N61414.AR.001750
NAB LITTLE CREEK
5090.3

FINAL TECHNICAL MEMORANDUM RISK ASSESSMENT UPDATE VAPOR INTRUSION EVALUATION FOR SOLID WASTE MANAGEMENT UNIT 3 (SWMU 3) JEB LITTLE CREEK VA

6/14/2013

CH2MHILL

CH2MHILL®

Risk Assessment Update - Vapor Intrusion Evaluation, SWMU 3, Joint Expeditionary Base Little Creek, Virginia Beach, Virginia

PREPARED FOR: Joint Expeditionary Base Little Creek Tier I Partnering Team

PREPARED BY: CH2M HILL

DATE: June 14, 2013

Introduction

This technical memorandum (TM) presents an evaluation of potential risks associated with vapor intrusion at Solid Waste Management Unit (SWMU) 3. This TM was prepared for the Department of the Navy (Navy), Naval Facilities Engineering Command Mid-Atlantic, under the Comprehensive Long-term Environmental Action – Navy Contract N62470-08-D-1000, Contract Task Order 0062, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan.

Conceptual Site Model

SWMU 3, the Pier 10 Sandblast Yard, is located in a developed area on Little Creek Harbor's western side (**Figure 1**). SWMU 3 was used for sandblasting boats between 1962 and 1984 (RGH, 1984). Sandblasting activities took place on a concrete pad located to the west of Building 1263. After 1984, anchors and chains were sandblasted on the concrete pad. The sandblast material was periodically characterized using extraction procedure (EP) toxicity testing protocols, and removed from the site for disposal. Results of the EP toxicity tests indicated the sandblast residue was not a hazardous waste. In 1995, the concrete pad was taken out of service, and a new sandblasting area was constructed in the northwestern corner of the site. The new sandblasting area consisted of a concrete pad surrounded by a 4-to-5-foot-high concrete wall. All sandblasting operations at SWMU 3 ceased in 1996 when the new indoor sandblasting facility (CB125), located adjacent to Desert Cove and Environmental Restoration Program Site SWMU 7b, was completed. A graphical representation of the conceptual site model (CSM) is presented on **Figure 2**, and additional details are described as follows.

Historical releases from SWMU 3 likely occurred when sandblasting residue was lying directly on the ground surface. Prior to 1993, runoff from sandblasting operations occurred as overland sheet flow to Little Creek Harbor. In 1993, a catch basin with a regulated outfall was constructed. Surface water drainage from the sandblasting area currently flows to this catch basin and empties into Little Creek Harbor at the Virginia Department of Environmental Quality (VDEQ)-permitted Outfall 008 (Permit Number VA0079928) located under Pier 10, approximately 35 feet from its easternmost edge (**Figure 1**). Under the VDEQ permit, Outfall 008 has no monitoring requirements. Some runoff from other areas of SWMU 3 may continue to flow directly into Little Creek Harbor.

The ground surface at SWMU 3 is generally covered with concrete or asphalt, except for a very small strip of gravel-covered land east of the more recent sandblasting pad, a small grassy area in the northeastern corner of the fenced compound, and a small grassy area west of the more recent sandblasting area outside of the fenced compound. The SWMU 3 area is fenced and locked outside of working hours. JEB Little Creek activities in the SWMU 3 area include dive team training and boat maintenance activities. Several buildings are located within the SWMU 3 study area boundary. Building descriptions and uses are summarized on **Table 1**. Temporary structures are occasionally placed on cinder blocks within the fenced compound for additional work space.

The land where SWMU 3 is located and the surrounding area were created from the placement of dredge spoils between 1937 and 1954, thus the shallow geology and underlying surficial aquifer material are not representative of the upper Holocene and Pleistocene unconsolidated fine sand and silt deposits of the Columbia aquifer (CH2M HILL, 2009). Beneath this dredged fill material, the low-permeability silt, clay, and sandy clay deposits of the Yorktown confining unit are noted at the site. For the purpose of this discussion, the saturated soil underlying SWMU 3 will be referred to as the surficial aquifer. The surficial aquifer extends to a depth of between 13.0 to 23.5 feet below ground surface (bgs) across the site and consists of primarily fine- to medium-grained sands. Shallow groundwater is generally encountered at 5 feet bgs. Groundwater flow across the site is south-southeast, discharging to Little Creek Harbor (**Figure 3**). Groundwater geochemistry in the surficial aquifer beneath SWMU 3 is generally brackish, and is a transition zone where upgradient fresh water mixes with seawater intrusion (CH2M HILL, 2012).

Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total and dissolved metals have been detected in groundwater (CH2M HILL, 2009). Pesticides and polychlorinated biphenyls are not related to historical site activities, and were not sampled for during site investigations. The chlorinated VOCs tetrachloroethene (PCE) and several "breakdown product" compounds formed from the biological and chemical degradation of PCE – namely trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC) – were detected in groundwater above maximum contaminant levels. The maximum concentration of PCE was detected in upgradient monitoring well LW03-MW06 in 2002. Maximum concentrations of breakdown products TCE, cis-1,2-DCE, and VC were detected at monitoring well LW03-MW12 in 2007, and their distribution is likely the result of degradation of PCE and advection of daughter products over time. No source for the VOCs has been identified at the site. SVOCs were detected in one monitoring well (LW03-MW04) in 1998, and were not sampled for during subsequent site investigations. Total and dissolved metals have been detected in groundwater above background values across the site during each site investigation. Detected soil concentrations of VOCs, SVOCs, and metals do not indicate that any continuing source of contamination is present in the site soil.

The results of the human health risk assessment (HHRA) conducted as part of the Remedial Investigation (RI) indicate there are no unacceptable risks to human health associated with exposure to surface water based on detected concentrations of VOCs, SVOCs, and metals in this medium (CH2M HILL, 2005). The results of the revised groundwater HHRA conducted as part of the Supplemental Remedial Investigation (SRI) indicate there are no unacceptable human health risks associated with construction worker exposure to groundwater (CH2M HILL, 2009). However, the SRI concluded that hypothetical potable use of shallow groundwater may result in unacceptable cancer risks and non-cancer hazards for future industrial workers and hypothetical future residents. As part of a risk assessment update, the conceptual site model for SWMU 3 was updated (CH2M HILL, 2012) and the viability of the future potable use scenario as an applicable human health exposure pathway for groundwater at the site was evaluated. Based upon aquifer characteristics, the lack of potential downgradient users, and USEPA restriction against potable use of groundwater characterized as having a high-to-intermediate degree of interconnection with an adjacent surface water body, the Navy, in partnership with USEPA and VDEQ, agreed that potable use of groundwater (future residential and industrial worker) is not a viable exposure scenario for human health risk evaluation at SWMU 3. Vapor intrusion is not considered a *current* exposure pathway at SWMU 3, and therefore was not evaluated as part of the HHRAs in the SWMU 3 RI and SRI. However, due to the presence of VOCs in groundwater, and the uncertainties associated with quantifying risks associated with the potential *future* vapor intrusion pathway, it was assumed that vapor intrusion from shallow groundwater into indoor air could potentially pose unacceptable risks to future receptors. No unacceptable risks associated with ecological receptor exposure to surface water were identified based on detected concentrations of VOCs, SVOCs, and metals in this medium. Potentially unacceptable risks associated with lower-trophic-level receptor exposure to sediment were identified and are currently being addressed as part of a removal action. An evaluation of human health and ecological risks associated with groundwater discharge to Little Creek Harbor concluded that discharge of groundwater to surface water does not pose an unacceptable incremental increase in risks to aquatic receptors in Little Creek Harbor.

Vapor Intrusion Human Health Risk Assessment

An updated, conservative HHRA was performed to determine the potential for human health risks associated with future exposure to indoor air based on vapor intrusion from groundwater at SWMU 3. The HHRA consists of the following components:

- Data Evaluation and Identification of Chemicals of Potential Concern (COPCs)
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

Data Evaluation and Chemical of Potential Concern Identification

Data Used in the Human Health Risk Assessment

VOC data collected as part of the SRI in January and September 2007 were used in the risk assessment, covering potential seasonal variance in concentrations. All monitoring well data were utilized, which include the results of shallow and deep samples collected during the September 2007 event. Generally, the higher VOC concentrations were detected in the shallow groundwater, which is the source of vapors off-gassing from groundwater. January 2007 shallow direct-push technology data collected outside of a 50-foot radius (one half of the standard "100 feet from a building" rule of thumb for potential vapor intrusion impacts) of any monitoring wells were also utilized (eight samples total) in the assessment to provide for adequate spatial coverage of the site. A list of the samples used in the evaluation is provided in **Table 2** and sample locations are depicted on **Figure 2**.

Identification of Vapor Intrusion Chemicals of Potential Concern

The groundwater concentration data for VOCs were compared to residential groundwater-to-indoor-air vapor intrusion screening levels (VISLs) in order to identify preliminary COPCs. The purpose of identifying COPCs is to focus further vapor intrusion investigation activities only on the VOCs likely to represent a vapor intrusion concern. Groundwater VISLs were obtained from the USEPA's VISL Calculator tool (USEPA, 2012). Using the calculator, a target risk level is selected and the target groundwater concentration (the VISL) corresponding to a chemical's target indoor air concentration is calculated by dividing the target indoor air concentration by the USEPA (2004) default attenuation factor (1E-03) and then converting the vapor concentration to an equivalent groundwater concentration, assuming equilibrium between the aqueous and vapor phases at the water table. Because the default attenuation factor is not based on site-specific subsurface data, the VISLs used in the screening of groundwater may underestimate or overestimate the potential for vapor intrusion.

VISLs based on non-carcinogenic effects are based on a more conservative target hazard quotient (HQ) of 0.1 (rather than 1.0) to account for exposure to multiple constituents. VISLs based on carcinogenic effects are based on a target carcinogenic risk of 1×10^{-6}. A site-specific average groundwater temperature, based upon groundwater quality data collected in January and September 2007, of 20.89 degrees Celsius was used to calculate the VISLs. If the maximum-detected groundwater concentration was greater than the groundwater VISL, the constituent was identified as a COPC for the vapor intrusion pathway.

Results of the COPC screening are provided in **Table 3**; calculation of the residential VISLs is provided in **Table 3 Supplement A**. Seven VOCs exceeded their respective VISL and were identified as COPCs – 1,1-dichloroethane (1,1-DCA), chloroform, cis-1,2-DCE, methylcyclohexane, trans-1,2- DCE, TCE, and VC. These seven COPCs were carried forward and risks were quantified for them.

Exposure Assessment

The exposure assessment consists of three main steps:

1. Evaluation of exposure pathways and identification of receptors
2. Estimation of exposure point concentrations (EPCs)
3. Estimation of human intake

Exposure Pathway and Scenario Quantified

There is no current vapor intrusion exposure pathway at SWMU 3. Future residential exposures to indoor air via vapor intrusion from groundwater was evaluated in the updated risk assessment.

Exposure Point Concentrations

The EPC is the concentration of a COPC in the relevant media at the point of exposure, for each receptor and exposure route. As stated in the Department of Defense Vapor Intrusion Handbook: "The EPC should be a reasonable upper bound concentration of a chemical that a person could be exposed to. When there are sufficient samples, the EPC is often a statistically-derived upper bound value, typically the 95% UCL" (DoD, 2009). Additionally, the USEPA (1989) Superfund program advocates the use of a reasonable maximum exposure (RME) approach (such as the 95 percent Upper Confidence Limit [UCL]) when estimating exposures. EPCs for evaluation of potential future vapor intrusion risk at SWMU 3 were identified based on measured COPC concentrations in groundwater. Risk estimates for the vapor intrusion evaluation were calculated using two separate EPCs for each COPC – (1) the maximum detected concentration and (2) the 95 percent UCL.

EPCs based on the UCL were estimated following the most-recent parametric (distributional) and nonparametric USEPA recommendations in ProUCL Version 4.1.01 (USEPA, 2011). ProUCL provides approaches for calculating UCLs of the mean, particularly when non-detected concentrations are present. These approaches consider a large variety of inputs, including the perceived distribution of the detected results (if no perceived distribution is acceptable, nonparametric alternatives are provided), sample size, variability, and skewness. The maximum detected concentration was used in place of the UCL as the EPC when the calculated UCL was greater than the maximum detected concentration or there was only one detected value.

The EPCs based on the maximum detected concentrations of COPCs are provided in **Table 4**, while the EPCs based on the UCLs are provided in **Table 5**. The ProUCL output is provided in **Attachment 1**.

Chemical Intake and Exposure Factors

Chemical exposure estimates for the inhalation pathway are generally expressed as follows:

$$EC = \frac{Ca \times ET \times EF \times ED \times CF}{AT}$$

Where:

EC = exposure concentration (milligrams per cubic meter [mg/m^3])

Ca = chemical concentration in air (mg/m^3)

ET = exposure time (hours per day)

EF = exposure frequency (days per year)

ED = exposure duration (years)

CF = conversion factor (day per 24 hours)

AT = averaging time (days)

An RME scenario was quantified for the residential receptor under a potential future land use scenario. The exposure factors used in the exposure concentration (EC) calculations are presented in **Table 4**.

A number of regulatory agencies (such as USEPA Regions 3, 9, and 10; New Jersey Department of Environmental Quality; and Massachusetts Department of Environmental Protection) have developed provisional short-term indoor air action levels (2 to 20 micrograms per cubic meter [$\mu g/m^3$]) for TCE in buildings affected by subsurface vapor intrusion. These action levels are based on the potential occurrence of developmental health effects. Although the predicted indoor air concentration (5.6 $\mu g/m^3$) based on the maximum EPC (**Table 4**) slightly exceeds the USEPA Region 3 provisional remedial action level (RAL) (2 $\mu g/m^3$), no further action is warranted since: 1) it is within the range (2 to20 $\mu g/m^3$) of other USEPA and state provisional values; 2) the EPC based on the 95 percent UCL (1.3 $\mu g/m^3$) is below this range of provisional values; 3) there are no occupied buildings and the vapor intrusion pathway is incomplete; and 4) maximum and calculated UCL values are representative of site conditions in 2007 and are likely overestimates (see as follows).

Toxicity Assessment

The inhalation toxicity values (inhalation unit risks [IURs] and reference concentrations [RfCs]) used in the risk assessment were obtained from the USEPA standard hierarchy of toxicity value sources (USEPA, 2003), as follows:

- Integrated Risk Information System (USEPA, 2013)
- Provisional Peer-Reviewed Toxicity Values
- Other USEPA and non-USEPA sources, including the Health Effects Assessment Summary Tables (USEPA, 1997), California Environmental Protection Agency Toxicity Criteria Database (Cal/EPA, 2013), and Agency for Toxic Substances and Disease Registry.

Risk Characterization

Risk characterization combines the results of the previous elements of the risk assessment (COPC selection, exposure assessment, and toxicity assessment) to evaluate the potential health risks associated with exposure to the COPCs.

Potential human health risks are discussed independently for carcinogenic and non-carcinogenic constituents because of the different toxicological endpoints, relevant exposure durations, and methods used to characterize risk. Exposure to some constituents may result in both non-carcinogenic and carcinogenic effects (for example, chloroform, PCE, TCE, and VC), and therefore, these constituents were evaluated in both groups. The methodology used to estimate non-carcinogenic hazards and carcinogenic risks is described as follows.

Non-carcinogenic Hazard Estimation

The HHRA evaluated the potential for non-carcinogenic effects by comparing exposure intakes of each COPC over a specified time period (chronic or subchronic) with RfDs derived for similar exposure periods. For the inhalation exposure route, non-carcinogenic effects were evaluated by comparing the ECs of each COPC with the RfC. This ratio of exposure to toxicity is referred to as a HQ. The HQ assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level exceeds this threshold, there is the potential for non-cancer health effects to occur. The HQ is calculated as follows:

$$HQ = \frac{Exposure\ \ Concentration}{RfC}$$

ECs and RfCs are expressed in the same units (mg/m^3). An HQ that exceeds 1 (that is, intake exceeds the RfD or EC exceeds the RfC) indicates that there is a potential for adverse health effects associated with exposure to that COPC.

To assess the potential for non-carcinogenic health effects posed by exposure to multiple COPCs and exposure routes, a hazard index (HI) approach was used (USEPA, 1989). This approach assumes that non-carcinogenic hazards associated with exposure to more than one COPC and exposure route are additive. Synergistic or antagonistic interactions between COPCs are not quantified. The HI may exceed 1 even if all of the individual HQs are less than 1. The HI is equal to the sum of the HQs, and is calculated as follows:

$$HI = \frac{EC_1}{RfC_1} + \frac{EC_2}{RfC_2} + \dots\ \frac{EC_j}{RfC_j}$$

Where:

EC = Exposure concentration (mg/m^3)
RfC = Reference concentration (mg/m^3)
EC_j = Exposure concentration for the "*j*"th constituent
RfC_i = Reference concentration for the "*j*"th constituent

HIs were calculated in a phased approach. Screening HIs were calculated by summing all HQs, and final HIs were calculated for each potential receptor by target organ (or critical effect or target system). If a final HI (target organ specific HI) exceeds 1, there is a potential for adverse non-carcinogenic effects on that target organ/system or critical effect.

Carcinogenic Risk Estimation

The potential for carcinogenic effects due to exposure to site media was evaluated by estimating the estimated lifetime cancer risk (ELCR). The ELCR is the incremental increase in the probability of developing cancer during one's lifetime (as a result of exposure to site media) above the probability of developing cancer from non-site exposures.

Potential ELCRs associated with exposure to individual carcinogens were calculated using IURs and ECs for inhalation exposures. The linear low-dose equation was used to estimate the incremental probability of an individual developing cancer over a lifetime as a result of exposure to potential carcinogens. Estimated ELCRs are calculated by multiplying the EC by the IUR:

$$ELCR = EC \times IUR$$

Where:

ELCR = unitless probability of developing cancer
EC = exposure concentration averaged over 70 years
IUR = inhalation unit risk

The theoretical probability of developing cancer as a consequence of exposure to two or more COPCs and by two or more exposure pathways was calculated by summing the risk estimates for each COPC in the appropriate scenarios using the following equations:

$$TotalELCR = \left(EC_1 \times IUR_1\right) + \left(EC_2 \times IUR_2\right) + \ldots \left(EC_i \times IUR_j\right)$$

Where:

EC = Exposure concentration (micrograms per cubic meter [$\mu g/m^3$])
IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$
EC_j = Exposure concentration for the "*j*"th constituent
IUR_j = Inhalation unit risk for the "*j*"th constituent

Summary of Risk Estimates

Potential exposures to indoor air via vapor intrusion of COPCs from groundwater were quantified for potential future residents at SWMU 3. The estimated ELCRs and HIs based on COPC maximum-detected concentrations and the UCLs are presented in **Tables 4 and 5**, respectively.

The estimated total ELCRs and HIs from potential exposures to COPCs are as follows:

- **Residents (maximum COPC concentrations)**
  - 9×10^{-4} cumulative ELCR, primarily due to VC, and smaller contributions from TCE, 1,1-DCA, and chloroform
  - Total HI of 5.0, primarily due to VC (HI = 1.4) and TCE (HI = 2.7); target organ HI's exceeding 1 are liver (HI = 1.6), immunotoxicity (HI = 2.7), and heart malformations (HI = 2.7)
- **Residents (UCL COPC concentrations)**
  - 7×10^{-5} cumulative ELCR
  - Total HI less than 1 (HI = 0.9)

Risk Management Considerations and Recommendations

Following the calculation (assessment) of risk, the CSM is considered with the results of the risk assessment in managing the need for and practicability of taking an action to address potential risks. When applicable, considerations for risk management are developed. The following discussion presents considerations for risk management of vapor intrusion at SWMU 3.

Although the predicted indoor air concentration based on the maximum slightly exceeds the USEPA Region 3 provisional RAL, no further action is warranted based a review of multiple lines of evidence. Calculated risks based upon maximum detected concentrations are above USEPA's acceptable carcinogenic risk range of 10^{-4} to 10^{-6} and non-carcinogenic hazard level of 1. However, calculated risks based upon 95 percent UCL values, an estimate that may be more representation of an RME scenario consistent with the goal of USEPA RAGs (USEPA, 1989), are below USEPA's acceptable thresholds. Additionally, maximum-detected constituent concentrations and calculated UCL values are representative of site conditions in 2007 and based upon the CSM, as presented in the following bullets, are likely an overestimation of site risks under current site conditions.

- No continuing vadose zone/soil source of VOCs has been identified at the site.
- Based upon data collected during the SRI, the average groundwater flow velocity was calculated to be approximately 10 feet per year (CH2M HILL, 2009). As a result, groundwater concentrations detected in 2007 have likely migrated and discharged to the harbor. Risks associated with groundwater discharge to surface water were previously evaluated and no potentially unacceptable risks were identified.
- VOC concentrations are expected to decrease over time. Geochemical data collected as part of the 2007 SRI indicate site conditions are reducing and conducive for reductive dechlorination of VOCs (CH2M HILL, 2009). Additionally, the presence of breakdown products cis-1,2-DCE and VC indicate degradation is occurring. As a result, it is likely that detected concentrations of VOCs from 2007 have since decreased.

Elevated concentrations of the primary risk drivers, TCE and VC, were generally detected in close proximity (less than 150 feet) to the adjacent shoreline (**Figure 5**). Based upon the previously presented bullets, concentrations of these constituents are expected to have undergone natural degradation, as well as advection with groundwater flow, and discharged to Little Creek Harbor. As a result, EPCs and resulting risk calculations utilizing maximum-detected concentrations and calculated UCL values representative of site conditions in 2007 are likely an overestimation of potential risks; therefore, no present or future action is recommended to address vapor intrusion at SWMU 3.

References

California Environmental Protection Agency (Cal/EPA). 2013. Toxicity Criteria Database. Office of Environmental Health Hazard Assessment. [Online]. Available: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp.

CH2M HILL. 2005. *Final Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment for SWMU 3, Pier 10, Sandblast Yard.* August.

CH2M HILL. 2009. *Final Supplemental Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment for SWMU 3, Pier 10, Sandblast Yard.* April.

CH2M HILL. 2012. *Technical Memorandum Risk Assessment Update – Evaluation of Future Potable Use of Groundwater and Groundwater Discharge to Surface Water at SWMU 3-Pier 10 Sandblast Yard.* July.

Department of Defense (DoD). 2009. *Department of Defense Vapor Intrusion Handbook*.

Massachusetts Department of Environmental Protection (MADEP). 2013. *New EPA TCE Toxicity Information: Implications for Chronic and Shorter-Term Exposure and Status of MassDEP Review*. January 23, 2013. Massachusetts Department of Environmental Protection.

Rogers, Golden, and Halpern (RGH). 1984. *Initial Assessment Study of Naval Amphibious Base, Little Creek, Virginia Beach, Virginia.* December.

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

USEPA. 1997. *Health Effects Assessment Summary Tables, Annual Update*. U. S. Environmental Protection Agency, Environmental Criterion Assessment Office, Office of Research and Development, Cincinnati, OH. July.

USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessments.* OSWER Directive 9285.7-53. December.

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

USEPA. 2011. ProUCL, Version 4.1.00. Prepared by Lockheed Martin Environmental Services. February.

USEPA. 2012. *Vapor Intrusion Screening Level (VISL) Calculator, Version 2.0*. http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6

USEPA. 2013. Integrated Risk Information System (IRIS) Database. [Online]. Available: http://www.epa.gov/iris/index.html.

Tables

TABLE 1
Building Summary
SWMU 3 Vapor Intrusion Evaluation
JEB Little Creek, Virginia Beach, Virginia

Building Number	Command	Ocuppancy	Description/Use
1262	AFDL-6 (Drydock)	Unoccupied	Fire Fighting equipment storage
1263	AFDL-6 (Drydock)	Occasional	Garage with rolling door built in 1978. Orginally used as flammable storage. Currently used for welding and metal working. Occassional use of thinner disposed of as hazardous waste.
1268	AFDL-6 (Drydock)	Unoccupied	Three-sided structure. Originally used to store hydroblasting equipment. Currently used as dry storage for wooden blocking material.
1265-1	NAVNETWARCOM	Occupied	Trailer positioned on blocks above ground surface. Currently used as administrative spaces for IT support.
1265-3	NAVNETWARCOM	Occupied	Trailer positioned on blocks above ground surface. Currently used as administrative spaces for IT support.
1269	NAVNETWARCOM	Occasional	Open-air picnic gazaebo
1528	MWR Marina	Occasional	Restrooms
1516	MWR Marina	Unoccupied	Former marina building damaged during storm.
1604	USO	Occupied	Currently used for administrative space and cooking.

TABLE 2

Groundwater Samples Used in the Vapor Intrusion Human Health Risk Assessmen

SWMU 3 Vapor intrusion Evaluation

JEB Little Creek, Virginia Beach, Virginia

Date of Sampling	Sample Location	Sample	Parameters
1/23/2007	LW03-A-DP207	LW03-ADP207-0509	VOCs
1/23/2007	LW03-B-DP205	LW03-BDP205-0812	VOCs
1/24/2007	LW03-D-DP210	LW03-DDP210-0711	VOCs
1/23/2007	LW03-DP204	LW03-DP204-0711	VOCs
1/23/2007	LW03-DP204	LW03-DP204-0711-QC*	VOCs
1/23/2007	LW03-DP206	LW03-DP206-0509	VOCs
1/31/2007	LW03-DP223	LW03-DP223-0711	VOCs
2/6/2007	LW03-DP224	LW03-DP224-0711	VOCs
1/25/2007	LW03-E-DP212	LW03-EDP212-0711	VOCs
1/25/2007	LW03-E-DP212	LW03-EDP212-0711-QC*	VOCs
2/14/2007	LW03-MW01	LW03-MW01-07A	VOCs
9/20/2007	LW03-MW01	LW03-MW01-07-07C	VOCs
9/20/2007	LW03-MW01	LW03-MW01P-07-07C*	VOCs
9/20/2007	LW03-MW01	LW03-MW01-13-07C	VOCs
2/12/2007	LW03-MW02	LW03-MW02-07A	VOCs
9/20/2007	LW03-MW02	LW03-MW02-07-07C	VOCs
9/20/2007	LW03-MW02	LW03-MW02-13-07C	VOCs
2/14/2007	LW03-MW03	LW03-MW03-07A	VOCs
9/19/2007	LW03-MW03	LW03-MW03-07-07C	VOCs
9/19/2007	LW03-MW03	LW03-MW03-13-07C	VOCs
2/14/2007	LW03-MW04	LW03-MW04-07A	VOCs
9/18/2007	LW03-MW04	LW03-MW04-13-07C	VOCs
9/19/2007	LW03-MW04	LW03-MW04-07-07C	VOCs
2/13/2007	LW03-MW05	LW03-MW05-07A	VOCs
9/19/2007	LW03-MW05	LW03-MW05-07-07C	VOCs
9/19/2007	LW03-MW05	LW03-MW05-13-07C	VOCs
2/15/2007	LW03-MW06	LW03-MW06-07A	VOCs
2/15/2007	LW03-MW06	LW03-MW06P-07A*	VOCs
9/21/2007	LW03-MW06	LW03-MW06-07-07C	VOCs
9/21/2007	LW03-MW06	LW03-MW06-10-07C	VOCs
9/21/2007	LW03-MW06	LW03-MW06-16-07C	VOCs
2/14/2007	LW03-MW07	LW03-MW07-07A	VOCs
9/18/2007	LW03-MW07	LW03-MW07-07-07C	VOCs
9/18/2007	LW03-MW07	LW03-MW07-12-07C	VOCs
9/18/2007	LW03-MW07	LW03-MW07P-12-07C*	VOCs
2/15/2007	LW03-MW08	LW03-MW08-07A	VOCs
9/22/2007	LW03-MW08	LW03-MW08-07-07C	VOCs
9/22/2007	LW03-MW08	LW03-MW08-13-07C	VOCs
2/13/2007	LW03-MW09	LW03-MW09-07A	VOCs
9/22/2007	LW03-MW09	LW03-MW09-10-07C	VOCs
9/22/2007	LW03-MW09	LW03-MW09-18-07C	VOCs
2/13/2007	LW03-MW10	LW03-MW10-07A	VOCs
9/22/2007	LW03-MW10	LW03-MW10-13-07C	VOCs
9/22/2007	LW03-MW10	LW03-MW10-18-07C	VOCs
2/13/2007	LW03-MW11	LW03-MW11-07A	VOCs
9/18/2007	LW03-MW11	LW03-MW11-08-07C	VOCs
9/18/2007	LW03-MW11	LW03-MW11-15-07C	VOCs
2/13/2007	LW03-MW12	LW03-MW12-07A	VOCs
2/13/2007	LW03-MW12	LW03-MW12P-07A*	VOCs
9/19/2007	LW03-MW12	LW03-MW12-09-07C	VOCs
9/19/2007	LW03-MW12	LW03-MW12-15-07C	VOCs
2/14/2007	LW03-MW13	LW03-MW13-07A	VOCs
9/20/2007	LW03-MW13	LW03-MW13-07-07C	VOCs
9/20/2007	LW03-MW13	LW03-MW13-14-07C	VOCs
2/12/2007	LW03-MW14	LW03-MW14-07A	VOCs
9/21/2007	LW03-MW14	LW03-MW14-09-07C	VOCs
9/21/2007	LW03-MW14	LW03-MW14-16-07C	VOCs
2/12/2007	LW03-MW15	LW03-MW15-07A	VOCs
9/21/2007	LW03-MW15	LW03-MW15-10-07C	VOCs
9/21/2007	LW03-MW15	LW03-MW15P-10-07C*	VOCs
9/21/2007	LW03-MW15	LW03-MW15-18-07C	VOCs

Notes:

* - Duplicate of samples listed above

VOC - Volatile organic compound

TABLE 3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

SWMU 3 Vapor Intrusion Evaluation

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Indoor Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Groundwater	76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	1.4E-01 J	5.0E+00 J	UG/L	LW03-MW11-15-07C	5/55	0.5 - 10	5.0E+00	N/A	1.7E+02 NC	N/A		NO	BSL
SWMU 3	75-34-3	1,1-Dichloroethane	8.6E-02 J	1.4E+01	UG/L	LW03-DP204-0711	15/55	0.5 - 10	1.4E+01	N/A	7.9E+00 C	N/A		YES	ASL
	75-35-4	1,1-Dichloroethene	9.9E-02 J	2.0E+00 J	UG/L	LW03-MW12-07A	4/55	0.5 - 10	2.0E+00	N/A	2.3E+01 NC	7.0E+00	MCL	NO	BSL
	95-50-1	1,2-Dichlorobenzene	1.2E-01 J	6.9E-01 J	UG/L	LW03-DP204-0711	2/56	0.5 - 10	6.9E-01	N/A	3.5E+02 NC	6.0E+02	MCL	NO	BSL
	67-64-1	Acetone	4.0E+00 J	4.0E+00 J	UG/L	LW03-MW05-13-07C	1/55	5 - 10	4.0E+00	N/A	2.7E+06 NC	N/A		NO	BSL
	71-43-2	Benzene	1.2E-01 J	7.8E-01 J	UG/L	LW03-DP204-0711	2/55	0.5 - 10	7.8E-01	N/A	1.7E+00 C	5.0E+00	MCL	NO	BSL
	75-15-0	Carbon disulfide	9.9E-02 J	4.9E-01 J	UG/L	LW03-MW13-07A	6/55	0.5 - 10	4.9E-01	N/A	1.4E+02 NC	N/A		NO	BSL
	75-00-3	Chloroethane	1.8E+01	4.0E+01 J	UG/L	LW03-MW08-13-07C	3/55	0.5 - 10	4.0E+01	N/A	2.6E+03 NC	N/A		NO	BSL
	67-66-3	Chloroform	1.3E-01 J	1.3E+00	UG/L	LW03-MW14-07A	3/55	0.5 - 10	1.3E+00	N/A	8.4E-01 C	8.0E+01	MCL	YES	ASL
	156-59-2	cis-1,2-Dichloroethene	1.2E-01 J	2.6E+02	UG/L	LW03-MW12P-07A	20/55	0.5 - 20	2.6E+02	N/A	4.4E+01 NC	7.0E+01	MCL	YES	ASL
	10061-01-5	cis-1,3-Dichloropropene	1.0E-01 J	1.0E-01 J	UG/L	LW03-MW02-07A	1/55	0.5 - 10	1.0E-01	N/A	5.2E+00 C	N/A		NO	BSL
	110-82-7	Cyclohexane	1.9E-01 J	2.5E-01 J	UG/L	LW03-DP204-0711-QC	2/55	0.5 - 10	2.5E-01	N/A	1.2E+02 NC	N/A		NO	BSL
	98-82-8	Isopropylbenzene	1.1E-01 J	1.6E-01 J	UG/L	LW03-MW01-07-07C	2/55	0.5 - 10	1.6E-01	N/A	1.2E+02 NC	N/A		NO	BSL
	m&pXYLENE	m- and p-Xylene	1.0E-01 J	1.0E-01 J	UG/L	LW03-EDP212-0711-QC	1/4	2 - 2	1.0E-01	N/A	4.5E+01 NC	N/A		NO	BSL
	108-87-2	Methylcyclohexane	8.5E-01 J	2.0E+00 J	UG/L	LW03-MW12-07A : LW03-MW12P-07A	2/55	0.5 - 10	2.0E+00	N/A	1.2E+00 NC	N/A		YES	ASL
	75-09-2	Methylene chloride	1.0E+00 J	1.0E+00 J	UG/L	LW03-MW12-07A : LW03-MW12P-07A	1/55	0.5 - 10	1.0E+00	N/A	5.5E+02 NC	5.0E+00	MCL	NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	8.4E-02 J	1.5E-01 J	UG/L	LW03-MW10-13-07C	4/55	0.5 - 10	1.5E-01	N/A	4.6E+02 C	N/A		NO	BSL
	127-18-4	Tetrachloroethene	1.0E-01 J	3.4E-01 J	UG/L	LW03-DP223-0711	2/55	0.5 - 10	3.4E-01	N/A	7.2E+00 NC	5.0E+00	MCL	NO	BSL
	156-60-5	trans-1,2-Dichloroethene	1.6E-01 J	1.0E+02	UG/L	LW03-DP204-0711	16/55	0.5 - 10	1.0E+02	N/A	4.4E+01 NC	1.0E+02	MCL	YES	ASL
	79-01-6	Trichloroethene	1.2E-01 J	1.7E+01	UG/L	LW03-MW12-07A	16/55	0.5 - 10	1.7E+01	N/A	6.3E-01 NC	5.0E+00	MCL	YES	ASL
	75-01-4	Vinyl chloride	6.1E-01	1.4E+02	UG/L	LW03-DP204-0711-QC	12/55	0.5 - 17	1.4E+02	N/A	1.6E-01 C	2.0E+00	MCL	YES	ASL
	1330-20-7	Xylene, total	1.1E-01 J	1.1E-01 J	UG/L	LW03-EDP212-0711-QC	1/55	0.5 - 10	1.1E-01	N/A	6.3E+01 NC	1.0E+04	MCL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Vapor Intrusion Screening Level Calculator (EPA, 2012). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.
SL value for n-hexane used as a surrogate for methylcyclohexane.
SL value for m-xylene used as a surrogate for m- and p-xylenes.
SL value for trans-1,2-dichloroethene used as surrogate for cis-1,2-dichloroethene.
SL value for 1,3-dichloropropene used as a surrogate for cis-1,3-dichloropropene and trans-1,3-dichloropropene.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
C = Carcinogenic
NC = Noncarcinogenic
MCL = maximum contaminant level
N/A = no available

Table 3.1 Supplement A
Vapor Intrusion Screening Level Calculations
OSWER VAPOR INTRUSION ASSESSMENT
Vapor Intrusion Screening Level (VISL) Calculator Version 2.0, November 2012 RSLs

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	0.1	Enter target hazard quotient for non-carcinogens
Average Groundwater Temperature (^oC)	Tgw	20.89	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

	CAS	Chemical Name	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source?	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source?	Target Indoor Air Conc. @ TCR = 1E-06 or THQ = 0.1	Toxicity Basis	Target Sub-Slab and Exterior Soil Gas Conc. @ TCR = 1E-06 or THQ = 0.1	Target Ground Water Conc. @ TCR = 1E-06 or THQ = 0.1	Is Target Ground Water Conc. < MCL?	Temperature for Groundwater Vapor Conc.	Lower Explosive Limit**	LEL Source	Inhalation Unit Risk	IUR Source*	Reference Concentration	RFC Source*	Mutagenic Indicator	Target Indoor Air Conc. for Carcinogens @ TCR = 1E-06	Target Indoor Air Conc. for Non-Carcinogens @ THQ = 0.1
			Cvp > Cia,target/AFss?	Cvp > Cia,target/AFgw?	MIN(Cia,c;Cia,nc)		Csg	Cgw	Cgw<MCL?	Tgw or 25	LEL		IUR		RfC		i	Cia,c	Cia,nc
			Yes/No	Yes/No	(ug/m^3)	C/NC	(ug/m^3)	(ug/L)	Yes/No (MCL ug/L)	C	(% by vol)		($(ug/m^3)^{-1}$)		(mg/m^3)			(ug/m^3)	(ug/m^3)
x	67-64-1	Acetone	Yes	Yes	3.2E+03	NC	3.2E+04	2.7E+06	--	20.89	2.6	E			3.10E+01	A			3.2E+03
x	71-43-2	Benzene	Yes	Yes	3.1E-01	C	3.1E+00	1.7E+00	Yes (5)	20.89	1.2	N	7.80E-06	I	3.00E-02	I		3.1E-01	3.1E+00
x	75-15-0	Carbon Disulfide	Yes	Yes	7.3E+01	NC	7.3E+02	1.4E+02	--	20.89	1.3	N			7.00E-01	I			7.3E+01
x	67-66-3	Chloroform	Yes	Yes	1.1E-01	C	1.1E+00	8.4E-01	Yes (80)	20.89			2.30E-05	I	9.80E-02	A		1.1E-01	1.0E+01
x	98-82-8	Cumene	Yes	Yes	4.2E+01	NC	4.2E+02	1.2E+02	--	20.89	0.9	N			4.00E-01	I			4.2E+01
x	110-82-7	Cyclohexane	Yes	Yes	6.3E+02	NC	6.3E+03	1.2E+02	--	20.89					6.00E+00	I			6.3E+02
x	95-50-1	Dichlorobenzene, 1,2-	Yes	Yes	2.1E+01	NC	2.1E+02	3.5E+02	Yes (600)	20.89	2.2	N			2.00E-01	H			2.1E+01
x	75-34-3	Dichloroethane, 1,1-	Yes	Yes	1.5E+00	C	1.5E+01	7.9E+00	--	20.89	5.4	N	1.60E-06	CA				1.5E+00	
x	75-35-4	Dichloroethylene, 1,1-	Yes	Yes	2.1E+01	NC	2.1E+02	2.3E+01	No (7)	20.89	6.5	N			2.00E-01	I			2.1E+01
x	156-59-2	Dichloroethylene, 1,2-cis-	No Inhal. Tox. Info	No Inhal. Tox. Info	--	--	--	--	No (70)	20.89	9.7	M							
x	156-60-5	Dichloroethylene, 1,2-trans-	Yes	Yes	6.3E+00	NC	6.3E+01	4.4E+01	Yes (100)	20.89	9.7	M			6.00E-02	P			6.3E+00
x	542-75-6	Dichloropropene, 1,3-	Yes	Yes	6.1E-01	C	6.1E+00	5.2E+00	--	20.89	5.3	N	4.00E-06	I	2.00E-02	I		6.1E-01	2.1E+00
x	110-54-3	Hexane, N-	Yes	Yes	7.3E+01	NC	7.3E+02	1.2E+00	--	20.89	1.1	N			7.00E-01	I			7.3E+01
x	1634-04-4	Methyl tert-Butyl Ether (MTBE)	Yes	Yes	9.4E+00	C	9.4E+01	4.6E+02	--	20.89	1.6	M	2.60E-07	CA	3.00E+00	I		9.4E+00	3.1E+02
x	75-09-2	Methylene Chloride	Yes	Yes	6.3E+01	NC	6.3E+02	5.5E+02	No (5)	20.89	13	N	1.00E-08	I	6.00E-01	I	Mut	9.6E+01	6.3E+01
x	127-18-4	Tetrachloroethylene	Yes	Yes	4.2E+00	NC	4.2E+01	7.2E+00	No (5)	20.89			2.60E-07	I	4.00E-02	I		9.4E+00	4.2E+00
x	76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	Yes	Yes	3.1E+03	NC	3.1E+04	1.7E+02	--	20.89					3.00E+01	H			3.1E+03
x	79-01-6	Trichloroethylene	Yes	Yes	2.1E-01	NC	2.1E+00	6.3E-01	Yes (5)	20.89	8	N	see note	I	2.00E-03	I	TCE	4.3E-01	2.1E-01
x	75-01-4	Vinyl Chloride	Yes	Yes	1.6E-01	C	1.6E+00	1.6E-01	Yes (2)	20.89	3.6	N	4.40E-06	I	1.00E-01	I	VC	1.6E-01	1.0E+01
x	1330-20-7	Xylenes	Yes	Yes	1.0E+01	NC	1.0E+02	6.3E+01	Yes (10000)	20.89					1.00E-01	I			1.0E+01

Notes:

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

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell E5) Symbol	Selected Value
Averaging time for carcinogens	(yrs)	ATc_R	70	ATc_C	70	ATc	70
Averaging time for non-carcinogens	(yrs)	ATnc_R	30	ATnc_C	25	ATnc	30
Exposure duration	(yrs)	ED_R	30	ED_C	25	ED	30
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	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario in cell E5) Symbol	Selected Value
Groundwater	(-)	AFgw_R	0.001	AFgw_C	0.001	AFgw	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R	0.1	AFss_C	0.1	AFss	0.1

(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 E5) Symbol	Selected Value
	mIURTCE_R	1.00E-06	mIURTCE_C	0.00E+00	mIURTCE	1.00E-06
	IURTCE_R	3.10E-06	IURTCE_C	4.10E-06	IURTCE	3.10E-06

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

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

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 - 30 years	14	1

Mutagenic-mode-of-action (MMOA) adjustment factor 76 — This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride — 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:
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:
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 4
Risk Summary (Based on Maximium Detected Concentrations)
OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 2.0, November 2012 RSLs

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 (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	0.1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^{o}C)	Tgw	20.89	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ	Target Organ	Inhalation Unit Risk IUR $(ug/m^3)^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i
67-66-3	Chloroform	1.3E+00	1.64E-01	2E-06	1.6E-03	Liver	2.30E-05	I	9.80E-02	A	
75-34-3	Dichloroethane, 1,1-	1.4E+01	2.70E+00	2E-06	No RfC	NA	1.60E-06	CA			
156-59-2	Dichloroethylene, 1,2-cis-	2.6E+02	3.66E+01	No IUR	5.9E-01	NA					
156-60-5	Dichloroethylene, 1,2-trans-	1.0E+02	1.41E+01	No IUR	2.3E-01	Liver, Lung			6.00E-02	P	
110-54-3	Hexane, N- (surrogate for methylcyclohexane)	2.0E+00	1.23E+02	No IUR	1.7E-01	Kidney			7.00E-01	I	
79-01-6	Trichloroethylene	1.7E+01	5.61E+00	1E-05	2.7E+00	Immunotoxicity, Heart malformations	see note	I	2.00E-03	I	TCE
75-01-4	Vinyl Chloride	1.4E+02	1.42E+02	9E-04	1.4E+00	Liver	4.40E-06	I	1.00E-01	I	VC
			TOTAL	**9.0E-04**	**5.0**						

Total Liver HI =	1.6E+00
Total Lung HI =	2.3E-01
Total Kidney HI =	1.7E-01
Total Immunotoxoicity HI =	2.7E+00
Total Heart Malformations HI =	2.7E+00

Notes:

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

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on Symbol	Selected (based on Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	30	ATnc_C_GW	25	Atnc_GW	30
Exposure duration	(yrs)	ED_R_GW	30	ED_C_GW	25	ED_GW	30
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	350
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	24

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on Symbol	Selected (based on Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.1	AFss_C_GW	0.1	AFss_GW	0.1

(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**

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on Symbol	Selected (based on Value
Trichloroethylene	mIURTCE_R_GW	1.00E-06	ıIURTCE_C_GW	0.00E+00	mIURTCE_GW	1.00E-06
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	3.10E-06

Mutagenic Chemicals

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

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

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 30 years	14	1

Mutagenic-mode-of-action (MMOA) adjustment factor 76 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride

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

Notation:

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

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.

Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

TABLE 5
Risk Summary (Based on UCL as Concentration)
OSWER VAPOR INTRUSION ASSESSMENT
Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 2.0, November 2012 RSLs

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 (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	0.1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (^{o}C)	Tgw	20.89	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m^3)	VI Carcinogenic Risk CR	VI Hazard HQ	Target Organ	Inhalation Unit Risk IUR (ug/m^3)$^{-1}$	IUR Source*	Reference Concentration RfC (mg/m^3)	RFC Source*	Mutagenic Indicator i
67-66-3	Chloroform	2.7E-01	3.37E-02	3E-07	3.3E-04	Liver	2.30E-05	I	9.80E-02	A	
75-34-3	Dichloroethane, 1,1-	2.3E+00	4.54E-01	3E-07	No RfC	NA	1.60E-06	CA			
156-59-2	Dichloroethylene, 1,2-cis-	2.6E+01	3.66E+00	No IUR	5.9E-02	NA					
156-60-5	Dichloroethylene, 1,2-trans-	1.1E+01	1.53E+00	No IUR	2.4E-02	Liver, Lung			6.00E-02	P	
110-54-3	Hexane, N- (surrogate for methylcyclohexane)	9.5E-01	5.87E+01	No IUR	8.0E-02	Kidney			7.00E-01	I	
79-01-6	Trichloroethylene	3.8E+00	1.26E+00	3E-06	6.0E-01	Immunotoxicity, Heart malformations	see note	I	2.00E-03	I	TCE
75-01-4	Vinyl Chloride	1.1E+01	1.15E+01	7E-05	1.1E-01	Liver	4.40E-06	I	1.00E-01	I	VC
			TOTAL	**7.5E-05**	**0.9**						

Total Liver HI =	1.3E-01
Total Lung HI =	2.4E-02
Total Kidney HI =	8.0E-02
Total Immunotoxoicity HI =	6.0E-01
Total Heart Malformations HI =	6.0E-01

Notes:

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

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	30	ATnc_C_GW	25	Atnc_GW	30
Exposure duration	(yrs)	ED_R_GW	30	ED_C_GW	25	ED_GW	30
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	350
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	24

(2) **Generic Attenuation Factors:**

Source Medium of Vapors	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.1	AFss_C_GW	0.1	AFss_GW	0.1

(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**

	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected Value
Trichloroethylene						
	mIURTCE_R_GW	1.00E-06	mIURTCE_C_GW	0.00E+00	mIURTCE_GW	1.00E-06
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	3.10E-06

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

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

Age Cohort	Exposure Duration	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 30 years	14	1

Mutagenic-mode-of-action (MMOA) adjustment factor 76 This factor is used in the equations for mutagenic chemicals.

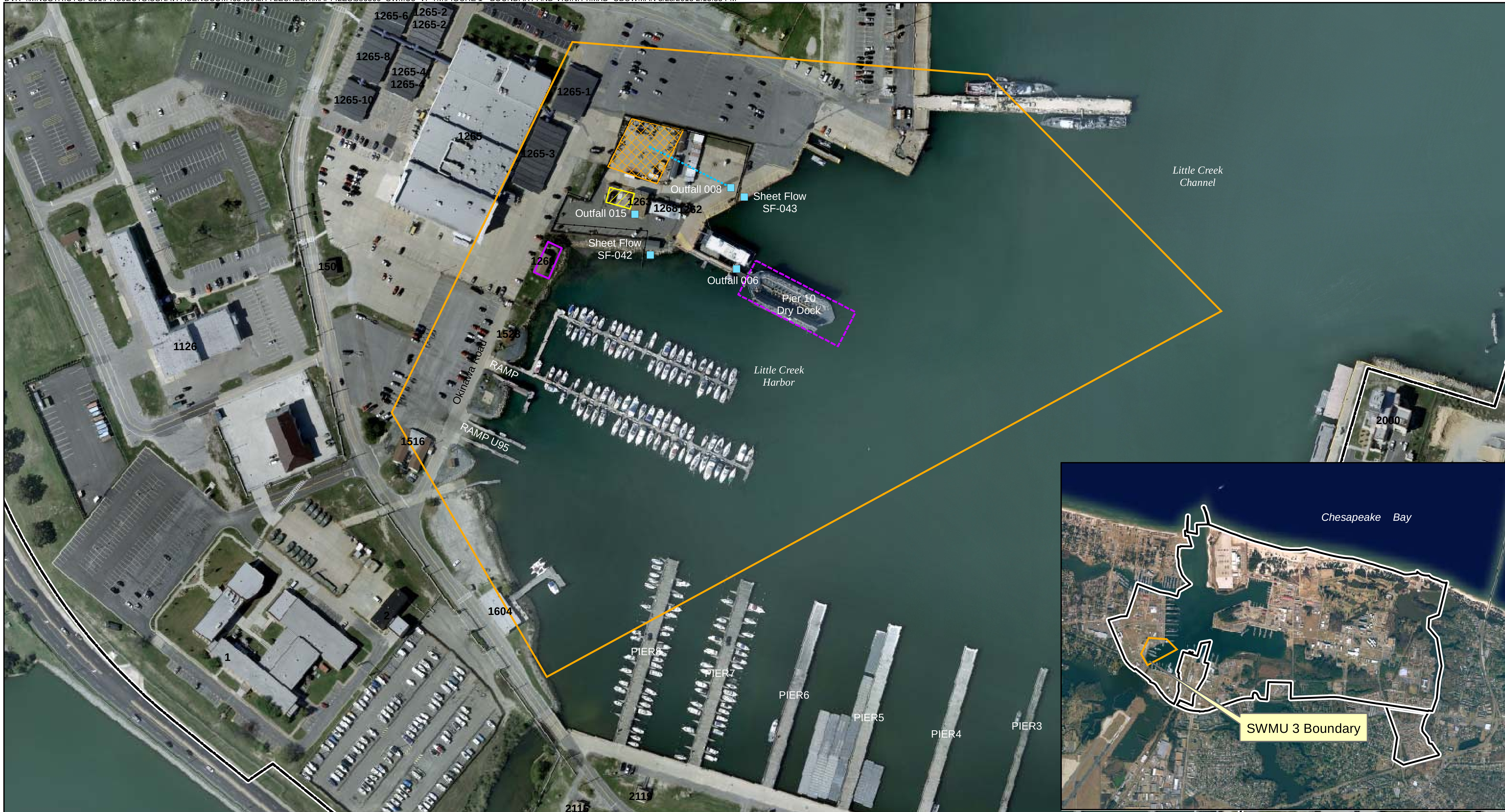
Vinyl Chloride — See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

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
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.
Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

Figures

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\386509_SWMU3_VI_TM\FIGURE 1 - BOUNDARY AND VICINITY.MXD CBOWMAN 3/28/2013 2:13:35 PM



Legend

- Outfall Locations
- Underground Drain Pipe
- Fenced Area
- Picnic Area
- 1995 Dredging Limits
- SWMU 3 Boundary
- Former Sandblasting Area (1962-1995)
- More Recent Sandblasting Area (1995-1996)
- Installation Boundary

N
W E
S

0 200 400
Feet

Figure 1
SWMU 3 Boundary and Immediate Vicinity
SWMU 3 Vapor Intrusion Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

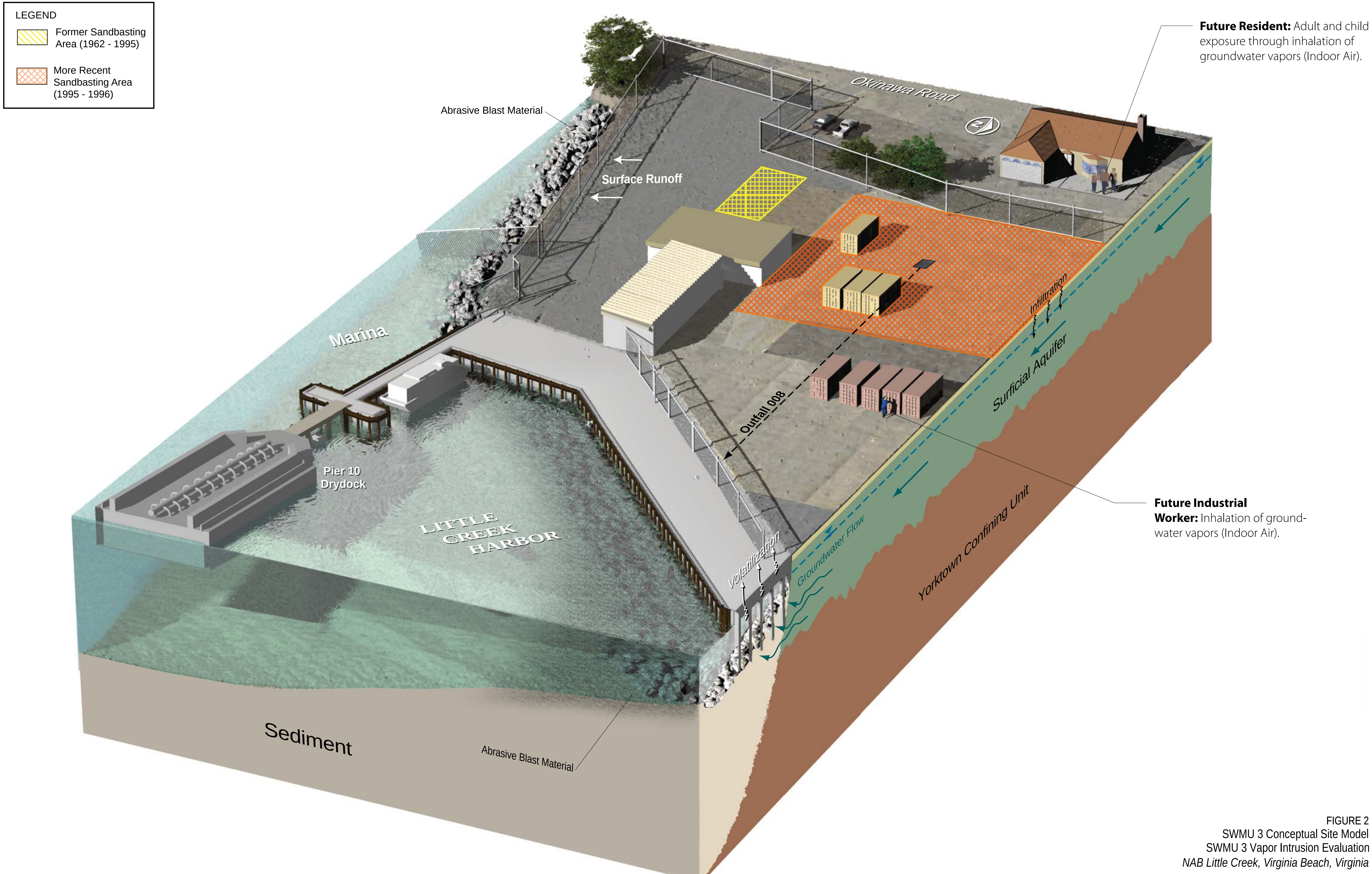


FIGURE 2
SWMU 3 Conceptual Site Model
SWMU 3 Vapor Intrusion Evaluation
NAB Little Creek, Virginia Beach, Virginia

Legend

- Monitoring Well
- Potentiometric Surface
- Inferred Potentiometric Surface
- Fenced Area
- SWMU 3 Boundary
- Groundwater Flow Direction
- Former Sandblasting Area (1962-1995)
- More Recent Sandblasting Area (1995-1996)
- Picnic Area

* Unable to resurvey well. Groundwater elevation may not be accurate.
Location not used to generate potentiometric surface.

N W E S

0 50 100 Feet

Figure 3
Groundwater Flow Map (September 2007)
SWMU 3 Vapor Intrusion Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\386509_SWMU3_VI_TM\FIGURE 4 - GW SAMPLE LOCATIONS.MXD CBOWMAN 3/29/2013 7:36:21 AM

Legend

- Grab Groundwater Sample Location
- Monitoring Well Location
- Fenced Area
- SWMU 3 Boundary

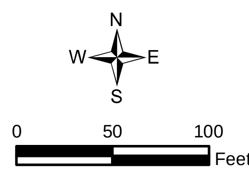


Figure 4
Groundwater Sample Locations
SWMU 3 Vapor Intrusion Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

Monitoring Well ID	LW03-MW05					
Sample ID	LW03-MW05-98C	LW03-MW05-15-02C	LW03-MW05-05-02C	LW03-MW05-07A	LW03-MW05-07-07C	LW03-MW05-13-07C
Sample Date	09/18/98	08/31/02	08/31/02	02/13/07	09/19/07	09/19/07
VOC						
PCE	1 U	0.5 U	0.5 U	10 U	10 UJ	10 UJ
TCE	**5**	0.5 U	0.5 B	10 U	10 UJ	10 UJ
cis-1,2-DCE	**23**	**0.21 J**	**5**	10 U	10 UJ	10 UJ
trans-1,2-DCE	**3**	0.5 U	**0.18 J**	10 U	10 UJ	10 UJ
Vinyl chloride	**5**	**0.14 J**	**2.7**	10 U	10 UJ	10 UJ

Monitoring Well ID	LW03-MW14		
Sample ID	LW03-MW14-07A	LW03-MW14-09-07C	LW03-MW14-16-07C
Sample Date	02/12/07	09/21/07	09/21/07
VOC			
PCE	0.5 U	**0.1 J**	0.5 U
TCE	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	0.5 U	**0.14 J**	0.5 U
trans-1,2-DCE	0.5 U	0.5 U	0.5 U
Vinyl chloride	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW06					
Sample ID	LW03-MW06-18-02C*	LW03-MW06-08-02C	LW03-MW06-07A*	LW03-MW06-07-07C	LW03-MW06-10-07C	LW03-MW06-16-07C
Sample Date	08/31/02	08/31/02	02/15/07	09/21/07	09/21/07	09/21/07
VOC						
PCE	**210**	**190**	10 U	10 U	10 UJ	10 U
TCE	**180**	**170**	10 U	10 U	10 UJ	10 U
cis-1,2-DCE	**47**	**42**	10 U	10 U	10 UJ	10 U
trans-1,2-DCE	**14**	**12**	10 U	10 U	10 UJ	10 U
Vinyl chloride	**21**	**21**	10 U	10 U	10 UJ	10 U

Monitoring Well ID	LW03-MW15		
Sample ID	LW03-MW15-07A	LW03-MW15-10-07C*	LW03-MW15-18-07C
Sample Date	02/12/07	09/21/07	09/21/07
VOC			
PCE	0.5 U	0.5 U	0.5 U
TCE	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	0.5 U	0.5 U	0.5 U
Vinyl chloride	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW09		
Sample ID	LW03-MW09-07A	LW03-MW09-10-07C	LW03-MW09-18-07C
Sample Date	02/13/07	09/22/07	09/22/07
VOC			
PCE	0.5 U	0.5 U	0.5 U
TCE	**0.63**	**0.59**	**0.52**
cis-1,2-DCE	**2.3**	**1.5**	**1.5**
trans-1,2-DCE	**0.16 J**	**0.25 J**	**0.2 J**
Vinyl chloride	0.5 U	**0.61**	0.5 U

Monitoring Well ID	LW03-MW12		
Sample ID	LW03-MW12-07A*	LW03-MW12-09-07C	LW03-MW12-15-07C
Sample Date	02/13/07	09/19/07	09/19/07
VOC			
PCE	10 U	10 U	10 U
TCE	**17**	**16**	**13**
cis-1,2-DCE	**260**	**140**	**110**
trans-1,2-DCE	**79**	**64**	**44**
Vinyl chloride	**56 J**	**35**	**33**

Monitoring Well ID	LW03-MW07				
Sample ID	LW03-MW07-15-02C	LW03-MW07-05-02C	LW03-MW07-07A	LW03-MW07-07-07C	LW03-MW07-12-07C*
Sample Date	08/30/02	08/30/02	02/14/07	09/18/07	09/18/07
VOC					
PCE	0.5 U	**0.18 J**	10 U	10 U	10 U
TCE	2 B	**3.4**	10 U	10 U	10 U
cis-1,2-DCE	**48**	**52**	**21**	**23**	**19**
trans-1,2-DCE	**9.2**	**10**	**5 J**	**8.5 J**	**7.6 J**
Vinyl chloride	**14**	0.5 U	**10**	**12**	**9.6 J**

Monitoring Well ID	LW03-MW08				
Sample ID	LW03-MW08-15-02C	LW03-MW08-05-02C	LW03-MW08-07A	LW03-MW08-07-07C	LW03-MW08-13-07C
Sample Date	09/03/02	09/03/02	02/15/07	09/22/07	09/22/07
VOC					
PCE	**0.87**	**0.84**	10 U	10 UJ	10 UJ
TCE	0.6 B	0.48 B	10 U	10 UJ	10 UJ
cis-1,2-DCE	**4.1**	**4**	10 U	**1.6 J**	10 UJ
trans-1,2-DCE	**0.53**	**0.53**	10 U	10 UJ	10 UJ
Vinyl chloride	**8.1**	**7.7**	10 U	10 UJ	10 UJ

Monitoring Well ID	LW03-MW13		
Sample ID	LW03-MW13-07A	LW03-MW13-07-07C	LW03-MW13-14-07C
Sample Date	02/14/07	09/20/07	09/20/07
VOC			
PCE	0.5 U	0.5 U	0.5 U
TCE	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	0.5 U	0.5 U	0.5 U
Vinyl chloride	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW10		
Sample ID	LW03-MW10-07A	LW03-MW10-13-07C	LW03-MW10-18-07C
Sample Date	02/13/07	09/22/07	09/22/07
VOC			
PCE	0.5 U	0.5 U	0.5 U
TCE	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	**0.12 J**	0.5 U	0.5 U
trans-1,2-DCE	0.5 U	0.5 U	0.5 U
Vinyl chloride	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW01					
Sample ID	LW03-MW01-98C	LW03-MW01-15-02C	LW03-MW01-05-02C	LW03-MW01-07A	LW03-MW01-07-07C*	LW03-MW01-13-07C
Sample Date	09/18/98	08/30/02	08/30/02	02/14/07	09/20/07	09/20/07
VOC						
PCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TCE	1 U	0.23 B	0.15 B	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	1 U	0.5 U	**0.12 J**	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW11		
Sample ID	LW03-MW11-07A	LW03-MW11-15-07C	LW03-MW11-08-07C
Sample Date	02/13/07	09/18/07	09/18/07
VOC			
PCE	10 U	10 UJ	10 UL
TCE	10 U	10 UJ	10 UL
cis-1,2-DCE	10 U	10 UJ	10 UL
trans-1,2-DCE	10 U	10 UJ	10 UL
Vinyl chloride	10 U	10 UJ	10 UL

Monitoring Well ID	LW03-MW02					
Sample ID	LW03-MW02-98C	LW03-MW02-15-02C*	LW03-MW02-05-02C	LW03-MW02-07A	LW03-MW02-07-07C	LW03-MW02-13-07C
Sample Date	09/18/98	08/31/02	08/31/02	02/12/07	09/20/07	09/20/07
VOC						
PCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW03					
Sample ID	LW03-MW03-98C	LW03-MW03-15-02C	LW03-MW03-05-02C	LW03-MW03-07A	LW03-MW03-07-07C	LW03-MW03-13-07C
Sample Date	09/18/98	08/31/02	08/31/02	02/14/07	09/19/07	09/19/07
VOC						
PCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-DCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Monitoring Well ID	LW03-MW04					
Sample ID	LW03-MW04-98C	LW03-MW04-15-02C	LW03-MW04-05-02C	LW03-MW04-07A	LW03-MW04-13-07C	LW03-MW04-07-07C
Sample Date	09/18/98	08/30/02	08/30/02	02/14/07	09/18/07	09/19/07
VOC						
PCE	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TCE	**2**	0.55 B	0.85 B	**0.98**	**0.29 J**	**0.39 J**
cis-1,2-DCE	**5**	**3.4**	**2.3**	**5.6**	**2.3**	**2.5**
trans-1,2-DCE	1 U	**0.36 J**	**0.22 J**	**0.79**	**0.71**	**0.67**
Vinyl chloride	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Legend

- Monitoring Well Location
- SWMU 3 Boundary
- Installation Boundary

Notes:
* Duplicate sample collected at this location. Most conservative value reported.
Bold text indicates detection.
B - Analyte not detected above associated blank.
J - Analyte present. Reported value is estimated.
U - Analyte not detected.
UJ - Analyte not detected. Quantitation limit may be inaccurate.
UL - Analyte not detected. Quantitation limit may be higher.

N W E S

0 100 200 300 Feet

Figure 5
Monitoring Well Data
SWMU 3 Vapor Intrusion Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

Attachment 1

Attachment 1
ProUCL Output
SWMU 3
NAB Little Creek, Virginia Beach, Virginia

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	ProUCL.wst
Full Precision	OFF
Confidence Coefficient	95%
mber of Bootstrap Operations	2000

1,1-Dichloroethane

General Statistics

Number of Valid Data	55	Number of Detected Data	15
Number of Distinct Detected Data	14	Number of Non-Detect Data	40
		Percent Non-Detects	72.73%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.086	Minimum Detected	-2.453
Maximum Detected	14	Maximum Detected	2.639
Mean of Detected	4.234	Mean of Detected	0.748
SD of Detected	3.973	SD of Detected	1.49
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303
Note: Data have multiple DLs - Use of KM Method is recommenc		Number treated as Non-Detect	54
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	1
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	98.18%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.889	Shapiro Wilk Test Statistic	0.901
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.391	Mean	-0.1
SD	2.975	SD	1.479
95% DL/2 (t) UCL	3.062	95% H-Stat (DL/2) UCL	4.93
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.558
		SD in Log Scale	1.475
		Mean in Original Scale	1.618
		SD in Original Scale	2.684
		95% t UCL	2.224
		95% Percentile Bootstrap UCL	2.22
		95% BCA Bootstrap UCL	2.351
		95% H-UCL	3.095
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.723	**Data appear Normal at 5% Significance Level**	
Theta Star	5.858		
nu star	21.68		
A-D Test Statistic	0.457	**Nonparametric Statistics**	
5% A-D Critical Value	0.77	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.77	Mean	1.632
5% K-S Critical Value	0.229	SD	2.803
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.429
		95% KM (t) UCL	2.349
Assuming Gamma Distribution		95% KM (z) UCL	2.337
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.338
Minimum	1E-06	95% KM (bootstrap t) UCL	2.615
Maximum	14	95% KM (BCA) UCL	2.398
Mean	1.977	95% KM (Percentile Bootstrap) UCL	2.406
Median	0.536	95% KM (Chebyshev) UCL	3.5
SD	2.824	97.5% KM (Chebyshev) UCL	4.309
k star	0.148	99% KM (Chebyshev) UCL	5.897
Theta star	13.32		
Nu star	16.33	**Potential UCLs to Use**	
AppChi2	8.197	95% KM (t) UCL	2.349
95% Gamma Approximate UCL (Use when n >= 40)	3.94	95% KM (Percentile Bootstrap) UCL	2.406
95% Adjusted Gamma UCL (Use when n < 40)	4.016		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

Chloroform

General Statistics

Number of Valid Data	55	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	52
		Percent Non-Detects	94.55%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.13	Minimum Detected	-2.04
Maximum Detected	1.3	Maximum Detected	0.262
Mean of Detected	0.74	Mean of Detected	-0.671
SD of Detected	0.587	SD of Detected	1.211
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303

Note: Data have multiple DLs - Use of KM Method is recommenc		Number treated as Non-Detect	55
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.995	Shapiro Wilk Test Statistic	0.903
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.959	Mean	-0.199
SD	2.237	SD	1.373
95% DL/2 (t) UCL	2.463	95% H-Stat (DL/2) UCL	3.591
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.945
		SD in Log Scale	0.898
		Mean in Original Scale	0.214
		SD in Original Scale	0.226
		95% t UCL	0.265
		95% Percentile Bootstrap UCL	0.27
		95% BCA Bootstrap UCL	0.279
		95% H-UCL	0.281

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.187
5% K-S Critical Value	N/A	SD	0.226
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0485
		95% KM (t) UCL	0.268
Assuming Gamma Distribution		95% KM (z) UCL	0.267
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.6
Minimum	N/A	95% KM (bootstrap t) UCL	0.226
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	0.399
SD	N/A	97.5% KM (Chebyshev) UCL	0.49
k star	N/A	99% KM (Chebyshev) UCL	0.67
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.268
95% Gamma Approximate UCL (Use when n >= 40)	N/A	95% KM (Percentile Bootstrap) UCL	N/A
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

cis-1,2-Dichloroethene

General Statistics

Number of Valid Data	55	Number of Detected Data	20
Number of Distinct Detected Data	18	Number of Non-Detect Data	35
		Percent Non-Detects	63.64%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	260	Maximum Detected	5.561
Mean of Detected	40.52	Mean of Detected	1.936
SD of Detected	74.06	SD of Detected	2.143
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303
Note: Data have multiple DLs - Use of KM Method is recommenc		Number treated as Non-Detect	46
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	9
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	83.64%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.604	Shapiro Wilk Test Statistic	0.952
5% Shapiro Wilk Critical Value	0.905	5% Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	15.95	Mean	0.526
SD	47.8	SD	2.003
95% DL/2 (t) UCL	26.73	95% H-Stat (DL/2) UCL	34.42
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.671
		SD in Log Scale	2.791
		Mean in Original Scale	15.02
		SD in Original Scale	48.05
		95% t UCL	25.86
		95% Percentile Bootstrap UCL	26.58
		95% BCA Bootstrap UCL	29.17
		95% H-UCL	166.3
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.353	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	114.7		
nu star	14.13		
A-D Test Statistic	1.053	**Nonparametric Statistics**	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.829	Mean	14.98
5% K-S Critical Value	0.208	SD	47.62
)ata follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	6.589
		95% KM (t) UCL	26
Assuming Gamma Distribution		95% KM (z) UCL	25.82
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	25.82
Minimum	1E-06	95% KM (bootstrap t) UCL	34.7
Maximum	260	95% KM (BCA) UCL	27.73
Mean	15.39	95% KM (Percentile Bootstrap) UCL	26.45
Median	1E-06	95% KM (Chebyshev) UCL	43.7
SD	48.09	97.5% KM (Chebyshev) UCL	56.13
k star	0.0891	99% KM (Chebyshev) UCL	80.54
Theta star	172.7		
Nu star	9.804	**Potential UCLs to Use**	
AppChi2	3.82	95% KM (t) UCL	26
95% Gamma Approximate UCL (Use when n >= 40)	39.51		
95% Adjusted Gamma UCL (Use when n < 40)	40.57		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

Methylcyclohexane

General Statistics

Number of Valid Data	55	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	53
		Percent Non-Detects	96.36%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.85	Minimum Detected	-0.163
Maximum Detected	2	Maximum Detected	0.693
Mean of Detected	1.425	Mean of Detected	0.265
SD of Detected	0.813	SD of Detected	0.605
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303

Note: Data have multiple DLs - Use of KM Method is recommenc	Number treated as Non-Detect	55
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.956	Mean	-0.144
SD	2.168	SD	1.346
95% DL/2 (t) UCL	2.446	95% H-Stat (DL/2) UCL	3.599
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.881
5% K-S Critical Value	N/A	SD	0.186
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0434
		95% KM (t) UCL	0.954
Assuming Gamma Distribution		95% KM (z) UCL	0.952
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.623
Minimum	N/A	95% KM (bootstrap t) UCL	N/A
Maximum	N/A	95% KM (BCA) UCL	2
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	1.07
SD	N/A	97.5% KM (Chebyshev) UCL	1.152
k star	N/A	99% KM (Chebyshev) UCL	1.312
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.954
95% Gamma Approximate UCL (Use when n >= 40)	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

trans-1,2-Dichloroethene

General Statistics

Number of Valid Data	55	Number of Detected Data	16
Number of Distinct Detected Data	16	Number of Non-Detect Data	39
		Percent Non-Detects	70.91%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.16	Minimum Detected	-1.833
Maximum Detected	100	Maximum Detected	4.605
Mean of Detected	20.35	Mean of Detected	1.242
SD of Detected	32.58	SD of Detected	2.233
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303

Note: Data have multiple DLs - Use of KM Method is recommenc	Number treated as Non-Detect	51
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	4
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	92.73%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.672	Shapiro Wilk Test Statistic	0.917
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.243	Mean	0.149
SD	19.24	SD	1.799
95% DL/2 (t) UCL	11.58	95% H-Stat (DL/2) UCL	13.51
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.699
		SD in Log Scale	2.191
		Mean in Original Scale	6.382
		SD in Original Scale	19.42
		95% t UCL	10.77
		95% Percentile Bootstrap UCL	11
		95% BCA Bootstrap UCL	12.38
		95% H-UCL	18.01

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.347	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	58.7		
nu star	11.09		
A-D Test Statistic	0.773	**Nonparametric Statistics**	
5% A-D Critical Value	0.822	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.822	Mean	6.335
5% K-S Critical Value	0.231	SD	19.28
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.691
		95% KM (t) UCL	10.84
Assuming Gamma Distribution		95% KM (z) UCL	10.76
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	10.74
Minimum	1E-06	95% KM (bootstrap t) UCL	14.35
Maximum	100	95% KM (BCA) UCL	10.82
Mean	7.237	95% KM (Percentile Bootstrap) UCL	10.87
Median	1E-06	95% KM (Chebyshev) UCL	18.07
SD	19.72	97.5% KM (Chebyshev) UCL	23.14
k star	0.0951	99% KM (Chebyshev) UCL	33.11
Theta star	76.13		
Nu star	10.46	**Potential UCLs to Use**	
AppChi2	4.229	95% KM (t) UCL	10.84
95% Gamma Approximate UCL (Use when n >= 40)	17.89		
95% Adjusted Gamma UCL (Use when n < 40)	18.36		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

Trichloroethene

		General Statistics	
Number of Valid Data	55	Number of Detected Data	16
Number of Distinct Detected Data	16	Number of Non-Detect Data	39
		Percent Non-Detects	70.91%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	17	Maximum Detected	2.833
Mean of Detected	4.369	Mean of Detected	0.309
SD of Detected	6.129	SD of Detected	1.653
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303
Note: Data have multiple DLs - Use of KM Method is recommend		Number treated as Non-Detect	51
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	92.73%
		UCL Statistics	
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.7	Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.839	Mean	0.00357
SD	3.914	SD	1.523
95% DL/2 (t) UCL	3.722	95% H-Stat (DL/2) UCL	6.022
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	14.72	Mean in Log Scale	-1.071
SD	2.385	SD in Log Scale	1.608
95% MLE (t) UCL	15.26	Mean in Original Scale	1.532
95% MLE (Tiku) UCL	16.7	SD in Original Scale	3.735
		95% t UCL	2.375
		95% Percentile Bootstrap UCL	2.382
		95% BCA Bootstrap UCL	2.648
		95% H UCL	2.493
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.479	**Data appear Lognormal at 5% Significance Level**	
Theta Star	9.113		
nu star	15.34		
A-D Test Statistic	1.14	**Nonparametric Statistics**	
5% A-D Critical Value	0.793	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.793	Mean	1.535
5% K-S Critical Value	0.227	SD	3.711
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.524
		95% KM (t) UCL	2.411
Assuming Gamma Distribution		95% KM (z) UCL	2.396
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.393
Minimum	1E-06	95% KM (bootstrap t) UCL	2.801
Maximum	17	95% KM (BCA) UCL	2.473
Mean	1.755	95% KM (Percentile Bootstrap) UCL	2.43
Median	1E-06	95% KM (Chebyshev) UCL	3.818
SD	3.863	97.5% KM (Chebyshev) UCL	4.806
k star	0.115	99% KM (Chebyshev) UCL	6.746
Theta star	15.29		
Nu star	12.63	**Potential UCLs to Use**	
AppChi2	5.642	95% KM (Chebyshev) UCL	3.818
95% Gamma Approximate UCL (Use when n >= 40)	3.928		
95% Adjusted Gamma UCL (Use when n < 40)	4.018		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.

Vinyl chloride

General Statistics

Number of Valid Data	55	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	43
		Percent Non-Detects	78.18%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.61	Minimum Detected	-0.494
Maximum Detected	140	Maximum Detected	4.942
Mean of Detected	26.86	Mean of Detected	2.332
SD of Detected	39.41	SD of Detected	1.607
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	10	Maximum Non-Detect	2.303
Note: Data have multiple DLs - Use of KM Method is recommenc		Number treated as Non-Detect	48
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	7
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	87.27%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.677	Shapiro Wilk Test Statistic	0.977
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.233	Mean	0.234
SD	20.72	SD	1.797
95% DL/2 (t) UCL	11.91	95% H-Stat (DL/2) UCL	14.62
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.125
		SD in Log Scale	3.229
		Mean in Original Scale	6.024
		SD in Original Scale	20.97
		95% t UCL	10.76
		95% Percentile Bootstrap UCL	10.97
		95% BCA Bootstrap UCL	13.4
		95% H-UCL	258.7
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.535	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	50.23		
nu star	12.83		
A-D Test Statistic	0.228	**Nonparametric Statistics**	
5% A-D Critical Value	0.774	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.774	Mean	6.443
5% K-S Critical Value	0.257	SD	20.68
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.915
		95% KM (t) UCL	11.32
Assuming Gamma Distribution		95% KM (z) UCL	11.24
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	10.75
Minimum	1E-06	95% KM (bootstrap t) UCL	18
Maximum	140	95% KM (BCA) UCL	13.91
Mean	5.86	95% KM (Percentile Bootstrap) UCL	12.39
Median	1E-06	95% KM (Chebyshev) UCL	19.15
SD	21.02	97.5% KM (Chebyshev) UCL	24.65
k star	0.0785	99% KM (Chebyshev) UCL	35.45
Theta star	74.68		
Nu star	8.632	**Potential UCLs to Use**	
AppChi2	3.106	95% KM (t) UCL	11.32
95% Gamma Approximate UCL (Use when n >= 40)	16.29		
95% Adjusted Gamma UCL (Use when n < 40)	16.76		

Note: DL/2 is not a recommended method.

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).
For additional insight, the user may want to consult a statistician.