.E-07
Soil and Groundwater							
Benzene	2.7E-06	2.2E-06	4.9E-14	2.7E-07	2.2E-07	4.9E-15	5.E-07
Ethylbenzene	2.2E-05	1.8E-05	1.3E-14	2.5E-07	2.0E-07	1.1E-16	4.E-07
Methyl tertiary-butyl ether (MTBE)	NA	NA	2.4E-14	NA	NA	4.3E-17	4.E-17
							1E-06

Notes:
CDI= chronic daily intake
COPC= chemical of potential concern
mg/kg-day= milligrams per kilogram per day
NA= not applicable

Table 8b
Summary of Chronic Daily Intake and Hazards for Noncarcinogens
Commercial/Industrial Worker Scenario
MSC, Oakland, California

COPC	Incidental Ingestion with Soil CDI (mg/kg-day)	Direct Dermal Contact with Soil CDI (mg/kg-day)	Inhalation Indoor Air CDI (mg/kg-day)	HQ via Incidental Ingestion with Soil	HQ via Direct Dermal Contact with Soil	HQ via Inhalation Indoor Air	Total HQ for COPC
Soil							
Fluorene	6.4E-07	5.1E-07	NA	1.6E-05	1.3E-05	NA	3.E-05
Naphthalene	2.3E-06	1.8E-06	NA	1.1E-04	9.2E-05	NA	2.E-04
2-Methylnaphthalene	1.0E-06	6.1E-06	NA	5.1E-05	1.5E-03	NA	2.E-03
Soil and Groundwater							
Benzene	7.6E-06	6.1E-06	4.7E-08	1.9E-03	1.5E-03	2.7E-06	3.E-03
Ethylbenzene	6.3E-05	5.0E-05	1.2E-08	6.3E-04	5.0E-04	2.1E-08	1.E-03
Methyl tertiary-butyl ether (MTBE)	NA	NA	2.3E-08	NA	NA	2.6E-08	3.E-08
TPH-D [a]	1.6E-03	1.3E-03	NA	1.6E-02	1.3E-02	NA	3.E-02
TPH-G [b]	5.4E-04	4.3E-04	8.0E-07	1.3E-02	1.1E-02	4.0E-06	2.E-02
TPH-K [b]	4.2E-03	3.4E-03	NA	4.2E-02	3.4E-02	NA	8.E-02
TPH-MO	1.1E-03	8.5E-04	NA	5.3E-04	4.2E-04	NA	1.E-03
Toluene	1.4E-05	1.2E-05	1.5E-09	1.8E-04	1.4E-04	NA	3.E-04
Xylenes, total [c]	3.4E-05	2.7E-05	3.7E-09	1.7E-04	1.4E-04	1.9E-08	3.E-04
						TOTAL HI	1E-01

Notes:
"-"= Data not available
a= Hexane Dermal Permeability Constant was used for TPH-purgeable (Massachusetts DEP 2002)
b= Diesel compositional assumptions are 60 percent of C11 to C22 aromatics and 40 percent of C9 to C18 aliphatics (Massachusetts DEP 2002)
c= m-Xylene Dermal Permeability Constant used as surrogate for xylene, total
CDI= chronic daily intake
cm/h= centimeters per hour
COPC= chemical of potential concern
HI= hazard index
HQ= hazard quotient
mg/kg-day= milligrams per kilogram per day
NA= not applicable
TPH (C5-C8 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 5 to 8 carbons)
TPH (C9-C18 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 9 to 18 carbons)
TPH (C19-C36 Aliphatics) = total petroleum hydrocarbon (aliphatic hydrocarbon with chain lengths from 19 to 36 carbons)
TPH (C9-C10 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 9 to 10 carbons)
TPH (C11-C22 Aromatics) = total petroleum hydrocarbon (aromatic compounds with 11 to 22 carbons)
TPH-diesel= total petroleum hydrocarbon- diesel (carbon 13-22 range)
TPH-oil= total petroleum hydrocarbon- oil (carbon 22-40+ range)
TPH-purgeable= total petroleum hydrocarbon- purgeable (carbon 4-13 range)

Table 9
Summary of Risks and Hazards
MSC, Oakland, California

Exposure Scenario	Reasonable Maximum Exposure			
	Total Estimated Carcinogenic Risk Soil Exposure No PAHs	Total Estimated Hazard Index Soil Exposure No PAHs	Total Estimated Carcinogenic PAHs In Soil Exposure	Total Estimated Hazard Index PAHs in Soil Exposure
Construction Worker	3.E-07	7.E-01	1.E-06	7.E-01
Commercial/Industrial Worker	1.E-06	1.E-01	1.E-06	1.E-01

Notes:

NA= not applicable

PAHs = polycyclic aromatic hydrocarbons

0 2000 Feet

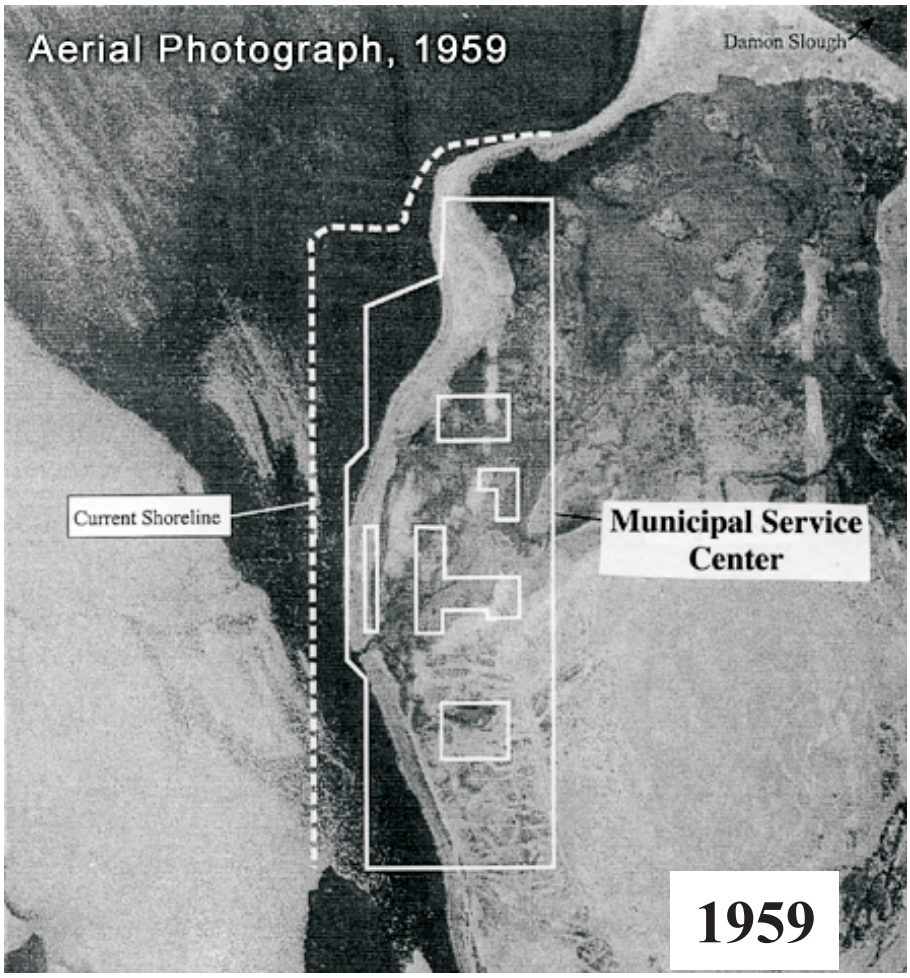
Site Vicinity Map

MSC, Oakland, California

Figure 1

LFR an ARCADIS company

I:\Design\028\10060\07\dwg\Site Map - 7101 Edgewater Dr.dwg Dec 14,2009-2:41pm



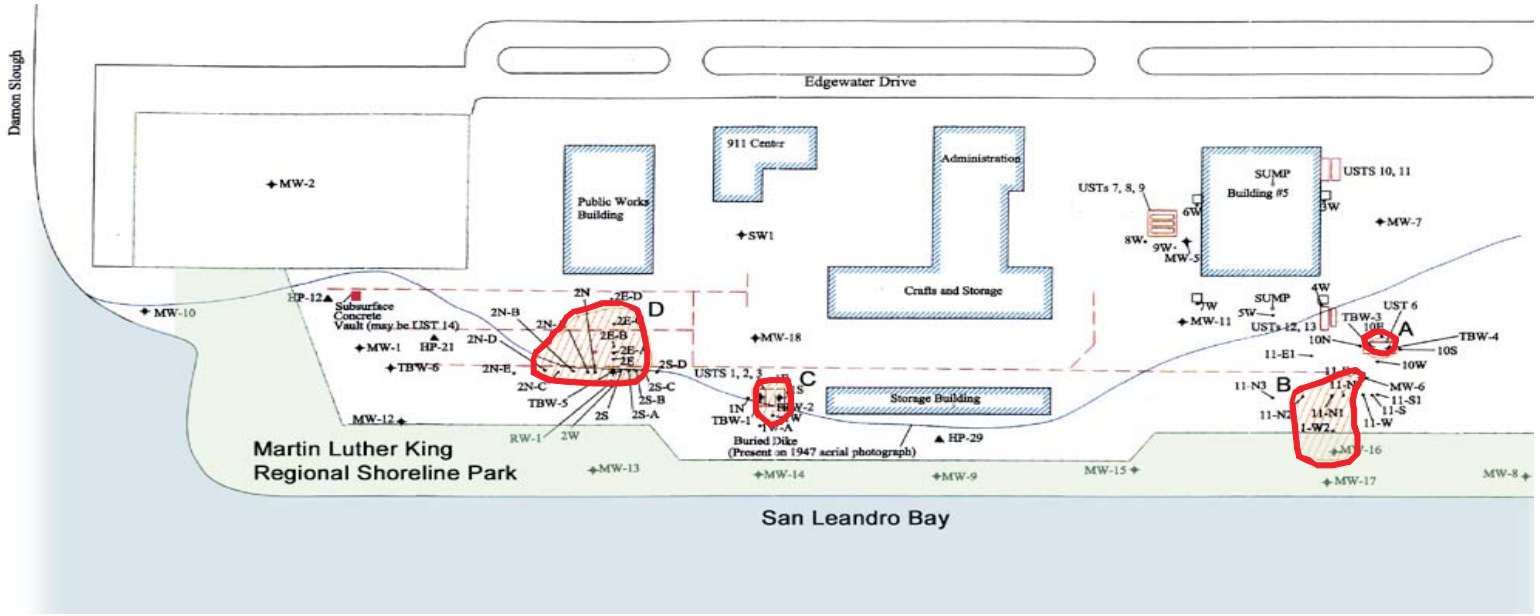
Fill History

MSC, Oakland, California

Figure 2

LFR an ARCADIS company

DESIGN\028\10060\07\MSC Oakland Exposure MSC Oakland - Fill History.cdr



Site Setting and Sample Locations

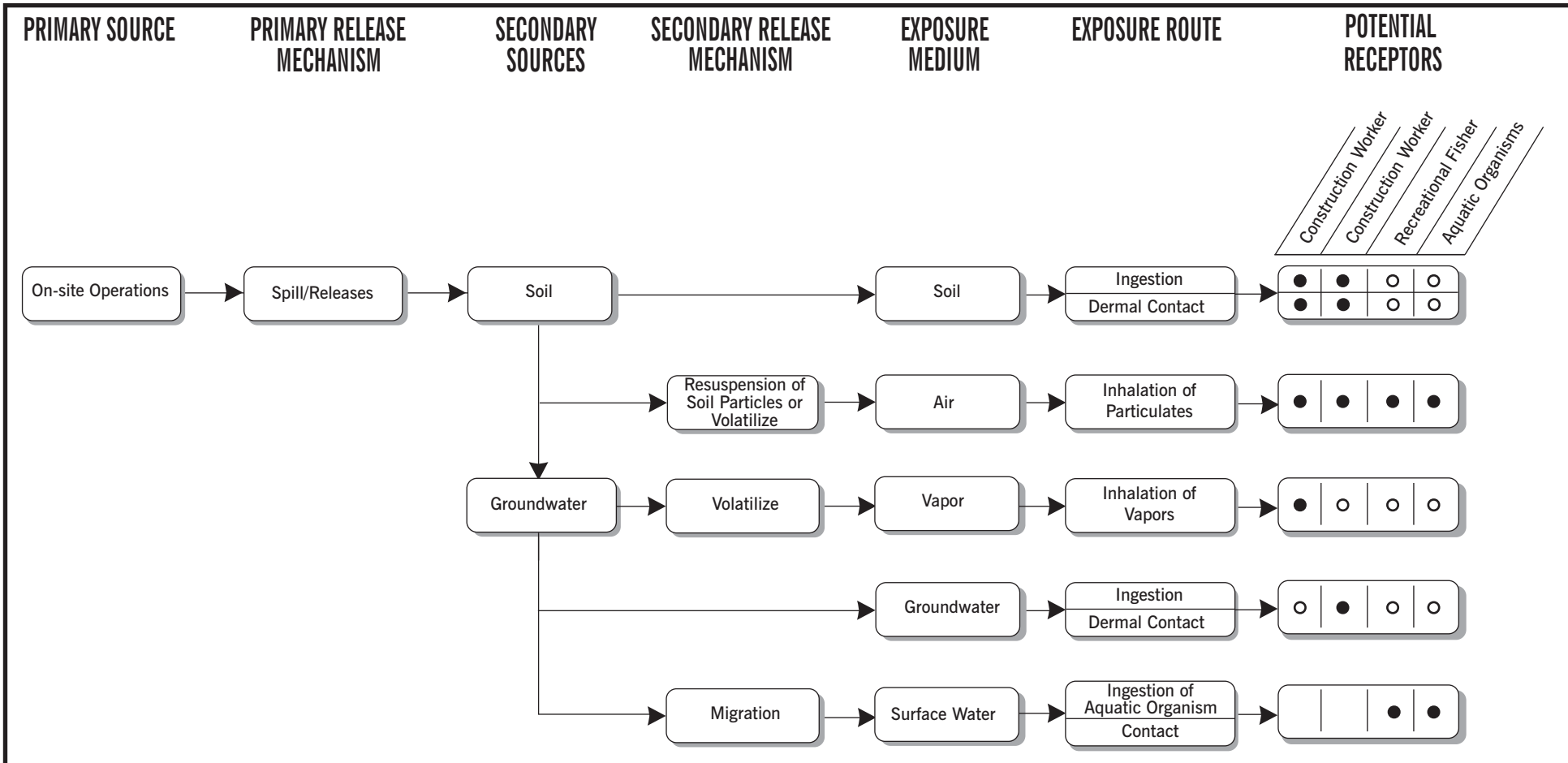
MSC, Oakland, California

Figure 3

LFR an ARCADIS company

DESIGN\028\10060\07\MSC Oakland Site Setting and Samp Locs.cdr

DESIGN\028\10060\07\MSC Oakland Exposure Pathway Evaluation2.cdr



EXPLANATION

- ● Complete exposure pathway, quantitative evaluation
- ○ Incomplete or insignificant exposure pathway based on current site configuration and use

MSC, OAKLAND, CALIFORNIA

Exposure Pathway Evaluation
Potential Current and Future Conditions

ARCADIS

FIGURE
4

APPENDIX A

ProUCL and Johnson & Ettinger Model Results

General UCL Statistics for Full Data Sets

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzene GW MSC

General Statistics

Number of Valid Samples	61	Number of Unique Samples	51
Number of Missing Values	59		

Raw Statistics		Log-transformed Statistics	
Minimum	0.98	Minimum of Log Data	-0.0202
Maximum	520	Maximum of Log Data	6.254
Mean	59.21	Mean of log Data	2.649
Median	11	SD of log Data	1.712
SD	118.1		
Coefficient of Variation	1.994		
Skewness	2.919		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.311	Lilliefors Test Statistic	0.0828
Lilliefors Critical Value	0.113	Lilliefors Critical Value	0.113
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	84.47	95% H-UCL	121
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	136.1
95% Adjusted-CLT UCL	90.11	97.5% Chebyshev (MVUE) UCL	169.9
95% Modified-t UCL	85.41	99% Chebyshev (MVUE) UCL	236.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.439	Data appear Lognormal at 5% Significance Level	
Theta Star	134.7		
nu star	53.61		
Approximate Chi Square Value (.05)	37.79	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0461	95% CLT UCL	84.08
Adjusted Chi Square Value	37.47	95% Jackknife UCL	84.47
		95% Standard Bootstrap UCL	84.06
Anderson-Darling Test Statistic	2.928	95% Bootstrap-t UCL	94.06
Anderson-Darling 5% Critical Value	0.828	95% Hall's Bootstrap UCL	86.09
Kolmogorov-Smirnov Test Statistic	0.185	95% Percentile Bootstrap UCL	85.2
Kolmogorov-Smirnov 5% Critical Value	0.121	95% BCA Bootstrap UCL	88.82
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	125.1
		97.5% Chebyshev(Mean, Sd) UCL	153.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	209.6
95% Approximate Gamma UCL	84		
95% Adjusted Gamma UCL	84.72		

Potential UCL to Use		Use 95% H-UCL	121

Ethylbenzene GW MSC

General Statistics

Number of Valid Samples	31	Number of Unique Samples	29
Number of Missing Values	89		

Raw Statistics		Log-transformed Statistics	
Minimum	1.2	Minimum of Log Data	0.182
Maximum	560	Maximum of Log Data	6.328
Mean	89.27	Mean of log Data	2.883
Median	7.3	SD of log Data	1.925
SD	142.3		
Coefficient of Variation	1.595		
Skewness	1.786		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.673	Shapiro Wilk Test Statistic	0.859
Shapiro Wilk Critical Value	0.929	Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	132.7	95% H-UCL	418.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	297.1
95% Adjusted-CLT UCL	140.1	97.5% Chebyshev (MVUE) UCL	383.1
95% Modified-t UCL	134	99% Chebyshev (MVUE) UCL	552.1
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.39	Data do not follow a Discernable Distribution (0.05)	
Theta Star	229		
nu star	24.17		
Approximate Chi Square Value (.05)	13.98	Nonparametric Statistics	
Adjusted Level of Significance	0.0413	95% CLT UCL	131.3
Adjusted Chi Square Value	13.54	95% Jackknife UCL	132.7
		95% Standard Bootstrap UCL	130.4
Anderson-Darling Test Statistic	2.549	95% Bootstrap-t UCL	145.3
Anderson-Darling 5% Critical Value	0.83	95% Hall's Bootstrap UCL	140.2
Kolmogorov-Smirnov Test Statistic	0.288	95% Percentile Bootstrap UCL	133.3
Kolmogorov-Smirnov 5% Critical Value	0.169	95% BCA Bootstrap UCL	141
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	200.7
		97.5% Chebyshev(Mean, Sd) UCL	248.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	343.6
95% Approximate Gamma UCL	154.4		
95% Adjusted Gamma UCL	159.3		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	343.6

MTBE GW MSC

General Statistics

Number of Valid Samples	34	Number of Unique Samples	29
Number of Missing Values	86		

Raw Statistics		Log-transformed Statistics	
Minimum	0.5	Minimum of Log Data	-0.693
Maximum	94	Maximum of Log Data	4.543
Mean	17.23	Mean of log Data	1.928
Median	6.1	SD of log Data	1.491
SD	23.95		
Coefficient of Variation	1.39		
Skewness	2.136		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.693	Shapiro Wilk Test Statistic	0.957
Shapiro Wilk Critical Value	0.933	Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	24.18	95% H-UCL	45.97
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	47.56
95% Adjusted-CLT UCL	25.59	97.5% Chebyshev (MVUE) UCL	59.65
95% Modified-t UCL	24.43	99% Chebyshev (MVUE) UCL	83.41
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.624	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	27.59		
nu star	42.46		
Approximate Chi Square Value (.05)	28.52	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0422	95% CLT UCL	23.98
Adjusted Chi Square Value	27.95	95% Jackknife UCL	24.18
		95% Standard Bootstrap UCL	24.08
Anderson-Darling Test Statistic	0.672	95% Bootstrap-t UCL	27.73
Anderson-Darling 5% Critical Value	0.796	95% Hall's Bootstrap UCL	28.04
Kolmogorov-Smirnov Test Statistic	0.144	95% Percentile Bootstrap UCL	24.23
Kolmogorov-Smirnov 5% Critical Value	0.158	95% BCA Bootstrap UCL	25.63
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	35.13
		97.5% Chebyshev(Mean, Sd) UCL	42.88
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	58.1
95% Approximate Gamma UCL	25.65		
95% Adjusted Gamma UCL	26.17		
Potential UCL to Use		Use 95% Approximate Gamma UCL	25.65

Toluene GW MSC

General Statistics

Number of Valid Samples	35	Number of Unique Samples	23

Number of Missing Values	85		

Raw Statistics		Log-transformed Statistics	
Minimum	0.52	Minimum of Log Data	-0.654
Maximum	13	Maximum of Log Data	2.565
Mean	3.099	Mean of log Data	0.829
Median	2.1	SD of log Data	0.784
SD	2.676		
Coefficient of Variation	0.864		
Skewness	1.999		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.797	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.934	Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.863	95% H-UCL	4.174
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.052
95% Adjusted-CLT UCL	4.006	97.5% Chebyshev (MVUE) UCL	5.904
95% Modified-t UCL	3.889	99% Chebyshev (MVUE) UCL	7.578

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.672	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.854		
nu star	117		
Approximate Chi Square Value (.05)	93.03	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0425	95% CLT UCL	3.843
Adjusted Chi Square Value	92.02	95% Jackknife UCL	3.863
		95% Standard Bootstrap UCL	3.836
Anderson-Darling Test Statistic	0.584	95% Bootstrap-t UCL	4.133
Anderson-Darling 5% Critical Value	0.762	95% Hall's Bootstrap UCL	4.222
Kolmogorov-Smirnov Test Statistic	0.139	95% Percentile Bootstrap UCL	3.88
Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	4.04
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.07
		97.5% Chebyshev(Mean, Sd) UCL	5.923
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7.599
95% Approximate Gamma UCL	3.897		
95% Adjusted Gamma UCL	3.94		

Potential UCL to Use		Use 95% Approximate Gamma UCL	3.897

TPH-D GW MSC

General Statistics

Number of Valid Samples	71	Number of Unique Samples	54
Number of Missing Values	49		

Raw Statistics		Log-transformed Statistics	
Minimum	50	Minimum of Log Data	3.912

Maximum	52000	Maximum of Log Data	10.86
Mean	1382	Mean of log Data	5.723
Median	220	SD of log Data	1.332
SD	6211		
Coefficient of Variation	4.493		
Skewness	7.97		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.415	Lilliefors Test Statistic	0.12
Lilliefors Critical Value	0.105	Lilliefors Critical Value	0.105
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2611	95% H-UCL	1123
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1377
95% Adjusted-CLT UCL	3340	97.5% Chebyshev (MVUE) UCL	1659
95% Modified-t UCL	2727	99% Chebyshev (MVUE) UCL	2212
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.422	Data do not follow a Discernable Distribution (0.05)	
Theta Star	3274		
nu star	59.96		
Approximate Chi Square Value (.05)	43.16	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0466	95% CLT UCL	2595
Adjusted Chi Square Value	42.86	95% Jackknife UCL	2611
		95% Standard Bootstrap UCL	2595
Anderson-Darling Test Statistic	7.897	95% Bootstrap-t UCL	7814
Anderson-Darling 5% Critical Value	0.834	95% Hall's Bootstrap UCL	6653
Kolmogorov-Smirnov Test Statistic	0.244	95% Percentile Bootstrap UCL	2832
Kolmogorov-Smirnov 5% Critical Value	0.113	95% BCA Bootstrap UCL	3746
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4595
		97.5% Chebyshev(Mean, Sd) UCL	5985
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8716
95% Approximate Gamma UCL	1921		
95% Adjusted Gamma UCL	1934		
Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	5985

TPH-G GW MSC

General Statistics

Number of Valid Samples	63	Number of Unique Samples	46
Number of Missing Values	57		
Raw Statistics		**Log-transformed Statistics**	
Minimum	55	Minimum of Log Data	4.007
Maximum	4800	Maximum of Log Data	8.476
Mean	979.9	Mean of log Data	5.997
Median	270	SD of log Data	1.393
SD	1278		

Coefficient of Variation	1.304
Skewness	1.578

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.271	Lilliefors Test Statistic	0.135
Lilliefors Critical Value	0.112	Lilliefors Critical Value	0.112
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1249	95% H-UCL	1708
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2066
95% Adjusted-CLT UCL	1279	97.5% Chebyshev (MVUE) UCL	2514
95% Modified-t UCL	1254	99% Chebyshev (MVUE) UCL	3395
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.659	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1486		
nu star	83.06		
Approximate Chi Square Value (.05)	63.06	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0462	95% CLT UCL	1245
Adjusted Chi Square Value	62.65	95% Jackknife UCL	1249
		95% Standard Bootstrap UCL	1244
Anderson-Darling Test Statistic	2.527	95% Bootstrap-t UCL	1307
Anderson-Darling 5% Critical Value	0.799	95% Hall's Bootstrap UCL	1266
Kolmogorov-Smirnov Test Statistic	0.186	95% Percentile Bootstrap UCL	1247
Kolmogorov-Smirnov 5% Critical Value	0.117	95% BCA Bootstrap UCL	1268
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1682
		97.5% Chebyshev(Mean, Sd) UCL	1985
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2582
95% Approximate Gamma UCL	1291		
95% Adjusted Gamma UCL	1299		
Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	1985

TPH-K GW MSC

General Statistics

Number of Valid Samples	52	Number of Unique Samples	47
Number of Missing Values	68		

Raw Statistics		Log-transformed Statistics	
Minimum	50	Minimum of Log Data	3.912
Maximum	31000	Maximum of Log Data	10.34
Mean	1318	Mean of log Data	5.899
Median	305	SD of log Data	1.389
SD	4340		
Coefficient of Variation	3.293		
Skewness	6.542		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.385	Lilliefors Test Statistic	0.0992
Lilliefors Critical Value	0.123	Lilliefors Critical Value	0.123
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2326	95% H-UCL	1631
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1932
95% Adjusted-CLT UCL	2891	97.5% Chebyshev (MVUE) UCL	2368
95% Modified-t UCL	2417	99% Chebyshev (MVUE) UCL	3224
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.479	Data appear Lognormal at 5% Significance Level	
Theta Star	2749		
nu star	49.86		
Approximate Chi Square Value (.05)	34.65	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0454	95% CLT UCL	2308
Adjusted Chi Square Value	34.29	95% Jackknife UCL	2326
		95% Standard Bootstrap UCL	2314
Anderson-Darling Test Statistic	3.567	95% Bootstrap-t UCL	5220
Anderson-Darling 5% Critical Value	0.816	95% Hall's Bootstrap UCL	5670
Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL	2470
Kolmogorov-Smirnov 5% Critical Value	0.13	95% BCA Bootstrap UCL	3266
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3941
		97.5% Chebyshev(Mean, Sd) UCL	5077
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	7306
95% Approximate Gamma UCL	1897		
95% Adjusted Gamma UCL	1917		
Potential UCL to Use		Use 95% H-UCL	1631

TPH-MO GW MSC

General Statistics			
Number of Valid Samples	22	Number of Unique Samples	19
Number of Missing Values	98		
Raw Statistics		**Log-transformed Statistics**	
Minimum	320	Minimum of Log Data	5.768
Maximum	110000	Maximum of Log Data	11.61
Mean	6244	Mean of log Data	6.766
Median	558.5	SD of log Data	1.383
SD	23312		
Coefficient of Variation	3.734		
Skewness	4.605		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.27	Shapiro Wilk Test Statistic	0.664
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	14796	95% H-UCL	5760
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5302
95% Adjusted-CLT UCL	19633	97.5% Chebyshev (MVUE) UCL	6691
95% Modified-t UCL	15609	99% Chebyshev (MVUE) UCL	9420

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.326	Data do not follow a Discernable Distribution (0.05)	
Theta Star	19170		
nu star	14.33		
Approximate Chi Square Value (.05)	6.799	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	14419
Adjusted Chi Square Value	6.413	95% Jackknife UCL	14796
		95% Standard Bootstrap UCL	14270
Anderson-Darling Test Statistic	5.053	95% Bootstrap-t UCL	161848
Anderson-Darling 5% Critical Value	0.838	95% Hall's Bootstrap UCL	147377
Kolmogorov-Smirnov Test Statistic	0.45	95% Percentile Bootstrap UCL	15851
Kolmogorov-Smirnov 5% Critical Value	0.2	95% BCA Bootstrap UCL	21110
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	27908
		97.5% Chebyshev(Mean, Sd) UCL	37282
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	55696
95% Approximate Gamma UCL	13162		
95% Adjusted Gamma UCL	13952		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	55696

Xylene GW MSC

General Statistics

Number of Valid Samples	55	Number of Unique Samples	47
Number of Missing Values	65		

Raw Statistics		Log-transformed Statistics	
Minimum	0.5	Minimum of Log Data	-0.693
Maximum	44	Maximum of Log Data	3.784
Mean	5.144	Mean of log Data	1.195
Median	3.03	SD of log Data	0.92
SD	6.499		
Coefficient of Variation	1.263		
Skewness	4.257		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.237	Lilliefors Test Statistic	0.107
Lilliefors Critical Value	0.119	Lilliefors Critical Value	0.119
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	6.611	95% H-UCL	6.653
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.107

95% Adjusted-CLT UCL	7.123	97.5% Chebyshev (MVUE) UCL	9.457
95% Modified-t UCL	6.695	99% Chebyshev (MVUE) UCL	12.11
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.212	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4.243		
nu star	133.4		
Approximate Chi Square Value (.05)	107.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0456	95% CLT UCL	6.586
Adjusted Chi Square Value	107.1	95% Jackknife UCL	6.611
		95% Standard Bootstrap UCL	6.581
Anderson-Darling Test Statistic	0.982	95% Bootstrap-t UCL	7.695
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	13.06
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL	6.672
Kolmogorov-Smirnov 5% Critical Value	0.123	95% BCA Bootstrap UCL	7.097
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.964
		97.5% Chebyshev(Mean, Sd) UCL	10.62
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	13.86
95% Approximate Gamma UCL	6.371		
95% Adjusted Gamma UCL	6.408		
Potential UCL to Use		Use 95% H-UCL	6.653

Potential UCL to Use		Use 95% Student's-t UCL	257.2

COPPER, TOTAL

General Statistics

Number of Valid Samples	28	Number of Unique Samples	26
Number of Missing Values	21		

Raw Statistics		Log-transformed Statistics	
Minimum	3.6	Minimum of Log Data	1.281
Maximum	150	Maximum of Log Data	5.011
Mean	49.72	Mean of log Data	3.617
Median	39.5	SD of log Data	0.886
SD	33.57		
Coefficient of Variation	0.675		
Skewness	0.925		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.924	Shapiro Wilk Critical Value	0.924
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	60.52	95% H-UCL	82
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	98.26
95% Adjusted-CLT UCL	61.34	97.5% Chebyshev (MVUE) UCL	117.4
95% Modified-t UCL	60.71	99% Chebyshev (MVUE) UCL	154.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.703	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	29.2		
nu star	95.34		
Approximate Chi Square Value (.05)	73.82	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0404	95% CLT UCL	60.15
Adjusted Chi Square Value	72.65	95% Jackknife UCL	60.52
		95% Standard Bootstrap UCL	59.79
Anderson-Darling Test Statistic	0.441	95% Bootstrap-t UCL	61.5
Anderson-Darling 5% Critical Value	0.759	95% Hall's Bootstrap UCL	61.97
Kolmogorov-Smirnov Test Statistic	0.131	95% Percentile Bootstrap UCL	60.34
Kolmogorov-Smirnov 5% Critical Value	0.168	95% BCA Bootstrap UCL	61.46
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	77.37
		97.5% Chebyshev(Mean, Sd) UCL	89.34
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	112.8
95% Approximate Gamma UCL	64.21		
95% Adjusted Gamma UCL	65.25		

Potential UCL to Use		Use 95% Approximate Gamma UCL	64.21

LEAD, TOTAL

General Statistics

Number of Valid Samples	47	Number of Unique Samples	30
Number of Missing Values	2		

Raw Statistics		Log-transformed Statistics	
Minimum	1.8	Minimum of Log Data	0.588
Maximum	130	Maximum of Log Data	4.868
Mean	16.85	Mean of log Data	2.421
Median	9.9	SD of log Data	0.746
SD	24.5		
Coefficient of Variation	1.454		
Skewness	3.586		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.454	Shapiro Wilk Test Statistic	0.82
Shapiro Wilk Critical Value	0.946	Shapiro Wilk Critical Value	0.946
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	22.85	95% H-UCL	18.69
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22.48
95% Adjusted-CLT UCL	24.73	97.5% Chebyshev (MVUE) UCL	25.83
95% Modified-t UCL	23.16	99% Chebyshev (MVUE) UCL	32.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.307	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	12.89		
nu star	122.9		
Approximate Chi Square Value (.05)	98.27	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0449	95% CLT UCL	22.73
Adjusted Chi Square Value	97.58	95% Jackknife UCL	22.85
		95% Standard Bootstrap UCL	22.48
Anderson-Darling Test Statistic	5.812	95% Bootstrap-t UCL	26.65
Anderson-Darling 5% Critical Value	0.77	95% Hall's Bootstrap UCL	22.73
Kolmogorov-Smirnov Test Statistic	0.278	95% Percentile Bootstrap UCL	23.38
Kolmogorov-Smirnov 5% Critical Value	0.132	95% BCA Bootstrap UCL	25.21
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	32.43
		97.5% Chebyshev(Mean, Sd) UCL	39.17
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	52.42
95% Approximate Gamma UCL	21.07		
95% Adjusted Gamma UCL	21.22		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	32.43

ZINC, TOTAL

General Statistics

Number of Valid Samples	33	Number of Unique Samples	29

Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	14	Minimum of Log Data	2.639
Maximum	150	Maximum of Log Data	5.011
Mean	71.67	Mean of log Data	4.148
Median	70	SD of log Data	0.558
SD	32.25		
Coefficient of Variation	0.45		
Skewness	0.45		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.931	Shapiro Wilk Critical Value	0.931
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	81.18	95% H-UCL	89.82
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	106.5
95% Adjusted-CLT UCL	81.38	97.5% Chebyshev (MVUE) UCL	120.7
95% Modified-t UCL	81.25	99% Chebyshev (MVUE) UCL	148.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.819	**Data appear Normal at 5% Significance Level**	
Theta Star	18.77		
nu star	252		
Approximate Chi Square Value (.05)	216.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0419	95% CLT UCL	80.91
Adjusted Chi Square Value	214.6	95% Jackknife UCL	81.18
		95% Standard Bootstrap UCL	81.04
Anderson-Darling Test Statistic	0.557	95% Bootstrap-t UCL	82.17
Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	82.44
Kolmogorov-Smirnov Test Statistic	0.105	95% Percentile Bootstrap UCL	80.84
Kolmogorov-Smirnov 5% Critical Value	0.154	95% BCA Bootstrap UCL	81.16
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	96.14
		97.5% Chebyshev(Mean, Sd) UCL	106.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	127.5
95% Approximate Gamma UCL	83.52		
95% Adjusted Gamma UCL	84.19		
Potential UCL to Use		Use 95% Student's-t UCL	81.18

	General UCL Statistics for Full Data Sets
User Selected Options	MSC Soil VOCs
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

1,2,4-TRIMETHYLBENZENE

General Statistics

Number of Valid Samples	7	Number of Unique Samples	7
Number of Missing Values	147		

Raw Statistics		Log-transformed Statistics	
Minimum	0.009	Minimum of Log Data	-4.711
Maximum	62	Maximum of Log Data	4.127
Mean	10.95	Mean of log Data	-1.04
Median	0.08	SD of log Data	3.56
SD	22.87		
Coefficient of Variation	2.089		
Skewness	2.486		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.574	Shapiro Wilk Test Statistic	0.88
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	27.74	95% H-UCL	5.256E+9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	77.1
95% Adjusted-CLT UCL	33.84	97.5% Chebyshev (MVUE) UCL	103.9
95% Modified-t UCL	29.1	99% Chebyshev (MVUE) UCL	156.4

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.217	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	50.55		
nu star	3.032		
Approximate Chi Square Value (.05)	0.382	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	25.17
Adjusted Chi Square Value	0.197	95% Jackknife UCL	27.74
		95% Standard Bootstrap UCL	24.21
Anderson-Darling Test Statistic	0.546	95% Bootstrap-t UCL	192.2
Anderson-Darling 5% Critical Value	0.817	95% Hall's Bootstrap UCL	200.4
Kolmogorov-Smirnov Test Statistic	0.295	95% Percentile Bootstrap UCL	27.09
Kolmogorov-Smirnov 5% Critical Value	0.341	95% BCA Bootstrap UCL	30.22
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	48.63
		97.5% Chebyshev(Mean, Sd) UCL	64.93
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	96.96
95% Approximate Gamma UCL	86.9		
95% Adjusted Gamma UCL	168.7		

Potential UCL to Use		Use 95% Adjusted Gamma UCL	168.7
Recommended UCL exceeds the maximum observation			

1,3,5-TRIMETHYLBENZENE

General Statistics			
Number of Valid Samples	6	Number of Unique Samples	6
Number of Missing Values	147		

Raw Statistics		Log-transformed Statistics	
Minimum	0.0061	Minimum of Log Data	-5.099
Maximum	15	Maximum of Log Data	2.708
Mean	3.174	Mean of log Data	-1.606
Median	0.514	SD of log Data	3.302
SD	5.909		
Coefficient of Variation	1.862		
Skewness	2.253		

Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.64	Shapiro Wilk Test Statistic	0.892
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.034	95% H-UCL	1.246E+10
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	23.8
95% Adjusted-CLT UCL	9.512	97.5% Chebyshev (MVUE) UCL	32.03
95% Modified-t UCL	8.404	99% Chebyshev (MVUE) UCL	48.21
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.239	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	13.27		
nu star	2.871		
Approximate Chi Square Value (.05)	0.335	Nonparametric Statistics	
Adjusted Level of Significance	0.0122	95% CLT UCL	7.141
Adjusted Chi Square Value	0.151	95% Jackknife UCL	8.034
		95% Standard Bootstrap UCL	6.784
Anderson-Darling Test Statistic	0.391	95% Bootstrap-t UCL	46.92
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL	49.64
Kolmogorov-Smirnov Test Statistic	0.27	95% Percentile Bootstrap UCL	7.669
Kolmogorov-Smirnov 5% Critical Value	0.36	95% BCA Bootstrap UCL	8.501
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13.69
		97.5% Chebyshev(Mean, Sd) UCL	18.24
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	27.18
95% Approximate Gamma UCL	27.18		
95% Adjusted Gamma UCL	60.51		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	60.51
Recommended UCL exceeds the maximum observation			

ACETONE

General Statistics

Number of Valid Samples	11	Number of Unique Samples	11
Number of Missing Values	143		

Raw Statistics		Log-transformed Statistics	
Minimum	0.024	Minimum of Log Data	-3.73
Maximum	3.4	Maximum of Log Data	1.224
Mean	0.546	Mean of log Data	-1.919
Median	0.13	SD of log Data	1.555
SD	1.063		
Coefficient of Variation	1.946		
Skewness	2.436		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.554	Shapiro Wilk Test Statistic	0.878
Shapiro Wilk Critical Value	0.85	Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.127	95% H-UCL	3.822
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.296
95% Adjusted-CLT UCL	1.325	97.5% Chebyshev (MVUE) UCL	1.681
95% Modified-t UCL	1.166	99% Chebyshev (MVUE) UCL	2.438
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.414	Data appear Lognormal at 5% Significance Level	
Theta Star	1.32		
nu star	9.104		
Approximate Chi Square Value (.05)	3.39	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0278	95% CLT UCL	1.073
Adjusted Chi Square Value	2.846	95% Jackknife UCL	1.127
		95% Standard Bootstrap UCL	1.039
Anderson-Darling Test Statistic	1.255	95% Bootstrap-t UCL	7.827
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	4.698
Kolmogorov-Smirnov Test Statistic	0.357	95% Percentile Bootstrap UCL	1.109
Kolmogorov-Smirnov 5% Critical Value	0.27	95% BCA Bootstrap UCL	1.411
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.943
		97.5% Chebyshev(Mean, Sd) UCL	2.548
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3.735
95% Approximate Gamma UCL	1.467		
95% Adjusted Gamma UCL	1.747		
Potential UCL to Use		Use 99% Chebyshev (MVUE) UCL	2.438

BENZENE

General Statistics			
Number of Valid Samples	45	Number of Unique Samples	41
Number of Missing Values	83		

Raw Statistics		Log-transformed Statistics	
Minimum	0.0019	Minimum of Log Data	-6.266
Maximum	110	Maximum of Log Data	4.7
Mean	8.678	Mean of log Data	-0.179
Median	1.1	SD of log Data	2.42
SD	23.95		
Coefficient of Variation	2.76		
Skewness	3.727		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.398	Shapiro Wilk Test Statistic	0.972
Shapiro Wilk Critical Value	0.945	Shapiro Wilk Critical Value	0.945
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	14.68	95% H-UCL	72.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	42.24
95% Adjusted-CLT UCL	16.67	97.5% Chebyshev (MVUE) UCL	55.09
95% Modified-t UCL	15.01	99% Chebyshev (MVUE) UCL	80.34
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.291	**Data appear Lognormal at 5% Significance Level**	
Theta Star	29.87		
nu star	26.15		
Approximate Chi Square Value (.05)	15.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0447	95% CLT UCL	14.55
Adjusted Chi Square Value	15.22	95% Jackknife UCL	14.68
		95% Standard Bootstrap UCL	14.45
Anderson-Darling Test Statistic	2.48	95% Bootstrap-t UCL	24
Anderson-Darling 5% Critical Value	0.864	95% Hall's Bootstrap UCL	20.14
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL	15.01
Kolmogorov-Smirnov 5% Critical Value	0.143	95% BCA Bootstrap UCL	16.54
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	24.24
		97.5% Chebyshev(Mean, Sd) UCL	30.98
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	44.21
95% Approximate Gamma UCL	14.65		
95% Adjusted Gamma UCL	14.91		
Potential UCL to Use		Use 97.5% Chebyshev (MVUE) UCL	55.09

ETHYLBENZENE

General Statistics			
Number of Valid Samples	62	Number of Unique Samples	55
Number of Missing Values	90		

Raw Statistics		Log-transformed Statistics	
Minimum	0.0011	Minimum of Log Data	-6.812
Maximum	470	Maximum of Log Data	6.153
Mean	24.57	Mean of log Data	0.484
Median	1.9	SD of log Data	2.825
SD	79.73		
Coefficient of Variation	3.245		
Skewness	4.794		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.393	Lilliefors Test Statistic	0.145
Lilliefors Critical Value	0.113	Lilliefors Critical Value	0.113
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	41.48	95% H-UCL	443.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	239.4
95% Adjusted-CLT UCL	47.81	97.5% Chebyshev (MVUE) UCL	314.3
95% Modified-t UCL	42.51	99% Chebyshev (MVUE) UCL	461.2
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.258	Data do not follow a Discernable Distribution (0.05)	
Theta Star	95.26		
nu star	31.98		
Approximate Chi Square Value (.05)	20.06	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0461	95% CLT UCL	41.23
Adjusted Chi Square Value	19.83	95% Jackknife UCL	41.48
		95% Standard Bootstrap UCL	40.7
Anderson-Darling Test Statistic	2.578	95% Bootstrap-t UCL	81.14
Anderson-Darling 5% Critical Value	0.882	95% Hall's Bootstrap UCL	104.5
Kolmogorov-Smirnov Test Statistic	0.18	95% Percentile Bootstrap UCL	43.02
Kolmogorov-Smirnov 5% Critical Value	0.124	95% BCA Bootstrap UCL	48.83
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	68.71
		97.5% Chebyshev(Mean, Sd) UCL	87.81
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	125.3
95% Approximate Gamma UCL	39.18		
95% Adjusted Gamma UCL	39.62		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	125.3

METHYL ETHYL KETONE

General Statistics

Number of Valid Samples	7	Number of Unique Samples	7
Number of Missing Values	146		

Raw Statistics		Log-transformed Statistics	
Minimum	0.01	Minimum of Log Data	-4.605
Maximum	0.26	Maximum of Log Data	-1.347
Mean	0.0537	Mean of log Data	-3.653

Median	0.02	SD of log Data	1.104
SD	0.0913		
Coefficient of Variation	1.7		
Skewness	2.601		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.536	Shapiro Wilk Test Statistic	0.804
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.121	95% H-UCL	0.288
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.12
95% Adjusted-CLT UCL	0.147	97.5% Chebyshev (MVUE) UCL	0.153
95% Modified-t UCL	0.126	99% Chebyshev (MVUE) UCL	0.218
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.559	**Data appear Lognormal at 5% Significance Level**	
Theta Star	0.096		
nu star	7.831		
Approximate Chi Square Value (.05)	2.638	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	0.11
Adjusted Chi Square Value	1.819	95% Jackknife UCL	0.121
		95% Standard Bootstrap UCL	0.107
Anderson-Darling Test Statistic	1.063	95% Bootstrap-t UCL	0.574
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL	0.439
Kolmogorov-Smirnov Test Statistic	0.375	95% Percentile Bootstrap UCL	0.12
Kolmogorov-Smirnov 5% Critical Value	0.322	95% BCA Bootstrap UCL	0.157
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.204
		97.5% Chebyshev(Mean, Sd) UCL	0.269
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.397
95% Approximate Gamma UCL	0.159		
95% Adjusted Gamma UCL	0.231		
Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	0.12

NAPHTHALENE

General Statistics

Number of Valid Samples	15	Number of Unique Samples	15
Number of Missing Values	137		
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0073	Minimum of Log Data	-4.92
Maximum	8.6	Maximum of Log Data	2.152
Mean	2.487	Mean of log Data	-0.359
Median	2.4	SD of log Data	2.463
SD	2.48		
Coefficient of Variation	0.997		
Skewness	1.095		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.802
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.614	95% H-UCL	534.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	33.87
95% Adjusted-CLT UCL	3.733	97.5% Chebyshev (MVUE) UCL	44.96
95% Modified-t UCL	3.644	99% Chebyshev (MVUE) UCL	66.74
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.445	**Data appear Normal at 5% Significance Level**	
Theta Star	5.594		
nu star	13.34		
Approximate Chi Square Value (.05)	6.119	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	3.54
Adjusted Chi Square Value	5.528	95% Jackknife UCL	3.614
		95% Standard Bootstrap UCL	3.508
Anderson-Darling Test Statistic	0.723	95% Bootstrap-t UCL	3.913
Anderson-Darling 5% Critical Value	0.793	95% Hall's Bootstrap UCL	4.019
Kolmogorov-Smirnov Test Statistic	0.23	95% Percentile Bootstrap UCL	3.519
Kolmogorov-Smirnov 5% Critical Value	0.234	95% BCA Bootstrap UCL	3.635
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.277
		97.5% Chebyshev(Mean, Sd) UCL	6.485
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8.857
95% Approximate Gamma UCL	5.419		
95% Adjusted Gamma UCL	5.999		
Potential UCL to Use		Use 95% Student's-t UCL	3.614

TOLUENE

General Statistics			
Number of Valid Samples	50	Number of Unique Samples	42
Number of Missing Values	94		
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.004	Minimum of Log Data	-5.521
Maximum	150	Maximum of Log Data	5.011
Mean	13.99	Mean of log Data	-0.234
Median	0.905	SD of log Data	2.701
SD	35.63		
Coefficient of Variation	2.546		
Skewness	2.848		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.445	Shapiro Wilk Test Statistic	0.958

Shapiro Wilk Critical Value	0.947	Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	22.44	95% H-UCL	175
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	82.5
95% Adjusted-CLT UCL	24.45	97.5% Chebyshev (MVUE) UCL	108.3
95% Modified-t UCL	22.78	99% Chebyshev (MVUE) UCL	159.1
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.246	Data appear Lognormal at 5% Significance Level	
Theta Star	56.86		
nu star	24.61		
Approximate Chi Square Value (.05)	14.32	Nonparametric Statistics	
Adjusted Level of Significance	0.0452	95% CLT UCL	22.28
Adjusted Chi Square Value	14.08	95% Jackknife UCL	22.44
		95% Standard Bootstrap UCL	22.27
Anderson-Darling Test Statistic	3.281	95% Bootstrap-t UCL	27.38
Anderson-Darling 5% Critical Value	0.886	95% Hall's Bootstrap UCL	22.1
Kolmogorov-Smirnov Test Statistic	0.22	95% Percentile Bootstrap UCL	22.71
Kolmogorov-Smirnov 5% Critical Value	0.138	95% BCA Bootstrap UCL	24.54
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	35.96
		97.5% Chebyshev(Mean, Sd) UCL	45.47
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	64.14
95% Approximate Gamma UCL	24.06		
95% Adjusted Gamma UCL	24.46		
Potential UCL to Use		Use 97.5% Chebyshev (MVUE) UCL	108.3

TPH-D

General Statistics			
Number of Valid Samples	125	Number of Unique Samples	95
Number of Missing Values	29		
Raw Statistics		Log-transformed Statistics	
Minimum	1.1	Minimum of Log Data	0.0953
Maximum	16000	Maximum of Log Data	9.68
Mean	768.5	Mean of log Data	4.572
Median	120	SD of log Data	2.319
SD	1920		
Coefficient of Variation	2.498		
Skewness	5.063		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.345	Lilliefors Test Statistic	0.0637
Lilliefors Critical Value	0.0792	Lilliefors Critical Value	0.0792
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	

95% Student's-t UCL	1053	95% H-UCL	3027
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3375
95% Adjusted-CLT UCL	1134	97.5% Chebyshev (MVUE) UCL	4265
95% Modified-t UCL	1066	99% Chebyshev (MVUE) UCL	6012
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.325	**Data appear Lognormal at 5% Significance Level**	
Theta Star	2362		
nu star	81.34		
Approximate Chi Square Value (.05)	61.56	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0481	95% CLT UCL	1051
Adjusted Chi Square Value	61.36	95% Jackknife UCL	1053
		95% Standard Bootstrap UCL	1045
Anderson-Darling Test Statistic	3.504	95% Bootstrap-t UCL	1183
Anderson-Darling 5% Critical Value	0.861	95% Hall's Bootstrap UCL	1300
Kolmogorov-Smirnov Test Statistic	0.125	95% Percentile Bootstrap UCL	1071
Kolmogorov-Smirnov 5% Critical Value	0.0898	95% BCA Bootstrap UCL	1168
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1517
		97.5% Chebyshev(Mean, Sd) UCL	1841
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2477
95% Approximate Gamma UCL	1015		
95% Adjusted Gamma UCL	1019		
Potential UCL to Use		Use 95% H-UCL	3027

TPH-G

General Statistics

Number of Valid Samples	80	Number of Unique Samples	66
Number of Missing Values	73		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.1	Minimum of Log Data	-2.303
Maximum	30000	Maximum of Log Data	10.31
Mean	1117	Mean of log Data	4.533
Median	175	SD of log Data	2.999
SD	3491		
Coefficient of Variation	3.125		
Skewness	7.422		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.375	Lilliefors Test Statistic	0.122
Lilliefors Critical Value	0.0991	Lilliefors Critical Value	0.0991
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1767	95% H-UCL	40402
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22883
95% Adjusted-CLT UCL	2105	97.5% Chebyshev (MVUE) UCL	30031
95% Modified-t UCL	1821	99% Chebyshev (MVUE) UCL	44071

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.278	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	4014		
nu star	44.53		
Approximate Chi Square Value (.05)	30.22	Nonparametric Statistics	
Adjusted Level of Significance	0.047	95% CLT UCL	1759
Adjusted Chi Square Value	30.01	95% Jackknife UCL	1767
		95% Standard Bootstrap UCL	1764
Anderson-Darling Test Statistic	0.919	95% Bootstrap-t UCL	2929
Anderson-Darling 5% Critical Value	0.874	95% Hall's Bootstrap UCL	4156
Kolmogorov-Smirnov Test Statistic	0.0877	95% Percentile Bootstrap UCL	1876
Kolmogorov-Smirnov 5% Critical Value	0.109	95% BCA Bootstrap UCL	2491
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2818
		97.5% Chebyshev(Mean, Sd) UCL	3554
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5000
95% Approximate Gamma UCL	1646		
95% Adjusted Gamma UCL	1658		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	1658

TPH-K

General Statistics			
Number of Valid Samples	25	Number of Unique Samples	22
Number of Missing Values	129		

Raw Statistics		Log-transformed Statistics	
Minimum	1	Minimum of Log Data	0
Maximum	9400	Maximum of Log Data	9.148
Mean	672.1	Mean of log Data	3.736
Median	22	SD of log Data	2.527
SD	2009		
Coefficient of Variation	2.99		
Skewness	3.952		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.374	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.918	Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1360	95% H-UCL	12711
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2626
95% Adjusted-CLT UCL	1672	97.5% Chebyshev (MVUE) UCL	3470
95% Modified-t UCL	1413	99% Chebyshev (MVUE) UCL	5127
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.251	Data appear Lognormal at 5% Significance Level	
Theta Star	2675		

nu star	12.56
Approximate Chi Square Value (.05)	5.598
Adjusted Level of Significance	0.0395
Adjusted Chi Square Value	5.283
Anderson-Darling Test Statistic	1.736
Anderson-Darling 5% Critical Value	0.871
Kolmogorov-Smirnov Test Statistic	0.214
Kolmogorov-Smirnov 5% Critical Value	0.191
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
95% Approximate Gamma UCL	1508
95% Adjusted Gamma UCL	1598
Potential UCL to Use	

Nonparametric Statistics	
95% CLT UCL	1333
95% Jackknife UCL	1360
95% Standard Bootstrap UCL	1311
95% Bootstrap-t UCL	6626
95% Hall's Bootstrap UCL	4424
95% Percentile Bootstrap UCL	1401
95% BCA Bootstrap UCL	1928
95% Chebyshev(Mean, Sd) UCL	2424
97.5% Chebyshev(Mean, Sd) UCL	3182
99% Chebyshev(Mean, Sd) UCL	4671
Use 99% Chebyshev (MVUE) UCL	5127

TPH-MO

General Statistics

Number of Valid Samples	77	Number of Unique Samples	59
Number of Missing Values	77		

Raw Statistics		**Log-transformed Statistics**	
Minimum	6.5	Minimum of Log Data	1.872
Maximum	13000	Maximum of Log Data	9.473
Mean	779.2	Mean of log Data	5.129
Median	160	SD of log Data	1.722
SD	2027		
Coefficient of Variation	2.601		
Skewness	4.837		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.352	Lilliefors Test Statistic	0.0764
Lilliefors Critical Value	0.101	Lilliefors Critical Value	0.101
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1164	95% H-UCL	1355
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1590
95% Adjusted-CLT UCL	1295	97.5% Chebyshev (MVUE) UCL	1971
95% Modified-t UCL	1185	99% Chebyshev (MVUE) UCL	2719
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.418	**Data appear Lognormal at 5% Significance Level**	
Theta Star	1864		
nu star	64.37		
Approximate Chi Square Value (.05)	46.92	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0469	95% CLT UCL	1159
Adjusted Chi Square Value	46.63	95% Jackknife UCL	1164

		95% Standard Bootstrap UCL	1155
Anderson-Darling Test Statistic	3.782	95% Bootstrap-t UCL	1702
Anderson-Darling 5% Critical Value	0.836	95% Hall's Bootstrap UCL	2818
Kolmogorov-Smirnov Test Statistic	0.204	95% Percentile Bootstrap UCL	1154
Kolmogorov-Smirnov 5% Critical Value	0.109	95% BCA Bootstrap UCL	1355
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1786
		97.5% Chebyshev(Mean, Sd) UCL	2222
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3077
95% Approximate Gamma UCL	1069		
95% Adjusted Gamma UCL	1076		
Potential UCL to Use		Use 95% H-UCL	1355

XYLENES, TOTAL

General Statistics

Number of Valid Samples	71	Number of Unique Samples	66
Number of Missing Values	83		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0012	Minimum of Log Data	-6.725
Maximum	992	Maximum of Log Data	6.9
Mean	48.07	Mean of log Data	0.511
Median	1.7	SD of log Data	3.174
SD	142.9		
Coefficient of Variation	2.974		
Skewness	4.819		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.368	Lilliefors Test Statistic	0.075
Lilliefors Critical Value	0.105	Lilliefors Critical Value	0.105
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	76.34	95% H-UCL	1696
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	688.8
95% Adjusted-CLT UCL	86.34	97.5% Chebyshev (MVUE) UCL	909.7
95% Modified-t UCL	77.96	99% Chebyshev (MVUE) UCL	1344
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.217	**Data appear Lognormal at 5% Significance Level**	
Theta Star	222		
nu star	30.75		
Approximate Chi Square Value (.05)	19.08	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0466	95% CLT UCL	75.97
Adjusted Chi Square Value	18.89	95% Jackknife UCL	76.34
		95% Standard Bootstrap UCL	75.98
Anderson-Darling Test Statistic	3.221	95% Bootstrap-t UCL	100.2
Anderson-Darling 5% Critical Value	0.903	95% Hall's Bootstrap UCL	157.8
Kolmogorov-Smirnov Test Statistic	0.203	95% Percentile Bootstrap UCL	78.79

Kolmogorov-Smirnov 5% Critical Value	0.117	95% BCA Bootstrap UCL	89.81
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	122
		97.5% Chebyshev(Mean, Sd) UCL	154
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	216.8
95% Approximate Gamma UCL	77.46		
95% Adjusted Gamma UCL	78.24		
Potential UCL to Use		Use 97.5% Chebyshev (MVUE) UCL	909.7

ISOPROPYLBENZENE

General Statistics

Number of Valid Samples	4	Number of Unique Samples	4
Number of Missing Values	140		

Raw Statistics		Log-transformed Statistics	
Minimum	0.21	Minimum of Log Data	-1.561
Maximum	1.5	Maximum of Log Data	0.405
Mean	0.603	Mean of log Data	-0.84
Median	0.35	SD of log Data	0.898
SD	0.609		
Coefficient of Variation	1.01		
Skewness	1.81		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.767	Shapiro Wilk Test Statistic	0.881
Shapiro Wilk Critical Value	0.748	Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.319	95% H-UCL	42.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.634
95% Adjusted-CLT UCL	1.397	97.5% Chebyshev (MVUE) UCL	2.093
95% Modified-t UCL	1.365	99% Chebyshev (MVUE) UCL	2.993
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.579	Data appear Normal at 5% Significance Level	
Theta Star	1.041		
nu star	4.63		
Approximate Chi Square Value (.05)	0.985	Nonparametric Statistics	
Adjusted Level of Significance	N/A	95% CLT UCL	1.103
Adjusted Chi Square Value	N/A	95% Jackknife UCL	1.319
		95% Standard Bootstrap UCL	1.041
Anderson-Darling Test Statistic	0.464	95% Bootstrap-t UCL	13.87
Anderson-Darling 5% Critical Value	0.662	95% Hall's Bootstrap UCL	5.021
Kolmogorov-Smirnov Test Statistic	0.276	95% Percentile Bootstrap UCL	1.178
Kolmogorov-Smirnov 5% Critical Value	0.399	95% BCA Bootstrap UCL	1.185
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.929
		97.5% Chebyshev(Mean, Sd) UCL	2.503
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3.63

95% Approximate Gamma UCL	2.831		
95% Adjusted Gamma UCL	N/A		
Potential UCL to Use		Use 95% Student's-t UCL	1.319

N-BUTYLBENZENE

General Statistics

Number of Valid Samples	4	Number of Unique Samples	4
Number of Missing Values	140		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0072	Minimum of Log Data	-4.934
Maximum	4.1	Maximum of Log Data	1.411
Mean	1.802	Mean of log Data	-0.668
Median	1.55	SD of log Data	2.884
SD	1.708		
Coefficient of Variation	0.948		
Skewness	0.834		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.781
Shapiro Wilk Critical Value	0.748	Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.812	95% H-UCL	1.038E+20
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22.04
95% Adjusted-CLT UCL	3.587	97.5% Chebyshev (MVUE) UCL	29.63
95% Modified-t UCL	3.871	99% Chebyshev (MVUE) UCL	44.55
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.293	**Data appear Normal at 5% Significance Level**	
Theta Star	6.153		
nu star	2.343		
Approximate Chi Square Value (.05)	0.208	**Nonparametric Statistics**	
Adjusted Level of Significance	N/A	95% CLT UCL	3.207
Adjusted Chi Square Value	N/A	95% Jackknife UCL	3.812
		95% Standard Bootstrap UCL	3.01
Anderson-Darling Test Statistic	0.467	95% Bootstrap-t UCL	4.376
Anderson-Darling 5% Critical Value	0.681	95% Hall's Bootstrap UCL	11.62
Kolmogorov-Smirnov Test Statistic	0.353	95% Percentile Bootstrap UCL	3.077
Kolmogorov-Smirnov 5% Critical Value	0.41	95% BCA Bootstrap UCL	3.4
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.525
		97.5% Chebyshev(Mean, Sd) UCL	7.136
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.3
95% Approximate Gamma UCL	20.32		
95% Adjusted Gamma UCL	N/A		
Potential UCL to Use		Use 95% Student's-t UCL	3.812

N-PROPYLBENZENE

General Statistics

Number of Valid Samples	7	Number of Unique Samples	7
Number of Missing Values	137		

Raw Statistics		Log-transformed Statistics	
Minimum	0.012	Minimum of Log Data	-4.423
Maximum	6.7	Maximum of Log Data	1.902
Mean	1.653	Mean of log Data	-0.504
Median	0.77	SD of log Data	1.97
SD	2.316		
Coefficient of Variation	1.401		
Skewness	2.251		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.7	Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.354	95% H-UCL	889
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.992
95% Adjusted-CLT UCL	3.889	97.5% Chebyshev (MVUE) UCL	13.24
95% Modified-t UCL	3.478	99% Chebyshev (MVUE) UCL	19.61
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.445	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	3.715		
nu star	6.23		
Approximate Chi Square Value (.05)	1.759	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	3.093
Adjusted Chi Square Value	1.136	95% Jackknife UCL	3.354
		95% Standard Bootstrap UCL	3.013
Anderson-Darling Test Statistic	0.278	95% Bootstrap-t UCL	7.999
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	9.466
Kolmogorov-Smirnov Test Statistic	0.203	95% Percentile Bootstrap UCL	3.279
Kolmogorov-Smirnov 5% Critical Value	0.325	95% BCA Bootstrap UCL	3.959
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.469
		97.5% Chebyshev(Mean, Sd) UCL	7.12
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.36
95% Approximate Gamma UCL	5.856		
95% Adjusted Gamma UCL	9.069		
Potential UCL to Use		Use 95% Approximate Gamma UCL	5.856

SEC-BUTYLBENZENE

General Statistics			
Number of Valid Samples	5	Number of Unique Samples	5
Number of Missing Values	133		

Raw Statistics		Log-transformed Statistics	
Minimum	0.18	Minimum of Log Data	-1.715
Maximum	0.33	Maximum of Log Data	-1.109
Mean	0.246	Mean of log Data	-1.423
Median	0.25	SD of log Data	0.229
SD	0.0568		
Coefficient of Variation	0.231		
Skewness	0.593		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Test Statistic	0.983
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.3	95% H-UCL	0.32
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.356
95% Adjusted-CLT UCL	0.295	97.5% Chebyshev (MVUE) UCL	0.403
95% Modified-t UCL	0.301	99% Chebyshev (MVUE) UCL	0.496
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	9.691	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0254		
nu star	96.91		
Approximate Chi Square Value (.05)	75.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	0.288
Adjusted Chi Square Value	66.88	95% Jackknife UCL	0.3
		95% Standard Bootstrap UCL	0.283
Anderson-Darling Test Statistic	0.209	95% Bootstrap-t UCL	0.312
Anderson-Darling 5% Critical Value	0.679	95% Hall's Bootstrap UCL	0.298
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL	0.286
Kolmogorov-Smirnov 5% Critical Value	0.357	95% BCA Bootstrap UCL	0.284
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.357
		97.5% Chebyshev(Mean, Sd) UCL	0.405
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.499
95% Approximate Gamma UCL	0.317		
95% Adjusted Gamma UCL	0.356		
Potential UCL to Use		Use 95% Student's-t UCL	0.3

DATA ENTRY SHEET

GW-SCREEN
Version 3.0; 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES: X

DTSC
Vapor Intrusion Guidance
Interim Final 12/04
(last modified 2/4/09)

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432	1.99E+03	Benzene

MORE ê

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	168	sc	20	5

MORE ê

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
sc	OR		sc	1.63	0.385	0.197

MORE ê

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	25	25	250

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	2.9E-05	3.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
153	0.188	0.299	1.77E-09	0.837	1.48E-09	30.00	0.385	0.030	0.355	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
3.39E+04	1.00E+06	5.00E-03	15	8,019	4.39E-03	1.83E-01	1.78E-04	2.27E-03	1.66E-05	8.23E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
153	15	3.64E+05	1.25	8.33E+01	2.27E-03	5.00E+03	6.74E+31	1.58E-05	5.73E+00	2.9E-05	3.0E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.79E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.1E-05	1.3E-01

MESSAGE SUMMARY BELOW:

END

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