Human Health Risk Assessment Report

Tutu Wells Superfund Site Focused Source RI/FS Operable Unit 2

EPA Contract No. EP-W-09-009
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537645

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ABBREVIATIONS AND ACRONYMS

ADAF	Age-dependent adjustment factor
AT	Averaging time
B	Ratio of permeability coefficients
Bgs	Below ground surface
BW	Body weight
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_a	Chemical concentration in air
CAF	Cancer adjustment factor
cis-1,2-DCE	cis-1,2-dichloroethene
CLP	EPA Contract Laboratory Program
cm	Centimeter
CNS	Central nervous system
COPC	Constituents of potential concern
CSM	Conceptual site model
CSF	Cancer slope factor
CT	Central tendency
CVOC	Chlorinated volatile organic compound
DA-event	Dermally absorbed dose per event
DER	Data evaluation report
DESA	Division of Environmental Sciences and Assessment
DNAPL	Dense non-aqueous phase liquid
ED	Exposure duration
EDD	Electronic data deliverable
EF	Exposure frequency
ELCR	Excess lifetime cancer risk
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERT	Environmental Response Team
FA	Fraction absorbed water
FSRI/FS	Focused Source Remedial Investigation/Feasibility Study
FYR	Five-Year Review
GIABS	Gastrointestinal absorption factor

HDR	Henningson, Durham and Richardson Architecture and Engineering, P.C.
HHRA	Human Health Risk Assessment
HI	Hazard index
HQ	Hazard quotient
IARC	International Agency for Research on Cancer
IR	Ingestion rate
IRIS	EPA Integrated Risk Information System
IUR	Inhalation unit risk
kg	Kilogram
Kp	Permeability constant
L	Liter
m^3	cubic meter
MAF	Mutagen adjustment factor
MCL	Maximum contaminant level
mg/kg-day	Milligrams per kilogram per day
min	Minute
mL	Milligrams per liter
MMOA	Mutagenic mode of action
MS/MSD	Matrix spike/matrix spike duplicate
NPL	National Priorities List
OSWER	EPA Office of Solid Waste and Emergency Response
OU	Operable Unit
PAR	Pathway Analysis Report
PCE	Tetrachloroethylene
PPRTV	EPA Provisional Peer Reviewed Toxicity Values
QAPP	Quality Assurance Project Plan
QL	Quantitation Limit
RA	Remedial Action
RAGS	EPA Risk Assessment Guidance for Superfund
RfD	Oral reference dose
RfC	Inhalation reference concentration
RI	Remedial investigation
RME	Reasonable maximum exposure

ROD	Record of Decision
ROS	Regression on Order Statistics
RSL	EPA Regional Screening Level
SOP	Standard operating procedure
SVE	Soil vapor extraction
t*	Time to reach steady state
t-event	Exposure time
Tau-event	Lag time per event
TCL	EPA target compound list
TCE	Trichloroethylene
TIC	Tentatively identified compound
Tutu	Tutu Wells Superfund Site
UCL	Upper confidence limit
USVI	United States Virgin Islands
VC	Vinyl chloride
VI	Vapor intrusion
VIDE	U.S. Virgin Islands Department of Education
VIDPNR	U.S. Virgin Islands Department of Planning and Natural Resources
VISL	Vapor intrusion screening level
VOC	Volatile organic compound
VURAM	Virginia Department of Environmental Quality's Unified Risk Assessment Model

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1 Introduction

This baseline Human Health Risk Assessment (HHRA) has been prepared on behalf of the United States Environmental Protection Agency (EPA) by Henningson, Durham & Richardson Architecture & Engineering, P.C. in association with HDR Engineering, Inc. (HDR) to assess the nature, magnitude and probability of potential harm to public health posed by contamination in the deep groundwater aquifer as part of the Focused Source Remedial Investigation/Feasibility Study (FSRI/FS) for the Tutu Wells (Tutu) Superfund Site in St. Thomas, U.S. Virgin Islands (USVI) (**Figure 1-1, Site Plan**).

The FSRI/FS is being performed under Work Assignment Number 031-RICO-021D, under the EPA Remedial Action Contract 2 Contract Number EP-W-09-009.

This HHRA is based upon the April 2, 2015 EPA Statement of Work, the 2015 Quality Assurance Project Plan (QAPP, HDR 2015a) and Subtask 3.1.13 as described in the EPA-approved October 2015 FSRI/FS Work Plan (HDR 2015b). The HHRA has been performed in accordance with EPA Risk Assessment Guidance for Superfund (RAGS; EPA 1989).

Based on the Second Five-Year Review (FYR) of the Tutu Wells Superfund Site (EPA 2014d) and analytical results indicating a possible source of continuing contamination in the deep part of the aquifer at the USVI Department of Education (VIDE) Curriculum Center (Curriculum Center), the EPA created Operable Unit (OU) 2 to further investigate this possible source. The focus of the FSRI/FS is the Curriculum Center and immediate vicinity, located in the northern portion of the Tutu Wells Superfund Site.

The purpose of the FSRI/FS is to investigate the overall nature and extent of contamination at the Curriculum Center, evaluate risks to human health, and identify and evaluate remedial alternatives in support of a Record of Decision (ROD) for OU2.

Previous investigations at the Tutu Site (CERCLIS ID No. VID982272569) completed since 1987 identified four sources of contamination that impacted groundwater with chlorinated volatile organic compounds (CVOCs) and/or petroleum product-related compounds, i.e., benzene, toluene, ethylbenzene, and xylene (BTEX). A summary of prior investigations, removal and remedial actions (RA) is provided in the FSRI/FS.

1.1 Overview of the HHRA

A Pathway Analysis Report (PAR) was first prepared to identify the potential exposure points and routes of exposure for each exposure pathway, as well as parameters regarding human receptor characteristics and behavior (e.g., body weight, ingestion rate and exposure frequency) and toxicity criteria. The PAR is a preliminary planning document to allow stakeholders to review and comment on the approach to the identification of constituents of potential concern (COPC), exposure assessment and toxicity assessment, completed before work on the HHRA is initiated so that appropriate changes can be made.

The purpose of this HHRA is to evaluate potential exposures and define risks to public health and the environment related to the deep groundwater aquifer.

This report contains the information necessary to understand how the risks at the Site are calculated under current guidance, including the choice and statistical treatment of the data set, evaluation of COPCs, the exposure pathways, receptors, exposure parameters and the current toxicological values (e.g., reference dose). This HHRA is performed in accordance with EPA (1989), other relevant risk assessment guidance and the detailed information provided in the PAR. COPCs that contribute the most to cancer risks and noncancer HIs are identified as Constituents of Concern (COC) in the Section 6 Risk Characterization.

1.2 Report Organization

The HHRA is organized as follows:

Section 1 Introduction: Identifies the purpose of the HHRA and the areas to be addressed.

Section 2 Site Background: Describes the Site location, history and contamination.

Section 3 Sample Collection, Data Evaluation and Identification of COPCs: Describes the collection and preparation of data sets and the process by which the COPCs were identified.

Section 4 Exposure Assessment: Presents a conceptual site model (CSM) that identifies the exposure pathways and potentially exposed receptors and describes how exposure intakes are calculated.

Section 5 Toxicity Assessment: Provides a discussion of the toxicity values and the hierarchy by which they are chosen.

Section 6 Risk Characterization: Provides a description of the carcinogenic classes and the methods by which cancer risks and noncancer hazard quotients are calculated.

Section 7 Uncertainty Analysis: Describes the inherent uncertainties in the HHRA conclusions.

Section 8 References: Provides information on the literature cited in the HHRA.

2 Site Description

2.1.1 Tutu Wells Superfund Site

The Tutu Wells Superfund Site encompasses a 1.5 square mile area in the Anna's Retreat section of St. Thomas, east of the city of Charlotte-Amalie (**Figure 1-1**).

Investigation work at the Tutu Wells Superfund Site began in 1987 in response to complaints from local residents about chemical odors emanating from their groundwater supply wells and from water supplied by a vendor pumping from the aquifer south of the former LAGA Industries, Limited (LAGA) clothing manufacturing building on Smith Bay Road (Highway 38). Subsequent sampling investigations by an EPA contractor and a Remedial Investigation (RI) completed in 1995 identified a plume of groundwater contaminated with CVOCs and plumes of groundwater contaminated by releases of petroleum products (i.e., BTEX) at two filling stations (the Texaco and Esso plumes).

The Site was included on the National Priorities List (NPL) in September 1995 and the ROD for the site was signed on August 5, 1996. Details on site history and progress are available in the Final Pre-Design Report (CDM 2001), the Remediation System Evaluation Report (EPA 2011c) and EPA's Second 5-Year Review (EPA 2014d).

The current land use surrounding the Site consists of institutional, commercial and residential uses (**Figure 1-1**).

OU2 - US VI Department of Education Curriculum Center

The target of the OU2 FSRI/FS, the northern-most (upgradient) source of CVOC groundwater contamination, is located on the Curriculum Center property at 386 Smith Bay Road (Highway 38), Anna's Retreat, St. Thomas. The property is currently owned and operated by the VIDE.

From 1969 to 1979, LAGA manufactured textiles at the property, which included an industrial dry cleaning operation using tetrachloroethylene (PCE) as the dry cleaning solvent. Panex Co., a corporation formed by the former owners of LAGA, owned the property from 1979 until 1982 (Delaware Chancery Court 2007). Information on site operations during Panex ownership is not available. Since 1982, the building has been owned by VIDE and used as a library, warehouse, and school district maintenance shops and for administrative offices (EPA 2011c). The Curriculum Center property continues to be occupied by the single-story building, housing offices, maintenance shops, warehouse for school supplies and large freezers that supply the school district cafeterias.

Following extensive RI activities, the EPA constructed a groundwater extraction and treatment system at the Curriculum Center property to achieve hydraulic control and remove CVOC mass from the saturated zone of the shallow and deep aquifers. The system with three recovery wells became operational in 2004. The operation and maintenance of the treatment system was transferred from EPA to the USVI government in April 2013. Groundwater monitoring is routinely performed to assess RA progress. Groundwater sampling was performed on a quarterly basis from system start-up until April 2007; annual groundwater sampling has been performed since that time.

Because CVOC contamination also existed in the immediate vicinity of the work shop in the northern back side of the Curriculum Center building, a soil vapor extraction (SVE) system consisting of two SVE wells was also constructed in 2004 to remediate the unsaturated zone source of the CVOC groundwater contamination. Following a significant decrease in SVE influent concentrations and achievement of asymptotic conditions, the SVE system was shut down in April 2006.

2.2 Geology, Hydrology and Hydrogeology

The geology, hydrology and hydrogeology of the Tutu Site are summarized below and described in detail in the FSRI report.

2.2.1 Geology

Regional Geology

St. Thomas is part of the Greater Antilles, a series of islands consisting of volcanic and intrusive igneous rocks deposited along the Caribbean Island Arc. St. Thomas is comprised of deep ocean lava flows and shallow ocean tuffs, breccias, and lava flows. Tectonics and metamorphism lithified the volcanoclastic, angular rubble into hard, dense rocks of low permeability (Back 1988).

Site Geology

Bedrock in the site area in the upper Turpentine Run basin consists of two volcanic formations, the Water Island Formation and the younger Louisenhoj Formation. On gentle slopes of hills and along the valley axes, the bedrock is overlain by thin, unconsolidated deposits of stream-transported sediments, consisting of poorly sorted mixtures of clay, silt, sand, gravel, cobbles, and boulders. These colluvial/alluvial deposits are generally only 2 to 4 feet thick, but locally reach thicknesses of 10-30 feet in the valley axes. Beneath paved roads and in the commercially developed central part of the valley, fill has been brought in to level the area (CDM 2001). Approximately 10 feet of fill consisting of sand and angular gravel were observed at boring location OU2-2016-MW-5 during the 2016/2017 FSRI/FS, while at other boring locations, as little as two feet of fill or soil was observed.

2.2.2 Hydrology and Hydrogeology

The water table at the Tutu site is located in bedrock roughly 15-30 feet below ground surface (bgs). Based on previous investigations, the saturated zone of bedrock can be divided into two zones:

- An upper, more productive zone extends from the water table (15 to 30 feet bgs) to a depth of 80 to 90 feet bgs;
- A lower, less productive zone extends from 80 to 90 feet bgs to 200 feet bgs.

The andesitic tuff and/or andesitic breccia at the site have primary (matrix) and secondary (fracture) porosity. Advective groundwater flow occurs through the secondary fracture porosity while the primary matrix porosity can act as a potential storage zone of contaminants. Groundwater flow in the upper zone is relatively fast and flow in the lower zone is relatively slow due to a low hydraulic conductivity. The degree and aperture of fracturing observed from 80 to 200 feet bgs suggests limited potential for contaminant migration in the lower less productive zone.

The area around Curriculum Center is in the Upper Turpentine Run surface drainage basin of the Tutu Valley. This basin covers approximately 2.3 square miles, trends roughly north-south, and is bounded by the steep slopes of the surrounding hills. Turpentine Run is a dry stream bed with intermittent storm water flow from surface runoff after heavy rains. Groundwater does not discharge to Turpentine Run within the OU2 study area. Treated water from GWTF#1 at the Curriculum Center is discharged to Turpentine Run from within the adjoining property to the northwest. Turpentine Run is partially channelized (about 1,000 feet total, 750 feet upgradient and 250 feet side gradient of the Site) and runs through a culvert for approximately 3,000 feet within the Upper Turpentine Run surface drainage basin of the Tutu Valley; therefore, it was not evaluated during the OU2 investigation.

2.3 Site Contamination

The focus of the FSRI and HHRA is the source area at the Curriculum Center. The principal CVOCs detected in the northern part of the plume are cis-1,2-dichloroethene (cis-1,2-DCE), PCE, trichloroethylene (TCE), and vinyl chloride (VC). During the 1995 RI, the highest detected concentrations were 360 micrograms per liter (ug/L) for PCE, 78 ug/L for TCE, 1,300 ug/L for VC and 2,100 μg/L for cis-1,2-DCE, all of which exceeded their respective Federal Maximum Contaminant Level (MCL, EPA 2009a), which are 5, 5, 2 and 70 μg/L, respectively. During subsequent investigations, higher CVOC concentrations were identified in additional wells installed near the source area, some of which were considerably deeper than the original RI wells. A total CVOC concentration of 478,500 ug/L was reported for monitoring well RD-9 rear of the Curriculum Center in April 2011 (Arrowhead 2016). A CVOC concentration in recovery well RW-6 was reported at just under 260,000 ug/L in October 2015 (Arrowhead 2016). Results from HDR's 2017 field sampling indicates that well RD-9 continues to exhibit the highest concentrations across the site; the maximum detected concentrations are 92,000 for PCE, 29,000 for TCE, 38,000 for VC and 160,000 for cis-1,2-DCE. Additional detail regarding the distribution of current concentrations from recent sampling is provided in the FSRI.

In 1995, the northern part of the CVOC plume extended approximately 1,600 feet to the south, in the direction of groundwater flow, to a point just southeast of Four Winds Plaza, and was estimated to be 500 feet wide. Since the start-up of the groundwater treatment facility at the Curriculum Center (GWTF #1), the northern part of the CVOC plume has contracted somewhat and now extends from the Curriculum Center to the vicinity of the Four Winds Plaza property (EPA 2014d). The groundwater treatment consists of three wells, RW-6, RW-7 and RW-9; while extraction wells RW-7 and RW-9 are completed in the shallow, more productive portion of the aquifer (30 to 80 feet bgs and 40 to 60 feet bgs, respectively), extraction well RW-6 is completed in the deeper, less productive portion of the aquifer (80 to 130 feet bgs). GWTF#1, as it is currently configured, does not effectively treat the deeper zone. Treatment system GWTF #2 is located further downgradient and provides additional control of the contamination plume.

The elevated concentrations of CVOCs in groundwater adjacent to and immediately downgradient of the Curriculum Center indicated a high probability that an additional source of PCE was present in the bedrock. As early as 2004, significant PCE mass was suspected to exist in the deeper, less productive zone beneath the Curriculum Center (CDM 2004).

Based on analytical data summarized in the annual reports for the long-term response action, including the most recent report (Arrowhead 2017), CVOC concentrations in most wells in the vicinity of the Curriculum Center have decreased somewhat since the startup of the groundwater extraction and treatment facility in 2004, but have remained relatively unchanged over the three- to five-year period before the FSRI/FS. The data indicates that the treatment facility is successfully removing contaminant mass and retarding the migration of the CVOC groundwater plume. However, the consistency of contaminant concentrations over the past several years in the shallow zone just downgradient of the facility suggests that some contamination from highly contaminated zones outside the direct influence of the treatment facility may be migrating to the shallow capture zone of

the treatment facility. Observed contamination at recently installed borehole OU2-MD-2 and monitoring well OU2-MW-6, immediately down and cross gradient respectively from the treatment facility, support this theory. Dense non-aqueous phase liquid (DNAPL) was observed at OU2-MD-2; PCE was detected at 19,000 ug/L at 120 feet bgs in OU2-MW-6.

The historic discharge point or discharge points at the LAGA facility were never definitively identified. Spent PCE and residue from the dry cleaning process were reportedly disposed in an outdoor pit located to the north of the building; however, no waste pit was identified during the 1995 RI or subsequent investigations. A drum disposal area located less than 100 feet to the northwest of the LAGA building, where 22 drums had been deposited in an uncontrolled manner was identified in a 1989 Preliminary Assessment (NUS 1989). Additional potential discharge areas identified in the 1995 RI included a former discharge pipe and sink on the north side of the building (Geraghty & Miller 1995) and facility floor drains. The discharge pipe was suspected to be associated with the dry cleaning operations. In addition, underground piping that contained oil and 30% PCE solvent was discovered in 1995. This piping did not appear on as-built plans; EPA was able to trace the piping to a room that apparently held the PCE reclamation still and further on to the former dry cleaning room. While no evidence of leakage in the section of investigated pipe was found, the full extent of the piping and its integrity remained unknown.

3 Sample Collection, Data Refinements and Identification of COPCs

3.1 Sample Collection

The 2016 - 2017 FSRI activities were conducted in three phases. Phase I was completed in April 2016 and consisted of a surface geophysical survey using GeoTrax™ technology that supported the selection of monitoring well and rock borehole drilling locations.

Phase II ran from October 2016 to January 2017 and included:

- Bedrock coring, rock matrix diffusion sampling and analysis by a subcontractor;
- Installation of six new monitoring wells; and,
- Downhole geophysical investigation of new monitoring wells and boreholes, and several previously existing monitoring wells.

Phase III ran from January to March 2017 and consisted of:

- Packer testing and groundwater sampling at five boreholes (January 2017);
- Collection of synoptic depth to water measurements (February 2017); and,
- Collection of groundwater samples at 29 monitoring wells (February/March 2017).

Sampling locations are presented on **Figure 1-1**.

HDR collected and managed samples as outlined in the QAPP (HDR 2015a) as part of the Phase III RI activities described above. The samples collected in January 2017 were analyzed by the Chemtech Consulting Group (Chemtech) Laboratory in Mountainside, New Jersey, under the EPA's Contract Laboratory Program (CLP).

Samples collected in February/March 2017 were analyzed by the EPA's Division of Environmental Sciences and Assessment (DESA) laboratory in Edison, New Jersey, as summarized in the following table.

Samples were analyzed for Target Compound List (TCL) trace-level volatile organic compounds (VOCs) only, using laboratory method E524.2 and EPA Standard Operating Procedure (SOP) DW-1. CLP data underwent Level 3 validation (EPA Region II 2014c). DESA performed validation in accordance with EPA Region 2 SOP # G26 (EPA Region II 2014e). Validated electronic data deliverables (EDDs) were provided to HDR. HDR will submit the EDDs to EPA Region 2 Superfund EDD Database Section personnel.

Table 3-1. Summary of Laboratory Analyses

Round	Sampling Dates	Lab	Analyses/SOP	Sample Types
1	January 22-30, 2017	Chemtech	CLP TCL Trace Volatiles, E524.2, EPA SOP DW-1	Groundwater and QC
2	Feb. 21 – March 6, 2017	DESA	CLP TCL Trace Volatiles, E524.2, EPA SOP DW-1	Groundwater and QC

HDR reviewed and compiled the data in a Data Evaluation Report (DER, Appendix B of the FSRI), to determine whether the data met the data quality indicators of the QAPP (i.e., representativeness, completeness, comparability, precision and accuracy), identify data gaps and determine the usability of the data for the HHRA.

3.1.1 Groundwater Sampling

During Phase III of the FSRI activities, HDR conducted two groundwater sampling events.

During the first sampling event, packer testing groundwater screening samples from five boreholes were collected between January 22 and January 30, 2017. This included the collection of samples from packer testing intervals and of samples from several target depths within an open borehole, for a total of 17 samples.

Investigative and field quality control samples (field duplicate samples, equipment rinsate blank samples, field blank samples, and trip blank samples) were analyzed for TCL VOCs as detailed in **Table 3-2**.

During the second sampling event, groundwater samples from 29 monitoring wells were collected between February 21 and March 6, 2017. Investigative and field quality control (field duplicate samples, equipment rinsate blank samples, field blank samples, and trip blank samples) samples were analyzed for TCL VOCs as detailed in Table 3-3. Purging and sampling was conducted in accordance with the EPA's Low Stress/Low Flow protocol (SOP-FS-15 in HDR 2015b).

Table 3-2. Summary of Packer Testing Groundwater Screening Samples

Well	Pump Intake [feet bgs]	Sample ID	Sampling Date	CLP Sample ID	Notes
OU2-MD2	37.5	OU2-MD2-37.5-20170122	01/22/2017	BC4J1	
OU2-MD2	40.5	OU2-MD2-40.5-20170122	01/22/2017	BC4J2	
OU2-MD2	66	OU2-MD2-66-20170122	01/22/2017	BC4J4	
OU2-MD2	76.5	OU2-MD2-76.5-20170122	01/22/2017	BC4J3	
OU2-MD2	96	OU2-MD2-96-20170123	01/23/2017	BC4J8	MS/MSD volume collected[Ŧ]
OU2-MD2	131	OU2-MD2-131-20170124	01/24/2017	BC4K6	
OU2-MD2	131	OU2-MD2-131-20170124-1	01/24/2017	BC4K7	Duplicate
OU2-MD2	164	OU2-MD2-164-20170124	01/24/2017	BC4K8	
OU2-MW1	60-70	OU2-MW1-60-70-20170126	01/26/2017	BC4L4	
OU2-MW1	75-85	OU2-MW1-75-85-20170126	01/26/2017	BC4L5	
OU2-MW1	64-73	OU2-MW1-64-73-20170127	01/27/2017	BC4L6	
OU2-MW2	47-55	OU2-MW2-47-55-20170125	01/25/2017	BC4L3	
OU2-MW3	85-95	OU2-MW3-85-95-20170128	01/28/2017	BC4M1	
OU2-MW3	122-132	OU2-MW3-122-132-20170128	01/28/2017	BC4M2	
OU2-MW3	135-149	OU2-MW3-135-149-20170129	01/29/2017	BC4M3	
OU2-MW6	60-70	OU2-MW6-60-70-20170123	01/23/2017	BC4K4	
OU2-MW6	115-125	OU2-MW6-115-125-20170124	01/24/2017	BC4K5	

[Ŧ] Matrix spike/matrix spike duplicate (MS/MSD) sample not analyzed.

Table 3-3. Summary of Groundwater Monitoring Well Samples

Well	Pump Intake [feet bgs]	Sample ID	Sampling Date	Notes
BP1	49.5	BP1-49.5-20170222	2/22/2017	
BP1	49.5	BP1-49.5-20170222-1	2/22/2017	Duplicate
BP2	50	BP2-50-20170222	2/22/2017	
BP3	50	BP3-50-20170222	2/22/2017	
IW1	85	IW1-85-20170302	3/2/2017	
IW1S	48.5	IW1S-48.5-20170227	2/27/2017	
IW2	82.9	IW2-82.9-20170302	3/2/2017	
IW2S	50.3	IW2S-50.3-20170302	3/2/2017	
MW1D	80	MW1D-80-20170228	2/28/2017	
MW13	70.5	MW13-70.5-20170301	3/1/2017	
MW13D	110	MW13D-110-20170221	2/21/2017	
MW14	35.2	MW14-35.2-20170227	2/27/2017	
MW15	26	MW15-26-20170223	2/23/2017	
MW16	34.6	MW16-34.6-20170301	3/1/2017	
MW17	11	MW17-11-20170223	2/23/2017	
OU2-MW1	75	OU2-MW1-75-20170301	3/1/2017	
OU2-MW2	49	OU2-MW2-49-20170224	2/24/2017	
OU2-MW3	90.5	OU2-MW3-90.5-20170306	3/6/2017	
OU2-MW3	140	OU2-MW3-140-20170306	3/6/2017	
OU2-MW4	95	OU2-MW4-95-20170222	2/22/2017	
OU2-MW5	135	OU2-MW5-135-20170224	2/24/2017	
OU2-MW6	120	OU2-MW6-120-20170228	2/28/2017	
RD9	97.5	RD9-97.5-20170228	2/28/2017	
RD10	90	RD10-90-20170223	2/23/2017	
RD11	97.5	RD11-97.5-20170227	2/27/2017	
RD12	142.5	RD12-142.5-20170222	2/22/2017	
RD13	112.5	RD13-112.5-20170224	2/24/2017	
RW6	125	RW6-125-20170301	3/1/2017	
RW6	125	RW6-125-20170301-1	3/1/2017	Duplicate
RW7	75	RW7-75-20170301	3/1/2017	
RW8	80	RW8-80-20170228	2/28/2017	
RW9	55	RW9-55-20170301	3/1/2017	

3.2 Data Refinement

Data that were determined appropriate for use in the risk assessments, based on the analyses completed and as documented in the DER, were further refined for use in the HHRA. Data refinements were made to standardize the data to better support the exposure, toxicity and risk assessments.

3.2.1 General Refinements

In accordance with EPA Guidance for Data Useability in Risk Assessment (Part A; EPA 1991):

- Chemical concentrations qualified as not detected (i.e., U-qualified data) are evaluated as non-detects. Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment at the estimated value. Rejected R-qualified data are not used.
- The sample quantitation limit (QL) is used to represent non-detect results; if not available, then the reporting limit was used. Note that ProUCL applies the Regression on Order Statistics (ROS) methods for lognormal and gamma distributed data sets to provide a better estimate of the non-detected sample's true value based on actual detected concentrations. For normal distributions, ProUCL utilizes Kaplan-Meier estimates in lieu of the ROS methods because the ROS methods tend to yield biased and negative non-detect values for these distributions (EPA 2015b and c).
- The maximum result of the normal and field duplicate sample pairs is used if constituents are detected in both samples. The detected value is used when one was detected and the other was non-detect.
- The concentrations of specific isomers are evaluated individually instead of summing the results to calculate a result for the total. This applies to the following constituents:
    - m,p-xylene and o-xylene
    - cis and trans 1,3-dichloropropene

3.2.2 Data Refinements Using EPA "Core of the Plume Guidance"

Certain groundwater data are excluded to meet the requirements in the EPA memorandum titled *Determining Groundwater Exposure Point Concentrations, Supplemental Guidance* (referred to herein as "Core of the Plume", EPA 2014a). This memorandum specifies which groundwater data are acceptable for calculating the exposure point concentrations based on the type of well sample (e.g., monitoring well) and data quality (e.g., low turbidity).

In accordance with this guidance, the samples collected during packer testing from open boreholes, prior to completion with monitoring wells, and that were used for screening purposes only to determine the final well completion depths are excluded; these samples were not collected using low flow techniques.

3.3 Identification of COPCs

The COPC screening table for Site-wide groundwater is presented in the format of RAGS Part D Planning Tables (EPA 2001) in **Attachment A, Table 2.1**.

Site-wide groundwater COPCs were determined in accordance with the criteria included in Chapter 5 of EPA RAGS Part A (EPA 1989) as follows:

- A constituent that is detected in fewer than five percent of the samples is eliminated as a COPC if a sufficient number of samples are collected for analysis. According to RAGS, Part A (EPA 1989), at least 20 samples are needed in the data set if a frequency of detection limit of 5 percent is used as one criterion for eliminating compounds from further consideration in the HHRA. For this COPC screening, none of the constituents had less than five percent detection – see **Attachment A, Table 2.1**.
- Constituents are excluded from the COPC list if they are essential nutrients and are present at levels not likely to pose appreciable risk to human health, as per RAGS, Part A (EPA 1989). Chemicals that are considered to be essential nutrients include iron, calcium, chloride, magnesium, potassium and sodium. As the data set consists of only VOCs, none of the constituents were essential nutrients – see **Attachment A, Table 2.1**.
- Tentatively identified compounds (TICs) are excluded from the COPC screening. Total alkane TICs range from 1.1 to 9.6 ug/L and the maximum for one unknown TIC is 340 ug/L. A review of the VOC data to the TIC data from the same wells indicates no evident pattern in the relationship between the TICs and COPCs in the data set.

For the remaining constituents, the maximum detected concentrations of these constituents in groundwater are compared to screening levels to assess the potential for adverse impact to human health and to identify COPCs. Exceedances of screening levels do not in themselves indicate that an unacceptable exposure exists. Rather, the exceedance of a screening level indicates the need for further evaluation in the HHRA.

Groundwater maximum detected concentrations are compared to the minimum of the following criteria:

- EPA Regional Screening Levels (RSLs) for Residential Tapwater at a target cancer risk of 1E-06 and target noncancer hazard quotient (HQ) of 0.1 (EPA 2017c); and
- EPA Federal MCLs (2015a).

The USVI does not have drinking water source-based quality standards for organics in groundwater, as drinking water is taken from rainwater cisterns or from pumped water supply using desalinated seawater. If the maximum detected concentration of a constituent was less than the screening level, it was eliminated as a COPC, as it is assumed it will not contribute significantly to potential unacceptable risk (EPA 1989). Constituents without a screening level are retained for further quantitative evaluation in the HHRA; this did not apply for this data set.

The COPC screening resulted in 13 COPCs identified in Site-wide groundwater. COPCs are presented in **Table 3-4** below as well as in **Attachment A, Table 2.Supp.1**.

Table 3-4. Constituents of Potential Concern

1,1,2-Trichloroethane
1,1-Dichloroethene
1,2,4-Trichlorobenzene
1,2-Dichloroethane
1,3- Dichlorobenzene
1,4-Dichlorobenzene
Bromodichloromethane
Chlorobenzene
cis-1,2-Dichloroethylene
Tetrachloroethylene
trans-1,2-Dichloroethylene
Trichloroethylene
Vinyl chloride

4 Exposure Assessment

The objective of the exposure assessment is to estimate the magnitude, frequency, duration and routes of current and reasonably anticipated future human exposure to COPCs associated with the site. The exposure assessment is based on the receptor scenarios for Site-related COPCs via site-specific routes of exposure.

The standard default exposure factors recommended by EPA for estimating reasonable maximum exposure are used where available and appropriate. Where standard default exposure factors are not available for an exposure pathway, the evaluation is conducted using similarly health-protective exposure factors that are based on site-specific considerations and professional judgment. These were presented to EPA in the PAR for review and approval prior to being incorporated in the HHRA.

This section presents a CSM that identifies the exposure pathways and the potentially exposed receptors. It also describes the receptors and exposure pathways, how they are quantitatively and qualitatively evaluated and the rationale for each.

4.1 Conceptual Site Model

The CSM is a dynamic tool for understanding site conditions and potential exposure scenarios for human receptors that may be exposed to site-related contamination. An exposure pathway consists of:

- A source (e.g., discharge pipe or leak) and mechanism of constituent release from source;
- A retention or transport medium (e.g., groundwater) for the constituent;
- A point of contact (e.g., drinking water) between the human receptor and the medium; and
- A route of exposure (e.g., ingestion) for the potential human receptor at the contact point.

An exposure pathway is considered complete only if all four components are present. In the HHRA, only complete exposure pathways are evaluated quantitatively. A schematic presentation of the CSM is included as **Figure 4-1** and in a tabular format in **Attachment A, Table 1**.

4.2 Receptors

Potential receptors are defined as human populations that are subject to contaminant exposure. Both current and future land- and water-use conditions are considered when determining exposure scenarios. The current land use surrounding the Site consists of institutional, commercial and residential uses and is expected to remain the same in the future. The passing of Hurricane Irma in September caused damage near the Tutu Valley and the Curriculum Center. The south west corner of the Curriculum Center roof and structure were destroyed or removed by the strong winds. The building has been condemned due to this severe damage and the building has been closed. No additional damage was caused by Hurricane Maria that passed through two weeks later.

Therefore, as there is no current use of the facility, the following potential receptors are identified: future on-Site worker, future on-Site construction worker and future adult and child resident. These receptors are depicted in diagram format on **Figure 4-1** and in tabular format in **Attachment A, Table 1**.

4.2.1 Future On-Site Construction Worker

Redevelopment of the Site is likely to occur in the future. A future on-Site construction worker's exposure to incidental ingestion of, dermal contact with and inhalation of CVOCs from groundwater while working in a trench has been evaluated in the HHRA, as the depth of groundwater varies from approximately 15-30 feet bgs across the Site.

4.2.2 Future On-Site Worker

The future on-Site worker is assumed to include employees that perform activities indoors and outdoors. They are involved with future non-intrusive indoor and outdoor activities, such as landscape maintenance and Site operations. The Curriculum Center is connected to a public water supply system managed by USVI Water and Power Authority. However, in accordance with EPA guidance, (EPA 1989, 1991) the groundwater has been evaluated as a potable water supply, in the absence of institutional controls for the future exposure pathway, including ingestion of and dermal contact with groundwater, in addition to a qualitative assessment of the vapor intrusion (VI) pathway.

There is the assumption that a worker will be present and working at this location during the day. Inhalation via VI is evaluated qualitatively using EPA groundwater vapor intrusion screening levels (VISL calculator, EPA 2017d).

4.2.3 Future Resident (Adult/Child)

Institutional controls currently include a requirement to obtain a permit from the VI Department of Planning and Natural Resources (VIDPNR) for installation/use of groundwater from local wells. However, the goal is to restore groundwater to its most

beneficial use (potable water supply) under the National Contingency Plan; groundwater may be used in the future as a potable water source. In addition, the EPA memorandum titled *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA 1991c) requires the assumption of no treatment of the water source and no institutional (e.g., restrictive ordinances) or engineering (e.g., point of entry treatment) controls. Evaluation of a resident will be protective should on-Site contamination potentially migrate off-Site. Therefore, a future resident's exposure to Site-wide groundwater and indoor air contaminants via ingestion, dermal contact, shower inhalation and VI has been evaluated on a quantitative basis. Inhalation via VI has been evaluated qualitatively using the EPA VISL calculator (EPA 2017d). This qualitative assessment indicates that areas outside of the source area also exceed the groundwater VISL – see **Section 6.4**.

Resident exposure to groundwater has also been assessed qualitatively for this receptor by comparing data from wells downgradient and outside of the contaminant source area to the Federal MCLs (EPA 2015a) and EPA Groundwater VISLs (EPA 2017d) – see **Section 6.5**.

Prior to the recent hurricanes, a portion of the Curriculum Center was used as an educational area for children and young adults; the resident's exposure scenario is a conservative surrogate scenario to represent this population's potential risk and therefore is included here.

4.3 Exposure Point Concentrations

Estimates of COPC concentrations at points of potential human exposure are necessary for evaluating chemical intakes by potentially exposed individuals. The concentrations of chemicals in the exposure medium at the exposure point are termed "exposure point concentrations" (EPC). The EPC for the HHRA is defined as the 95 percent upper confidence limit (UCL) of the arithmetic mean or maximum detected concentration of an individual COPC, per media, whichever is lower. Calculation of the UCL was conducted in accordance with EPA guidance (EPA 2002, 2015b and c). The ProUCL software package, version 5.1.002 (2015b) was used to determine the underlying statistical distributions and the EPCs based on the characteristics of the data.

The EPCs for Site-wide groundwater in the exposure assessment were calculated and are presented in **Attachment A, Table 3.1**. The supporting ProUCL data input and outputs are provided in **Attachment B**.

4.4 Chemical Exposure Intake

The EPCs are used in combination with exposure factors from EPA guidance and standard default parameters (EPA 2011a) to estimate chemical intake via each exposure pathway for each receptor. Many of the default exposure factors have been updated in the 2014 EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.1-120 (EPA 2014b); these values are incorporated where applicable.

Chemical intake is expressed in terms of milligrams of chemical per kilogram of body weight per day (mg/kg-day), using the following general equation, which are adjusted based on the exposure pathway and medium:

$$Intake = \frac{EPC\ x\ IR\ x\ EF\ x\ ED}{BW\ x\ AT}$$

Where:

Intake	=	daily intake or exposure dose (mg/kg-day)
EPC	=	exposure point concentration of COPC [micrograms/liter (ug/L)]
IR	=	ingestion rate; the amount of contaminated medium ingested over the exposure period (L/day)
EF	=	exposure frequency; describes how often exposure occurs (days/year)
ED	=	exposure duration; describes how long exposure occurs (years)
BW	=	body weight; the average body weight over the exposure period (kg)
AT	=	averaging time; period over which exposure is averaged (days)

Each of the intake variables in the above equation consist of a range of values taken from RAGS, Part A through F (EPA 1989, EPA 2009b) and other applicable risk guidance, e.g., the *Exposure Factors Handbook* (EPA 2011a). The exposure factors and intakes for receptor population groups for each exposure pathway from groundwater are presented in **Attachment A, Table 4.1** and are summarized below. Supplemental values for the exposure factors are presented in **Attachment A, Tables 4.Supp.1 to 4.Supp.4**.

4.4.1 Exposure Factors

The AT for cancer risk and BW are the same for all exposure pathways, as follows:

- The AT for evaluating cancer risk is equal to a lifetime of 70 years or 25,550 days (EPA 2014b). The AT for evaluating noncancer hazard quotients is equal to the ED, which varies by receptor (EPA 2014b).
- The body weight of 80 kg is the standard EPA-recommended body weight for assessing exposure to adults; a body weight of 15 kg is used for children (0 to 6 years; EPA 2014b).

Ingestion Pathway of Exposure

- *Ingestion Rate*

  The incidental ingestion rate of groundwater in a trench for a construction worker is 0.02 L/day, which is a default value taken from the construction worker scenario in the Virginia Department of Environmental Quality's Unified Risk Assessment Model (VURAM; VADEQ 2016).

  The ingestion rate of groundwater via tapwater by a worker is 1.25 L/day, which is assumed to be half of an individual's daily water intake (i.e., a resident's ingestion rate; EPA 2014b *Frequently Asked Questions*).

Residents are assumed to drink 2.5 L/day of tap water as an adult and 0.78 L/day as a child (0 to 6 years), which are weighted averages of 90th percentile values for ingestion of drinking water (EPA 2014b).

- *Exposure Duration and Frequency*

  The ED for a construction worker incidentally ingesting groundwater is one year of activity for 250 days/year (EPA 2017c).

  The worker is assumed to be exposed to contaminants in tapwater for 250 days/year for 25 years (EPA 2014b, 2017c).

  Resident adults are assumed to ingest groundwater-derived tap water 350 days/year for 20 years (EPA 2017c). The same exposure frequency of 350 days/year is also applied to a resident child, for six years (EPA 2014b, 2017c).

Dermal Contact Pathway of Exposure

- *Skin Surface Area*

  The skin surface area available for contact with water for a construction worker and worker is 3,527 square centimeters (cm^2), which is based on the weighted average of mean values for head, hands and forearms (male and female, 21+ years, EPA 2014b).

  The skin surface area available for contact with water during showering for a resident is 19,652 cm^2 for an adult and 6,365 cm^2 for a child (0 to 6 years), which are weighted average of mean values for total surface area of the whole body (EPA 2014b). These values are greater than the skin surface area for contact with surface water, as it is assumed there will be more skin exposure to water during showering.

- *Absorbed Dose per Event in Water*

  The dermally absorbed dose per event (DA-event) from water contact is calculated using default equations and values presented in *RAGS Part E* (EPA 2004, pages 3-1 to 3-8). Chemical-specific dermal factors incorporated in the calculation include dermal permeability constant (Kp), ratio of permeability coefficients (B), lag time per event (tau-event), time to reach steady state (t*) and fraction absorbed water (FA). Updated values of these factors are identified in the chemical parameter table of the EPA RSLs (2017c). The calculations of DA-event for Site-wide groundwater for each receptor scenario are presented in **Attachment A, Table 4.Supp.3**.

- *Exposure Duration and Frequency*

  The ED and EF for each scenario is the same as those identified for the ingestion pathway above.

- *Event Duration (t-event) and Frequency*

  The event frequency is assumed to be one event/day for all exposures (EPA 2004).

  The t-event is assumed to be four hours for a construction worker, which is a default value in the VURAM (VADEQ 2016). The t-event is one hour for an on-site worker, which assumes hand washing during breaks and meals, based on professional judgment.

The t-event for a resident showering is assumed to be 0.71 hour/event for an adult and 0.54 hour/event for a child, which are weighted averages of the 90th percentile spent bathing or showering in a day (EPA 2014b).

Inhalation Pathway of Exposure

Potential risks related to the VI are evaluated separately using the EPA VISL calculator. The following refers to construction worker exposures in a trench and residential exposure during showering.

- *Concentration in Air*

  Construction Worker

  The VADEQ spreadsheet box model is used to derive chemical concentrations in air using groundwater concentrations for construction workers via the inhalation pathway (VADEQ 2007). Calculator defaults were applied and the calculations are presented in **Attachment C**.

  Resident

  The Andelman model as modified by Schaum et al. as referenced in *Water Consumption and Health: Integration of Exposure Assessment, Toxicology, and Risk Assessment* (Wang 1994) is used to estimate the chemical concentration in air (C_a) of VOCs during time spent showering and in the bathroom for a resident adult and child. In the derivation of C_a, it is assumed that the volume of the bathroom is six cubic meters (m^3) and the shower water flow rate is 1000 L/hour, which are based on upper estimates of the range of values presented in the Adelman model (Wang 1994). The fraction of chemical concentration volatilized is 50 percent (0.5), which is the average of the range of values in Wang 1994, and is applied here to be consistent with the RSL calculator (EPA 1991b, 2017c). The calculations to model Site-wide groundwater concentrations in air concentrations are presented in **Attachment A, Table 4.Supp.4**.

  The total exposure time for showering is 0.71 hour for an adult and 0.54 hour for a child (EPA 2014b). Since the Andelman model separates out exposure during showering from exposure while in the bathroom, professional judgment is used to split up the time spent for each in the calculation of the air concentration. For adult exposure, 15 minutes (min) for showering followed by 28 min in the bathroom, for a total of 43 min (0.71 hour) is assumed. For a child, approximately 20 min bathing followed by 13 min in the bathroom, for a total of 33 min (0.54 hour) is assumed. These values are consistent with the exposure time range identified in Table 1 of the Andelman model study (Wang 1994), EPA-recommended assumptions in Exhibit 3-2 of *RAGS Part E* (EPA 2004) and fall within the range of estimates presented in Table 16-1 of the *Exposure Factors Handbook* (EPA 2011a).

- *Exposure Time*

  Water

  The exposure time for a construction worker's incidental inhalation of groundwater vapors is assumed to be four hours, which is the value used in the construction worker scenario in the VADEQ VURAM software (VADEQ 2016).

The exposure times for inhalation of groundwater-derived water vapor during showering are 0.71 hour/day for a resident adult and 0.54 hour/day for a resident child (0 to 6 years), which are weighted averages of the 90th percentile spent bathing or showering in a day (EPA 2014b).

- *Exposure Duration and Frequency*

  The EDs and EFs for each scenario is the same as those identified for the ingestion pathway above.

4.4.2 Age-Based Adjustments for Adult and Child

The HHRA calculations incorporate age-adjustments for each COPC in the exposure intake term for calculating the cancer risk over the lifetime of a resident or recreator as both a child and adult. For the ingestion exposure pathway, the adjusted ingestion rate is a summation of the individual ingestion rates weighted by the body weights and EDs of the receptor from birth to 26 years as described in the EPA RSL equations (EPA 2017c).

$$IR_{Adj} = \frac{\sum ED \; x \; IR}{BW}$$

Where:

IR-Adj = Adjusted ingestion rate (mg-year/day-kg)

ED = Exposure duration (year)

IR = Ingestion rate (mg/day)

BW = Body weight (kg)

For the dermal exposure pathway, the adjusted surface area is a summation of the individual surface areas weighted by the BWs and EDs of the receptor from birth to 26 years similar to the above equation.

The age-adjustment equations are presented in **Attachment A, Table 4.1** and calculated in **Attachment A, Table 4.Supp.1**.

The inhalation exposure pathway does not require an age-adjustment as per *RAGS Part F, Appendix A, Section 6.1* (EPA 2009b).

4.4.3 Mutagen Adjustments for Early-Life Exposure

EPA has identified several carcinogens that act via a mutagenic mode of action (MMOA). These carcinogens or their metabolites cause mutations in the DNA that may mediate tumor formation when receptors are exposed at a young age. In addition, the mutations caused by these carcinogens are heritable (EPA 2007). To account for early life exposures to these mutagens, age-dependent adjustment factors (ADAFs) have been incorporated into the intake equation. This approach is consistent with the 2005 *Guidelines for Carcinogen Risk Assessment* (EPA 2005a) and the *Supplemental Guidance for Assessing Susceptibility from Early Life Exposure to Carcinogens* (EPA 2005b). The intake equations are described in the EPA RSL equations (EPA 2017c); the equation for the ingestion exposure pathway is shown here:

$$IR_{Adj} = \frac{\sum ED \; x \; IR}{BW} \times ADAF$$

Where:

ADAF = Age dependent adjustment factors, where

0-<2 years applied an ADAF of 10,

2-<6 years applied an ADAF of 3,

6-<16 years applied an ADAF of 3, and

16-26 years applied and ADAF of 1.

For the dermal exposure pathway, the adjusted surface area is a summation of the individual surface areas weighted by the BWs and EDs of the receptor from birth to 26 years. That surface area is then multiplied by the ADAF, similar to the above equation.

The MMOA age adjustment equations are presented in **Attachment A, Table 4.1** and are calculated in **Attachment A, Table 4.Supp.2**.

Exposure intakes for the mutagen TCE incorporate specific calculations, as the toxicity assessment for TCE requires that we address the mutagenic effects on the kidney versus the standard cancer effects on the liver and potential for developing non-Hodgkin's lymphoma. To accomplish this, the mutagenic and standard cancer equations are combined. The different toxicity values for use in the cancer and mutagen intake equations are incorporated using a toxicity value adjustment factor for cancer (CAF) and mutagens (MAF) for all exposure pathways as identified in the EPA RSL equations and described in the User's Guide (EPA 2017c).

For the mutagen VC, exposure intakes also incorporate specific calculations that are based on the EPA RSL equations (EPA 2017c). When evaluating both early life and adult exposures, the regular cancer equation is applied along with the addition of a non-pro-rated early life exposure. For the shower inhalation pathway, the dose for an adult is multiplied by the toxicity value of 4.4E-06 ug/m^3 for continuous lifetime exposure during adulthood and added to the dose for a child multiplied by the toxicity value of 8.8E-06 ug/m^3 for continuous lifetime exposure from birth.

All of the mutagen equations are presented in **Attachment A, Table 4.1**.

5 Toxicity Assessment

The toxicity assessment provides a framework for characterizing the relationship between the magnitude of exposure to a COPC and the nature and likelihood of adverse health effects that may result from such exposure. For all exposure pathways, there are two approaches for deriving toxicity values. One involves the derivation of a noncancer reference value, i.e., an oral or dermal reference dose (RfD) and inhalation reference concentration (RfC), while the other involves derivation of a predictive cancer risk estimate, i.e., an oral or dermal cancer slope factor (CSF) and inhalation unit risk (IUR). An overview of the hierarchy to apply toxicity values is described in **Section 5.1**. The

methodology that is used to develop a toxicity assessment as part of the HHRA is provided in **Sections 5.2** and **5.3**.

5.1 Sources of Toxicity Values

Pertinent toxicological information on COPCs is selected from the following sources, in descending order of hierarchy, in accordance with EPA's OSWER Directive 9285.7-53, *Human Health Toxicity Values in Superfund Risk Assessments* (EPA 2003).

- Tier 1 – EPA's Integrated Risk Information System (IRIS) (EPA 2017a).
- Tier 2 – EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) – The Superfund Health Risk Technical Support Center develops PPRTVs on a chemical specific basis when requested by EPA's Superfund program (EPA 2017b).
- Tier 3 – Other Toxicity Values – Tier 3 includes additional EPA and non-EPA sources of toxicity information (ATSDR 2017, Cal EPA 2016 and EPA 2011b). Priority is given to sources of information that are the most current, transparent, publicly available and those which have been peer reviewed.

The EPA RSL tables provide toxicity values following the above hierarchy; therefore, the most recent November 2017 RSL summary table is used as the source of toxicity values (EPA 2017c).

The cancer and noncancer toxicity values for the COPCs that are used in the risk assessment are presented in **Attachment A, Tables 5.1 through 6.2**.

5.2 Evaluation of Non-Carcinogenic Effects

An oral RfD is calculated for the ingestion exposure pathway; typically expressed as mg/kg-day. A RfC is calculated for the inhalation pathway, expressed in terms of the concentration in the air, as mg/m^3.

In the current absence of dermal slope factors, EPA has devised a process that utilizes the dose-response relationship obtained from oral administration studies and makes an adjustment for absorption efficiency to represent the toxicity factor in terms of absorbed dose, using route-to-route (oral-to-dermal) extrapolations for systemic effects. This is performed using a chemical-specific oral absorption factor (GIABS) that accounts for the fact that most slope factors are expressed as the amount administered per unit time and body weight, with exposure estimates for the dermal pathway expressed as a dose absorbed in the gastrointestinal tract (EPA 1989, 2004).

In the calculation of these toxicity values, EPA uses values (i.e., No Observable Adverse Effect Levels and Lowest Observable Adverse Effect Levels) that express the potential non-carcinogenic effects to identify thresholds for each chemical, and derive an estimate of the exposure below which adverse health effects are not expected to occur over a lifetime.

Two types of noncancer toxicity values are available from EPA depending on the length of exposure being evaluated (i.e., chronic or sub-chronic). Chronic toxicity values are specifically developed to be protective for long-term exposure to a compound, and are generally used to evaluate the non-carcinogenic effects associated with exposure

periods between seven years and a lifetime. Sub-chronic toxicity values are useful for characterizing potential non-carcinogenic effects associated with shorter-term exposures.

The toxicity values for this HHRA were taken from the November 2017 RSL summary table, which provides chronic toxicity values when they are available and supplements these with subchronic toxicity values (EPA 2017c), which were used when chronic values were not provided.

The noncancer toxicity values for the COPCs that are used in the HHRA are presented in **Attachment A, Tables 5.1 and 5.2**.

5.3 Evaluation of Carcinogenic Effects

Carcinogenic risks associated with a given level of exposure to potential carcinogens are typically extrapolated based on slope factors or unit risks. Oral slope factors are the upper 95th percent confidence limit of the slope of the dose-response curve, expressed in terms of risk per unit dose [$(mg/kg\text{-}day)^{-1}$]. Inhalation unit risks similarly relate the risk of cancer development with the concentration of carcinogen [$(mg/m^3)^{-1}$].

In the absence of dermal toxicity values for cancer development, EPA uses the oral dose-response relationship obtained from oral administration studies and adjusts for absorption efficiency with a GIABS factor to derive an absorbed dose in order to assess dermal exposure impacts for cancer, which is described in **Section 5.2** above (EPA 1989, EPA 2004).

The cancer toxicity values for the COPCs that are used in the HHRA are presented in **Attachment A, Tables 6.1 and 6.2**.

For constituents that EPA assessed prior to publication of the *Guidelines for Carcinogen Risk Assessment* (EPA 2005a), EPA considers those belonging to the following cancer weight of evidence groups to be human carcinogens (EPA 1986):

- Group A – Known Human Carcinogen – Sufficient evidence of carcinogenicity in humans;
- Group B1 – Probable Human Carcinogen – Limited evidence of carcinogenicity in humans;
- Group B2 – Probable Human Carcinogen – Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans; and
- Group C – Possible Human Carcinogen – Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans.

For constituents that EPA assessed after the 2005 Guidelines were published, EPA uses a narrative approach to characterize carcinogenicity (EPA 2005a):

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential

As shown in **Attachment A, Tables 6.1 and 6.2**, approximately half of the COPCs are known carcinogens or are likely to be carcinogenic.

5.4 Health Effects of COPCs

The potential health effects from human health exposure to COPCs in media that are the primary contributors to the risks (see **Section 6.3**) are described here, as they are important for understanding the relevance of the risk estimates determined in this HHRA. The information presented here is consistent with the basis of the toxicity values determined by EPA IRIS and other agencies.

- PCE primarily affects the central nervous system (CNS), kidney, liver, reproductive system and developing fetus. EPA IRIS indicates PCE is likely to be carcinogenic to humans by all routes of exposure and the International Agency for Research on Cancer (IARC) indicates PCE is probably carcinogenic to humans. PCE is readily absorbed through the lung, gastrointestinal tract and skin and is widely distributed in the body regardless of the route of exposure. Most absorbed PCE is excreted unchanged in the exhaled air regardless of the route of exposure and PCE metabolites are excreted in the urine. (ATSDR 2014a)
- TCE affects the CNS, kidney, liver, immune system, male reproductive system and developing fetus. IRIS and IARC indicate TCE is carcinogenic to humans and available human data strongly suggest the possibility of TCE-induced kidney cancer and the potential for liver cancer and malignant lymphoma in humans. TCE has similar toxicokinetics as those noted for PCE above. TCE is unlikely to bioaccumulate in the food chain. TCE has been determined to be a mutagen, which means that it can cause DNA changes that lead to the development of cancer when exposed to at an early age and these changes are heritable. (ATSDR 2014b)
- 1,2-DCE primarily affects the kidney through the oral route. Inhalation of 1,2-DCE can result in nausea and drowsiness, but there is insufficient data and no toxicity values have been developed for this pathway. IRIS indicates that cis-1,2-DCE is not classifiable as to its human carcinogenicity and does not have a classification for trans-1,2-DCE. 1,2-DCE evaporates rapidly into the air and once in groundwater, it takes about three months to a year to break down half of it. Data regarding oral or dermal absorption in humans or distribution of 1,2-DCE in the body are not available. (ATSDR 1996)
- VC primarily affects the liver, but also the heart and blood vessels, immune system and developing fetus. IRIS indicates it is a known human carcinogen. Data regarding oral or dermal absorption in humans or distribution of VC in the body are not available. VC is also a mutagen. It is unlikely VC bioaccumulates in the food chain. (ATSDR 2006)

6 Hazard Identification and Risk Characterization

The information obtained from the exposure assessment (**Section 4**) and toxicity assessment (**Section 5**) is integrated to identify the potential non-carcinogenic hazard and characterize excess lifetime cancer risk (ELCR) posed by COPCs selected for evaluation in the HHRA. The risk associated with exposure to individual COPCs is described and then the risk associated with exposures to multiple COPCs is characterized.

6.1 Non-Carcinogenic Hazard Identification

Potential hazards for non-carcinogenic effects are typically estimated by calculating the HQ for each COPC, using the following general equation, which can vary by exposure pathway.

$$HQ = \frac{Intake}{Toxicity}$$

Where:

HQ	=	Hazard quotient (unitless)
Intake	=	Chronic daily intake of chemicals or exposure dose (mg/kg-day or mg/m^3)
Toxicity	=	Oral reference dose (mg/kg-day), dermal reference dose (mg/kg-day) or inhalation reference concentration (mg/m^3)

The cumulative noncancer HI from exposure to the combination of COPCs in an environmental medium and across all media for a receptor is estimated using the following equation (EPA 1989):

$$Hazard\ Index\ = \sum_i HQ_i$$

When the HI for a COPC exceeds unity (one), there may be concern for potential noncancer effects from that COPC. The HI is an indicator that potential hazard for a specific receptor exposed to a COPC in the environment cannot be ruled out, if it is greater than one, not that the hazard actually exists. In interpreting HI values, it is important to understand that the values are estimates, based on predictive models, and are subject to the uncertainties inherent in both the estimates of exposure and toxicity benchmarks.

6.2 Carcinogenic Risk Characterization

Potential risks for carcinogenic effects are typically estimated by calculating an ELCR as a result of exposure to Site-related carcinogens. Calculation of an ELCR for an exposure pathway involves multiplying the chronic daily intake for each chemical by its upper-

bound cancer slope factor, as described by the following general equation (EPA 1989), which can vary by exposure pathway and COPC:

$$Risk = Intake \; x \; Toxicity$$

where:

Risk	=	Cancer risk (unitless)
Intake	=	Chronic daily intake of chemicals (expressed in mg/kg-day)
Toxicity	=	Oral slope factor [$(mg/kg\text{-}day)^{-1}$], dermal slope factor [$(mg/kg\text{-}day)^{-1}$] or inhalation unit risk [$(ug/m^3)^{-1}$]

The single-chemical cancer risk equation above is a linear model that is valid only at low risk levels per RAGS Part A, Chapter 8 (EPA 1989). Thus, the calculation of the single-chemical risk also includes a secondary exponential equation to incorporate the one-hit equation for cancer risks greater than 0.01, as required in RAGS. The one-hit equation is only applied to scenarios where the exposure dose is high; it assumes any single "hit" of an amount of a carcinogen at a cellular target, e.g., DNA, can initiate a series of events leading to a tumor. The one-hit equation is an exponential model that limits the single-chemical risk to less than one whereas the regular linear cancer model may calculate values greater than one. The equation is as follows:

$$Risk = 1 - e^{(-Intake \times Toxicity)}$$

The cumulative cancer risk from exposure to the combination of constituents in an environmental medium and also across all media for a receptor is estimated following EPA guidance (EPA 1989) and the following general equation:

$$Cumulative\ Risk = \sum_i Risk_i$$

For known or suspected carcinogens, EPA considers acceptable exposure levels to generally be concentration levels that represent an ELCR to an individual of between one in ten thousand (1.0E-04) and one in a million (1.0E-06).

6.3 Risk Assessment Results

The results of the hazard identification and risk characterization are presented below, by receptor. The cancer risks and noncancer HQs are presented in **Attachment A, RAGS Part D Tables 7.1 through 7.3**. **Tables 7.1 to 7.3** present risk estimates for exposure of construction workers, workers and residents groundwater across the site, respectively. COPCs are identified for only exposure pathways that have an ELCR greater than 1.0E-06 and a HI greater than one; these constituents are considered to be primary contributors to the risk estimates.

6.3.1 Construction Worker

The cumulative cancer risks and noncancer HIs by exposure pathway for a future on-Site construction worker's exposure to COPCs in groundwater are summarized in **Table 6-1** below. Chemical-specific cancer risks and noncancer HQs are presented in **Attachment A, RAGS Part D Planning Table 7.1**.

The total ELCR for a construction worker's exposure to COPCs in groundwater from all pathways is 2.2E-03. The ELCR for groundwater inhalation exposure is 1.9E-03; the primary contributors are VC, TCE and PCE at 1.3E-03, 5.5E-04 and 1.0E-04, respectively. The ELCR for groundwater dermal exposure is 2.3E-04 and that for incidental ingestion is 3.5E-05, with VC as the primary contributor for both pathways.

Table 6-1. Construction Worker's Exposure to Groundwater

Exposure Route	Cumulative Cancer Risk	Primary COPCs	Hazard Index	Primary COPCs
	Lifetime			
Incidental Ingestion	3.5E-05	VC (3.3E-05), TCE (1.4E-06)	1.3E+01	cis-1,2-DCE (6.1E+00), TCE (4.3E+00), PCE (1.1E+00), VC (1.1E+00)
Dermal	2.3E-04	VC (2.1E-04), TCE (1.5E-05), PCE (6.7E-06)	1.4E+02	cis-1,2-DCE (5.4E+01), TCE (4.4E+01), PCE (3.7E+01), VC (6.9E+00), trans-1,2-DCE (1.1E-01)
Inhalation	1.9E-03	VC (1.3E-03), TCE (5.5E-04), PCE (1.0E-04)	5.6E+03	TCE (4.7E+03), PCE (6.7E+02), VC (2.0E+02), 1,1,2-trichloroethane (2.5E+00)
Total	2.2E-03		5.8E+03	

The total noncancer HI is 5.8E+03. The HI for groundwater inhalation is 5.6E+03; primary contributors to this HI are TCE, PCE and VC with HQs of 4.7E+03, 6.7E+02 and 2.0E+02, respectively. The HI for groundwater dermal exposure is 1.4E+02 and that for incidental ingestion exposure is 1.3E+01; the primary contributor is cis-1,2-DCE followed by TCE, PCE and VC. See **Table 6-1.**

6.3.2 Worker

The cumulative cancer risks and noncancer HIs by exposure pathway for a future on-Site worker's exposure to COPCs in groundwater are summarized in **Table 6-2** below. Chemical-specific cancer risks and noncancer HQs are presented in **Attachment A, RAGS Part D Planning Table 7.2**.

The total ELCR for a worker's exposure to COPCs in groundwater via tapwater use from all pathways is 5.5E-02. The ELCR for groundwater ingestion exposure is 5.3E-02, with primary contributors of VC, TCE and PCE at 5.0E-02, 2.2E-03 and 3.2E-04, respectively. The ELCR for groundwater dermal exposure is 2.0E-03 with the same primary contributors. The one-hit model was applied for VC via the groundwater ingestion pathway, as the linear model resulted in a cancer risk greater than 0.01; the initial cancer risk was 5.2E-02. The revised one-hit model cancer risk was calculated to be 5.0E-02, which is shown in a separate column in **Attachment A, RAGS Part D Planning Table 7.2**.

The total noncancer HI is 8.5E+02. The HI for groundwater ingestion is 7.9E+02 and the primary contributors are cis-1,2-DCE, TCE, PCE and VC at 3.8E+02, 2.7E+02, 7.2E+01

and 6.7E+01, respectively. The HI for groundwater dermal exposure is 5.9E+01 with same primary contributors. See **Table 6-2**.

Table 6-2. Worker's Exposure to Groundwater

Exposure Route	Cumulative Cancer Risk	Primary COPCs	Hazard Index	Primary COPCs
	Lifetime			
Ingestion	5.3E-02	VC (5.0E-02), TCE (2.2E-03), PCE (3.2E-04)	7.9E+02	cis-1,2-DCE (3.8E+02), TCE (2.7E+02), PCE (7.2E+01), VC (6.7E+01), trans-1,2-DCE (8.0E-01)
Dermal	2.0E-03	VC (1.8E-03), TCE (1.5E-04), PCE (8.0E-05)	5.9E+01	cis-1,2-DCE (2.0E+01), TCE (1.9E+01), PCE (1.8E+01), VC (2.3E+00)
Total	5.5E-02		8.5E+02	

6.3.3 Resident

The cumulative cancer risks and noncancer HIs by exposure pathway for a future on-Site resident adult and child's exposure to COPCs in groundwater are summarized in **Table 6-3** below. Chemical-specific cancer risks and noncancer HQs are presented in **Attachment A, RAGS Part D Planning Table 7.3**.

The ELCRs for a resident's exposure to COPCs in groundwater via tapwater is 6.1E-01 from the ingestion pathway, 6.2E-02 from the dermal pathway and 4.4E-02 from the inhalation pathway. The groundwater ingestion pathway contributes the most to the risk; the primary contributors are VC, TCE, PCE and bromodichloromethane with individual COPC risks of 6.1E-01, 1.4E-02, 1.3E-03 and 1.1E-06, respectively. There are high concentrations of carcinogenic COPCs (e.g., VC with an EPC of 18,727 ug/L, cis-1,2-DCE with an EPC of 71,118 ug/L, PCE with an EPC of 40,294 ug/L and TCE with an EPC of 12,672 ug/L – see **Attachment A, Table 3.1**) in the source area behind the Curriculum Center building. The presence of these COPCs at such elevated levels results in high chemical risks (e.g., 6.0E-01 for VC via the ingestion pathway).

The one-hit model was applied for TCE and VC via the groundwater ingestion and inhalation pathways as well as for VC via the dermal pathway, as the linear model resulted in cancer risks greater than 0.01; the revised one-hit model cancer risks are shown in a separate column in **Attachment A, Table 7.3**.

The total noncancer HI is 6.3E+03 for an adult and 7.4E+03 for a child. The groundwater inhalation and ingestion pathways contribute the most to these HIs with adult HIs of 3.7E+03 and 2.2E+03, respectively, and child HIs of 3.1E+03 and 3.7E+03, respectively. Cis-1,2-DCE, TCE, PCE and VC are the primary contributors for all pathways. See Table 6-3.

The risk assessment results are summarized by COPC and the noncancer hazards are separated by target organ in Attachment A, Tables 9.1 to 9.3. Table 9.1 presents the summary and target organ evaluation for a construction worker, Table 9.2 that for a worker and Table 9.3 that for a resident. Review of these tables indicates that multiple

Table 6-3. Resident's Exposure to Groundwater

Exposure Route	Cumulative Cancer Risk	Primary COPCs	Hazard Index		Primary COPCs
	Lifetime		Adult	Child	
Ingestion	6.1E-01	VC (6.0E-01), TCE (1.4E-02), PCE (1.3E-03), bromodichloromethane (1.1E-06)	2.2E+03	3.7E+03	cis-1,2-DCE (adult 1.1E+03, child 1.8E+03), TCE (adult 7.6E+02, child 1.3E+03), PCE (adult 2.0E+02, child 3.3E+02), VC (adult 1.9E+02, child 3.1E+02), trans-1,2-DCE (adult 2.3E+00, child 3.7E+00)
Dermal	6.2E-02	VC (5.9E-02), TCE (1.8E-03), PCE (6.7E-04)	3.8E+02	5.8E+02	cis-1,2-DCE (adult 1.3E+02, child 2.0E+02), PCE (adult 1.2E+02, child 1.8E+02), TCE (adult 1.2E+02, child 1.8E+02), VC (adult 1.4E+01, child 2.1E+01), trans-1,2-DCE (adult 2.7E-01), child 4.1E-01)
Inhalation	4.4E-02	TCE (2.5E-02), VC (1.7E-02) PCE (1.8E-03), bromodichloromethane (7.4E-06), 1,2-dichloroethane (2.5E-06), 1,1,2-trichloroethane (1.9E-06), 1,4-dichlorobenzene (1.7E-06)	3.7E+03	3.1E+03	TCE (adult 3.1E+03, child 2.6+03), PCE (adult 4.9E+02, child 4.2E+02), VC (adult 9.1E+01, child 7.7E+01), 1,1,2-trichloroethane (adult 1.7E+00, child 1.4E+00)
Total	7.2E-01		6.3E+03	7.4E+03	

organs are targeted from exposures to these COPCs, as TCE is a primary contributor to the hazards and TCE has shown evidence of affecting the developmental, hepatic, renal, nervous, lymphatic and reproductive systems. In addition, in **Attachment A, Table 9.3**, while 1,2,4-trichlorobenzene does not have individual pathway cancer risks greater than 1E-06 for a resident's groundwater exposure, the cumulative cancer risk from all exposure pathways is 1.2E-06; therefore, 1,2,4-trichlorobenzene is also of potential concern to future residents and retained as a COC.

6.4 Vapor Intrusion Evaluation

To calculate potential risks from VI, concepts from the *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (EPA, 2015d) were used in concert with EPA's VISL Calculator (version 3.5.2 using Nov 2017 RSLs; EPA 2017d) to evaluate VI risks at the Site. The VISL calculator incorporates information on volatile chemicals known to have a potential cancer risk or noncancer hazard through the inhalation pathway that provides screening level concentrations for groundwater, soil gas and indoor air using default target risk levels and exposure scenarios.

The VISL calculator was run to calculate Site-specific groundwater VISLs for both residential and commercial scenarios using calculator defaults. The VI calculations are presented in **Attachment D**. **Tables D.1** and **D.2** present the calculation of the groundwater VISLs for the residential and commercial scenarios, respectively. **Table D.3** compares the maximum Site-wide groundwater concentrations to the groundwater VISLs. Note that the VISL calculator does not produce VISLs for 1,3-dichlorobenzene, as this COPC does not have inhalation toxicity values.

Comparison of the residential groundwater VISLs to the maximum groundwater concentration indicates there are six COPCs whose concentrations are greater than their

respective residential VISL values. These include 1,1-dichloroethene, 1,4-dichlorobenzene, bromodichloromethane, PCE, TCE and VC. Only PCE, TCE and VC have concentrations greater than the commercial groundwater VISLs.

EPA's Environmental Response Team (ERT) investigated the potential for VI at the Curriculum Center building. Two field investigations were completed by a contractor in December 2007 and December 2011 (Lockheed 2008, 2012). On both occasions, 16 sub-slab soil gas samples, 30 indoor air samples and two ambient air samples were collected from the three areas of the building: i.e., Curriculum, Warehouse and Maintenance. The analytical results from the sampling events are summarized in **Tables 6-4** and **6-5** below.

The current EPA VISLs for sub-slab soil gas and indoor air are also included in the tables, to allow for comparison to the maximum detected concentrations identified in 2007 and 2011 (EPA 2017d). The comparison indicates that PCE and TCE have VISL exceedances in the sub-slab soil gas and in the indoor air. For indoor air, a majority of the samples are well below the residential and commercial indoor air VISLs. There are three PCE exceedances of the residential and commercial indoor air VISLs in the Maintenance area (locations MA-I-2 and MA-I-3; concentrations of 58, 56 and 58 ug/m^3, respectively) and one PCE exceedance of the residential indoor air VISL in location MA-I-3 with a concentration of 13.1 ug/m^3 that was qualified as estimated. There are two TCE exceedances (0.488 and 0.47 ug/m^3) of the residential indoor air VISL from the same two locations in the Maintenance area noted above. No other exceedances of the commercial indoor air VISLs are noted.

The building has windows and large roll-up doors in the Warehouse, windows in the Maintenance area and air conditioners in the Curriculum area, which will increase the ventilation in the building and reduce the effects of potential VI. In addition, part of the Site is paved, the building is condemned from damage from Hurricane Irma and it is not currently in use.

Table 6-4. 2007 and 2011 Sub-slab Soil Gas Sampling Summary

COPC	Year	Range of Concentrations (ug/m^3)	EPA Residential Sub-Slab VISL (ug/m^3)	EPA Commercial Sub-Slab VISL (ug/m^3)	Is Maximum >= VISLs?
PCE	2007	54 - 79,000	359	1572	**Yes**
	2011	51.6 – 147,000			**Yes**
TCE	2007	ND - 810	15.9	99.7	**Yes**
	2011	ND – 688			**Yes**
cis-1,2-DCE	2007	ND	Not available; lack of toxicity value	Not available; lack of toxicity value	No
	2011	ND – 52.2			No
trans-1,2-DCE	2007	ND	Not available; lack of toxicity value	Not available; lack of toxicity value	No
	2011	ND – 4.0			No
VC	2007	ND	5.59	92.9	No
	2011	ND			No
1,1-DCE	2007	ND – 1,100	6,952	29,200	No
	2011	ND – 0.646			No

Table 6-5. 2007 and 2011 Indoor Air Sampling Summary

COPC	Year	Range of Concentrations (ug/m^3)	EPA Residential IA VISL (ug/m^3)	EPA Commercial IA VISL (ug/m^3)	Is Maximum >= VISLs?
PCE	2007	0.32 - 58	10.8	47.2	**Yes**
	2011	0.806 - 58			**Yes**
TCE	2007	ND - 0.47	0.478	2.99	No
	2011	ND - 0.488			**Yes**
cis-1,2-DCE	2007	ND – 0.042	Not available; lack of toxicity value	Not available; lack of toxicity value	No
	2011	ND – 0.283			No
trans-1,2-DCE	2007	ND	Not available; lack of toxicity value	Not available; lack of toxicity value	No
	2011	ND - 0.177			No
VC	2007	ND	0.168	2.79	No
	2011	ND			No
1,1-DCE	2007	ND – 0.13	208.6	876	No
	2011	ND			No

6.5 Non-Source Area Data Evaluation

Wells downgradient of the source area are not as highly contaminated; an evaluation was performed here to help understand the magnitude of contamination that may be present downgradient. A review of the wells sampled by HDR indicated eight are downgradient of source area. It is noted that no data are available for the nearby off-site MW-2, MW-5 and Tillet wells for the RI. OU2-MD1 is a matrix diffusion borehole that has been grouted closed (see **Figure 1-1**). Therefore, the wells included in this evaluation are MW-1D, MW-14, MW-15, MW-17, OU2-MW-3, OU2-MW-4, OU2-MW-5 and RD-13.

Table 6-6. Non-Source Area Data Comparison to MCLs and VISLs

Constituent	Range of Data	Location of Maximum	Detection Frequency (%)	Federal MCL	EPA Residential GW VISL	EPA Commercial GW VISL	Maximum of Source Area
Acetone	5.8 - 5.8	MW5	11	No MCL	23,000,000	95,000,000	13
Bromodichloromethane	1.2 - 1.2	MW4	11	80	0.88	3.8	2.7
Chloromethane	0.51 - 0.51	MW3	11	No MCL	260	1100	0.51
1,1-Dichloroethene	0.74 - 0.74	MW4	11	7	200	820	400
cis-1,2-DCE	0.67 - 1700	MW3	100	70	NA	NA	160,000
trans-1,2-DCE	1.6 - 240	RD13	56	100	NA	NA	2,300
PCE	1.1 - 3500	MW3	100	5	15	65	92,000
Toluene	2.3 - 4	MW3	22	1,000	19,000	81,000	4.7
TCE	0.7 - 200	MW3	89	5	1.2	7.4	29,000
VC	2.2 - 74	RD13	56	2	0.15	2.5	38,000
Note: Concentrations and criteria are in units of ug/L. NA = Not available.							

The data from these wells were assessed for useability and the maximum detected concentrations were compared to the Federal MCLs (EPA 2015a) and VISLs (EPA 2017d), with results as shown in Table 6-6. Constituents shown on the table are those that are detected in the data set. The evaluation indicates that PCE and its breakdown products have maximum detected concentrations that are well above their respective MCL and VISL in this downgradient area, though at concentrations less than and, in some instances, well below the source area maximum detected concentrations.

6.6 Risk Assessment Conclusions

This HHRA was prepared to evaluate potential baseline health risks for future receptor exposure to COPCs present in groundwater. The COPC screening of the HHRA identified 13 COPCs. The potential exposure scenarios considered in this HHRA include drinking water ingestion, dermal contact and inhalation of groundwater by residents, drinking water ingestion and dermal contact by workers as well as incidental ingestion, contact and inhalation with groundwater by construction workers in a trench, as shown in the CSM, **Figure 4-1**.

The evaluation of potential cancer risks and noncancer hazards to future receptors on-Site from exposure to COPCs in environmental media indicates that there are several primary COPCs, now identified as COCs, whose concentrations in environmental media contribute to the hazard and risk estimates, and exposure to these COCs may result in potential adverse health effects, as detailed below.

The evaluation for on-Site future construction workers indicates that VC, TCE, PCE, cis-1,2-DCE and 1,1,2-trichloroethane have been identified as COCs for groundwater exposure, based on an ELCR exceeding 1E-06 or resulting in an HI greater than or equal to one.

The evaluation for on-Site future workers indicates that VC, TCE, PCE and cis-1,2-DCE have been identified as COCs for groundwater exposure, based on an ELCR exceeding 1E-06 or resulting in an HI greater than or equal to one. PCE and TCE volatilizing into buildings are also of potential concern to workers based on groundwater, indoor air and sub-slab soil gas data. VC volatilizing into buildings may be of potential concern to workers based on groundwater concentrations compared to the VC groundwater VISL; however, VC was non-detect in the sub-slab soil gas and indoor air during two sampling events in 2007 and 2011, as indicated in **Section 6.4**.

The evaluation of potential cancer risks and noncancer hazards to future residents indicates VC, TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, bromodichloromethane, 1,2-dichloroethane, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene and 1,1,2-trichloroethane have been identified as COCs for groundwater exposure, based on an ELCR exceeding 1E-06 or resulting in an HI greater than or equal to one.

PCE, TCE and other VOCs volatilizing into buildings are also of potential concern to future residents based on an evaluation of groundwater, indoor air and sub-slab soil gas data.

The ELCR for 1,1-DCE is less than 1E-06; however, its maximum detected concentration exceeds its MC, so it too is included as a COC.

7 Uncertainty Analysis

This section includes a discussion on the inherent uncertainties in the HHRA methods, inputs and conclusions and the additional sensitivity analyses performed.

7.1 HHRA Uncertainties

There is uncertainty inherent in the methods, inputs and conclusions of any HHRA. This level of uncertainty results from the fact that the risk assessment process involves numerous assumptions and unknowns, contributing to the total uncertainty in the final conclusions. EPA uses default and appropriate values that guard against underestimating risk while also being scientifically plausible given existing uncertainties. These include, but are not limited to:

- Environmental parameters, chemistry and sampling analysis;
- Assumptions in the derivation of screening benchmarks that are used to identify Site-related COCs;
- The exposure factors used for quantifying exposure are conservative and reflect upper-bound assumptions;
- Maximum concentrations applied as a measure of exposure for each medium and receptor in the COPC screening, which is a conservative assumption intentionally used to focus the risk assessment on those pathways and receptors potentially at risk; and
- Bioavailability of 100% of the chemical substance is assumed for uptake by humans, which is conservative and is known to not be the case for many chemical substances under varying environmental conditions.

Uncertainties specific to this HHRA include:

- Drinking water ingestion by construction workers was not evaluated, which likely underestimates risks and HQs. The workers' drinking water ingestion pathway is a conservative surrogate for a construction workers'.
- The COPC 1,3-dichlorobenzene was retained because no screening levels are available. There are no toxicity values for this COPC, which prevents calculation of cancer risks and non-cancer HQs and may contribute to underestimating the risk estimates to receptors exposed to groundwater contamination.
- TICs detected in certain wells are excluded from the COPC screening. Total alkane TICs range from 1.1-9.6 ppb, the maximum concentration for one unknown TIC is 340 ppb. A review of data from wells located on or near the site that have TIC data (i.e., OU2-MW1, OU2-MW2, OU2-MW3, OU2-MW5, OU2-MW6, IW1 and RD12) indicates VOC levels range from ND and single digit to the tens of thousands ppb range (in wells closest to source area). There is no evident pattern in the relationship between TICs and COCs in the data set.

  COC concentrations vary considerably; in some wells, TIC concentrations may be masked by the presence of other constituents at high concentrations.

Therefore, the risks associated with potential exposure to TICs are likely to be underestimated.

- The risk characterization for the construction worker incorporates the 4 hour t-event default value included for a construction worker in the VADEQ model; documentation for the model does not identify whether or not the value is considered a reasonable maximum exposure (RME) or central tendency (CT) scenario. Use of the 4 hour work shift default value potentially underestimates risks to the construction worker.
- The QAPP measurement performance criteria have been met for accuracy, representativeness, comparability, completeness and blank contamination. The measurement performance criteria were not met for precision and sensitivity in a few instances, which is discussed further in the DER (FSRI Appendix B).

  For precision, there are three instances out of 153 in which the relative percent differences between parent and field duplicate samples are greater than 50 percent (PCE, trans-1,2-DCE and VC); the concentrations are well above the minimum groundwater risk-based screening levels and have been retained in this HHRA.

  For sensitivity, several constituents have QLs greater than risk-based criteria. This occurs in approximately eight percent of the usable data, which may mask potential exceedances of the risk-based criteria. However, the detected concentrations for these instances are well above the risk-based criteria and therefore, not an issue for this HHRA. Several constituents have reporting detection limits greater than the QAPP's contract required quantitation limits. This is true for approximately four percent of the usable data, where samples were diluted by the laboratory during analysis. These data have been retained for use in the HHRA.

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FIGURES

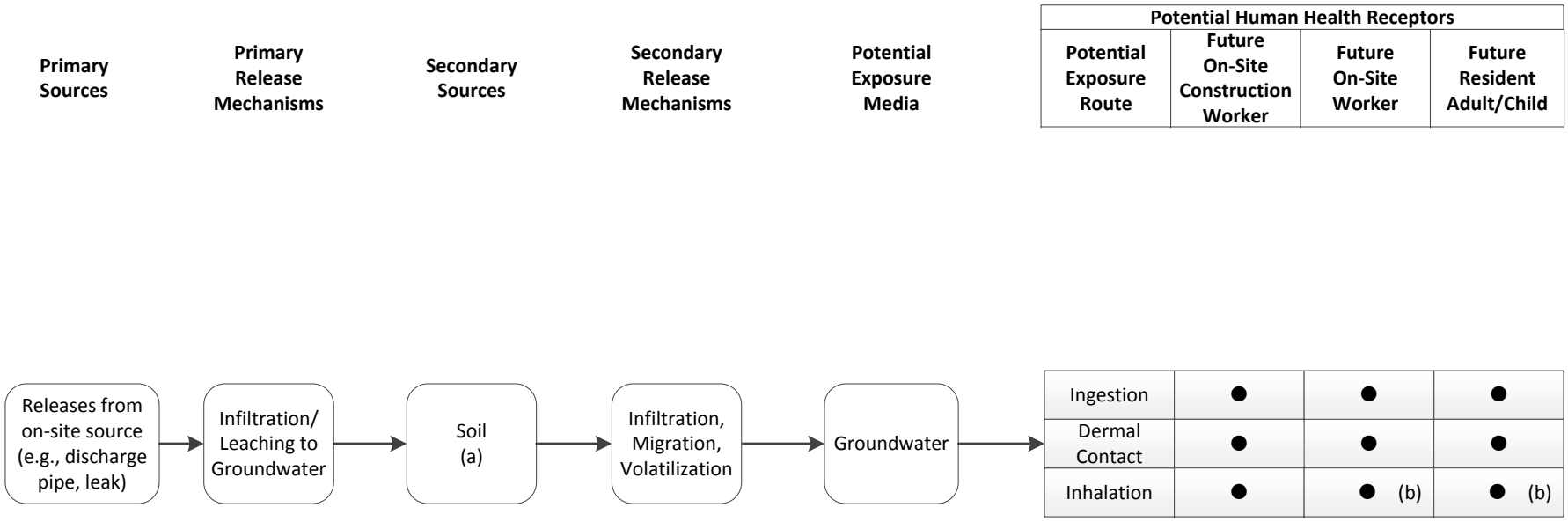
FIGURES TABLE OF CONTENTS:

United States Environmental Protection Agency

SITE PLAN

ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 1-1



NOTES

- ● Pathway assumed to be complete.
- (a) Only groundwater exposures are evaluated in this HHRA.
- (b) Assessed via EPA Vapor Intrusion Screening Level calculator. For the resident, inhalation of shower vapors is also evaluated using the Andelman model.

Figure 4-1
Human Health Conceptual Site Model
Tutu Wells Superfund Site
St. Thomas, U.S. Virgin Islands

ATTACHMENT A

RAGS Part D Human Health Risk Assessment Tables

ATTACHMENT A TABLE OF CONTENTS:

TABLE 0
SITE RISK ASSESSMENT IDENTIFICATION INFORMATION
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Site Name/OU:	Tutu Wells Superfund Site
Region:	2
EPA ID Number:	VID982272569
State:	St. Thomas, U.S. Virgin Islands
Status:	Revised
Federal Facility (Y/N):	N
EPA Project Manager:	Caroline Kwan
EPA Risk Assessor:	Julie McPherson
Prepared by (Organization):	HDR
Prepared for (Organization):	USEPA
Document Title:	Human Health Risk Assessment
Document Date:	January 2018
Probabilistic Risk Assessment (Y/N):	N
Comments:	RAGS Tables 0 to 9.3

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe	Source	Receptor Population	Receptor Age	Medium / Exposure Medium	Exposure Point	Exposure Route	Type of Evaluation	Rationale for Selection or Exclusion of Exposure Pathway
Future	LAGA Former Textile Manufacturing Plant (CVOC plume under Curriculum Center)	On-Site Worker	Adult	Groundwater	Tapwater	Ingestion	Quantitative	The Curriculum Center is connected to a public water supply system managed by V.I. Water and Power Authority. However, the groundwater is evaluated in the absence of institutional controls for the future exposure pathway (ingestion of groundwater as a drinking water source, etc.), in addition to the vapor intrusion pathway, with the assumption that a worker will be present and working at this location during the day. Inhalation via vapor intrusion is evaluated qualitatively using USEPA groundwater vapor intrusion screening levels (VISL calculator).
						Dermal		
					Indoor Air	Inhalation	Qualitative	
Future		On-Site Construction Worker	Adult	Groundwater	Trench water	Ingestion	Quantitative	Redevelopment of the site is likely to occur and water levels vary across the site (9 to 65 feet below ground surface); therefore a future on-site construction worker's exposure to groundwater in a trench is evaluated quantitatively via the ingestion, dermal and inhalation pathways.
						Dermal		
					Trench Air	Inhalation		
Future		Resident	Adult	Groundwater	Tapwater	Ingestion	Quantitative	Institutional controls currently require permit for installation/use of groundwater from local wells. However, the goal is to restore groundwater to its most beneficial use (potable water supply) under the National Contingency Plan; groundwater may be used in the future as a potable water source. Therefore, a future resident's exposure to groundwater and indoor air contaminants via showering and vapor intrusion will be evaluated in this HHRA. Inhalation via vapor intrusion is evaluated qualitatively using USEPA groundwater vapor intrusion screening levels (VISL calculator).
						Dermal		
					Shower Vapors	Inhalation		
					Indoor Air	Inhalation	Qualitative	
			Child (0-6 years)	Groundwater	Tapwater	Ingestion	Quantitative	
						Dermal		
					Shower Vapors	Inhalation		
					Indoor Air	Inhalation	Qualitative	

Abbreviation:

CVOCs -- Chlorinated volatile organic compounds

References:

HDR 2015. Final Focused Source Remedial Investigation/Feasibility Study Work Plan, Tutu Wells Superfund Site, St. Thomas, USVI. EPA Work Assignment Number: 031-RICO-021D, EPA Contract Number: EP-W-09-009. October.

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TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF HUMAN HEALTH COPCS FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	T or D	Constituent Group	Constituent	CASRN	Minimum Detected Concentration (ug/L)	Qual	Maximum Detected Concentration (ug/L)	Qual	Location of Maximum Detected Concentration	Sample Count	Detect Count	Detection Frequency (%)	Range of Detection Limits (ug/L)	Concentration used for Screening (ug/L) (1)	Federal MCL (ug/L) (2)	USEPA RSL Resident Tapwater (ug/L) (3)		COPC Flag (Y/N)	Rationale for Selection or Deletion
																Value	Basis		
Groundwater	T	VOC	1,1,1-Trichloroethane	71-55-6	ND		ND		NA	26	0	0	0.5 - 0.5	ND	200	800	n	N	Not detected.
Groundwater	T	VOC	1,1,2,2-Tetrachloroethane	79-34-5	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	0.076	c	N	Not detected.
Groundwater	T	VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	1,000	n	N	Not detected.
Groundwater	T	VOC	1,1,2-Trichloroethane	79-00-5	1.3		1.6		IW1	26	2	8	0.5 - 0.5	1.6	5	0.041	n	Y	Above screening level.
Groundwater	T	VOC	1,1-Dichloroethane	75-34-3	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	2.8	c	N	Not detected.
Groundwater	T	VOC	1,1-Dichloroethene	75-35-4	0.74		400		RD9	26	6	23	0.5 - 50	400	7	28	n	Y	Above screening level.
Groundwater	T	VOC	1,2,3-Trichlorobenzene	87-61-6	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	0.7	n	N	Not detected.
Groundwater	T	VOC	1,2,4-Trichlorobenzene	120-82-1	1		4.1		RD9	26	4	15	0.5 - 0.5	4.1	70	0.4	n	Y	Above screening level.
Groundwater	T	VOC	1,2-Dibromo-3-chloropropane	96-12-8	ND		ND		NA	26	0	0	0.5 - 0.5	ND	0.2	0.00033	c	N	Not detected.
Groundwater	T	VOC	1,2-Dibromoethane	106-93-4	ND		ND		NA	26	0	0	0.5 - 0.5	ND	0.05	0.0075	c	N	Not detected.
Groundwater	T	VOC	1,2-Dichlorobenzene	95-50-1	ND		ND		NA	26	0	0	0.5 - 0.5	ND	600	30	n	N	Not detected.
Groundwater	T	VOC	1,2-Dichloroethane	107-06-2	0.65		0.8		RD9	26	2	8	0.5 - 0.5	0.8	5	0.17	c**	Y	Above screening level.
Groundwater	T	VOC	1,2-Dichloropropane	78-87-5	ND		ND		NA	26	0	0	0.5 - 0.5	ND	5	0.82	n	N	Not detected.
Groundwater	T	VOC	1,3-Dichlorobenzene	541-73-1	0.6		0.74		MW2	26	3	12	0.5 - 0.5	0.74	NC	NC		Y	No screening level.
Groundwater	T	VOC	1,4-Dichlorobenzene	106-46-7	0.53		2.8		IW1	26	5	19	0.5 - 0.5	2.8	75	0.48	c	Y	Above screening level.
Groundwater	T	VOC	2-Hexanone	591-78-6	ND		ND		NA	26	0	0	5 - 5	ND	NC	3.8	n	N	Not detected.
Groundwater	T	VOC	Acetone	67-64-1	5.8		13		RD9	26	2	8	5 - 5	13	NC	1,400	n	N	Below screening level.
Groundwater	T	VOC	Benzene	71-43-2	ND		ND		NA	26	0	0	0.5 - 0.5	ND	5	0.46	c**	N	Not detected.
Groundwater	T	VOC	Bromochloromethane	74-97-5	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	8.3	n	N	Not detected.
Groundwater	T	VOC	Bromodichloromethane	75-27-4	1.2		2.7		BP2	26	2	8	0.5 - 0.5	2.7	80	0.13	c	Y	Above screening level.
Groundwater	T	VOC	Bromoform	75-25-2	ND		ND		NA	26	0	0	0.5 - 0.5	ND	80	3.3	c*	N	Not detected.
Groundwater	T	VOC	Bromomethane	74-83-9	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	0.75	n	N	Not detected.
Groundwater	T	VOC	Carbon tetrachloride	56-23-5	ND		ND		NA	26	0	0	0.5 - 0.5	ND	5	0.46	c*	N	Not detected.
Groundwater	T	VOC	Chlorobenzene	108-90-7	1.9		48		RD9	26	5	19	0.5 - 0.5	48	100	7.8	n	Y	Above screening level.
Groundwater	T	VOC	Chloroethane	75-00-3	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	2,100	n	N	Not detected.
Groundwater	T	VOC	Chloroform	67-66-3	ND		ND		NA	26	0	0	0.5 - 0.5	ND	80	0.22	c*	N	Not detected.
Groundwater	T	VOC	Chloromethane	74-87-3	0.51		0.51		MW3	26	1	4	0.5 - 0.5	0.51	NC	19	n	N	Below screening level.
Groundwater	T	VOC	cis-1,2-Dichloroethylene	156-59-2	0.67	L	160,000		RD9	26	24	92	0.5 - 2500	160,000	70	3.6	n	Y	Above screening level.
Groundwater	T	VOC	cis-1,3-Dichloropropene	10061-01-5	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	0.47	c**	N	Not detected.
Groundwater	T	VOC	Cyclohexane	110-82-7	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	1,300	n	N	Not detected.
Groundwater	T	VOC	Dibromochloromethane	124-48-1	ND		ND		NA	26	0	0	0.5 - 0.5	ND	80	0.87	c*	N	Not detected.
Groundwater	T	VOC	Dichlorodifluoromethane	75-71-8	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	20	n	N	Not detected.
Groundwater	T	VOC	Ethylbenzene	100-41-4	ND		ND		NA	26	0	0	0.5 - 0.5	ND	700	1.5	c*	N	Not detected.
Groundwater	T	VOC	Isopropylbenzene (Cumene)	98-82-8	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	45	n	N	Not detected.
Groundwater	T	VOC	m,p-Xylene	179601-23-1	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	NC		N	Not detected.
Groundwater	T	VOC	Methyl acetate	79-20-9	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	2,000	n	N	Not detected.
Groundwater	T	VOC	Methyl Ethyl Ketone (2-butanone)	78-93-3	ND		ND		NA	26	0	0	5 - 5	ND	NC	560	n	N	Not detected.
Groundwater	T	VOC	Methyl Isobutyl Ketone	108-10-1	ND		ND		NA	26	0	0	5 - 5	ND	NC	630	n	N	Not detected.
Groundwater	T	VOC	Methyl tert-butyl ether	1634-04-4	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	14	c*	N	Not detected.
Groundwater	T	VOC	Methylcyclohexane	108-87-2	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	NC		N	Not detected.
Groundwater	T	VOC	Methylene chloride	75-09-2	3		3		IW2	26	1	4	0.5 - 0.5	3	5	11	n	N	Below screening level.
Groundwater	T	VOC	o-Xylene	95-47-6	0.52		0.52		RD11	26	1	4	0.5 - 0.5	0.52	NC	19	n	N	Below screening level.
Groundwater	T	VOC	Styrene	100-42-5	2.1		2.1		IW1	26	1	4	0.5 - 0.5	2.1	100	120	n	N	Below screening level.
Groundwater	T	VOC	Tetrachloroethylene	127-18-4	0.97		92,000		RD9	26	26	100	0.5 - 2500	92,000	5	4.1	n	Y	Above screening level.

TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF HUMAN HEALTH COPCS FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	T or D	Constituent Group	Constituent	CASRN	Minimum Detected Concentration (ug/L)	Qual	Maximum Detected Concentration (ug/L)	Qual	Location of Maximum Detected Concentration	Sample Count	Detect Count	Detection Frequency (%)	Range of Detection Limits (ug/L)	Concentration used for Screening (ug/L) (1)	Federal MCL (ug/L) (2)	USEPA RSL Resident Tapwater (ug/L) (3)		COPC Flag (Y/N)	Rationale for Selection or Deletion
																Value	Basis		
Groundwater	T	VOC	Toluene	108-88-3	0.82		4.7		RD9	26	6	23	0.5 - 0.5	4.7	1,000	110	n	N	Below screening level.
Groundwater	T	VOC	trans-1,2-Dichloroethylene	156-60-5	0.68		2,300		RD9	26	16	62	0.5 - 50	2,300	100	36	n	Y	Above screening level.
Groundwater	T	VOC	trans-1,3-Dichloropropene	10061-02-6	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	0.47	c**	N	Not detected.
Groundwater	T	VOC	Trichloroethylene	79-01-6	0.51		29,000		RD9	26	22	85	0.5 - 2500	29,000	5	0.28	n	Y	Above screening level.
Groundwater	T	VOC	Trichlorofluoromethane	75-69-4	ND		ND		NA	26	0	0	0.5 - 0.5	ND	NC	520	n	N	Not detected.
Groundwater	T	VOC	Vinyl chloride	75-01-4	2.2		38,000		RD9	26	16	62	0.5 - 2500	38,000	2	0.019	c	Y	Above screening level.
Groundwater	T	OTHER	Carbon disulfide	75-15-0	6.6	L	6.6	L	RD9	26	1	4	0.5 - 0.5	6.6	NC	81	n	N	Below screening level.

Notes:
(1) The maximum detected concentrations for site-wide groundwater are used for the COPC screening. Groundwater data that do not meet the requirements in the USEPA memorandum titled Determining *Groundwater Exposure Point Concentrations, Supplemental Guidance* were not excluded from this screening, e.g., packer
(2) Federal Maximum Contaminant Levels (MCLs) are taken from USEPA Regional Screening Level (RSL) tables and checked against the source website.
(3) USEPA RSLs at a target risk of 1E-06 and target hazard quotient of 0.1.
The COPC screening applies the minimum of the Federal MCLs, USEPA Tapwater RSLs and USEPA National Recommended Water Quality Criteria (WQC).
+ The criteria for 1,3-dichloropropene is applied to its isomers, cis- and trans-.

Abbreviations:
COPC -- Constituent of potential concern
MCL -- Maximum Contaminant Level
NA -- Not applicable
NC -- No criteria
ND -- Not detected
Qual -- Qualifier
RSL -- USEPA Regional Screening Levels
T or D -- Total or dissolved
ug/L -- Micrograms per liter
USEPA -- United States Environmental Protection Agency
VOC -- Volatile organic compound
WQC -- Water quality criteria

Qualifiers:
B -- Blank contamination

RSL Basis:
* -- Where noncancer RSL < 100 times cancer RSL
c -- Cancer
n -- Noncancer

References:
USEPA. 2014. Memorandum – Determining Groundwater Exposure Point Concentrations, Supplemental Guidance. March 11. Available online: https://www.epa.gov/risk/exposure-point-concentrations-groundwater
USEPA. 2017. Regional Screening Levels Generic Tables. November. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls
USEPA. 2017. National Recommended Water Quality Criteria - Human Health Criteria Table. Website Last Updated May 16. Available online: https://www.epa.gov/wqc/national-recommended-water-quality-criteria

TABLE 2.SUPP.1
SUMMARY OF HUMAN HEALTH COPCS
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Site-wide Groundwater
VOC	1,1,2-Trichloroethane	79-00-5	Yes
VOC	1,1-Dichloroethene	75-35-4	Yes
VOC	1,2,4-Trichlorobenzene	120-82-1	Yes
VOC	1,2-Dichloroethane	107-06-2	Yes
VOC	1,3-Dichlorobenzene	541-73-1	Yes
VOC	1,4-Dichlorobenzene	106-46-7	Yes
VOC	Bromodichloromethane	75-27-4	Yes
VOC	Chlorobenzene	108-90-7	Yes
VOC	cis-1,2-Dichloroethylene	156-59-2	Yes
VOC	Tetrachloroethylene	127-18-4	Yes
VOC	trans-1,2-Dichloroethylene	156-60-5	Yes
VOC	Trichloroethylene	79-01-6	Yes
VOC	Vinyl chloride	75-01-4	Yes

Abbreviations:
COPC -- Constituent of potential concern

VOC -- Volatile organic compound

* 1,3-dichlorobenzene is listed as a COPC because screening levels are not available for comparison.

TABLE 3.1
EXPOSURE POINT CONCENTRATION SUMMARY FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

T or D	COPC Group	COPC	CASRN	Medium-Specific COPC	Maximum Detected Concentration (ug/L)	95% UCL (ug/L)	95% UCL Method	ProUCL Notes	Sample Count	Detect Count	Detection Frequency (%)	Exposure Point Concentration (EPC)		
												Value (ug/L)	Statistic	Rationale
T	VOC	1,1,2-Trichloroethane	79-00-5	Yes	1.6	0.695	95% KM (t) UCL	b, e	26	2	8	0.695	UCL	Lower of the UCL and maximum
T	VOC	1,1-Dichloroethene	75-35-4	Yes	400	56.8	95% KM (t) UCL		26	6	23	56.8	UCL	Lower of the UCL and maximum
T	VOC	1,2,4-Trichlorobenzene	120-82-1	Yes	4.1	1.215	95% KM (t) UCL		26	4	15	1.215	UCL	Lower of the UCL and maximum
T	VOC	1,2-Dichloroethane	107-06-2	Yes	0.8	0.547	95% KM (t) UCL	b, e	26	2	8	0.547	UCL	Lower of the UCL and maximum
T	VOC	1,3-Dichlorobenzene	541-73-1	Yes	0.74	0.541	95% KM (t) UCL	f	26	3	12	0.541	UCL	Lower of the UCL and maximum
T	VOC	1,4-Dichlorobenzene	106-46-7	Yes	2.8	0.884	95% KM (t) UCL		26	5	19	0.884	UCL	Lower of the UCL and maximum
T	VOC	Bromodichloromethane	75-27-4	Yes	3	1.142	95% KM (Chebyshev) UCL	e	26	2	8	1.142	UCL	Lower of the UCL and maximum
T	VOC	Chlorobenzene	108-90-7	Yes	48	8	95% KM (t) UCL		26	5	19	8	UCL	Lower of the UCL and maximum
T	VOC	cis-1,2-Dichloroethylene	156-59-2	Yes	160,000	71,118	99% KM (Chebyshev) UCL		26	24	92	71,118	UCL	Lower of the UCL and maximum
T	VOC	Tetrachloroethylene	127-18-4	Yes	92,000	40,294	99% Chebyshev (Mean, Sd) UCL		26	26	100	40,294	UCL	Lower of the UCL and maximum
T	VOC	trans-1,2-Dichloroethylene	156-60-5	Yes	2,300	1,502	99% KM (Chebyshev) UCL		26	16	62	1,502	UCL	Lower of the UCL and maximum
T	VOC	Trichloroethylene	79-01-6	Yes	29,000	12,672	99% KM (Chebyshev) UCL		26	22	85	12,672	UCL	Lower of the UCL and maximum
	VOC	Vinyl chloride	75-01-4	Yes	38000	18727	99% KM (Chebyshev) UCL		26	16	62	18,727	UCL	Lower of the UCL and maximum

Notes:

These EPCs for groundwater will be used in the future resident, current/future worker and future construction worker scenarios. Only unfiltered (total) groundwater data are evaluated.
The exposure point concentration (EPC) is the 95% upper confidence limit (UCL) of the arithmetic mean. When the UCL is greater than the maximum detected concentration or ProUCL did not calculate an UCL, the maximum detected concentration is chosen.
The most appropriate UCL is chosen from those ProUCL suggests based on the distribution of the databset and ProUCL guidance. ProUCL outputs are provided in Attachmen

Abbreviations:

COPC -- Constituent of potential concern
EPC -- Exposure point concentration
Qual -- Qualifier
NA -- Not analyzed or applicable
ND -- Not detected
UCL -- 95% Upper confidence limit

References:

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ProUCL Notes and Warnings:

b One or more recommended UCL not available.
e Data set has only 2 Detected Values.
f Data set has only 3 Detected Values.

TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS FOR GROUNDWATER
REASONABLE MAXIMUM EXPOSURE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale / Reference	Intake Equation / Model Name
Ingestion	Construction Worker	Adult	Groundwater Excavation (Incidental Ingestion)	AT	Averaging Time-cancer	25550	days	USEPA 2011	Intake (mg/kg-day) = (CW x IR x CF x EF x ED) / (BW x AT)
				AT	Averaging Time-noncancer	365	days	USEPA 2011	
				BW	Body Weight	80	kg	USEPA 2014	
				CF	Conversion Factor	0.001	mg/µg	--	
				CW	Chemical Concentration in Water	EPC	µg/L	--	
				ED	Exposure Duration	1	years	USEPA 2014	
				EF	Exposure Frequency	250	days/yr	USEPA 2011	
				IR	Ingestion Rate	0.02	L/day	VADEQ 2016	
	Worker	Adult	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	Intake (mg/kg-day) = (CW x IR x CF x EF x ED) / (BW x AT)
				AT	Averaging Time-noncancer	9125	days	USEPA 2011	
				BW	Body Weight	80	kg	USEPA 2014	
				CF	Conversion Factor	0.001	mg/µg	--	
				CW	Chemical Concentration in Water	EPC	µg/L	--	
				ED	Exposure Duration	25	years	USEPA 2014	
				EF	Exposure Frequency	250	days/yr	USEPA 2011	
				IR	Ingestion Rate	1.25	L/day	USEPA 2014 FAQs	
	Resident	Adult	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	For noncancer, Intake (mg/kg-day) = (CW x IR x CF x EF x ED) / (BW x AT), separately for adult and child using IR-adult or IR-child.
				AT	Averaging Time-noncancer	7300	days	USEPA 2011	
				BW	Body Weight	80	kg	USEPA 2014	
				CF	Conversion Factor	0.001	mg/µg	--	For cancer, the ingestion rate was calculated for an adult (birth - 26 yrs), adjusting for age-specific exposure factors, where IR-Adj = ∑ (ED * IR) / BW. Intake (mg/kg-day) = (CW x (IR-Adj-adult + IR-Adj-child) x CF x EF) / AT
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	
				ED	Exposure Duration	20	years	USEPA 2014	
				EF	Exposure Frequency	350	days/yr	USEPA 2011	
				IR-adult	Ingestion Rate	2.5	L/day	USEPA 2014	
				IR-Adj-adult	Ingestion Rate Age-Adjusted	0.7	L-yr/day-kg	Calculated - Table 4.Supp.1	For MMOA cancer, the IR-Adj was weighted for each age bin using Age-Dependent Adjustment Factors (ADAFs), where 0-<2 yrs applied an ADAF of 10, 2-<6 yrs applied an ADAF of 3, 6-<16 yrs applied an ADAF of 3, and 16-26 yrs applied and ADAF of 1.
				IR-Adj-6-16	Ingestion Rate Age-Adjusted MMOA 6-<16	1.1	L-yr/day-kg	Calculated - Table 4.Supp.2	
				IR-Adj-16-26	Ingestion Rate Age-Adjusted MMOA 16-<26	0.33	L-yr/day-kg	Calculated - Table 4.Supp.2	
				CAFo	TCE Cancer Adjustment Factor-oral	0.804	unitless	USEPA RSL Eqns/User's Guide	
				MAFo	TCE Mutagen Adjustment Factor-oral	0.202	unitless	USEPA RSL Eqns/User's Guide	
		Child (0-6 years)	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	For TCE cancer, the intake (mg/kg-day) = (CW x [CAF x (IR-Adj-adult + IR-Adj-child) + MAF x (IR-Adj-0-2 + IR-Adj-2-6 + IR-Adj-6-16 + IR-Adj-16-26)] x EF x CF) / AT. Adult intake equation is aggregate of child and adult age ranges.
				AT	Averaging Time-noncancer	2190	days	USEPA 2011	
				BW	Body Weight	15	kg	USEPA 2014	
				CF	Conversion Factor	0.001	mg/µg	--	
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	
				ED	Exposure Duration	6	years	USEPA 2014	For VC cancer, the intake (mg/kg-day) = CW x CF x [(EF x (IR-Adj-adult + IR-Adj-child) / AT) + (IR-child / BW-child)]
				EF	Exposure Frequency	350	days/yr	USEPA 2011	
				IR-child	Ingestion Rate	0.78	L/day	USEPA 2014	
				IR-Adj-child	Ingestion Rate Age-Adjusted	0.42	L-yr/day-kg	Calculated - Table 4.Supp.1	
				IR-Adj-0-2	Ingestion Rate Age-Adjusted MMOA 0-<2	2.1	L-yr/day-kg	Calculated - Table 4.Supp.2	Blood lead in children will be evaluated using the EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model.
				IR-Adj-2-6	Ingestion Rate Age-Adjusted MMOA 2-<6	0.65	L-yr/day-kg	Calculated - Table 4.Supp.2	
Dermal	Construction Worker	Adult	Groundwater Excavation	AT	Averaging Time-cancer	25550	days	USEPA 2011	Dermally Absorbed Dose (mg/kg-day) = (DA-event x EV x SA x EF x ED) / (BW x AT)
				AT	Averaging Time-noncancer	365	days	USEPA 2011	
				B	Ratio of permeability coefficent of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	Chemical-specific	--	USEPA 2004	where for organic compounds, if t-event ≤ t*: DA-event (mg/cm^2-event) = 2 x FA x Kp x Cw x (sqrt((6 x τevent x tevent) / (π))) x CF1 x CF2, where CF1 = 0.001 mg/ug and CF2 = 0.001 L/cm^3
				BW	Body Weight	80	kg	USEPA 2014	
				CW	Chemical Concentration in Water	EPC	µg/L	--	
				DA-event	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	
				t-event	Event Time	4	hr/event	VADEQ 2016	OR if tevent>t*: DAevent (mg/cm^2-event) = FA x Kp x CW x (tevent/(1+B) + 2 x τevent x ((1 + 3B + 3B^2)/(1+B)^2)) x CF1 x CF2
				EV	Event Frequency	1	events/day	USEPA 2004	
				EF	Exposure Frequency	250	days/year	USEPA 2011	
				ED	Exposure Duration	1	years	USEPA 2014	
				FA	Fraction Absorbed Water	Chemical-specific	--	USEPA 2004	
				Kp	Permeability Constant	Chemical-specific	cm/hr	USEPA 2004	where for inorganic compounds, DA-event (mg/cm^2-event) = Kp x CW x tevent x CF1 x CF2
				SA	Skin Surface Area Available for Contact	3527	cm^2	USEPA 2014	
				tau-event	Lag time per event	Chemical-specific	hr/event	USEPA 2004	

TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS FOR GROUNDWATER
REASONABLE MAXIMUM EXPOSURE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale / Reference	Intake Equation / Model Name
Dermal	Worker	Adult	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	Dermally Absorbed Dose (mg/kg-day) =
				AT	Averaging Time-noncancer	9125	days	USEPA 2011	(DA-event x EV x SA x EF x ED) / (BW x AT)
				B	Ratio of permeability coefficent of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	Chemical-specific	--	USEPA 2004	where for organic compounds, if t-event ≤ t*: DA-event (mg/cm^2-event) =
				BW	Body Weight	80	kg	USEPA 2014	2 x FA x Kp x Cw x (sqrt((6 x τevent x tevent) / (π))) x CF1 x CF2, where CF1 =
				CW	Chemical Concentration in Water	EPC	µg/L	--	0.001 mg/ug and CF2 = 0.001 L/cm^3
				DA-event	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	
				t-event	Event Time	1	hr/event	Professional judgment	OR if tevent>t*: DAevent (mg/cm^2-event) =
				EV	Event Frequency	1	events/day	USEPA 2004	FA x Kp x CW x (tevent/(1+B) + 2 x τevent x ((1 + 3B + 3B^2)/(1+B)^2)) x CF1 x
				EF	Exposure Frequency	250	days/yr	USUSEPA 2014	CF2
				ED	Exposure Duration	25	years	USEPA 2014	
				FA	Fraction Absorbed Water	Chemical-specific	--	USEPA 2004	
				Kp	Permeability Constant	Chemical-specific	cm/hr	USEPA 2004	where for inorganic compounds,
				SA	Skin Surface Area Available for Contact	3527	cm^2	USEPA 2014	DA-event (mg/cm^2-event) =
				tau-event	Lag time per event	Chemical-specific	hr/event	USEPA 2004	Kp x CW x tevent x CF1 x CF2
	Resident	Adult	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	For noncancer, Dermally Absorbed Dose (DAD) (mg/kg-day) =
				AT	Averaging Time-noncancer	7300	days	USEPA 2011	(DA-event x EV x SA x EF x ED) / (BW x AT). Separate calculations are performed for adult and child using SA-adult or SA-child.
				B	Ratio of permeability coefficent of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	Chemical-specific	--	USEPA 2004	where for organic compounds,
				BW	Body Weight	80	kg	USEPA 2014	if t-event ≤ t*: DA-event (mg/cm^2-event) =
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	2 x FA x Kp x Cw x (sqrt((6 x τevent x tevent) / (π))) x CF1 x CF2, where CF1 =
				DA-event-adult	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated - Table 4.Supp.3	0.001 mg/ug and CF2 = 0.001 L/cm^3
				t-event	Event Time	0.71	hr/event	USEPA 2014	
				EV	Event Frequency	1	events/day	USEPA 2004	OR if tevent>t*: DAevent (mg/cm2-event) =
				EF	Exposure Frequency	350	days/year	USEPA 2011	FA x Kp x CW x (tevent/(1+B) + 2 x τevent x ((1 + 3B + 3B^2)/(1+B)^2)) x CF1 x
				ED	Exposure Duration	20	years	USEPA 2014	CF2
				FA	Fraction Absorbed Water	Chemical-specific	--	USEPA 2004	
				Kp	Permeability Constant	Chemical-specific	cm/hr	USEPA 2004	where for inorganic compounds,
				SA-adult	Skin Surface Area Available for Contact	19652	cm^2	USEPA 2014 - See Notes	DA-event (mg/cm^2-event) =
				SA-Adj-adult	Skin Surface Area Age-Adjusted	5508	cm^2-yr/kg	Calculated - Table 4.Supp.1	Kp x CW x tevent x CF1 x CF2
				SA-Adj-6-16	Skin Surface Area Age-Adjusted MMOA 6-<16	9293	cm^2-yr/kg	Calculated - Table 4.Supp.2	
				SA-Adj-16-26	Skin Surface Area Age-Adjusted MMOA 16-<26	2410	cm^2-yr/kg	Calculated - Table 4.Supp.2	For cancer, the DAD was calculated for an adult
				tau-event	Lag time per event	Chemical-specific	hr/event	USEPA 2004	(birth - 26 yrs), adjusting for age-specific exposure factors,
				CAFo	TCE Cancer Adjustment Factor-oral	0.804	unitless	USEPA RSL Eqns/User's Guide	where SA-Adj = ∑ (ED * SA) / BW.
				MAFo	TCE Mutagen Adjustment Factor-oral	0.202	unitless	USEPA RSL Eqns/User's Guide	(DAD) (mg/kg-day) = ((DA-event-adult x SA-Adj-adult + DA-event-child x SA-Adj-
		Child (0-6 years)	Tap Water	AT	Averaging Time-cancer	25550	days	USEPA 2011	child) x EV x EF) / AT
				AT	Averaging Time-noncancer	2190	days	USEPA 2011	
				B	Ratio of permeability coefficent of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	Chemical-specific	--	USEPA 2004	For MMOA cancer, the IR-Adj was weighted for each age bin using ADAFs, where 0-<2 yrs applied an ADAF of 10, 2-<6 yrs applied an ADAF of 3, 6-<16 yrs applied an ADAF of 3, and 6-26 yrs applied and ADAF of 1.
				BW	Body Weight	15	kg	USEPA 2014	
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	
				DA-event-child	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated - Table 4.Supp.3	For TCE cancer, the DAD (mg/kg-day) =
				t-event	Event Time	0.54	hr/event	USEPA 2014	([CAFo x (DA-event-adult x SA-Adj-adult + DA-event-child x SA-Adj-child) + MAFo
				EV	Event Frequency	1	events/day	USEPA 2004	x (DA-event-adult x (SA-Adj-6-16 + SA-Adj-16-26) + DA-event-child x (SA-Adj-0-2
				EF	Exposure Frequency	350	days/year	USEPA 2011	+ SA-Adj-2-6))] x EV x EF) / AT
				ED	Exposure Duration	6	years	USEPA 2014	Adult intake equation is aggregate of child and adult age ranges.
				FA	Fraction Absorbed Water	Chemical-specific	--	USEPA 2004	
				Kp	Permeability Constant	Chemical-specific	cm/hr	USEPA 2004	For VC cancer, the DAD (mg/kg-day) =
				SA-child	Skin Surface Area Available for Contact	6365	cm^2	USEPA 2014 - See Notes	(EV x EF x (DA-event-adult x SA-Adj-adult + DA-event-child x SA-Adj-child) / AT)
				SA-Adj-child	Skin Surface Area Age-Adjusted	2649	cm^2-yr/kg	Calculated - Table 4.Supp.1	+ (DA-event-child x (EV x SA-child / BW-child))
				SA-Adj-0-2	Skin Surface Area Age-Adjusted MMOA 0-<2	9814	cm^2-yr/kg	Calculated - Table 4.Supp.2	
				SA-Adj-2-6	Skin Surface Area Age-Adjusted MMOA 2-<6	5004	cm^2-yr/kg	Calculated - Table 4.Supp.2	
				tau-event	Lag time per event	Chemical-specific	hr/event	USEPA 2004	

TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS FOR GROUNDWATER
REASONABLE MAXIMUM EXPOSURE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale / Reference	Intake Equation / Model Name
Inhalation	Construction Worker	Adult	Groundwater Excavation	AT	Averaging Time-cancer	25550	days	USEPA 2011	Exposure Concentration (mg/m^3) = (CA x ET x ED x EF x CF) / AT CA calculated using VADEQ's groundwater in trench calculator, which is described further in the calculator.
				AT	Averaging Time-noncancer	365	days	USEPA 2011	
				CW	Chemical Concentration in Water	EPC	µg/L	--	
				CA	Chemical Concentration in Air	Calculated	mg/m^3	--	
				CF	Conversion Factor	0.042	day/hr	--	
				ET	Exposure Time	4	hr/day	VADEQ 2016	
				EF	Exposure Frequency	250	days/year	USEPA 2011	
				ED	Exposure Duration	1	years	USEPA 2014	
	Resident	Adult	Water Vapors in Bathroom Air	AT	Averaging Time-cancer	25550	days	USEPA 2011	The Andelman shower model as modified by Schaum et al. calculates chemical concentrations in air using chemical concentrations in water; the model is applied to VOCs only. For noncancer, Exposure Concentration (EC) (mg/m^3) = (CA x ET x ED x EF x CF) / AT, separately for adult and child using CA-adult or CA-child. For cancer, EC (mg/m^3) = ((CA-adult x ET-adult x ED-adult + CA-child x ET-child x ED-child) x EF x CF) / AT For MMOA cancer, EC (mg/m^3) = ((CA-adult x ET-adult + CA-child x ET-child) x (ED-0-2 x 10 + ED-2-6 x 3 + ED-6-16 x 3 + ED-16-26 x 1) x EF x CF) / AT For TCE cancer, the EC (mg/m3) = ((CA-adult x ET-adult + CA-child x ET-child) x [CAFi x ED-adj + MAF x (ED-0-2 x 10 + ED-2-6 x 3 + ED-6-16 x 3 + ED-16-26 x 1)] x EF x CF) / AT Adult intake equation is aggregate of child and adult age ranges. For VC cancer, EC (mg/m^3) = ((CA-adult x ET-adult x ED-adult x EF x CF / AT x Toxicity-adult of 4.4E-06 ug/m^3 x 1000) + (CA-child x ET-child x ED-child x EF x CF / AT x Toxicity-child of 8.8E-06 ug/m^3 x 1000)
				AT	Averaging Time-noncancer	7300	days	USEPA 2011	
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	
				CA-adult	Chemical Concentration in Air from Shower	Calculated	mg/m^3	Calculated - Table 4.Supp.4	
				CF	Conversion Factor	0.042	day/hr	1 day / 24 hours	
				ET	Exposure Time	0.71	hr/day	USEPA 2014	
				EF	Exposure Frequency	350	days/year	USEPA 2011	
				ED	Exposure Duration	20	years	USEPA 2014	
				ED-adj	TCE Exposure Duration-cancer aggregate	26	years	USEPA 2011	
				CAFi	TCE Cancer Adjustment Factor-inhalation	0.756	unitless	USEPA RSL Eqns/User's Guide	
				MAFi	TCE Mutagen Adjustment Factor-inhalation	0.244	unitless	USEPA RSL Eqns/User's Guide	
		Child (0-6 years)	Water Vapors in Bathroom Air	AT	Averaging Time-cancer	25550	days	USEPA 2011	
				AT	Averaging Time-noncancer	2190	days	USEPA 2011	
				CW	Chemical Concentration in Water	EPC	µg/L	Calculated - Table 3.1	
				CA-child	Chemical Concentration in Air from Shower	Calculated	mg/m^3	Calculated - Table 4.Supp.4	
				CF	Conversion Factor	0.042	day/hr	1 day / 24 hours	
				ET	Exposure Time	0.54	hr/day	USEPA 2014	
				EF	Exposure Frequency	350	days/year	USEPA 2011	
				ED	Exposure Duration	6	years	USEPA 2014	

Notes:
Intake equations are derived from USEPA's RSL equations and also taken from USEPA's Risk Assessment Guidance for Superfund (RAGS).
The skin surface area available for contact is the weighted average of mean values for males and females combined for total surface area, which includes the head, trunk, arms, hands, legs and feet (USEPA 2014).

Abbreviations:
Adj -- Adjusted to include both adult and child exposure factors
DAD -- Dermally absorbed dose
EC -- Exposure concentration
EPC -- Exposure point concentration
RSL -- USEPA Regional Screening Level
TCE -- Trichloroethene
USEPA -- United States Environmental Protection Agency

References:

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TABLE 4.SUPP.1
CALCULATION OF AGE-ADJUSTED EXPOSURE FACTORS FOR A RESIDENT
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

AGE	Exposure Duration	Body Weight (1)	Intake Rate	Dermal Surface Area	Age-Adjusted Exposure Factors: AGE GROUP	Intake Rate	Dermal Surface Area
			Tap Water IR-W (2)	Tap Water SA (3)		IR-W-Adj	SA-W-Adj
year	years	kg	L/day	cm^2		L-yr/day-kg	cm^2-yr/kg
Birth to 1 month	0.083	4.8	0.839	2,900			
1 to <3 months	0.17	5.9	0.896	3,300			
3 to 6 < months	0.25	7.4	1.06	3,800			
6 to <12 months	0.5	9.2	1.06	4,500			
1 to < 2 yrs	1	11.4	0.837	5,300			
2 to <3 yrs	1	13.8	0.877	6,100			
3 to < 6 yrs	3	18.6	0.959	7,600	0-<6 yrs	0.42	2,649
6 to <11 yrs	5	31.8	1.32	10,800			
11 to <16 yrs	5	56.8	1.82	15,900			
16 to <18 yrs	2	71.6	1.78	18,400			
18 to < 21 yrs	3	71.6	2.37	18,400			
21 to < 26 yrs	5	80	2.96	18,000	6-<26 yrs	0.7	5,508

Equations:

IR-W-Adj (L-yr/day-kg) = $\sum$ (ED * IR-W / BW)
SA-W-Adj (cm^2-yr/kg) = $\sum$ (ED * SA-W / BW)

Note:

USEPA Risk Assessment Guidance for Superfund (RAGS) Part A recommends applying 95th or 90th percentile values for ingestion rate and exposure duration and applying the mean values for surface area and body weight (Exhibit 6-13 and Section 6.6.1).

Abbreviations:

BW -- Body weight
ED -- Exposure duration
ET -- Event time

References:

(1) USEPA. 2011. Exposure Factors Handbook. Table 8-1 - Recommended Values for Body Weight. Mean. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252

(2) USEPA. 2011. Exposure Factors Handbook. Table 3-1 - Recommended Values for Drinking Water Ingestion Rates. 95th Percentile, L/day. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252

(3) USEPA. 2011. Exposure Factors Handbook. Table 7-1 - Recommended Values for Total Body Surface Area. Mean value. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252

TABLE 4.SUPP.2
CALCULATION OF AGE-ADJUSTED EXPOSURE FACTORS FOR COPCS MUTAGENIC MODE OF ACTION FOR A RESIDENT
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

AGE	Exposure Duration	Body Weight (1)	Intake Rate	Dermal Surface Area	Age-Adjusted Exposure Factors			
			Tap Water IR-W (2)	Tap Water SA (3)	AGE GROUP	ADAF (4)	Intake Rate IR-W-Adj	Dermal Surface Area SA-W-Adj
year	years	kg	L/day	cm^2			L-yr/day-kg	cm^2-yr/kg
Birth to 1 month	0.083	4.8	0.839	2,900				
1 to <3 months	0.17	5.9	0.896	3,300				
3 to 6 < months	0.25	7.4	1.06	3,800				
6 to <12 months	0.5	9.2	1.06	4,500				
1 to < 2 yrs	1	11.4	0.837	5,300	0-<2 yrs	10	2.1	9,814
2 to <3 yrs	1	13.8	0.877	6,100				
3 to < 6 yrs	3	18.6	0.959	7,600	2-<6 yrs	3	0.65	5,004
6 to <11 yrs	5	31.8	1.32	10,800				
11 to <16 yrs	5	56.8	1.82	15,900	6-<16 yrs	3	1.1	9,293
16 to <18 yrs	2	71.6	1.78	18,400				
18 to < 21 yrs	3	71.6	2.37	18,400				
21 to < 26 yrs	5	80	2.96	18,000	16-<26 yrs	1	0.33	2,410

Equations:

IR-W-Adj (L-yr/day-kg) = $\sum$ (ED * IR-W / BW)
SA-W-Adj (cm^2-yr/kg) = $\sum$ (ED * SA-W / BW)

Note:

USEPA Risk Assessment Guidance for Superfund (RAGS) Part A recommends applying 95th or 90th percentile values for ingestion rate and exposure duration and applying the mean values for surface area and body weight (Exhibit 6-13 and Section 6.6.1).

Abbreviations:
ADAF -- Age-Dependent Adjustment Factor
BW -- Body weight
ED -- Exposure duration
ET -- Event time

References:
(1) USEPA. 2011. Exposure Factors Handbook. Table 8-1 - Recommended Values for Body Weight. Mean. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252
(2) USEPA. 2011. Exposure Factors Handbook. Table 3-1 - Recommended Values for Drinking Water Ingestion Rates. 95th Percentile, L/day. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252
(3) USEPA. 2011. Exposure Factors Handbook. Table 7-1 - Recommended Values for Total Body Surface Area. Mean value. September. Available online: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252
(4) USEPA. 2005. Supplemental Guidance for Assessing Susceptibility from Early Life Exposure to Carcinogens. EPA/630/R-03/003F. March. Available online: http://www.epa.gov/ttnatw01/childrens_supplement_final.pdf

TABLE 4.SUPP.3
CALCULATION OF DA-EVENT FOR DERMAL EXPOSURE TO GROUNDWATER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	Casrn	EPC (1)	Permeability Coefficient	Ratio of Permeability Coefficients	Lag Time	Time to Reach Steady State	Fraction Absorbed	Duration of Event (t-event)				DA-event							
									Construction Worker	Worker	Resident Adult	Resident Child (0-6 yrs)	Construction Worker		Worker		Resident Adult		Resident Child (0-6 yrs)	
			Cw	K_p	B	τ_{event}	t*	FA												
			ug/L	cm/hr	unitless	hr/event	hr	unitless	hr/event	hr/event	hr/event	hr/event	mg/cm2-event	Eqn	mg/cm2-event	Eqn	mg/cm2-event	Eqn	mg/cm2-event	Eqn
VOC	1,1,2-Trichloroethane	79-00-5	0.695	0.0050	0.022	0.59	1.4	1	4	1	0.71	0.54	1.8E-08	3	7.4E-09	2	6.3E-09	2	5.5E-09	2
VOC	1,1-Dichloroethene	75-35-4	56.8	0.012	0.044	0.37	0.88	1	4	1	0.71	0.54	3.1E-06	3	1.1E-06	3	9.4E-07	2	8.2E-07	2
VOC	1,2,4-Trichlorobenzene	120-82-1	1.215	0.071	0.37	1.1	2.6	1	4	1	0.71	0.54	5.0E-07	3	2.5E-07	2	2.1E-07	2	1.8E-07	2
VOC	1,2-Dichloroethane	107-06-2	0.547	0.0042	0.016	0.38	0.90	1	4	1	0.71	0.54	1.1E-08	3	4.0E-09	3	3.3E-09	2	2.9E-09	2
VOC	1,3-Dichlorobenzene	541-73-1	0.541	NA	NA	NA	NA	1	4	1	0.71	0.54								
VOC	1,4-Dichlorobenzene	106-46-7	0.884	0.045	0.21	0.7	1.7	1	4	1	0.71	0.54	2.0E-07	3	9.3E-08	2	7.8E-08	2	6.8E-08	2
VOC	Bromodichloromethane	75-27-4	1.142	0.0040	0.020	0.87	2.1	1	4	1	0.71	0.54	2.6E-08	3	1.2E-08	2	1.0E-08	2	8.7E-09	2
VOC	Chlorobenzene	108-90-7	7.994	0.028	0.12	0.45	1.1	1	4	1	0.71	0.54	1.0E-06	3	4.2E-07	2	3.5E-07	2	3.1E-07	2
VOC	cis-1,2-Dichloroethylene	156-59-2	71118	0.011	0.042	0.37	0.88	1	4	1	0.71	0.54	3.6E-03	3	1.3E-03	3	1.1E-03	2	9.6E-04	2
VOC	Tetrachloroethylene	127-18-4	40294	0.033	0.17	0.89	2.14	1	4	1	0.71	0.54	7.4E-03	3	3.5E-03	2	3.0E-03	2	2.6E-03	2
VOC	trans-1,2-Dichloroethylene	156-60-5	1502	0.011	0.042	0.37	0.88	1	4	1	0.71	0.54	7.6E-05	3	2.8E-05	3	2.3E-05	2	2.0E-05	2
VOC	Trichloroethylene	79-01-6	12672	0.012	0.051	0.57	1.4	1	4	1	0.71	0.54	7.4E-04	3	3.1E-04	2	2.6E-04	2	2.3E-04	2
VOC	Vinyl chloride	75-01-4	18727	0.0084	0.025	0.24	0.57	1	4	1	0.71	0.54	6.9E-04	3	2.3E-04	3	1.8E-04	3	1.5E-04	2

Equations:

Inorganics: DAevent (mg/cm^2-event) =

(Eq 1) DA_{event} =

Kp x CW x tevent x CF1 x CF2

where CF1 = 0.001 mg/ug and CF2 = 0.001 L/cm3

Organics: DA_{event} (mg/cm^2-event) =

(Eq 2) $t_{event} \leq t^*$: DA_{event} (mg/cm^2-event) =

$2 \times FA \times K_p \times C_w \times (\sqrt{((6 \times \tau_{event} \times t_{event}) / (\pi))}) \times CF1 \times CF2$

(Eq 3) $t_{event} > t^*$: DA_{event} (mg/cm^2-event) =

$FA \times K_p \times C_W \times (t_{event}/(1+B) + 2 \times \tau_{event} \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF1 \times CF2$

Note:
(1) The EPC is the lower of the 95% upper confidence limit and maximum detected concentration. See Table 3s.
The dermal parameters were taken from the chemical parameter table of the USEPA June 2017 RSL tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017) and equations from RAGS Part E.

Abbreviations:
CF1 -- Conversion Factor 1 (0.001 mg/ug)
CF2 -- Conversion Factor 2 (0.001 L/cm^3)
Cw -- Groundwater or surface water concentration
VOC -- Volatile organic compound

Reference:
USEPA. 2004. Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment. Final. USEPA/540/R/99/005. July. Available online: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e
USEPA. 2017. Regional Screening Levels Generic Tables. June. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls

TABLE 4.SUPP.4
BATHROOM AIR CONCENTRATIONS FROM EXPOSURE TO TAPWATER FOR A RESIDENT USING GROUNDWATER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	EPC (1)	Adult		Child (0-6 years)	
			CW	$C_{a\text{-}max}$	C_a	C_{amax}	C_a
			mg/L	mg/m^3	mg/m^3	mg/m^3	mg/m^3
VOC	1,1,2-Trichloroethane	79-00-5	0.0007	0.014	0.012	0.019	0.013
VOC	1,1-Dichloroethene	75-35-4	0.05680	1.183	0.975	1.562	1.085
VOC	1,2,4-Trichlorobenzene	120-82-1	0.001215	0.025	0.021	0.033	0.023
VOC	1,2-Dichloroethane	107-06-2	0.00055	0.011	0.009	0.015	0.010
VOC	1,3-Dichlorobenzene	541-73-1	0.0005	0.011	0.009	0.015	0.010
VOC	1,4-Dichlorobenzene	106-46-7	0.00088	0.018	0.015	0.024	0.017
VOC	Bromodichloromethane	75-27-4	0.0011	0.024	0.020	0.031	0.022
VOC	Chlorobenzene	108-90-7	0.00799	0.167	0.137	0.220	0.153
VOC	cis-1,2-Dichloroethylene	156-59-2	71.1180	1481.625	1220.776	1955.745	1358.156
VOC	Tetrachloroethylene	127-18-4	40.2940	839.458	691.666	1108.085	769.503
VOC	trans-1,2-Dichloroethylene	156-60-5	1.50200	31.292	25.783	41.305	28.684
VOC	Trichloroethylene	79-01-6	12.6720	264.000	217.521	348.480	242.000
VOC	Vinyl chloride	75-01-4	18.727	390.15	321.46	514.993	357.634

Variables	Units	Exposure Assumptions
C_a = concentration of chemical in air	mg/m^3	Solved by Eq 1
C_{amax} = maximum concentration of chemical in air	mg/m^3	Solved by Eq 2
t_1 = Adult time in shower	hr	0.25
t_1 = Child time in shower	hr	0.33
t_2 = Adult time in bathroom after shower	hr	0.46
t_2 = Child time in bathroom after shower	hr	0.21
f = fraction volatilized for chemical	unitless	0.5
F_w = shower water flow rate	L/hr	1000
V_a = bathroom volume	m^3	6

Equation 1:	C_a =	$((C_{amax}/2) * t_1 + C_{amax} * t_2) / (t_1 + t_2)$
Equation 2:	C_{amax} =	$(C_w * f * F_w * t_1) / V_a$

Note:
(1) The EPC is the lower of the 95% UCL and maximum detected concentration - see Table 3s.
Conservative values for each exposure parameter, as presented in Schaum et al 1994, are applied for the calculations. The shower model air chemical concentrations are calculated for only VOCs.

Total exposure times for are 0.71 hr for an adult and 0.54 hr for a child (0-6 years). Professional judgement is used to split up the time spent in the shower versus in the bathroom after shower. An adult is assumed to spend approximately 15 minutes showering followed by 28 minutes in the bathroom, for a total of 43 minutes (0.71 hr). A child is assumed to spend approximately 20 minutes bathing followed by 13 minutes in the bathroom for a total of 32 minutes (0.54 hr).

Abbreviation:
CW -- Groundwater water concentration
EPC -- Exposure point concentration
VOC -- Volatile organic compound

Reference:
Wang, Rhoda G.M. et al. 1994. Water Consumption and Health: Integration of Exposure Assessment, Toxicology, and Risk Assessment. Wang. Macel Dekker, Inc., New York. Estimating Dermal and Inhalation Exposure to Volatile Chemicals in Domestic Water, Schaum et al., Pages 307-320.

TABLE 5.1
NONCANCER TOXICITY DATA -- ORAL/DERMAL
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Chronic / Subchronic	Oral Reference Dose (RfD)		GIABS	Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty / Modifying Factors	Source	Source Date
				Value	Units			Value	Units				
VOC	1,1,2-Trichloroethane	79-00-5	Chronic	0.004	mg/kg-day	1	100%	0.004	mg/kg-day	Lymphatic	1000 / 1	IRIS	9/26/1988
VOC	1,1-Dichloroethene	75-35-4	Chronic	0.05	mg/kg-day	1	100%	0.05	mg/kg-day	Hepatic	100 / 1	IRIS	8/13/2002
VOC	1,2,4-Trichlorobenzene	120-82-1	Chronic	0.01	mg/kg-day	1	100%	0.01	mg/kg-day	Endocrine	1000 / 1	IRIS	5/1/1992
VOC	1,2-Dichloroethane	107-06-2	Chronic	0.006	mg/kg-day	1	100%	0.006	mg/kg-day	Renal	10000	PPRTV Appendix	10/1/2010
VOC	1,3-Dichlorobenzene	541-73-1	NA			NA	NA			NA	NA	NA	NA
VOC	1,4-Dichlorobenzene	106-46-7	Subchronic	0.07	mg/kg-day	1	100%	0.07	mg/kg-day	Hepatic	100	ATSDR	7/1/2006
VOC	Bromodichloromethane	75-27-4	Chronic	0.02	mg/kg-day	1	100%	0.02	mg/kg-day	Renal	1000 / 1	IRIS	9/30/1987
VOC	Chlorobenzene	108-90-7	Subchronic	0.02	mg/kg-day	1	100%	0.02	mg/kg-day	Hepatic	1000	IRIS	7/1/1993
VOC	cis-1,2-Dichloroethylene	156-59-2	Chronic	0.002	mg/kg-day	1	100%	0.002	mg/kg-day	Renal	3000	IRIS	9/30/2010
VOC	Tetrachloroethylene	127-18-4	Chronic	0.006	mg/kg-day	1	100%	0.006	mg/kg-day	Nervous, Hepatic, Renal	1000	IRIS	2/10/2012
VOC	trans-1,2-Dichloroethylene	156-60-5	Subchronic	0.02	mg/kg-day	1	100%	0.02	mg/kg-day	Lymphatic	3000	IRIS	9/30/2010
VOC	Trichloroethylene	79-01-6	Chronic	0.0005	mg/kg-day	1	100%	0.0005	mg/kg-day	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	100,1000,10 multiple studies	IRIS	9/28/2011
VOC	Vinyl chloride	75-01-4	Chronic	0.003	mg/kg-day	1	100%	0.003	mg/kg-day	Hepatic	30	IRIS	8/7/2000

Note:
The oral RfDs are taken from the USEPA Regional Screening Levels (RSLs) table, which gathers toxicity reference values from multiple sources using an established hierarchy.
The absorbed RfD for dermal is calculated by the following equation: RfD-oral x GIABS.
USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%.

Abbreviations:
GIABS -- Gastrointestinal absorption factor
NA -- Not available
RfD -- Reference dose
RSLs -- EPA Regional Screening Levels
VOC -- Volatile organic compound

References:
ATSDR. 2017. Minimal Risk Levels (MRLs). June. Available online: http://www.atsdr.cdc.gov/mrls/index.asp
USEPA. 2017. Integrated Risk Information System (IRIS). Last Updated June 16. Available online: https://www.epa.gov/iris
USEPA. 2017. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). January. Available online: https://hhpprtv.ornl.gov/index.html
USEPA. 2017. Regional Screening Levels User's Guide. November. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls

TABLE 5.2
NONCANCER TOXICITY DATA -- INHALATION
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Chronic / Subchronic	Inhalation Reference Concentration (RfC)		Primary Target Organ(s)	Combined Uncertainty / Modifying Factors	Source	Source Date
				Value	Units				
VOC	1,1,2-Trichloroethane	79-00-5	Subchronic	0.0002	mg/m3	Hepatic	3000	PPRTV	4/1/2011
VOC	1,1-Dichloroethene	75-35-4	Chronic	0.2	mg/m3	Hepatic	30 / 1	IRIS	8/13/2002
VOC	1,2,4-Trichlorobenzene	120-82-1	Chronic	0.002	mg/m3	Endocrine	3000	PPRTV	6/16/2009
VOC	1,2-Dichloroethane	107-06-2	Chronic	0.007	mg/m3	Nervous	300	PPRTV	10/1/2010
VOC	1,3-Dichlorobenzene	541-73-1	NA			NA	NA	NA	NA
VOC	1,4-Dichlorobenzene	106-46-7	Subchronic	0.8	mg/m3	Hepatic	100 / 1	IRIS	11/1/1996
VOC	Bromodichloromethane	75-27-4							
VOC	Chlorobenzene	108-90-7	Chronic	0.05	mg/m3	Hepatic, Renal	1000	PPRTV	10/12/2006
VOC	cis-1,2-Dichloroethylene	156-59-2							
VOC	Tetrachloroethylene	127-18-4	Chronic	0.04	mg/m3	Nervous, Hepatic, Renal	1000	IRIS	2/10/2012
VOC	trans-1,2-Dichloroethylene	156-60-5							
VOC	Trichloroethylene	79-01-6	Chronic	0.002	mg/m3	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	100,10 multiple studies	IRIS	9/28/2011
VOC	Vinyl chloride	75-01-4	Chronic	0.1	mg/m3	Hepatic	30	IRIS	8/7/2000

Note:
The inhalation RfCs are taken from the USEPA Regional Screening Levels (RSLs) table, which gathers toxicity reference values from multiple sources using an established hierarchy.

Abbreviation:

NA -- Not available

RfC -- Reference concentration

RSLs -- EPA Regional Screening Levels

VOC -- Volatile organic compound

References:

USEPA. 2017. Integrated Risk Information System (IRIS). Last Updated June 16. Available online: https://www.epa.gov/iris
USEPA. 2017. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). January. Available online: https://hhpprtv.ornl.gov/index.html
USEPA. 2017. Regional Screening Levels User's Guide. November. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Mutagenic	Oral Slope Factor (CSFo)		GIABS	Oral Absorption Efficiency for Dermal	Absorbed CSFd for Dermal		Weight of Evidence / Cancer Guidelines Description	Source	Source Date
				Value	Units			Value	Units			
VOC	1,1,2-Trichloroethane	79-00-5	N	0.057	(mg/kg-day)-1	1	100%	0.057	(mg/kg-day)-1	C / Possible human carcinogen	IRIS	3/31/1987
VOC	1,1-Dichloroethene	75-35-4	N			1	100%			Data are inadequate for assessment	IRIS	8/13/2002
VOC	1,2,4-Trichlorobenzene	120-82-1	N	0.029	(mg/kg-day)-1	1	100%	0.029	(mg/kg-day)-1	D (IRIS) / Likely to be carcinogenic to humans (PPRTV)	PPRTV	6/16/2009
VOC	1,2-Dichloroethane	107-06-2	N	0.091	(mg/kg-day)-1	1	100%	0.091	(mg/kg-day)-1	B2 / Probable human carcinogen	IRIS	3/31/1987
VOC	1,3-Dichlorobenzene	541-73-1	NA			NA	NA			NA	NA	NA
VOC	1,4-Dichlorobenzene	106-46-7	N	0.0054	(mg/kg-day)-1	1	100%	0.0054	(mg/kg-day)-1	B2 / Probable human carcinogen	CAL EPA	2/1/1997
VOC	Bromodichloromethane	75-27-4	N	0.062	(mg/kg-day)-1	1	100%	0.062	(mg/kg-day)-1	B2 / Probable human carcinogen	IRIS	2/1/1993
VOC	Chlorobenzene	108-90-7	N			1	100%					
VOC	cis-1,2-Dichloroethylene	156-59-2	N			1	100%			Data are inadequate for assessment	IRIS	9/30/2010
VOC	Tetrachloroethylene	127-18-4	N	0.0021	(mg/kg-day)-1	1	100%	0.0021	(mg/kg-day)-1	Likely to be carcinogenic in humans	IRIS	2/10/2012
VOC	trans-1,2-Dichloroethylene	156-60-5	N			1	100%					
VOC	Trichloroethylene	79-01-6	Y	0.046	(mg/kg-day)-1	1	100%	0.046	(mg/kg-day)-1	Carcinogenic to humans	IRIS	9/28/2011
VOC	Vinyl chloride	75-01-4	Y	0.72	(mg/kg-day)-1	1	100%	0.72	(mg/kg-day)-1	Known/likely human carcinogen	IRIS	8/7/2000

Note:
The oral SFs are taken from the USEPA Regional Screening Levels (RSLs) table, which gathers toxicity reference values from multiple sources using an established hierarchy.
The absorbed SFd for dermal is calculated by the following equation: SF-oral / GIABS.
USEPA recommends that the oral SF should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%.

Abbreviations:
GIABS -- Gastrointestinal absorption factor
NA -- Not available
RSLs -- EPA Regional Screening Levels
SFd -- Dermal slope factor
SFo -- Oral cancer slope factor
VOC -- Volatile organic compound

References:
Cal EPA. 2016. Toxicity Criteria Database. Office of Environmental Health Hazard Assessment (OEHHA). Available online: http://oehha.ca.gov/chemicals
USEPA. 2017. Integrated Risk Information System (IRIS). Last Updated June 16. Available online: https://www.epa.gov/iris
USEPA. 2017. Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). January. Available online: https://hhpprtv.ornl.gov/index.html
USEPA. 2017. Regional Screening Levels User's Guide. November. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Mutagenic	Inhalation Unit Risk (IUR)		Weight of Evidence / Cancer Guidelines Description	Source	Source Date
				Value	Units			
VOC	1,1,2-Trichloroethane	79-00-5	N	0.000016	(ug/m3)-1	C / Possible human carcinogen	IRIS	3/31/1987
VOC	1,1-Dichloroethene	75-35-4	N			Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential	IRIS	8/13/2002
VOC	1,2,4-Trichlorobenzene	120-82-1	N					
VOC	1,2-Dichloroethane	107-06-2	N	0.000026	(ug/m3)-1	B2 / Probable human carcinogen	IRIS	3/31/1987
VOC	1,3-Dichlorobenzene	541-73-1	NA			NA	NA	NA
VOC	1,4-Dichlorobenzene	106-46-7	N	0.000011	(ug/m3)-1	B2 / Probable human carcinogen	CAL EPA	2/1/1997
VOC	Bromodichloromethane	75-27-4	N	0.000037	(ug/m3)-1	Carcinogenic - no class listed	CAL EPA	1/1/1990
VOC	Chlorobenzene	108-90-7	N					
VOC	cis-1,2-Dichloroethylene	156-59-2	N			Data are inadequate for assessment	IRIS	9/30/2010
VOC	Tetrachloroethylene	127-18-4	N	0.00000026	(ug/m3)-1	Likely to be carcinogenic in humans	IRIS	2/10/2012
VOC	trans-1,2-Dichloroethylene	156-60-5	N					
VOC	Trichloroethylene	79-01-6	Y	0.0000041	(ug/m3)-1	Carcinogenic to humans	IRIS	9/28/2011
VOC	Vinyl chloride	75-01-4	Y	0.0000044	(ug/m3)-1	Known/likely human carcinogen	IRIS	8/7/2000

Note:
The IURs are taken from the USEPA Regional Screening Levels (RSLs) table, which gathers toxicity reference values from multiple sources using an established hierarchy.

Abbreviation:
IUR -- Inhalation unit risk
NA -- Not available
RSLs -- EPA Regional Screening Levels
VOC -- Volatile organic compound

References:
Cal EPA. 2016. Toxicity Criteria Database. Office of Environmental Health Hazard Assessment (OEHHA). Available online: http://oehha.ca.gov/chemicals
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TABLE 7.1
CALCULATION OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A CONSTRUCTION WORKER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC Group	COPC	CASRN	EPC		Cancer Risk Calculations						Non-Cancer Hazard Calculations				
									Exposure Intake		CSF/IUR		Cancer Risk	Cancer Risk (One-Hit)	Exposure Intake		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	Value	Units			Value	Units	Value	Units	
Groundwater	Groundwater	Groundwater	Incidental Ingestion																
				VOC	1,1,2-Trichloroethane	79-00-5	7.0E-01	ug/L	1.7E-09	mg/kg-day	5.7E-02	(mg/kg-day)-1	9.7E-11	9.7E-11	1.2E-07	mg/kg-day	4.0E-03	mg/kg-day	3.0E-05
				VOC	1,1-Dichloroethene	75-35-4	5.7E+01	ug/L	1.4E-07	mg/kg-day					9.7E-06	mg/kg-day	5.0E-02	mg/kg-day	1.9E-04
				VOC	1,2,4-Trichlorobenzene	120-82-1	1.2E+00	ug/L	3.0E-09	mg/kg-day	2.9E-02	(mg/kg-day)-1	8.6E-11	8.6E-11	2.1E-07	mg/kg-day	1.0E-02	mg/kg-day	2.1E-05
				VOC	1,2-Dichloroethane	107-06-2	5.5E-01	ug/L	1.3E-09	mg/kg-day	9.1E-02	(mg/kg-day)-1	1.2E-10	1.2E-10	9.4E-08	mg/kg-day	6.0E-03	mg/kg-day	1.6E-05
				VOC	1,3-Dichlorobenzene	541-73-1	5.4E-01	ug/L	1.3E-09	mg/kg-day					9.3E-08	mg/kg-day			
				VOC	1,4-Dichlorobenzene	106-46-7	8.8E-01	ug/L	2.2E-09	mg/kg-day	5.4E-03	(mg/kg-day)-1	1.2E-11	1.2E-11	1.5E-07	mg/kg-day	7.0E-02	mg/kg-day	2.2E-06
				VOC	Bromodichloromethane	75-27-4	1.1E+00	ug/L	2.8E-09	mg/kg-day	6.2E-02	(mg/kg-day)-1	1.7E-10	1.7E-10	2.0E-07	mg/kg-day	2.0E-02	mg/kg-day	9.8E-06
				VOC	Chlorobenzene	108-90-7	8.0E+00	ug/L	2.0E-08	mg/kg-day					1.4E-06	mg/kg-day	2.0E-02	mg/kg-day	6.8E-05
				VOC	cis-1,2-Dichloroethylene	156-59-2	7.1E+04	ug/L	1.7E-04	mg/kg-day					1.2E-02	mg/kg-day	2.0E-03	mg/kg-day	6.1E+00
				VOC	Tetrachloroethylene	127-18-4	4.0E+04	ug/L	9.9E-05	mg/kg-day	2.1E-03	(mg/kg-day)-1	2.1E-07	2.1E-07	6.9E-03	mg/kg-day	6.0E-03	mg/kg-day	1.1E+00
				VOC	trans-1,2-Dichloroethylene	156-60-5	1.5E+03	ug/L	3.7E-06	mg/kg-day					2.6E-04	mg/kg-day	2.0E-02	mg/kg-day	1.3E-02
				VOC	Trichloroethylene	79-01-6	1.3E+04	ug/L	3.1E-05	mg/kg-day	4.6E-02	(mg/kg-day)-1	1.4E-06	1.4E-06	2.2E-03	mg/kg-day	5.0E-04	mg/kg-day	4.3E+00
				VOC	Vinyl chloride	75-01-4	1.9E+04	ug/L	4.6E-05	mg/kg-day	7.2E-01	(mg/kg-day)-1	3.3E-05	3.3E-05	3.2E-03	mg/kg-day	3.0E-03	mg/kg-day	1.1E+00
			Ingestion Total											**3.5E-05**					**1.3E+01**
Groundwater	Groundwater	Groundwater	Dermal																
				VOC	1,1,2-Trichloroethane	79-00-5	7.0E-01	ug/L	7.7E-09	mg/kg-day	5.7E-02	(mg/kg-day)-1	4.4E-10	4.4E-10	5.4E-07	mg/kg-day	4.0E-03	mg/kg-day	1.4E-04
				VOC	1,1-Dichloroethene	75-35-4	5.7E+01	ug/L	1.3E-06	mg/kg-day					9.2E-05	mg/kg-day	5.0E-02	mg/kg-day	1.8E-03
				VOC	1,2,4-Trichlorobenzene	120-82-1	1.2E+00	ug/L	2.2E-07	mg/kg-day	2.9E-02	(mg/kg-day)-1	6.3E-09	6.3E-09	1.5E-05	mg/kg-day	1.0E-02	mg/kg-day	1.5E-03
				VOC	1,2-Dichloroethane	107-06-2	5.5E-01	ug/L	4.7E-09	mg/kg-day	9.1E-02	(mg/kg-day)-1	4.2E-10	4.2E-10	3.3E-07	mg/kg-day	6.0E-03	mg/kg-day	5.4E-05
				VOC	1,3-Dichlorobenzene	541-73-1	5.4E-01	ug/L											
				VOC	1,4-Dichlorobenzene	106-46-7	8.8E-01	ug/L	8.6E-08	mg/kg-day	5.4E-03	(mg/kg-day)-1	4.7E-10	4.7E-10	6.0E-06	mg/kg-day	7.0E-02	mg/kg-day	8.6E-05
				VOC	Bromodichloromethane	75-27-4	1.1E+00	ug/L	1.1E-08	mg/kg-day	6.2E-02	(mg/kg-day)-1	7.0E-10	7.0E-10	7.9E-07	mg/kg-day	2.0E-02	mg/kg-day	3.9E-05
				VOC	Chlorobenzene	108-90-7	8.0E+00	ug/L	4.5E-07	mg/kg-day					3.1E-05	mg/kg-day	2.0E-02	mg/kg-day	1.6E-03
				VOC	cis-1,2-Dichloroethylene	156-59-2	7.1E+04	ug/L	1.6E-03	mg/kg-day					1.1E-01	mg/kg-day	2.0E-03	mg/kg-day	5.4E+01
				VOC	Tetrachloroethylene	127-18-4	4.0E+04	ug/L	3.2E-03	mg/kg-day	2.1E-03	(mg/kg-day)-1	6.7E-06	6.7E-06	2.2E-01	mg/kg-day	6.0E-03	mg/kg-day	3.7E+01
				VOC	trans-1,2-Dichloroethylene	156-60-5	1.5E+03	ug/L	3.3E-05	mg/kg-day					2.3E-03	mg/kg-day	2.0E-02	mg/kg-day	1.1E-01
				VOC	Trichloroethylene	79-01-6	1.3E+04	ug/L	3.2E-04	mg/kg-day	4.6E-02	(mg/kg-day)-1	1.5E-05	1.5E-05	2.2E-02	mg/kg-day	5.0E-04	mg/kg-day	4.4E+01
				VOC	Vinyl chloride	75-01-4	1.9E+04	ug/L	3.0E-04	mg/kg-day	7.2E-01	(mg/kg-day)-1	2.1E-04	2.1E-04	2.1E-02	mg/kg-day	3.0E-03	mg/kg-day	6.9E+00
			Dermal Total											**2.3E-04**					**1.4E+02**
Groundwater	Groundwater	Groundwater	Outdoor Inhalation																
				VOC	1,1,2-Trichloroethane	79-00-5	4.3E-03	mg/m3	7.0E-06	mg/m3	1.6E-02	(mg/m3)-1	1.1E-07	1.1E-07	4.9E-04	mg/m3	2.0E-04	mg/m3	2.5E+00
				VOC	1,1-Dichloroethene	75-35-4	4.3E-01	mg/m3	7.1E-04	mg/m3					5.0E-02	mg/m3	2.0E-01	mg/m3	2.5E-01
				VOC	1,2,4-Trichlorobenzene	120-82-1	6.6E-03	mg/m3	1.1E-05	mg/m3					7.5E-04	mg/m3	2.0E-03	mg/m3	3.8E-01
				VOC	1,2-Dichloroethane	107-06-2	3.9E-03	mg/m3	6.4E-06	mg/m3	2.6E-02	(mg/m3)-1	1.7E-07	1.7E-07	4.5E-04	mg/m3	7.0E-03	mg/m3	6.4E-02
				VOC	1,3-Dichlorobenzene	541-73-1	3.3E-03	mg/m3	5.4E-06	mg/m3					3.8E-04	mg/m3			
				VOC	1,4-Dichlorobenzene	106-46-7	5.4E-03	mg/m3	8.8E-06	mg/m3	1.1E-02	(mg/m3)-1	9.7E-08	9.7E-08	6.1E-04	mg/m3	8.0E-01	mg/m3	7.7E-04
				VOC	Bromodichloromethane	75-27-4	6.5E-03	mg/m3	1.1E-05	mg/m3	3.7E-02	(mg/m3)-1	3.9E-07	3.9E-07	7.4E-04	mg/m3			
				VOC	Chlorobenzene	108-90-7	5.6E-02	mg/m3	9.1E-05	mg/m3					6.4E-03	mg/m3	5.0E-02	mg/m3	1.3E-01
				VOC	cis-1,2-Dichloroethylene	156-59-2	5.4E+02	mg/m3	8.8E-01	mg/m3					6.1E+01	mg/m3			
				VOC	Tetrachloroethylene	127-18-4	2.4E+02	mg/m3	3.8E-01	mg/m3	2.6E-04	(mg/m3)-1	1.0E-04	1.0E-04	2.7E+01	mg/m3	4.0E-02	mg/m3	6.7E+02
				VOC	trans-1,2-Dichloroethylene	156-60-5	1.1E+01	mg/m3	1.9E-02	mg/m3					1.3E+00	mg/m3			
				VOC	Trichloroethylene	79-01-6	8.3E+01	mg/m3	1.4E-01	mg/m3	4.1E-03	(mg/m3)-1	5.5E-04	5.5E-04	9.5E+00	mg/m3	2.0E-03	mg/m3	4.7E+03
				VOC	Vinyl chloride	75-01-4	1.8E+02	mg/m3	2.9E-01	mg/m3	4.4E-03	(mg/m3)-1	1.3E-03	1.3E-03	2.0E+01	mg/m3	1.0E-01	mg/m3	2.0E+02
			Outdoor Inhalation Total											**1.9E-03**					**5.6E+03**
Groundwater Total														**2.2E-03**					**5.8E+03**
Receptor Total														**2.2E-03**					**5.8E+03**

Notes:
The exposure point concentration (EPC) is the 95% upper confidence limit (UCL), except when the UCL was greater than the maximum detected concentration or ProUCL did not calculate an UCL.
The constituent of potential concern (COPC) list is based on exceedances from screening of maximum detected concentrations against risk-based criteria in Table 2-1.
The single-chemical cancer risks incorporate the one hit equation if cancer risks are > 0.01, per RAGs Part A Chapter 8: Risk = 1 - exp(-Dose x SF). For the risks presented here, the one-hit equation is not needed.
RAGS Part E does not provide dermal soil absorption fraction values (ABSd) for most VOCs; therefore a dermally absorbed dose is not calculated.
The DAevent values for dermal exposure to groundwater are calculated in Table 4.Supp.3.

Abbreviations:
COPC -- Constituent of potential concern
CSF -- Oral cancer slope factor
EPC -- Exposure point concentration
IUR - Inhalation unit risk
NA -- Not applicable.
RfC -- Inhalation reference concentration
RfD -- Oral reference dose

TABLE 7.2
CALCULATION OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A WORKER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC Group	COPC	CASRN	EPC		Cancer Risk Calculations						Non-Cancer Hazard Calculations					
									Exposure Intake		CSF/IUR		Cancer Risk	Cancer Risk (One-Hit)	Exposure Intake		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	Value	Units			Value	Units	Value	Units	
Groundwater	Groundwater	Groundwater	Ingestion	VOC	1,1,2-Trichloroethane	79-00-5	7.0E-01	ug/L	2.7E-06	mg/kg-day	5.7E-02	(mg/kg-day)-1	1.5E-07	1.5E-07	7.4E-06	mg/kg-day	4.0E-03	mg/kg-day	1.9E-03
				VOC	1,1-Dichloroethene	75-35-4	5.7E+01	ug/L	2.2E-04	mg/kg-day					6.1E-04	mg/kg-day	5.0E-02	mg/kg-day	1.2E-02
				VOC	1,2,4-Trichlorobenzene	120-82-1	1.2E+00	ug/L	4.6E-06	mg/kg-day	2.9E-02	(mg/kg-day)-1	1.3E-07	1.3E-07	1.3E-05	mg/kg-day	1.0E-02	mg/kg-day	1.3E-03
				VOC	1,2-Dichloroethane	107-06-2	5.5E-01	ug/L	2.1E-06	mg/kg-day	9.1E-02	(mg/kg-day)-1	1.9E-07	1.9E-07	5.9E-06	mg/kg-day	6.0E-03	mg/kg-day	9.8E-04
				VOC	1,3-Dichlorobenzene	541-73-1	5.4E-01	ug/L	2.1E-06	mg/kg-day					5.8E-06	mg/kg-day			
				VOC	1,4-Dichlorobenzene	106-46-7	8.8E-01	ug/L	3.4E-06	mg/kg-day	5.4E-03	(mg/kg-day)-1	1.8E-08	1.8E-08	9.5E-06	mg/kg-day	7.0E-02	mg/kg-day	1.4E-04
				VOC	Bromodichloromethane	75-27-4	1.1E+00	ug/L	4.4E-06	mg/kg-day	6.2E-02	(mg/kg-day)-1	2.7E-07	2.7E-07	1.2E-05	mg/kg-day	2.0E-02	mg/kg-day	6.1E-04
				VOC	Chlorobenzene	108-90-7	8.0E+00	ug/L	3.1E-05	mg/kg-day					8.6E-05	mg/kg-day	2.0E-02	mg/kg-day	4.3E-03
				VOC	cis-1,2-Dichloroethylene	156-59-2	7.1E+04	ug/L	2.7E-01	mg/kg-day					7.6E-01	mg/kg-day	2.0E-03	mg/kg-day	3.8E+02
				VOC	Tetrachloroethylene	127-18-4	4.0E+04	ug/L	1.5E-01	mg/kg-day	2.1E-03	(mg/kg-day)-1	3.2E-04	3.2E-04	4.3E-01	mg/kg-day	6.0E-03	mg/kg-day	7.2E+01
				VOC	trans-1,2-Dichloroethylene	156-60-5	1.5E+03	ug/L	5.7E-03	mg/kg-day					1.6E-02	mg/kg-day	2.0E-02	mg/kg-day	8.0E-01
				VOC	Trichloroethylene	79-01-6	1.3E+04	ug/L	4.8E-02	mg/kg-day	4.6E-02	(mg/kg-day)-1	2.2E-03	2.2E-03	1.4E-01	mg/kg-day	5.0E-04	mg/kg-day	2.7E+02
				VOC	Vinyl chloride	75-01-4	1.9E+04	ug/L	7.2E-02	mg/kg-day	7.2E-01	(mg/kg-day)-1	5.2E-02	5.0E-02	2.0E-01	mg/kg-day	3.0E-03	mg/kg-day	6.7E+01
			Ingestion Total											**5.3E-02**					**7.9E+02**
Groundwater	Groundwater	Tapwater	Dermal	VOC	1,1,2-Trichloroethane	79-00-5	7.0E-01	ug/L	8.0E-08	mg/kg-day	5.7E-02	(mg/kg-day)-1	4.6E-09	4.6E-09	2.2E-07	mg/kg-day	4.0E-03	mg/kg-day	5.6E-05
				VOC	1,1-Dichloroethene	75-35-4	5.7E+01	ug/L	1.2E-05	mg/kg-day					3.5E-05	mg/kg-day	5.0E-02	mg/kg-day	6.9E-04
				VOC	1,2,4-Trichlorobenzene	120-82-1	1.2E+00	ug/L	2.7E-06	mg/kg-day	2.9E-02	(mg/kg-day)-1	7.7E-08	7.7E-08	7.5E-06	mg/kg-day	1.0E-02	mg/kg-day	7.5E-04
				VOC	1,2-Dichloroethane	107-06-2	5.5E-01	ug/L	4.3E-08	mg/kg-day	9.1E-02	(mg/kg-day)-1	3.9E-09	3.9E-09	1.2E-07	mg/kg-day	6.0E-03	mg/kg-day	2.0E-05
				VOC	1,3-Dichlorobenzene	541-73-1	5.4E-01	ug/L											
				VOC	1,4-Dichlorobenzene	106-46-7	8.8E-01	ug/L	1.0E-06	mg/kg-day	5.4E-03	(mg/kg-day)-1	5.4E-09	5.4E-09	2.8E-06	mg/kg-day	7.0E-02	mg/kg-day	4.0E-05
				VOC	Bromodichloromethane	75-27-4	1.1E+00	ug/L	1.3E-07	mg/kg-day	6.2E-02	(mg/kg-day)-1	7.9E-09	7.9E-09	3.6E-07	mg/kg-day	2.0E-02	mg/kg-day	1.8E-05
				VOC	Chlorobenzene	108-90-7	8.0E+00	ug/L	4.5E-06	mg/kg-day					1.3E-05	mg/kg-day	2.0E-02	mg/kg-day	6.3E-04
				VOC	cis-1,2-Dichloroethylene	156-59-2	7.1E+04	ug/L	1.5E-02	mg/kg-day					4.1E-02	mg/kg-day	2.0E-03	mg/kg-day	2.0E+01
				VOC	Tetrachloroethylene	127-18-4	4.0E+04	ug/L	3.8E-02	mg/kg-day	2.1E-03	(mg/kg-day)-1	8.0E-05	8.0E-05	1.1E-01	mg/kg-day	6.0E-03	mg/kg-day	1.8E+01
				VOC	trans-1,2-Dichloroethylene	156-60-5	1.5E+03	ug/L	3.1E-04	mg/kg-day					8.6E-04	mg/kg-day	2.0E-02	mg/kg-day	4.3E-02
				VOC	Trichloroethylene	79-01-6	1.3E+04	ug/L	3.3E-03	mg/kg-day	4.6E-02	(mg/kg-day)-1	1.5E-04	1.5E-04	9.3E-03	mg/kg-day	5.0E-04	mg/kg-day	1.9E+01
				VOC	Vinyl chloride	75-01-4	1.9E+04	ug/L	2.5E-03	mg/kg-day	7.2E-01	(mg/kg-day)-1	1.8E-03	1.8E-03	6.9E-03	mg/kg-day	3.0E-03	mg/kg-day	2.3E+00
			Dermal Total											**2.0E-03**					**5.9E+01**
Groundwater Total														**5.5E-02**					**8.5E+02**
Receptor Total														**5.5E-02**					**8.5E+02**

Notes:
The exposure point concentration (EPC) is the 95% upper confidence limit (UCL), except when the UCL was greater than the maximum detected concentration or ProUCL did not calculate an UCL.
The constituent of potential concern (COPC) list is based on exceedances from screening of maximum detected concentrations against risk-based criteria in Table 2-1.
The single-chemical cancer risks incorporate the one hit equation if cancer risks are > 0.01, per RAGs Part A Chapter 8: Risk = 1 - exp(-Dose x SF). **The one hit equation is applied for vinyl chloride above, indicated by an underline.**
RAGS Part E does not provide dermal soil absorption fraction values (ABSd) for most VOCs; therefore a dermally absorbed dose is not calculated.
The DAevent values for dermal exposure to groundwater are calculated in Table 4.Supp.3.

Abbreviations:
COPC -- Constituent of potential concern
CSF -- Oral cancer slope factor
EPC -- Exposure point concentration
IUR - Inhalation unit risk
RfC -- Inhalation reference concentration
RfD -- Oral reference dose

TABLE 7.3
CALCULATION OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A RESIDENT
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult and Child (0-6 yrs)

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC Group	COPC	CASRN	Mutagenic	EPC			Cancer Risk Calculations						Non-Cancer Hazard Calculations									
								Adult	Child	Units	Adult and Child Age-Adjusted						Adult					Child (0-6 years)				
								Value	Value		Exposure Intake		CSF/Unit Risk		Cancer Risk	Cancer Risk (One-Hit)	Exposure Intake		RfD/RfC		Hazard Quotient	Exposure Intake		RfD/RfC		Hazard Quotient
											Value	Units	Value	Units			Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tapwater	Ingestion																							
				VOC	1,1,2-Trichloroethane	79-00-5	N	7.0E-01	7.0E-01	ug/L	1.1E-05	mg/kg-day	5.7E-02	(mg/kg-day)-1	6.1E-07	6.1E-07	2.1E-05	mg/kg-day	4.0E-03	mg/kg-day	5.2E-03	3.5E-05	mg/kg-day	4.0E-03	mg/kg-day	8.7E-03
				VOC	1,1-Dichloroethene	75-35-4	N	5.7E+01	5.7E+01	ug/L	8.8E-04	mg/kg-day					1.7E-03	mg/kg-day	5.0E-02	mg/kg-day	3.4E-02	2.8E-03	mg/kg-day	5.0E-02	mg/kg-day	5.7E-02
				VOC	1,2,4-Trichlorobenzene	120-82-1	N	1.2E+00	1.2E+00	ug/L	1.9E-05	mg/kg-day	2.9E-02	(mg/kg-day)-1	5.4E-07	5.4E-07	3.6E-05	mg/kg-day	1.0E-02	mg/kg-day	3.6E-03	6.1E-05	mg/kg-day	1.0E-02	mg/kg-day	6.1E-03
				VOC	1,2-Dichloroethane	107-06-2	N	5.5E-01	5.5E-01	ug/L	8.4E-06	mg/kg-day	9.1E-02	(mg/kg-day)-1	7.7E-07	7.7E-07	1.6E-05	mg/kg-day	6.0E-03	mg/kg-day	2.7E-03	2.7E-05	mg/kg-day	6.0E-03	mg/kg-day	4.5E-03
				VOC	1,3-Dichlorobenzene	541-73-1	NA	5.4E-01	5.4E-01	ug/L	8.3E-06	mg/kg-day					1.6E-05	mg/kg-day				2.7E-05	mg/kg-day			
				VOC	1,4-Dichlorobenzene	106-46-7	N	8.8E-01	8.8E-01	ug/L	1.4E-05	mg/kg-day	5.4E-03	(mg/kg-day)-1	7.4E-08	7.4E-08	2.6E-05	mg/kg-day	7.0E-02	mg/kg-day	3.8E-04	4.4E-05	mg/kg-day	7.0E-02	mg/kg-day	6.3E-04
				VOC	Bromodichloromethane	75-27-4	N	1.1E+00	1.1E+00	ug/L	1.8E-05	mg/kg-day	6.2E-02	(mg/kg-day)-1	1.1E-06	1.1E-06	3.4E-05	mg/kg-day	2.0E-02	mg/kg-day	1.7E-03	5.7E-05	mg/kg-day	2.0E-02	mg/kg-day	2.8E-03
				VOC	Chlorobenzene	108-90-7	N	8.0E+00	8.0E+00	ug/L	1.2E-04	mg/kg-day					2.4E-04	mg/kg-day	2.0E-02	mg/kg-day	1.2E-02	4.0E-04	mg/kg-day	2.0E-02	mg/kg-day	2.0E-02
				VOC	cis-1,2-Dichloroethylene	156-59-2	N	7.1E+04	7.1E+04	ug/L	1.1E+00	mg/kg-day					2.1E+00	mg/kg-day	2.0E-03	mg/kg-day	1.1E+03	3.5E+00	mg/kg-day	2.0E-03	mg/kg-day	1.8E+03
				VOC	Tetrachloroethylene	127-18-4	N	4.0E+04	4.0E+04	ug/L	6.2E-01	mg/kg-day	2.1E-03	(mg/kg-day)-1	1.3E-03	1.3E-03	1.2E+00	mg/kg-day	6.0E-03	mg/kg-day	2.0E+02	2.0E+00	mg/kg-day	6.0E-03	mg/kg-day	3.3E+02
				VOC	trans-1,2-Dichloroethylene	156-60-5	N	1.5E+03	1.5E+03	ug/L	2.3E-02	mg/kg-day					4.5E-02	mg/kg-day	2.0E-02	mg/kg-day	2.3E+00	7.5E-02	mg/kg-day	2.0E-02	mg/kg-day	3.7E+00
				VOC	Trichloroethylene	79-01-6	Y	1.3E+04	1.3E+04	ug/L	3.0E-01	mg/kg-day	4.6E-02	(mg/kg-day)-1	1.4E-02	1.4E-02	3.8E-01	mg/kg-day	5.0E-04	mg/kg-day	7.6E+02	6.3E-01	mg/kg-day	5.0E-04	mg/kg-day	1.3E+03
				VOC	Vinyl chloride	75-01-4	Y	1.9E+04	1.9E+04	ug/L	1.3E+00	mg/kg-day	7.2E-01	(mg/kg-day)-1	9.1E-01	6.0E-01	5.6E-01	mg/kg-day	3.0E-03	mg/kg-day	1.9E+02	9.3E-01	mg/kg-day	3.0E-03	mg/kg-day	3.1E+02
			Ingestion Total													**6.1E-01**					**2.2E+03**					**3.7E+03**
Groundwater	Groundwater	Tapwater	Dermal																							
				VOC	1,1,2-Trichloroethane	79-00-5	N	7.0E-01	7.0E-01	ug/L	6.7E-07	mg/kg-day	5.7E-02	(mg/kg-day)-1	3.8E-08	3.8E-08	1.5E-06	mg/kg-day	4.0E-03	mg/kg-day	3.7E-04	2.2E-06	mg/kg-day	4.0E-03	mg/kg-day	5.5E-04
				VOC	1,1-Dichloroethene	75-35-4	N	5.7E+01	5.7E+01	ug/L	1.0E-04	mg/kg-day					2.2E-04	mg/kg-day	5.0E-02	mg/kg-day	4.4E-03	3.3E-04	mg/kg-day	5.0E-02	mg/kg-day	6.7E-03
				VOC	1,2,4-Trichlorobenzene	120-82-1	N	1.2E+00	1.2E+00	ug/L	2.2E-05	mg/kg-day	2.9E-02	(mg/kg-day)-1	6.5E-07	6.5E-07	4.9E-05	mg/kg-day	1.0E-02	mg/kg-day	4.9E-03	7.4E-05	mg/kg-day	1.0E-02	mg/kg-day	7.4E-03
				VOC	1,2-Dichloroethane	107-06-2	N	5.5E-01	5.5E-01	ug/L	3.5E-07	mg/kg-day	9.1E-02	(mg/kg-day)-1	3.2E-08	3.2E-08	7.7E-07	mg/kg-day	6.0E-03	mg/kg-day	1.3E-04	1.2E-06	mg/kg-day	6.0E-03	mg/kg-day	1.9E-04
				VOC	1,3-Dichlorobenzene	541-73-1	NA	5.4E-01	5.4E-01	ug/L																
				VOC	1,4-Dichlorobenzene	106-46-7	N	8.8E-01	8.8E-01	ug/L	8.4E-06	mg/kg-day	5.4E-03	(mg/kg-day)-1	4.5E-08	4.5E-08	1.8E-05	mg/kg-day	7.0E-02	mg/kg-day	2.6E-04	2.8E-05	mg/kg-day	7.0E-02	mg/kg-day	4.0E-04
				VOC	Bromodichloromethane	75-27-4	N	1.1E+00	1.1E+00	ug/L	1.1E-06	mg/kg-day	6.2E-02	(mg/kg-day)-1	6.6E-08	6.6E-08	2.3E-06	mg/kg-day	2.0E-02	mg/kg-day	1.2E-04	3.5E-06	mg/kg-day	2.0E-02	mg/kg-day	1.8E-04
				VOC	Chlorobenzene	108-90-7	N	8.0E+00	8.0E+00	ug/L	3.8E-05	mg/kg-day					8.3E-05	mg/kg-day	2.0E-02	mg/kg-day	4.1E-03	1.2E-04	mg/kg-day	2.0E-02	mg/kg-day	6.2E-03
				VOC	cis-1,2-Dichloroethylene	156-59-2	N	7.1E+04	7.1E+04	ug/L	1.2E-01	mg/kg-day					2.6E-01	mg/kg-day	2.0E-03	mg/kg-day	1.3E+02	3.9E-01	mg/kg-day	2.0E-03	mg/kg-day	2.0E+02
				VOC	Tetrachloroethylene	127-18-4	N	4.0E+04	4.0E+04	ug/L	3.2E-01	mg/kg-day	2.1E-03	(mg/kg-day)-1	6.7E-04	6.7E-04	7.0E-01	mg/kg-day	6.0E-03	mg/kg-day	1.2E+02	1.1E+00	mg/kg-day	6.0E-03	mg/kg-day	1.8E+02
				VOC	trans-1,2-Dichloroethylene	156-60-5	N	1.5E+03	1.5E+03	ug/L	2.5E-03	mg/kg-day					5.5E-03	mg/kg-day	2.0E-02	mg/kg-day	2.7E-01	8.3E-03	mg/kg-day	2.0E-02	mg/kg-day	4.1E-01
				VOC	Trichloroethylene	79-01-6	Y	1.3E+04	1.3E+04	ug/L	4.0E-02	mg/kg-day	4.6E-02	(mg/kg-day)-1	1.8E-03	1.8E-03	6.1E-02	mg/kg-day	5.0E-04	mg/kg-day	1.2E+02	9.2E-02	mg/kg-day	5.0E-04	mg/kg-day	1.8E+02
				VOC	Vinyl chloride	75-01-4	Y	1.9E+04	1.9E+04	ug/L	8.5E-02	mg/kg-day	7.2E-01	(mg/kg-day)-1	6.1E-02	5.9E-02	4.3E-02	mg/kg-day	3.0E-03	mg/kg-day	1.4E+01	6.3E-02	mg/kg-day	3.0E-03	mg/kg-day	2.1E+01
			Dermal Total													**6.2E-02**					**3.8E+02**					**5.8E+02**
Groundwater	Groundwater	Water Vapors in Bathroom	Inhalation																							
				VOC	1,1,2-Trichloroethane	79-00-5	N	1.2E-02	1.3E-02	mg/m3	1.2E-04	mg/m3	1.6E-02	(mg/m3)-1	1.9E-06	1.9E-06	3.4E-04	mg/m3	2.0E-04	mg/m3	1.7E+00	2.9E-04	mg/m3	2.0E-04	mg/m3	1.4E+00
				VOC	1,1-Dichloroethene	75-35-4	N	9.8E-01	1.1E+00	mg/m3	9.9E-03	mg/m3					2.8E-02	mg/m3	2.0E-01	mg/m3	1.4E-01	2.3E-02	mg/m3	2.0E-01	mg/m3	1.2E-01
				VOC	1,2,4-Trichlorobenzene	120-82-1	N	2.1E-02	2.3E-02	mg/m3	2.1E-04	mg/m3					5.9E-04	mg/m3	2.0E-03	mg/m3	3.0E-01	5.0E-04	mg/m3	2.0E-03	mg/m3	2.5E-01
				VOC	1,2-Dichloroethane	107-06-2	N	9.4E-03	1.0E-02	mg/m3	9.5E-05	mg/m3	2.6E-02	(mg/m3)-1	2.5E-06	2.5E-06	2.7E-04	mg/m3	7.0E-03	mg/m3	3.8E-02	2.3E-04	mg/m3	7.0E-03	mg/m3	3.2E-02
				VOC	1,3-Dichlorobenzene	541-73-1	NA	9.3E-03	1.0E-02	mg/m3	9.4E-05	mg/m3					2.6E-04	mg/m3				2.2E-04	mg/m3			
				VOC	1,4-Dichlorobenzene	106-46-7	N	1.5E-02	1.7E-02	mg/m3	1.5E-04	mg/m3	1.1E-02	(mg/m3)-1	1.7E-06	1.7E-06	4.3E-04	mg/m3	8.0E-01	mg/m3	5.4E-04	3.6E-04	mg/m3	8.0E-01	mg/m3	4.6E-04
				VOC	Bromodichloromethane	75-27-4	N	2.0E-02	2.2E-02	mg/m3	2.0E-04	mg/m3	3.7E-02	(mg/m3)-1	7.4E-06	7.4E-06	5.6E-04	mg/m3				4.7E-04	mg/m3			
				VOC	Chlorobenzene	108-90-7	N	1.4E-01	1.5E-01	mg/m3	1.4E-03	mg/m3					3.9E-03	mg/m3	5.0E-02	mg/m3	7.8E-02	3.3E-03	mg/m3	5.0E-02	mg/m3	6.6E-02
				VOC	cis-1,2-Dichloroethylene	156-59-2	N	1.2E+03	1.4E+03	mg/m3	1.2E+01	mg/m3					3.5E+01	mg/m3				2.9E+01	mg/m3			
				VOC	Tetrachloroethylene	127-18-4	N	6.9E+02	7.7E+02	mg/m3	7.0E+00	mg/m3	2.6E-04	(mg/m3)-1	1.8E-03	1.8E-03	2.0E+01	mg/m3	4.0E-02	mg/m3	4.9E+02	1.7E+01	mg/m3	4.0E-02	mg/m3	4.2E+02
				VOC	trans-1,2-Dichloroethylene	156-60-5	N	2.6E+01	2.9E+01	mg/m3	2.6E-01	mg/m3					7.3E-01	mg/m3				6.2E-01	mg/m3			
				VOC	Trichloroethylene	79-01-6	Y	2.2E+02	2.4E+02	mg/m3	6.1E+00	mg/m3	4.1E-03	(mg/m3)-1	2.5E-02	2.5E-02	6.2E+00	mg/m3	2.0E-03	mg/m3	3.1E+03	5.2E+00	mg/m3	2.0E-03	mg/m3	2.6E+03
				VOC	Vinyl chloride	75-01-4	Y	3.2E+02	3.6E+02	mg/m3	See note	mg/m3	See note	(mg/m3)-1	1.7E-02	1.7E-02	9.1E+00	mg/m3	1.0E-01	mg/m3	9.1E+01	7.7E+00	mg/m3	1.0E-01	mg/m3	7.7E+01
			Water Vapor Inhalation Total													**4.4E-02**					**3.7E+03**					**3.1E+03**
Groundwater Total																**7.2E-01**					**6.3E+03**					**7.4E+03**
Receptor Total																**7.2E-01**					**6.3E+03**					**7.4E+03**

Notes:
The exposure point concentration (EPC) is the 95% upper confidence limit (UCL), except when the UCL was greater than the maximum detected concentration or ProUCL did not calculate an UCL.
The constituent of potential concern (COPC) list is based on exceedances from screening of maximum detected concentrations against risk-based criteria in Table 2-1.
The single-chemical cancer risks incorporate the one hit equation if cancer risks are > 0.01, per RAGs Part A Chapter 8: Risk = 1 - exp(-Dose x SF). **The one hit equations are applied for trichloroethylene and vinyl chloride above,**
RAGS Part E does not provide dermal soil absorption fraction values (ABSd) for most VOCs; therefore a dermally absorbed dose is not calculated.
The age-adjustments for a resident's cancer risk are calculated in Table 4.Supp.1.
The exposure intakes for MMOA chemicals (e.g., chromium) are adjusted for age are calculated in Tables 4.Supp.2.
The DAvent values for dermal exposure to groundwater are calculated in Table 4.Supp.3.
The inhalation pathway uses groundwater-derived shower vapors (Ca) as the EPC, which are calculated using the Andelman model modified by Schaum et al, in Table 4.Supp.4.
The cancer risk for vinyl chloride is calculated using the toxicity value of 4.4E-06 for continuous lifetime exposure during adulthood and toxicity value of 8.8E-06 for continuous lifetime exposure from birth. See Table 4.1 for the full equation.

Abbreviations:
COPC -- Constituent of potential concern
CSF -- Oral cancer slope factor
EPC -- Exposure point concentration
IUR - Inhalation unit risk
RfC -- Inhalation reference concentration
RfD -- Oral or dermal reference dose
UCL -- Upper confidence limit

TABLE 9.1
SUMMARY OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A CONSTRUCTION WORKER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COPC Group	COPC	CASRN	Cancer Risk Summary				Non-Cancer Hazard Summary					
						Ingestion	Dermal	Inhalation	Exposure RoutesTotal	Target Organ (Ing/Dermal)	Ingestion	Dermal	Target Organ (Inhalation)	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Groundwater	VOC	1,1,2-Trichloroethane	79-00-5	9.7E-11	4.4E-10	1.1E-07	1.1E-07	Lymphatic	3.0E-05	1.4E-04	Hepatic	2.5E+00	2.5E+00
			VOC	1,1-Dichloroethene	75-35-4					Hepatic	1.9E-04	1.8E-03	Hepatic	2.5E-01	2.5E-01
			VOC	1,2,4-Trichlorobenzene	120-82-1	8.6E-11	6.3E-09		6.4E-09	Endocrine	2.1E-05	1.5E-03	Endocrine	3.8E-01	3.8E-01
			VOC	1,2-Dichloroethane	107-06-2	1.2E-10	4.2E-10	1.7E-07	1.7E-07	Renal	1.6E-05	5.4E-05	Nervous	6.4E-02	6.4E-02
			VOC	1,3-Dichlorobenzene	541-73-1					N/A			N/A		
			VOC	1,4-Dichlorobenzene	106-46-7	1.2E-11	4.7E-10	9.7E-08	9.7E-08	Hepatic	2.2E-06	8.6E-05	Hepatic	7.7E-04	8.6E-04
			VOC	Bromodichloromethane	75-27-4	1.7E-10	7.0E-10	3.9E-07	3.9E-07	Renal	9.8E-06	3.9E-05	N/A		4.9E-05
			VOC	Chlorobenzene	108-90-7					Hepatic	6.8E-05	1.6E-03	Hepatic, Renal	1.3E-01	1.3E-01
			VOC	cis-1,2-Dichloroethylene	156-59-2					Renal	6.1E+00	5.4E+01	N/A		6.0E+01
			VOC	Tetrachloroethylene	127-18-4	2.1E-07	6.7E-06	1.0E-04	1.1E-04	Nervous, Hepatic, Renal	1.1E+00	3.7E+01	Nervous, Hepatic, Renal	6.7E+02	7.1E+02
			VOC	trans-1,2-Dichloroethylene	156-60-5					Lymphatic	1.3E-02	1.1E-01	N/A		1.3E-01
			VOC	Trichloroethylene	79-01-6	1.4E-06	1.5E-05	5.5E-04	5.7E-04	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	4.3E+00	4.4E+01	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	4.7E+03	4.8E+03
			VOC	Vinyl chloride	75-01-4	3.3E-05	2.1E-04	1.3E-03	1.5E-03	Hepatic	1.1E+00	6.9E+00	Hepatic	2.0E+02	2.1E+02
Groundwater Total									**2.2E-03**						**5.8E+03**
Receptor Total								**Receptor Risk Total:**	**2.2E-03**				**Receptor Hazard Total:**		**5.8E+03**

Abbreviation:
COPC -- Constituent of potential concern

Total **Cardiovascular** HI across media =	**N/A**
Total **Developmental** HI across media =	**4.8E+03**
Total **Digestive** HI across media =	**N/A**
Total **Endocrine** HI across media =	**3.8E-01**
Total **Hepatic** HI across media =	**5.7E+03**
Total **Integumentary** HI across media =	**N/A**
Total **Lymphatic** HI across media =	**4.8E+03**
Total **Muscoskeletal** HI across media =	**N/A**
Total **Nervous** HI across media =	**5.5E+03**
Total **Renal** HI across media =	**5.6E+03**
Total **Reproductive** HI across media =	**4.8E+03**
Total **Respiratory** HI across media =	**N/A**
Total **No Specified Target Organ/System** HI across media =	**N/A**

TABLE 9.2
SUMMARY OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A WORKER
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	COPC Group	COPC	CASRN	Cancer Risk Summary			Non-Cancer Hazard Summary			
						Ingestion	Dermal	Exposure Routes Total	Target Organ (Ing/Dermal)	Ingestion	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tapwater										
			VOC	1,1,2-Trichloroethane	79-00-5	1.5E-07	4.6E-09	1.6E-07	Lymphatic	1.9E-03	5.6E-05	1.9E-03
			VOC	1,1-Dichloroethene	75-35-4				Hepatic	1.2E-02	6.9E-04	1.3E-02
			VOC	1,2,4-Trichlorobenzene	120-82-1	1.3E-07	7.7E-08	2.1E-07	Endocrine	1.3E-03	7.5E-04	2.0E-03
			VOC	1,2-Dichloroethane	107-06-2	1.9E-07	3.9E-09	1.9E-07	Renal	9.8E-04	2.0E-05	1.0E-03
			VOC	1,3-Dichlorobenzene	541-73-1				N/A			
			VOC	1,4-Dichlorobenzene	106-46-7	1.8E-08	5.4E-09	2.4E-08	Hepatic	1.4E-04	4.0E-05	1.8E-04
			VOC	Bromodichloromethane	75-27-4	2.7E-07	7.9E-09	2.8E-07	Renal	6.1E-04	1.8E-05	6.3E-04
			VOC	Chlorobenzene	108-90-7				Hepatic	4.3E-03	6.3E-04	4.9E-03
			VOC	cis-1,2-Dichloroethylene	156-59-2				Renal	3.8E+02	2.0E+01	4.0E+02
			VOC	Tetrachloroethylene	127-18-4	3.2E-04	8.0E-05	4.0E-04	Nervous, Hepatic, Renal	7.2E+01	1.8E+01	9.0E+01
			VOC	trans-1,2-Dichloroethylene	156-60-5				Lymphatic	8.0E-01	4.3E-02	8.5E-01
			VOC	Trichloroethylene	79-01-6	2.2E-03	1.5E-04	2.4E-03	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	2.7E+02	1.9E+01	2.9E+02
			VOC	Vinyl chloride	75-01-4	5.2E-02	1.8E-03	5.3E-02	Hepatic	6.7E+01	2.3E+00	6.9E+01
Groundwater Total								**5.6E-02**				**8.5E+02**
Receptor Total					**Receptor Risk Total:**			**5.6E-02**				**8.5E+02**

Abbreviation:
COPC -- Constituent of potential concern

Total **Cardiovascular** HI across media =	**N/A**
Total **Developmental** HI across media =	**2.9E+02**
Total **Digestive** HI across media =	**N/A**
Total **Endocrine** HI across media =	**2.0E-03**
Total **Hepatic** HI across media =	**4.5E+02**
Total **Integumentary** HI across media =	**N/A**
Total **Lymphatic** HI across media =	**2.9E+02**
Total **Muscoskeletal** HI across media =	**N/A**
Total **Nervous** HI across media =	**3.8E+02**
Total **Renal** HI across media =	**7.8E+02**
Total **Reproductive** HI across media =	**2.9E+02**
Total **Respiratory** HI across media =	**N/A**
Total **No Specified Target Organ/System** HI across media =	**N/A**

TABLE 9.3
SUMMARY OF COPC CANCER RISKS AND NONCANCER HAZARDS FOR A RESIDENT
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult and Child (0-6 yrs)

Medium	Exposure Medium	Exposure Point	COPC Group	COPC	CASRN	Cancer Risk Summary				Non-Cancer Hazard Summary											
										Adult						Child					
						Ingestion	Dermal	Inhalation	Exposure RoutesTotal	Target Organ (Ing/Dermal)	Ingestion	Dermal	Target Organ (Inhalation)	Inhalation	Exposure Routes Total	Target Organ (Ing/Dermal)	Ingestion	Dermal	Target Organ (Inhalation)	Inhalation	Exposure Routes Total
Groundwater	Groundwater	Tapwater	VOC	1,1,2-Trichloroethane	79-00-5	6.1E-07	3.8E-08	1.9E-06	2.6E-06	Lymphatic	5.2E-03	3.7E-04	Hepatic	1.7E+00	1.7E+00	Lymphatic	8.7E-03	5.5E-04	Hepatic	1.4E+00	1.4E+00
			VOC	1,1-Dichloroethene	75-35-4					Hepatic	3.4E-02	4.4E-03	Hepatic	1.4E-01	1.8E-01	Hepatic	5.7E-02	6.7E-03	Hepatic	1.2E-01	1.8E-01
			VOC	1,2,4-Trichlorobenzene	120-82-1	5.4E-07	6.5E-07		1.2E-06	Endocrine	3.6E-03	4.9E-03	Endocrine	3.0E-01	3.0E-01	Endocrine	6.1E-03	7.4E-03	Endocrine	2.5E-01	2.6E-01
			VOC	1,2-Dichloroethane	107-06-2	7.7E-07	3.2E-08	2.5E-06	3.3E-06	Renal	2.7E-03	1.3E-04	Nervous	3.8E-02	4.1E-02	Renal	4.5E-03	1.9E-04	Nervous	3.2E-02	3.7E-02
			VOC	1,3-Dichlorobenzene	541-73-1					N/A			N/A			N/A			N/A		
			VOC	1,4-Dichlorobenzene	106-46-7	7.4E-08	4.5E-08	1.7E-06	1.8E-06	Hepatic	3.8E-04	2.6E-04	Hepatic	5.4E-04	1.2E-03	Hepatic	6.3E-04	4.0E-04	Hepatic	4.6E-04	1.5E-03
			VOC	Bromodichloromethane	75-27-4	1.1E-06	6.6E-08	7.4E-06	8.5E-06	Renal	1.7E-03	1.2E-04	N/A		1.8E-03	Renal	2.8E-03	1.8E-04	N/A		3.0E-03
			VOC	Chlorobenzene	108-90-7					Hepatic	1.2E-02	4.1E-03	Hepatic, Renal	7.8E-02	9.4E-02	Hepatic	2.0E-02	6.2E-03	Hepatic, Renal	6.6E-02	9.2E-02
			VOC	cis-1,2-Dichloroethylene	156-59-2					Renal	1.1E+03	1.3E+02	N/A		1.2E+03	Renal	1.8E+03	2.0E+02	N/A		2.0E+03
			VOC	Tetrachloroethylene	127-18-4	1.3E-03	6.7E-04	1.8E-03	3.8E-03	Nervous, Hepatic, Renal	2.0E+02	1.2E+02	Nervous, Hepatic, Renal	4.9E+02	8.1E+02	Nervous, Hepatic, Renal	3.3E+02	1.8E+02	Nervous, Hepatic, Renal	4.2E+02	9.3E+02
			VOC	trans-1,2-Dichloroethylene	156-60-5					Lymphatic	2.3E+00	2.7E-01	N/A		2.5E+00	Lymphatic	3.7E+00	4.1E-01	N/A		4.2E+00
			VOC	Trichloroethylene	79-01-6	1.4E-02	1.8E-03	2.5E-02	4.1E-02	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	7.6E+02	1.2E+02	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	3.1E+03	4.0E+03	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	1.3E+03	1.8E+02	Developmental, Hepatic, Renal, Nervous, Lymphatic, Reproductive	2.6E+03	4.1E+03
			VOC	Vinyl chloride	75-01-4	9.1E-01	6.1E-02	1.7E-02	9.9E-01	Hepatic	1.9E+02	1.4E+01	Hepatic	9.1E+01	2.9E+02	Hepatic	3.1E+02	2.1E+01	Hepatic	7.7E+01	4.1E+02
Groundwater Total									**1.0E+00**						**6.3E+03**						**7.4E+03**
Receptor Total									**Receptor Risk Total: 1.0E+00**						**Adult Receptor Hazard Total: 6.3E+03**						**Child Receptor Hazard Total: 7.4E+03**

Abbreviation:
COPC -- Constituent of potential concern

Adult		Child	
Total **Cardiovascular** HI across media =	**N/A**	Total **Cardiovascular** HI across media =	**N/A**
Total **Developmental** HI across media =	**4.0E+03**	Total **Developmental** HI across media =	**4.1E+03**
Total **Digestive** HI across media =	**N/A**	Total **Digestive** HI across media =	**N/A**
Total **Endocrine** HI across media =	**3.0E-01**	Total **Endocrine** HI across media =	**2.6E-01**
Total **Hepatic** HI across media =	**5.1E+03**	Total **Hepatic** HI across media =	**5.4E+03**
Total **Integumentary** HI across media =	**N/A**	Total **Integumentary** HI across media =	**N/A**
Total **Lymphatic** HI across media =	**4.0E+03**	Total **Lymphatic** HI across media =	**4.1E+03**
Total **Muscoskeletal** HI across media =	**N/A**	Total **Muscoskeletal** HI across media =	**N/A**
Total **Nervous** HI across media =	**4.8E+03**	Total **Nervous** HI across media =	**5.0E+03**
Total **Renal** HI across media =	**6.0E+03**	Total **Renal** HI across media =	**7.0E+03**
Total **Reproductive** HI across media =	**4.0E+03**	Total **Reproductive** HI across media =	**4.1E+03**
Total **Respiratory** HI across media =	**N/A**	Total **Respiratory** HI across media =	**N/A**
Total **No Specified Target Organ/System** HI across media =	**N/A**	Total **No Specified Target Organ/System** HI across media =	**N/A**

ATTACHMENT B

ProUCL Software Inputs and Outputs

ATTACHMENT B TABLE OF CONTENTS:

TABLE B.1
PROUCL 5.1 RAW INPUT FOR GROUNDWATER - SITE-WIDE AREA
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Notes:
The data set provided here are for constituents of potential concern (COPCs) that were determined in the initial screening of site-wide data to calculate 95% upper confidence limits (UCLs) using USEPA ProUCL software for the risk assessment. This is not a complete data set.
The maximum of the field duplicate and parent sample results was applied.
The detection limit is the quantitation limit if available; otherwise, it is the reporting limit.

ProUCL Group	ProUCL Result (ug/L)	ProUCL Flag	Location	Sample ID	Sample Type	Sample Date	Analysis Date	Analytical Method	T or D	COPC Group	COPC	CASRN	Qualifier	Quantitation Limit (ug/L)
1,1,2-Trichloroethane_79-00-5	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	1.6	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5		0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1,2-Trichloroethane_79-00-5	1.3	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5		0.5
1,1,2-Trichloroethane_79-00-5	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1,2-Trichloroethane	79-00-5	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.74	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		0.5
1,1-Dichloroethene_75-35-4	1.2	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	170	1	IW1	IW1-85-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		25
1,1-Dichloroethene_75-35-4	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	UL	0.5
1,1-Dichloroethene_75-35-4	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	400	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		50
1,1-Dichloroethene_75-35-4	1.5	1	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		0.5
1,1-Dichloroethene_75-35-4	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,1-Dichloroethene_75-35-4	98	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4		25
1,1-Dichloroethene_75-35-4	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,1-Dichloroethene	75-35-4	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	4	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1		0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	1.8	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1		0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	1	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1		0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	4.1	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1		0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2,4-Trichlorobenzene_120-82-1	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2,4-Trichlorobenzene	120-82-1	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.65	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2		0.5
1,2-Dichloroethane_107-06-2	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,2-Dichloroethane_107-06-2	0.8	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2		0.5
1,2-Dichloroethane_107-06-2	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,2-Dichloroethane	107-06-2	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.6	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1		0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.64	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1		0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.74	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1		0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,3-Dichlorobenzene_541-73-1	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,3-Dichlorobenzene	541-73-1	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	1.2	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7		0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.62	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7		0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.53	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7		0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7	U	0.5
1,4-Dichlorobenzene_106-46-7	2.8	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7		0.5
1,4-Dichlorobenzene_106-46-7	2.1	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	1,4-Dichlorobenzene	106-46-7		0.5
Bromodichloromethane_75-27-4	0.5	0	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	2.7	1	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4		0.5
Bromodichloromethane_75-27-4	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	1.2	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4		0.5
Bromodichloromethane_75-27-4	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Bromodichloromethane_75-27-4	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Bromodichloromethane	75-27-4	U	0.5
Chlorobenzene_108-90-7	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	30	1	IW1	IW1-85-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7		0.5
Chlorobenzene_108-90-7	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	48	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7		0.5
Chlorobenzene_108-90-7	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	11	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7		0.5
Chlorobenzene_108-90-7	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	UL	0.5
Chlorobenzene_108-90-7	3.2	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7		0.5
Chlorobenzene_108-90-7	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
Chlorobenzene_108-90-7	1.9	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7		0.5
Chlorobenzene_108-90-7	0.5	0	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Chlorobenzene	108-90-7	U	0.5
cis-1,2-Dichloroethylene_156-59-2	0.72	1	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	47	1	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	1.7	1	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	760	1	BP2	BP2-50-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		12
cis-1,2-Dichloroethylene_156-59-2	20	1	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	140	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2	K	25
cis-1,2-Dichloroethylene_156-59-2	410	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		25
cis-1,2-Dichloroethylene_156-59-2	49	1	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2	U	0.5
cis-1,2-Dichloroethylene_156-59-2	36	1	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2	L	0.5
cis-1,2-Dichloroethylene_156-59-2	380	1	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		25
cis-1,2-Dichloroethylene_156-59-2	140	1	RD13	RD13-112.5-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		12
cis-1,2-Dichloroethylene_156-59-2	12	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	7.1	1	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5

TABLE B.1
PROUCL 5.1 RAW INPUT FOR GROUNDWATER - SITE-WIDE AREA
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Notes:
The data set provided here are for constituents of potential concern (COPCs) that were determined in the initial screening of site-wide data to calculate 95% upper confidence limits (UCLs) using USEPA ProUCL software for the risk assessment. This is not a complete data set.
The maximum of the field duplicate and parent sample results was applied.
The detection limit is the quantitation limit if available; otherwise, it is the reporting limit.

ProUCL Group	ProUCL Result (ug/L)	ProUCL Flag	Location	Sample ID	Sample Type	Sample Date	Analysis Date	Analytical Method	T or D	COPC Group	COPC	CASRN	Qualifier	Quantitation Limit (ug/L)
cis-1,2-Dichloroethylene_156-59-2	44	1	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	2.8	1	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	0.67	1	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2	L	0.5
cis-1,2-Dichloroethylene_156-59-2	94	1	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		12
cis-1,2-Dichloroethylene_156-59-2	28000	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/15/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		2500
cis-1,2-Dichloroethylene_156-59-2	160000	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		2500
cis-1,2-Dichloroethylene_156-59-2	190	1	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/8/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		2.5
cis-1,2-Dichloroethylene_156-59-2	33000	1	IW1	IW1-85-20170302	N	3/2/2017	3/15/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		2500
cis-1,2-Dichloroethylene_156-59-2	2.1	1	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		0.5
cis-1,2-Dichloroethylene_156-59-2	150	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		50
cis-1,2-Dichloroethylene_156-59-2	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2	U	0.5
cis-1,2-Dichloroethylene_156-59-2	1700	1	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	cis-1,2-Dichloroethylene	156-59-2		50
Tetrachloroethylene(PCE)_127-18-4	2.3	1	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	2100	1	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		25
Tetrachloroethylene(PCE)_127-18-4	92000	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		2500
Tetrachloroethylene(PCE)_127-18-4	3500	1	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/15/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		250
Tetrachloroethylene(PCE)_127-18-4	33	1	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	110	1	RD10	RD10-90-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		5
Tetrachloroethylene(PCE)_127-18-4	0.97	1	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	16	1	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	84	1	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		5
Tetrachloroethylene(PCE)_127-18-4	12	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	3.5	1	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	7.9	1	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	340	1	BP2	BP2-50-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		12
Tetrachloroethylene(PCE)_127-18-4	290	1	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		2.5
Tetrachloroethylene(PCE)_127-18-4	0.98	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	19000	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		250
Tetrachloroethylene(PCE)_127-18-4	13	1	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4	L	0.5
Tetrachloroethylene(PCE)_127-18-4	86	1	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		2.5
Tetrachloroethylene(PCE)_127-18-4	1100	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		25
Tetrachloroethylene(PCE)_127-18-4	5.4	1	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	16	1	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	4100	1	IW1	IW1-85-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		50
Tetrachloroethylene(PCE)_127-18-4	2500	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		25
Tetrachloroethylene(PCE)_127-18-4	15	1	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	3.2	1	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
Tetrachloroethylene(PCE)_127-18-4	1.1	1	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Tetrachloroethylene	127-18-4		0.5
trans-1,2-Dichloroethene_156-60-5	2300	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		50
trans-1,2-Dichloroethene_156-60-5	19	1	BP2	BP2-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	3.5	1	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	1.8	1	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	1.5	1	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	2.5	1	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	2100	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		25
trans-1,2-Dichloroethene_156-60-5	2.1	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	4.7	1	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	0.68	1	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	240	1	RD13	RD13-112.5-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		12
trans-1,2-Dichloroethene_156-60-5	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5	U	0.5
trans-1,2-Dichloroethene_156-60-5	1.6	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	7	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	17	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
trans-1,2-Dichloroethene_156-60-5	1400	1	IW1	IW1-85-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		25
trans-1,2-Dichloroethene_156-60-5	1.2	1	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	trans-1,2-Dichloroethylene	156-60-5		0.5
Trichloroethene (TCE)_79-01-6	10	1	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	0.82	1	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	2.3	1	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	9.3	1	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6	U	0.5
Trichloroethene (TCE)_79-01-6	270	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		25
Trichloroethene (TCE)_79-01-6	200	1	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		25
Trichloroethene (TCE)_79-01-6	50	1	RD13	RD13-112.5-20170224	N	2/24/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	6	1	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	50	1	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	0.5	0	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6	U	0.5
Trichloroethene (TCE)_79-01-6	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6	U	0.5
Trichloroethene (TCE)_79-01-6	11	1	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	29000	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		2500
Trichloroethene (TCE)_79-01-6	14	1	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	5800	1	IW1	IW1-85-20170302	N	3/2/2017	3/15/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		2500
Trichloroethene (TCE)_79-01-6	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6	U	0.5
Trichloroethene (TCE)_79-01-6	2.1	1	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	0.51	1	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	130	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		25
Trichloroethene (TCE)_79-01-6	5	1	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	140	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		50
Trichloroethene (TCE)_79-01-6	0.7	1	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6	L	0.5
Trichloroethene (TCE)_79-01-6	2.9	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		0.5
Trichloroethene (TCE)_79-01-6	310	1	BP2	BP2-50-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		12
Trichloroethene (TCE)_79-01-6	1300	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Trichloroethylene	79-01-6		25
Vinyl Chloride_75-01-4	2.2	1	MW4	OU2-MW4-95-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	4.3	1	RD12	RD12-142.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	0.5	0	RD10	RD10-90-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	7.8	1	RD11	RD11-97.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	4.7	1	BP3	BP3-50-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	0.5	0	IW1S	IW1S-48.5-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	2.6	1	MW6	OU2-MW6-120-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	0.5	0	MW1	OU2-MW1-75-20170301	N	3/1/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	0.5	0	MW13D	MW13D-110-20170221	N	2/21/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	9.2	1	MW3	OU2-MW3-90.5-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	180	1	MW2	OU2-MW2-49-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		25
Vinyl Chloride_75-01-4	4.6	1	IW2S	IW2S-50.3-20170302	N	3/2/2017	3/9/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	0.5	0	MW14	MW14-35.2-20170227	N	2/27/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	UL	0.5
Vinyl Chloride_75-01-4	74	1	RD13	RD13-112.5-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		12
Vinyl Chloride_75-01-4	8.4	1	MW1D	MW1D-80-20170228	N	2/28/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	38000	1	RD9	RD9-97.5-20170228	N	2/28/2017	3/8/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		2500
Vinyl Chloride_75-01-4	0.5	0	MW5	OU2-MW5-135-20170224	N	2/24/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	0.5	0	MW13	MW13-70.5-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	12000	1	IW1	IW1-85-20170302	N	3/2/2017	3/15/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		2500
Vinyl Chloride_75-01-4	0.5	0	MW16	MW16-34.6-20170301	N	3/1/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	16000	1	IW2	IW2-82.9-20170302	N	3/2/2017	3/15/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		2500
Vinyl Chloride_75-01-4	15	1	BP1	BP1-49.5-20170222	N	2/22/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	L	0.5
Vinyl Chloride_75-01-4	6.2	1	MW3	OU2-MW3-140-20170306	N	3/6/2017	3/10/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		0.5
Vinyl Chloride_75-01-4	79	1	BP2	BP2-50-20170222	N	2/22/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4		12
Vinyl Chloride_75-01-4	0.5	0	MW17	MW17-11-20170223	N	2/23/2017	3/6/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5
Vinyl Chloride_75-01-4	0.5	0	MW15	MW15-26-20170223	N	2/23/2017	3/7/2017	USEPA SOP DW-1	T	VOC	Vinyl chloride	75-01-4	U	0.5

TABLE B.2

PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE

TUTU WELLS SUPERFUND SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.19/13/2017 11:13:16 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

result (1,1,2-trichloroethane_79-00-5)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	24
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	1.3	Minimum Non-Detect	0.5
Maximum Detect	1.6	Maximum Non-Detect	0.5
Variance Detects	0.045	Percent Non-Detects	92.31%
Mean Detects	1.45	SD Detects	0.212
Median Detects	1.45	CV Detects	0.146
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.366	SD of Logged Detects	0.147

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.573	KM Standard Error of Mean	0.0712
KM SD	0.257	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.695	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.69	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.787	95% KM Chebyshev UCL	0.883
97.5% KM Chebyshev UCL	1.017	99% KM Chebyshev UCL	1.281

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	93.11	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0156	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	372.4	nu star (bias corrected)	N/A
Mean (detects)	1.45		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.573	SD (KM)	0.257
Variance (KM)	0.0658	SE of Mean (KM)	0.0712
k hat (KM)	4.99	k star (KM)	4.44
nu hat (KM)	259.5	nu star (KM)	230.9
theta hat (KM)	0.115	theta star (KM)	0.129
80% gamma percentile (KM)	0.781	90% gamma percentile (KM)	0.937
95% gamma percentile (KM)	1.081	99% gamma percentile (KM)	1.386

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (230.88, α)	196.7	Adjusted Chi Square Value (230.88, β)	194.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.673	95% Gamma Adjusted KM-UCL (use when n<50)	0.68

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.537	Mean in Log Scale	-0.802
SD in Original Scale	0.35	SD in Log Scale	0.612
95% t UCL (assumes normality of ROS data)	0.655	95% Percentile Bootstrap UCL	0.653
95% BCA Bootstrap UCL	0.683	95% Bootstrap t UCL	0.689
95% H-UCL (Log ROS)	0.696		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.612	KM Geo Mean	0.542
KM SD (logged)	0.284	95% Critical H Value (KM-Log)	1.806
KM Standard Error of Mean (logged)	0.0787	95% H-UCL (KM -Log)	0.626
KM SD (logged)	0.284	95% Critical H Value (KM-Log)	1.806
KM Standard Error of Mean (logged)	0.0787		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.342	Mean in Log Scale	-1.251
SD in Original Scale	0.329	SD in Log Scale	0.477
95% t UCL (Assumes normality)	0.452	95% H-Stat UCL	0.386

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.695	KM H-UCL	0.626
95% KM (BCA) UCL	N/A		

TABLE B.2

PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE

TUTU WELLS SUPERFUND SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (1,1-dichloroethene_75-35-4)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	20
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.74	Minimum Non-Detect	0.5
Maximum Detect	400	Maximum Non-Detect	0.5
Variance Detects	24674	Percent Non-Detects	76.92%
Mean Detects	111.9	SD Detects	157.1
Median Detects	49.75	CV Detects	1.404
Skewness Detects	1.55	Kurtosis Detects	2.203
Mean of Logged Detects	2.666	SD of Logged Detects	2.861

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.792	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	26.21	KM Standard Error of Mean	17.91
KM SD	83.36	95% KM (BCA) UCL	59.69
95% KM (t) UCL	56.8	95% KM (Percentile Bootstrap) UCL	57.9
95% KM (z) UCL	55.66	95% KM Bootstrap t UCL	121.5
90% KM Chebyshev UCL	79.93	95% KM Chebyshev UCL	104.3
97.5% KM Chebyshev UCL	138	99% KM Chebyshev UCL	204.4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.539	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.314	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.356	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.331	k star (bias corrected MLE)	0.277
Theta hat (MLE)	338.2	Theta star (bias corrected MLE)	404.7
nu hat (MLE)	3.97	nu star (bias corrected)	3.318
Mean (detects)	111.9		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	25.83
Maximum	400	Median	0.01
SD	85.13	CV	3.295
k hat (MLE)	0.127	k star (bias corrected MLE)	0.138
Theta hat (MLE)	202.9	Theta star (bias corrected MLE)	186.8
nu hat (MLE)	6.62	nu star (bias corrected)	7.19
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (7.19, α)	2.275	Adjusted Chi Square Value (7.19, β)	2.097
95% Gamma Approximate UCL (use when n>=50)	81.63	95% Gamma Adjusted UCL (use when n<50)	88.57

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	26.21	SD (KM)	83.36
Variance (KM)	6948	SE of Mean (KM)	17.91
k hat (KM)	0.0989	k star (KM)	0.113
nu hat (KM)	5.141	nu star (KM)	5.881
theta hat (KM)	265.1	theta star (KM)	231.7
80% gamma percentile (KM)	21.44	90% gamma percentile (KM)	72.96
95% gamma percentile (KM)	150.6	99% gamma percentile (KM)	391.2

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.88, α)	1.579	Adjusted Chi Square Value (5.88, β)	1.438
95% Gamma Approximate KM-UCL (use when n>=50)	97.59	95% Gamma Adjusted KM-UCL (use when n<50)	107.2

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.823	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	25.83	Mean in Log Scale	-6.443
SD in Original Scale	85.12	SD in Log Scale	6.77
95% t UCL (assumes normality of ROS data)	54.35	95% Percentile Bootstrap UCL	55.25
95% BCA Bootstrap UCL	72.51	95% Bootstrap t UCL	123.2

95% H-UCL (Log ROS)	2.731E+14

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.0822	KM Geo Mean	1.086
KM SD (logged)	1.891	95% Critical H Value (KM-Log)	3.831
KM Standard Error of Mean (logged)	0.406	95% H-UCL (KM -Log)	27.66
KM SD (logged)	1.891	95% Critical H Value (KM-Log)	3.831
KM Standard Error of Mean (logged)	0.406		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	26.02	Mean in Log Scale	-0.451
SD in Original Scale	85.07	SD in Log Scale	2.161
95% t UCL (Assumes normality)	54.51	95% H-Stat UCL	41.66

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	56.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (1,2,4-trichlorobenzene_120-82-1)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	22
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	1	Minimum Non-Detect	0.5
Maximum Detect	4.1	Maximum Non-Detect	0.5
Variance Detects	2.449	Percent Non-Detects	84.62%
Mean Detects	2.725	SD Detects	1.565
Median Detects	2.9	CV Detects	0.574
Skewness Detects	-0.218	Kurtosis Detects	-4.718
Mean of Logged Detects	0.846	SD of Logged Detects	0.682

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.842	KM Standard Error of Mean	0.218
KM SD	0.963	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.215	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.201	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.496	95% KM Chebyshev UCL	1.793
97.5% KM Chebyshev UCL	2.204	99% KM Chebyshev UCL	3.012

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.43	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.323	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.358	k star (bias corrected MLE)	1.006
Theta hat (MLE)	0.811	Theta star (bias corrected MLE)	2.708
nu hat (MLE)	26.87	nu star (bias corrected)	8.05
Mean (detects)	2.725		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.435
Maximum	4.1	Median	0.01
SD	1.135	CV	2.611
k hat (MLE)	0.252	k star (bias corrected MLE)	0.248
Theta hat (MLE)	1.727	Theta star (bias corrected MLE)	1.751
nu hat (MLE)	13.08	nu star (bias corrected)	12.91
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (12.91, α)	5.83	Adjusted Chi Square Value (12.91, β)	5.518
95% Gamma Approximate UCL (use when n>=50)	0.962	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.842	SD (KM)	0.963
Variance (KM)	0.927	SE of Mean (KM)	0.218
k hat (KM)	0.765	k star (KM)	0.703
nu hat (KM)	39.8	nu star (KM)	36.54
theta hat (KM)	1.101	theta star (KM)	1.199

80% gamma percentile (KM)	1.384	90% gamma percentile (KM)	2.112
95% gamma percentile (KM)	2.863	99% gamma percentile (KM)	4.654

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (36.54, α)	23.7	Adjusted Chi Square Value (36.54, β)	23.02
95% Gamma Approximate KM-UCL (use when n>=50)	1.298	95% Gamma Adjusted KM-UCL (use when n<50)	1.337

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.874	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.286	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.556	Mean in Log Scale	-2.092
SD in Original Scale	1.102	SD in Log Scale	1.87
95% t UCL (assumes normality of ROS data)	0.925	95% Percentile Bootstrap UCL	0.925
95% BCA Bootstrap UCL	1.076	95% Bootstrap t UCL	1.514
95% H-UCL (Log ROS)	2.94		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.456	KM Geo Mean	0.634
KM SD (logged)	0.602	95% Critical H Value (KM-Log)	2.057
KM Standard Error of Mean (logged)	0.136	95% H-UCL (KM -Log)	0.973
KM SD (logged)	0.602	95% Critical H Value (KM-Log)	2.057
KM Standard Error of Mean (logged)	0.136		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.631	Mean in Log Scale	-1.043
SD in Original Scale	1.06	SD in Log Scale	0.855
95% t UCL (Assumes normality)	0.986	95% H-Stat UCL	0.756

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.215

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (1,2-dichloroethane_107-06-2)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	24
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.65	Minimum Non-Detect	0.5
Maximum Detect	0.8	Maximum Non-Detect	0.5
Variance Detects	0.0113	Percent Non-Detects	92.31%
Mean Detects	0.725	SD Detects	0.106
Median Detects	0.725	CV Detects	0.146
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.327	SD of Logged Detects	0.147

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.517	KM Standard Error of Mean	0.0176
KM SD	0.0635	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.547	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.546	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.57	95% KM Chebyshev UCL	0.594
97.5% KM Chebyshev UCL	0.627	99% KM Chebyshev UCL	0.692

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	93.11	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00779	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	372.4	nu star (bias corrected)	N/A
Mean (detects)	0.725		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.517	SD (KM)	0.0635
Variance (KM)	0.00403	SE of Mean (KM)	0.0176
k hat (KM)	66.45	k star (KM)	58.81
nu hat (KM)	3455	nu star (KM)	3058
theta hat (KM)	0.00779	theta star (KM)	0.0088
80% gamma percentile (KM)	0.573	90% gamma percentile (KM)	0.605

95% gamma percentile (KM)	0.633	99% gamma percentile (KM)	0.687

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (N/A, α)	2930	Adjusted Chi Square Value (N/A, β)	2922
95% Gamma Approximate KM-UCL (use when n>=50)	0.54	95% Gamma Adjusted KM-UCL (use when n<50)	0.541

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.269	Mean in Log Scale	-1.496
SD in Original Scale	0.175	SD in Log Scale	0.612
95% t UCL (assumes normality of ROS data)	0.327	95% Percentile Bootstrap UCL	0.325
95% BCA Bootstrap UCL	0.334	95% Bootstrap t UCL	0.345
95% H-UCL (Log ROS)	0.348		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.665	KM Geo Mean	0.514
KM SD (logged)	0.102	95% Critical H Value (KM-Log)	1.713
KM Standard Error of Mean (logged)	0.0282	95% H-UCL (KM -Log)	0.535
KM SD (logged)	0.102	95% Critical H Value (KM-Log)	1.713
KM Standard Error of Mean (logged)	0.0282		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.287	Mean in Log Scale	-1.305
SD in Original Scale	0.131	SD in Log Scale	0.289
95% t UCL (Assumes normality)	0.33	95% H-Stat UCL	0.314

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.547	KM H-UCL	0.535
95% KM (BCA) UCL	N/A		

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (1,3-dichlorobenzene_541-73-1)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	4
Number of Detects	3	Number of Non-Detects	23
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.6	Minimum Non-Detect	0.5
Maximum Detect	0.74	Maximum Non-Detect	0.5
Variance Detects	0.0052	Percent Non-Detects	88.46%
Mean Detects	0.66	SD Detects	0.0721
Median Detects	0.64	CV Detects	0.109
Skewness Detects	1.152	Kurtosis Detects	N/A
Mean of Logged Detects	-0.419	SD of Logged Detects	0.107

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.276	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.518	KM Standard Error of Mean	0.0132
KM SD	0.0549	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.541	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.54	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.558	95% KM Chebyshev UCL	0.576
97.5% KM Chebyshev UCL	0.601	99% KM Chebyshev UCL	0.65

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	128.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00513	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	772.1	nu star (bias corrected)	N/A
Mean (detects)	0.66		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.

TABLE B.2
PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.271
Maximum	0.74	Median	0.25
SD	0.208	CV	0.767
k hat (MLE)	1.037	k star (bias corrected MLE)	0.943
Theta hat (MLE)	0.262	Theta star (bias corrected MLE)	0.288
nu hat (MLE)	53.91	nu star (bias corrected)	49.02
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (49.02, α)	33.95	Adjusted Chi Square Value (49.02, β)	33.12
95% Gamma Approximate UCL (use when n>=50)	0.392	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.518	SD (KM)	0.0549
Variance (KM)	0.00301	SE of Mean (KM)	0.0132
k hat (KM)	89.21	k star (KM)	78.95
nu hat (KM)	4639	nu star (KM)	4105
theta hat (KM)	0.00581	theta star (KM)	0.00657
80% gamma percentile (KM)	0.567	90% gamma percentile (KM)	0.595
95% gamma percentile (KM)	0.618	99% gamma percentile (KM)	0.664

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	3957	Adjusted Chi Square Value (N/A, β)	3948
95% Gamma Approximate KM-UCL (use when n>=50)	0.538	95% Gamma Adjusted KM-UCL (use when n<50)	0.539

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.265	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.372	Mean in Log Scale	-1.055
SD in Original Scale	0.141	SD in Log Scale	0.37
95% t UCL (assumes normality of ROS data)	0.419	95% Percentile Bootstrap UCL	0.418
95% BCA Bootstrap UCL	0.423	95% Bootstrap t UCL	0.428
95% H-UCL (Log ROS)	0.428		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.662	KM Geo Mean	0.516
KM SD (logged)	0.0924	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0222	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0924	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0222		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.297	Mean in Log Scale	-1.275
SD in Original Scale	0.135	SD in Log Scale	0.316
95% t UCL (Assumes normality)	0.343	95% H-Stat UCL	0.33

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.541

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (1,4-dichlorobenzene_106-46-7)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	21
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	0.53	Minimum Non-Detect	0.5
Maximum Detect	2.8	Maximum Non-Detect	0.5
Variance Detects	0.961	Percent Non-Detects	80.77%
Mean Detects	1.45	SD Detects	0.98
Median Detects	1.2	CV Detects	0.676
Skewness Detects	0.606	Kurtosis Detects	-1.641
Mean of Logged Detects	0.168	SD of Logged Detects	0.73

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.201	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.683	KM Standard Error of Mean	0.118
KM SD	0.537	95% KM (BCA) UCL	0.872
95% KM (t) UCL	0.884	95% KM (Percentile Bootstrap) UCL	0.885
95% KM (z) UCL	0.876	95% KM Bootstrap t UCL	1.018
90% KM Chebyshev UCL	1.036	95% KM Chebyshev UCL	1.196
97.5% KM Chebyshev UCL	1.418	99% KM Chebyshev UCL	1.853

TABLE B.2
PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.315	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.238	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.613	k star (bias corrected MLE)	1.179
Theta hat (MLE)	0.555	Theta star (bias corrected MLE)	1.23
nu hat (MLE)	26.13	nu star (bias corrected)	11.79
Mean (detects)	1.45		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.287
Maximum	2.8	Median	0.01
SD	0.699	CV	2.436
k hat (MLE)	0.285	k star (bias corrected MLE)	0.278
Theta hat (MLE)	1.006	Theta star (bias corrected MLE)	1.033
nu hat (MLE)	14.83	nu star (bias corrected)	14.45
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (14.45, α)	6.88	Adjusted Chi Square Value (14.45, β)	6.536
95% Gamma Approximate UCL (use when n>=50)	0.603	95% Gamma Adjusted UCL (use when n<50)	0.634

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.683	SD (KM)	0.537
Variance (KM)	0.288	SE of Mean (KM)	0.118
k hat (KM)	1.618	k star (KM)	1.457
nu hat (KM)	84.16	nu star (KM)	75.78
theta hat (KM)	0.422	theta star (KM)	0.468
80% gamma percentile (KM)	1.06	90% gamma percentile (KM)	1.433
95% gamma percentile (KM)	1.796	99% gamma percentile (KM)	2.617

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (75.78, α)	56.73	Adjusted Chi Square Value (75.78, β)	55.64
95% Gamma Approximate KM-UCL (use when n>=50)	0.912	95% Gamma Adjusted KM-UCL (use when n<50)	0.93

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.342	Mean in Log Scale	-2.668
SD in Original Scale	0.681	SD in Log Scale	1.953
95% t UCL (assumes normality of ROS data)	0.57	95% Percentile Bootstrap UCL	0.57
95% BCA Bootstrap UCL	0.656	95% Bootstrap t UCL	0.897
95% H-UCL (Log ROS)	2.173		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.528	KM Geo Mean	0.59
KM SD (logged)	0.444	95% Critical H Value (KM-Log)	1.919
KM Standard Error of Mean (logged)	0.0974	95% H-UCL (KM -Log)	0.772
KM SD (logged)	0.444	95% Critical H Value (KM-Log)	1.919
KM Standard Error of Mean (logged)	0.0974		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.481	Mean in Log Scale	-1.087
SD in Original Scale	0.622	SD in Log Scale	0.69
95% t UCL (Assumes normality)	0.689	95% H-Stat UCL	0.575

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.884

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (bromodichloromethane_75-27-4)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	24
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	1.2	Minimum Non-Detect	0.5
Maximum Detect	2.7	Maximum Non-Detect	0.5
Variance Detects	1.125	Percent Non-Detects	92.31%

Mean Detects	1.95	SD Detects	1.061
Median Detects	1.95	CV Detects	0.544
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	0.588	SD of Logged Detects	0.573

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.612	KM Standard Error of Mean	0.122
KM SD	0.439	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.819	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.812	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.977	95% KM Chebyshev UCL	1.142
97.5% KM Chebyshev UCL	1.372	99% KM Chebyshev UCL	1.822

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	6.409	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.304	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	25.63	nu star (bias corrected)	N/A
Mean (detects)	1.95		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.612	SD (KM)	0.439
Variance (KM)	0.193	SE of Mean (KM)	0.122
k hat (KM)	1.942	k star (KM)	1.744
nu hat (KM)	101	nu star (KM)	90.67
theta hat (KM)	0.315	theta star (KM)	0.351
80% gamma percentile (KM)	0.93	90% gamma percentile (KM)	1.229
95% gamma percentile (KM)	1.516	99% gamma percentile (KM)	2.158

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (90.67, α)	69.72	Adjusted Chi Square Value (90.67, β)	68.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.795	95% Gamma Adjusted KM-UCL (use when n<50)	0.809

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.203	Mean in Log Scale	-3.976
SD in Original Scale	0.564	SD in Log Scale	2.39
95% t UCL (assumes normality of ROS data)	0.392	95% Percentile Bootstrap UCL	0.418
95% BCA Bootstrap UCL	0.5	95% Bootstrap t UCL	1.202
95% H-UCL (Log ROS)	3.012		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.595	KM Geo Mean	0.552
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.856
KM Standard Error of Mean (logged)	0.0997	95% H-UCL (KM -Log)	0.673
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.856
KM Standard Error of Mean (logged)	0.0997		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.381	Mean in Log Scale	-1.234
SD in Original Scale	0.508	SD in Log Scale	0.549
95% t UCL (Assumes normality)	0.551	95% H-Stat UCL	0.422

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.142

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (chlorobenzene_108-90-7)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	21
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	1.9	Minimum Non-Detect	0.5
Maximum Detect	48	Maximum Non-Detect	0.5
Variance Detects	392	Percent Non-Detects	80.77%
Mean Detects	18.82	SD Detects	19.8
Median Detects	11	CV Detects	1.052
Skewness Detects	0.919	Kurtosis Detects	-0.793
Mean of Logged Detects	2.295	SD of Logged Detects	1.39

TABLE B.2

PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE

TUTU WELLS SUPERFUND SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.023	KM Standard Error of Mean	2.325
KM SD	10.6	95% KM (BCA) UCL	7.688
95% KM (t) UCL	7.994	95% KM (Percentile Bootstrap) UCL	7.673
95% KM (z) UCL	7.847	95% KM Bootstrap t UCL	12.95
90% KM Chebyshev UCL	11	95% KM Chebyshev UCL	14.16
97.5% KM Chebyshev UCL	18.54	99% KM Chebyshev UCL	27.16

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.284	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.694	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.224	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.365	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.912	k star (bias corrected MLE)	0.498
Theta hat (MLE)	20.63	Theta star (bias corrected MLE)	37.78
nu hat (MLE)	9.121	nu star (bias corrected)	4.982
Mean (detects)	18.82		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.627
Maximum	48	Median	0.01
SD	10.95	CV	3.018
k hat (MLE)	0.166	k star (bias corrected MLE)	0.172
Theta hat (MLE)	21.87	Theta star (bias corrected MLE)	21.05
nu hat (MLE)	8.623	nu star (bias corrected)	8.962
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (8.96, α)	3.304	Adjusted Chi Square Value (8.96, β)	3.08
95% Gamma Approximate UCL (use when n>=50)	9.839	95% Gamma Adjusted UCL (use when n<50)	10.55

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.023	SD (KM)	10.6
Variance (KM)	112.4	SE of Mean (KM)	2.325
k hat (KM)	0.144	k star (KM)	0.153
nu hat (KM)	7.486	nu star (KM)	7.955
theta hat (KM)	27.95	theta star (KM)	26.3
80% gamma percentile (KM)	4.45	90% gamma percentile (KM)	11.96
95% gamma percentile (KM)	22.06	99% gamma percentile (KM)	51.24

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.96, α)	2.709	Adjusted Chi Square Value (7.96, β)	2.511
95% Gamma Approximate KM-UCL (use when n>=50)	11.81	95% Gamma Adjusted KM-UCL (use when n<50)	12.75

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.192	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.714	Mean in Log Scale	-3.075
SD in Original Scale	10.92	SD in Log Scale	3.699
95% t UCL (assumes normality of ROS data)	7.373	95% Percentile Bootstrap UCL	7.422
95% BCA Bootstrap UCL	8.859	95% Bootstrap t UCL	19.82
95% H-UCL (Log ROS)	7205		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.118	KM Geo Mean	0.888
KM SD (logged)	1.298	95% Critical H Value (KM-Log)	2.915
KM Standard Error of Mean (logged)	0.285	95% H-UCL (KM -Log)	4.395
KM SD (logged)	1.298	95% Critical H Value (KM-Log)	2.915
KM Standard Error of Mean (logged)	0.285		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.821	Mean in Log Scale	-0.678
SD in Original Scale	10.88	SD in Log Scale	1.581
95% t UCL (Assumes normality)	7.467	95% H-Stat UCL	5.088

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	7.994

TABLE B.2
PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (cis-1,2-dichloroethylene_156-59-2)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
Number of Detects	24	Number of Non-Detects	2
Number of Distinct Detects	23	Number of Distinct Non-Detects	1
Minimum Detect	0.67	Minimum Non-Detect	0.5
Maximum Detect	160000	Maximum Non-Detect	0.5
Variance Detects	1.103E+9	Percent Non-Detects	7.692%
Mean Detects	9383	SD Detects	33208
Median Detects	71.5	CV Detects	3.539
Skewness Detects	4.43	Kurtosis Detects	20.49
Mean of Logged Detects	4.478	SD of Logged Detects	3.275

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.319	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.466	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8661	KM Standard Error of Mean	6277
KM SD	31334	95% KM (BCA) UCL	18606
95% KM (t) UCL	19383	95% KM (Percentile Bootstrap) UCL	20776
95% KM (z) UCL	18986	95% KM Bootstrap t UCL	444124
90% KM Chebyshev UCL	27493	95% KM Chebyshev UCL	36023
97.5% KM Chebyshev UCL	47862	99% KM Chebyshev UCL	71118

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.783	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.933	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.311	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.2	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.163	k star (bias corrected MLE)	0.17
Theta hat (MLE)	57682	Theta star (bias corrected MLE)	55158
nu hat (MLE)	7.808	nu star (bias corrected)	8.165
Mean (detects)	9383		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	8661
Maximum	160000	Median	48
SD	31954	CV	3.689
k hat (MLE)	0.146	k star (bias corrected MLE)	0.155
Theta hat (MLE)	59349	Theta star (bias corrected MLE)	55973
nu hat (MLE)	7.589	nu star (bias corrected)	8.046
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (8.05, α)	2.762	Adjusted Chi Square Value (8.05, β)	2.561
95% Gamma Approximate UCL (use when n>=50)	25233	95% Gamma Adjusted UCL (use when n<50)	27212

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8661	SD (KM)	31334
Variance (KM)	9.818E+8	SE of Mean (KM)	6277
k hat (KM)	0.0764	k star (KM)	0.0932
nu hat (KM)	3.973	nu star (KM)	4.848
theta hat (KM)	113356	theta star (KM)	92899
80% gamma percentile (KM)	5402	90% gamma percentile (KM)	22343
95% gamma percentile (KM)	50424	99% gamma percentile (KM)	142453

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (4.85, α)	1.083	Adjusted Chi Square Value (4.85, β)	0.972
95% Gamma Approximate KM-UCL (use when n>=50)	38785	95% Gamma Adjusted KM-UCL (use when n<50)	43193

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8661	Mean in Log Scale	3.882
SD in Original Scale	31954	SD in Log Scale	3.785
95% t UCL (assumes normality of ROS data)	19365	95% Percentile Bootstrap UCL	19977
95% BCA Bootstrap UCL	27041	95% Bootstrap t UCL	52144
95% H-UCL (Log ROS)	13188611		

TABLE B.2

PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE

TUTU WELLS SUPERFUND SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.08	KM Geo Mean	59.14
KM SD (logged)	3.375	95% Critical H Value (KM-Log)	6.347
KM Standard Error of Mean (logged)	0.676	95% H-UCL (KM -Log)	1274301
KM SD (logged)	3.375	95% Critical H Value (KM-Log)	6.347
KM Standard Error of Mean (logged)	0.676		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	8661	Mean in Log Scale	4.027
SD in Original Scale	31954	SD in Log Scale	3.523
95% t UCL (Assumes normality)	19365	95% H-Stat UCL	2913408

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL 71118

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (tetrachloroethylene(pce)_127-18-4)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	0.97	Mean	4821
Maximum	92000	Median	24.5
SD	18179	Std. Error of Mean	3565
Coefficient of Variation	3.771	Skewness	4.784

Normal GOF Test

Shapiro Wilk Test Statistic	0.292	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.439	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.17	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	10911	95% Adjusted-CLT UCL (Chen-1995)	14259
		95% Modified-t UCL (Johnson-1978)	11468

Gamma GOF Test

A-D Test Statistic	2.384	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.924	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.244	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.192	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.175	k star (bias corrected MLE)	0.181
Theta hat (MLE)	27488	Theta star (bias corrected MLE)	26666
nu hat (MLE)	9.12	nu star (bias corrected)	9.401
MLE Mean (bias corrected)	4821	MLE Sd (bias corrected)	11338
		Approximate Chi Square Value (0.05)	3.571
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	3.336

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	12692	95% Adjusted Gamma UCL (use when n<50)	13584

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.17	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.0305	Mean of logged Data	4.199
Maximum of Logged Data	11.43	SD of logged Data	3.225

Assuming Lognormal Distribution

95% H-UCL	612427	90% Chebyshev (MVUE) UCL	17533
95% Chebyshev (MVUE) UCL	23151	97.5% Chebyshev (MVUE) UCL	30948
99% Chebyshev (MVUE) UCL	46264		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	10685	95% Jackknife UCL	10911
95% Standard Bootstrap UCL	10528	95% Bootstrap-t UCL	73331
95% Hall's Bootstrap UCL	44113	95% Percentile Bootstrap UCL	11822
95% BCA Bootstrap UCL	15644		

90% Chebyshev(Mean, Sd) UCL	15516	95% Chebyshev(Mean, Sd) UCL	20361
97.5% Chebyshev(Mean, Sd) UCL	27085	99% Chebyshev(Mean, Sd) UCL	40294

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL 40294

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (trans-1,2-dichloroethene_156-60-5)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	10
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	0.68	Minimum Non-Detect	0.5
Maximum Detect	2300	Maximum Non-Detect	0.5
Variance Detects	626051	Percent Non-Detects	38.46%
Mean Detects	381.4	SD Detects	791.2
Median Detects	4.1	CV Detects	2.074
Skewness Detects	1.931	Kurtosis Detects	2.288
Mean of Logged Detects	2.597	SD of Logged Detects	2.826

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.542	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.427	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	234.9	KM Standard Error of Mean	127.4
KM SD	628.9	95% KM (BCA) UCL	448.2
95% KM (t) UCL	452.5	95% KM (Percentile Bootstrap) UCL	449.3
95% KM (z) UCL	444.4	95% KM Bootstrap t UCL	648.9
90% KM Chebyshev UCL	617.1	95% KM Chebyshev UCL	790.2
97.5% KM Chebyshev UCL	1030	99% KM Chebyshev UCL	1502

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.093	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.876	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.341	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.237	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.217	k star (bias corrected MLE)	0.218
Theta hat (MLE)	1757	Theta star (bias corrected MLE)	1749
nu hat (MLE)	6.947	nu star (bias corrected)	6.978
Mean (detects)	381.4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	234.7
Maximum	2300	Median	1.55
SD	641.4	CV	2.733
k hat (MLE)	0.138	k star (bias corrected MLE)	0.148
Theta hat (MLE)	1699	Theta star (bias corrected MLE)	1588
nu hat (MLE)	7.182	nu star (bias corrected)	7.686
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (7.69, α)	2.555	Adjusted Chi Square Value (7.69, β)	2.363
95% Gamma Approximate UCL (use when n>=50)	706.2	95% Gamma Adjusted UCL (use when n<50)	763.4

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	234.9	SD (KM)	628.9
Variance (KM)	395525	SE of Mean (KM)	127.4
k hat (KM)	0.14	k star (KM)	0.149
nu hat (KM)	7.255	nu star (KM)	7.751
theta hat (KM)	1684	theta star (KM)	1576
80% gamma percentile (KM)	254.4	90% gamma percentile (KM)	696
95% gamma percentile (KM)	1294	99% gamma percentile (KM)	3034

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.75, α)	2.592	Adjusted Chi Square Value (7.75, β)	2.398
95% Gamma Approximate KM-UCL (use when n>=50)	702.5	95% Gamma Adjusted KM-UCL (use when n<50)	759.1

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.815	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	234.7	Mean in Log Scale	-0.144

SD in Original Scale	641.4	SD in Log Scale	4.349
95% t UCL (assumes normality of ROS data)	449.6	95% Percentile Bootstrap UCL	448.5
95% BCA Bootstrap UCL	527.5	95% Bootstrap t UCL	651.4
95% H-UCL (Log ROS)	12302861		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.332	KM Geo Mean	3.788
KM SD (logged)	2.677	95% Critical H Value (KM-Log)	5.143
KM Standard Error of Mean (logged)	0.542	95% H-UCL (KM -Log)	2144
KM SD (logged)	2.677	95% Critical H Value (KM-Log)	5.143
KM Standard Error of Mean (logged)	0.542		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	234.8	Mean in Log Scale	1.065
SD in Original Scale	641.4	SD in Log Scale	2.949
95% t UCL (Assumes normality)	449.7	95% H-Stat UCL	6136

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	1502

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (trichloroethene (tce)_79-01-6)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	22
Number of Detects	22	Number of Non-Detects	4
Number of Distinct Detects	21	Number of Distinct Non-Detects	1
Minimum Detect	0.51	Minimum Non-Detect	0.5
Maximum Detect	29000	Maximum Non-Detect	0.5
Variance Detects	38728143	Percent Non-Detects	15.38%
Mean Detects	1696	SD Detects	6223
Median Detects	12.5	CV Detects	3.669
Skewness Detects	4.421	Kurtosis Detects	20.03
Mean of Logged Detects	3.398	SD of Logged Detects	2.935

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.301	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.452	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1435	KM Standard Error of Mean	1129
KM SD	5626	95% KM (BCA) UCL	3637
95% KM (t) UCL	3364	95% KM (Percentile Bootstrap) UCL	3616
95% KM (z) UCL	3293	95% KM Bootstrap t UCL	31539
90% KM Chebyshev UCL	4823	95% KM Chebyshev UCL	6358
97.5% KM Chebyshev UCL	8488	99% KM Chebyshev UCL	12672

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.384	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.911	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.287	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.207	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.185	k star (bias corrected MLE)	0.19
Theta hat (MLE)	9191	Theta star (bias corrected MLE)	8942
nu hat (MLE)	8.119	nu star (bias corrected)	8.346
Mean (detects)	1696		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1435
Maximum	29000	Median	9.65
SD	5738	CV	3.998
k hat (MLE)	0.151	k star (bias corrected MLE)	0.159
Theta hat (MLE)	9532	Theta star (bias corrected MLE)	9036
nu hat (MLE)	7.829	nu star (bias corrected)	8.259
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (8.26, α)	2.886	Adjusted Chi Square Value (8.26, β)	2.68
95% Gamma Approximate UCL (use when n>=50)	4107	95% Gamma Adjusted UCL (use when n<50)	4423

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1435	SD (KM)	5626
Variance (KM)	31654700	SE of Mean (KM)	1129

k hat (KM)	0.0651	k star (KM)	0.0832
nu hat (KM)	3.384	nu star (KM)	4.327
theta hat (KM)	22055	theta star (KM)	17249
80% gamma percentile (KM)	736.1	90% gamma percentile (KM)	3486
95% gamma percentile (KM)	8358	99% gamma percentile (KM)	24948

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (4.33, α)	0.855	Adjusted Chi Square Value (4.33, β)	0.761
95% Gamma Approximate KM-UCL (use when n>=50)	7264	95% Gamma Adjusted KM-UCL (use when n<50)	8161

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1435	Mean in Log Scale	2.34
SD in Original Scale	5738	SD in Log Scale	3.717
95% t UCL (assumes normality of ROS data)	3357	95% Percentile Bootstrap UCL	3612
95% BCA Bootstrap UCL	4937	95% Bootstrap t UCL	31261
95% H-UCL (Log ROS)	1813581		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.769	KM Geo Mean	15.94
KM SD (logged)	3.022	95% Critical H Value (KM-Log)	5.736
KM Standard Error of Mean (logged)	0.607	95% H-UCL (KM -Log)	49216
KM SD (logged)	3.022	95% Critical H Value (KM-Log)	5.736
KM Standard Error of Mean (logged)	0.607		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1435	Mean in Log Scale	2.662
SD in Original Scale	5738	SD in Log Scale	3.215
95% t UCL (Assumes normality)	3357	95% H-Stat UCL	124342

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL 12672

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).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

result (vinyl chloride_75-01-4)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	10
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	2.2	Minimum Non-Detect	0.5
Maximum Detect	38000	Maximum Non-Detect	0.5
Variance Detects	1.046E+8	Percent Non-Detects	38.46%
Mean Detects	4150	SD Detects	10226
Median Detects	8.8	CV Detects	2.464
Skewness Detects	2.852	Kurtosis Detects	8.503
Mean of Logged Detects	3.793	SD of Logged Detects	3.268

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.484	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.464	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2554	KM Standard Error of Mean	1625
KM SD	8025	95% KM (BCA) UCL	5469
95% KM (t) UCL	5330	95% KM (Percentile Bootstrap) UCL	5471
95% KM (z) UCL	5228	95% KM Bootstrap t UCL	9818
90% KM Chebyshev UCL	7430	95% KM Chebyshev UCL	9639
97.5% KM Chebyshev UCL	12705	99% KM Chebyshev UCL	18727

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.475	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.915	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.339	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.241	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.167	k star (bias corrected MLE)	0.177
Theta hat (MLE)	24885	Theta star (bias corrected MLE)	23424
nu hat (MLE)	5.336	nu star (bias corrected)	5.669
Mean (detects)	4150		

TABLE B.2

PROUCL 5.1 RAW OUTPUT FOR GROUNDWATER - SITE-WIDE

TUTU WELLS SUPERFUND SITE

ST. THOMAS, U.S. VIRGIN ISLANDS

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2554
Maximum	38000	Median	4.45
SD	8184	CV	3.205
k hat (MLE)	0.11	k star (bias corrected MLE)	0.123
Theta hat (MLE)	23185	Theta star (bias corrected MLE)	20749
nu hat (MLE)	5.728	nu star (bias corrected)	6.4
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (6.40, α)	1.848	Adjusted Chi Square Value (6.40, β)	1.691
95% Gamma Approximate UCL (use when n>=50)	8846	95% Gamma Adjusted UCL (use when n<50)	9665

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2554	SD (KM)	8025
Variance (KM)	64402076	SE of Mean (KM)	1625
k hat (KM)	0.101	k star (KM)	0.115
nu hat (KM)	5.267	nu star (KM)	5.992
theta hat (KM)	25217	theta star (KM)	22163
80% gamma percentile (KM)	2137	90% gamma percentile (KM)	7152
95% gamma percentile (KM)	14645	99% gamma percentile (KM)	37752

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.99, α)	1.636	Adjusted Chi Square Value (5.99, β)	1.491
95% Gamma Approximate KM-UCL (use when n>=50)	9355	95% Gamma Adjusted KM-UCL (use when n<50)	10264

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2554	Mean in Log Scale	0.661
SD in Original Scale	8184	SD in Log Scale	4.984
95% t UCL (assumes normality of ROS data)	5295	95% Percentile Bootstrap UCL	5469
95% BCA Bootstrap UCL	7160	95% Bootstrap t UCL	9803
95% H-UCL (Log ROS)	4.577E+9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.068	KM Geo Mean	7.908
KM SD (logged)	3.305	95% Critical H Value (KM-Log)	6.227
KM Standard Error of Mean (logged)	0.67	95% H-UCL (KM -Log)	114365
KM SD (logged)	3.305	95% Critical H Value (KM-Log)	6.227
KM Standard Error of Mean (logged)	0.67		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2554	Mean in Log Scale	1.801
SD in Original Scale	8184	SD in Log Scale	3.607
95% t UCL (Assumes normality)	5295	95% H-Stat UCL	529769

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	18727

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).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ATTACHMENT C

VADEQ Calculator Outputs of Air Concentrations in a Trench

(Based on Groundwater Concentrations)

ATTACHMENT C TABLE OF CONTENTS:

TABLE C.1

Virginia Department of Environmental Quality (VADEQ)

3.2.2 Exposure of Workers to Volatiles in a Construction/Utility Trench

Inputs

For Mass-Transfer Coefficients			For Emission Flux and Concentration in Trench			Trench dimensions		
Kg,H2O	0.833	cm/s	CF1	1.00E-03	L/cm3	Length	**8**	ft
MWH2O	18		CF2	1.00E+04	cm2/m2		2.44	m
Kl,O2	0.002	cm/s	CF3	3600	s/hr	Width	**3**	ft
MWO2	32		F	**1**			0.91	m
T	**25**	F	ACH	2	hr-1	Depth	**8**	ft
T	269	K					2.44	m
R	8.20E-05	atm-m3/mol-K				Width/Depth	0.38	

Note:

Calculator defaults were applied.

References:

VADEQ 2007. Voluntary Remediation Program - Risk Assessment Guidance. 3.2.2 Exposure of Workers to Volatiles in a Construction/Utility Trench. October 7. Available online: http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RemediationProgram/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Guidance.aspx#3.22

TABLE C.2
Virginia Department of Environmental Quality (VADEQ)
3.2.2 Exposure of Workers to Volatiles in a Construction/Utility Trench
Calculation of Chemical Concentrations in Air using Groundwater - Site-wide

VADEQ Table 3.8 Exposure-point concentrations (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep revised 10/5/07 Chemical	CAS No.	Molecular Weight MWi g/mol	Henry's Law Constant Hi atm-m3/mol	Gas-Phase Mass Transfer Coefficient KiG cm/s	Liquid-Phase Mass Transfer Coefficient KiL cm/s	Overall Mass Transfer Coefficient Ki cm/s	EPC Concentration of Contaminant in Groundwater Cgw ug/L	Volatilization Factor VF L/m3	Concentration of Contaminant in Trench Ctrench ug/m3	Concentration of Contaminant in Trench Ctrench mg/m3
Bromodichloromethane	75-27-4	163.83	1.60E-03	3.59E-01	7.98E-04	7.74E-04	1.14E+00	5.71E+00	6.53E+00	6.53E-03
Chlorobenzene	108-90-7	112.56	3.70E-03	4.07E-01	9.63E-04	9.49E-04	7.99E+00	7.01E+00	5.60E+01	5.60E-02
1,3-Dichlorobenzene (meta	541-73-1	147.00	3.10E-03	3.72E-01	8.42E-04	8.29E-04	5.41E-01	6.12E+00	3.31E+00	3.31E-03
1,4-Dichlorobenzene (para)	106-46-7	147.00	2.43E-03	3.72E-01	8.42E-04	8.25E-04	8.84E-01	6.09E+00	5.39E+00	5.39E-03
1,2-Dichloroethane	107-06-2	98.96	9.79E-04	4.25E-01	1.03E-03	9.74E-04	5.47E-01	7.19E+00	3.93E+00	3.93E-03
1,1-Dichloroethene	75-35-4	96.94	2.61E-02	4.28E-01	1.04E-03	1.04E-03	5.68E+01	7.64E+00	4.34E+02	4.34E-01
cis-1,2-Dichloroethene	156-59-2	96.94	4.08E-03	4.28E-01	1.04E-03	1.02E-03	7.11E+04	7.56E+00	5.37E+05	5.37E+02
trans-1,2-Dichloroethene	156-60-5	96.94	9.38E-03	4.28E-01	1.04E-03	1.03E-03	1.50E+03	7.61E+00	1.14E+04	1.14E+01
Tetrachloroethene	127-18-4	165.83	1.84E-02	3.57E-01	7.93E-04	7.91E-04	4.03E+04	5.84E+00	2.35E+05	2.35E+02
1,2,4-Trichlorobenzene	120-82-1	181.45	1.42E-03	3.47E-01	7.58E-04	7.33E-04	1.22E+00	5.41E+00	6.58E+00	6.58E-03
1,1,2-Trichloroethane	79-00-5	133.40	9.13E-04	3.84E-01	8.84E-04	8.38E-04	6.95E-01	6.18E+00	4.30E+00	4.30E-03
Trichloroethene	79-01-6	131.39	1.03E-02	3.86E-01	8.91E-04	8.87E-04	1.27E+04	6.54E+00	8.29E+04	8.29E+01
Vinyl Chloride	75-01-4	62.50	2.70E-02	4.95E-01	1.29E-03	1.29E-03	1.87E+04	9.52E+00	1.78E+05	1.78E+02

Note:
The groundwater concentrations are the same exposure point concentrations (EPCs) that are used in the risk assessment.

References:

VADEQ 2007. Voluntary Remediation Program - Risk Assessment Guidance. 3.2.2 Exposure of Workers to Volatiles in a Construction/Utility Trench. October 7. Available online:
http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RemediationProgram/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Guidance.aspx#3.22

ATTACHMENT D

Vapor Intrusion Screening Level Assessment

ATTACHMENT D TABLE OF CONTENTS:

TABLE D.1
CALCULATION OF DEFAULT RESIDENTIAL VISLS
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

OSWER VAPOR INTRUSION ASSESSMENT
Vapor Intrusion Screening Level (VISL) Calculator Version 3.5 (June 2017 RSLs) - updated 12/14/2017 for Nov RSLs, version 3.5.2

The primary objective of risk-based screening is to identify sites or buildings unlikely to pose a health concern through the vapor intrusion pathway. Generally, at properties where subsurface concentrations of vapor-forming chemicals (e.g., groundwater or "near source" soil gas concentrations) fall below screening levels (i.e., VISLs), no further action or study is warranted, so long as the exposure assumptions match those taken into account by the calculations and the site fulfills the conditions and assumptions of the generic conceptual model underlying the screening levels. In a similar fashion, the results of risk-based screening can help the data review team identify areas, buildings, and/or chemicals that can be eliminated from further assessment. The generic conceptual model underlying these screening levels is described in OSWER Publication 9200.2-154 (OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Vapor Sources to Indoor Air) (EPA 2015; Section 6.5)

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Residential	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? Cvp > Cia,target?	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? Chc > Cia,target?	Target Indoor Air Conc. @ TCR = 1E-06 or THQ = 1 MIN(Cia,c;Cia,nc)	Toxicity Basis	Target Sub-Slab and Exterior Soil Gas Conc. @ TCR = 1E-06 or THQ = 1 Csg	Target Ground Water Conc. @ TCR = 1E-06 or THQ = 1 Cgw	Is Target Ground Water Conc. < MCL? Cgw<MCL?	Pure Phase Vapor Conc. @ 25°C Cvp	Maximum Groundwater Vapor Conc. Chc	Temperature for Max. Groundwater Vapor Conc. Tgw or 25	Lower Explosive Limit** LEL	LEL Source	Inhalation Unit Risk IUR	IUR Source*	Reference Concentration RfC	RFC Source*	Mutagenic Indicator i	Target Indoor Air Conc. for Carcinogens @ TCR = 1E-06 Cia,c	Target Indoor Air Conc. for Non-Carcinogens @ THQ = 1 Cia,nc
		Yes/No	Yes/No	Yes/No	Yes/No	(ug/m^3)	C/NC	(ug/m^3)	(ug/L)	Yes/No (MCL ug/L)	(ug/m^3)	(ug/m^3)	C	(% by vol)		(ug/m^3)$^{-1}$		(mg/m^3)			(ug/m^3)	(ug/m^3)
75-27-4	Bromodichloromethane	Yes	Yes	Yes	Yes	7.6E-02	C	2.5E+00	8.8E-01	Yes (8.0E+01(F))	4.41E+08	2.63E+08	25			3.70E-05	CA				7.6E-02	
108-90-7	Chlorobenzene	Yes	No	Yes	Yes	5.2E+01	NC	1.7E+03	4.1E+02	No (100)	7.25E+07	6.33E+07	25	1.3	N			5.00E-02	P			5.2E+01
106-46-7	Dichlorobenzene, 1,4-	Yes	Yes	Yes	Yes	2.6E-01	C	8.5E+00	2.6E+00	Yes (75)	1.38E+07	8.01E+06	25	2.5	N	1.10E-05	CA	8.00E-01	I		2.6E-01	8.3E+02
107-06-2	Dichloroethane, 1,2-	Yes	No	Yes	Yes	1.1E-01	C	3.6E+00	2.2E+00	Yes (5)	4.20E+08	4.15E+08	25	6.2	N	2.60E-05	I	7.00E-03	P		1.1E-01	7.3E+00
75-35-4	Dichloroethylene, 1,1-	Yes	No	Yes	Yes	2.1E+02	NC	7.0E+03	2.0E+02	No (7)	3.13E+09	2.58E+09	25	6.5	N			2.00E-01	I			2.1E+02
156-59-2	Dichloroethylene, 1,2-cis-	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	--	--	--	--	No (70)	1.04E+09	1.07E+09	25	9.7	M							
156-60-5	Dichloroethylene, 1,2-trans-	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	--	--	--	--	No (100)	1.73E+09	1.73E+09	25	9.7	M							
127-18-4	Tetrachloroethylene	Yes	No	Yes	Yes	1.1E+01	C	3.6E+02	1.5E+01	No (5)	1.65E+08	1.49E+08	25			2.60E-07	I	4.00E-02	I		1.1E+01	4.2E+01
120-82-1	Trichlorobenzene, 1,2,4-	Yes	No	Yes	Yes	2.1E+00	NC	7.0E+01	3.6E+01	Yes (70)	4.49E+06	2.84E+06	25	2.5	N			2.00E-03	P			2.1E+00
79-00-5	Trichloroethane, 1,1,2-	Yes	Yes	Yes	Yes	1.8E-01	C	5.8E+00	5.2E+00	No (5)	1.65E+08	1.55E+08	25	6	N	1.60E-05	I	2.00E-04	X		1.8E-01	2.1E-01
79-01-6	Trichloroethylene	Yes	Yes	Yes	Yes	4.8E-01	C	1.6E+01	1.2E+00	Yes (5)	4.88E+08	5.15E+08	25	8	N	see note	I	2.00E-03	I	TCE	4.8E-01	2.1E+00
75-01-4	Vinyl Chloride	Yes	Yes	Yes	Yes	1.7E-01	C	5.6E+00	1.5E-01	Yes (2)	1.00E+10	1.00E+10	25	3.6	N	4.40E-06	I	1.00E-01	I	VC	1.7E-01	1.0E+02

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
Averaging time for carcinogens	(yrs)	ATc_R	70	ATc_C	70	ATc	70
Averaging time for non-carcinogens	(yrs)	ATnc_R	26	ATnc_C	25	ATnc	26
Exposure duration	(yrs)	ED_R	26	ED_C	25	ED	26
Exposure frequency	(days/yr)	EF_R	350	EF_C	250	EF	350
Exposure time	(hr/day)	ET_R	24	ET_C	8	ET	24

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
Groundwater (-)	AFgw_R	0.001	AFgw_C	0.001	AFgw	0.001
Sub-Slab and Exterior Soil Gas (-)	AFss_R	0.03	AFss_C	0.03	AFss	0.03

(3) **Formulas**
Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**
Trichloroethylene

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
mIURTCE	mIURTCE_R	1.00E-06	mIURTCE_C	0.00E+00	mIURTCE	1.00E-06
IURTCE	IURTCE_R	3.10E-06	IURTCE_C	4.10E-06	IURTCE	3.10E-06

Mutagenic Chemicals

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Age Cohort	Exposure Duration (years)	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 72 This factor is used in the equations for mutagenic chemicals.

See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:
NVT = Not sufficiently volatile and/or toxic to pose inhalation risk in selected exposure scenario for the indicated medium
C = Carcinogenic
NC = Non-carcinogenic
I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
E = The Engineering ToolBox. Available online at http://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html
N = Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. Available online at: http://www.cdc.gov/niosh/npg/default.html http://www.cdc.gov/niosh/npg/default.html
M = Chemical-specific MSDS
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user.
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.
**Lower explosive limit is the minimum concentration of the compound in air (% by volume) that is needed for the gas to ignite and explode.

TABLE D.2
CALCULATION OF DEFAULT COMMERCIAL VISLS
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

OSWER VAPOR INTRUSION ASSESSMENT
Vapor Intrusion Screening Level (VISL) Calculator Version 3.5 (June 2017 RSLs) - updated 12/14/2017 for Nov RSLs, version 3.5.2

The primary objective of risk-based screening is to identify sites or buildings unlikely to pose a health concern through the vapor intrusion pathway. Generally, at properties where subsurface concentrations of vapor-forming chemicals (e.g., groundwater or "near source" soil gas concentrations) fall below screening levels (i.e., VISLs), no further action or study is warranted, so long as the exposure assumptions match those taken into account by the calculations and the site fulfills the conditions and assumptions of the generic conceptual model underlying the screening levels. In a similar fashion, the results of risk-based screening can help the data review team identify areas, buildings, and/or chemicals that can be eliminated from further assessment. The generic conceptual model underlying these screening levels is described in OSWER Publication 9200.2-154 (OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Vapor Sources to Indoor Air) (EPA 2015; Section 6.5)

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1) Yes/No	Does chemical have inhalation toxicity data? (IUR and/or RfC) Yes/No	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? Cvp > Cia,target? Yes/No	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? Chc > Cia,target? Yes/No	Target Indoor Air Conc. @ TCR = 1E-06 or THQ = 1 MIN(Cia,c;Cia,nc) (ug/m^3)	Toxicity Basis C/NC	Target Sub-Slab and Exterior Soil Gas Conc. @ TCR = 1E-06 or THQ = 1 Csg (ug/m^3)	Target Ground Water Conc. @ TCR = 1E-06 or THQ = 1 Cgw (ug/L)	Is Target Ground Water Conc. < MCL? Cgw<MCL? Yes/No (MCL ug/L)	Pure Phase Vapor Conc. @ 25°C Cvp (ug/m^3)	Maximum Groundwater Vapor Conc. Chc (ug/m^3)	Temperature for Max. Groundwater Vapor Conc. Tgw or 25 C	Lower Explosive Limit** LEL (% by vol)	LEL Source	Inhalation Unit Risk IUR (ug/m^3)$^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i	Target Indoor Air Conc. for Carcinogens @ TCR = 1E-06 Cia,c (ug/m^3)	Target Indoor Air Conc. for Non-Carcinogens @ THQ = 1 Cia,nc (ug/m^3)
75-27-4	Bromodichloromethane	Yes	Yes	Yes	Yes	3.3E-01	C	1.1E+01	3.8E+00	Yes (8.0E+01(F))	4.41E+08	2.63E+08	25			3.70E-05	CA				3.3E-01	
108-90-7	Chlorobenzene	Yes	No	Yes	Yes	2.2E+02	NC	7.3E+03	1.7E+03	No (100)	7.25E+07	6.33E+07	25	1.3	N			5.00E-02	P			2.2E+02
106-46-7	Dichlorobenzene, 1,4-	Yes	Yes	Yes	Yes	1.1E+00	C	3.7E+01	1.1E+01	Yes (75)	1.38E+07	8.01E+06	25	2.5	N	1.10E-05	CA	8.00E-01	I		1.1E+00	3.5E+03
107-06-2	Dichloroethane, 1,2-	Yes	No	Yes	Yes	4.7E-01	C	1.6E+01	9.8E+00	No (5)	4.20E+08	4.15E+08	25	6.2	N	2.60E-05	I	7.00E-03	P		4.7E-01	3.1E+01
75-35-4	Dichloroethylene, 1,1-	Yes	No	Yes	Yes	8.8E+02	NC	2.9E+04	8.2E+02	No (7)	3.13E+09	2.58E+09	25	6.5	N			2.00E-01	I			8.8E+02
156-59-2	Dichloroethylene, 1,2-cis-	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	--	--	--	--	No (70)	1.04E+09	1.07E+09	25	9.7	M							
156-60-5	Dichloroethylene, 1,2-trans-	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	--	--	--	--	No (100)	1.73E+09	1.73E+09	25	9.7	M							
127-18-4	Tetrachloroethylene	Yes	No	Yes	Yes	4.7E+01	C	1.6E+03	6.5E+01	No (5)	1.65E+08	1.49E+08	25			2.60E-07	I	4.00E-02	I		4.7E+01	1.8E+02
120-82-1	Trichlorobenzene, 1,2,4-	Yes	No	Yes	Yes	8.8E+00	NC	2.9E+02	1.5E+02	No (70)	4.49E+06	2.84E+06	25	2.5	N			2.00E-03	P			8.8E+00
79-00-5	Trichloroethane, 1,1,2-	Yes	Yes	Yes	Yes	7.7E-01	C	2.6E+01	2.3E+01	No (5)	1.65E+08	1.55E+08	25	6	N	1.60E-05	I	2.00E-04	X		7.7E-01	8.8E-01
79-01-6	Trichloroethylene	Yes	Yes	Yes	Yes	3.0E+00	C	1.0E+02	7.4E+00	No (5)	4.88E+08	5.15E+08	25	8	N	see note	I	2.00E-03	I	TCE	3.0E+00	8.8E+00
75-01-4	Vinyl Chloride	Yes	Yes	Yes	Yes	2.8E+00	C	9.3E+01	2.5E+00	No (2)	1.00E+10	1.00E+10	25	3.6	N	4.40E-06	I	1.00E-01	I	VC	2.8E+00	4.4E+02

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
Averaging time for carcinogens	(yrs)	ATc_R	70	ATc_C	70	ATc	70
Averaging time for non-carcinogens	(yrs)	ATnc_R	26	ATnc_C	25	ATnc	25
Exposure duration	(yrs)	ED_R	26	ED_C	25	ED	25
Exposure frequency	(days/yr)	EF_R	350	EF_C	250	EF	250
Exposure time	(hr/day)	ET_R	24	ET_C	8	ET	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
Groundwater (-)	AFgw_R	0.001	AFgw_C	0.001	AFgw	0.001
Sub-Slab and Exterior Soil Gas (-)	AFss_R	0.03	AFss_C	0.03	AFss	0.03

(3) **Formulas**
Cia, target = MIN(Cia,c; Cia,nc)
Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)
Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**
Trichloroethylene

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell G15) Symbol	Selected Value
mIURTCE	mIURTCE_R	1.00E-06	mIURTCE_C	0.00E+00	mIURTCE	0.00E+00
IURTCE	IURTCE_R	3.10E-06	IURTCE_C	4.10E-06	IURTCE	4.10E-06

Mutagenic Chemicals

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Age Cohort	Exposure Duration (years)	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:
NVT = Not sufficiently volatile and/or toxic to pose inhalation risk in selected exposure scenario for the indicated medium
C = Carcinogenic
NC = Non-carcinogenic
I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html
P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml
A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html
CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml
S = See RSL User Guide, Section 5
X = PPRTV Appendix
E = The Engineering ToolBox. Available online at http://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html
N = Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. Available online at: http://www.cdc.gov/niosh/npg/default.html http://www.cdc.gov/niosh/npg/default.html
M = Chemical-specific MSDS
Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).
VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).
TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).
Yellow highlighting indicates site-specific parameters that may be edited by the user.
Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.
**Lower explosive limit is the minimum concentration of the compound in air (% by volume) that is needed for the gas to ignite and explode.

TABLE D.3
COMPARISON OF MAXIMUM GROUNDWATER CONCENTRATIONS FOR COPCS TO VISLS
TUTU WELLS SUPERFUND SITE
ST. THOMAS, U.S. VIRGIN ISLANDS

COPC Group	COPC	CASRN	Residential VISL Target Groundwater (ug/L)	Commercial VISL Target Groundwater (ug/L)		Tutu Maximum Groundwater Concentration (ug/L)
VOC	1,1,2-Trichloroethane	79-00-5	5.21	22.8		1.6
VOC	1,1-Dichloroethene	75-35-4	195	821		400
VOC	1,2,4-Trichlorobenzene	120-82-1	35.9	151		4.1
VOC	1,2-Dichloroethane	107-06-2	2.24	9.78		0.8
VOC	1,4-Dichlorobenzene	106-46-7	2.59	11.3		2.8
VOC	Bromodichloromethane	75-27-4	0.876	3.82		2.7
VOC	Chlorobenzene	108-90-7	410	1,722		48
VOC	cis-1,2-Dichloroethylene	156-59-2	NA	NA		160,000
VOC	Tetrachloroethylene	127-18-4	14.9	65.2		**92,000**
VOC	trans-1,2-Dichloroethylene	156-60-5	NA	NA		2,300
VOC	Trichloroethylene	79-01-6	1.19	7.43		**29,000**
VOC	Vinyl chloride	75-01-4	0.147	2.45		**38,000**

Note:
The VISLs are calculated at a target cancer risk of 1E-06 or target hazard quotient of 1 and using the default groundwater temperature of 25 degC.
Concentrations greater than the Residential VISL are shaded and concentrations greater than the Commercial VISL are **bold**.

Abbreviations:
COPC -- Constituent of potential concern
NA -- Not available
VISL -- Vapor Intrusion Screening Level