BOARD OF WATER SUPPLY

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December 13, 2016

Dr. Virginia Pressler
Director
State of Hawaii
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Pressler:

Subject: Results of Toxicology Study and Request for Immediate Action in Response to Releases to Groundwater at the Red Hill Bulk Fuel Storage Facility

The Board of Water Supply (BWS) writes to inform the Hawaii Department of Health (DOH) of the results of a toxicological study and risk assessment that BWS has performed on the groundwater in the vicinity of the Red Hill Bulk Fuel Storage Facility (the "Facility"), and to request an appropriate response. This study confirms that impacts to the groundwater beneath the underground storage tanks at the Facility pose an unacceptable risk to our critical drinking water resources. As the agency charged with managing Oahu's municipal water resources and providing residents with safe and dependable water service, we must request that the DOH exercise its authority to require the United States Navy and Defense Logistics Agency (DLA) to immediately take steps to address groundwater conditions to protect the public from this imminent and substantial threat to human health and the environment.

Since at least 2005, the Navy has been sampling the groundwater at and around the Facility to investigate the impact of fuel releases from its underground storage tanks, and monitoring data has demonstrated that various contaminants, including volatile organic chemicals and solvents, polyaromatic hydrocarbons, and lead, are present in the groundwater. Although the sampling conducted to date indicates that water provided by public water systems remains compliant with standards for safe drinking water, the results of the Navy's investigation make clear that the release of fuel from the Facility has impacted the very groundwater aquifers that sustain Honolulu's drinking water supply. Unfortunately, the Navy and DLA have done little in the ensuing decade to address these conditions and, as a result, the significant fuel releases from the Facility continue to impact this vital source of drinking water.

The Hawaii Constitution requires that, "[f]or the benefit of present and future generations, the State and its political subdivisions shall protect and conserve ... all natural resources, including ... water ... and shall promote the development and utilization of these resources ... in a manner consistent with their conservation" and further declares that "[a]ll public natural resources are held in trust for the benefit of the people." Haw. Const. art. XI, § 1; *see also* Haw. Const. art. XI, § 7 ("The State has an obligation to protect, control and regulate the use of Hawaii's water

resources for the benefit of its people."). The Supreme Court of Hawaii has concluded that this constitutional mandate "encompasses a duty to promote the reasonable and beneficial use of water resources in order to maximize their social and economic benefits to the people of this state" and, moreover, this responsibility is "unlimited by any surface-ground distinction," extending to all water resources, including groundwater. *In re Water Use Permit Applications*, 94 Haw. 97, 133-135, 139 (2000).

State policy for water resources in Hawaii is likewise directed toward achieving the highest water quality consistent with maximum benefit to the people of the state. See Hawaii Revised Statutes (H.R.S.) § 174C-2(c) (the Hawaii Water Code "shall be liberally interpreted to obtain maximum beneficial use of the waters of the State"). Pertinent here, drinking water is one of the highest beneficial use of groundwater. The Hawaii Water Code tasks the DOH with creating a water quality plan, which is intended to promote and implement the proper conservation and development of the waters of the state, the control of waters of the state for public purposes, the attainment of adequate water quality, and the implementation of the water resources policies expressed in the Water Code. H.R.S. § 174C-31(g). One of the water protection goals expressed in the DOH's draft water quality plan is to "[a]ssess the susceptibility of public drinking water sources and protect them from contamination."[1] The groundwater that nourishes Honolulu's drinking water supply undoubtedly deserves the utmost protection from potential environmental impacts.

Given the importance of our drinking water resources, the BWS has actively engaged in discussions with the United States Environmental Protection Agency (USEPA) and the DOH (collectively, the "Regulatory Agencies") to ensure that the Navy and DLA take appropriate corrective action to address all past and future fuel releases from the Facility, and has provided extensive comment throughout the Administrative Order on Consent (AOC) process with the objective of protecting residents from any potential harm attributable to the fuel released from the Facility. Notwithstanding these attempts at collaboration, insufficient progress has been made to achieve the AOC objective of "ensur[ing] that the groundwater resource in the vicinity of the Facility is protected and ensur[ing] that the Facility is operated and maintained in an environmentally protective manner." AOC § 1(b).

Since the groundwater aquifers near the Facility are valuable sources for drinking water, the BWS retained two duly-qualified experts, Exponent, Inc. and INTERA, Inc., to evaluate whether the concentrations of contaminants of concern in groundwater detected in monitoring wells at the Facility are potentially harmful to the public.[2] Exponent and INTERA, working independently of each other, used sampling data collected at the Facility between January 2011 and January 2016 and applied EPA-approved methods to derive contaminant screening levels representing drinking water concentrations where no adverse health effects are expected as a result of exposure. For total petroleum hydrocarbon as diesel fuel/middle distillates (TPH-d), Exponent and INTERA concluded that TPH-d concentrations below 210 µg/L and 162 µg/L, respectively

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[1] *See* Hawaii Department of Health, *Draft Water Quality Plan* (Aug. 4, 2014).

[2] The complete expert reports provided by Exponent and INTERA are attached as Attachment A and Attachment B, respectively.

do not pose an unacceptable risk to human health or the environment. The Exponent and INTERA screening levels are similar to and consistent with the DOH's environmental action levels for drinking water toxicity and gross contamination, which have been set at 160 µg/L and 100 µg/L TPH-d, respectively.[3] In short, the results of the BWS' toxicological study confirm the DOH's conservative and reasonable action levels for sites that threaten drinking water resources.

By contrast, the Red Hill Bulk Fuel Storage Facility Final Groundwater Protection Plan does not require the Navy to take any meaningful action until monitoring data demonstrates that concentrations of TPH-d in groundwater exceed 4,500 µg/L. It is our understanding from working with the Regulatory Agencies that this threshold is based on a solubility limit for jet fuel and/or diesel marine fuel, rather than a health-based value. As such, the BWS does not believe that this site-specific level is adequate to protect this invaluable drinking water source or the public. Nor does the BWS understand how the 4,500 µg/L solubility level approved in the groundwater protection plan is consistent with DOH guidance for advanced evaluations of environmental hazards posed by contaminated groundwater, which states:[4]

> Action levels for drinking water are not easily adjustable. Toxicity-based drinking water action levels for approximately 40% of the chemicals listed in the lookup tables are based on promulgated standards and cannot be changed (refer to Appendix 1). Action levels for the remaining chemicals are based on a USEPA model for tapwater. The latter could in theory be adjusted based on alternative exposure assumptions and toxicity factors but the approach used is relatively straight forward and rigid, and adjustment is considered unlikely. The same is true for drinking water action levels based on gross contamination, taste and odor concerns.

On the contrary, groundwater monitoring data has identified concentrations of TPH-d in excess of applicable environmental action levels. The results of the baseline risk assessment performed to assess the condition of the groundwater at the Facility indicate that the concentrations of TPH-d and associated target analytes present in groundwater pose an unacceptable risk to Oahu's drinking water supply, and thus immediate action to address these conditions is warranted.

The potential for migration of TPH-d and/or other constituents to nearby drinking water wells necessitates that the groundwater conditions under the tanks at the Facility be addressed as quickly as possible. The public cannot afford to await the results of a lengthy site-specific evaluation of plume mobility in light of this serious threat to our drinking water resources.

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[3] *See* Hawaii Department of Health, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater Volume 2: Background Documentation for Development of Tier 1 Environmental Action Levels Appendix 1: Detailed Lookup Tables, Hawaii Ed.* (Summer 2016, rev Nov. 2016) at tbl. D-1b. The Exponent and INTERA screening levels are also similar to and consistent with drinking water criteria for total petroleum hydrocarbons established by Massachusetts and Minnesota, which have each been set at 200 µg/L.

[4] *See* Hawaii Department of Health, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater Volume 1: User's Guide, Hawaii Ed.* (Summer 2016, rev Nov. 2016) at 4-19.

Moreover, given the immense volume of fuel maintained at the Facility, the fact that the tanks at the Facility are over 70 years old, and the likelihood that an ongoing or catastrophic release may occur, time is of the essence to take action. Accordingly, the BWS respectfully requests that the DOH fulfill its constitutional and statutory duty to protect Hawaii's important drinking water resources by exercising its powers under Hawaii Revised Statutes chapters 340E, 342D, and 342L and any other applicable statutes or regulations, to require the Navy and DLA to immediately address the groundwater conditions in the vicinity of the Facility to the 100 µg/L TPH-d gross contamination taste and odor threshold and to expedite all necessary tank repairs and/or relocation efforts. In addition, the BWS respectfully requests that the DOH require the Navy and DLA to increase the frequency of groundwater monitoring from quarterly to monthly so as to facilitate a rapid and complete characterization of the drinking water source quality in the vicinity of several public water supply systems near the Facility.

If you have any questions, please feel free to call me at 808-748-5061.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

Enclosures

cc: Bryan P. Andaya, Board Chair
Gina McCarthy, U.S. Environmental Protection Agency
Alexis Strauss, U.S. Environmental Protection Agency Region IX
Steven Chang, State of Hawaii Department of Health

ATTACHMENT “A”

Development of Drinking Water Screening Levels for TPHs and Associated Chemicals

Prepared for:
Honolulu Board of Water Supply

Prepared by
Exponent
1800 Diagonal Road
Suite 500
Alexandria, VA 22314

December 10, 2016

Exponent®

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Acronyms and Abbreviations

COPC	chemicals of potential concern
CSF	cancer oral slope factor
DOH	Department of Health
EPA	U.S. Environmental Protection Agency
HI	hazard index
HQ	hazard quotient
LOD	limit of detection
RfD	reference dose, oral
RHSF	Red Hill Bulk Fuel Storage Facility
TPH	total petroleum hydrocarbon

Limitations

The conclusions and recommendations presented herein are based on the work performed as described below. Exponent reserves the right to revise these conclusions and recommendations if and when additional credible information becomes available. We have made every effort to accurately and completely present all areas of concern identified during our analysis. If there are perceived omissions or misstatements in this presentation regarding any aspect of our work, we ask that they be brought to our attention as soon as possible so we have the opportunity to address them fully.

Exponent has relied on the monitoring data provided by Intera, Inc. in this analysis; the accuracy of these data are the responsibility of Intera. These data were used to derive screening drinking water concentrations for Total Petroleum Hydrocarbon (TPH) fractions according to the EPA (2009) recommended approach. This is a risk assessment-based approach and therefore, this analysis is limited by the specific assumptions adopted and the inherent uncertainties in this method.

Executive Summary

At the Red Hill Bulk Fuel Storage Facility (RHSF) on Oahu, Hawaii, 20 underground jet fuel storage tanks have been monitored for over a decade. Monitoring has included the analysis of specific chemicals as well as various types of petroleum hydrocarbon mixtures in groundwater. Exponent was requested to develop acceptable drinking water concentrations for the total petroleum hydrocarbons (TPHs) detected at RHSF. The U.S. Environmental Protection Agency method (EPA 2009) for assessing risks from exposure to complex mixtures of petroleum hydrocarbons was used as the framework to derive site-specific screening concentrations in drinking water.

A total of 64 chemicals have been monitored for at the RHSF. Chemicals have been selected as representative of chemical constituents associated with jet fuel and marine diesel fuel (DON 2016). These include volatile organic chemicals and solvents, polyaromatic hydrocarbons, and lead. In addition, three sub-types of TPHs were analyzed at RHSF: TPH-g (gasoline), TPH-d (diesel), and TPH-o (oil). Categorization of TPHs depends on the purpose and analytical method used. Collectively, they represent a range of compounds from short to long chain aliphatic compounds. TPH-g is total petroleum hydrocarbons as gasoline and includes the more volatile and short chain constituents; some analytical methods describe this sub-type as including chains of 6 to 10 carbons (C6-C10). The TPH-g samples were considered to represent the low carbon aliphatic fraction in this analysis, which EPA (2009) has designated to include aliphatics of C5-C8. TPH-d is total petroleum hydrocarbons as diesel and has been described as the middle distillates of 10 to 28 carbon-chain length. The TPH-d represents the medium carbon fraction of aliphatics in this analysis or C9-C18 as characterized in EPA (2009). TPH-o is total petroleum hydrocarbons as oil and is composed of the heaviest constituents with the longest carbon chains, presumably greater than 28 carbons. TPH-o is considered to represent the high carbon aliphatic fraction in this analysis and are designated by EPA (2009) to include C19-C32. The specific carbon chain length for each of the TPH sub-types analyzed at RHSF are unknown.

Exponent's analysis of the monitoring data and derivation of screening levels was based on the most current six years of groundwater monitoring data (2010 – 2015). Only monitoring well data were included; the monitoring at a drinking water well location was not included. Field

duplicates were excluded from estimates of potential exposure. Chemicals of potential concern (COPCs) were identified as those that had been detected at least once between 2010 and 2015. Daily and lifetime intakes of the COPCs were estimated based on mean groundwater concentrations and assuming that the samples designated as "non-detect" were present at one-half the limit of detection (LOD).

Our approach to deriving screening drinking water concentrations was based on the site-specific monitoring data and the risks associated with the COPCs within the EPA TPH framework. The estimated risks based on the monitoring data provided an understanding of the risk profile at the site. This risk profile and the relative contribution that each chemical added to the total risk was the foundation for developing site-specific screening levels for drinking water.

Non-cancer-based screening concentrations for drinking water were developed under a series of scenarios that reflect the risk profile for one of the six years of monitoring data analyzed in this report. Scenario 1 assumed that the COPC representing the greatest contribution to the risk profile for all six years, TPH-d (diesel fraction), was the only chemical present. Scenario 1 resulted in a screening concentration of 280 µg/L for TPH-d. If TPH-d is present at that concentration, no other chemical can be present in the drinking water without exceeding the target risk, and therefore, is not appropriate for screening the mixture of chemicals present at RHSF. Scenario 2 was developed based on the risk profile from 2011, when TPH-d contributed the least to the overall risk, resulting in a screening concentration of 262 µg/L TPH-d. In this scenario, screening levels were estimated for the other COPCs, although many of these water concentrations were low in comparison to drinking water standards. In Scenario 3, the relative contribution to risk for TPH-d was set arbitrarily at 90% of the overall risk profile, which equates to a screening concentration of 252 µg/L for TPH-d and higher screening water concentrations for the other COPCs. The contribution of TPH-d was set to an even lower proportion of overall risk at 75% in a fourth scenario, which resulted in a screening concentration of 210 µg/L for TPH-d.

Cancer-based screening drinking water concentrations were developed based on a range of acceptable target risks for cancer: 1 in 10,000 to 1 in one million. Cancer-based screening levels are only available for eight of the COPCs, as these were the only chemicals that are considered

by EPA to be carcinogens and have an oral cancer slope factor (CSF) from which to estimate risk. An age-adjustment was also incorporated into the derivation of cancer-based screening levels to account for a potentially greater susceptibility for cancer in younger individuals (EPA 2005a). The cancer assessment results in much lower screening concentrations for drinking water than the non-cancer-based assessment for those eight chemicals.

A number of limitations exist with this analysis that may impact the interpretation of the proposed screening levels. Key concerns that may affect the potential risks include the high LOD of the analytical method for some chemicals and time periods from the monitoring wells. Use of high LODs could result in a failure to detect chemicals that are actually present, but at low levels; therefore, these chemicals would not have been selected as COPCs and underestimate the risk. Alternatively, a high LOD for a COPC will likely result in a higher mean groundwater concentration (represented as half of the LOD for non-detect samples) and overestimate the potential risk.

An additional factor that affects the proposed screening concentrations for drinking water is the presumption of an additive model of risk that does not take into account mode of action and target organ toxicity. Estimates were made using the cautious assumption that non-cancer effects for different chemicals could be added to each other in proportion to their dose, despite the lack of any such evidence. For non-cancer effects, the risk assessment tends to be driven nearly completely by a single category of TPH contaminants, TPH-d. Cancer potency was also added over the different chemicals, for which a CSF existed. There are no data available to support or refute this addition. The risks estimates for cancer are much lower than the cancer screening levels.

The screening levels developed as Scenario 4 in the non-cancer assessment and the age-adjusted values for a 1 in 10,000 risk level were also compared to the Hawaii Department of Health (DOH) exposure action levels (EAL), EPA maximum contaminant levels (MCL), and EPA drinking water equivalent level (DWEL) values. The majority of the proposed screening levels are below these regulatory standards. Given the fact that some of these regulatory standards are based on technology or analytical limitations, the screening levels developed in this report may

not be achievable. Additional consideration will need to be given to the analytical methods for the various constituents being monitored for at RHSF.

The proposed screening level of 210 µg/L for TPH-d in drinking water (Scenario 4) is protective of public health because it is based ingestion the water over the course of a lifetime (70 years) without any appreciable risk to human health. The Hawaii EAL for drinking water based on toxicity (190 µg/L) is similar to the proposed screening level. However, an alternative EAL has been established for gross contamination based on the taste and odor threshold for TPHs at 100 µg/L. Given the potential for public concerns regarding the palatability of the drinking water, it is recommended that the Hawaii EAL of 100 µg/L be relied on as the clean-up level for TPHs.

Background and Recommended Approach

The RHSF is a US federal government site located in Halawa Heights on the Island of Oahu which contains 18 active and two inactive underground jet fuel storage tanks. The site is operated by the Naval Supply Systems Command Fleet Logistics Center (NAVSUP FLC Pearl Harbor), and compliance of groundwater monitoring well testing is overseen by the Hawaii Department of Health (DOH).

Monitoring is performed quarterly to assess the potential leaching of chemical constituents associated with jet fuel and marine diesel fuel into the local groundwater. A total of 64 COPCs, including TPH components, have been historically monitored from a number of water sampling points. Five monitoring wells are located outside of the RHSF tunnel system (OWDFMW01, HDMW2253-03, RHMW04, RHMW06, and RHMW07) and four are located within the lower access tunnel (RHMW01, RHMW02, RHMW03, and RHMW05). One sampling point is within the nearest drinking water supply well in the Red Hill Shaft Well RHMW2254-01.

Exponent was requested to develop site-specific screening drinking water concentrations for TPHs. Our approach to developing the screening drinking water concentrations is described below. In brief, site-specific risks were estimated to determine the risk profile or the relative contribution of each COPC to overall risk. Screening levels were then derived based on the risk profile for the COPCs detected at RHSF and an acceptable target risk level.

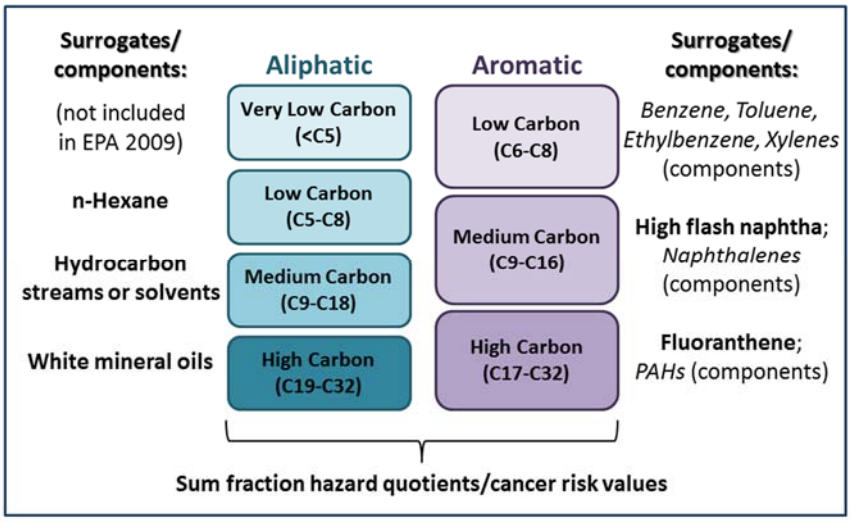
Our Approach

TPHs represent a complex mixture of chemicals derived from fuels and each constituent has its own health risks. Several different approaches exist to assess risks due to exposure from complex mixtures of hydrocarbons, including those developed by the Massachusetts Department of Environmental Protection (MADEP), the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG), and the US Environmental Protection Agency (EPA). The EPA guideline on “Provisional Peer-Reviewed Toxicity Values for Complex Mixtures of Aliphatic and Aromatic Hydrocarbons” (EPA 2009) builds on previous approaches (including MADEP and TPHCWG), incorporates EPA standard risk assessment methodology, and utilizes a hybrid

approach that combines the use of individual chemicals or a surrogate chemical to assess the toxicity of each fraction of the mixture. The EPA method was used for the derivation of site-specific screening levels in drinking water based on the chemicals detected in the monitoring wells of RHSF.

EPA's approach is a fraction-based risk assessment framework for complex mixtures of aliphatic and aromatic hydrocarbons. Fractions are based on the expected transport in the environment and analytical methods employed to identify and quantify petroleum hydrocarbon environmental contamination. Risks for non-cancer and cancer effects are determined separately. Toxicity values are assigned for each fraction, based on individual chemicals (components) or representatives of each fraction as a whole (surrogates). Dose-addition (for non-cancer) or response-addition (for cancer) is assumed across and within fractions to develop the risk assessment for the whole mixture. This additive risk approach is very conservative and does not take into account the potential differences in target organ toxicity or mode of action for individual chemicals. Figure 1 presents the TPH fractions with the respective surrogates or components for each fraction.[1]

Figure 1: TPH Fractions[2]



[1] This diagram includes a fraction for very low carbon (<C5) aliphatics that are not typically included in the EPA framework for assessing petroleum hydrocarbon mixtures, but were added to the analysis to incorporate the potential risks posed by these chemicals detected at the site.

[2] Surrogates (bold) and components (italicized) for each fraction are listed next to that fraction.

To assess total non-cancer health risks for TPHs, the hazard quotient (HQ) for each detected chemical is estimated based on the site-specific water concentration at the monitoring wells and proposed/established[3] "safe" daily oral concentrations for each component or surrogate. A hazard index (HI) for each of the fractions (e.g., aromatic low carbon) is calculated by summing the HQ for each component or surrogate in that fraction. In some cases, such as the aliphatic high carbon fraction which is represented by the detection of a single COPC, TPH-o, the HQ is equal to the HI. The calculated HIs for each fraction are then summed to derive a total risk estimate. A similar method is used for cancer risk estimations, where overall risk is determined by summing the cancer risks calculated for each fraction.

Screening levels for TPH chemicals in drinking water were based on the risk profile of COPCs detected in the monitoring wells at RHSF, the relative contribution of each compound to the overall risk, and an acceptable target risk level. Target risk levels were set as the HI=1 for non-cancer and 1 in 10,000 or 1 in one million for cancer. The drinking water concentrations are characterized as screening levels, because they are conservative and assume that the potential risks associated with the chemicals are additive. This approach does not take into account the differences in mode-of-action or target organ toxicity.

The individual steps in our approach to deriving site-specific drinking water concentrations are outlined below:

Step 1: Identification of COPCs and data analysis:

- Organized the cumulative monitoring data from wells at RHSF
- Identified COPCs
- Determined the mean water concentration for each COPC on an annual basis
- Categorized the COPCs into the appropriate fractions

[3] In most cases, an oral reference dose (RfD) exists for the COPCs. However, in some cases the regulatory threshold concentration is a proposed value as provided in EPA's PPRTV documentation.

Step 2: Risk estimate calculations:

- Calculated average daily or lifetime intakes for each COPC
- Calculated HQs and HIs (non-cancer)
- Calculated cancer risks

Step 3: Calculation of screening drinking water concentrations:

- Determined the relative contribution to the HI and total cancer risk for each COPC/fraction based on the annual/lifetime risk profile
- Based on the relative proportion to the total risk that each COPC contributed and the target risk level, screening drinking water concentrations were calculated for each COPC

Identification of COPCs and Data Analysis

As a first step, the monitoring data from wells at RHSF were organized by year and whether or not the chemical had been detected. Samples other than "water" were excluded, along with samples prior to 2010. The Red Hill Shaft Department of Navy (DON) drinking water well, RHMW2254-01, was excluded from the analysis as well. Field duplicates were also excluded from further analysis. COPCs were any chemical that had been detected at least once in a RHSF monitoring well between 2010 and 2015.

Sampling data were available for nine monitoring wells, although not all wells were active for the entire period of 2010 through 2015. Out of 64 chemicals monitored for at RHSF, 27 chemicals were selected as COPCs. All COPCs were analyzed each quarter, with the exception of TPH-o (residual fuels) which was not analyzed in 2010 and 2013.

Annual average groundwater concentrations were calculated for each COPC (these data are provided in Appendix A, Table A-1). Samples designated as "undetected" were assumed to be equal to half of the LOD in the calculation of the annual average groundwater concentrations. The LOD for each chemical was highly variable, with up to a 250-fold difference between the highest and lowest LOD. For those COPCs with limited detection (i.e., detected only once or twice and reported at levels less than LODs), this variability may have affected the annual groundwater averages. For the years without sampling data for TPH-o, the mean concentration based on data from the other four years of monitoring data was substituted as the groundwater concentration for 2010 and 2013.

COPCs were assigned to the fractions specified in the EPA guidance (EPA 2009). However, nine of the monitored chemicals selected as a COPC are not specifically included in EPA's approach for assessing a complex mixture of TPHs and cannot be classified into any of the six fraction categories. These include volatile organic chemicals (VOCs) such as 1,1,2,2-tetrachloroethane and acetone. Therefore, a seventh fraction category (very low carbon aliphatic) was added to accommodate these COPCs monitored at RHSF. Table 1 presents the 27 COPCs in their respective fractions.

Table 1: Fraction Assignment of COPCs

Category	Fraction	Chemical	# Carbons
Aliphatics	Very Low Carbon (<C5)	1,1,2,2-Tetrachloroethane	2
		1,2,3-Trichloropropane	3
		1,2-Dichloroethane	2
		Acetone	3
		Bromodichloromethane	1
		Chloroform	1
		Chloromethane (Methyl Chloride)	1
		Methylene Chloride (Dichloromethane)	1
		Methyl ethyl ketone	4
	Low Carbon Range (C5-C8)	TPH-g (gasoline)	?
	Medium Carbon Range (C9-C18)	TPH-d (middle distillates)	?
	High Carbon Range (C19-32)	TPH-o (residual fuels)	?
Aromatics	Low Carbon Range (C6-C8)	Benzene	6
		Toluene	7
		Ethylbenzene	8
		Xylenes	8
	Medium Carbon Range (C9-C16)	Acenaphthene	12
		Acenaphthylene	12
		Anthracene	14
		Fluorene	13
		Phenanthrene	14
		Pyrene	16
		1-Methylnaphthalene	11
		2-Methylnaphthalene	11
		Naphthalene	10
	High Carbon Range (C17-C32)	Fluoranthene	16
		Benz(a)anthracene	18

The chain lengths for the TPH sub-types at RHSF may not correspond directly with the EPA (2009) designated fractions; the exact number of carbons for each of the sub-types of TPHs in the RHSF samples are unknown. The EPA method 8015 is specified as the analytical method used to evaluate groundwater samples at RHSF. However, it is not clear which aliphatics and their respective chain length are included in each TPH-sub-type based on a general description of this method. Modifications to the method may also have been incorporated to analyze TPH-o, in particular. Further, it is not clear if any overlap exists in the analytical method for these sub-types (ATSDR 1999).

Finally, although fluoranthene has only 16 carbons, EPA recommends that this chemical is included in the high carbon range aromatics fraction (C17-C32). The inclusion of fluoranthene in this fraction is due to a lack of non-cancer toxicity reference values for the other compounds in this fraction and the availability of an RfD for fluoranthene (EPA 2009). Thus, fluoranthene serves as the surrogate for all of the chemicals included in this fraction.

Risk Estimates for Chemical Fractions

In order to derive site-specific screening concentrations for drinking water, the relative contribution of each COPC to the overall risk needed to be determined. Therefore, risk estimates were calculated for both non-cancer and cancer at the RHSF site in order to understand the site-specific risk profile based on the COPCs detected in the monitoring wells.

Non-cancer Risk

Non-cancer risk estimates are based on the ratio of a daily intake to a regulatory threshold dose. For oral exposures, the regulatory threshold dose typically relied on is an oral reference dose (i.e., RfD). The RfD is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive groups, such as asthmatics, or life stages, such as children or the elderly) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA 2002). The resulting ratio of the daily intake and the RfD is called the HQ (i.e., hazard quotient).

The mean daily intake was calculated for each COPC, based on the annual mean water concentrations as described above using standard EPA risk assessment methods (EPA 1989, 2014). The details and assumptions used in the intake equation are provided in Appendix B. An EPA recommended reference dose (RfD) or alternative oral intake value was available for all COPCs and were used in the calculation of HQs. This was calculated for each COPC or fraction by dividing the calculated daily intake by the oral reference value:

$$Hazard\ Quotient\ (HQ)_{chemical} = \frac{Daily\ Intake\ (mg/kg/day)}{RfD\ (mg/kg/day)}$$

HQ values were summed for each fraction to determine the HI for each of the six years (Table 2):

$$Hazard\ Index\ (HI) = \sum HQ_{chemical\ or\ fraction}$$

Table 2: Hazard Indices (HI) by TPH-Fraction and Year

Chemical	Hazard Index					
	2010	2011	2012	2013	2014	2015
1,1,2,2-Tetrachloroethane	0.041	0.041	0.049	0.073	0.068	0.026
1,2,3-Trichloropropane						
1,2-Dichloroethane						
Acetone						
Bromodichloromethane						
Chloroform						
Chloromethane (Methyl Chloride)						
Methylene Chloride (Dichloromethane)						
Methyl ethyl ketone						
TPH-g (gasoline)	0.004	0.001	0.003	0.006	0.003	0.002
TPH-d (middle distillates)	4.784	0.824	1.569	2.136	2.042	2.152
TPH-o (residual fuels)	0.001	0.001	0.001	0.001	0.0005	0.001
Benzene	0.001	0.002	0.003	0.003	0.002	0.001
Toluene						
Ethylbenzene						
Xylenes						
Acenaphthene	0.026	0.013	0.018	0.061	0.048	0.065
Acenaphthylene						
Anthracene						
Fluorene						
Phenanthrene						
Pyrene						
1-Methylnaphthalene						
2-Methylnaphthalene						
Naphthalene						
Fluoranthene	0.00006	0.0001	0.0001	0.00005	0.00004	0.00002
Benz(a)anthracene						

As described above, sampling data are lacking for TPH-o (residual fuels) in 2010 and 2013. The mean groundwater concentration for the years with monitoring data (i.e., 2011, 2012, 2014, and 2015) was used to derive a mean HQ for 2010 and 2013.

The HQs were summed for all fractions by year to determine the HI for each year as depicted in Figure 1. An HI of less than 1 would not trigger further evaluation because the non-cancer risks

for lifetime exposures resulting in HIs less than 1 are considered acceptable. The risk profile for COPCs presented in Table 2 demonstrate that TPH-d (diesel or middle distillates) is, by far, the greatest contributor to the overall non-cancer risk every year, with the largest HQ/HI, 4.784, in 2010. This was also the year with the highest mean groundwater concentration for TPH-d based on the monitoring data (Appendix A, Table A-1).

Cancer Risk

Cancer risk is estimated from a lifetime average daily intake and a cancer slope factor (CSF). The CSF is an upper-bound estimate of the average risk in a population or for a randomly selected individual (EPA 2005b). Cancer risks are typically presented as the risk of developing cancer on a population basis, such as a 1 in one million risk of developing cancer.

Only eight of the 27 COPCs had oral CSF values; these were used to estimate cancer risks. In contrast to the non-cancer risk estimation which evaluates daily exposure, a lifetime average daily intake was estimated assuming the average of six years of monitoring data are reflective of typical chemical concentrations over a lifetime of exposure (see Appendix B). The cancer risk was calculated for each of the COPCs with a CSF by multiplying the daily intake by the CSF:

$$Cancer\ Risk = Daily\ intake\ (mg/kg/day) \times CSF\ (per\ mg/kg/day)$$

EPA (2009) recommends using the well-established chemical mixture method of employing relative potency factors (RPFs) for polyaromatic hydrocarbons (PAHs), with benzo[a]pyrene used as the surrogate to represent the carcinogenicity of other PAHs. In the case of benz(a)anthracene, the RPF of 0.1 was multiplied by the CSF for benzo[a]pyrene to determine cancer risk. No other PAH identified as a COPC has been assigned a RPF, and therefore, has not been included in the estimation of cancer risk.

Table 3 presents the cancer risk profile for the eight COPCs, which were subsequently summed to determine the total cancer risk. The blank cells in the table are COPCs that are not considered carcinogenic and lack a CSF to estimate potential cancer risk.

Table 3: Lifetime Cancer Risk

Chemical	Lifetime Cancer Risk
1,1,2,2-Tetrachloroethane	4.31E-07
1,2,3-Trichloropropane	1.69E-04
1,2-Dichloroethane	2.06E-07
Acetone	—
Bromodichloromethane	1.29E-07
Chloroform	2.35E-08
Chloromethane (Methyl Chloride)	—
Methylene Chloride (Dichloromethane)	1.29E-08
Methyl ethyl ketone	—
TPH-g (gasoline)	—
TPH-d (middle distillates)	—
TPH-o (residual fuels)	—
Benzene	4.19E-08
Toluene	—
Ethylbenzene	—
Xylenes	—
Acenaphthene	—
Acenaphthylene	—
Anthracene	—
Fluorene	—
Phenanthrene	—
Pyrene	—
1-Methylnaphthalene	—
2-Methylnaphthalene	—
Naphthalene	—
Fluoranthene	—
Benz(a)anthracene	3.50E-07

The COPC with the greatest contribution towards the cancer risk profile is 1,2,3-trichloropropane. This is not due to particularly high concentrations of the chemical, but due to a large CSF value of 30. In fact, 1,2,3-trichloropropane was detected only once from 2010 – 2015 and at a concentration that was roughly half of the LOD for that sample. The cancer risk estimates for each of the other substances were less than one in a million (10^{-6}).

The cancer-based screening levels presented above are based on a risk profile developed using adult drinking water intake only. EPA has published supplementary guidance for assessing the

susceptibility to cancer in children (EPA 2005a). In the case of mutagens, it is recommended that CSFs be adjusted to account for a potential increase in susceptibility when individuals are exposed at an early age. In the case of drinking water, an additional adjustment is required to account for the differences in intake for an infant (≤2 years of age), child (>2 to 16 years old), and adults (≥16 years old). Of the eight COPCs for which cancer-based screening levels have been developed, only six are considered to be mutagens. Inclusion of an age-adjustment factor for the CSF and incorporating differences in intake, results in a 4.8-fold greater risk for all mutagenic COPCs (Table 4).

Table 4: Age-adjustment of Cancer Risk for Mutagenic Chemicals

Mutagenic Chemicals	Age-Adjusted Cancer Risk[1]	Mean Lifetime Cancer Risk	Fold-Difference
1,2,3-Trichloropropane	8.05E-04	1.69E-04	4.8
1,2-Dichloroethane	9.81E-07	2.06E-07	4.8
Bromodichloromethane	6.14E-07	1.29E-07	4.8
Methylene Chloride (Dichloromethane)	6.12E-08	1.29E-08	4.8
Benzene	1.99E-07	4.19E-08	4.8
Benz(a)anthracene	1.67E-06	3.50E-07	4.8

[1] Mean concentration multiplied by CSF is multiplied by the age-adjusted cancer risk factor (0.063)

Development of Groundwater Screening Concentrations

Screening concentrations for drinking water were derived from the site-specific risk profiles developed in the previous section of this report. Allowable concentrations in drinking water were estimated based on the chemicals being present in the same proportions as the risk profile, assuming an acceptable target risk level. For predicting drinking water concentrations based on non-cancer risks, the acceptable target risk was a HI of 1.0. The target cancer risk was selected to bracket the range of acceptable risk levels and was set at 1 in 10,000 or 1 in one million. Therefore, the water concentrations reflect the relative contributions of COPCs to risk at the RHSF site. For example, if TPH-d contributed 90% of the risk, then a screening drinking water concentration was calculated based on 90% of the acceptable risk being allocated to the TPH-d concentration. Separate assessments were conducted to estimate screening water concentrations based on non-cancer risks and cancer risks.

Non-cancer-based Screening Drinking Water Concentrations

Non-cancer-based screening drinking water concentrations were based on the relative contribution or percent of the total HI for each fraction or COPC, reflecting the annual risk profile (Table 5). As shown in Table 4, TPH-d (middle distillates) contributed the majority of the total risk, >93% for any given year (range of 93.4 – 98.5%).

Table 5: Percentage of Total Hazard Index (%HI) by TPH-Fraction and Year

Chemical	% Hazard Index					
	2010	2011	2012	2013	2014	2015
1,1,2,2-Tetrachloroethane	0.853	4.627	2.955	3.191	3.165	1.169
1,2,3-Trichloropropane						
1,2-Dichloroethane						
Acetone						
Bromodichloromethane						
Chloroform						
Chloromethane (Methyl Chloride)						
Methylene Chloride (Dichloromethane)						
Methyl ethyl ketone						
TPH-g (gasoline)	0.077	0.098	0.154	0.245	0.123	0.088
TPH-d (middle distillates)	98.486	93.420	95.520	93.698	94.341	95.741
TPH-o (residual fuels)	0.021	0.143	0.077	0.045	0.023	0.048
Benzene	0.030	0.244	0.168	0.125	0.114	0.049
Toluene						
Ethylbenzene						
Xylenes						
Acenaphthene	0.530	1.453	1.120	2.694	2.232	2.903
Acenaphthylene						
Anthracene						
Fluorene						
Phenanthrene						
Pyrene						
1-Methylnaphthalene						
2-Methylnaphthalene						
Naphthalene						
Fluoranthene	0.001	0.015	0.007	0.002	0.002	0.001
Benz(a)anthracene						
% HI Sum	100	100	100	100	100	100

Assuming an overall HI of 1 (100% of total HI) and the relative contribution of risk for a specific COPC, the non-cancer-based screening water concentrations were calculated based on a re-arrangement of the standard risk equation used to calculate mean daily intake (see Appendix C). As Table 5 demonstrates, there was variability in the distribution of risk among the 6 years of monitoring data. To capture a range of potential screening concentrations for drinking water and account for yearly variation in the proportions of total risk, four scenarios were developed.

The first scenario assumes that the fraction of TPH-d represents 100% of the overall non-cancer risk (Table 6). This scenario reflects the risk profile from 2010 where the TPH-d is 98.5% of the risk. Scenario 1 results in a screening water concentration of 280 µg/L TPH-d. In this case, if

TPH-d is present at the screening level of 280 µg/L, no other COPCs can be present in the groundwater samples without exceeding the target risk, and therefore, it is not appropriate for screening the mixture of chemicals present at RHSF.

Scenario 2 is based on the year in which TPH-d contributed the lowest proportion of total risk. This occurred in 2011, when TPH-d contributed 93.42% of the total non-cancer risk. The drinking water screening concentrations for the remaining COPCs were calculated assuming the same risk profile and associated contributions to total non-cancer risk. Consequently, the screening water concentrations for TPH-d was lower than in Scenario 1 or 261.57 µg/L TPH-d (Table 6). The screening levels for other COPCs were estimated to range from 120.19 µg/L for TPH-o to 0.06 µg/L for anthracene. In Scenario 2, several of the individual COPCs have extremely low screening levels. In fact, some of these levels are impractical based on the typical detection limits used to analyze these compounds. For example, the LOD range for acetone was 1.9 – 10 µg/L from 2010 to 2015 and in Scenario 2, the screening concentration is 1.08 µg/L. Thus, the analytical methods used over the last six years would not be sufficient to detect acetone at this concentration. In fact, the LOD became less precise and increased to 10 µg/L for all acetone measurements beginning in 2013. TPH-g is another example of a chemical whose proposed screening concentration would not be detectable with the historical analytical methods, as the screening concentration from Scenario 2 of 8.24 µg/L for TPH-g is less than the lowest LOD (12.12 µg/L). The minimum LOD and screening concentrations for each COPC in Scenario 2 are presented in Table D-1 in Appendix D.

In Scenario 3, TPH-d was arbitrarily set at 90% of the HI and percentages for the other 26 chemicals were based on the same risk profile from 2011, as in Scenario 2. Scenario 3 results in a screening concentration of 252 µg/L TPH-d and higher allowable concentrations of TPH-o (182.64 µg/L) and anthracene (0.09 µg/L) (Table 6).

In Scenario 4, TPH-d was arbitrarily set at 75% of the HI in order to allow for the allocation of potential risk resulting from a broader range of the chemicals detected in the groundwater. Additionally, this allocation of risk results in an acceptable drinking water concentrations for other chemicals that under Scenarios 1-3 could not be present in the water due to the allowable concentration estimated to be below the LOD. With an even lower contribution to the overall

risk, the screening concentration for TPH-d is further reduced to 210 µg/L. Again, this allows for higher concentrations of other chemicals such as TPH-o (456.61 µg/L) and anthracene (0.22 µg/L) (Table 6). Scenarios 3 and 4 provide examples of the impact of balancing the relative contributions to overall risk across all COPCs on site.

Table 6: Non-cancer Water Screening Levels

Chemical	Screening Concentration (µg/L)			
	Scenario 1 TPH-d = 100%	Scenario 2 TPH-d = 93%	Scenario 3: TPH-d = 90%	Scenario 4: TPH-d = 75%
1,1,2,2-Tetrachloroethane	0	0.11	0.17	0.43
1,2,3-Trichloropropane	0	0.44	0.67	1.68
1,2-Dichloroethane	0	0.16	0.24	0.60
Acetone	0	1.08	1.64	4.09
Bromodichloromethane	0	0.16	0.24	0.60
Chloroform	0	0.08	0.12	0.31
Chloromethane (Methyl Chloride)	0	0.38	0.58	1.45
Methylene Chloride (Dichloromethane)	0	0.40	0.60	1.51
Methyl ethyl ketone	0	0.68	1.03	2.58
TPH-g (gasoline)	0	8.24	12.52	31.29
TPH-d (middle distillates)	280	261.57	252.00	210.00
TPH-o (residual fuels)	0	120.19	182.64	456.61
Benzene	0	0.25	0.38	0.94
Toluene	0	0.19	0.30	0.74
Ethylbenzene	0	0.26	0.40	1.00
Xylenes	0	0.25	0.38	0.95
Acenaphthene	0	0.10	0.15	0.39
Acenaphthylene	0	0.07	0.11	0.27
Anthracene	0	0.06	0.09	0.22
Fluorene	0	0.08	0.12	0.29
Phenanthrene	0	0.08	0.12	0.30
Pyrene	0	0.09	0.14	0.34
1-Methylnaphthalene	0	1.26	1.92	4.79
2-Methylnaphthalene	0	0.23	0.36	0.89
Naphthalene	0	3.05	4.64	11.59
Fluoranthene	0	0.09	0.14	0.34
Benz(a)anthracene	0	0.08	0.12	0.30

Cancer-based Screening Drinking Water Concentrations

Cancer-based screening drinking water concentrations were derived based on the relative contribution or percent of the total cancer risk (either 1 in 10,000 or 1 in one million) for each

fraction or COPC (Table 7). However, in contrast to non-cancer risks which are based on daily exposure, cancer risk is estimated from a lifetime of exposure. Therefore, the cancer-based screening concentrations are calculated from the lifetime risk profile that reflects the average exposures to COPCs from the six years of monitoring data. Only eight of the COPCs have been identified by EPA as carcinogenic and have CSF values to estimate potential cancer risks. As shown in Table 7, 1,2,3-tricholoropropane contributed, by far, the largest proportion of risk (>99%) and consequently will be allotted the largest proportion of allowable risk in the derivation of a screening water concentration. As noted above, 1,2,3-trichloropropane was detected only once in the six years evaluated and for other sampling dates was assumed to be present at one-half the LOD. Therefore, this is a high theoretical risk based on very limited evidence.

Table 7: Proportion of Lifetime Cancer Risk and Screening Concentrations

Chemical	% Total Lifetime Cancer Risk	Screening Concentration for Drinking Water (µg/L)		
		Lifetime Average (10^{-6})	Lifetime Average (10^{-4})	Infant Age-adjusted (10^{-4})
1,1,2,2-Tetrachloroethane	0.253	0.00095	0.095	—
1,2,3-Trichloropropane	99.299	0.00250	0.250	0.096
1,2-Dichloroethane	0.121	0.00100	0.100	0.039
Acetone	—	—	—	—
Bromodichloromethane	0.076	0.00092	0.092	0.035
Chloroform	0.014	0.00104	0.104	—
Chloromethane (Methyl Chloride)	—	—	—	—
Methylene Chloride (Dichloromethane)	0.008	0.00285	0.285	0.110
Methyl ethyl ketone	—	—	—	—
TPH-g (gasoline)	—	—	—	—
TPH-d (middle distillates)	—	—	—	—
TPH-o (residual fuels)	—	—	—	—
Benzene	0.025	0.00124	0.124	0.048
Toluene	—	—	—	—
Ethylbenzene	—	—	—	—
Xylenes	—	—	—	—
Acenaphthene	—	—	—	—
Acenaphthylene	—	—	—	—
Anthracene	—	—	—	—
Fluorene	—	—	—	—
Phenanthrene	—	—	—	—
Pyrene	—	—	—	—
1-Methylnaphthalene	—	—	—	—
2-Methylnaphthalene	—	—	—	—
Naphthalene	—	—	—	—
Fluoranthene	—	—	—	—
Benz(a)anthracene	0.206	0.00021	0.021	0.008

Similar to the calculation of non-cancer-based screening water concentration, the risk equation was re-arranged to derive the cancer-based water concentration screening levels for each fraction or COPC (Appendix C). The additional factors used to estimate cancer-based screening concentrations include the percentage of lifetime cancer risk, the chemical-specific CSF, and the target cancer risk level. Two target cancer risk levels were used to derive the water concentrations to bracket the range of acceptable cancer risk from an upper bound of 1 in one million (10^{-6}) to a lower-bound of 1 in 10,000 (10^{-4}). The cancer-based screening water concentrations are very low, particularly at the 1 in one million risk level. At this risk level, screening concentrations range from 0.00021 µg/L benz(a)anthracene to 0.00285 µg/L

methylene chloride. Obviously, at the 1 in 10,000 risk level, the screening levels for these compounds are 100-fold higher: 0.021 µg/L benz(a)anthracene to 0.285 µg/L methylene chloride.

Age-adjusted cancer-based screening concentrations were also calculated for the six COPCs for which there is some evidence that they may induce cancer by a mutagenic mode of action. Screening drinking water concentrations were estimated at the 1 in 10,000 risk level using the same calculations as for the lifetime average concentrations presented in Appendix C. The screening concentrations developed for an infant were lower than those calculated based on a child's (2-16 years of age) or adult's age-adjusted exposure (Appendix E, Table E-1). The lowest concentrations are expected for an infant based on the greatest adjustment to the CSF (10-fold) and the relatively greater intake of water on a body weight basis. The infant screening water concentrations for the relevant COPCs are presented in Table 7 and the assumptions used are provided in Appendix C.

Comparison with Established Exposure Levels

Non-cancer-based (Scenario 4) and cancer-based (1 in 10,000 risk) screening concentrations for drinking water are summarized in Table 8 together with the Hawaii DOH exposure action levels (EAL), EPA maximum contaminant levels (MCL), and EPA drinking water equivalent level (DWEL) values. Historically, the chemical EALs have been used for comparison with monitoring well sampling data by the U.S. Department of the Navy. The shaded cells in the tables indicate where the screening levels exceed the EALs.

As seen in Table 8, many of the proposed screening levels are lower than the various regulatory standards. Some of these standards are not strictly health-based and have been established based on technology or analytical limitations. Consequently, some of the screening levels developed in this report may not be achievable. The minimum LOD used for groundwater monitoring samples from RHSF and screening concentrations for each COPC in Scenarios 2 and 4 are presented in Table D-1 in Appendix D and demonstrate which levels may not be achievable given current LODs. Additional consideration will need to be given to the analytical methods for the various constituents being monitored for at RHSF.

Table 8: Summary of Non-cancer and Cancer Screening Concentrations

Chemical	Hawaii DOH EAL (µg/L)	MCL (µg/L)	DWEL (µg/L)	Screening Concentration for Drinking Water (µg/L)		
				Non-cancer Scenario 4	Lifetime Average Cancer (10^{-4})	Infant Age-adjusted Cancer (10^{-4})
1,1,2,2-Tetrachloroethane	0.067	5	400	0.43	0.095	—
1,2,3-Trichloropropane	0.6	—	100	1.68	0.250	0.096
1,2-Dichloroethane	0.15	5	—	0.60	0.100	0.039
Acetone	1,500	—	—	4.09	—	—
Bromodichloromethane	0.12	80	100	0.60	0.092	0.035
Chloroform	70	80	350	0.31	0.104	—
Chloromethane (Methyl Chloride)	1.8	—	—	1.45	—	—
Methylene Chloride (Dichloromethane)	4.8	5	2000	1.51	0.285	0.110
Methyl ethyl ketone	7,100	—	20000	2.58	—	—
TPH-g (gasoline)	100	—	—	31.29	—	—
TPH-d (middle distillates)	100	—	—	210.00	—	—
TPH-o (residual fuels)	100	—	—	456.61	—	—
Benzene	5	5	100	0.94	0.124	0.048
Toluene	40	1000	3000	0.74	—	—
Ethylbenzene	30	700	3000	1.00	—	—
Xylenes	20	10000	7000	0.95	—	—
Acenaphthene	20	—	2000	0.39	—	—
Acenaphthylene	240	—	—	0.27	—	—
Anthracene	22	—	10000	0.22	—	—
Fluorene	240	—	1000	0.29	—	—
Phenanthrene	240	—	—	0.30	—	—
Pyrene	68	—	—	0.34	—	—
1-Methylnaphthalene	4.7	—	—	4.79	—	—
2-Methylnaphthalene	10	—	—	0.89	—	—
Naphthalene	17	—	700	11.59	—	—
Fluoranthene	130	—	—	0.34	—	—
Benz(a)anthracene	0.092	—	—	0.30	0.021	0.008

Gray shaded cells: screening concentration is greater than Hawaii DOH EAL (most conservative regulatory standard)

Limitations/Additional Considerations

A number of limitations exist in the data analysis leading to uncertainty in the drinking water screening concentrations derived in this report. These limitations, their consequences, and some further considerations are outlined below:

- The historical groundwater monitoring data are variable. Prior to 2010, several other sampling wells or sites existed, and monitoring wells RHMW06 and RHMW07 were only added in 2014. In the future, if new wells are added or if older wells are included again in the monitoring analysis, the detected levels of certain chemicals would likely change. These changes could result in an altered chemical risk profile that would consequently require modification of the COPC screening concentrations.
- Exponent's analysis included 27 COPCs, but there were an additional 34 chemicals historically analyzed from RHSF monitoring wells. These chemicals were not detected in any of the nine monitoring wells between 2010 and 2015, and therefore, were not included in the analysis of risk estimates or screening concentrations. In the future, if these chemicals are detected in monitoring wells, they would contribute towards overall health risks and may need to be considered for inclusion in the non-cancer and cancer risk profiles for derivation of drinking water screening concentrations.
- There is a potential overlap among the TPH fraction measurements based on the analytical methods. As a consequence, TPH-g, -d, and –o measurements may inaccurately estimate concentrations in the monitoring wells. If the analytical methods overestimate the levels of TPHs, this would increase their contribution to overall risk. Given that TPH-d contributed the greatest proportion of non-cancer risk in the entire time period of interest (2010-2015), the accuracy of quantitation method for this fraction is crucial.
- TPH-o was not analyzed in 2010 and 2013. Therefore, the four available years of sampling data were used to determine an annual mean concentration and adopted as a representative concentration for 2010 and 2013. This fraction was missing one-third of the groundwater monitoring data compared to the other COPCs, and therefore, may be inaccurately represented in the risk profiles of this report. It is unknown whether TPH-o

contributed more or less towards non-cancer risks during 2010 and 2013, and therefore, causes some uncertainty in the proposed screening concentrations for drinking water.

- The LOD for each chemical was highly variable, with up to a 250-fold difference between the highest and lowest LOD over the timeframe from 2010-2015. Several chemicals (11 of 27) had limited detection, in which they were detected in only one or two samples and at levels that are less than LODs. Given that samples designated as "undetected" were assumed to be equal to half of the LOD in the calculation of the average groundwater concentrations, this variability may have increased the groundwater averages. In the future, should the analytical precision/methodology be improved, this would affect the risk profile. A trend in the range of LODs demonstrated higher LODs in more recent years, which indicates that lower detection limits can be achieved. An additional concern is that there may be chemicals (of all those tested from RHSF monitoring wells) missing from the risk profile because some LODs may have been too high to detect low levels of those chemicals. This could include some of the 34 chemicals excluded from the analysis in this report, because they were not detected in the last six years.
- The EPA fraction approach assumes additive risk, which is very conservative. It does not take into account the independence of target organ toxicity or mode of action for individual chemicals. The screening concentrations are based on an acceptable level of risk assuming that all COPCs together are below the target risk level. The addition of the "very low carbon" aliphatics fraction adds an extra nine chemicals to the overall risk profile, thereby further reducing the allowable risk for the chemicals normally considered in the EPA fraction-based approached for complex mixtures of petroleum compounds. This resulted in the low screening concentrations for some of the chemicals.

Conclusions

At the RHSF on Oahu, Hawaii, 20 underground jet fuel storage tanks have been monitored for over a decade. Monitoring has included the analysis of specific chemicals as well as various types of petroleum hydrocarbon mixtures in groundwater. Exponent was requested to develop acceptable drinking water concentrations for the TPHs detected at RHSF. The EPA method (EPA 2009) for assessing risks from exposure to complex mixtures of petroleum hydrocarbons was used as the framework to derive site-specific screening concentrations in drinking water. Monitoring of chemicals in the groundwater were identified as representative of constituents of the fuel stored in the tanks and included VOCs, PAHs, lead, and TPH fractions.

Exponent's analysis of the monitoring data and derivation of screening levels was based on the most current six years of groundwater monitoring data (2010 – 2015). Only monitoring well data were included; the monitoring at a drinking water well location was not included. Field duplicates were excluded from estimates of potential exposure. COPCs were identified as those that had been detected at least once between 2010 and 2015. Daily and lifetime intakes of the COPCs were estimated based mean groundwater concentrations and assuming that the samples designated as "non-detect" were present at one-half the LOD.

Non-cancer-based screening concentrations for drinking water were developed under a series of scenarios that reflect the risk profile for one of the six years of monitoring data analyzed in this report. Scenario 1 assumed that the COPC representing the greatest contribution to the risk profile for all six years, TPH-d, was the only chemical present and resulted in a screening concentration of 280 µg/L for TPH-d. If TPH-d is present at that concentration, no other chemical can be present in the drinking water without exceeding the target risk, and therefore, is not appropriate for screening the mixture of chemicals detected at RHSF. Scenario 2 was developed based on the risk profile from 2011, when TPH-d contributed the least to the overall risk, resulting in a screening concentration of 262 µg/L TPH-d. In this scenario, screening levels were estimated for the other COPCs, although most of these water concentrations were low. In Scenarios 3 and 4, the relative contribution to risk for TPH-d was set arbitrarily at 90% and 75% of the overall risk profile, respectively. This equates to screening concentrations of 252 µg/L and 210 µg/L for TPH-d, respectively, and higher screening water concentrations for the other

COPCs. These scenarios demonstrate how balancing the relative contributions of all COPCs based on the overall risk impacts individual screening concentrations.

Cancer-based screening drinking water concentrations were developed based on a range of acceptable target risks for cancer: 1 in 10,000 to 1 in one million. Cancer-based screening levels are only available for eight of the COPCs as these were the only chemicals that are considered by EPA to be carcinogens and have a CSF from which to estimate risk. Although EPA guidance proposes the incorporation of an age-adjustment to address early life exposures for mutagens, this does not affect the risk profile of the COPCs at RHSF, but it does result in an approximately 3-fold lower screening drinking water concentration based on two years of exposure as an infant. The cancer assessment results in much lower screening concentrations for drinking water than the non-cancer assessment for those eight chemicals.

A number of limitations exist with this analysis that may impact the interpretation of the proposed screening levels. Key concerns that may affect the potential risks include the high analytical method LODs for some chemicals and time periods for groundwater in the monitoring wells. Use of high LODs could result in a failure to detect chemicals that are actually present at low levels; therefore, these chemicals would not have been selected as COPCs and underestimate the risk. Alternatively, a high LOD for a COPC will likely result in a higher mean groundwater concentration and overestimate the potential risk.

An additional factor that affects the proposed screening concentrations for drinking water is the presumption of an additive model of risk that does not take into account mode of action and target organ toxicity. The estimates made the cautious assumption that non-cancer effects for different chemicals could be added to each other in proportion to their dose, despite the lack of any such evidence. For non-cancer effects, the risk assessment tends to be driven nearly completely by a single category of TPH contaminants, TPH-d. Cancer potency was also added over the different chemicals, for which a CSF existed. There are no data available to support or refute this addition. The risks estimates for cancer are much lower than the cancer screening levels.

The screening levels developed as Scenario 4 in the non-cancer assessment and the age-adjusted values for an infant at a 1 in 10,000 risk level were also compared to the Hawaii DOH EALs,

EPA MCLs, and EPA DWEL values. Most of the proposed screening levels are below these regulatory standards. Given the fact that some of these regulatory standards are based on technology or analytical limitations, the screening levels developed in this report may not be achievable. Additional consideration will need to be given to the analytical methods for the various constituents being monitored for at RHSF.

The proposed screening level of 210 µg/L for TPH-d in drinking water (Scenario 4) is protective of public health because it is based on a lifetime of ingesting the water without any appreciable risk to human health. The Hawaii EAL for drinking water based on toxicity is similar to the proposed screening level (190 µg/L). However, an alternative EAL has been established for gross contamination based on the taste and odor threshold for TPHs of 100 µg/L. Given the potential for public concerns regarding the palatability of the drinking water, it is recommended that the Hawaii EAL of 100 µg/L be relied on as the clean-up level for TPHs.

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Appendix A

Table A-1: COPC Mean Concentrations by Year

		Mean Concentration (µg/L)							
Fraction	**Chemical**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**6-yr Mean**	**Toxicity Estimation Method**
Very Low Carbon (<C5)	1,1,2,2-Tetrachloroethane	0.138	0.100	0.138	0.250	0.244	0.104	0.162	(component)
	1,2,3-Trichloropropane	0.328	0.390	0.417	0.583	0.500	0.334	0.425	(component)
	1,2-Dichloroethane	0.148	0.140	0.168	0.250	0.238	0.083	0.171	(component)
	Acetone	2.576	0.950	2.096	13.875	5.818	12.519	6.306	(component)
	Bromodichloromethane	0.025	0.140	0.168	0.250	0.244	0.116	0.157	(component)
	Chloroform	0.245	0.073	0.115	0.250	0.241	0.139	0.177	(component)
	Chloromethane (Methyl Chloride)	0.310	0.337	0.931	1.125	0.955	0.343	0.667	(component)
	Methylene Chloride (Dichloromethane)	0.844	0.350	0.397	0.583	0.500	0.237	0.485	(component)
	Methyl ethyl ketone	2.500	0.600	0.998	2.500	2.409	2.352	1.893	(component)
Low Carbon (C5-C8)	TPH-g (gasoline)	31.536	7.263	21.295	46.958	22.400	16.681	24.356	Hexane (surrogate)
Medium Carbon (C9-C18)	TPH-d (middle distillates)	1339.400	230.700	439.450	598.104	571.690	602.431	630.296	Hydrocarbon streams (surrogate)
High Carbon Range (C19-32)	TPH-o (residual fuels)	#DIV/0!	106.000	106.000	#DIV/0!	41.000	90.897	85.974	White mineral oil (surrogate)
Low Carbon Range (C6-C8)	Benzene	0.130	0.218	0.282	0.287	0.240	0.108	0.211	(component)
	Toluene	0.276	0.172	0.219	0.250	0.383	0.110	0.235	(component)
	Ethylbenzene	0.292	0.233	0.235	0.239	0.235	0.122	0.226	(component)
	Xylenes	0.536	0.220	0.278	0.502	0.443	0.204	0.364	(component)
Medium Carbon (C9-C16)	Acenaphthene	0.075	0.090	0.099	0.113	0.093	0.084	0.092	High-flash naphtha (surrogate)
	Acenaphthylene	0.030	0.063	0.052	0.025	0.024	0.019	0.036	(surrogate)
	Anthracene	0.025	0.050	0.044	0.025	0.024	0.009	0.029	(surrogate)
	Fluorene	0.687	0.067	0.072	0.064	0.049	0.041	0.163	(surrogate)
	Phenanthrene	0.030	0.070	0.059	0.025	0.024	0.011	0.036	(surrogate)
	Pyrene	0.032	0.080	0.066	0.025	0.024	0.010	0.040	(surrogate)
	1-Methylnaphthalene	1.547	1.112	1.275	3.899	3.072	4.831	2.622	(component)
	2-Methylnaphthalene	0.425	0.206	0.584	2.384	1.926	2.196	1.287	(component)
	Naphthalene	7.295	2.690	3.481	11.142	8.487	11.640	7.456	(component)
High Carbon (C17-C32)	Fluoranthene	0.032	0.080	0.066	0.025	0.024	0.014	0.040	Fluoranthene (surrogate)
	Benz(a)anthracene	0.030	0.070	0.059	0.025	0.024	0.010	0.036	(surrogate)

Appendix B

Equation to Calculate Mean Daily Intake (EPA 1989, 2014)

$$Intake\ (mg/kg/day) = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:	**Value**
CW = chemical concentration in water (mg/L)	To be determined
IR = ingestion rate (L/day water)	2.5
EF = exposure frequency (days/year)	365
ED = exposure duration (years)	
non-cancer (national 90th percentile upper-bound time at one residence, years):	26
cancer (lifetime, years):	26
BW = body weight (kg)	70
AT = averaging time (period over which exposure is averaged - days)	
non-cancer (26 years):	9490
cancer (70 years):	25550

Appendix C

Equation to Calculate Screening Concentrations (EPA 1989, 2014)

Non-cancer values:

$$CW\ (mg/L) = \frac{\%HI \times Intake \times BW \times AT}{IR \times EF \times ED}$$

Where:	**Value**
CW = chemical concentration in water (mg/L)	To be determined
HI = hazard index (%HI is the percentage of total HI sum)	2011 values
Intake = oral reference dose (mg/kg/day)	RfD
IR = ingestion rate (L/day water)	2.5
EF = exposure frequency (days/year)	365
ED = exposure duration (years)	
non-cancer (national 90th percentile upper-bound time at one residence, years):	26
BW = body weight (kg)	70
AT = averaging time (period over which exposure is averaged - days)	
non-cancer (26 years):	9490

Cancer values:

$$CW\ (mg/L) = \frac{\%CR \times CRL \times BW \times AT}{CSF \times IR \times EF \times ED}$$

Where:	**Value**
CW = chemical concentration in water (mg/L)	To be determined
CR = cancer risk (%CR is the fraction of cancer risk sum)	mean values
CRL = target CR level	10^{-6} or 10^{-4}
IR = ingestion rate (L/day water)	2.5 or 0.9*
EF = exposure frequency (days/year)	365
ED = exposure duration (years)	
cancer (lifetime, years):	26 or 2*
BW = body weight (kg)	70 or 7.7*
AT = averaging time (period over which exposure is averaged - days)	
cancer (70 years):	20075 or 730

* Infant (< 2 years) age-adjusted factors

Appendix D

Table D-1: COPC Screening Concentrations and Minimum LOD

Chemical	Screening Concentration for Drinking Water (µg/L)					Min LOD (µg/L)
	Non-Cancer Scenario 2 TPH-d = 93%	Non-Cancer Scenario 4 TPH-d = 75%	Lifetime Average Cancer (10^{-6})	Lifetime Average Cancer (10^{-4})	Infant Age-adjusted Cancer (10^{-4})	
1,1,2,2-Tetrachloroethane	0.11	0.43	0.00095	0.095	—	0.002
1,2,3-Trichloropropane	0.44	1.68	0.00250	0.250	0.096	0.5
1,2-Dichloroethane	0.16	0.60	0.00100	0.100	0.039	0.015
Acetone	1.08	4.09	—	—	—	1.9
Bromodichloromethane	0.16	0.60	0.00092	0.092	0.035	0.01
Chloroform	0.08	0.31	0.00104	0.104	—	0.14
Chloromethane (Methyl Chloride)	0.38	1.45	—	—	—	0.2
Methylene Chloride (Dichloromethane)	0.40	1.51	0.00285	0.285	0.110	0.2
Methyl ethyl ketone	0.68	2.58	—	—	—	0.5
TPH-g (gasoline)	8.24	31.29	—	—	—	12.12
TPH-d (middle distillates)	261.57	210.00	—	—	—	10
TPH-o (residual fuels)	120.19	456.61	—	—	—	50
Benzene	0.25	0.94	0.00124	0.124	0.048	0.1
Toluene	0.19	0.74	—	—	—	0.1
Ethylbenzene	0.26	1.00	—	—	—	0.1
Xylenes	0.25	0.95	—	—	—	0.2
Acenaphthene	0.10	0.39	—	—	—	0.005
Acenaphthylene	0.07	0.27	—	—	—	0.005
Anthracene	0.06	0.22	—	—	—	0.005
Fluorene	0.08	0.29	—	—	—	0.005
Phenanthrene	0.08	0.30	—	—	—	0.005
Pyrene	0.09	0.34	—	—	—	0.0096
1-Methylnaphthalene	1.26	4.79	—	—	—	0.005
2-Methylnaphthalene	0.23	0.89	—	—	—	0.005
Naphthalene	3.05	11.59	—	—	—	0.005
Fluoranthene	0.09	0.34	—	—	—	0.0096
Benz(a)anthracene	0.08	0.30	0.00021	0.021	0.008	0.005

Shaded cells: screening concentration is less than the minimum LOD from 2010-2015.

Appendix E

Table E-1: Mutagenic COPC Age-Adjusted Screening Concentrations

Mutagenic Chemicals	Age-Ajusted Screening Concentrations (µg/L)		
	Adult	Child	Infant
1,2,3-Trichloropropane	0.591	0.145	0.096
1,2-Dichloroethane	0.238	0.058	0.039
Bromodichloromethane	0.218	0.054	0.035
Methylene Chloride (Dichloromethane)	0.675	0.165	0.110
Benzene	0.293	0.072	0.048
Benz(a)anthracene	0.050	0.012	0.008

All values are for a 1 in 10,000 cancer risk.

ATTACHMENT "B"

Calculation of Groundwater Screening Levels and a Groundwater Baseline Risk Assessment

FINAL

Honolulu, Honolulu County, Hawaii

Prepared for:

Board of Water Supply
630 S. Beretania Street, Room 201
Honolulu, Hawaii 96843

Prepared by:

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December 13, 2016

Calculation of Groundwater Screening Levels and a Groundwater Baseline Risk Assessment

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EXECUTIVE SUMMARY

The purpose of this report is to evaluate the potential human health risks for exposures to groundwater in the Halawa Valley, Hawai'i, based on analysis of data obtained from groundwater sampling conducted on 10 Halawa Valley monitoring wells between January 2011 and January 2016.

Groundwater screening levels were identified and a groundwater baseline risk assessment was conducted on 10 monitoring wells located within the Halawa Valley. The purpose of identifying groundwater screening levels is to determine the concentrations that protect human health from potential adverse effects. Groundwater screening levels were identified by selecting the lower of:

(1) the Hawai'i Department of Health (HDOH) taste and odor threshold, or

(2) the risk-based screening level calculated using the Environmental Protection Agency's (EPA) tap water scenario, which analyzes exposure risks to adult and child residents using groundwater as a drinking water source.

Risk-based screening levels were calculated based on EPA's acceptable excess lifetime cancer risk range (ELCR) of 1 x 10^{-6} to 1 × 10^{-4} for carcinogens; or, for noncarcinogens, by using a target hazard quotient (HQ) for individual analytes resulting in a hazard index (HI) for each well.

The purpose of the baseline risk assessment is to identify monitoring wells that report contaminant concentrations that exceed the upper end of the EPA's acceptable ELCR of 1 × 10^{-4} or a target HI of 1. Monitoring wells that exceed the upper end of the acceptable ELCR range or an HI of 1 warrant further evaluation to determine whether remedial action is necessary.

A total ELCR greater than 1 × 10^{-4} was reported at two wells, including RHMW02 (4.4 × 10^{-4}) and RHMW04 (1.8 × 10^{-4}). The primary contributors to risk at well RHMW02 include 1,2,3-trichloropropane (1.0 × 10^{-4}), 1-methylnaphthalene (1.2 × 10^{-5}), benzo(a)anthracene (2.1 × 10^{-6}), and naphthalene (5.2 × 10^{-4}). The primary contributor to risk at RHMW04 is dibenzo(a,h)anthracene (1.8 × 10^{-4}).

The groundwater screening levels identified for the primary cancer risk contributors are as follows:

- 1,2,3-trichloropropane (0.0075 µg/L),
- 1-methylnaphthalane (1.1 µg/L),
- benzo(a)anthracene (0.012 µg/L),
- dibenzo(a,h)anthracene (0.0034 µg/L), and
- naphthalene (0.17 µg/L)

The remaining eight wells (HDMW2253-03, ODWFMW01, RHMW01, RHMW03, RHMW05, RHMW06, RHMW07 and RHMW2254-01) report cancer risks within or below the EPA's acceptable cancer risk range of 1×10^{-4} and 1×10^{-6}.

A noncancer HI greater than 1 was reported at four wells: HDMW2253-03 (HI = 1.3), OWDFMW01 (HI = 20), RHMW01 (HI = 1.3), and RHMW02 (HI = 36). The primary contributor to the noncancer HI at wells HDMW2253-03, RHMW01, and OWDFMW01 is TPH-middle distillates; and the primary contributors to noncancer HI at well RHMW02 are TPH-middle distillates and naphthalane.

The groundwater screening levels identified for the primary noncancer hazard contributors are as follows:

- TPH-middle distillates (160 micrograms per liter [µg/L])
- naphthalene (0.17 µg/L).

The remaining six wells (RHMW03, RHMW04, RHMW05, RHMW06, RHMW07, RHMW2254-01) report an HI less than 1.

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
95% UCL	95th percent upper confidence limit
ATSDR	Agency for Toxic Substances and Disease Registry
BRA	baseline risk assessment
BWS	bureau of water supply
CalEPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	contaminant of potential concern
DWS	drinking water standard
EAL	environmental action level
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentrations
ESL	environmental screening level
HDOH	Hawai'i Department of Health
HHE	human health and the environment
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IRIS	EPA Integrated Risk Information System
MCL	maximum contaminant level
MCLG	maximum contaminant limit goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PAH	polnuclear aromatic hydrocarbons
RfC	reference concentration
RfD	reference dose

RME	reasonably maximally exposed
RSL	regional screening levels
TPH	total petroleum hydrocarbon
UCL	upper confidence limit

1.0 INTRODUCTION

The purpose of this report is to identify screening levels for contaminants that have been detected in groundwater from the Hawai'i Bureau of Water Supply (BWS) Halawa Valley. Additionally, a groundwater baseline risk assessment (BRA) has been conducted to identify those contaminants that are the primary contributors to risk, based on the contaminants that are currently detected in the 10 wells included in this evaluation.

U.S. Environmental Protection Agency (EPA) guidance provided in *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (Clay, 1991) describes how to use the BRA to make risk management decisions, such as determining whether remedial action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104 or Section 106 is necessary. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (Clay, 1991) describes the following conditions when a CERCLA action is generally warranted:

- The BRA indicates that a cumulative site risk to an individual, using reasonably maximally exposed (RME) assumptions, for either current or future land use, exceeds the 10^{-4} excess lifetime cancer risk (ELCR) end of the risk range.
- For groundwater actions, maximum contaminant levels (MCLs) and nonzero maximum contaminant limit goals (MCLGs) will generally be used to gauge whether remedial action is warranted.
- Chemical-specific standards that define acceptable risk levels also may be used to determine whether an exposure is associated with an unacceptable risk to human health and the environment (HHE) and whether remedial action is warranted.

Additionally, human health protection was evaluated by comparing individual groundwater concentrations detected in the Halawa Valley groundwater monitoring wells to existing federal or state MCLs or nonzero MCLGs. Individual groundwater concentrations were also compared to risk-based concentrations based on the EPA Regional Screening Levels Tap Water scenario. Cancer risk and noncancer hazards are calculated using the tap water (residential) scenario which is used to identify the wells that report cancer risks and noncancer hazards greater than the acceptable cancer risk and noncancer hazard thresholds, and finally to identify the contaminants of potential concern (COPCs) that are the most likely contributors to cancer risk and noncancer hazards.

The following analyses are performed to identify COPCs and associated screening levels:

- Individual groundwater concentrations are compared to the lower of the MCLs and nonzero MCLGs, the Hawai'i Department of Health (HDOH) Tier 1 Environmental

Action Levels (EALs) (HDOH, 2012b), and risk-based concentrations using the EPA tap water scenario to determine if individual concentrations are greater than screening levels based on a target cancer risk of 1×10^{-6} or a noncancer hazard index (HI) greater than or equal to 1.

- Cumulative cancer risks and noncancer hazards for chemicals based on the results of the EPA tap water (residential) scenario are compared to the upper end of the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) (40 CFR 300) risk range for cumulative carcinogenic site risk (1×10^{-4}), or a HI of 1 to an individual based on RME to return groundwater to its highest beneficial use.

The following information is presented in this report:

- Section 2 contains the data analysis (identifies the data set that is used in this evaluation);
- Section 3 contains the exposure assessment, which is a description of the exposure assumptions and equations used to calculate screening levels;
- Section 4 contains the toxicity assessment that provides a list of the toxicity values used, their sources, and HDOH-specific information on reference dose and reference concentrations;
- Section 5 contains the risk characterization, which presents a summary of the identified screening levels, the results of comparing individual concentrations from each well to screening levels, and the cumulative cancer risks and noncancer hazards based on the tap water scenario;
- Section 6 contains the summary of the results of the evaluation.

2.0 DATA ANALYSIS

This section describes the source of analytical data, the data processing and reduction steps, and the steps used to identify contaminants of potential concern in groundwater that will be included in the groundwater evaluation. The comparison of individual groundwater concentrations to screening levels and the groundwater risk assessment are used to prioritize those COPCs that may pose an unacceptable risk and identify wells that may warrant a remedial action.

The groundwater data set used for this evaluation consists of sampling and analysis data from 10 monitoring wells within the Halawa Valley. The monitoring well network represents locations where human receptors could potentially encounter groundwater. The primary exposure pathway for humans is through groundwater obtained from a residential or community water well. The data set contains the analytical results from groundwater samples collected between January 2011 and January 2016, which were considered representative of current groundwater conditions. A list of the monitoring wells included in this evaluation are provided in Table 2-1.

2.1 Analytical Data Processsing

The groundwater data set used for evaluation includes the analytical results from samples collected from 10 monitoring wells (Table 2-1). This analytical data set was processed to obtain a single set of results per sampling location and time of collection.

After analytical data processing and reduction (as described below), the data set was used for computation of exposure point concentrations (EPCs) and to develop summary statistics that include frequency of detection, minimum and maximum detection limits, and minimum and maximum detected concentrations. The data set included the following types of information:

- Analytical results from both unfiltered and filtered samples
- Data qualification and data validation flags, including rejected results
- Parent and field duplicate sample results

The analytical data were processed using the steps below to identify one set of results per sampling location and date of sample collection. Descriptions of the data processing steps follow.

2.1.1 Sample Results

Analytical results from unfiltered samples are used in identifying COPCs; note that most wells only reported filtered lead results. Because total lead concentrations were not available, dissolved lead concentrations were used for comparison to screening levels. Unfiltered sample results represent total concentrations of the analytes, while filtered sample results represent only dissolved

concentrations. Use of filtered sampling results might lead to underestimation of chemical concentrations (e.g., in water from an unfiltered tap).

The risk assessment guide (EPA/540/1-89/002), addresses this issue in providing guidance on estimating exposure concentrations in groundwater:

> *While filtration of ground-water samples provides useful information for understanding chemical transport within an aquifer, the use of filtered samples for estimating exposure is very controversial, because these data may underestimate chemical concentrations in water from an unfiltered tap. Therefore, data from unfiltered samples should be used to estimate exposure concentrations.*

2.1.2 Laboratory and Data Validation Flags

Analytical data are received from the laboratory with data qualification flags. Validation qualifiers are assigned during the data validation process. The following rules determine how flagged and/or qualified sample results are used to generate summary statistics and calculate EPCs:

- Sample results flagged with a "U" data qualifier or combinations of qualifiers that include a "U," such as a "UJ," are considered nondetected results.
- Sample results without a "U" data qualifier are considered detected concentrations, including results with no data qualifier or with a "J" data qualifier.
- Sample results that are rejected and flagged with an "R" validation qualifier are not used in identifying COPCs.

where:

U = Analyzed for but not detected above limiting criteria.

J = Estimated value.

R = Do not use. Further review indicates the result is not valid.

2.1.3 Field Duplicate Results

Field duplicate samples are collected in the field and analyzed by the laboratory as unique samples. The parent sample and field duplicate sample are collected from the same location (i.e., monitoring well) on the same date, resulting in more than one sample per location and date.

The following criteria are used to reduce multiple sample results for an individual location/date to a single result:

- If two detections are reported, then the highest concentration is used.

- If there is one detected and one nondetected result, then the detected concentration is used.
- If there are two nondetected results, then the lowest detection limit is used.

2.2 Identification of COPCs

After extracting and processing the data set, the data set is further reduced by identifying a subset of analytes (COPCs) that will be have summary statistics calculated and also be processed through ProUCL software (EPA 2015a; EPA 2015b) to calculate the 95th percent upper confidence limit (95% UCL) (described in Section 3.4.1) which in turn are used as EPCs. These results will be included in the risk characterization step of the risk assessment (Section 5). Analytes that have been analyzed for but not detected in any sample were eliminated. In total, 34 analytes were not detected in any sample from the Halawa Valley wells. All analytes detected at least once were carried forward for the statistical or 95% UCL calculations. A total of 36 analytes were detected at least once and are identified as COPCs, and are carried forward into the next step of the evaluation. All analytes detected at least once are summarized in Table 2-2.

The exposure assessment, including the methodology used to calculate EPCs and the exposure assumptions and equations used to calculate risk-based screening levels, is discussed in Section 3, the toxicity assessment is presented in Section 4. Section 5 describes the risk characterization step, including the selection process for screening levels for each COPC, a comparison of EPCs to screening levels, and the cancer risks and noncancer hazards for the EPA tap water scenario.

3.0 EXPOSURE ASSESSMENT

The exposure assessment component of the risk assessment typically identifies the populations that may be exposed, the routes by which these receptors may become exposed, and the magnitude, frequency, and duration of potential exposures.

An exposure pathway can be described as the physical course that a COPC takes from the point of release to a receptor. The route of exposure is the means by which a COPC enters a receptor. For an exposure pathway to be complete, all of the following components must be present:

- Contaminant source (or release point)
- Mechanism of chemical release
- Environmental transport mechanism
- Exposure point
- Exposure route
- Receptor or exposed population

In the absence of any one of these components, an exposure pathway is considered incomplete; therefore, it creates no risk or hazard.

3.1 Contaminant Sources

The primary sources of contamination are releases from above-ground storage tanks used to store aviation fuel.

3.2 Release Mechanisms and Environmental Transport Media

The primary COPC release mechanisms and transport media include the following:

- Direct contact with groundwater containing COPCs
- Volatilization of COPCs in groundwater from showering or household activities

3.3 Potentially Complete Human Exposure Pathways and Receptors

Potential human receptors are assumed to be current and hypothetical future residential groundwater users. Potential routes of exposure to human receptors from groundwater contaminants include the following:

- Ingestion of contaminated water by drinking or in food preparation
- Inhalation of contaminant vapors during showering or other household activities

- Dermal contact exposure to contaminants in groundwater

The EPA tap water (residential) exposure scenario is used to calculate risk-based screening levels and to evaluate exposure to humans from the above exposure pathways and routes. A description of the EPA tap water (residential) scenario is provided below.

3.3.1 EPA Tap Water Scenario (Residential)

As described in EPA (2016a, b, c), *Regional Screening Levels (RSLs) - User's Guide* (hereafter referred to as EPA Regional Screening Levels), the EPA tap water scenario reflects an RME scenario. The EPA tap water scenario is consistent with a residential exposure scenario because it incorporates default residential exposure assumptions. Potentially complete exposure routes for the EPA tap water scenario include exposure of adult and children residents to groundwater used as a drinking water source.

A summary of the exposure assumptions used for the tap water (residential) scenario is provided in Table 3-1.

3.3.1.1 Equations Used to Calculate Screening Levels for Water Ingestion

The following section provides the equations used to calculate screening levels for carcinogens, noncarcinogens, mutagens, and trichloroethylene. A separate equation is provided for trichloroethylene because it is classified as both a carcinogen and a mutagen.

3.3.1.1.1 Ingestion of Water – Carcinogenic Effects

The following shows the equations used to calculate the screening levels for ingestion of carcinogens:

$$SL_{ca-ing} = \frac{TR \times AT_{can} \times CF_4}{CSF_o \times IRW_{adj}}$$

where:

$$IRW_{adj} = \frac{EF \times ED_c \times IRW_c}{BW_c} + \frac{EF \times (ED_a - ED_c) \times IRW_a}{BW_a}$$

3.3.1.1.2 Ingestion of Water – Noncarcinogen Effects

The following shows the equation used to calculate the screening levels for ingestion of noncarcinogens:

$$SL_{nc-ing} = \frac{THQ \times AT_{nc} \times BW_c \times CF_4}{EF \times ED_c \times IRW_c \times \frac{1}{RfD_o}}$$

3.3.1.1.3 Ingestion of Water – Mutagenic Effects

The following shows the equations used to calculate the screening levels for ingestion of mutagens:

$$SL_{mut-ing} = \frac{TR \times AT_{can} \times CF_4}{CSF_o \times IRWM_{adj}}$$

where:

$$IRWM_{adj} = \frac{EF \times ED_{0-2} \times IRW_c \times 10}{BW_c} + \frac{EF \times ED_{2-6} \times IRW_c \times 3}{BW_c} + \frac{EF \times ED_{6-16} \times IRW_a \times 3}{BW_a} + \frac{EF \times ED_{16-26} \times IRW_a \times 1}{BW_a}$$

3.3.1.1.4 Ingestion of Water – Trichloroethylene

The following shows the equation used to calculate the screening levels for ingestion of trichloroethylene:

$$SL_{tce-ing} = \frac{TR \times AT_{can} \times CF_4}{CSF_o \times \left(\left(IRWM_{adj} \times MAF_o\right) + \left(IRW_{adj} \times CAF_o\right)\right)}$$

3.3.1.2 Equations Used to Calculate Screening Levels for Dermal Contact with Water

The following section provides the equations used to calculate screening levels for dermal contact with carcinogens, noncarcinogens, mutagens, and trichloroethylene. A separate equation is provided for trichloroethylene because it is classified as both a carcinogen and a mutagen.

3.3.1.2.1 Dermal Contact with Water – Carcinogenic Effects

The following shows the equations used to calculate the screening levels for dermal contact with carcinogens:

$$SL_{ca-der} = \frac{TR \times DA_{event} \times AT_{ca} \times CF_4}{\frac{CSF_o}{GIABS} \times SA_{adj}}$$

where:

$$SA_{adj} = \frac{EF \times ED_c \times SA_c \times EV}{BW_c} + \frac{EF \times (ED_a - ED_c) \times SA_a \times EV}{BW_a}$$

3.3.1.2.2 Dermal Contact with Water – Noncarcinogen Effects

The following shows the equation used to calculate the screening levels for dermal contact with noncarcinogens:

$$SL_{nc-der} = \frac{THQ \times DA_{event} \times AT_{nc} \times CF_4 \times BW_c}{EF \times ED_c \times SA_c \times \frac{1}{RfD_o} \times GIABS}$$

3.3.1.2.3 Dermal Contact with Water – Mutagenic Effects

The following shows the equations used to calculate the screening levels for dermal contact with mutagens:

$$SL_{mut-der} = \frac{TR \times DA_{event} \times AT_{ca} \times CF_4}{\frac{CSF_o}{GIABS} \times SA_{adj-mut}}$$

where:

$$SA_{adj-mut} = \frac{EF \times ED_{0-2} \times SA_c \times EV \times 10}{BW_c} + \frac{EF \times ED_{2-6} \times SA_c \times EV \times 3}{BW_c} + \frac{EF \times ED_{6-16} \times SA_a \times EV \times 3}{BW_a} + \frac{EF \times ED_{16-26} \times SA_a \times EV \times 1}{Bw_a}$$

3.3.1.2.4 Dermal Contact with Water – Trichloroethylene

The following shows the equation used to calculate the screening levels for dermal contact with trichloroethylene:

$$SL_{tce-der} = \frac{TR \times DA_{event} \times AT_{can} \times CF_4}{\frac{CSF_o}{GIABS} \times \left(\left(SA_{adj} \times MAF_o\right) + \left(SA_{adj-mut} \times CAF_o\right)\right)}$$

3.3.1.3 Equations Used to Calculate Dermally Absorbed Dose

The exposure time used in the risk calculations is healtheffect-dependent. For noncarcinogens, the exposure time is not adjusted for age ($ET = ET_c$). For carcinogens, an age-adjusted exposure time is calculated using the following equation:

$$ET_{adj} = \frac{(ED_c \times ET_c) + ([ED_a - ED_c] \times ET_a)}{ED_a}$$

For mutagens, an age-adjusted exposure time is calculated using the following equation:

$$ET_{adj-mut} = \frac{(ED_{0-2} \times ET_c) + (ED_{2-6} \times ET_c) + (ED_{6-16} \times ET_a) + (ED_{16-26} \times ET_a)}{ED_{0-2} + ED_{2-6} + ED_{6-16} + ED_{16-26}}$$

For organics, the following equations are used to calculate the dermally absorbed dose per event (DA_{event}), using the child exposure time for noncarcinogenic effects and the age-adjusted exposure time (as calculated above) for carcinogenic effects and mutagenic effects:

If ET ≤ t*, the following nonsteady-state equation is used:

$$DA_{event} = 2 \times FA \times K_p \times C_w \times CF3 \times \sqrt{\frac{6 \times \tau \times ET}{\pi}}$$

If ET > t*, the following pseudosteady-state equation is used:

$$DA_{event} = FA \times K_p \times C_w \times CF3 \times \left[\frac{ET}{1+B} + 2 \times \tau \times \left(\frac{1 + 3B + 3B^2}{(1+B)^2}\right)\right]$$

where:

ET = for noncarcinogenic, carcinogenic, or mutagenic effects, respectively.

For inorganics, the following steady-state equation is used to estimate DA_{event}:

$$DA_{event} = K_p \times C_w \times ET \times CF3$$

where:

$ET = ET_c$ *or* ET_{adj}, or $ET_{adj\text{-}mut}$ for noncarcinogenic, carcinogenic, or mutagenic effects effects, respectively.

3.3.1.4 Equations Used to Calculate Screening Levels for Inhalation of Volatiles

The following section provides the equations used to calculate screening levels for inhalation of carcinogens, noncarcinogens, mutagens, and for trichloroethylene. A separate equation is provided for trichloroethylene because it is classified as both a carcinogen and a mutagen.

3.3.1.4.1 Inhalation of Volatiles – Carcinogenic Effects

The following shows the equations used to calculate the screening levels for inhalation of carcinogenic volatiles:

$$SL_{ca-inh} = \frac{TR \times AT_{can}}{EF \times ED_a \times ET_{inh} \times CF_2 \times VF \times IUR}$$

3.3.1.4.2 Inhalation of Volatiles– Noncarcinogen Effects

The following shows the equation used to calculate the screening levels for inhalation of noncarcinogenic volatiles:

$$SL_{nc-inh} = \frac{THQ \times AT_{nc} \times CF_4}{EF \times ED_c \times ET_{inh} \times CF_2 \times VF \times \frac{1}{RfC}}$$

3.3.1.4.3 Inhalation of Volatiles – Mutagenic Effects

The following shows the equations used to calculate the screening levels for inhalation of mutagenic volatiles:

$$SL_{mut-inh} = \frac{TR \times AT_{can}}{VF \times INHM_{adj} \times IUR}$$

where:

$$INHM_{adj} = (EF \times ED_{0-2} \times ET_{inh} \times CF_2 \times 10\ ) + \ (EF \times ED_{2-6} \times ET_{inh} \times CF_2 \times 3) + (EF \times ED_{6-16} \times ET_{inh} \times CF_2 \times 3) + (EF \times ED_{16-26} \times ET_{inh} \times CF_2 \times 1)$$

3.3.1.4.4 Inhalation of Volatiles – Trichloroethylene

The following shows the equations used to calculate the screening levels for inhalation of trichloroethylene:

$$SL_{ca-inh} = \frac{TR \times AT_{can}}{\left((EF \times ED_a \times ET_{inh} \times CF_2 \times CAF_i) + (INHM_{tce-inh})\right) \times VF \times IUR}$$

where:

$$INHM_{adj-tce} = \left((EF \times ED_{0-2} \times ET_{inhc} \times CF_{24} \times MAF_i \times 10\ ) + (\ EF \times ED_{2-6} \times ET_{cinh} \times CF_{42} \times MAF_i \times 3) + (EF \times ED_{6-16} \times ET_{inha} \times CF_{24} \times MAF_i \times 3) + (EF \times ED_{16-26} \times ET_{inh} \times CF_2 \times MAF_i \times 1)\right)$$

3.3.1.5 Equations Used to Calculate Screening Levels for All Exposure Routes Combined

The following section provides the equations used to calculate screening levels for exposure to carcinogens, noncarcinogens, mutagens, and trichloroethylene. A separate equation is provided for trichloroethylene because it is classified as both a carcinogen and a mutagen.

3.3.1.5.1 Total Screening Level – Carcinogenic Effects

The following shows the equation used to calculate the total screening levels for exposure to carcinogens:

$$SL_{ca-tot} = \frac{1}{SL_{ca-ing} + SL_{ca-der} + SL_{ca-inh}}$$

3.3.1.5.2 Total Screening Level – Noncarcinogenic Effects

The following shows the equation used to calculate the total screening levels for exposure to noncarcinogens:

$$SL_{nc-tot} = \frac{1}{SL_{nc-ing} + SL_{nc-der} + SL_{nc-inh}}$$

3.3.1.5.3 Total Screening Level – Mutagenic Effects

The following shows the equation used to calculate the total screening levels for exposure to mutagens:

$$SL_{mut-tot} = \frac{1}{SL_{mut-ing} + SL_{mut-der} + SL_{mut-inh}}$$

3.3.1.5.4 Total Screening Level – Trichloroethylene

The following shows the equation used to calculate the total screening levels for exposure to trichloroethylene:

$$SL_{tce-tot} = \frac{1}{SL_{tce-ing} + SL_{tce-der} + SL_{tce-inh}}$$

3.4 Exposure Point Concentrations

OSWER Directive 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (hereafter referred to as Calculating UCL for EPCs), states that, "…an exposure point concentration (EPC) is a conservative estimate of the average chemical concentration in an exposure medium." OSWER Publication 9285.7-08I, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, states that, "…because of the uncertainty associated with estimating the true average concentration at a site, the 95% UCL of the arithmetic mean should be used for this variable." Use of the 95% UCL of the arithmetic mean yields risk estimates that correspond to an RME. Instances where a value different from a UCL is used as the EPC are clearly identified and the reasons and justifications for the departure are provided.

Calculating UCL for EPCs (OSWER Directive 9285.6-10) further states the following:

> *The EPC is determined for each individual exposure unit within a site. An exposure unit is the area throughout which a receptor moves and encounters an environmental medium for*

the duration of the exposure. Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over the time frame of the risk assessment.

For this groundwater risk assessment, the terms "exposure unit" and "exposure area" are considered operationally equivalent. Each individual well included in this groundwater BRA is identified as an exposure area.

3.4.1 95 Percent Upper Confidence Limit (95% UCL) Calculation Methodology

Calculating UCL for EPCs (OSWER Directive 9285.6-10) is the most recent EPA guidance for UCL calculation, and ProUCL version 5.1 (EPA 2015a; EPA 2015b) serves as the companion software package for this guidance. ProUCL version 5.1 contains rigorous parametric and nonparametric statistical methods (including bootstrap methods) that can be used on data sets without nondetect results and on data sets with nondetect results (results reported below detection limits). Both ProUCL and OSWER Directive 9285.6-10 were used to calculate the UCLs for the Halawa Valley groundwater monitoring wells. A summary of the exposure point concentrations for each well and each detected COPC is provided in Table 3-2.

4.0 TOXICITY ASSESSMENT

This toxicity assessment evaluates the relationship between the magnitude of exposure to a contaminant at the Halawa Valley and the likelihood of adverse health effects to potentially exposed populations. This assessment provides, where possible, a numerical estimate of the increased likelihood of adverse effects associated with contaminant exposure. The toxicity assessment contains two steps: hazard characterization and dose response evaluation, as discussed in the following subsections.

4.1 Hazard Characterization

Hazard characterization identifies the types of toxic effects that a chemical can exert. For the toxicity assessment, chemicals can be divided into three broad groups—noncarcinogens, carcinogens, and mutagens—based on their effects on human health.

Carcinogens are those contaminants that are known or suspected causes of cancer following exposure; noncarcinogenic compounds are associated with a wide variety of systemic effects, such as liver toxicity or developmental effects; mutagens are are those contaminants that are known or or suspected of cancer following early-life exposure and act through a mutagenic mode of action. Some contaminants (e.g., arsenic) are capable of eliciting both carcinogenic and noncarcinogenic responses; therefore, these contaminants are evaluated for both effects.

For cancer effects, EPA has developed a carcinogen classification system (*Guidelines for Carcinogen Risk Assessment* [EPA/630/P-03/001F]) that uses a weight-of-evidence approach for classifying the likelihood that a chemical is a human carcinogen. Information considered in developing the classification includes human studies of the association between cancer incidence and exposure, as well as long-term animal studies under controlled laboratory conditions. Other supporting evidence considered includes short-term tests for genotoxicity, metabolic and pharmacokinetic properties, toxicological effects other than cancer, structure-activity relationships, and physical and chemical properties of the chemical.

For mutagenic effects, EPA has developed an approach (*Supplemental Guidance for Assessment Susceptibility from Early-Life Exposure to Carcinogens* [EPA/630/R-03/003F]) that applies modifications (adjustment factors) to cancer slope factors to address the potential for differential risk of early-lifestage exposure. Default adjustment factors are used only when chemical-specific data are not available to assess direct cancer susceptibility from early life exposure to a carcinogen that acts through a mutagenic mode of action.

For noncancer effects, toxicity values are derived based on the critical toxic endpoint (i.e., the most sensitive adverse effect following exposure). Table 4-1 lists the COPCs detected in the Halawa Valley groundwater that have been identified as having documented systemic effects.

4.2 Dose Response

The magnitude of toxicity of a contaminant depends on the dose to a receptor. Dose refers to exposure to a contaminant concentration over a specified period of time. Human exposures are generally classified as acute (typically less than 2 weeks), subchronic (about 2 weeks to 7 years), or chronic (7 years to a lifetime). This Human Health Risk Assessment (HHRA) specifically addresses chronic exposure. Acute exposures and risks are evaluated only when chronic exposure estimates pose a high risk. A dose response curve describes the relationship between the degree of exposure (i.e., dose) and the incidence of the adverse effects (i.e., response) in the exposed population. EPA uses this dose response information to establish toxicity values for particular chemicals, as described in the following sections.

4.2.1 Reference Doses for Noncancer Effects

The toxicity value describing the dose-response relationship for noncancer effects is the RfD value. For noncarcinogenic effects, the body's protective mechanisms must be overcome before an adverse effect is manifested. If exposure is high enough and these protective mechanisms (or thresholds) are exceeded, adverse health effects can occur. EPA attempts to identify the upper bound of this tolerance range in the development of noncancer toxicity values. EPA uses the apparent toxic threshold value, in conjunction with uncertainty factors based on the strength of the toxicological evidence, to derive a reference dose (RfD) value. EPA defines an RfD value as follows:

> *In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is generally expressed in units of mg/kg-day.*

Available chronic RfD values for the oral and inhalation exposure routes are used to calculate screening levels. Because EPA has not derived toxicity values specific to skin contact, dermal slope factors and RfD values were derived from oral toxicity factors in accordance with EPA guidance. The RfD values for the contaminants evaluated are summarized in Table 4-1.

4.2.2 Slope Factors for Cancer Effects

The dose-response relationship for cancer effects is expressed as a cancer slope factor that converts estimated intake directly to ELCR. Slope factors are expressed in units of risk per level of exposure (or intake). The data used for estimating the dose-response relationship are taken from lifetime

animal studies or human occupational or epidemiological studies where excess cancer risk has been associated with exposure to the chemical. However, because risk at low intake levels cannot be directly measured in animal or human epidemiological studies, a number of mathematical models and procedures have been developed to extrapolate from the high doses used in the studies to the low doses typically associated with environmental exposures. The model choice leads to uncertainty associated with the carcinogenic response at very low levels of exposure. EPA assumes linearity at low doses when uncertainty exists about the mechanism of action of a carcinogen and when information suggesting nonlinearity is absent.

It is assumed, therefore, that if a cancer response occurs at the dose levels used in the study, then there is some probability that a response will occur at all lower exposure levels (i.e., a dose-response relationship with no threshold is assumed). Moreover, the dose-response slope chosen is usually the 95% UCL on the mean on the actual dose-response curve observed in the laboratory studies. As a result, uncertainty and conservatism are built into the EPA risk extrapolation approach. EPA has stated that cancer risks estimated by this method produce estimates that "provide a rough but plausible upper limit of risk." The cancer slope factors used in this assessment are summarized in Table 4-1.

4.2.3 Selection of Toxicity Values

The COPC-specific toxicity values presented in Table 4-1 are determined using the recommended reference hierarchy as described in OSWER Directive 9285.7-53, *Human Health Toxicity Values in Superfund Risk Assessments*. The hierarchy is summarized below:

- Tier 1—The EPA Integrated Risk Information System (IRIS) database
- Tier 2—The EPA Provisional Peer Reviewed Toxicity Values
- Tier 3—Other Toxicity Values

4.2.3.1 Tier 1 - IRIS

The preferred source of toxicity data is EPA's IRIS database. Expert toxicologists at EPA have derived the values in this database and the values have undergone a thorough review and validation both within and outside EPA. If a toxicity value is available in IRIS, that value is used in preference to any other value.

4.2.3.2 Tier 2 - Provisional Peer Reviewed Toxicity Values

If a toxicity value is not available in IRIS, the next source is EPA's Provisional Peer Reviewed Toxicity Values. This source includes toxicity values that have been developed by the Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center. This database is not available to the public, but is accessible to

EPA risk assessors via EPA's intranet. These values are also published at *Regional Screening Levels* (EPA, 2016a, b, c).

4.2.3.3 Tier 3 - Other Toxicity Values

Tier 3 includes additional EPA and non-EPA sources of toxicity information, including the following:

- The *California EPA (CalEPA) Toxicity Criteria Database* contains toxicity values that are peer reviewed and address both cancer and noncancer effects.
- The *Agency for Toxic Substances and Disease Registry (ATSDR)* database Minimal Risk Levels for Hazardous Substances are peer-reviewed estimates of the daily human exposure to hazardous substances that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure.

4.2.3.4 Total Petroleum Hydrocarbon Fractions

The Hawaii Department of Health (HDOH) *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater, Volume 2: Background Documentation for the Development of Tier 1 Environmental Action Levels* (HDOH, 2012b) describes how reference dose and reference concentrations should be calculated for the three total petroleum hydrocarbon fractions (gasoline, middle distillates, and residual fuels). This guide describes the methodology for calculating a weighted reference concentration (RfC) for the inhalation exposure pathway and a weighted oral RfD.

The following equation is used to calculate the weighted RfC for each total petroleum hydrocarbon (TPH) fraction:

$$Weighted\ RfC(\frac{mg}{m^3} = \frac{1}{\frac{Fraction\ C_5 - C_8\ aliphatics}{RfC_{C5-C8\ aliphatics}}} + \frac{1}{\frac{Fraction\ C_9 - C_{12}\ aliphatics}{RfC_{C9-C12\ aliphatics}}} + \frac{1}{\frac{Fraction\ C_9 - C_{10} +\ aromatics}{RfC_{C9-C10+aromatics}}}$$

The following equation is used to calculate the weighted RfD for each TPH fraction.

$$Weighted\ RfD\left(\frac{mg}{kg-day}\right) = \frac{1}{\frac{Fraction\ C_5 - C_8\ aliphatics}{RfD_{C5-C8\ aliphatics}}} + \frac{1}{\frac{Fraction\ C_9 - C_{12}\ aliphatics}{RfD_{C9-C12\ aliphatics}}} + \frac{1}{\frac{Fraction\ C_{19+}\ aliphatics}{RfD_{C19+\ aliphatics}}} + \frac{1}{\frac{Fraction\ C_9 - C_{10} +\ aromatics}{RfC_{C9-C10+\ aromatics}}}$$

The default carbon range of each TPH fraction is based on the Indiana Department of Environmental Management. The default carbon ranges are shown in Table 4-2.

The toxicity factors and associated critical effects (mechanisms of action) identified for each individual carbon range fraction are shown in Table 4-3.

The weighted reference dose and reference concentrations are shown in Table 4-4.

5.0 RISK CHARACTERIZATION

Risk characterization is completed through the comparison of the EPC to the groundwater screening levels and the comparison of total cancer risk and noncancer HI to their respective thresholds. These comparisons are used to determine whether current groundwater concentrations protect human health or whether a remedial action may be warranted. It is also used to determine if current groundwater concentrations within an individual well have the potential to exceed an HI greater than 1 or the upper end of the NCP risk range for total cancer risk.

Although this risk assessment produces numerical estimates of risk, it should be recognized that these numbers might not predict actual health outcomes because they are based largely on hypothetical assumptions. Their purpose is to provide a frame of reference for risk management decision-making. Interpretation of the risk estimates provided should consider the nature and weight of evidence supporting these estimates, as well as the magnitude of uncertainty surrounding them.

5.1 Evaluation of Measured Groundwater Concentrations

This section presents a comprehensive interpretation of the sampling results used to identify COPC concentrations that are greater than groundwater screening levels. Groundwater screening levels are derived from chemical-specific drinking water standards, risk-based concentrations using default exposure assumptions from the tap water (residential) exposure scenario, and taste and odor thresholds (organoleptic effects). The results of this evaluation are used in combination with the groundwater BRA, to identify the COPCs that are the primary contributors to cancer risk and noncancer hazards. The groundwater BRA provides a comprehensive evaluation of cumulative cancer risks and noncancer hazards on a well-by-well basis.

Ten monitoring wells were identified for inclusion in this evaluation and samples were collected between January 2011 and January 2016, which were considered representative of current groundwater conditions. A list of the wells is provided in Table 2-1.

5.1.1 Screening Levels

The *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater, Volume I Users Guide (Fall 2012 rev June 2015)* (HDOH, 2012a) states that all groundwater should be considered a potential source of drinking water unless otherwise approved by the overseeing regulatory agency. As a result, screening levels from chemical-specific drinking water standards (DWSs), risk-based concentrations using default exposure assumptions, and CalEPA taste and order thresholds (gross contamination) are included.

The *User's Guide* (HDOH, 2012a) also states that all shallow groundwater will ultimately discharge to a body of surface water that will potentially impact aquatic organisms. Groundwater included in this evaluation does not represent shallow groundwater conditions. As a result water quality standards and criteria protective of aquatic organisms are not evaluated. Finally, intrusion of subsurface vapors into buildings is considered an incomplete exposure pathway because groundwater monitoring wells are not located directly beneath buildings.

The sources of screening levels from federal regulations are as follows:

- 40 CFR 141, "National Primary Drinking Water Regulations"; consulted for MCLs; secondary MCLs; and nonzero maximum contaminant level goals (MCLGs) established under the *Safe Drinking Water Act of 1974*
- *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites*, which details EPA's acceptable ELCR of 1×10^{-6} to 1×10^{-4} for carcinogens and target hazard quotients (HQs) for individual noncarcinogens

The source of screening levels from the Hawai'i Department of Health (HDOH) is the following:

- Tier 1 Environmental Screening Levels (Tier 1 ESLs); Table F-1a (HDOH, 2012b)

The *User's Guide* (HDOH, 2012a) also indicates that the Tier 1 ESLs are considered to be adequately protective provided that no more than three carcinogenic COPCs and no more than five noncarcinogenic COPCs are present at a site. This is based on a combination of conservative exposure assumptions and target risk factors in direct-exposure models. That is, the individual Tier 1 ESLs are not based on a HQ of 1; rather an adjustment factor has been applied to the ESL account for multiple chemicals. For example, noncarcinogenic ESLs are calculated based on a target HQ of 0.2, which assumes that up to five COPCs have the same critical effect. As a result, these values are listed for reference but are not selected as a final screening level because more than three carcinogenic COPCs and more than five noncarcinogenic COPCs are detected in the Halawa Valley groundwater.

Section 6.6 of the *User's Guide* (HDOH, 2012a) provides guidance on the selection of screening levels for TPH-impacted groundwater. A TPH-diesel taste and odor threshold of 100 µg/L referenced in the technical document *A Compilation of Water Quality Goals 17th Edition* (CalEPA, 2016) was referred to as a substitute secondary MCL for all categories of TPH. This takes precedence over the toxicity-based action level for selection of a final drinking water action level.

A complete summary of the groundwater screening levels from the sources listed above is provided in Table 5-1.

5.1.2 Results of Comparison to Groundwater Screening Levels

As described earlier, the groundwater data for each monitoring well were compiled and statistically analyzed, and the results are presented in Table 5-2. These tables present the summary statistics for each analyte detected with the monitoring well, the selected screening level, and the basis for the screening level.

The following sections describe the results for each well based on the TPH-fraction and its associated target analytes as shown in Table 5-3.

5.1.2.1 Well HDMW2253-03

TPH-gasoline was detected in 5 of 21 samples collected from this well at concentrations ranging between 15 µg/L and 27 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 400 µg/L. Benzene was detected in 3 of 22 samples collected from this well at concentrations ranging between 0.2 µg/L and 0.92 µg/L; one sample was greater than the risk-based concentration of 0.46 µg/L. Toluene, naphthalene, and lead were also detected in this well but at concentrations less than their respective nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 13 of 22 samples collected with concentrations ranging between 13 µg/L and 600 µg/L. Concentrations of TPH-middle distillates were greater than the nuisance-based screening level of 100 µg/L in 3 samples and greater than the risk-based concentration of 160 µg/L in 2 samples. Benzene, toluene, and naphthalene are common target analytes and are discussed above. No other target analytes were detected.

TPH-residual fuels were detected in 3 of 6 samples collected with concentrations ranging between 55 µg/L and 77 µg/L. All sample concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Benzene, toluene, naphthalene are common target analytes and are discussed above. Benzo(a)anthracene was detected in 1 of 20 samples collected at a concentration of 0.0032 µg/L, which is less than the risk-based concentration of 0.012 µg/L. No other target analytes were detected.

5.1.2.2 Well OWDFMW01

TPH-gasoline was detected in 5 of 21 samples collected with concentrations ranging between 17 µg/L and 31 µg/L. All sample concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 400 µg/L. TPH-gasoline was detected in 5 of 21 samples collected with concentrations ranging between 17 µg/L and 31 µg/L. Benzene was detected in 13 of 21 samples collected with concentrations ranging between 0.07 µg/L and 0.13 µg/L; 6 samples reported concentrations greater than the risk-based concentration of 0.46 µg/L.

Toluene, total xylenes, naphthalene, and lead were also detected in this well but at concentrations less than their respective cleanup levels. No other target analytes were detected.

TPH-middle distillates were detected in 15 of 21 samples collected with concentrations ranging between 17 µg/L and 3,100 µg/L. Concentrations of TPH-middle distillates were greater than the nuisance-based screening level of 100 µg/L in 11 samples and greater than the risk-based concentration of 160 µg/L in 10 samples. Benzene, toluene, xylenes, and naphthalene are common target analytes and are discussed above. Additionally, 1-methylnapthalene and 2-methylnapthalene were detected at this well, at concentrations less than their risk-based concentration or nuisance-based screening level, respectively. No other target analytes were detected.

TPH-residual fuels were detected in 4 of 6 samples collected with concentrations ranging between 69 µg/L and 390 µg/L. Concentrations of TPH-residual fuels were greater than the nuisance-based cleanup level of 100 µg/L in 2 samples and no samples were greater than the risk-based concentration of 2,500 µg/L. Benzene, toluene, xylenes, naphthalene, 1-methylnapthalene and 2-methylnapthalene are common target analytes and are discussed above. Six additional polynuclear aromatic hydrocarbons (PAHs) (acenaphthylene, benzo(a)anthracene, fluorene, phenanthrene, and pyrene) were detected in this well. All six of the PAHs were detected at concentrations less than their nuisance-based screening level or risk-based concentration. Four chlorinated solvents (1,2-dichloroethane, bromodichloromethane, chloromethane, methylene chloride) were detected at this well. Bromodichloromethane was detected in 1 of 20 samples at a concentration of 0.5 µg/L, which is greater than the risk-based concentrations level of 0.13 µg/L. Concentrations of 1,2-dichloroethane, chloromethane, and methylene chloride were less than their risk-based concentrations. Methylene chloride is also considered a common laboratory contaminant. No other target analytes were detected.

5.1.2.3 Well RHMW01

TPH-gasoline was detected in 4 of 22 samples collected with concentrations ranging between 13 µg/L and 26 µg/L. All concentrations were less than the nuisance-based cleanup level of 100 µg/L and the risk-based concentration of 400 µg/L. Naphthalene was detected in 11 of 28 samples collected with concentrations ranging between 0.037 µg/L and 0.2 µg/L. Naphthalene was detected in 11 of 28 samples with concentrations ranging between 0.037 µg/L and 0.2 µg/L; 2 samples were greater than the risk-based concentration of 0.17 µg/L. Toluene and lead concentrations were also detected but at concentrations less than their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 25 of 28 samples collected with concentrations ranging between 33 µg/L and 430 µg/L. Concentrations of TPH-middle distillates were greater than the

nuisance-based screening level of 100 µg/L in 12 samples and greater than the risk-based concentration of 160 µg/L in 8 samples. Toluene and naphthalene are common target analytes and are discussed above. Additionally, 1-methylnapthalene and 2-methylnapthalene were detected at this well both at concentrations less than their risk-based or nuisance-based cleanup level. No other target analytes were detected.

TPH-residual fuels were detected in 4 of 6 samples collected with concentrations ranging between 21 µg/L and 60 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Toluene, naphthalene, 1-methylnapthalene, and 2-methylnapthalene are common target analytes for this fraction of TPH. Six additional PAHs (acenaphthene, acenaphthylene, benzo(a)anthracene, fluorene, phenanthrene, and pyrene) were detected in this well. All six of the PAHs were detected at concentrations less than their nuisance-based screening level or risk-based concentration. Two chlorinated solvents (chloroform and methylene chloride) were detected at this well. Concentrations of chloroform and methylene chloride were both less than their risk-based concentration. No other target analytes were detected.

5.1.2.4 Well RHMW02

TPH-gasoline was detected in 15 of 20 samples with concentrations ranging between 36 µg/L and 660 µg/L. Two samples were greater than the nuisance-based screening level of 100 µg/L and one sample was greater than the risk-based concentration of 400 µg/L. Benzene, ethylbenzene, naphthalene, toluene, xylenes, and lead were detected in this well. Naphthalene was detected in 11 of 28 samples collected with concentrations ranging between 0.037 µg/L and 0.2 µg/L. Naphthalene was detected in all 25 samples at concentrations ranging between 1 µg/L and 160 µg/L; all concentrations were greater than the risk-based concentration of 0.17 µg/L. Benzene, ethylbenzene, toluene, xylenes, and lead concentrations were less than their nuisance-based or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected all 27 samples collected with concentrations ranging between 750 µg/L and 6,500 µg/L. All sample concentrations were greater than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 160 µg/L. Benzene, ethylbenzene, naphthalene, toluene, and xylenes are common target analytes and are discussed above. Additionally, 1-methylnapthalene and 2-methylnapthalene were both detected at this well. 1-methylnaphthalene was detected in all 26 samples where concentrations range between 0.57 µg/L and 68 µg/L; 24 samples were greater than the risk-based concentration of 1.1 µg/L. 2-methylnaphthalene was detected in all 27 samples where concentrations range between 0.16 µg/L and 43 µg/L; 7 samples were greater than the nuisance-based screening level of 10 µg/L and 2 were greater than the risk-based concentration of 36 µg/L. No other target analytes were detected.

TPH-residual fuels were detected in 4 of 6 samples with concentrations ranging between 260 µg/L and 360 µg/L. All concentrations were greater than the nuisance-based screening level of 100 µg/L and all concentrations were less than the risk-based concentration of 2,500 µg/L. Benzene, ethylbenzene, toluene, xylenes, naphthalene, 1-methylnapthalene, and 2-methylnapthalene are common target analytes and are discussed above. Six additional PAHs (acenaphthene, acenaphthylene, benzo(a)anthracene, fluorene, phenanthrene, and pyrene) were detected in this well. All six of the PAHs were detected at concentrations less than their nuisance-based or risk-based cleanup level. Three chlorinated solvents (1,1,2,2-tetrachloroethane, 1,2,3-trichloropropane, and methylene chloride) were detected in this well. 1,1,2,2-tetrachloroethane and methylene chloride were both detected at concentrations less than the risk-based concentrations level of 0.076 µg/L and 11µg/L, respectively. 1,2,3-trichloropropane was detected in 1 of 19 samples at a concentration of 0.27 µg/L, which is greater than the risk-based concentration of 0.00075 µg/L. No other target analytes were detected.

5.1.2.5 Well RHMW03

TPH-gasoline was detected in 2 of 21 samples with concentrations ranging between 20 µg/L and 23 µg/L. Both concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 400 µg/L. Toluene, naphthalene, and lead were detected in this well. Naphthalene was detected in 7 of 21 samples collected with concentrations ranging between 0.0094 µg/L and 0.32 µg/L; 1 sample was greater than the risk-based concentration of 0.17 µg/L. Toluene and lead concentrations were less than their nuisance-based or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 14 of 21 samples collected with concentrations ranging between 37 µg/L and 150 µg/L. Concentrations of TPH-middle distillates were greater than the nuisance-based screening level of 100 µg/L in 2 samples and no sample concentrations were greater than the risk-based concentration of 160 µg/L. Toluene and naphthalene are common target analytes and are discussed above. Additionally, 1-methylnapthalene and 2-methylnapthalene were detected at this well where concentrations for both analytes were less than the risk-based concentration or nuisance-based screening level of 1.1 µg/L and 10 µg/L, respectively. No other target analytes were detected.

TPH-residual fuels were detected in 4 of 6 samples collected with concentrations ranging between 110 µg/L and 160 µg/L. Four samples were greater than the nuisance-based screening level of 100 µg/L and all sample concentrations were less than the risk-based concentration of 2,500 µg/L. Toluene, naphthalene, 1-methylnapthalene and 2-methylnapthalene are common target analytes and are discussed above. Two additional PAHs (benzo(a)anthracene and phenanthrene) were detected in this well. Both PAHs were detected at concentrations less than their risk-based concentrations. No other target analytes were detected.

5.1.2.6 Well RHMW04

TPH-gasoline was not detected in any of the samples collected from this well. Benzene, toluene, naphthalene, and lead were detected in this well but at concentrations less their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 4 of 7 samples collected with concentrations ranging between 10 µg/L and 36 µg/L. All concentrations were less than the nuisance-based cleanup level of 100 µg/L and the risk-based concentration of 160 µg/L. Benzene, toluene, naphthalene are common target analytes and are discussed above. 1-methylnaphthalene and 2-methylnaphthalene were detected at this well at concentrations less than their risk-based concentration or nuisance-based screening level. No other target analytes were detected.

TPH-residual fuels were detected in 3 of 4 samples collected with concentrations ranging between 25 µg/L and 52 µg/L. All sample concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Benzene, toluene, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene are common target analytes and are discussed above. Six additional PAHs (acenaphthylene, anthracene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, fluorene, and phenanthrene) were detected in this well. Dibenzo(a,h)anthracene was detected in 1 of 6 samples at a concentration of 0.011 µg/L, which is greater than the risk-based concentration of 0.0034 µg/L. The remaining 5 PAHs were detected at concentrations less than their risk-based cleanup levels. No other target analytes were detected.

5.1.2.7 RHMW05

TPH-gasoline was in 4 of 20 samples with concentrations ranging between 15 µg/L and 23 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 400 µg/L. Toluene, naphthalene, and lead were detected in this well. All concentrations were less than their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 10 of 25 samples collected with concentrations ranging between 16 µg/L and 62 µg/L. Concentrations of TPH-middle distillates were less than the nuisance-based screening level of 100 µg/L and the risk-based screening level of 160 µg/L. Toluene and naphthalene are common target analytes and are discussed above. Additionally, 1-methylnapthalene and 2-methylnapthalene were both detected at this well where all concentrations were less than the risk-based concentration or nuisance-based screening level. No other target analytes were detected.

TPH-residual fuels were detected in 3 of 6 samples collected with concentrations ranging between 34 µg/L and 45 µg/L. All sample concentrations were less than the nuisance-based screening level

of 100 µg/L and the risk-based screening level of 2,500 µg/L. Toluene, naphthalene, 1-methylnapthalene, and 2-methylnapthalene are common target analytes and are discussed above. Two additional PAHs (benzo(a)anthracene and phenanthrene) were detected in this well. Both PAHs were detected at concentrations less than their risk-based concentrations. No other target analytes were detected.

5.1.2.8 RHMW06

TPH-gasoline was not detected in any of the 6 samples collected from this well. Toluene and lead were detected in this well but at concentrations less their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 3 of 6 samples collected with concentrations ranging between 17 µg/L and 21 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 160 µg/L. Toluene is common target analyte and is discussed above. 2-methylnaphthalene was also detected in this well, but at concentrations less than the nuisance-based screening level. No other target analytes were detected.

TPH-residual fuels were detected in 1 of 6 samples collected at a concentration of 47 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Toluene and 2-methylnaphthalene are common target analytes and are discussed above. One additional PAH (benzo(a)anthracene) was detected in this well at a concentration less than the risk-based concentration. One chlorinated solvent (bromodichloromethane) was detected in 2 of 5 samples at concentrations ranging between 0.00044 µg/L and 0.0039 µg/L, which were less than the risk-based concentration of 0.13 µg/L. No other target analytes were detected.

5.1.2.9 RHMW07

TPH-gasoline was not detected in any of the 6 samples collected from this well. Toluene, naphthalene, and lead were detected in this well. All concentrations were less than their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 5 of 6 samples collected with concentrations ranging between 22 µg/L and 66 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L the risk-based concentration of 160 µg/L. Toluene and naphthalene are common target analytes and are discussed above. 1-naphthalene and 2-methylnaphthalene were detected at this well. All concentrations were less than their respective risk-based concentration or nuisance-based screening level. No other target analytes were detected.

TPH-residual fuels were detected in 3 of 6 samples collected with concentrations ranging between 44 µg/L and 48 µg/L. All sample concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Toluene, naphthalene, 1-naphthalene, and 2-methylnaphthalene are common target analytes and are discussed above. Three additional PAHs (benzo(a)anthracene, fluorene, and phenanthrene) were detected in this well, all at concentrations less than their risk-based concentrations. No other target analytes were detected.

5.1.2.10 RHMW2254-01

TPH-gasoline was detected in 3 of 20 samples with concentrations ranging between 13 µg/L and 18 µg/L. All concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 400 µg/L. Toluene, naphthalene, and lead were detected in this well. All concentrations were less than their nuisance-based screening level or risk-based concentration. No other target analytes were detected.

TPH-middle distillates were detected in 6 of 24 samples collected with concentrations ranging between 14 µg/L and 22 µg/L. Concentrations of TPH-middle distillates were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 160 µg/L. Toluene and naphthalene are common target analytes and are discussed above. No other target analytes were detected.

TPH-residual fuels were detected in 2 of 6 samples collected with concentrations ranging between 37 µg/L and 42 µg/L. All sample concentrations were less than the nuisance-based screening level of 100 µg/L and the risk-based concentration of 2,500 µg/L. Toluene and naphthalene are common target analytes and are discussed above. One chlorinated solvent (trichloroethylene) was detected in this well. Trichloroethylene was detected in 1 of 19 samples collected at a concentration of 0.17 µg/L, which is less than the risk-based concentration of 0.49 µg/L. No other target analytes were detected.

5.2 Cancer Risks and Noncancer Hazards

For the purpose of this risk characterization step, the potential for unacceptable human health risk is identified using the following risk thresholds:

- ELCR values are compared to the "target range" of 1×10^{-4} to 1×10^{-6} that is generally used by regulatory agencies. ELCR values within or exceeding this target range require a risk management decision that includes evaluating site-specific characteristics and exposure scenario factors to assess whether remedial action is warranted.

- An HI (the sum of the ratios of the chemical intake to the RfDs for all COPCs) greater than 1 indicates that some potential exists for adverse noncancer health effects associated with exposure to the COPCs.

5.2.1 Cancer Risk Estimation Method

The potential for cancer effects is evaluated by estimating the ELCR . This risk is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cvancer (that is, if no exposure to chemicals occurs). To estimate the cancer risks from exposure to an individual carcinogen from all exposure routes (ingestion, dermal contact routes, and inhalation of volatiles), the following equation is used:

$$Risk_i = \sum_i \frac{EPC_{water}}{SL_{carcinogen}} \times TR$$

$Risk_i$ =ELCR for individual chemical

EPC_{water} =groundwater exposure point concentration (µg/L)

$SL_{carcinogen}$ =groundwater screening level based on 10^{-6} carcinogenic effect (µg/L)

TR =target cancer risk (10^{-6})

To estimate the cancer risks from exposure to mulitple carcinogens from all exposure routes considered, the following equation is used:

$$Risk_i = \sum_T \frac{EPC_{water}}{SL_{carcinogen}} \times TR$$

$Risk_T$ =total ELCR for all chemicals

EPC_{water} =groundwater exposure point concentration (µg/L)

$SL_{carcinogen}$ =groundwater screening level based on 10^{-6} carcinogenic effect (µg/L)

TR =target cancer risk (10^{-6})

i =the sum of the ratios for the i^{th} chemical

5.2.2 Noncancer Hazard Estimation Method

For noncancer effects, the likelihood that a receptor will develop an adverse effect is estimated by comparing the predicted level of exposure for a particular chemical with the highest level of exposure that is considered protective (that is, it's RfD). The ratio of the EPC divided by the screening level is the HQ.

When the HQ for a chemical exceeds 1 (that is, exposure exceeds RfD), a concern exists for potential noncancer health effects. To estimate the HQ from all exposure routes considered for an individual chemicals, the following equation is used.

$$HQ_i = \sum_i \frac{EPC_{water}}{SL_{noncarcinogen}}$$

Where:

HQ = hazard quotient for individual chemical

EPC_{water} =groundwater exposure point concentration (µg/L)

$SL_{noncarcinogen}$ =groundwater screening level based on a HQ of 1 (µg/L)

To estimate the HI from all exposure routes considered for multiple chemicals, the following equation is used.

$$HI_T = \sum_i \frac{EPC_{water}}{SL_{noncarcinogen}}$$

HI = hazard index

EPC_{water} =groundwater exposure point concentration (µg/L)

$SL_{noncarcinogen}$ =groundwater screening level based on HQ of 1 (µg/L)

i =the sum of the ratios for the i^{th} chemical

5.2.3 Well-Specific Cancer Risk and Noncancer Hazard Results

The results of the well-specific risk evaluation results are provided in Tables 5-4 through 5-13.

5.2.3.1 Well HDMW2253-03

Table 5-4 provides a summary of the cancer risks and noncancer hazards by exposure route for Well HDMW2253-03. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-1 and A-2).

The total ELCR for Well HDMW2254-03 is 1.3×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well HDMW2254-03 is 1.3, which is greater than the target HI value of 1. The primary contributor to the noncancer HI is TPH-middle distillates (HQ = 1.2; 93 percent contribution). The mechanisms of action (critical effects) for TPH-middle distillates is provided in Table 4-4.

5.2.3.2 Well OWDFMW01

Table 5-5 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well OWDFMW01. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-3 and A-4).

The total ELCR for Well OWDFMW01 is 7.3×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well OWDFMW01 is 20, which is greater than the target HI value of 1. The primary contributor to the noncancer HI is TPH-middle distillates (HQ = 20; 99 percent contribution). The mechanisms of action (critical effects) for TPH-middle distillates is provided in Table 4-4.

5.2.3.3 Well RHMW01

Table 5-6 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW01. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-5 and A-6).

The total ELCR for Well RHMW01 is 2.4×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW02is is 1.3, which is greater than the target HI value of 1. The primary contributor to the noncancer HI in this well is TPH-middle distillates (HQ = 1.2; 94 percent contribution). The mechanisms of action (critical effects) for TPH-middle distillates is provided in Table 4-4.

5.2.3.4 Well RHMW02

Table 5-7 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW02. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-7 and A-8).

The total ELCR for Well RHMW02 is 6.4×10^{-4}, which is greater than the EPA upper cancer risk range of 1×10^{-4}. The primary contributors to risk include 1,2,3-trichloropropane (ELCR = 1.0×10^{-4}; 16%), 1-methynaphthalene (ELCR = 1.2×10^{-6}; 1.9%), benzo(a)anthracene (ELCR = 2.1×10^{-6}; 0.32%), and naphthalene (ELCR = 5.2×10^{-4}; 61%).

The HI for Well RHMW02 is 36, which is greater than the target HI value of 1. The primary contributors to the noncancer HI are TPH-middle distillates (HQ = 20; 56 percent contribution) and naphthalene (HQ = 14; 40 percent contribution). The mechanisms of action (critical effects) for TPH-middle distillates is provided in Table 4-4.

5.2.3.5 Well RHMW03

Table 5-8 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW03. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-9 and A-10).

The total ELCR for Well RHMW03 is 2.4×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW03 is 0.64, which is less than the target HI value of 1.

5.2.3.6 Well RHMW04

Table 5-9 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW04. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-11 and A-12).

The total ELCR for Well RHMW04 is 1.8×10^{-4}, which is greater than the EPA upper cancer risk threshold of 1×10^{-4}. The primary contributor to risk is dibenzo(a,h)anthracene (ELCR = 1.8×10^{-4}; >99%).

The HI for Well RHMW04 is 0.19, which is less than the target HI value of 1.

5.2.3.7 Well RHMW05

Table 5-10 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW05. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-13 and A-14).

The total ELCR for Well RHMW05 is 2.0×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW05 is 0.22, which is less than the target HI value of 1.

5.2.3.8 Well RHMW06

Table 5-11 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW06. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-15 and A-6).

The total ELCR for Well RHMW06 is 1.3×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW06 is 0.17, which is less than the target HI value of 1.

5.2.3.9 Well RHMW07

Table 5-12 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW07. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-17 and A-18).

The total ELCR for Well RHMW07 is 1.2×10^{-6}, which is within the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW07 is 0.35, which is less than the target HI value of 1.

5.2.3.10 Well RHMW2254-01

Table 5-13 provides a summary of the cancer risks and noncancer hazards by exposure route for the Well RHMW2254-01. Additional details, including analyte-specific risk contributions, are provided in Appendix A (Tables A-19 and A-20).

The total ELCR for Well RHMW2254-01 is 8.3×10^{-7}, which is below the EPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}.

The HI for Well RHMW2254-01 is 0.24, which is less than the target HI value of 1.

6.0 SUMMARY OF RESULTS

The overall results of comparing individual groundwater concentrations to screening levels and the groundwater risk assessment are provided in Tables 6-1 through Table 6-10. The primary contributors to cancer risk are the associated target analytes associated with TPH-middle distillates and TPH-residual fuels, including benzene, benzo(a)anthracene, bromodichloromethane, dibenzo(a)anthracene, 1-methylnaphthalene, naphthalene, and 1,2,3-trichloropropane. The primary contributors to noncancer hazards are TPH-gasoline and TPH-middle distillates.

A total ELCR greater than 1×10^{-4} was reported at two wells, including RHMW02 (4.4×10^{-4}) and RHMW04 (1.8×10^{-4}). The primary contributors to risk at well RHMW02 include 1,2,3-trichloropropane (1.0×10^{-4}), 1-methylnaphthalene (1.2×10^{-5}), benzo(a)anthracene (2.1×10^{-6}), and naphthalene (5.2×10^{-4}). The primary contributor to risk at RHMW04 is dibenzo(a,h)anthracene (1.8×10^{-4}).

The groundwater screening levels identified for the primary cancer risk contributors are as follows:

- 1,2,3-trichloropropane (0.0075 µg/L),
- 1-methylnaphthalane (1.1 µg/L),
- benzo(a)anthracene (0.012 µg/L),
- dibenzo(a,h)anthracene (0.0034 µg/L), and
- naphthalene (0.17 µg/L)

The remaining eight wells (HDMW2253-03, ODWFMW01, RHMW01, RHMW03, RHMW05, RHMW06, RHMW07 and RHMW2254-01) report cancer risks within or below the EPA's acceptable cancer risk range of 1×10^{-4} and 1×10^{-6}.

A noncancer HI greater than 1 was reported at four wells: HDMW2253-03 (HI = 1.3), OWDFMW01 (HI = 20), RHMW01 (HI = 1.3), and RHMW02 (HI = 36). The primary contributor to the noncancer HI at wells HDMW2253-03, RHMW01, and OWDFMW01 is TPH-middle distillates; and the primary contributors to noncancer HI at well RHMW02 are TPH-middle distillates and naphthalane.

The groundwater screening levels identified for the primary noncancer hazard contributors are as follows:

- TPH-middle distillates (160 micrograms per liter [µg/L])
- naphthalene (0.17 µg/L).

The remaining six wells (RHMW03, RHMW04, RHMW05, RHMW06, RHMW07, RHMW2254-01) report an HI less than 1.

7.0 REFERENCES

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TABLES

Table 2-1. Halawa Valley Monitoring Wells

HDMW2253-03	OWDFMW01	RHMW01	RHMW02	RHMW03
RHMW04	RHMW05	RHMW06	RHMW08	RHMW2254-01

Table 2-2. Summary of Contaminants of Potential Concern

Volatile Organic Compounds		
1,1,2,2-Tetrachloroethane	1,2,3-Trichloropropane	1,2-Dichloropropane
Acetone	Benzene	Bromodichloromethane
Chloroform	Chloromethane	Ethylbenzene
Methyl ethyl ketone	Methane	Methylene chloride
Toluene	Trichloroethylene	Xylenes (total)
Polynuclear Aromatic Hydrocarbons		
1-Methylnapthalene	2-Methylnaphthalene	Acenaphthene
Acenaphthylene	Anthracene	Benzo(a)anthracene
Benzo(g,h,i)perylene	Dibenz(a,h0anthracene	Fluorene
Naphthalene	Phenanthrene	Pyrene
Total Petroleum Hydrocarbon Fractions		
Gasoline	Middle distillates	Residual fuels
Metals		
	Lead	
Anions and General Chemical		
Chloride	Nitrate + nitrite as nitrogen	Sulfate

Note that alkalinity as CaCO3 was reported, however it was not included in the evaluation.

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – Cancer Risk	AT_{can}	25,550	days	EPA/540/R-92/003
Averaging Time – Noncancer Hazard Index	AT_{nc}	2,190	days	EPA, 2011
Partitioning constant derived by Bunge Model	B	Analyte-Specific	unitless	See Table 4-1
Adult Body Weight	BW_a	80	kg	EPA/600/R-090/052F
Body Weight - child	BW_c	15	kg	EPA/600/R-090/052F
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF2	1/24	days/ hour	1 day = 24 hours
Conversion Factor	CF3	0.001	L/cm^3	1 L = 1,000 cm^3
Conversion Factor	CF4	1,000	µg/mg	1,000 µg = 1 mg
Cancer Slope Factor - oral	CSF_o	Analyte-Specific	$(mg/kg\text{-}day)^{-1}$	See Table 4-1
Screening Level – carcinogen ingestion	$SL_{ca\text{-}ing}$	Calculated value	µg/L	EPA 2016
Screening Level – noncarcinogen ingestion	$SL_{nc\text{-}ing}$	Calculated value	µg/L	EPA 2016
Screening Level – mutagen ingestion	$SL_{mut\text{-}ing}$	Calculated value	µg/L	EPA 2016
Screening Level – trichloroethylene ingestion	$SL_{tce\text{-}ing}$	Calculated value	µg/L	EPA 2016
Screening Level – dermal contact with carcinogens	$SL_{ca\text{-}der}$	Calculated value	µg/L	EPA 2016
Screening Level – dermal contact with noncarcinogens	$SL_{nc\text{-}der}$	Calculated value	µg/L	EPA 2016
Screening Level – dermal contact with mutagens	$SL_{mut\text{-}der}$	Calculated value	µg/L	EPA 2016
Screening Level –dermal contact with trichloroethylene	$SL_{tce\text{-}der}$	Calculated value	µg/L	EPA 2016
Screening Level – carcinogen inhalation	$SL_{ca\text{-}inh}$	Calculated value	µg/L	EPA 2016
Screening Level – noncarcinogen inhalation	$SL_{nc\text{-}inh}$	Calculated value	µg/L	EPA 2016
Screening Level – mutagen inhalation	$SL_{mut\text{-}inh}$	Calculated value	µg/L	EPA 2016

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario

Exposure Factor	Symbol	Value	Units	Source
Screening Level – trichloroethylene inhalation	$SL_{tce\text{-}inh}$	Calculated value	µg/L	EPA 2016
Screening Level – carcinogen total	$SL_{ca\text{-}tot}$	Calculated value	µg/L	EPA 2016
Screening Level – noncarcinogen total	$SL_{nc\text{-}tot}$	Calculated value	µg/L	EPA 2016
Screening Level – mutagen total	$SL_{mut\text{-}tot}$	Calculated value	µg/L	EPA 2016
Screening Level – trichloroethylene total	$SL_{tce\text{-}tot}$	Calculated value	µg/L	EPA 2016
Age-adjusted water ingestion rate- carcinogen	IRW_{adj}	327.95	L/kg	Calculated value
Age-adjusted water ingestion rate- mutagen	$IRWM_{adj}$	1019.9	L/kg	Calculated value
Absorbed dose per event	DA_{event}	Calculated value	mg/cm^2-event	EPA 2016
Carcinogenic adjustment factor - oral	CAFo	0.804	unitless	EPA 2016
Carcinogenic adjustment factor - inhalation	CAFi	0.756	unitless	EPA 2016
Exposure Duration - adult	ED_a	26	years	EPA/600/R-090/052F
Exposure Duration - child	ED_c	6	years	EPA/540/R-92/003
Exposure Duration – child (0 – 2 years)	$ED_{0\text{-}2}$	2	years	EPA 2016
Exposure Duration – child (2 – 6 years)	$ED_{2\text{-}6}$	4	years	EPA 2016
Exposure Duration – child (6 – 16 years)	$ED_{6\text{-}16}$	10	years	EPA 2016
Exposure Duration – child (16 – 26 years)	$ED_{16\text{-}26}$	10	years	EPA 2016
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Time – resident inhalation	ET_{inh}	24	hours/day	OSWER Directive 9200.1-120
Exposure Time – adult dermal	ET_a	0.71	hours/day	EPA/600/R-090/052F
Exposure Time – child dermal	ET_c	0.54	hours/day	EPA/600/R-090/052F

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario

Exposure Factor	Symbol	Value	Units	Source
Age-Adjusted Exposure Time – dermal carcinogen	ET_{adj}	0.671	hours/event	Calculated value
Age-Adjusted Exposure Time – dermal mutagen	$ET_{adj\text{-}mut}$	0.671	hours/event	Calculated value
Event frequency	EV	1	event/day	EPA/540/R/99/005
Fraction of absorbed water	FA	Analyte-Specific	unitless	See Table 4-1
Gastrointestinal absorption factor	GIABS	Analyte-Specific	unitless	See Table 4-1
Inhalation Rate - adult	INH_a	20	m^3/day	OSWER Directive 9285.6-03
Inhalation Rate - child	INH_c	10	m^3/day	EPA/600/P-95/002Fa
Age-adjusted inhalation rate - mutagenic	$INHM_{adj}$	604,800	hours	Calculated
Age-adjusted inhalation rate – mutagenic trichloroethylene	$INHM_{adj\text{-}tce}$	147,571	hours	Calculated
Water Ingestion Rate - adult	IRW_a	2.5	L/day	EPA/600/R-090/052F
Water Ingestion Rate - child	IRW_c	0.78	L/day	EPA/600/R-090/052F
Inhalation Unit Risk	IUR	Analyte-Specific	$(\mu g/m^3)^{-1}$	See Table 4-1
Dermal permeability coefficient	K_p	Analyte-Specific	cm/hour	See Table 4-1
Mutagenic adjustment factor - oral	MAFo	0.202	unitless	EPA 2016
Mutagenic adjustment factor - inhalation	MAFi	0.244	unitless	EPA 2016
Reference Concentration	RfC	Analyte-Specific	mg/m^3	See Table 4-1
Oral Chronic Reference Dose	RfD_o	Analyte-Specific	mg/kg-day	See Table 4-1
Age-adjusted Skin Surface Area - carcinogenic	SA_{adj}	2,610,650	cm^2-event/kg	Calculated value
Age-adjusted Skin Surface Area - mutagenic	$SA_{adj\text{-}mut}$	8,191,633	cm^2-event/kg	Calculated value

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario

Exposure Factor	Symbol	Value	Units	Source
Skin Surface Area – adult	SA_a	19,652	cm^2	EPA/600/R-090/052F
Skin Surface Area - child	SA_c	6,365	cm^2	EPA/600/R-090/052F
Target hazard quotient	THQ	1	unitless	EPa 2016
Target risk	TR	1×10^{-6}	unitless	EPA 2016
Time to reach steady state conditions	t*	Analyte-Specific	hour	See Table 4-1
Lag time	τ	Analyte-Specific	hours/event	See Table 4-1
Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003

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Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
ALL WELLS	1,1,2,2-Tetrachloroethane	79-34-5	120	1	119	0.83	ug/L	0.0020	0.50	0.065	0.065	0	0.065	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 1,1,2,2-Tetrachloroethane was not processed!
ALL WELLS	1,2,3-Trichloropropane	96-18-4	130	1	129	0.77	ug/L	0.20	2.0	0.27	0.27	0	0.27	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 1,2,3-Trichloropropane was not processed!
ALL WELLS	1,2-Dichloroethane	107-06-2	140	4	136	2.86	ug/L	0.0058	5.8	9.00E-04	0.012	0.61	0.0056	95% KM (t) UCL	
ALL WELLS	1-Methylnaphthalene	90-12-0	156	43	113	27.56	ug/L	0.0035	0.12	0.0039	68	1.5	13	99% KM (Chebyshev) UCL	
ALL WELLS	2-Methylnaphthalene	91-57-6	156	50	106	32.05	ug/L	0.0023	0.12	0.0034	43	1.8	4.6	95% KM (Chebyshev) UCL	
ALL WELLS	Acenaphthene	83-32-9	124	24	100	19.35	ug/L	0.0044	0.12	0.0053	0.65	0.57	0.10	95% KM (t) UCL	
ALL WELLS	Acenaphthylene	208-96-8	129	8	121	6.2	ug/L	0.0034	0.24	0.0037	0.26	1.0	0.014	95% KM (t) UCL	
ALL WELLS	Acetone	67-64-1	128	17	111	13.28	ug/L	1.9	10	1.9	150	1.2	10	95% KM Approximate Gamma UCL	
ALL WELLS	Alkalinity (as CaCO3)	Alkalinity (as CaCO3)	4	4	0	100	ug/L	--	--	1.18E+08	1.84E+08	0.20	1.77E+08	95% Student's-t UCL	
ALL WELLS	Anthracene	120-12-7	118	1	117	0.85	ug/L	0.0050	0.10	0.0051	0.0051	0	0.0051	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Anthracene was not processed!
ALL WELLS	Benzene	71-43-2	152	20	132	13.16	ug/L	0.062	0.50	0.070	1.3	0.83	0.16	95% KM (t) UCL	
ALL WELLS	Benzo(a)anthracene	56-55-3	128	11	117	8.59	ug/L	0.0026	0.14	0.0026	0.0047	0.22	0.0033	95% KM (t) UCL	
ALL WELLS	Benzo(g,h,i)perylene	191-24-2	123	1	122	0.81	ug/L	0.0029	0.16	0.0076	0.0076	0	0.0076	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(g,h,i)perylene was not processed!
ALL WELLS	Bromodichloromethane	75-27-4	125	3	122	2.4	ug/L	0.0034	0.50	4.40E-04	0.50	1.7	0.013	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
ALL WELLS	Chloride	Chloride	2	2	0	100	ug/L	--	--	319,000	362,000	0.089	362,000	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Chloride was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
ALL WELLS	Chloroform	67-66-3	130	1	129	0.77	ug/L	0.072	0.50	0.13	0.13	0	0.13	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Chloroform was not processed!
ALL WELLS	Chloromethane	74-87-3	125	3	122	2.4	ug/L	0.0068	5.0	0.070	0.12	0.27	0.078	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
ALL WELLS	Dibenzo(a,h)anthracene	53-70-3	123	1	122	0.81	ug/L	0.0026	0.10	0.011	0.011	0	0.011	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Dibenzo(a,h)anthracene was not processed!
ALL WELLS	Ethylbenzene	100-41-4	154	22	132	14.29	ug/L	0.050	0.50	0.014	0.30	0.32	0.10	95% KM (t) UCL	
ALL WELLS	Fluorene	86-73-7	129	26	103	20.16	ug/L	0.0038	0.12	0.0039	0.32	0.75	0.049	95% KM (t) UCL	
ALL WELLS	Lead, Dissolved	Lead, Dissolved	133	73	60	54.89	ug/L	0.20	0.80	0.0060	2.2	1.6	0.33	95% KM (Chebyshev) UCL	
ALL WELLS	Lead, Total	Lead, Total	17	10	7	58.82	ug/L	0.090	0.090	0.14	0.83	0.76	0.32	95% GROS Adjusted Gamma UCL	

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
ALL WELLS	Methane	74-82-8	4	2	2	50	ug/L	0.45	0.45	1.7	2.8	0.35	2.8	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
ALL WELLS	Methyl ethyl ketone	78-93-3	120	1	119	0.83	ug/L	0.50	5.0	1.0	1.0	0	1.0	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Methyl ethyl ketone was not processed!
ALL WELLS	Methylene chloride	75-09-2	130	3	127	2.31	ug/L	0.10	2.0	0.10	0.59	0.87	0.15	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
ALL WELLS	Naphthalene	91-20-3	155	83	72	53.55	ug/L	0.0038	0.10	0.0038	160	2.2	19	95% KM (Chebyshev) UCL	
ALL WELLS	Nitrate+Nitrite as N	Nitrate+Nitrite as N	4	4	0	100	ug/L	--	--	63	630	0.64	1,169	97.5% Chebyshev (Mean, Sd)	Recommended UCL Exceeds Maximum Concentration: EPC set to 97.5% Chebyshev (Mean, Sd).
ALL WELLS	Nitrate+Nitrite as N	Nitrate+Nitrite as N	4	4	0	100	ug/L	--	--	63	630	0.64	630	(Alt) Maximum Detect	Recommended UCL Exceeds Maximum Concentration; EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs also exceed maximum concentration.
ALL WELLS	Phenanthrene	85-01-8	128	12	116	9.38	ug/L	0.0050	0.14	0.0052	0.019	0.45	0.0075	95% KM (t) UCL	
ALL WELLS	Pyrene	129-00-0	128	3	125	2.34	ug/L	0.0010	0.16	0.0058	0.027	0.93	0.0043	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
ALL WELLS	Sulfate	Sulfate	4	4	0	100	ug/L	--	--	59,900	87,800	0.18	84,251	95% Student's-t UCL	
ALL WELLS	Toluene	108-88-3	156	30	126	19.23	ug/L	0.054	0.50	0.060	3.8	1.4	0.26	95% KM Approximate Gamma UCL	
ALL WELLS	TPH (gasolines)	TPH (gasolines)	137	37	100	27.01	ug/L	8.3	30	13	660	2.0	46	95% KM (Chebyshev) UCL	
ALL WELLS	TPH (middle distillates)	TPH (middle distillates)	154	118	36	76.62	ug/L	10	86	10	6,500	1.8	987	95% KM (Chebyshev) UCL	
ALL WELLS	TPH (residual fuels)	TPH (residual fuels)	57	30	27	52.63	ug/L	20	212	21	390	0.98	93	95% KM H-UCL	
ALL WELLS	Trichloroethylene	79-01-6	130	1	129	0.77	ug/L	0.10	0.50	0.17	0.17	0	0.17	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Trichloroethylene was not processed!
ALL WELLS	Xylenes, Total	1330-20-7	156	25	131	16.03	ug/L	0.18	1.5	0.21	0.69	0.28	0.26	95% KM (t) UCL	
HDMW2253-03	Benzene	71-43-2	22	3	19	13.64	ug/L	0.062	0.50	0.20	0.92	0.72	0.27	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
HDMW2253-03	Benzo(a)anthracene	56-55-3	20	1	19	5	ug/L	0.0026	0.14	0.0032	0.0032	0	0.0032	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(a)anthracene was not processed!
HDMW2253-03	Lead, Dissolved	Lead, Dissolved	20	9	11	45	ug/L	0.20	0.22	0.025	0.90	1.3	0.90	Maximum Detect	
HDMW2253-03	Naphthalene	91-20-3	22	6	16	27.27	ug/L	0.0038	0.10	0.0042	0.16	0.97	0.044	95% KM (t) UCL	
HDMW2253-03	Toluene	108-88-3	22	4	18	18.18	ug/L	0.10	0.50	0.070	3.8	1.6	3.8	Maximum Detect	
HDMW2253-03	TPH (gasolines)	TPH (gasolines)	21	5	16	23.81	ug/L	8.3	30	15	27	0.32	16	95% KM (t) UCL	
HDMW2253-03	TPH (middle distillates)	TPH (middle distillates)	22	13	9	59.09	ug/L	12	81	13	600	1.7	187	95% KM (Chebyshev) UCL	
HDMW2253-03	TPH (residual fuels)	TPH (residual fuels)	6	3	3	50	ug/L	22	212	55	77	0.17	77	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
OWDFMW01	1,2-Dichloroethane	107-06-2	21	4	17	19.05	ug/L	0.28	0.50	9.00E-04	0.012	0.61	0.012	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
OWDFMW01	1-Methylnaphthalene	90-12-0	21	4	17	19.05	ug/L	0.048	0.12	0.0096	0.030	0.42	0.028	95% KM (t) UCL	
OWDFMW01	2-Methylnaphthalene	91-57-6	21	4	17	19.05	ug/L	0.048	0.12	0.0097	0.020	0.30	0.019	95% KM (t) UCL	

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
OWDFMW01	Acenaphthylene	208-96-8	20	1	19	5	ug/L	0.0050	0.12	0.0082	0.0082	0	0.0082	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acenaphthylene was not processed!
OWDFMW01	Acetone	67-64-1	20	14	6	70	ug/L	1.9	10	2.3	150	1.1	150	Maximum Detect	
OWDFMW01	Benzene	71-43-2	21	13	8	61.9	ug/L	0.062	0.50	0.070	1.3	0.68	0.50	95% KM (t) UCL	
OWDFMW01	Benzo(a)anthracene	56-55-3	20	2	18	10	ug/L	0.0026	0.14	0.0033	0.0046	0.23	0.0046	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
OWDFMW01	Bromodichloromethane	75-27-4	20	1	19	5	ug/L	0.0034	0.50	0.50	0.50	0	0.50	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Bromodichloromethane was not processed!
OWDFMW01	Chloromethane	74-87-3	20	3	17	15	ug/L	0.62	5.0	0.070	0.12	0.27	0.12	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
OWDFMW01	Fluorene	86-73-7	20	1	19	5	ug/L	0.0038	0.12	0.0039	0.0039	0	0.0039	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Fluorene was not processed!
OWDFMW01	Lead, Dissolved	Lead, Dissolved	20	9	11	45	ug/L	0.20	0.22	0.033	0.43	0.81	0.18	95% KM (t) UCL	
OWDFMW01	Methyl ethyl ketone	78-93-3	19	1	18	5.26	ug/L	1.2	5.0	1.0	1.0	0	1.0	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Methyl ethyl ketone was not processed!
OWDFMW01	Methylene chloride	75-09-2	20	1	19	5	ug/L	0.10	1.0	0.20	0.20	0	0.20	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Methylene chloride was not processed!
OWDFMW01	Naphthalene	91-20-3	21	12	9	57.14	ug/L	0.049	0.10	0.016	0.12	0.68	0.056	95% KM Adjusted Gamma UCL	
OWDFMW01	Phenanthrene	85-01-8	20	3	17	15	ug/L	0.048	0.14	0.0073	0.014	0.40	0.013	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
OWDFMW01	Pyrene	129-00-0	20	1	19	5	ug/L	0.0053	0.16	0.0063	0.0063	0	0.0063	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Pyrene was not processed!
OWDFMW01	Toluene	108-88-3	21	4	17	19.05	ug/L	0.10	0.50	0.060	0.40	0.66	0.23	95% KM (t) UCL	
OWDFMW01	TPH (gasolines)	TPH (gasolines)	21	4	17	19.05	ug/L	8.3	30	17	31	0.31	15	95% KM (t) UCL	
OWDFMW01	TPH (middle distillates)	TPH (middle distillates)	21	15	6	71.43	ug/L	81	81	17	3,100	1.3	3,100	Maximum Detect	
OWDFMW01	TPH (residual fuels)	TPH (residual fuels)	6	4	2	66.67	ug/L	212	212	69	390	0.84	258	95% KM (t) UCL	
OWDFMW01	Xylenes, Total	1330-20-7	21	1	20	4.76	ug/L	0.18	1.0	0.39	0.39	0	0.39	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Xylenes, Total was not processed!
RHMW01	1-Methylnaphthalene	90-12-0	28	5	23	17.86	ug/L	0.050	0.12	0.014	0.040	0.46	0.036	95% KM (t) UCL	
RHMW01	2-Methylnaphthalene	91-57-6	28	6	22	21.43	ug/L	0.050	0.12	0.0093	0.039	0.51	0.033	95% KM (t) UCL	

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW01	Acenaphthene	83-32-9	21	4	17	19.05	ug/L	0.050	0.12	0.0053	0.027	0.67	0.027	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW01	Acenaphthylene	208-96-8	21	1	20	4.76	ug/L	0.0050	0.12	0.0041	0.0041	0	0.0041	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acenaphthylene was not processed!
RHMW01	Acetone	67-64-1	22	1	21	4.55	ug/L	1.9	10	15	15	0	15	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acetone was not processed!
RHMW01	Benzo(a)anthracene	56-55-3	21	2	19	9.52	ug/L	0.0026	0.14	0.0026	0.0029	0.077	0.0029	95% KM (t) UCL	Warning: One or more Recommended UCL(s) not available! Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW01	Chloroform	67-66-3	22	1	21	4.55	ug/L	0.072	0.50	0.13	0.13	0	0.13	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Chloroform was not processed!
RHMW01	Fluorene	86-73-7	21	4	17	19.05	ug/L	0.050	0.12	0.0096	0.035	0.62	0.031	95% KM (t) UCL	
RHMW01	Lead, Dissolved	Lead, Dissolved	26	16	10	61.54	ug/L	0.20	0.22	0.090	2.1	1.2	0.68	95% KM (Chebyshev) UCL	
RHMW01	Methylene chloride	75-09-2	22	1	21	4.55	ug/L	0.10	2.0	0.59	0.59	0	0.59	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Methylene chloride was not processed!
RHMW01	Naphthalene	91-20-3	28	11	17	39.29	ug/L	0.050	0.10	0.037	0.20	0.60	0.078	95% KM (t) UCL	
RHMW01	Phenanthrene	85-01-8	21	2	19	9.52	ug/L	0.0050	0.14	0.011	0.012	0.061	0.012	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW01	Pyrene	129-00-0	21	1	20	4.76	ug/L	0.0053	0.16	0.027	0.027	0	0.027	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Pyrene was not processed!
RHMW01	Toluene	108-88-3	28	4	24	14.29	ug/L	0.10	0.50	0.17	2.5	0.96	0.46	95% KM (t) UCL	
RHMW01	TPH (gasolines)	TPH (gasolines)	22	4	18	18.18	ug/L	8.3	30	13	26	0.31	14	95% KM (t) UCL	
RHMW01	TPH (middle distillates)	TPH (middle distillates)	28	25	3	89.29	ug/L	81	81	33	430	0.66	194	95% KM H-UCL	
RHMW01	TPH (residual fuels)	TPH (residual fuels)	5	3	2	60	ug/L	21	212	21	60	0.63	53	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates. Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW02	1,1,2,2-Tetrachloroethane	79-34-5	18	1	17	5.56	ug/L	0.12	0.50	0.065	0.065	0	0.065	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 1,1,2,2-Tetrachloroethane was not processed!
RHMW02	1,2,3-Trichloropropane	96-18-4	19	1	18	5.26	ug/L	0.20	2.0	0.27	0.27	0	0.27	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 1,2,3-Trichloropropane was not processed!
RHMW02	1-Methylnaphthalene	90-12-0	26	26	0	100	ug/L	--	--	0.57	68	1.0	33	95% Adjusted Gamma UCL	
RHMW02	2-Methylnaphthalene	91-57-6	27	27	0	100	ug/L	--	--	0.16	43	1.1	19	95% Adjusted Gamma UCL	
RHMW02	Acenaphthene	83-32-9	20	20	0	100	ug/L	--	--	0.17	0.65	0.33	0.50	95% Student's-t UCL	
RHMW02	Acenaphthylene	208-96-8	20	5	15	25	ug/L	0.047	0.24	0.071	0.26	0.58	0.093	95% KM (t) UCL	
RHMW02	Benzene	71-43-2	26	5	21	19.23	ug/L	0.32	0.50	0.080	0.15	0.27	0.12	95% KM (t) UCL	
RHMW02	Benzo(a)anthracene	56-55-3	19	1	18	5.26	ug/L	0.0026	0.14	0.0047	0.0047	0	0.0047	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(a)anthracene was not processed!
RHMW02	Ethylbenzene	100-41-4	26	22	4	84.62	ug/L	0.46	0.50	0.014	0.30	0.32	0.21	95% KM (t) UCL	
RHMW02	Fluorene	86-73-7	19	18	1	94.74	ug/L	0.047	0.047	0.083	0.32	0.35	0.25	95% KM (t) UCL	
RHMW02	Lead, Dissolved	Lead, Dissolved	24	15	9	62.5	ug/L	0.20	0.22	0.025	1.2	1.1	0.34	95% KM Adjusted Gamma UCL	
RHMW02	Methylene chloride	75-09-2	19	1	18	5.26	ug/L	0.10	2.0	0.10	0.10	0	0.10	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Methylene chloride was not processed!
RHMW02	Naphthalene	91-20-3	25	25	0	100	ug/L	--	--	1.0	160	0.86	87	95% Adjusted Gamma UCL	
RHMW02	Phenanthrene	85-01-8	19	1	18	5.26	ug/L	0.0050	0.14	0.019	0.019	0	0.019	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Phenanthrene was not processed!
RHMW02	Pyrene	129-00-0	19	1	18	5.26	ug/L	0.0053	0.16	0.0058	0.0058	0	0.0058	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Pyrene was not processed!
RHMW02	Toluene	108-88-3	26	4	22	15.38	ug/L	0.10	0.50	0.060	0.60	0.92	0.20	95% KM (t) UCL	
RHMW02	TPH (gasolines)	TPH (gasolines)	20	15	5	75	ug/L	12	12	36	660	1.5	238	95% KM (Chebyshev) UCL	
RHMW02	TPH (middle distillates)	TPH (middle distillates)	27	27	0	100	ug/L	--	--	750	6,500	0.61	3,185	95% H-UCL	
RHMW02	TPH (residual fuels)	TPH (residual fuels)	6	4	2	66.67	ug/L	212	212	260	360	0.14	340	95% KM (t) UCL	
RHMW02	Xylenes, Total	1330-20-7	28	24	4	85.71	ug/L	0.38	0.38	0.21	0.69	0.28	0.42	95% KM (t) UCL	
RHMW03	1-Methylnaphthalene	90-12-0	21	3	18	14.29	ug/L	0.0035	0.12	0.0039	0.10	1.3	0.029	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW03	2-Methylnaphthalene	91-57-6	21	3	18	14.29	ug/L	0.0023	0.12	0.0034	0.069	1.4	0.019	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW03	Benzo(a)anthracene	56-55-3	20	2	18	10	ug/L	0.0026	0.14	0.0037	0.0043	0.11	0.0043	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW03	Lead, Dissolved	Lead, Dissolved	20	7	13	35	ug/L	0.20	0.22	0.011	1.4	1.5	1.4	Maximum Detect	
RHMW03	Naphthalene	91-20-3	21	7	14	33.33	ug/L	0.0038	0.10	0.0094	0.32	1.1	0.076	95% KM (t) UCL	

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW03	Phenanthrene	85-01-8	20	2	18	10	ug/L	0.0050	0.14	0.0057	0.0058	0.012	0.0058	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW03	Toluene	108-88-3	21	3	18	14.29	ug/L	0.10	0.50	0.14	0.54	0.56	0.23	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW03	TPH (gasolines)	TPH (gasolines)	21	2	19	9.52	ug/L	12	30	20	23	0.099	17	95% KM (t) UCL	Warning: One or more Recommended UCL(s) not available! Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW03	TPH (middle distillates)	TPH (middle distillates)	21	14	7	66.67	ug/L	81	81	37	150	0.50	82	95% KM (t) UCL	
RHMW03	TPH (residual fuels)	TPH (residual fuels)	6	4	2	66.67	ug/L	212	212	110	160	0.16	160	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW04	1-Methylnaphthalene	90-12-0	7	1	6	14.29	ug/L	0.0035	0.10	0.0043	0.0043	0	0.0043	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 1-Methylnaphthalene was not processed!
RHMW04	2-Methylnaphthalene	91-57-6	7	2	5	28.57	ug/L	0.0023	0.052	0.0047	0.0059	0.16	0.0059	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW04	Acenaphthylene	208-96-8	6	1	5	16.67	ug/L	0.0034	0.052	0.0037	0.0037	0	0.0037	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acenaphthylene was not processed!
RHMW04	Acetone	67-64-1	6	1	5	16.67	ug/L	3.3	10	43	43	0	43	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acetone was not processed!
RHMW04	Anthracene	120-12-7	5	1	4	20	ug/L	0.0050	0.052	0.0051	0.0051	0	0.0051	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Anthracene was not processed!
RHMW04	Benzene	71-43-2	7	1	6	14.29	ug/L	0.062	0.50	0.080	0.080	0	0.080	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzene was not processed!
RHMW04	Benzo(g,h,i)perylene	191-24-2	6	1	5	16.67	ug/L	0.0050	0.10	0.0076	0.0076	0	0.0076	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(g,h,i)perylene was not processed!

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW04	Dibenzo(a,h)anthracene	53-70-3	6	1	5	16.67	ug/L	0.0050	0.052	0.011	0.011	0	0.011	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Dibenzo(a,h)anthracene was not processed!
RHMW04	Fluorene	86-73-7	6	1	5	16.67	ug/L	0.0038	0.052	0.0060	0.0060	0	0.0060	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Fluorene was not processed!
RHMW04	Lead, Dissolved	Lead, Dissolved	6	3	3	50	ug/L	0.20	0.20	0.0060	0.044	0.75	0.044	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW04	Naphthalene	91-20-3	7	2	5	28.57	ug/L	0.0038	0.052	0.0051	0.0075	0.27	0.0071	95% KM (t) UCL	Warning: One or more Recommended UCL(s) not available! Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW04	Phenanthrene	85-01-8	6	1	5	16.67	ug/L	0.0050	0.052	0.0069	0.0069	0	0.0069	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Phenanthrene was not processed!
RHMW04	Toluene	108-88-3	7	2	5	28.57	ug/L	0.10	0.50	0.11	0.42	0.83	0.42	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW04	TPH (middle distillates)	TPH (middle distillates)	7	4	3	57.14	ug/L	12	21	10	36	0.51	25	95% KM (t) UCL	
RHMW04	TPH (residual fuels)	TPH (residual fuels)	4	3	1	75	ug/L	21	21	25	52	0.35	52	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW05	1-Methylnaphthalene	90-12-0	25	2	23	8	ug/L	0.0035	0.12	0.0041	0.0050	0.14	0.0048	95% KM (t) UCL	Warning: One or more Recommended UCL(s) not available! Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW05	2-Methylnaphthalene	91-57-6	25	3	22	12	ug/L	0.0050	0.12	0.0036	0.0066	0.35	0.0058	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW05	Benzo(a)anthracene	56-55-3	19	1	18	5.26	ug/L	0.0026	0.14	0.0038	0.0038	0	0.0038	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(a)anthracene was not processed!
RHMW05	Lead, Dissolved	Lead, Dissolved	23	7	16	30.43	ug/L	0.20	0.22	0.032	0.29	0.65	0.14	95% KM (t) UCL	
RHMW05	Naphthalene	91-20-3	25	12	13	48	ug/L	0.0050	0.10	0.0046	0.17	0.89	0.053	95% KM (t) UCL	
RHMW05	Phenanthrene	85-01-8	19	1	18	5.26	ug/L	0.0050	0.14	0.0052	0.0052	0	0.0052	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Phenanthrene was not processed!

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW05	Toluene	108-88-3	25	3	22	12	ug/L	0.10	0.50	0.18	0.59	0.58	0.28	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW05	TPH (gasolines)	TPH (gasolines)	20	4	16	20	ug/L	8.3	30	15	23	0.22	14	95% KM (t) UCL	
RHMW05	TPH (middle distillates)	TPH (middle distillates)	25	10	15	40	ug/L	10	81	16	62	0.59	24	95% KM (BCA) UCL	
RHMW05	TPH (residual fuels)	TPH (residual fuels)	6	3	3	50	ug/L	21	212	34	45	0.15	45	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW06	2-Methylnaphthalene	91-57-6	6	1	5	16.67	ug/L	0.0023	0.010	0.0064	0.0064	0	0.0064	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable 2-Methylnaphthalene was not processed!
RHMW06	Alkalinity (as CaCO3)	Alkalinity (as CaCO3)	2	2	0	100	ug/L	--	--	1.18E+08	1.39E+08	0.12	1.39E+08	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Alkalinity (as CaCO3) was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW06	Benzo(a)anthracene	56-55-3	5	1	4	20	ug/L	0.0026	0.011	0.0028	0.0028	0	0.0028	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(a)anthracene was not processed!
RHMW06	Bromodichloromethane	75-27-4	5	2	3	40	ug/L	0.010	0.30	4.40E-04	0.0039	1.1	0.0039	Maximum Detect	Warning: Recommended UCL exceeds the maximum observation Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW06	Chloride	Chloride	1	1	0	100	ug/L	--	--	319,000	319,000	0	319,000	Maximum Detect	Warning: This data set only has 1 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Chloride was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW06	Lead, Dissolved	Lead, Dissolved	5	3	2	60	ug/L	0.40	0.80	0.0060	0.016	0.62	0.016	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW06	Methane	74-82-8	2	1	1	50	ug/L	0.45	0.45	1.7	1.7	0	1.7	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Methane was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW06	Nitrate+Nitrite as N	Nitrate+Nitrite as N	2	2	0	100	ug/L	--	--	530	630	0.12	630	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Nitrate+Nitrite as N was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW06	Sulfate	Sulfate	2	2	0	100	ug/L	--	--	66,600	87,800	0.19	87,800	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Sulfate was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW06	Toluene	108-88-3	6	2	4	33.33	ug/L	0.10	0.30	0.10	1.1	1.2	1.1	Maximum Detect	Warning: Recommended UCL exceeds the maximum observation Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW06	TPH (middle distillates)	TPH (middle distillates)	6	3	3	50	ug/L	20	86	17	21	0.11	21	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates. Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
RHMW06	TPH (residual fuels)	TPH (residual fuels)	6	1	5	16.67	ug/L	20	86	47	47	0	47	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable TPH (residual fuels) was not processed!
RHMW07	1-Methylnaphthalene	90-12-0	6	2	4	33.33	ug/L	0.0035	0.010	0.0046	0.0051	0.073	0.0051	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW07	2-Methylnaphthalene	91-57-6	6	4	2	66.67	ug/L	0.0052	0.010	0.0077	0.010	0.12	0.0098	95% KM (t) UCL	
RHMW07	Acetone	67-64-1	5	1	4	20	ug/L	2.0	10	1.9	1.9	0	1.9	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acetone was not processed!
RHMW07	Alkalinity (as CaCO3)	Alkalinity (as CaCO3)	2	2	0	100	ug/L	--	--	1.32E+08	1.84E+08	0.23	1.84E+08	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Alkalinity (as CaCO3) was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW07	Benzo(a)anthracene	56-55-3	5	1	4	20	ug/L	0.0026	0.010	0.0027	0.0027	0	0.0027	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Benzo(a)anthracene was not processed!
RHMW07	Chloride	Chloride	1	1	0	100	ug/L	--	--	362,000	362,000	0	362,000	Maximum Detect	Warning: This data set only has 1 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Chloride was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW07	Fluorene	86-73-7	5	2	3	40	ug/L	0.0038	0.010	0.0042	0.0042	0	0.0042	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Fluorene was not processed!
RHMW07	Lead, Dissolved	Lead, Dissolved	5	3	2	60	ug/L	0.40	0.80	0.0060	0.013	0.48	0.013	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW07	Methane	74-82-8	2	1	1	50	ug/L	0.45	0.45	2.8	2.8	0	2.8	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Methane was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!

Table 3-2. Summary of Exposure Point Concentrations for Halawa Valley Groundwater Monitoring Wells

Well	Analyte	CAS No.	Total Samples	Num Detects	Num Non-Detects	Frequency of Detection	Units	Min Non-Detect	Max Non-Detect	Min Detect	Max Detect	Coef. of Variation	EPC	EPC Basis	Comment
RHMW07	Naphthalene	91-20-3	6	3	3	50	ug/L	0.0052	0.050	0.0038	0.010	0.48	0.0090	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates. Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
RHMW07	Nitrate+Nitrite as N	Nitrate+Nitrite as N	2	2	0	100	ug/L	--	--	63	330	0.96	330	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Nitrate+Nitrite as N was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW07	Phenanthrene	85-01-8	5	2	3	40	ug/L	0.0050	0.010	0.0072	0.0084	0.11	0.0084	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW07	Sulfate	Sulfate	2	2	0	100	ug/L	--	--	59,900	64,200	0.049	64,200	Maximum Detect	Warning: This data set only has 2 observations! Data set is too small to compute reliable and meaningful statistics and estimates! The data set for variable Sulfate was not processed! It is suggested to collect at least 8 to 10 observations before using these statistical methods!
RHMW07	Toluene	108-88-3	6	1	5	16.67	ug/L	0.054	0.30	0.64	0.64	0	0.64	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Toluene was not processed!
RHMW07	TPH (middle distillates)	TPH (middle distillates)	6	5	1	83.33	ug/L	75	75	22	66	0.54	50	95% KM H-UCL	Warning: One or more Recommended UCL(s) not available! Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
RHMW07	TPH (residual fuels)	TPH (residual fuels)	6	3	3	50	ug/L	23	77	44	48	0.045	48	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW2254-01	Lead, Dissolved	Lead, Dissolved	12	3	9	25	ug/L	0.20	0.22	0.21	2.2	0.75	0.95	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW2254-01	Lead, Total	Lead, Total	17	10	7	58.82	ug/L	0.090	0.090	0.14	0.83	0.76	0.32	95% GROS Adjusted Gamma UCL	
RHMW2254-01	Naphthalene	91-20-3	24	7	17	29.17	ug/L	0.0038	0.10	0.036	0.099	0.42	0.044	95% KM (t) UCL	
RHMW2254-01	Toluene	108-88-3	24	3	21	12.5	ug/L	0.10	0.50	0.16	0.99	0.68	0.27	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW2254-01	TPH (gasolines)	TPH (gasolines)	20	3	17	15	ug/L	8.3	30	13	18	0.16	12	95% KM (t) UCL	Warning: Data set has only 3 Detected Values. This is not enough to compute meaningful or reliable statistics and estimates.
RHMW2254-01	TPH (middle distillates)	TPH (middle distillates)	24	6	18	25	ug/L	10	81	14	22	0.18	16	95% KM (t) UCL	
RHMW2254-01	TPH (residual fuels)	TPH (residual fuels)	6	2	4	33.33	ug/L	21	212	37	42	0.090	42	Maximum Detect	Recommended UCL Exceeds Maximum Concentration: EPC defaulting to Maximum Concentration since 97.5% and 99% Chebyshev(Mean, Sd) UCLs were not calculated.
RHMW2254-01	Trichloroethylene	79-01-6	19	1	18	5.26	ug/L	0.10	0.50	0.17	0.17	0	0.17	Maximum Detect	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Trichloroethylene was not processed!

Table 4-1. Summary of Toxicity Values

Analyte Name	Oral Reference Dose (RfD_o)[a] (mg/kg-day)	Key	Oral Cancer Slope Factor (CSF_o)[a] (mg/kg-day)$^{-1}$	Key	Inhalation Reference Concentration (RfC)[a] (mg/m^3)	Key	Inhalation Unit Risk (IUR)[a] (µg/m^3)$^{-1}$	Key	ABSGI[a]	Mutagen?[a]	Volatile?[a]	K_p[b] (cm/hr)	B[b] (unitless)	τ[b] (hours/event)	t*[b] (hours)	FA[a] (unitless)
1,1,2,2-Tetrachloroethane	2.0E-02	I	2.0E-01	I	--	--	5.8E-05	C	1		V	6.9E-03	0	0.93	2.24	1
1,2,3-Trichloropropane	4.0E-03	I	3.0E+01	I	3.0E-04	I	--	--	1		V	7.5E-03[c]	--	--	--	1
1,2-Dichloroethane	6.0E-03	X	9.1E-02	I	7.0E-03	P	2.6E-05	I	1		V	4.2E-03	0	0.38	0.92	1
1-Methylnaphthalene	7.0E-02	A	2.9E-02	P	--	--	--	--	1		V	9.3E-02[c]	--	--	--	1
2-Methylnaphthalene	4.0E-03	I	--	--	--	--	--	--	1		V	9.2E-02[c]	--	--	--	1
Acenaphthene	6.0E-02	I	--	--	--	--	--	--	1		V	8.6E-02[c]	--	--	--	1
Acenaphthylene	--	--	--	--	--	--	--	--	1		--	9.1E-02[c]	--	--	--	--
Acetone	9.0E-01	I	--	--	3.10E+01	A	--	--	1		V	5.1E-04[c]	--	--	--	--
Anthracene	3.0E-01	I	--	--	--	--	--	--	1		V	1.4E-01[c]	--	--	--	1
Benzene	4.0E-03	I	5.5E-02	I	3.0E-02	I	7.8E-06	I	1		V	1.5E-02	0.1	0.29	0.70	1
Benzo(a)anthracene	--	--	7.3E-01	E	--	--	1.1E-04	C	1	M	V	4.7E-01	2.8	2.03	8.53	1
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	1		--		--	--	--	1
Bromodichloromethane	2.0E-02	I	6.2E-02	I	--	--	3.7E-05	C	1		V	4.6E-03	0	0.88	2.12	1
Chloroform	1.0E-02	I	3.1E-02	C	9.8E-02	A	2.3E-05	I	1		V	6.8E-03	0	0.5	1.19	1
Chloromethane	--	--	--	--	9.0E-02	I	--	--	1		V	3.3E-03	0	0.20	0.49	1
Dibenzo(a,h)anthracene	--	--	7.3E+00	E	--	--	1.2E-03	C	1	M	--	1.5E+00	9.7	3.88	17.57	0.6
Ethylbenzene	1.0E-01	I	1.1E-02	C	1.0E+00	I	2.5E-06	C	1		V	4.9E-02	0.2	0.42	1.01	1
Fluorene	4.0E-02	I	--	--	--	--	--	--	1		V	1.1E-01[c]	--	--	--	1
Lead	--	--	--	--	--	--	--	--	1		--	1.0E-04	--	--	--	1
Methyl ethyl ketone	6.0E-01	I	--	--	5.0E+01	I	--	--	1		V	9.6E-04	0	0.27	0.65	1
Methylene chloride	6.0E-03	I	2.0E-03	I	6.0E-01	I	1.0E-08	I	1	M	V	3.5E-03	0	0.32	0.76	1
Naphthalene	2.0E-02	I	--	--	3.0E-03	I	3.4E-05	C	1		V	4.7E-02	0.2	0.56	1.34	1
Nitrate+Nitrite as N	1.6E+00	I	--	--	--	--	--	--	1		--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	1		--	1.4E-01	0.7	1.06	4.11	1
Pyrene	3.0E-02	I	--	--	--	--	--	--	1		V	2.0E-01[c]	--	--	--	1
Toluene	8.0E-02	I	--	--	5.0E+00	I	--	--	1		V	3.1E-02	0.1	0.35	0.84	1
TPH (gasolines)	3.0E-02	HDOH	--	--	5.7E-01	P	--	--	1		V	1.5E-02[c]	--	--	--	1
TPH (middle distillates)	2.0E-02	HDOH	--	--	1.3E-01	P	--	--	1		V	6.9E-02[c]	--	--	--	1
TPH (residual fuels)	1.2E-02	HDOH	--	--	--	--	--	--	1		--	3.1E-01[c]	--	--	--	1
Trichloroethylene	5.0E-04	I	4.6E-02	I	2.0E-03	I	4.1E-06	I	1	M	V	1.20E-02	0.1	0.58	1.39	1
Xylene Total	2.0E-01	I	--	--	1.0E-01	I	--	--	1		V	5.3E-02	0.2	0.42	1.01	1

Notes:

a. Source = EPA, 2016.

b. Source = EPA/540/R-99/005, Exhibits 3-1 (inorganic analytes) and B-3 (organic analytes).

c. Source = ORNL, 2016.

-- = indicates toxicity value not available for this contaminant and exposure route.

A = ATSDR

B = partitioning constant.

C = Cal EPA

E = See EPA 2016 Users Guide, Section 2.3.5.

FA = fraction absorbed.

GIABS = gastrointestinal absorption factor.

I = IRIS

K_p = dermal permeability constant.

P = PPRTV

t* = time to reach steady-state.

τ = lag time

V = volatile

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2016, "Summary Table", dated May 2016, available online at "Regional Screening Levels for Chemical Contaminants at Superfund Sites.", http://www.epa.gov/risk/regional-screening-table.

ORNL, 2016, "Chemical Parameters", available online at "The Risk Assessment Information System (RAIS)", http://rais.ornl.gov/.

Table 4-2. Select Carbon Ranges for TPH Fractions

Carbon Range	TPH-gasoline	TPH- middle distillates	TPH-residual fuels
C5-C8 aliphatics	45%	0.4%	0%
C9-C18 aliphatics	12%	35.2%	0%
C19+ aliphatics	0%	42.6%	75%
C9-16 aromatics	43%	21.8%	25%

Table 4-3. Select Toxicity Values and Critcal Effects for Carbon Ranges

Carbon Range	RfD_{oral} (mg/kg-day)	RfD_{oral} Critical Effect	RfC (mg/m^3)	RfC Critical Effect
C5-C8 aliphatics	0.04[a]	Reduced body weight and neurotoxicity at higher doses	0.6[b]	Nasal epithelial cell hyperplasia, Biodynamics
C9-C18 aliphatics	0.01[b]	Liver, kidney, and hematologic effects	0.1[b]	Nasal goblet cell hypertrophy and adrenal hyperplasia
C19+ aliphatics	3[b]	Lower end of human therapeutic dose range for laxative effects	--	--
C9+ aromatics	0.03[b]	Anemia, Bio/Dynamics	0.1[b]	Maternal body weight depression

a. MADEP, 2003
b. EPA, 2009

Table 4-4. Weighted Reference Dose and Reference Concentration Values for TPH Fractions

TPH-Fraction	RfDoral (mg/kg-day)	RfC (mg/m^3)
TPH-gasoline	0.03	0.571
TPH- middle distillates	0.02	0.126
TPH-residual fuels	0.12	--

Table 5-1. Summary of Federal and State DWSs Used as Human Health Screening Levels for the BWS Halawa Valley Groundwater Study

CAS Number	Analyte Name	Units	Applicable Groundwater Screening Levels					Human Health Screening Level Value	
			40 CFR 141		Hawaii - Tier 1 EAL[a]		RSL		
			Federal MCL	Federal MCLG	Gross Contamination (Taste & Odors, etc)	Drinking Water (Toxicity)[b]	Tap Water Risk-Based Screening Level[c]	Final Groundwater Screening Level	Final Groundwater Screening Level Basis
79-34-5	1,1,1,2-Tetrachloroethane	µg/L	—	—	500	0.067	0.076	0.076	RSL- Tapwater carcinogenic effects
96-18-4	1,2,3-Trichloropropane	µg/L	—	—	50,000	0.0045	0.00075	0.00075	RSL- Tapwater carcinogenic effects
107-06-2	1,2-Dichloroethane	µg/L	5	0	7,000	5	0.17	0.17	RSL- Tapwater carcinogenic effects
90-12-0	1-Methylnaphthalene	µg/L	—	—	10	4.7	1.1	1.1	RSL- Tapwater carcinogenic effects
91-57-6	2-Methylnaphthalene	µg/L	—	—	10	24	36	10	HDOH- gross contamination (taste & odor)
83-32-9	Acenaphthene	µg/L	—	—	20	370	530	20	HDOH- gross contamination (taste & odor)
208-96-8	Acenaphthylene	µg/L	—	—	2,000	240	—	240	HDOH – drinking water toxicity (noncarcinogenic effects)
67-64-1	Acetone	µg/L	—	—	20,000	22,000	14,000	14,000	RSL- Tapwater noncarcinogenic effects
120-12-7	Anthracene	µg/L	—	—	22	1,800	1,800	22	HDOH- gross contamination (taste & odor)
71-43-2	Benzene	µg/L	5	0	170	5	0.46	0.46	RSL- Tapwater carcinogenic effects
56-55-3	Benzo(a)anthracene	µg/L	—	—	4.7	0.029	0.012	0.012	RSL- Tapwater mutagenic effects
191-24-2	Benzo(g,h,i)perylene	µg/L	—	—	0.13	1,500	—	0.13	HDOH- gross contamination (taste & odor)
75-27-4	Bromodichloromethane	µg/L	80	—	50,000	0.12	0.13	0.13	RSL- Tapwater carcinogenic effects
16887-00-6	Chloride	µg/L	—	—	—	—	—	—	40 CFR 141 – secondary MCL
67-66-3	Chloroform	µg/L	80	—	2,400	100	0.22	0.22	RSL- Tapwater carcinogenic effects
74-87-3	Chloromethane	µg/L	—	—	50,000	1.8	190	190	RSL- Tapwater noncarcinogenic effects
53-70-3	Dibenzo(a,h)anthracene	µg/L	—	—	0.52	0.0029	0.0034	0.0034	RSL- Tapwater mutagenic effects
100-41-4	Ethylbenzene	µg/L	700	700	30	700	1.5	1.5	RSL- Tapwater carcinogenic effects
86-73-7	Fluorene	µg/L	—	—	950	240	290	290	RSL- Tapwater noncarcinogenic effects
7439-92-1	Lead	µg/L	15	0	50,000	15	—	15	40 CFR 141 – federal MCL
74-82-8	Methane	µg/L	—	—	—	—	—	—	—
78-93-3	Methy ethyl ketone	µg/L	—	—	8,400	7,100	5,600	5,600	RSL- Tapwater noncarcinogenic effects
75-09-2	Methylene chloride	µg/L	5	0	9,100	4.8	11	11	RSL- Tapwater carcinogenic effects
91-20-3	Naphthalene	µg/L	—	—	21	17	0.17	0.17	RSL- Tapwater carcinogenic effects
14797-55-8	Nitrate+ Nitrite as Nitrogen	µg/L	10,000	10,000	—	—	—	10,000	40 CFR 141 – federal MCL
85-01-8	Phenanthrene	µg/L	—	—	410	240	—	240	HDOH – drinking water toxicity (noncarcinogenic effects)
129-00-0	Pyrene	µg/L	—	—	68	180	120	68	HDOH- gross contamination (taste & odor)
14808-79-8	Sulfate	µg/L	—	—	—	—	—	250,000	40 CFR 141 – secondary MCL
108-88-3	Toluene	µg/L	1,000	1,000	40	1,000	1,100	40	HDOH- gross contamination (taste & odor)
TPH (gasoline)	Total petroleum hydrocarbons (gasoline)	µg/L	—	—	100	210	400	100 400	HDOH- gross contamination (taste & odor) RSL- Tapwater noncarcinogenic effects
TPH (middle distillates)	Total petroleum hydrocarbons (middle distillates)	µg/L	—	—	100	190	160	100 160	HDOH- gross contamination (taste & odor) RSL- Tapwater noncarcinogenic effects

Table 5-1. Summary of Federal and State DWSs Used as Human Health Screening Levels for the BWS Halawa Valley Groundwater Study

CAS Number	Analyte Name	Units	Applicable Groundwater Screening Levels					Human Health Screening Level Value	
			40 CFR 141		Hawaii - Tier 1 EAL[a]		RSL		
			Federal MCL	Federal MCLG	Gross Contamination (Taste & Odors, etc)	Drinking Water (Toxicity)[b]	Tap Water Risk-Based Screening Level[c]	Final Groundwater Screening Level	Final Groundwater Screening Level Basis
TPH (residual fuels)	Total petroleum hydrocarbons (residual fuels)	µg/L	—	—	100	4,400	2,500	100 2,500	HDOH- gross contamination (taste & odor) RSL- Tapwater noncarcinogenic effects
79-01-6	Trichloroethylene	µg/L	5	0	310	5	0.49	0.49	RSL- Tapwater carcinogenic and mutagenic effects
1330-20-7	Xylenes (total)	µg/L	10,000	10,000	20	10,000	190	20	HDOH- gross contamination (taste & odor)

Sources: 40 CFR 141, "National Primary Drinking Water Regulations."

State of Hawaii, Department of Health, 2015, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater, Volume 2: Background Documentation for the Development of Tier 1 Environmental Action Levels, Appendix 1: Detailed Lookup Tables*, Pacific Basin Edition.

EPA, 2016, "Resident Tapwater", dated May, 2016, available online at "Regional Screening Levels for Chemical Contaminants at Superfund Sites.", http://www.epa.gov/risk/regional-screening-table

a. Values obtained from Table F-1a, Groundwater Screening Levels (groundwater IS a current or potential drinking water resource)

b. EALs presented in this column are not considered in the final groundwater screening level selection. The Tier 1 ESLs are considered to be adequately protective when there are no more than three carcinogenic COPCs, and no more than five noncarcinogenic COPCs. There are more than three carcinogenic COPCs and more than five noncarcinogenic COPCs at this site.

c. The RSL presented in this column is the lower of the target risk value of 1×10^{-6} or a hazard quotient (HQ) of 1.

CAS = Chemical Abstract Services

EAL = Environmental Action Level

MCL = maximum contaminant level

MCLG = maximum contaminant level goal

RSL = regional screening level

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
HDMW2253-03														
Benzene	No	µg/L	1/21/2011	1/19/2016	22	3	13.64	0.062	0.5	0.20	0.92	0.46	1	RSL - Tapwater, Carcinogenic Effect
Benzo(a)anthracene	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.0026	0.14	0.0032	0.0032	0.012	0	RSL - Tapwater, Carcinogenic Effect
Lead, Dissolved	Yes	µg/L	1/21/2011	10/19/2015	20	9	45	0.20	0.22	0.025	0.90	15	0	40 CFR 141 - federal MCL
Naphthalene	No	µg/L	1/21/2011	1/19/2016	22	6	27.27	0.0038	0.10	0.0042	0.16	0.17	0	RSL - Tapwater, Carcinogenic Effect
Toluene	No	µg/L	1/21/2011	1/19/2016	22	4	18.18	0.1	0.5	0.07	3.8	40	0	HDOH- gross contamination (taste & odor
TPH (gasolines)	No	µg/L	1/21/2011	1/19/2016	21	5	23.81	8.3	30	15	27	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/21/2011	1/19/2016	22	13	59.09	12	81	13	600	100 160	3 2	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/21/2011	1/19/2016	6	3	50	22	212	55	77	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
OWDFMW01														
1,2-Dichloroethane	No	µg/L	1/21/2011	1/19/2016	21	4	19.05	0.28	0.5	0.0009	0.012	0.17	0	RSL - Tapwater, Carcinogenic Effect
1-Methylnaphthalene	No	µg/L	1/21/2011	1/19/2016	21	4	19.05	0.048	0.12	0.0096	0.03	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	1/21/2011	1/19/2016	21	4	19.05	0.048	0.12	0.0097	0.02	10	0	HDOH – gross contamination (taste & odor)
Acenaphthylene	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.005	0.12	0.0082	0.0082	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Acetone	No	µg/L	1/21/2011	10/19/2015	20	14	70	1.9	10	2.3	150	14,000	0	RSL - Tapwater, Noncarcinogenic Effect
Benzene	No	µg/L	1/21/2011	1/19/2016	21	13	61.9	0.062	0.5	0.07	1.3	0.46	6	RSL - Tapwater, Carcinogenic Effect
Benzo(a)anthracene	No	µg/L	1/21/2011	10/19/2015	20	2	10	0.0026	0.14	0.0033	0.0046	0.012	0	RSL - Tapwater, Mutagenic Effect
Bromodichloromethane	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.0034	0.5	0.5	0.5	0.13	1	RSL - Tapwater, Carcinogenic Effect
Chloromethane	No	µg/L	1/21/2011	10/19/2015	20	3	15	0.62	5	0.07	0.12	190	0	RSL - Tapwater, Noncarcinogenic Effect
Fluorene	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.0038	0.12	0.0039	0.0039	290	0	RSL - Tapwater, Noncarcinogenic Effect
Lead, Dissolved	Yes	µg/L	1/21/2011	10/19/2015	20	9	45	0.20	0.22	0.033	0.43	15	0	40 CFR 141 - federal MCL
Methyl ethyl ketone	No	µg/L	1/21/2011	7/22/2015	19	1	5.26	1.2	5	1	1	5,600	0	RSL - Tapwater, Noncarcinogenic Effect
Methylene chloride	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.1	1	0.2	0.2	11	0	RSL - Tapwater, Mutagenic Effect

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
Naphthalene	No	µg/L	1/21/2011	1/19/2016	21	12	57.14	0.049	0.10	0.016	0.12	0.17	0	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	1/21/2011	10/19/2015	20	3	15	0.048	0.14	0.0073	0.014	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Pyrene	No	µg/L	1/21/2011	10/19/2015	20	1	5	0.0053	0.16	0.0063	0.0063	68	0	HDOH – gross contamination (taste & odor)
Toluene	No	µg/L	1/21/2011	1/19/2016	21	4	19.05	0.10	0.5	0.06	0.4	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/21/2011	1/19/2016	21	4	19.05	8.3	30	17	31	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/21/2011	1/19/2016	21	15	71.43	81	81	17	3,100	100 160	12 11	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/21/2011	1/19/2016	6	4	66.67	212	212	69	390	100 2,500	2 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
Xylene, Total	No	µg/L	1/21/2011	1/19/2016	21	1	4.76	0.18	1	0.39	0.39	20	0	HDOH – gross contamination (taste & odor)
RHMW01														
1-Methylnaphthalene	No	µg/L	1/20/2011	1/20/2016	28	5	17.86	0.050000001	0.12	0.014	0.040	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	1/20/2011	1/20/2016	28	6	21.43	0.05	0.12	0.0093	0.040	10	0	HDOH – gross contamination (taste & odor)
Acenaphthene	No	µg/L	1/20/2011	10/20/2015	21	4	19.05	0.05	0.12	0.0053	0.027	20	0	HDOH – gross contamination (taste & odor)
Acenaphthylene	No	µg/L	1/20/2011	10/20/2015	21	1	4.76	0.005	0.12	0.0041	0.0041	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Acetone	No	µg/L	1/20/2011	10/20/2015	22	1	4.55	1.90	10	15	15	14,000	0	RSL - Tapwater, Noncarcinogenic Effect
Benzo(a)anthracene	No	µg/L	1/20/2011	10/20/2015	21	2	9.52	0.0026	0.14	0.0026	0.0029	0.012	0	RSL - Tapwater, Mutagenic Effect
Chloroform	No	µg/L	1/20/2011	10/20/2015	22	1	4.55	0.072	0.5	0.13	0.13	0.22	0	RSL - Tapwater, Carcinogenic Effect
Fluorene	No	µg/L	1/20/2011	10/20/2015	21	4	19.05	0.05	0.12	0.0096	0.035	290	0	RSL - Tapwater, Noncarcinogenic Effect
Lead, Dissolved	Yes	µg/L	1/20/2011	10/20/2015	26	16	61.54	0.20	0.22	0.09	2.1	15	0	40 CFR 141 - federal MCL
Methylene chloride	No	µg/L	1/20/2011	10/20/2015	22	1	4.55	0.1	2	0.59	0.59	11	0	RSL - Tapwater, Mutagenic Effect
Naphthalene	No	µg/L	1/20/2011	1/20/2016	28	11	39.29	0.050	0.10	0.037	0.2	0.17	2	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	1/20/2011	10/20/2015	21	2	9.52	0.005	0.14	0.011	0.012	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Pyrene	No	µg/L	1/20/2011	10/20/2015	21	1	4.76	0.0053	0.16	0.027	0.027	68	0	HDOH – gross contamination (taste & odor)

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
Toluene	No	µg/L	1/20/2011	1/20/2016	28	4	14.29	0.1	0.5	0.17	2.5	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/20/2011	1/20/2016	22	4	18.18	8.3	30	13	26	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/20/2011	1/20/2016	28	25	89.29	81	81	33	430	100 160	12 8	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/20/2011	1/20/2016	5	3	60	21	212	21	60	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW02														
1,1,2,2-Tetrachloroethane	No	µg/L	1/18/2011	7/20/2015	18	1	5.56	0.12	0.5	0.065	0.065	0.076	0	RSL - Tapwater, Carcinogenic Effect
1,2,3-Trichloropropane	No	µg/L	1/18/2011	10/20/2015	19	1	5.26	0.2	2	0.27	0.27	0.00075	1	RSL - Tapwater, Carcinogenic Effect
1-Methylnaphthalene	No	µg/L	1/18/2011	1/20/2016	26	26	100	--	--	0.57	68	1.1	24	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	1/18/2011	1/20/2016	27	27	100	--	--	0.16	43	10	7	HDOH – gross contamination (taste & odor)
Acenaphthene	No	µg/L	1/18/2011	10/20/2015	20	20	100	--	--	0.17	0.65	20	0	HDOH – gross contamination (taste & odor)
Acenaphthylene	No	µg/L	1/18/2011	10/20/2015	20	5	25	0.047	0.24	0.071	0.26	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Benzene	No	µg/L	1/18/2011	1/20/2016	26	5	19.23	0.32	0.5	0.08	0.15	0.46	0	RSL - Tapwater, Carcinogenic Effect
Benzo(a)anthracene	No	µg/L	1/18/2011	10/20/2015	19	1	5.26	0.0026	0.14	0.0047	0.0047	0.012	0	RSL - Tapwater, Mutagenic Effect
Ethylbenzene	No	µg/L	1/18/2011	1/20/2016	26	22	84.62	0.46	0.5	0.014	0.30	1.5	0	RSL - Tapwater, Carcinogenic Effect
Fluorene	No	µg/L	1/18/2011	10/20/2015	19	18	94.74	0.047	0.047	0.083	0.32	290	0	RSL - Tapwater, Noncarcinogenic Effect
Lead, Dissolved	Yes	µg/L	1/18/2011	10/20/2015	24	15	62.5	0.20	0.22	0.025	1.2	15	0	40 CFR 141 - federal MCL
Methylene chloride	No	µg/L	1/18/2011	10/20/2015	19	1	5.26	0.1	2	0.10	0.10	11	0	RSL - Tapwater, Mutagenic Effect
Naphthalene	No	µg/L	1/18/2011	1/20/2016	25	25	100	--	--	1	160	0.17	25	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	1/18/2011	10/20/2015	19	1	5.26	0.005	0.14	0.019	0.019	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Pyrene	No	µg/L	1/18/2011	10/20/2015	19	1	5.26	0.0053	0.16	0.0058	0.0058	68	0	HDOH – gross contamination (taste & odor)
Toluene	No	µg/L	1/18/2011	1/20/2016	26	4	15.38	0.10	0.5	0.06	0.60	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/18/2011	1/20/2016	20	15	75	12	12	36	660	100 400	2 1	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
TPH (middle distillates)	No	µg/L	1/18/2011	1/20/2016	27	27	100	--	--	750	6,500	100 160	27 27	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/19/2011	1/20/2016	6	4	66.67	212	212	260	360	100 2,500	4 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
Xylene, Total	No	µg/L	1/18/2011	1/20/2016	28	24	85.71	0.38	0.38	0.21	0.69	20	0	HDOH – gross contamination (taste & odor)
RHMW03														
1-Methylnaphthalene	No	µg/L	1/19/2011	1/20/2016	21	3	14.29	0.0035	0.12	0.0039	0.10	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	1/19/2011	1/20/2016	21	3	14.29	0.0023	0.12	0.0034	0.069	10	0	HDOH – gross contamination (taste & odor)
Benzo(a)anthracene	No	µg/L	1/19/2011	10/20/2015	20	2	10	0.0026	0.14	0.0037	0.0043	0.012	0	RSL - Tapwater, Mutagenic Effect
Lead, Dissolved	Yes	µg/L	1/19/2011	10/20/2015	20	7	35	0.20	0.22	0.011	1.4	15	0	40 CFR 141 - federal MCL
Naphthalene	No	µg/L	1/19/2011	1/20/2016	21	7	33.33	0.0038	0.10	0.0094	0.32	0.17	1	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	1/19/2011	10/20/2015	20	2	10	0.005	0.14	0.0057	0.0058	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Toluene	No	µg/L	1/19/2011	1/20/2016	21	3	14.29	0.1	0.5	0.14	0.54	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/19/2011	1/20/2016	21	2	9.52	12	30	20	23	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/19/2011	1/20/2016	21	14	66.67	81	81	37	150	100 |160	2 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/19/2011	1/20/2016	6	4	66.67	212	212	110	160	100 2,500	4 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW04														
1-Methylnaphthalene	No	µg/L	7/23/2014	1/19/2016	7	1	14.29	0.0035	0.10	0.0043	0.0043	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	7/23/2014	1/19/2016	7	2	28.57	0.0023	0.052	0.0047	0.0059	10	0	HDOH – gross contamination (taste & odor)
Acenaphthylene	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	0.0034	0.052	0.0037	0.0037	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Acetone	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	3.3	10	43	43	14,000	0	RSL - Tapwater, Noncarcinogenic Effect
Anthracene	No	µg/L	7/23/2014	8/20/2015	5	1	20	0.005	0.052	0.0051	0.0051	22	0	HDOH – gross contamination (taste & odor)
Benzene	No	µg/L	7/23/2014	1/19/2016	7	1	14.29	0.062	0.5	0.08	0.08	0.46	0	RSL - Tapwater, Carcinogenic Effect
Benzo(g,h,i)perylene	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	0.005	0.10	0.0076	0.0076	0.13	0	HDOH – gross contamination (taste & odor)

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
Dibenzo(a,h)anthracene	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	0.005	0.052	0.011	0.011	0.0034	1	RSL - Tapwater, Mutagenic Effect
Fluorene	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	0.0038	0.052	0.006	0.006	290	0	RSL - Tapwater, Noncarcinogenic Effect
Lead, Dissolved	Yes	µg/L	7/23/2014	10/19/2015	6	3	50	0.20	0.20	0.006	0.044	15	0	40 CFR 141 - federal MCL
Naphthalene	No	µg/L	7/23/2014	1/19/2016	7	2	28.57	0.0038	0.052	0.0051	0.0075	0.17	0	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	7/23/2014	10/19/2015	6	1	16.67	0.005	0.052	0.0069	0.0069	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Toluene	No	µg/L	7/23/2014	1/19/2016	7	2	28.57	0.1	0.5	0.11	0.42	40	0	HDOH – gross contamination (taste & odor)
TPH (middle distillates)	No	µg/L	7/23/2014	1/19/2016	7	4	57.14	12	21	10	36	100 160	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	4/22/2015	1/19/2016	4	3	75	21	21	25	52	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW05														
1-Methylnaphthalene	No	µg/L	1/19/2011	1/20/2016	25	2	8	0.0035	0.12	0.0041	0.005	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	1/19/2011	1/20/2016	25	3	12	0.005	0.12	0.0036	0.0066	10	0	HDOH – gross contamination (taste & odor)
Benzo(a)anthracene	No	µg/L	1/19/2011	10/20/2015	19	1	5.26	0.0026	0.14	0.0038	0.0038	0.012	0	RSL - Tapwater, Mutagenic Effect
Lead, Dissolved	No	µg/L	1/19/2011	10/20/2015	23	7	30.43	0.20	0.22	0.032	0.29	15	0	Primary Maximum Contaminant Level
Naphthalene	No	µg/L	1/19/2011	1/20/2016	25	12	48	0.005	0.10	0.0046	0.17	0.17	0	RSL - Tapwater, Carcinogenic Effect
Phenanthrene	No	µg/L	1/19/2011	10/20/2015	19	1	5.26	0.005	0.14	0.0052	0.0052	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Toluene	No	µg/L	1/19/2011	1/20/2016	25	3	12	0.1	0.5	0.18	0.59	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/19/2011	1/20/2016	20	4	20	8.3	30	15	23	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/19/2011	1/20/2016	25	10	40	10	81	16	62	100 160	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/19/2011	1/20/2016	6	3	50	21	212	34	45	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW06														
2-Methylnaphthalene	No	µg/L	10/21/2014	1/19/2016	6	1	16.67	0.0023	0.01	0.0064	0.0064	10	0	HDOH – gross contamination (taste & odor)

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
Benzo(a)anthracene	No	µg/L	10/21/2014	10/19/2015	5	1	20	0.0026	0.011	0.0028	0.0028	0.012	0	RSL - Tapwater, Mutagenic Effect
Bromodichloromethane	No	µg/L	10/21/2014	10/19/2015	5	2	40	0.01	0.30	0.00044	0.0039	0.13	0	RSL - Tapwater, Carcinogenic Effect
Chloride	No	µg/L	10/21/2014	10/21/2014	1	1	100	--	--	319,000	319,000	250,000	1	40 CFR 141 - secondary MCL
Lead, Dissolved	Yes	µg/L	10/21/2014	10/19/2015	5	3	60	0.40	0.80	0.006	0.016	15	0	40 CFR 141 - federal MCL
Methane	No	µg/L	10/21/2014	1/23/2015	2	1	50	0.45	0.45	1.7	1.7	--	--	--
Nitrate+Nitrite as N	No	µg/L	10/21/2014	1/23/2015	2	2	100	--	--	530	630	10,000	0	40 CFR 141 - federal MCL
Sulfate	No	µg/L	10/21/2014	1/23/2015	2	2	100	--	--	66,600	87,800	250,000	0	40 CFR 141-secondary MCL
Toluene	No	µg/L	10/21/2014	1/19/2016	6	2	33.33	0.1	0.30	0.1	1.1	40	0	HDOH – gross contamination (taste & odor)
TPH (middle distillates)	No	µg/L	10/21/2014	1/19/2016	6	3	50	20	86	17	21	100 160	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	10/21/2014	1/19/2016	6	1	16.67	20	86	47	47	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW07														
1-Methylnaphthalene	No	µg/L	10/20/2014	1/19/2016	6	2	33.33	0.0035	0.01	0.0046	0.0051	1.1	0	RSL - Tapwater, Carcinogenic Effect
2-Methylnaphthalene	No	µg/L	10/20/2014	1/19/2016	6	4	66.67	0.0052	0.01	0.0077	0.01	10	0	HDOH – gross contamination (taste & odor)
Acetone	No	µg/L	10/20/2014	10/19/2015	5	1	20	2	10	1.9	1.9	14,000	0	RSL - Tapwater, Noncarcinogenic Effect
Benzo(a)anthracene	No	µg/L	10/20/2014	10/19/2015	5	1	20	0.0026	0.01	0.0027	0.0027	0.012	0	RSL - Tapwater, Mutagenic Effect
Chloride	No	µg/L	10/20/2014	10/20/2014	1	1	100	--	--	362,000	319,000	250,000	1	40 CFR 141 - secondary MCL
Fluorene	No	µg/L	10/20/2014	10/19/2015	5	2	40	0.0038	0.01	0.0042	0.0042	290	0	RSL - Tapwater, Noncarcinogenic Effect
Lead, Dissolved	Yes	µg/L	10/20/2014	10/19/2015	5	3	60	0.40	0.80	0.006	0.013	15	0	40 CFR 141 - federal MCL
Methane	No	µg/L	10/20/2014	1/22/2015	2	1	50	0.45	0.45	2.8	2.8	--	--	--
Naphthalene	No	µg/L	10/20/2014	1/19/2016	6	3	50	0.0052	0.050	0.0038	0.01	0.17	0	RSL - Tapwater, Carcinogenic Effect
Nitrate+Nitrite as N	No	µg/L	10/20/2014	1/22/2015	2	2	100	--	--	63	330	10,000	0	Primary Maximum Contaminant Level
Phenanthrene	No	µg/L	10/20/2014	10/19/2015	5	2	40	0.005	0.01	0.0072	0.0084	240	0	HDOH – drinking water toxicity (noncarcinogenic effects)
Sulfate	No	µg/L	10/20/2014	1/22/2015	2	2	100	--	--	59,900	64,200	250,000	0	40 CFR 141 - secondary MCL
Toluene	No	µg/L	10/20/2014	1/19/2016	6	1	16.67	0.054	0.30	0.64	0.64	40	0	HDOH – gross contamination (taste & odor)

Table 5-2. Results of Comparisons of Groundwater Concentrations to Groundwater Screening Levels

Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	GW Screening Level	No. of Detects > GW Screening Level	GW Screening Level Basis
TPH (middle distillates)	No	µg/L	10/20/2014	1/19/2016	6	5	83.33	75	75	22	66	100 160	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	10/20/2014	1/19/2016	6	3	50	23	77	44	48	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
RHMW2254-01														
Lead, Dissolved	Yes	µg/L	1/20/2011	6/24/2014	12	3	25	0.20	0.22	0.21	2.2	15	0	40 CFR 141 - federal MCL
Lead, Total	No	µg/L	1/20/2011	10/20/2015	17	10	58.82	0.0898	0.090	0.14	0.83	15	0	40 CFR 141 - federal MCL
Naphthalene	No	µg/L	1/20/2011	1/20/2016	24	7	29.17	0.0038	0.10	0.036	0.099	0.17	0	RSL - Tapwater, Carcinogenic Effect
Toluene	No	µg/L	1/20/2011	1/20/2016	24	3	12.5	0.1	0.5	0.16	0.99	40	0	HDOH – gross contamination (taste & odor)
TPH (gasolines)	No	µg/L	1/20/2011	1/20/2016	20	3	15	8.3	30	13	18	100 400	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (middle distillates)	No	µg/L	1/20/2011	1/20/2016	24	6	25	10	81	14	22	100 160	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
TPH (residual fuels)	No	µg/L	7/20/2011	1/20/2016	6	2	33.33	21	212	37	42	100 2,500	0 0	HDOH- gross contamination (taste & odor) HDOH- risk-based concentration
Trichloroethylene	No	µg/L	1/20/2011	10/20/2015	19	1	5.26	0.1	0.5	0.17	0.17	0.49	0	RSL - Tapwater, Mutagenic Effect

Sources:

40 CFR 141, "National Primary Drinking Water Regulations."

DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*.

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards."

CalEPA = California Environmental Protection Agency

RSL = regional screening level

MCL = maximum contaminant level

HDOH = Hawaii Department of Health

Table 5-3. Target Analytes for Petroleum Contaminated Media

Petroleum Product	Recommended Target Analytes
Gasolines	TPH Benzene Toluene Ethylbenzene Xylenes Naphthalene MTBE Lead
Middle Distillates (diesel, kerosene, Stoddard solvent, heating fuels, jet fuel, etc.)	TPH Benzene Toluene Ethylbenzene Xylenes Naphthalene 1-Methylnaphthalene 2-Methylnaphthalene
Residual Fuels (lube oils, hydraulic oils, transformer oils, Fuel oil #6/Bunker C, waste oil, etc)	TPH Benzene Toluene Ethylbenzene Xylenes Chlorinated solvents Naphthalene 1-Methylnaphthalene 2-Methylnaphthalene 16 priority pollutant PAHs

Table 5-4. Summary of Cancer Risks and Noncancer Hazards for Well HDMW2253-03

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	2.8×10^{-7}	Benzo(a)anthracene (ELCR = 1.4×10^{-6}; 62%)	0.53	TPH – Middle distillates (HQ = 1.2; 93%)
Dermal Contact	1.2×10^{-6}		<0.01	
Inhalation of Volatiles	8.1×10^{-7}		0.74	
Total Risk	2.3×10^{-6}		Total HI	1.3

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-5. Summary of Cancer Risks and Noncancer Hazards for Well OWDFMW01

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	9.2×10^{-7}	Benzene (ELCR = 1.1×10^{-6}; 15%) Benzo(a)anthracene (ELCR = 2.0×10^{-6}; 28%) Bromodichloromethane (ELCR = 3.7×10^{-6}; 51%)	7.9	TPH – Middle distillates (HQ = 20; 99%)
Dermal Contact	1.7×10^{-6}		<0.01	
Inhalation of Volatiles	4.6×10^{-6}		12	
Total Risk	7.3×10^{-6}		Total HI	20

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-6. Summary of Cancer Risks and Noncancer Hazards for Well RHMW01

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	2.0×10^{-7}	Benzo(a)anthracene (1.3×10^{-6}; 53%)	0.54	TPH – Middle distillates (HQ = 1.2; 94%)
Dermal Contact	1.0×10^{-6}		<0.01	
Inhalation of Volatiles	1.2×10^{-6}		0.77	
Total Risk	2.4×10^{-6}		Total HI	1.3

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-7. Summary of Cancer Risks and Noncancer Hazards for Well RHMW02

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	1.2×10^{-4}	1,2,3-Trichloropropane (1.0×10^{-4}; 16%) 1-Methynaphthalene (1.2×10^{-6}; 1.9%) Benzo(a)anthracene (2.1×10^{-6}; 0.32%) Naphthalene (5.2×10^{-4}; 81%)	9.0	TPH – Middle distillates (HQ = 20; 56%) Naphthalene (HQ = 14; 40%)
Dermal Contact	1.8×10^{-6}		0.13	
Inhalation of Volatiles	5.3×10^{-4}		27	
Total Risk	6.4×10^{-4}		Total HI	36

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-8. Summary of Cancer Risks and Noncancer Hazards for Well RHMW03

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	1.4×10^{-7}	Benzo(a)anthracene (1.9×10^{-6};80%)	0.30	None
Dermal Contact	1.5×10^{-6}		<0.01	

Inhalation of Volatiles	6.9×10^{-7}		0.34	
Total Risk	2.4×10^{-6}		Total HI	0.64

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-9. Summary of Cancer Risks and Noncancer Hazards for Well RHMW04

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	3.3×10^{-6}	Dibenzo(a,h)anthracene (1.8×10^{-4};>99%)	0.087	None
Dermal Contact	1.7×10^{-4}		<0.01	
Inhalation of Volatiles	1.5×10^{-7}		0.098	
Total Risk	1.8×10^{-4}		Total HI	0.19

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-10. Summary of Cancer Risks and Noncancer Hazards for Well RHMW05

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	1.1×10^{-7}	Benzo(a)anthracene (1.7×10^{-6};>84%)	0.10	None
Dermal Contact	1.3×10^{-6}		<0.01	
Inhalation of Volatiles	5.3×10^{-7}		0.11	
Total Risk	2.0×10^{-6}		Total HI	0.22

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-11. Summary of Cancer Risks and Noncancer Hazards for Well RHMW06

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	8.5×10^{-8}	Benzo(a)anthracene (1.2×10^{-6};98%)	0.092	None
Dermal Contact	9.9×10^{-7}		<0.01	
Inhalation of Volatiles	1.8×10^{-7}		0.080	
Total Risk	1.3×10^{-6}		Total HI	0.17

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-12. Summary of Cancer Risks and Noncancer Hazards for Well RHMW07

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	8.1×10^{-8}	Benzo(a)anthracene (1.2×10^{-6};>95%)	0.16	None
Dermal Contact	9.6×10^{-7}		<0.01	
Inhalation of Volatiles	2.0×10^{-7}		0.19	
Total Risk	1.2×10^{-6}		Total HI	0.35

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 5-13. Summary of Cancer Risks and Noncancer Hazards for Well RHMW2254-01

Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Ingestion	1.4×10^{-7}	None	0.094	None
Dermal Contact	2.4×10^{-7}		0.026	
Inhalation of Volatiles	4.5×10^{-7}		0.12	
Total Risk	8.3×10^{-7}		Total HI	0.24

ELCR = excess lifetime cancer risk

HI = hazard index

HQ = hazard quotient

Table 6-1. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well HDMW2253-03

HDMW2253-03		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	2.3×10^{-6}	Benzo(a)anthracene 1.4×10^{-6}; 62%	0.0032	0.0032	0.012
Hazard Index	1.3	TPH-middle Distillates HQ = 1.2 ; 92%	187	600	100/160
TPH-Fractions		-gasoline	15	27	100/400
		-residual fuels	77	77	100/2,500

Table 6-2. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well OWDFMW01

OWDFMW01		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	7.3×10^{-6}	Benzene 1.1×10^{-6}; 15%	0.5	1,3	0.46
		Benzo(a)anthracene 2.0×10^{-6}; 28%	0.0046	0.0046	0.012
		Bromodichloromethane 3.7×10^{-6}; 51%	0.5	0.5	0.13
Hazard Index	20	TPH-middle Distillates HQ = 20 ; 99%	3,100	3,100	100/160
TPH-Fractions		-gasoline	15	31	100/400
		-residual fuels	258	390	100/2,500

Table 6-3. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW01

RHMW01		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	2.4×10^{-6}	Benzo(a)anthracene 1.3×10^{-6}; 53%	0.0029	0.0029	0.012
Hazard Index	1.3	TPH-middle Distillates HQ = 1.2 ; 94%	194	430	100/160
TPH-Fractions		-gasoline	14	26	100/400
		-residual fuels	53	60	100/2,500

Table 6-4. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW02

RHMW02		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	4.4×10^{-4}	1,2,3-Trichloropropane 1.0×10^{-4}; 16%	0.27	0.27	0.0075
		1-Methylnaphthalene 1.2×10^{-5}; 1.9%	33	68	1.1
		Benzo(a)anthracene 2.1×10^{-6}; 0.32%	0.0047	0.0047	0.012
		Naphthalene 5.2×10^{-4}; 81%	87	160	0.17
Hazard Index	36	TPH-middle distillates HQ = 20 ; 56%	3,190	6,500	100/160
		Naphthalene HQ = 14; 40%	87	160	0.17
TPH-Fractions and Target Analyte		-gasoline	238	660	100/400
		-residual fuels	340	360	100/2,500
		2-methylnaphthalene	19	43	10

Table 6-5. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW03

RHMW03		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	2.4×10^{-6}	Benzo(a)anthracene 1.9×10^{-6}; 80%	0.0043	0.0043	0.012
Hazard Index	0.64	None	--	--	--
TPH-Fractions		-gasoline	17	23	100/400
		-middle distillates	82	150	100/160
		-residual fuels	160	160	100/2,500

Table 6-6. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW04

RHMW04		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	1.8×10^{-4}	Dibenzo(a,h)anthracene 1.8×10^{-4}; >99%	0.011	0.011	0.0034
Hazard Index	0.19	None	--	--	--
TPH-Fractions		-gasoline	ND	ND	100/400
		-middle distillates	25	36	100/160
		-residual fuels	52	52	100/2,500

Table 6-7. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW05

RHMW05		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	2.0×10^{-6}	Benzo(a)anthracene 1.7×10^{-6}; 84%	0.0038	0.0038	0.012
Hazard Index	0.22	None	--	--	--
TPH-Fractions		-gasoline	14	23	100/400
		-middle distillates	24	62	100/160
		-residual fuels	45	45	100/2,500

Table 6-8. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW06

RHMW06		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	1.3×10^{-6}	Benzo(a)anthracene 1.2×10^{-6}; 98%	0.0028	0.0028	0.012
Hazard Index	0.17	None	--	--	--
TPH-Fractions		-gasoline	ND	ND	100/400
		-middle distillates	21	21	100/160
		-residual fuels	47	47	100/2,500

Table 6-9. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW07

RHMW07		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	1.2×10^{-6}	Benzo(a)anthracene 1.2×10^{-6}; 95%	0.0027	0.0027	0.012
Hazard Index	0.35	None	--	--	--
TPH-Fractions		-gasoline	ND	ND	100/400
		-middle distillates	50	66	100/160
		-residual fuels	48	48	100/2,500

Table 6-10. Summary of Cancer Risks, Noncancer Hazards, and Groundwater Screening Levels for Well RHMW2254-01

RHMW2254-01		Primary Contributors	Exposure Point Concentration (µg/L)	Maximum Concentration (µg/L)	Screening Level (µg/L)
Excess Lifetime Cancer Risk	8.7×10^{-7}	None	--	--	--
Hazard Index	0.35	None	--	--	--
TPH-Fractions		-gasoline	12	18	100/400
		-middle distillates	16	22	100/160
		-residual fuels	42	42	100/2,500

Appendix A

Summary of Tap Water Exposure Scenario Results

Table A-1. BWS Halawa Valley Groundwater Study HDMW2253-03 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
Benzene	71-43-2	0.00027	Yes	3.32E-03	4.44E-04	4.26E-03	8.02E-03	0.63
Benzo(a)anthracene	56-55-3	3.20E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.00090	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	4.38E-05	Yes	1.09E-04	6.37E-05	7.00E-03	7.18E-03	0.57
Toluene	108-88-3	0.0038	Yes	2.37E-03	7.20E-04	3.64E-04	3.45E-03	0.27
TPH (gasolines)	TPH (gasolines)	0.016	Yes	2.61E-02	--	1.32E-02	3.93E-02	3.10
TPH (middle distillates)	TPH (middle distillates)	0.19	Yes	4.66E-01	--	7.12E-01	1.18E+00	92.91
TPH (residual fuels)	TPH (residual fuels)	0.077	--	3.20E-02	--	--	3.20E-02	2.52
Total HI				5.30E-01	1.23E-03	7.37E-01	1.27E+00	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-2. BWS Halawa Valley Groundwater Study HDMW2253-03 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
Benzene	71-43-2	0.00027	Yes	1.88E-07	2.74E-08	3.70E-07	5.85E-07	25.98
Benzo(a)anthracene	56-55-3	3.20E-06	Yes	9.32E-08	1.14E-06	1.74E-07	1.40E-06	62.24
Lead, Dissolved	Lead, Dissolved	0.00090	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	4.38E-05	Yes	--	--	2.65E-07	2.65E-07	11.78
Toluene	108-88-3	0.0038	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.016	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.19	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.077	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				2.81E-07	1.16E-06	8.09E-07	2.25E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-3. BWS Halawa Valley Groundwater Study OWDFMW01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1,2-Dichloroethane	107-06-2	1.20E-05	Yes	9.97E-05	4.28E-06	8.22E-04	9.26E-04	0.00
1-Methylnaphthalene	90-12-0	2.77E-05	Yes	1.98E-05	--	--	1.98E-05	0.00
2-Methylnaphthalene	91-57-6	1.88E-05	Yes	2.35E-04	--	--	2.35E-04	0.00
Acenaphthylene	208-96-8	8.20E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.15	Yes	8.31E-03	--	2.32E-03	1.06E-02	0.05
Benzene	71-43-2	0.00050	Yes	6.18E-03	8.27E-04	7.92E-03	1.49E-02	0.08
Benzo(a)anthracene	56-55-3	4.60E-06	Yes	--	--	--	0.00E+00	0.00
Bromodichloromethane	75-27-4	0.00050	Yes	1.25E-03	8.92E-05	--	1.34E-03	0.01
Chloromethane	74-87-3	0.00012	Yes	--	--	6.31E-04	6.31E-04	0.00
Fluorene	86-73-7	3.90E-06	Yes	4.86E-06	--	--	4.86E-06	0.00
Lead, Dissolved	Lead, Dissolved	0.00018	--	--	--	--	0.00E+00	0.00
Methyl ethyl ketone	78-93-3	0.0010	Yes	8.31E-05	6.87E-07	1.60E-04	2.44E-04	0.00
Methylene chloride	75-09-2	0.00020	Yes	1.66E-03	5.45E-05	--	1.72E-03	0.01
Naphthalene	91-20-3	5.58E-05	Yes	1.39E-04	8.12E-05	8.92E-03	9.14E-03	0.05
Phenanthrene	85-01-8	1.34E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	6.30E-06	Yes	1.05E-05	--	--	1.05E-05	0.00
Toluene	108-88-3	0.00023	Yes	1.43E-04	4.36E-05	2.21E-05	2.09E-04	0.00
TPH (gasolines)	TPH (gasolines)	0.015	Yes	2.54E-02	--	1.28E-02	3.83E-02	0.19
TPH (middle distillates)	TPH (middle distillates)	3.1	Yes	7.73E+00	--	1.18E+01	1.95E+01	99.05
TPH (residual fuels)	TPH (residual fuels)	0.26	--	1.07E-01	--	--	1.07E-01	0.54
Xylene, Total	1330-20-7	0.00039	Yes	9.72E-05	5.54E-05	1.87E-03	2.02E-03	0.01
Total HI				7.88E+00	1.16E-03	1.18E+01	1.97E+01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-4. BWS Halawa Valley Groundwater Study OWDFMW01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1,2-Dichloroethane	107-06-2	1.20E-05	Yes	1.40E-08	6.54E-10	5.56E-08	7.02E-08	0.97
1-Methylnaphthalene	90-12-0	2.77E-05	Yes	1.03E-08	--	--	1.03E-08	0.14
2-Methylnaphthalene	91-57-6	1.88E-05	Yes	--	--	--	0.00E+00	0.00
Acenaphthylene	208-96-8	8.20E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.15	Yes	--	--	--	0.00E+00	0.00
Benzene	71-43-2	0.00050	Yes	3.50E-07	5.09E-08	6.89E-07	1.09E-06	15.00
Benzo(a)anthracene	56-55-3	4.60E-06	Yes	1.34E-07	1.63E-06	2.50E-07	2.02E-06	27.75
Bromodichloromethane	75-27-4	0.00050	Yes	3.98E-07	3.09E-08	3.29E-06	3.72E-06	51.25
Chloromethane	74-87-3	0.00012	Yes	--	--	--	0.00E+00	0.00
Fluorene	86-73-7	3.90E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.00018	--	--	--	--	0.00E+00	0.00
Methyl ethyl ketone	78-93-3	0.0010	Yes	--	--	--	0.00E+00	0.00
Methylene chloride	75-09-2	0.00020	Yes	1.60E-08	5.75E-10	9.86E-10	1.75E-08	0.24
Naphthalene	91-20-3	5.58E-05	Yes	--	--	3.38E-07	3.38E-07	4.65
Phenanthrene	85-01-8	1.34E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	6.30E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00023	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.015	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	3.1	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.26	--	--	--	--	0.00E+00	0.00
Xylene, Total	1330-20-7	0.00039	Yes	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				9.22E-07	1.72E-06	4.63E-06	7.26E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-5. BWS Halawa Valley Groundwater Study RHMW01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1-Methylnaphthalene	90-12-0	3.62E-05	Yes	2.58E-05	--	--	2.58E-05	0.00
2-Methylnaphthalene	91-57-6	3.29E-05	Yes	4.11E-04	--	--	4.11E-04	0.03
Acenaphthene	83-32-9	2.70E-05	Yes	2.24E-05	--	--	2.24E-05	0.00
Acenaphthylene	208-96-8	4.10E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.015	Yes	8.31E-04	--	2.32E-04	1.06E-03	0.08
Benzo(a)anthracene	56-55-3	2.90E-06	Yes	--	--	--	0.00E+00	0.00
Chloroform	67-66-3	0.00013	Yes	6.48E-04	5.17E-05	6.36E-04	1.34E-03	0.10
Fluorene	86-73-7	3.09E-05	Yes	3.86E-05	--	--	3.86E-05	0.00
Lead, Dissolved	Lead, Dissolved	0.00068	--	--	--	--	0.00E+00	0.00
Methylene chloride	75-09-2	0.00059	Yes	4.90E-03	1.61E-04	--	5.06E-03	0.39
Naphthalene	91-20-3	7.82E-05	Yes	1.95E-04	1.14E-04	1.25E-02	1.28E-02	0.98
Phenanthrene	85-01-8	1.20E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	2.70E-05	Yes	4.49E-05	--	--	4.49E-05	0.00
Toluene	108-88-3	0.00046	Yes	2.88E-04	8.75E-05	4.43E-05	4.20E-04	0.03
TPH (gasolines)	TPH (gasolines)	0.014	Yes	2.34E-02	--	1.18E-02	3.52E-02	2.71
TPH (middle distillates)	TPH (middle distillates)	0.19	Yes	4.84E-01	--	7.39E-01	1.22E+00	93.94
TPH (residual fuels)	TPH (residual fuels)	0.053	--	2.20E-02	--	--	2.20E-02	1.69
Total HI				5.37E-01	4.14E-04	7.65E-01	1.30E+00	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-6. BWS Halawa Valley Groundwater Study RHMW01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1-Methylnaphthalene	90-12-0	3.62E-05	Yes	1.35E-08	--	--	1.35E-08	0.56
2-Methylnaphthalene	91-57-6	3.29E-05	Yes	--	--	--	0.00E+00	0.00
Acenaphthene	83-32-9	2.70E-05	Yes	--	--	--	0.00E+00	0.00
Acenaphthylene	208-96-8	4.10E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.015	Yes	--	--	--	0.00E+00	0.00
Benzo(a)anthracene	56-55-3	2.90E-06	Yes	8.45E-08	1.03E-06	1.57E-07	1.27E-06	52.99
Chloroform	67-66-3	0.00013	Yes	5.17E-08	4.48E-09	5.32E-07	5.89E-07	24.55
Fluorene	86-73-7	3.09E-05	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.00068	--	--	--	--	0.00E+00	0.00
Methylene chloride	75-09-2	0.00059	Yes	4.71E-08	1.70E-09	2.91E-09	5.17E-08	2.16
Naphthalene	91-20-3	7.82E-05	Yes	--	--	4.73E-07	4.73E-07	19.74
Phenanthrene	85-01-8	1.20E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	2.70E-05	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00046	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.014	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.19	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.053	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				1.97E-07	1.03E-06	1.17E-06	2.40E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-7. BWS Halawa Valley Groundwater Study RHMW02 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1,1,2,2-Tetrachloroethane	79-34-5	6.50E-05	Yes	1.62E-04	1.79E-05	--	1.80E-04	0.00
1,2,3-Trichloropropane	96-18-4	0.00027	Yes	3.37E-03	--	4.32E-01	4.35E-01	1.22
1-Methylnaphthalene	90-12-0	0.033	Yes	2.37E-02	--	--	2.37E-02	0.07
2-Methylnaphthalene	91-57-6	0.019	Yes	2.36E-01	--	--	2.36E-01	0.66
Acenaphthene	83-32-9	0.00050	Yes	4.13E-04	--	--	4.13E-04	0.00
Acenaphthylene	208-96-8	9.26E-05	Yes	--	--	--	0.00E+00	0.00
Benzene	71-43-2	0.00012	Yes	1.54E-03	2.06E-04	1.97E-03	3.71E-03	0.01
Benzo(a)anthracene	56-55-3	4.70E-06	Yes	--	--	--	0.00E+00	0.00
Ethylbenzene	100-41-4	0.00021	Yes	1.05E-04	3.56E-04	1.00E-04	5.61E-04	0.00
Fluorene	86-73-7	0.00025	Yes	3.12E-04	--	--	3.12E-04	0.00
Lead, Dissolved	Lead, Dissolved	0.00034	--	--	--	--	0.00E+00	0.00
Methylene chloride	75-09-2	0.00010	Yes	8.31E-04	2.73E-05	--	8.58E-04	0.00
Naphthalene	91-20-3	0.087	Yes	2.16E-01	1.26E-01	1.38E+01	1.42E+01	39.75
Phenanthrene	85-01-8	1.90E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	5.80E-06	Yes	9.64E-06	--	--	9.64E-06	0.00
Toluene	108-88-3	0.00020	Yes	1.26E-04	3.83E-05	1.94E-05	1.84E-04	0.00
TPH (gasolines)	TPH (gasolines)	0.24	Yes	3.96E-01	--	2.00E-01	5.96E-01	1.67
TPH (middle distillates)	TPH (middle distillates)	3.2	Yes	7.94E+00	--	1.21E+01	2.01E+01	56.22
TPH (residual fuels)	TPH (residual fuels)	0.34	--	1.41E-01	--	--	1.41E-01	0.40
Xylene, Total	1330-20-7	0.00042	Yes	1.05E-04	5.97E-05	2.02E-03	2.18E-03	0.01
Total HI				8.96E+00	1.27E-01	2.66E+01	3.57E+01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-8. BWS Halawa Valley Groundwater Study RHMW02 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1,1,2,2-Tetrachloroethane	79-34-5	6.50E-05	Yes	1.67E-07	2.00E-08	6.71E-07	8.58E-07	0.13
1,2,3-Trichloropropane	96-18-4	0.00027	Yes	1.04E-04	--	--	1.04E-04	16.14
1-Methylnaphthalene	90-12-0	0.033	Yes	1.24E-05	--	--	1.24E-05	1.92
2-Methylnaphthalene	91-57-6	0.019	Yes	--	--	--	0.00E+00	0.00
Acenaphthene	83-32-9	0.00050	Yes	--	--	--	0.00E+00	0.00
Acenaphthylene	208-96-8	9.26E-05	Yes	--	--	--	0.00E+00	0.00
Benzene	71-43-2	0.00012	Yes	8.70E-08	1.27E-08	1.71E-07	2.71E-07	0.04
Benzo(a)anthracene	56-55-3	4.70E-06	Yes	1.37E-07	1.67E-06	2.55E-07	2.06E-06	0.32
Ethylbenzene	100-41-4	0.00021	Yes	2.96E-08	1.10E-07	9.33E-08	2.32E-07	0.04
Fluorene	86-73-7	0.00025	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.00034	--	--	--	--	0.00E+00	0.00
Methylene chloride	75-09-2	0.00010	Yes	7.98E-09	2.87E-10	4.93E-10	8.76E-09	0.00
Naphthalene	91-20-3	0.087	Yes	--	--	5.24E-04	5.24E-04	81.41
Phenanthrene	85-01-8	1.90E-05	Yes	--	--	--	0.00E+00	0.00
Pyrene	129-00-0	5.80E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00020	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.24	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	3.2	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.34	--	--	--	--	0.00E+00	0.00
Xylene, Total	1330-20-7	0.00042	Yes	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				1.17E-04	1.81E-06	5.26E-04	6.44E-04	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-9. BWS Halawa Valley Groundwater Study RHMW03 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1-Methylnaphthalene	90-12-0	2.91E-05	Yes	2.07E-05	--	--	2.07E-05	0.00
2-Methylnaphthalene	91-57-6	1.86E-05	Yes	2.31E-04	--	--	2.31E-04	0.04
Benzo(a)anthracene	56-55-3	4.30E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.0014	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	7.55E-05	Yes	1.88E-04	1.10E-04	1.21E-02	1.24E-02	1.95
Phenanthrene	85-01-8	5.80E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00023	Yes	1.40E-04	4.27E-05	2.16E-05	2.05E-04	0.03
TPH (gasolines)	TPH (gasolines)	0.017	Yes	2.75E-02	--	1.39E-02	4.13E-02	6.50
TPH (middle distillates)	TPH (middle distillates)	0.082	Yes	2.04E-01	--	3.11E-01	5.15E-01	81.02
TPH (residual fuels)	TPH (residual fuels)	0.16	--	6.65E-02	--	--	6.65E-02	10.46
Total HI				2.98E-01	1.52E-04	3.37E-01	6.36E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-10. BWS Halawa Valley Groundwater Study RHMW03 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1-Methylnaphthalene	90-12-0	2.91E-05	Yes	1.08E-08	--	--	1.08E-08	0.46
2-Methylnaphthalene	91-57-6	1.86E-05	Yes	--	--	--	0.00E+00	0.00
Benzo(a)anthracene	56-55-3	4.30E-06	Yes	1.25E-07	1.53E-06	2.33E-07	1.88E-06	80.10
Lead, Dissolved	Lead, Dissolved	0.0014	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	7.55E-05	Yes	--	--	4.57E-07	4.57E-07	19.44
Phenanthrene	85-01-8	5.80E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00023	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.017	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.082	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.16	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				1.36E-07	1.53E-06	6.90E-07	2.35E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-11. BWS Halawa Valley Groundwater Study RHMW04 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1-Methylnaphthalene	90-12-0	4.30E-06	Yes	3.06E-06	--	--	3.06E-06	0.00
2-Methylnaphthalene	91-57-6	5.90E-06	Yes	7.35E-05	--	--	7.35E-05	0.04
Acenaphthylene	208-96-8	3.70E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.043	Yes	2.38E-03	--	6.65E-04	3.05E-03	1.65
Anthracene	120-12-7	5.10E-06	Yes	8.48E-07	--	--	8.48E-07	0.00
Benzene	71-43-2	8.00E-05	Yes	9.97E-04	1.34E-04	1.28E-03	2.41E-03	1.30
Benzo(g,h,i)perylene	191-24-2	7.60E-06		--	--	--	0.00E+00	0.00
Dibenzo(a,h)anthracene	53-70-3	1.10E-05		--	--	--	0.00E+00	0.00
Fluorene	86-73-7	6.00E-06	Yes	7.48E-06	--	--	7.48E-06	0.00
Lead, Dissolved	Lead, Dissolved	4.40E-05	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	7.13E-06	Yes	1.78E-05	1.04E-05	1.14E-03	1.17E-03	0.63
Phenanthrene	85-01-8	6.90E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00042	Yes	2.62E-04	7.96E-05	4.03E-05	3.82E-04	0.21
TPH (middle distillates)	TPH (middle distillates)	0.025	Yes	6.20E-02	--	9.46E-02	1.57E-01	84.51
TPH (residual fuels)	TPH (residual fuels)	0.052	--	2.16E-02	--	--	2.16E-02	11.67
Total HI				8.73E-02	2.23E-04	9.77E-02	1.85E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-12. BWS Halawa Valley Groundwater Study RHMW04 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1-Methylnaphthalene	90-12-0	4.30E-06	Yes	1.60E-09	--	--	1.60E-09	0.00
2-Methylnaphthalene	91-57-6	5.90E-06	Yes	--	--	--	0.00E+00	0.00
Acenaphthylene	208-96-8	3.70E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.043	Yes	--	--	--	0.00E+00	0.00
Anthracene	120-12-7	5.10E-06	Yes	--	--	--	0.00E+00	0.00
Benzene	71-43-2	8.00E-05	Yes	5.65E-08	8.22E-09	1.11E-07	1.76E-07	0.10
Benzo(g,h,i)perylene	191-24-2	7.60E-06	--	--	--	--	0.00E+00	0.00
Dibenzo(a,h)anthracene	53-70-3	1.10E-05	--	3.21E-06	1.72E-04	--	1.75E-04	99.87
Fluorene	86-73-7	6.00E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	4.40E-05	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	7.13E-06	Yes	--	--	4.31E-08	4.31E-08	0.02
Phenanthrene	85-01-8	6.90E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00042	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.025	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.052	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				3.26E-06	1.72E-04	1.54E-07	1.76E-04	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-13. BWS Halawa Valley Groundwater Study RHMW05 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1-Methylnaphthalene	90-12-0	4.84E-06	Yes	3.45E-06	--	--	3.45E-06	0.00
2-Methylnaphthalene	91-57-6	5.77E-06	Yes	7.19E-05	--	--	7.19E-05	0.03
Benzo(a)anthracene	56-55-3	3.80E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	0.00014	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	5.31E-05	Yes	1.32E-04	7.72E-05	8.49E-03	8.70E-03	4.05
Phenanthrene	85-01-8	5.20E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00028	Yes	1.76E-04	5.34E-05	2.71E-05	2.56E-04	0.12
TPH (gasolines)	TPH (gasolines)	0.014	Yes	2.34E-02	--	1.18E-02	3.53E-02	16.40
TPH (middle distillates)	TPH (middle distillates)	0.024	Yes	6.02E-02	--	9.18E-02	1.52E-01	70.70
TPH (residual fuels)	TPH (residual fuels)	0.045	--	1.87E-02	--	--	1.87E-02	8.70
Total HI				1.03E-01	1.31E-04	1.12E-01	2.15E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-14. BWS Halawa Valley Groundwater Study RHMW05 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1-Methylnaphthalene	90-12-0	4.84E-06	Yes	1.80E-09	--	--	1.80E-09	0.09
2-Methylnaphthalene	91-57-6	5.77E-06	Yes	--	--	--	0.00E+00	0.00
Benzo(a)anthracene	56-55-3	3.80E-06	Yes	1.11E-07	1.35E-06	2.06E-07	1.67E-06	83.73
Lead, Dissolved	Lead, Dissolved	0.00014	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	5.31E-05	Yes	--	--	3.22E-07	3.22E-07	16.18
Phenanthrene	85-01-8	5.20E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00028	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.014	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.024	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.045	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				1.13E-07	1.35E-06	5.28E-07	1.99E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-15. BWS Halawa Valley Groundwater Study RHMW06 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
2-Methylnaphthalene	91-57-6	6.40E-06	Yes	7.98E-05	--	--	7.98E-05	0.05
Benzo(a)anthracene	56-55-3	2.80E-06	Yes	--	--	--	0.00E+00	0.00
Bromodichloromethane	75-27-4	3.90E-06	Yes	9.72E-06	6.95E-07	--	1.04E-05	0.01
Lead, Dissolved	Lead, Dissolved	1.60E-05	--	--	--	--	0.00E+00	0.00
Methane	74-82-8	0.0017		--	--	0.00E+00	0.00E+00	0.00
Nitrate+Nitrite as N	Nitrate+Nitrite as N	0.63		1.96E-02	8.65E-05	--	1.97E-02	11.44
Toluene	108-88-3	0.0011	Yes	6.86E-04	2.08E-04	1.05E-04	1.00E-03	0.58
TPH (middle distillates)	TPH (middle distillates)	0.021	Yes	5.22E-02	--	7.97E-02	1.32E-01	76.59
TPH (residual fuels)	TPH (residual fuels)	0.047	--	1.95E-02	--	--	1.95E-02	11.33
Total HI				9.22E-02	2.96E-04	7.98E-02	1.72E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-16. BWS Halawa Valley Groundwater Study RHMW06 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
2-Methylnaphthalene	91-57-6	6.40E-06	Yes	--	--	--	0.00E+00	0.00
Benzo(a)anthracene	56-55-3	2.80E-06	Yes	8.16E-08	9.93E-07	1.52E-07	1.23E-06	97.69
Bromodichloromethane	75-27-4	3.90E-06	Yes	3.10E-09	2.41E-10	2.57E-08	2.90E-08	2.31
Lead, Dissolved	Lead, Dissolved	1.60E-05	--	--	--	--	0.00E+00	0.00
Methane	74-82-8	0.0017	Yes	--	--	--	0.00E+00	0.00
Nitrate+Nitrite as N	Nitrate+Nitrite as N	0.63	--	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.0011	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.021	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.047	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				8.47E-08	9.94E-07	1.78E-07	1.26E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-17. BWS Halawa Valley Groundwater Study RHMW07 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
1-Methylnaphthalene	90-12-0	5.10E-06	Yes	3.63E-06	--	--	3.63E-06	0.00
2-Methylnaphthalene	91-57-6	9.82E-06	Yes	1.22E-04	--	--	1.22E-04	0.03
Acetone	67-64-1	0.0019	Yes	1.05E-04	--	2.94E-05	1.35E-04	0.04
Benzo(a)anthracene	56-55-3	2.70E-06	Yes	--	--	--	0.00E+00	0.00
Fluorene	86-73-7	4.20E-06	Yes	5.24E-06	--	--	5.24E-06	0.00
Lead, Dissolved	Lead, Dissolved	1.30E-05	--	--	--	--	0.00E+00	0.00
Methane	74-82-8	0.0028		--	--	0.00E+00	0.00E+00	0.00
Naphthalene	91-20-3	9.02E-06	Yes	2.25E-05	1.31E-05	1.44E-03	1.48E-03	0.42
Nitrate+Nitrite as N	Nitrate+Nitrite as N	0.33		1.03E-02	4.53E-05	--	1.03E-02	2.95
Phenanthrene	85-01-8	8.40E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00064	Yes	3.99E-04	1.21E-04	6.14E-05	5.82E-04	0.17
TPH (middle distillates)	TPH (middle distillates)	0.050	Yes	1.26E-01	--	1.92E-01	3.17E-01	90.68
TPH (residual fuels)	TPH (residual fuels)	0.048	--	1.99E-02	--	--	1.99E-02	5.70
Total HI				1.56E-01	1.80E-04	1.93E-01	3.50E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-18. BWS Halawa Valley Groundwater Study RHMW07 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	Volatile[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
1-Methylnaphthalene	90-12-0	5.10E-06	Yes	1.90E-09	--	--	1.90E-09	0.15
2-Methylnaphthalene	91-57-6	9.82E-06	Yes	--	--	--	0.00E+00	0.00
Acetone	67-64-1	0.0019	Yes	--	--	--	0.00E+00	0.00
Benzo(a)anthracene	56-55-3	2.70E-06	Yes	7.87E-08	9.58E-07	1.46E-07	1.18E-06	95.44
Fluorene	86-73-7	4.20E-06	Yes	--	--	--	0.00E+00	0.00
Lead, Dissolved	Lead, Dissolved	1.30E-05	--	--	--	--	0.00E+00	0.00
Methane	74-82-8	0.0028	Yes	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	9.02E-06	Yes	--	--	5.46E-08	5.46E-08	4.41
Nitrate+Nitrite as N	Nitrate+Nitrite as N	0.33	--	--	--	--	0.00E+00	0.00
Phenanthrene	85-01-8	8.40E-06	Yes	--	--	--	0.00E+00	0.00
Toluene	108-88-3	0.00064	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.050	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.048	--	--	--	--	0.00E+00	0.00
Total Nonradionuclide ELCR				8.06E-08	9.58E-07	2.01E-07	1.24E-06	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.

Table A-19. BWS Halawa Valley Groundwater Study RHMW2254-01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Noncancer Hazard Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	HQ (Ingestion)	HQ (Dermal)	HQ (Inhalation)	Total HQ	% Contribution
Lead, Dissolved	Lead, Dissolved	0.00095	--	--	--	--	0.00E+00	0.00
Lead, Total	Lead, Total	0.00032	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	4.43E-05	Yes	1.11E-04	6.45E-05	7.09E-03	7.26E-03	3.07
Toluene	108-88-3	0.00027	Yes	1.71E-04	5.20E-05	2.63E-05	2.49E-04	0.11
TPH (gasolines)	TPH (gasolines)	0.012	Yes	2.03E-02	--	1.02E-02	3.05E-02	12.88
TPH (middle distillates)	TPH (middle distillates)	0.016	Yes	3.88E-02	--	5.92E-02	9.80E-02	41.36
TPH (residual fuels)	TPH (residual fuels)	0.042	--	1.75E-02	--	--	1.75E-02	7.37
Trichloroethylene	79-01-6	0.00017	Yes	1.70E-02	2.57E-02	4.08E-02	8.34E-02	35.21
Total HI				9.37E-02	2.58E-02	1.17E-01	2.37E-01	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

HI = hazard index.

HQ = hazard quotient.

Table A-20. BWS Halawa Valley Groundwater Study RHMW2254-01 Tap Water Risk Assessment--Summary of Tap Water Exposure Scenario Cancer Risk Results

Analyte Name	CAS #	Exposure Point Concentration (mg/L)	**Volatile**[a,b]	Risk (Ingestion)	Risk (Dermal)	Risk (Inhalation)	Total Risk	% Contribution
Lead, Dissolved	Lead, Dissolved	0.00095	--	--	--	--	0.00E+00	0.00
Lead, Total	Lead, Total	0.00032	--	--	--	--	0.00E+00	0.00
Naphthalene	91-20-3	4.43E-05	Yes	--	--	2.69E-07	2.69E-07	32.44
Toluene	108-88-3	0.00027	Yes	--	--	--	0.00E+00	0.00
TPH (gasolines)	TPH (gasolines)	0.012	Yes	--	--	--	0.00E+00	0.00
TPH (middle distillates)	TPH (middle distillates)	0.016	Yes	--	--	--	0.00E+00	0.00
TPH (residual fuels)	TPH (residual fuels)	0.042	--	--	--	--	0.00E+00	0.00
Trichloroethylene	79-01-6	0.00017	Yes	1.44E-07	2.38E-07	1.78E-07	5.59E-07	67.56
Total Nonradionuclide ELCR				1.44E-07	2.38E-07	4.46E-07	8.28E-07	100

[a]Volatile contaminants as defined by EPA, 2016 "Regional Screening Levels for Chemical Contaminants at Superfund Sites," May, 2016.

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

ELCR = excess lifetime cancer risk.

Benzo(a)anthracene and methylene chloride are identified as mutagenic compoounds.

Trichloethylene is identified as a carcinogenic and mutagenic compound.