FINAL ADDENDUM
HUMAN HEALTH RISK ASSESSMENT FOR
MARSH RUN PARK
NEW CUMBERLAND, FAIRVIEW TOWNSHIP,
YORK COUNTY, PENNSYLVANIA
FUDS No. C03PA040301

Prepared for

U.S. Army Corps of Engineers, Baltimore District
Engineering Division-HTRW Branch
10 South Howard Street
10th Floor – CENAB-EN-HT
Baltimore, Maryland 21201
Contract W912DR-09-D-0018
Delivery Order 0003

Prepared by

EA Engineering, Science, and Technology, Inc.
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Sparks, Maryland 21152

Updated July 2012

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July 5, 2012

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QUALITY REVIEW STATEMENT

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In compliance with EA's Senior Technical Review Program, I hereby certify that I reviewed this final deliverable as the assigned Senior Technical Reviewer for this project. I consequently conclude that the information presented in this report/deliverable was prepared in accordance with the approved scope of services for the project and reflects a proper presentation of the data and/or the conclusions drawn and/or the analyses or design completed during the conduct of the work. This statement is based upon the standards identified in the contract and/or the standard of care existing at the time of the preparation.

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Lead Senior Technical Reviewer Signature:

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INDEPENDENT TECHNICAL REVIEW STATEMENT

This document has been produced within the framework of EA's total quality management system. As such, an independent technical review has been conducted, appropriate to the level of risk and complexity inherent in the project. This included review of assumptions (methods, procedures, and material used in analyses); alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

Independent Technical Reviewer Signature:

Barbara C. Roeper, P.E. 28 February 2012
Independent Technical Reviewer

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ABS	Dermal Absorption Factor
ADI	Allowable/Average Daily Intake
AF	Adherence Factor
AT	Averaging Time
BPJ	Best Professional Judgment
bw	Body Weight
CDI	Chronic Daily Intake
CF	Conversion factor
cm^2	Square Centimeter
COPC	Constituent of Potential Concern
CRDL	Contract Required Detection Limit
CSM	Conceptual Site Model
DCE	Dichloroethene
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
dL	Deciliter(s)
EC	Exposure concentration
ED	Exposure duration
EF	Exposure factor
EFH	Exposure Factors Handbook
EPC	Exposure Point Concentration
ft	Foot/Feet
FUDS	Formerly Used Defense Site
g	Gram(s)
GIABS	Gastrointestinal Dermal Absorption Factor
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
IR	Ingestion rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg	Kilogram(s)
L	Liter(s)
LADI	Lifetime Average Daily Intake

LOAEL	Lowest Observed Adverse Effect Level
m	Meter(s)
m^2	Square meter(s)
m^3	Cubic meter(s)
MCL	Maximum Contaminant Level
MF	Modifying Factor
mg	Milligram(s)
μg	Microgram(s)
NA	Not Applicable
NHAENS	National Health and Nutrition Examination Survey
NOAEL	No Observed Adverse Effect Level
NRC	National Research Council
PADEP	Pennsylvania Department of Envrionmental Protection
PAH	Polycyclic Aromatic Hydrocarbon
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbons
ncPAH	Non-carcinogenic Polycyclic Aromatic Hydrocarbons
PCE	Tetrachloroethene
PEF	Particulate emission factor
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RL	Reporting Limit
RSL	Regional Screening Level
s	second(s)
SA	Surface area for content
SF	Slope Factor
TCE	Trichloroethene
UCLM	Upper Confidence Limit on the Mean
UF	Uncertainty Factor
USACE	U.S. Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

A human health risk assessment (HHRA) was completed for the New Cumberland Army Depot Formerly Used Defense Site (FUDS), Marsh Run Park in New Cumberland, Pennsylvania. The HHRA was performed consistent with United States Environmental Protection Agency (U.S. EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance and Pennsylvania Department of Environmental Protection (PADEP) site-specific standards set forth in 25 PA Code, Title 25, Chapter 250, Subchapter D - Site-Specific Standard and Subchapter F - Exposure and Risk Determinations.

The Marsh Run Park property was previously owned by New Cumberland Army Depot. A portion of the property was formerly used as a landfill for the disposal of base-derived waste material starting in approximately 1917 and continuing until the late 1950s. The property was transferred to Fairview Township, exclusively for public park or public recreational purposes (as stated in the "Quitclaim Deed", April 23, 1976, Recorder of Deeds, County of York, State of Pennsylvania, Record Book 70E, p. 1034). The fill area was graded with fill to create a recreational field that was used from 1976 through 1987. The park was closed when preliminary investigations revealed chlorinated volatile organic compounds (VOCs) and metals existed in the subsurface soil and groundwater.

A Remedial Investigation (RI) was conducted by the USACE-Omaha District between 1988 and 1990. An HHRA was conducted as part of the 1990 RI to evaluate the risk for potential future exposure at Marsh Run Park (EA 1990). Contact with surface soil, surface water, sediment, and groundwater was evaluated in the HHRA. The 1990 HHRA determined there were no concerns for human health contact with surface soil, surface water, and sediment. Potential risk concerns were identified for a hypothetical residential exposure to groundwater.

The 1990 HHRA did not evaluate certain classes of chemicals due to a lack of toxicological values available at the time of the HHRA completion. Potential risks for ncPAHs, cPAHs, and lead could not be determined due to a lack of toxicity values available for these chemicals. Based upon reported concentrations, non-carcinogenic polycyclic aromatic hydrocarbons (ncPAHs), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and lead in surface soil may be a potential concern for future receptors at Marsh Run Park. This 2012 HHRA represents the baseline HHRA for ncPAHs, cPAHs, and lead at Marsh Run Park.

In addition, the 1990 HHRA did not evaluate all potential exposure pathways associated with groundwater. The 1990 HHRA only evaluated potential ingestion of groundwater as a tap water

source. Dermal contact with and inhalation of VOCs from groundwater were not evaluated. Furthermore, groundwater contamination was identified downgradient of the site since completion of the 1990 HHRA. This 2012 HHRA presents an evaluation of all potential groundwater exposure pathways for both onsite and offsite receptors.

This 2012 HHRA evaluates the potential sources of contamination within surface soil at Marsh Run Park and routes of migration for ncPAHs, cPAHs, and lead based on potential future site use. The exposure areas evaluated within the FUDS boundary for potential soil exposures differ according to the potential receptors evaluated. Potential risk concerns for exposure to contaminated groundwater onsite and offsite were also evaluated. The HHRA evaluates the reasonable maximum exposure that has a potential to occur at the site and offsite. The baseline risk assumes no means of exposure reduction (i.e., soil cover, digging restrictions, groundwater use restrictions). As a result, risks calculated in the HHRA are considered potential and should be used in making risk management decisions. The HHRA methodology involves a four-step process:

1. Data Evaluation – site-specific data are evaluated for inclusion in the HHRA,
2. Exposure Assessment – the calculation of exposure point concentrations (EPCs) representative for each chemical evaluated and identification of potential receptors and exposure pathways,
3. Toxicity Assessment – the consideration of the types of potential adverse health effects associated with exposures to each chemical evaluated, and
4. Risk Characterization - the estimation of chemical intakes for the identified receptor populations and quantitative estimate of both carcinogenic and non-carcinogenic risks.

Data Evaluation

Data evaluation includes the identification of the media of concern, summarization and evaluation of the analytical data that were collected, identification of the data to be used in the HHRA, and implementation of the data evaluation approach. As noted, the 1990 HHRA did not evaluate potential receptor exposures to ncPAHs, cPAHs, and lead in surface soil or evaluate all potential exposure pathways for receptor exposures to VOCs in groundwater both onsite and offsite. Because these constituents were identified as chemicals of potential concern (COPCs); lead and all ncPAHs and cPAHs detected at the site and all VOCs detected in groundwater onsite and off site, are included in this 2012 HHRA. The HHRA evaluated multiple data sets resulting from the 1990 RI sampling efforts, groundwater sampling from 2004 – 2011, and soil sampling conducted in June and December 2011.

Exposure Assessment

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the receptors of concern and exposure pathways are identified. For the Marsh Run Park, a human health site conceptual site model was developed to identify the receptors and exposure pathways evaluated. The area where the former landfill was located is surrounded by a perimeter fence, with an adjacent freshwater wetland. The fenced area has been maintained as a mowed grass field since 1987, with the exception of the soil vapor extraction area in the central portion of the field, where a synthetic cap covers the turf. The former recreational fields are vegetated, and a geomembrane cap associated with the former dual phase soil vapor extraction treatment system is intact beneath the portion of the fields with the most elevated concentrations of VOCs. As long as it is not removed, this cap would restrict any exposure to subsurface contaminants. The intended future use of the site, as described by the site owner, Fairview Township, is a recreational field, which is the type of land use permitted by the 1976 property transfer. No residential, commercial, or industrial site use is proposed, nor permitted by the future land use stipulated in the 1976 property deed transfer. Based upon the results of the 1990 HHRA, site layout, and intended future use, the primary medium of concern is surface soil.

As noted above, potential risk concerns for ingestion of groundwater were identified in the 1990 HHRA. The 1990 HHRA only evaluated onsite groundwater for ingestion. Exposure pathways and toxicity values have changed since completion of the 1990 HHRA, so onsite groundwater use was re-evaluated. Dermal contact with and inhalation of VOCs were not evaluated because they were not considered significant exposure pathways in comparison to potential groundwater ingestion. Furthermore, wells downgradient of the site were identified in 2003. Even though, these wells were only used infrequently by recreational users, they represents a complete exposure pathway for groundwater as a tap water source. Therefore, groundwater was also evaluated as a potential media of concern in this 2012 HHRA. Because chlorinated VOCs are the primary chemicals of concern in groundwater, there is also a potential for these chemicals to volatize from the subsurface to air. Both a vapor intrusion pathway and exposure to ambient air were evaluated.

The future, planned use of Marsh Run Park is recreational fields (most likely soccer). Therefore, the recreational user is the primary future receptor for Marsh Run Park. The recreational user is assumed at 6-16 years of age and is only expected to contact the area of the site near the recreational fields. They are not expected to contact the wetland area on the east of the site.

Trespassers are a possibility at the site. Access to Marsh Run Park is not controlled by security restrictions or other methods of control. A fence does exist around the former recreational fields; however, this does not limit all access. A trespasser is expected to potentially access the entire site, including the wooded and wetland areas to the north and east of the recreational fields. Therefore, the trespasser is expected to contact the entire area within the FUDS boundary.

Some construction/shallow earth moving will occur at the Marsh Run Park to make the area suitable for recreational fields. The construction activities include removal of sod from within the fenced portion of the site, removal of top soil in the southern portion of the fenced area of the site, placement of clean fill from offsite, and site grading within the fenced area of the site. As a result, a construction worker is expected to contact surface soil in the area of Marsh Run Park within the fence line during these activities. The construction worker exposure area is the same as that of the recreational user.

The exposure assessment also includes the estimation of EPCs and the calculation of exposure intakes. Reported concentrations of all ncPAHs and cPAHs were used to calculate the 95th percentile upper confidence limit on the mean (95%UCLM) in surface soil. The EPC is used to estimate chemical intakes for each pathway considered in the HHRA. Two exposure areas were evaluated for the Marsh Run Park. One exposure area is the area near the recreational fields, not including the wetland area to the west, representative of the recreational user exposure. The second exposure area is the entire FUDS Boundary, which is representative of the trespasser exposure.

The PAHs in surface soil are converted into systemic doses, taking into account different types and rates of contact (e.g., ingestion rates, dermal contact, and inhalation) and absorption rates. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

Toxicity Assessment

The toxicity assessment considers the types of potential adverse health effects and related uncertainties. Both non-carcinogenic and carcinogenic effects were considered in the HHRA. Toxicity values were selected in keeping with appropriate exposure duration and U.S. EPA guidance. For lead, blood-lead level modeling is conducted utilizing U.S. EPA recommended Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model and Adult Lead Model.

Risk Characterization

Risk characterization focuses on COPC comparisons to U. S. EPA recommended toxicity values. Carcinogenic risks and non-carcinogenic hazards are evaluated for each receptor on a cumulative basis across all pathways and media. Risk thresholds are defined as cumulative carcinogenic risks that exceed the risk range of 1 in 1 million ($1x10^{-6}$) to 1 in 10,000 ($1x10^{-4}$) or non-carcinogenic risks that exceed 1.0 (PADEP 1995 and U.S. EPA 1990).

Conclusions

A recreational user, trespasser, and construction worker potential exposure to surface soil within the Marsh Run Park were evaluated in this HHRA. The recreational user and construction worker were evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates from surface soil within the area of site near the recreational fields. The trespasser was evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates from surface soil within the FUDS boundary of Marsh Run Park. Non-carcinogenic hazards did not exceed 1.0 for any of the receptors. Carcinogenic risks for: the recreational user, trespasser, and construction worker were $7x10^{-5}$, $2x10^{-5}$, and $6x10^{-7}$, respectively, and all were within the acceptable risk range. An evaluation of lead in surface soil indicates that lead is not a site-wide concern.

A conservative (health protective) evaluation was performed in the HHRA that most likely overestimates potential carcinogenic risks to the recreational user. The HHRA assumes the recreational user would have full exposure to surface soil. The recreational fields will be maintained and vegetated, which limits contact to soil. Additionally, the recreational fields and adjacent areas are expected to have a minimum 1 ft of clean fill placement for site grading and restoration purposes. This additional fill material will further limit contact with surface soil. As a result, the exposures modeled in this HHRA and the resulting risk results are most likely over-estimated. Therefore, it is concluded from this 2012 HHRA and 1990 HHRA evaluation that there are no risk concerns for potential receptors from exposure to surface soil at Marsh Run Park.

As noted above, potential risk concerns for ingestion of groundwater were identified in the 1990 HHRA. Groundwater was evaluated qualitatively in this HHRA to determine impact to risk results from the changes in exposure pathways and toxicity values. The qualitative evaluation confirmed there are potential risk concerns for use of onsite groundwater as a tap

water source. Trichloroethene (TCE), vinyl chloride, and cis-1,2-dichloroethene (DCE) are the primary contributors to this concern.

In addition, offsite groundwater results were also evaluated in this 2012 HHRA. For the former Mifflin Avenue Cabin Well, the carcinogenic risk result from the highest reported concentration of TCE (30.1 ug/L from March 2006) was $7x10^{-5}$, which is within the acceptable risk range However, it is noted that the highest reported concentration of TCE in the Mifflin Avenue Cabin Well was above the Federally promulgated Maximum Contaminant Level (MCL). The Mifflin Avenue Cabin Well has been abandonedand replaced with the MADW 41-52 as a result. For the MADW 41-52, the carcinogenic risk results from the highest reported concentration of TCE (2.3 ug/L in May 2011) are $5x10^{-6}$, which is within the acceptable risk range. This reported concentration (2.3 ug/L) is below the MCL. However, groundwater from deeper intervals results in carcinogenic risks ranging up to $1x10^{-3}$, which is greater than the accepted risk range and indicates that consumption of groundwater from these deeper intervals could result in adverse health effects.

There is an additional hand-dug well, designated RW-305, on a recreational parcel adjacent to the parcel that contains the Mifflin Avenue Cabin Well and MADW 41-52. VOCs have not been reported in RW-305. Therefore, there are no potential risk concerns for use of RW-305 as a potable water supply. It is noted that this adjacent property is located downgradient from the site and concentrations of TCE were reported in exceedance of the MCL in the deeper bedrock aquifer on the adjacent property. As a result, there is a potential that groundwater contamination within the deeper intervals in bedrock are present at this adjacent property. The use of groundwater as a potable water supply from the deeper bedrock aquifer may result in adverse health effects.

TCE was detected in groundwater at concentrations in excess of the Residential Statewide Health MSCs for groundwater at the onsite and in offsite areas. As a result, the volatilization of TCE from groundwater and subsequent vapor intrusion to indoor air in onsite and offsite areas was evaluated through the use of the Johnson and Ettinger Model (U.S. EPA 2004b). The results of the model, based conservatively on the highest detected concentration in the overburden aquifer, revealed risk results of $1x10^{-7}$ for onsite groundwater and $2x10^{-7}$ for offsite groundwater. Therefore, there are no human health concerns for exposure to TCE within indoor air.

An evaluation was also performed for potential volatilization to ambient air within the recreational fields and indoor air to structures. Onsite, the bedrock aquifer (>40 ft bgs) has the highest reported concentrations of these chemicals. However, if volatilization from groundwater

to soil vapor and/or to ambient air was occurring, it would occur from the overburden aquifer and not the bedrock aquifer. It is expected that there is more than 5 feet of soil between the ground surface and groundwater at the site. VOCs were detected within two overburden aquifer monitoring wells (MW-1A, and MW-2A) at very low concentrations below or near drinking water standards. Low levels of chlorinated VOCs (e.g., up to 2.6 mg/kg TCE) have also been detected within some subsurface soil samples within the recreational fields.

The maximum concentrations of VOCs in soil and groundwater across the site are more than an order of magnitude lower that the default screening values for protection of residential indoor air as presented in the PADEP's Vapor Intrusion Guidance Document. In addition, the maximum concentration of VOCs in the onsite overburden aquifer groundwater were also below calculated screening values for protection of residential indoor air as presented in the U.S. EPA Vapor Intrusion Guidance (U.S. EPA 2002b). Potential exposures to ambient air at a recreational site are expected to be much lower than potential exposures associated with residential indoor air. The lower exposure is due to lower exposure frequency (e.g., number of days at the site) and duration associated with a recreational use and greater degree and rate of contaminant diffusion in ambient air. As a result, potential exposure to ambient air are considered incomplete and were not addressed this 2012 HHRA.

In summary, there are no risk concerns for the trespasser, recreational users or a construction worker exposure to surface soil and potential exposure to VOC volatilization to ambient and indoor air from groundwater at Marsh Run Park. Groundwater used as a potable water supply is a potential concern for the deeper bedrock aquifer both onsite and offsite of Marsh Run Park.

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1 INTRODUCTION

This document presents the human health risk assessment (HHRA) for New Cumberland Army Depot FUDS, Marsh Run Park, in New Cumberland, Pennsylvania. The HHRA was performed consistent with United States Environmental Protection Agency (U.S. EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance and Pennsylvania Department of Environmental Protection (PADEP) site-specific standards set forth in 25 PA Code, Title 25, Chapter 250, Subchapter D - Site-Specific Standard and Subchapter F - Exposure and Risk Determinations.

This introduction provides a brief background of the project, including an earlier HHRA, the project's objectives, and the general approach of the HHRA.

1.1 PROJECT BACKGROUND

The Marsh Run Park property was previously owned by New Cumberland Army Depot. A portion of the property was formerly used as a landfill for the disposal of base-derived waste material starting in approximately 1917 and continuing until the late 1950s. The property was transferred to Fairview Township, exclusively for public park or public recreational purposes (as stated in the "Quitclaim Deed", April 23, 1976, Recorder of Deeds, County of York, State of Pennsylvania, Record Book 70E, p. 1034). The fill area was graded with fill to create a recreational field that was used from 1976 through 1987. The former landfill is surrounded by a perimeter fence, with an adjacent freshwater wetland. The fenced area has been maintained as a mowed grass field since 1987, with the exception of the soil vapor extraction area in the central portion of the field, where a synthetic cap covers the turf. The intended future use is recreational fields and an associated parking area.

An environmental assessment was initiated in 1987 by the U.S. Army Corps of Engineers (USACE) that included installation and sampling of groundwater monitoring wells, test pits and subsurface soil collection, and collection of surface water and sediment samples (Woodward-Clyde 1987). Results indicated that chlorinated volatile organic compounds (VOCs) and metals existed in the subsurface soil and groundwater. When the preliminary sampling results were reviewed, the park was closed. The Army recommended that further investigations be conducted at the site. Two surface soil sampling events were conducted in 1988 within the area of the recreational fields: a Public Health Evaluation by the USACE, and a second independent investigation by the U.S. EPA.

A Remedial Investigation (RI) was conducted by the USACE-Omaha District between 1988 and 1990. An HHRA was conducted as part of the 1990 RI to evaluate the risk for potential future exposure at Marsh Run Park (EA 1990). Contact with surface soil, surface water, sediment, and groundwater was evaluated in the HHRA. Carcinogenic risk results were compared to the U.S. EPA and PADEP acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ (PADEP 1995 and U.S. EPA 1990), and non-carcinogenic hazards were compared to an acceptable hazard index (HI) threshold of 1.

1.1.1 1990 HHRA – Surface Soil

For surface soil, potential risk to children via direct contact, incidental ingestion, and inhalation while playing onsite was evaluated in the HHRA. The RI report does not indicate whether the surface soils were collected from fill material brought onto site by Fairview Township in the 1970s for grading purposes or whether the samples were collected from native site soil. The HHRA was completed for chemicals detected above background concentrations, which included non-carcinogenic polycyclic aromatic hydrocarbons (ncPAHs), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), diethylphthalate, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, cadmium, copper, lead, mercury, selenium, silver, thallium, zinc, and cyanide. The ncPAHs included acenaphthene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene; cPAHs included benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Arsenic, nickel, and chromium were not assessed as they did not exceed background concentrations. Additionally, potential risks for ncPAHs, cPAHs, and lead could not be assessed due to a lack of toxicity values available for these chemicals when the HHRA was completed.

During the HHRA, it was concluded that there was no risk above acceptable ranges for surface soil exposures, even under conservative worst case concentration scenarios. The HI for the sum of direct contact, incidental ingestion, and inhalation for non-carcinogenic compounds was 0.02 for average case exposures and 0.2 for worst case exposures, both of which are less than the HI threshold of 1. For carcinogenic compounds, the sum of direct contact, incidental ingestion, and inhalation, the lifetime excess cancer risk was $5x10^{-8}$ for average case exposures and $1x10^{-6}$ for worst case concentrations, both of which are equal to or below the acceptable range. Based on these findings, it was concluded that there were no risk concerns for exposure to onsite surface soil. Remediation of soil was not recommended. Subsurface soil was not evaluated in the HHRA because it was not considered a complete exposure pathway for past, current, and future receptors, as the future use of the site is limited to recreational use as stated in the "Quitclaim Deed" (dated April 23, 1976, Recorder of Deeds, County of York, State of Pennsylvania, Record Book 70E, p. 1034).

1.1.2 1990 HHRA – Surface Water and Sediment

Potential risk to children from exposure to surface water and sediment via direct contact and incidental ingestion while playing in Marsh Run Creek was also evaluated in the HHRA. The risk assessment assessed potential incidental ingestion and dermal contact for all chemicals detected in surface water above background concentrations, which included 1,2-dichloroethene (1,2-DCE), trichloroethene (TCE), tetrachloroethene (PCE), ncPAHS, 4,4'DDE (dichlorodiphenyldichloroethylene), 4,4'DDD (dichlorodiphenyldichloroethane), aluminum, barium, chromium, copper, iron, lead, manganese, vanadium, and zinc. Arsenic, calcium, magnesium, potassium, and silicon were not included because they did not exceed background values. Additionally, potential risk from ncPAHs in surface water could not be assessed due to a lack of toxicity values available for these chemicals. Potential risk due to dermal contact for all chemicals detected in sediment with concentrations exceeding background, which included ncPAHs, cPAHs, diethylphthalate, di-n-butylphthalate, bis (2-ethyhexyl) phthalate, 4,4'DDE, 4,4'DDD, 4,4'DDT (dichlorodiphenyltrichloroethane), antimony, arsenic, cadmium, lead, manganese, zinc, and cyanide was also assessed. Aluminum, barium, beryllium, chromium, cobalt, copper, iron, magnesium, mercury, nickel, potassium, selenium, sodium, and vanadium were not included because they did not exceed background values. Additionally, potential risks for ncPAHs, cPAHs, and lead in sediment could not be assessed in the 1990 HHRA due to a lack of toxicity values available for these chemicals.

It was concluded during the HHRA that risk results for surface water and sediment exposures combined were below acceptable risk ranges for these exposures. The HI for non-carcinogenic compounds was 0.0005 for average case exposures and 0.009 for worst case exposures, both of which are less than the threshold of 1. The lifetime excess cancer risk for carcinogenic compounds was $1x10^{-8}$ for average case exposures and $3x10^{-7}$ for worst case exposures, both of which are below the acceptable risk range. Based on these findings, it was determined that there were no risk concerns from exposure to surface water or sediment.

1.1.3 1990 HHRA – Groundwater

Exposure of future hypothetical residents to groundwater via direct ingestion from onsite wells was also evaluated in the HHRA. Sample results collected during February and August 1989 from monitoring wells 1, 1A, 2, 2A, 3A, 4, 4A, 7, and 7A were included in the HHRA. All chemicals detected in groundwater above background concentrations, which included ethylbenzene, 1,1-dichloroethene, 1,2-DCE, TCE, PCE, acetone, 1,1,2-trichloroethane, bis (2-ethylhexyl) phthalate, arsenic, iron, potassium, and boron were included in the evaluation.

Antimony, silver, thallium, molybdenum, aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, nickel, selenium, sodium, vanadium, zinc, silicon, and cobalt were not included because they did not exceed naturally occurring background ranges. Risk results for groundwater were above potential acceptable risk ranges. The HI for non-carcinogenic compounds was 0.7 for average case exposures and 2.7 for worst case exposures. Arsenic was the only chemical that had a non-carcinogenic Hazard Quotient (HQ) above 1. The lifetime excess cancer risks for carcinogenic compounds were $1x10^{-3}$ for average case exposures and $4x10^{-3}$ for worst case exposures, both of which are above the acceptable risk range. Arsenic, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, and TCE had carcinogenic risks above $1x10^{-4}$. Based on these findings, it was determined that there was potential risk from ingestion of onsite groundwater, and groundwater remediation was recommended.

1.1.4 1990 HHRA Summary

The HHRA completed for the 1990 RI identified potential risk concerns for a hypothetical residential exposure to groundwater. All exposures to surface soil, surface water, and sediment were within acceptable levels. Furthermore, the toxicity values for the chemicals in surface soil, surface water, and sediment that were quantitatively assessed in the 1990 RI generally have not changed or are now less conservative. As noted above, the HHRA did not evaluate certain classes of chemicals due to a lack of toxicological values available at the time of the HHRA completion.

1.1.5 Rationale for 2012 HHRA Update

The 1990 HHRA could not determine potential risks for ncPAHs, cPAHs, and lead due to a lack of toxicity values available for these chemicals. However, based upon reported concentrations, ncPAHs, cPAHs, and lead in surface soil may be a potential concern for future receptors at Marsh Run Park and were therefore further evaluated in this 2012 HHRA. For sediment collected in 1990 during the RI, cPAHS and ncPAHs were detected in one out of five sediment samples, and the sample with the reported polycyclic aromatic hydrocarbons (PAHs) was collected upstream from the site. Therefore PAHs are not a concern in stream sediment from the site. Lead was detected below the level of concern for surface water and sediment. Therefore, sediment and surface water were not considered a concern and are not further evaluated in this HHRA.

For surface soil, this 2012 HHRA represents the baseline HHRA for ncPAHs, cPAHs, and lead at Marsh Run Park. Surface soil within the entire New Cumberland Army Depot FUDS

boundary of Marsh Run Park is taken into account in this HHRA. However, the exposure areas evaluated within the FUDS boundary differ according to the potential receptors evaluated. The Exposure Assessment in Section 2.2 details the exposure areas evaluated. Furthermore, additional surface soil and wetlands surface soil samples have been collected since completion of the 1990 RI. These samples were collected in June and December 2011 to confirm and further delineate the PAH and lead results from 1988 and 1989. These 2011 samples were included in the evaluation for surface soil exposure in this HHRA.

Additionally, potential receptor exposure and toxicity values for VOCs in groundwater have changed since completion of the 1990 RI. The 1990 HHRA evaluated the hypothetical use of onsite groundwater as a potable water supply, even though this was not a known complete exposure pathway at that time. In 2003, a search was completed for potable wells located downgradient of the Marsh Run Park. Two wells were identified downgradient, a cistern (RW-305) and a well at a recreational cabin (referred to as the Mifflin Avenue Cabin Well). Initial sampling results in 2003 from these wells indicated no detectable VOCs in RW-305 and TCE levels at a concentration of 6.0 micrograms per liter (µg/L) in the Mifflin Avenue Cabin Well. Subsequent sampling of the Mifflin Avenue Cabin Well confirmed TCE was present with results ranging up to 30.1 µg/L. Even though the cabin use was seasonal and water use was limited to showering and not used as potable, the Mifflin Avenue Cabin Well measured TCE concentrations were above the Federally promulgated MCL and the Residential Statewide MSCs. Therefore the Mifflin Avenue Cabin Well was replaced with a new supply well in 2011 referred to as the Mifflin Avenue Deep Well 41-52 (MADW 41-52) to provide unrestricted use of the groundwater. Subsequent VOC measurements from the MADW 41-52 were below the MCL and PA MSC and metals were below background.

In addition, the 1990 HHRA only evaluated ingestion of groundwater because it was considered the most significant route of exposure. Dermal contact with and inhalation of groundwater were not evaluated in the 1990 HHRA. However, these exposure pathways can also contribute significantly to risk results for VOCs. To account for the changes in exposure pathways and toxicity values, VOCs detected in groundwater samples were evaluated qualitatively in this 2012 HHRA to determine potential risk to receptors.

1.2 PROJECT OBJECTIVES

The objective of this HHRA is to evaluate potential human health risk under current and potential future conditions within Marsh Run Park. The specific objectives of the HHRA include:

- Provide background information and a site description.
- Outline the regulatory basis and guidance for conducting the HHRA.
- Develop a conceptual site model (CSM) that characterizes relevant contaminant pathways and receptors of concern.
- Calculate potential carcinogenic risks and non-carcinogenic hazards to receptors of concern (e.g., any human contact at the site under present or future scenarios).
- Identify areas that pose no unacceptable risks to human health and require no further action.
- Identify areas that may pose a concern to human health and require further investigation or action.

1.3 GENERAL HHRA APPROACH

The risk assessment follows guidance as recommended by the U.S. EPA and PADEP. Specific application of guidance throughout the risk assessment process is detailed in Chapter 2 of this document. The HHRA is conducted in accordance with the following U.S. EPA Guidance:

- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) (Interim Final).* Report No. EPA/540/1-89/002. Office of Emergency and Remedial Response. U.S. EPA, December 1989.
- *Risk Assessment Guidance for Superfund Volume I-Human Health Evaluation Manual: (Part B - Development of Risk-Based Preliminary Remediation Goals) (Interim Final)*. Office of Emergency and Remedial Response. Publication 9285.7-01B. Interim. U.S. EPA, 1991a.
- *Memorandum: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"*. Office of Solid Waste and Emergency Response. OSWER Directive: 9285.6-03. March 25. U.S. EPA, 1991b.
- *Exposure Factors Handbook: Volumes I, II, and III*. Office of Research and Development. EPA/600/P-95/002a,b,c. U.S. EPA, August 1997.
- *Exposure Factors Handbook: 2011 Edition*. Office of Research and Development. EPA/600/R090/052F. U.S. EPA, September 2011a.
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D)*. Office of Emergency and Remedial Response. U.S. EPA, December 2002a.

- *Guidelines for Carcinogen Risk Assessment.* EPA/630/P-03/001F. Risk Assessment Forum, U.S. EPA 2005a.
- *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. EPA/630/R-03/003F. Risk Assessment Forum, U.S. EPA 2005b.
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. Final. Office of Superfund Remedial and Technology Innovation. U.S. EPA, July 2004a.
- *Risk Assessment Guidance for Superfund, Volume I*: *Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment*). Final. Office of Superfund Remediation and Technology Innovation. U.S. EPA, January 2009a.
- *Regional Screening Level (RSL) Tables.* U.S. EPA, April 2012a.
- *ProUCL Version 4.1.00*. Software developed by U.S. EPA. Obtained on the Internet at http://www.epa.gov/osp/hstl/tsc/software.htm. Technical Support Center for Monitoring and Site Characterization. U.S. EPA, 2011b.

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2 RISK ASSESSMENT METHODOLOGY

The 2012 HHRA includes evaluation of potential sources of contamination and routes of migration based on current and potential future site uses. HHRA results are based upon potential exposure pathways that can occur or are reasonably likely to occur in the future. The HHRA is conducted to evaluate baseline risks associated with exposure to the area. The baseline risk assessment assumes that no remedial actions or other means of exposure reduction (i.e., fencing, cover material) will be implemented. The HHRA identifies and evaluates the reasonable maximum exposure that has the potential to occur at the site. As a result, risks calculated in the HHRA are considered potential and should be used as a guideline in making risk management decisions.

The HHRA methodology involves a four-step process: data evaluation; exposure assessment; toxicity assessment; and risk characterization. A brief description of each step is provided below.

In the *data evaluation*, site-specific data are evaluated for inclusion in the HHRA. The data evaluation is discussed further in Section 2.1.

In the *exposure assessment*, the human population, or groups of individuals potentially exposed to site chemicals (i.e., potential human receptors), are characterized. From the many potential pathways of exposure, pathways applicable to potential receptors at the site are identified (i.e., ingestion, inhalation). Chemical exposure concentrations are estimated based upon the site-specific monitoring data. The concentrations of chemicals in relevant media (e.g., soil, air) are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily intakes over a specified period of time (e.g., lifetime, activity-specific duration). Section 2.2 presents further details concerning the exposure assessment.

In the *toxicity assessment*, the relationship between extent of exposure and extent of toxic injury or disease is estimated for each chemical evaluated in the HHRA. Chemical-specific toxicity values, such as cancer slope factors (SFs) for carcinogenic compounds and reference doses (RfDs) or reference concentrations (RfCs) for non-carcinogens are presented along with a discussion of their scientific basis and derivation. Further discussion of the toxicity assessment is provided in Section 2.3.

Risk characterization integrates the results of the toxicity assessment and the exposure assessment to derive quantitative estimates of human health risk, including the risk of both cancer and of non-carcinogenic effects. The major uncertainties and limitations associated with the estimates of risk and their potential ramifications are discussed. Section 2.4 presents the risk characterization.

2.1 DATA EVALUATION

Data evaluation is the first step of the HHRA process. It includes identification of the media of concern, summarization and evaluation of the analytical data that were collected, identification of the data to be used in the HHRA, and implementation of the data evaluation approach. Data evaluation also usually includes a risk-based screening step that would focus the HHRA on chemicals that contribute to overall risk results, also known as constituents of potential concern (COPCs). A previous HHRA was completed for the Marsh Run Park as part of the 1990 RI. That HHRA identified a number of COPCs, evaluated potential risks from these COPCs based on the HHRA methodology applicable to 1990, which does not differ substantially to current methodology, and concluded that there were no risk concerns for exposure to onsite surface soil. However, as noted in Section 1.1, the 1990 HHRA did not evaluate potential receptor exposures to ncPAHs, cPAHs, and lead. Because these constituents have been identified as COPCs, lead and all ncPAHs and cPAHs detected at the site are included in this 2012 HHRA.

In addition, for groundwater, both onsite and offsite exposures, a risk ratio was performed. The risk ratio evaluated maximum detected concentrations of VOCs in groundwater from onsite wells and downgradient offsite wells. The risk ratio presents a comparison of the maximum detected concentration to the U.S. EPA tap water RSLs (U.S. EPA 2012a). For VOCs with a U.S. EPA tap water RSL with a carcinogenic endpoint, the maximum detected concentration was divided by the RSL and multiplied by 10^{-6} to represent a carcinogenic risk. For VOCs with a U.S. EPA tap water RSL with a non-carcinogenic endpoint, the maximum detected concentration was divided by the RSL to present a hazard quotient (HQ). Groundwater within the overburden aquifer was also assessed for potential vapor intrusion into indoor air both onsite and offsite. In addition, both groundwater within the overburden aquifer and subsurface soil were assessed for potential volatilization from the subsurface to ambient air within the recreational fields.

2.1.1 Data Included in the HHRA

The HHRA evaluates multiple data sets resulting from the 1990 RI sampling efforts, groundwater monitoring from 2004 – 2012, and soil sampling conducted in June and December 2011. The sampling conducted in June and December 2011 was performed in

accordance with PADEP's Chapter 250 requirements to confirm and delineate historical soil sampling results with elevated concentrations of some metals and PAHs. Appendix A provides details about sample locations, date sampled, and sample depth for all results used in the HHRA. These data represent all of the available validated analytical data.

2.1.2 Data Quality Evaluation

Only validated data are used in the HHRA. Inclusion or exclusion of data in the HHRA on the basis of analytical qualifiers is performed in accordance with U.S. EPA guidance (U.S. EPA 1989). The first step is the evaluation of analytical data on the basis of qualifiers in soil.

- Analytical results bearing the R qualifier (indicating that the data were rejected during the validation process) are not used in the HHRA.
- Analytical results bearing the U or UJ qualifier (indicating that the analyte is not detected at the given reporting limit [RL]) are retained in the data set and considered non-detects. Where warranted for statistical purposes, each analyte is assigned a numerical value equal to one-half of its RL.
- Analytical results bearing the J qualifier (the reported value is estimated) and K qualifier (reported value may be biased high) are retained at the measured concentration.

If duplicate samples were collected or duplicate analyses were conducted on a single sample, the following guidelines are employed to select the appropriate sample measurement:

- If both samples/analyses indicate that the analyte is present, the average of the two detected concentrations is retained for analysis, based on conservative professional judgment;
- If both samples/analyses are not detected, the average of the two RL concentrations is retained for analysis; and
- If only one sample/analysis indicated that the analyte is present, it is retained for analysis and the non-detect value is discarded.

Current U.S. EPA methodology (U.S. EPA 2011b) recommends against using one-half the RL for statistical purposes. However, one-half the RL is used in this HHRA because the samples collected in 1988 and 1989 did not identify the RL, only the contract required detection limit (CRDL). The CRDL is typically higher than an RL, and the use of the full CRDL would overestimate chemical concentrations for samples collected in 1988 and 1989. In addition, confirmation samples (SB-3 and SB-10) were collected in 2011 based on discussions with PADEP to confirm detections of PAHs in soil samples from MW-2 and SS-8, which were collected in 1989 and 1988. Because the confirmation samples were collected next to the

original RI sample locations, the sample locations were averaged to represent a duplicate sample (i.e. sample location SB-10 was averaged with sample location SS-8, and sample location SB-3 was averaged with sample location MW-2). The sample results for each location and the average calculations are presented in Appendix A, Table A.2.

2.2 EXPOSURE ASSESSMENT

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the human population, or groups of individuals potentially exposed to site media (i.e., potential human receptors) are identified. Pathways applicable to potential receptors at the site are identified from the many potential pathways of exposure. Chemicals evaluated in site media are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates of different chemicals. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

Actual pathways and receptors that are assessed for quantitative evaluation are medium-specific. An exposure pathway describes a mechanism by which a population or individual may be exposed to chemicals present at a site. A completed exposure pathway requires the following four components:

- A source and mechanism of chemical release to the environment.
- An environmental transport medium for the released chemical.
- A point of potential human contact with the contaminated medium.
- A human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization. The exposure assessment includes several steps:

- Evaluating the exposure setting, which includes a description of the local land uses and the potentially exposed human populations.
- Developing the CSM identifying the source of contamination, contamination transport and release mechanisms, exposure media, the exposure routes, and potentially exposed populations.
- Calculating exposure point concentrations (EPCs) for each chemical evaluated for each of the exposure scenarios and routes (Tables 1 and 2).

- Identifying the exposure models and parameters with which to calculate the exposure doses.
- Calculating exposure doses.

2.2.1 Conceptual Site Model

A CSM has been developed to show potential sources of contamination, routes of migration, and receptors evaluated in this HHRA as identified in the exposure setting. Pathways begin from potential sources and progress through the environment through various fate and transport processes to potential human receptors. The primary objective of the CSM is to identify both complete and incomplete exposure pathways. A complete pathway has all of the components listed above, whereas an incomplete pathway is missing one or more components. Figure 1 presents the CSM.

2.2.2 Exposure Setting

The site is located in a rural area with low population density and low growth potential. A majority of the site is a former landfill. As stipulated in the 1976 property transfer, the future use of the site is exclusively for public park or public recreational purposes; additionally, local zoning does not allow for development of the site for residential purposes. Land use adjacent to the Marsh Run Park varies from restricted, government use to residential. The property adjacent to and west of the site is a part of Defense Depot Susquehanna, Pennsylvania and is used for military support. Access to this property is controlled by fencing and security. The property immediately to the north is railroad property, which primarily consists of railroad tracks. Beyond the railroad property are two privately owned properties on the Susquehanna River used primarily for weekend recreation. To the east of the site is private property that is comprised of wooded area, wetland, and Marsh Run Creek, beyond which is a residential community. To the south of the site is Marsh Run Creek, beyond which is Marsh Run Road. Southeast of Marsh Run Road are two residential properties and an American Legion hall. Land use east of the site is expected to remain residential.

The eastern and northern areas of the site are wooded. In addition, the eastern wooded area supports a wetland that is primarily wet throughout the year. Marsh Run Creek, which is located southwest, south, and east of the site, discharges to the Susquehanna River and is not utilized for drinking water. The limited depth and discharge of the Creek also suggests that it has not been, or will be, a habitat to support fish of a size adequate for possible human consumption.

The proposed final site remedy does not include the implementation of engineering controls although a fence currently exists around the former recreational fields within the site. The former recreational fields are vegetated, and a geomembrane cap associated with the former dual phase soil vapor extraction treatment system is intact beneath the portion of the fields with the most elevated concentrations of VOCs. As long as it is not removed, this cap would restrict any exposure to subsurface contaminants. The intended future use of the site, as described by the site owner, Fairview Township, is a recreational field, which is the type of land use permitted by the 1976 property transfer. No residential, commercial, or industrial site use is proposed, nor permitted by the future land use stipulated in the 1976 property deed transfer. Based on the planned recreational site use, a future bathroom and/or small concessions stand (e.g., the inactive onsite treatment building) may be constructed at the site. Additionally, some construction/earth moving of the surface soil will occur at the Marsh Run Park to make the area suitable for recreational fields and activities. The construction activities include removal of sod, placement of offsite fill, grading of surface material and creation of a parking area within the fenced area of the site.

2.2.2.1 Media of Concern

Based on the 1990 RI report and a detailed evaluation of all currently available information with respect to the applicable risk assessment guidance, surface soil and groundwater are the media of concern evaluated in this 2012 HHRA. Surface water and sediment are not media of concern for human health. Subsurface soil is not a medium of concern because future construction of residential or commercial-type buildings is not expected at the site due to the presence of the landfill, and the existing property use restrictions as set forth in the property deed.

Receptors were evaluated for exposure to cPAHs, ncPAHs, and lead within soil in this 2012 HHRA. The 1990 HHRA evaluated potential recreational user exposure to diethylphthalate, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, cadmium, copper, lead, mercury, selenium, silver, thallium, zinc, and cyanide in surface soil. Arsenic, nickel, and chromium were not assessed as they did not exceed background concentrations. The 1990 HHRA determined there was no risk above acceptable ranges for surface soil exposures, even under conservative worst case concentration scenarios. The HI for the sum of direct contact, incidental ingestion, and inhalation for non-carcinogenic compounds was 0.02 for average case exposures and 0.2 for worst case exposures, both of which are less than the HI threshold of 1. For carcinogenic compounds, the sum of direct contact, incidental ingestion, and inhalation, the lifetime excess cancer risk was $5x10^{-8}$ for average case exposures and $1x10^{-6}$ for worst case concentrations, both of which are equal to or below the acceptable range. However, chemicals in surface soil

evaluated in the 1990 HHRA and in 2011 were compared to the U.S. EPA industrial soil RSLs (U.S. EPA 2012a) to ensure the construction worker would not be affected by these chemicals. The maximum concentration of chemicals did not exceed the U.S. EPA industrial soil RSL, except thallium and lead. Thallium is not evaluated quantitatively in this 2012 HHRA because the screening value presented on the RSL table has too high an uncertainty to be considered reliable (U.S. EPA 2012a). Lead was evaluated through blood lead modeling (Section 2.3.4).

Groundwater was identified as a medium of concern that required remedial actions in the 1990 RI. However, no residential groundwater supply wells affected by the site were identified in the 1990 RI. Two groundwater wells, one used for a recreational cabin and the other a hand-dug well at adjacent property, were located downgradient of the Marsh Run Park site in 2003. The well used for the recreational cabin reported TCE concentrations exceeding the Federally promulgated Maximum Contaminant Level (MCL) for municipal drinking water supply systems and the PA MSCs; however, this well was not used as a residential supply well. However, a new supply well was installed in 2011 due to the MCL and MSC exceedance. Concentrations of TCE reported in samples collected from the new supply well are less than the MCL and MSC. The adjacent property's hand-dug well did not have any reported concentrations of VOCs, so no risk is posed from contamination from Marsh Run Park at this well. However, concentrations measured within the deeper bedrock aquifer offsite, if accessed and consumed, may pose adverse health effects. The sample results from the new supply well are evaluated qualitatively in this 2012 HHRA to determine potential risk to receptors.

Chlorinated VOCs in groundwater are the primary concern at the site, suggesting that there is a potential that VOCs may volatilize to the soil pore space and eventually to the ambient air and indoor air within buildings. Onsite, the bedrock aquifer (>40 ft bgs) has the highest reported concentrations of these chemicals. However, if volatilization from groundwater to soil vapor and/or to ambient air was occurring, it would occur from the overburden aquifer and not the bedrock aquifer. VOCs were detected within two overburden aquifer monitoring wells (MW-1A, and MW-2A) at very low concentrations below or near drinking water standards. The VOCs detected within onsite overburden aquifer monitoring wells were cis-1,2-DCE, trans-1,2-DCE, TCE, and vinyl chloride. Low levels of chlorinated VOCs (e.g., up to 2.6 mg/kg TCE) have also been detected within some subsurface soil samples within the recreational fields.

Only TCE was detected in groundwater at concentrations in excess of the Residential Statewide Health MSCs for groundwater at the onsite and in offsite areas. As a result, the volatilization of TCE from groundwater and subsequent vapor intrusion to indoor air in onsite and offsite areas was evaluated as a potentially complete exposure pathway. Vapor intrusion modeling, using the

Johnson and Ettinger model, was performed in support of the RI under the PADEP Act 2 Program for this site. The Johnson and Ettinger model indicated there are no concerns for human health from vapor intrusion of TCE to indoor air. Results from the Johnson and Ettinger model are presented in Appendix B.

Potential volatilization of VOCs from groundwater to the ambient air within the Marsh Run Park was also evaluated. The maximum concentrations of VOCs in the overburden aquifer groundwater onsite are more than an order of magnitude lower than the default screening values for protection of residential indoor air as presented in the PADEP's Vapor Intrusion Guidance Document. The maximum concentrations of VOCs in the onsite overburden aquifer groundwater were also compared to screening values for protection of residential indoor air as presented in the U.S. EPA Vapor Intrusion Guidance (U.S. EPA 2002b). The U.S. EPA Vapor Intrusion Guidance does set forth generic screening values; however, toxicity values for these VOCs have changed since issuance of the U.S. EPA guidance. The generic screening values were calculated based upon current toxicity values and are presented in Appendix B. Potential exposures to ambient air at a recreational site are expected to be much lower than potential exposures associated with residential indoor air. The lower exposure is due to lower exposure frequency (e.g., number of days at the site) and duration associated with a recreational use and greater degree and rate of contaminant diffusion in ambient air. Therefore, a risk screening level of 10^{-4}, which corresponds to the upper end of the U.S. EPA and PADEP acceptable risk range, is selected as the appropriate screening level. The following presents a comparison of the maximum detected VOC concentration from onsite overburden aquifer monitoring wells, from years 2002 to 2011, to the calculated screening levels:

- TCE: Maximum detected concentration = 31.9 µg/L (MW-4A on 11/22/2005), screening criteria = 107 µg/L.
- Trans-1,2-DCE: Maximum detected concentration = 7.8 µg/L (MW-1A on 3/26/2008), screening criteria = 4,520 µg/L.
- Vinyl chloride: Maximum detected concentration = 0.37 µg/L (MW-1A on 5/31/2011), screening criteria = 14 µg/L.

Cis-1,2-DCE is not evaluated for inhalation exposures because the U.S. EPA has not set forth toxicity values for this exposure pathway (U.S. EPA 2012A). The maximum detected VOC concentrations for the onsite overburden aquifer are well below the calculated screening values. As a result, potential exposure to VOCs in ambient air are considered incomplete for the Marsh Run Park and were not addressed this 2012 HHRA.

Because this site is a former landfill area, there is a possibility for the presence of methane gas. The area of the former landfill has a 2 ft fill cover and a geomembrane cap, which reduces soil gas migration to ambient air. In addition, a minimum of another foot of soil will be placed on geomembrane for protection of the cap. This additional layer of soil will also add another protective layer from potential gases. Although release of or accumulation of methane is unlikely at this site, methane in high concentrations can present an explosive hazard. Monitoring for explosive vapors is a standard procedure during construction within and around former landfills and will be performed during site restoration construction to assess explosive conditions.

2.2.2.2 Potential Receptors

Based on the planned future site use and site layout, an adolescent recreational user, adolescent trespasser, and construction worker were retained as potential receptors in this HHRA.

Recreational User—The future, planned use of Marsh Run Park is recreational fields (most likely soccer). Therefore, the recreational user is the primary future receptor for Marsh Run Park. The recreational user is assumed at 6-16 years of age and is only expected to contact the area of the site near the recreational fields. They are not expected to contact the wetland area on the east of the site. It is noted that the recreational fields are vegetated and will be maintained. Additionally, the fields will be covered with a minimum of 1 ft of clean fill material to aide in grading. Therefore, contact with any of the original site surface soil is highly unlikely. However, this exposure is evaluated to provide a conservative assessment of the recreational fields. Figure 2 presents the expected exposure area for the recreational user. Specific exposure pathways for a recreational user include:

- Inhalation of fugitive dust from surface soil
- Dermal contact with surface soil
- Incidental ingestion of surface soil.

Trespasser—Due to the proximity to residential houses and the Susquehanna River, trespassers are a possibility at the site. Access to Marsh Run Park is not controlled by security restrictions or other methods of control. A fence does exist around the former recreational fields; however, this does not limit all access. Based upon expected activities of trespassers, it is assumed that trespassers would only contact surface soil at the site. A trespasser is expected to potentially access the entire site, including the wooded and wetland areas to the north and east of the recreational fields. Therefore, this receptor is expected to contact the entire area within the

FUDS boundary (Figure 3). As noted, the recreational fields are well vegetated and planned for a minimum of 1 ft soil cover for site re-grading purposes. However, the trespasser is evaluated for exposure to surface soil within the recreational fields to provide a conservative estimate of potential risks. The trespasser is expected to be an adolescent, 12-16 years of age. Specific exposure pathways for an adolescent trespasser include:

- Inhalation of fugitive dust from surface soil
- Dermal contact with surface soil
- Incidental ingestion of surface soil.

Construction Worker – Construction and grading activities are planned for Marsh Run Park to provide the future, planned use as recreational fields. Therefore, a construction worker is expected at the site during these activities. The construction worker is assumed to be an adult and is only expected to contact the area of the site near the recreational fields because this is the limit of disturbance for the proposed site restoration construction. They are not expected to contact the wetland area on the east of the site. The construction worker is expected to have contact with the upper layer of soil for removal of sod and other surficial disturbances. Therefore, contact with surface soil is a complete exposure pathway. Depth to groundwater within the recreational fields is greater than 8 ft bgs. A construction worker is not expected to contact groundwater due to shallow depth of expected construction activities. Specific exposure pathways for a construction worker include:

- Inhalation of fugitive dust from surface soil
- Dermal contact with surface soil
- Incidental ingestion of surface soil.

Offsite Resident – Currently, no offsite potable water supply wells have been affected by the site. However, concentrations of TCE were reported in exceedance of the MCL in the deeper bedrock aquifer at properties located downgradient of the site. As a result, there is a potential that groundwater contamination within the deeper intervals in bedrock is present. Therefore, potential offsite resident exposure to groundwater as a potable water supply from the deeper bedrock aquifer is evaluated. The evaluation of groundwater is qualitative; however, this evaluation takes into account the following exposure pathways:

- Inhalation of VOCs from groundwater
- Dermal contact with groundwater
- Ingestion of groundwater.

2.2.3 Selection of Exposure Point Concentrations

EPCs are derived to quantify concentrations of chemicals for the purposes of assessing risks. As noted in Section 1.1, only PAHs and lead are evaluated in this HHRA. The EPC represents the concentration of chemicals in media of concern that a selected receptor is expected to contact over a designated exposure period. In this HHRA, EPCs are derived as representative of a reasonable maximum exposure scenario.

Reported concentrations, as discussed in Section 2.1.2, are used to calculate the 95th percentile upper confidence limit on the mean (UCLM) for chemicals evaluated in surface soil (U.S. EPA 1989). The 95% UCLM is used because assuming long-term contact with the maximum concentration is not reasonable (U.S. EPA 1989). The 95% UCLM is calculated using the U.S. EPA ProUCL program (U.S. EPA 2011b). The first step in estimation of an EPC is to determine how the medium-specific environmental data for the chemical evaluated are distributed (i.e., normal, log-normal, non-parametric, etc.). The second step is to calculate the 95% UCLM using a methodology appropriate for the distribution, sample size, and variance of each chemical evaluated. The ProUCL program calculates both the data distribution and the 95% UCLM. As noted in Section 2.2.1, two exposure areas are evaluated for the Marsh Run Park. One exposure area is the area near the recreational fields, not including the wetland area to the west. The second exposure area is the entire FUDS Boundary. Tables 1 and 2 present the EPCs for the recreational fields and the FUDS boundary, respectively. Outputs from this program, per each exposure area, are provided for each chemical in surface soil in Appendix C. In cases where the 95% UCLM values exceed the maximum detected concentration, the maximum detected concentration is used as the EPC (U.S. EPA 2011b).

2.2.4 Exposure Parameters

Recreational User—All exposure parameters for the recreational user and applicable guidance documents are presented on Table 3. The age group for the recreational user is assumed at 6-16 years of age. It is assumed that the recreational user will use the fields 2 days per week for 6 months out of the year (52 days/year). The recreational user is expected to incidentally ingest, have dermal contact with, and inhale particulates from soil while visiting the site. Specific soil ingestion rates for recreational users playing sports activities are not available, but the total soil ingestion rate used for the 6- to 16-year age range is 100 mg/day (U.S. EPA 2011a), which takes into account both indoor and outdoor activities. Because the recreational user is expected to have high contact with the area, it is conservatively assumed that 100% of the daily fraction of soil ingested is from the site.

For dermal contact with soil, the recreational user skin surface area available during dermal contact is estimated from Table 7-17 of U.S. EPA 2011 Exposure Factors Handbook (EFH), which identifies the percentage of exposed skin surface available during warm weather activities for 5- to 17-year olds in organized team sports as 29% (U.S. EPA 2011a). The percentage of exposed skin is multiplied by the skin surface area from Table 7-9 of U.S. EPA 2011 EFH (U.S. EPA 2011a). The total skin surface area for a 6- to 16-year old is estimated as the average of two age ranges presented in Table 7-9 that notes a total skin surface area of 10,500 square centimeters (cm^2) for ages 6 to <11 years of age and 15,700 cm^2 for ages 11 to <16 years of age for males and females combined. The adherence factor (AF) for soil to skin is selected based upon a range presented in U.S. EPA Risk Assessment Guidance for Superfund (RAGS) E Dermal guidance (U.S. EPA 2004a). U.S. EPA guidance presents multiple AFs for soccer players. U.S. EPA RAGS E Dermal guidance, Exhibit 3-3 presents a range of AF values from the 95th percentile (%) of 0.3 mg/cm^2 and a geometric mean of 0.04 mg/cm^2. However, per U.S. EPA, "It is not recommended that a high-end soil contact activity be used with a high-end adherence factor (U.S. EPA 2004a)." The AF should take into account high-end soil contact and average soil contact. U.S. EPA RAGS E Dermal guidance also presents AFs for an adult soccer player, ranging from 0.08 mg/cm^2 (95th%) to 0.01 mg/cm^2 (geometric mean). Recent U.S. EPA guidance presents a range of AFs for soccer players that range from 0.11 mg/cm^2 to 0.02 mg/cm^2 (Table 7-20 of U.S. EPA 2011a). Therefore, an AF of 0.08 mg/cm^2 is selected because it represents a value that is within the range presented for soccer players. This AF accounts for high-end contact for older soccer players and is within the range expected for adolescent soccer players. For inhalation exposures, the recreational user is assumed to spend 2 hours at the site each time they visit.

Trespasser—All exposure parameters for the trespasser and applicable guidance documents are presented on Table 4. The trespasser is expected to be an adolescent, 12-16 years of age. Although other age classes are possible, the trespasser is assumed to be an adolescent because this receptor is the most likely to contact the entire area of the FUDS boundary. The risks estimated for adolescent trespassers cover the potential exposure to adults engaged in the same type of activities. Exposure is expected to occur approximately 1 day per week for 6 months of the year (26 days per year). The trespasser is expected to incidentally ingest, have dermal contact with, and inhale particulates from soil while visiting the site. Specific soil ingestion rates for a trespasser are not available. The trespasser is not expected to have a high rate of contact with soil or remain at the site for long periods of time. The soil ingestion rate for the 12- to 16-year age range is 100 mg/day (U.S. EPA 2011a). However, this ingestion rate is a total daily rate for both indoor and outdoor activities. Therefore, it is assumed that 50% of the fraction of soil

ingested is from the site. For dermal contact with soil, the trespasser skin surface area available is estimated from Table 7-17 of U.S. EPA 2011 EFH which identifies the percentage of exposed skin surface available during warm weather activities for 5- to 17-year olds as 33% (U.S. EPA 2011a). The percentage of exposed skin is multiplied by the skin surface area from Table 7-9 of U.S. EPA 2011 EFH that notes a total skin surface area of 15,700 cm^2 for from 11 to <16 years of age for male and female combined (U.S. EPA 2011a). The AF for soil to skin is selected based upon a ranged presented in U.S. EPA RAGS E Dermal guidance, Exhibit 3-3 (U.S. EPA 2004a). As noted for the recreational user, the AF should take into account high-end soil contact and average soil contact. U.S. EPA RAGS E Dermal guidance, Exhibit 3-3 presents a range of AF values for children playing (dry soil), ages 8-12, from the 95th percentile (%) of 0.4 mg/cm^2 and a geometric mean of 0.04 mg/cm^2. This would represent average soil contact. The U.S. EPA RAGS E Dermal guidance also presents AFs for a soccer players (teens, moist conditions) ranging from 0.3 mg/cm^2 (95th%) to 0.04 mg/cm^2 (geometric mean), which would represent the high-end contact. Therefore, an AF of 0.04 mg/cm^2 is selected because it represents a value that is within the range presented for average and high-end contact. For inhalation exposures, the trespasser is assumed to spend 2 hours at the site each time they visit.

Construction Worker- Exposure parameters for the construction worker and applicable guidance documents are presented on Table 5. Construction activities are conservatively estimated to last for three months. The construction worker is expected to contact soil for 5 days per week for the entire length of construction. The soil ingestion rate for the construction worker is 100 mg/day (U.S. EPA 1991b, 2011a). This ingestion rate accounts for both soil and dust ingestion for an adult based upon a higher contact rate for soil. The construction worker dermal contact with soil is based on exposure parameters set forth in U.S. EPA RAGS E Dermal guidance. As noted in U.S. EPA RAGS E Dermal guidance, the construction worker is assumed to wear short-sleeved shirt, long pants, and shoes (U.S. EPA 2004a). The exposed skin surface is limited to the head, hands, and forearms. The surface area exposed to contaminated soil for the adult commercial/industrial receptor is 3300 cm^2 and is the average of the 50th percentile for males and females greater than 18 years of age (U.S. EPA 2004a). The recommended weighted AF for a construction (industrial) adult worker is 0.2 mg/cm^2 and is based on the 50th percentile weighted AF for utility workers (the activity determined to represent a high-end contact activity) (U.S. EPA 2004a). For inhalation exposures, the construction worker is assumed to spend an entire work day (8 hours) at the site each time they visit.

2.2.5 Exposure Intake Equations

The next step in the exposure assessment is to estimate chemical intakes for each pathway considered in the assessment. Intakes for each potential receptor are calculated using current U.S. EPA risk assessment guidance and are presented in applicable risk assessment spreadsheets. Most exposure assumptions used to estimate intakes are based on default assumptions described in U.S. EPA guidance documents (U.S. EPA 1989, 1991a, 1991b, 1997a, 2004a, and 2011a). Exposure parameters for the recreational user and the trespasser are presented on Tables 3 and 4.

Two different measures of intake are evaluated, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time [AT]) (U.S. EPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (U.S. EPA 1989).

2.2.5.1 Incidental Ingestion of Soil

Intake for the incidental ingestion of soil is estimated using the following equation:

$$(L)ADI = \frac{EPC \ x \ IR \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT} \qquad \text{(Equation 1)}$$

where:

(L)ADI	=	(Lifetime) Average daily intake (mg/kg-day)
EPC	=	Concentration in soil (mg/kg)
IR	=	Ingestion Rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion Factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
		For non-carcinogens, AT = ED x 365 days/year
		For carcinogens, AT = 70 years x 365 days/year.

2.2.5.2 Dermal Contact with Soil

Exposure associated with dermal contact with soil is estimated based upon the following equation:

$$(L)ADI = \frac{EPC \ x \ SA \ x \ AF \ x \ ABS \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT} \qquad \text{(Equation 2)}$$

where:

(L)ADI	=	(Lifetime) Average daily intake (mg/kg-day)
EPC	=	Concentration of a chemical in soil (mg/kg)
SA	=	Surface Area for Contact (cm^2)
AF	=	Skin adherence factor (mg/cm^2-event)
ABS	=	Absorption factor (dimensionless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion Factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
		For non-carcinogens, AT = ED x 365 days/year
		For carcinogens, AT = 70 years x 365 days/year.

Most exposure assumptions used to estimate intake from dermal contact with soil are based upon U.S. EPA default assumptions (U.S. EPA 2004a).

2.2.5.3 Inhalation of Air Containing Fugitive Dust/Volatiles Emitted from Soil

The intake of both particulates and vapors/gases are calculated using the same equation (U.S. EPA 2009a):

$$EC = \frac{C_{air} \ x \ ET \ x \ EF \ x \ ED \ x \ CF_2}{AT \ x \ CF_1} \qquad \text{(Equation 3)}$$

where:

EC	=	Exposure concentration ($\mu g/m^3$)
C_{air}	=	Concentration of chemical in air (mg/m^3)
ET	=	Exposure time (hours)
CF_1	=	Conversion Factor (24 hours/day)

CF_2	=	Conversion Factor (1,000 µg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (days)
		For non-carcinogens, AT = ED x 365 days/year x 24 hours/day
		For carcinogens, AT = 70 years x 365 days/year x 24 hours/day.

The concentration of chemicals in air resulting from emissions from soil is developed following procedures presented in the U.S. EPA Soil Screening guidance (U.S. EPA 2002c). The chemical concentration in air is calculated from:

$$C_{air} = C_{soil}\ x \left[\frac{1}{PEF} \right] \qquad \text{(Equation 4)}$$

where:

C_{air}	=	Concentration of chemical in air (mg/m^3)
C_{soil}	=	Chemical concentration in soil (mg/kg)
PEF	=	Particulate emission factor (m^3/kg).

The PEF relates the concentration of a chemical in soil with the concentration of dust particles in air. A PEF value of 1.36x10^9 m^3/kg is used from the U.S. EPA' s Guidance (U.S. EPA 2012a).

2.2.5.4 Vapor Intrusion of TCE in Groundwater to Indoor Air

TCE was detected in shallow groundwater at concentrations in excess of the Residential Statewide Health MSCs and MCLs for groundwater onsite site and in offsite areas. As a result, TCE in groundwater has the potential to migrate into indoor air through vapor intrusion. This exposure pathway was evaluated in support of the RI under the PADEP Act 2 Program for this site. Modeling this exposure pathway requires use of U.S. EPA's Johnson and Ettinger model (U.S. EPA 2004b). The Johnson and Ettinger model incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from groundwater into indoor air spaces located directly above the source of contamination. The Johnson and Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces. Results from the Johnson and Ettinger model are presented in Appendix B. The following presents a summary of the inputs used in the Johnson and Ettinger model.

Inputs to the model include chemical properties of TCE, saturated and unsaturated zone soil properties, and structural properties of the building. Default values are used for structural properties of the buildings. The buildings were assumed to be slab-on grade and the enclosed floor space does not extend below grade. This assumption was made because the structures evaluated include an onsite bathroom building and a recreational cabin. Site-specific soil types are entered into the model; however, default model values are used for soil parameters (i.e., soil vapor permeability, dry bulk density, etc.). A groundwater temperature of 13°C was conservatively used (i.e., results in a higher risk estimate) based on field records from well purging activities. Toxicity values for TCE were revised in the model to the most current values.

Onsite Exposures

The concentration of TCE in groundwater for onsite exposures was conservatively estimated as 25 ug/L, which represents the highest TCE concentration detected in the overburden groundwater during the past 7 years (i.e., at EW-1 in 2009). Based on soil boring logs onsite, the soil type above the shallow groundwater table was estimated as a loamy sand (which is considered to be conservative, as some of the shallow soils were described as silt and clayey soils which would be expected to have lower vapor permeability than sand). The depth to groundwater onsite was conservatively estimated as 5 feet below grade, which reflects the shallowest depth to groundwater recorded at any of the onsite monitoring wells over the past 10 years (in comparison, the shallowest depth to groundwater measured at overburden monitoring well MW-1A, which is located closest to the building that is being considered for use as a potential concessions stand, is 9.2 feet).

Onsite exposure was modeled based upon a recreational user. For the recreational user onsite exposure, contact is expected to be similar to the exposure frequency and duration utilized in the HHRA for the recreational user (i.e., 2 days per week for 6 months per year for 10 years), although the exposure time was conservatively assumed to be 24 hours per day instead of 2 hours per day.

Offsite Exposures

The depth to groundwater for offsite was estimated at 14 feet below grade, which reflects the average depth to groundwater measured in the MADW 41-52 well, and typical for the area being modeled. The concentration of TCE in offsite groundwater was conservatively estimated as 30 ug/L, which represents the highest TCE concentration ever detected in the groundwater at Mifflin Avenue Cabin Well. This concentration is considered to be conservative because

sampling of the shallowest groundwater interval in this area (i.e., at MADW 41-52) indicates a concentration that is consistently less than 5 ug/L.

Currently, the only structure present on offsite properties where TCE was detected above the Residential Statewide Health MSC for used aquifers (i.e., 5 ug/L) (i.e., to the northeast of the Marsh Run Park site) are periodically occupied structures, such as an existing recreational cabin. It is expected that such structures might be occupied by the same person at a frequency of not more than 30 weekends per year, but the exposure scenario for offsite exposures was conservatively estimated as a full-time residential exposure (i.e., 350 days per year, 24 hours per day for 30 years).

2.3 TOXICITY ASSESSMENT

Toxicity assessment is the third step of the HHRA process. The toxicity assessment considers the types of potential adverse health effects associated with exposures to chemicals; the relationship between the magnitude of exposure and potential adverse effects; and related uncertainties, such as the weight of evidence of a particular chemical's carcinogenicity in humans. U.S. EPA guidance specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment (U.S. EPA 1989). Hazard identification is the process of determining whether studies claim that exposure to a chemical may cause the incidence of an adverse effect. U.S. EPA specifies the dose-response assessment, which involves: (1) U.S. EPA's quantitative evaluation of the existing toxicity information, and (2) U.S. EPA's characterization of the relationship between the dose of the chemical administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived by U.S. EPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (U.S. EPA 1989). These U.S. EPA-derived toxicity values are called reference doses or RfDs for non-carcinogens and slope factors or SFs for potential carcinogens. Compounds lacking values, for which surrogates cannot be substituted, are not assessed quantitatively. Qualitative analysis of these compounds is provided in Section 3.2 (Uncertainties Section).

Toxicity values are selected in keeping with appropriate exposure duration and U.S. EPA guidance (U.S. EPA 1989 and 2003a). Tier 1 values are located using the Integrated Risk Information System (IRIS) for established, current values (U.S. EPA 2012b). When toxicity values are not available from IRIS, Tier 2 values are then examined.

Tier 2 values are U.S. EPA's Provisional Peer Reviewed Toxicity Values, which are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.

Tier 3, other toxicity values, are considered when Tier 1 or Tier 2 toxicity values are not available. These toxicity values are taken from additional U.S. EPA and non-U.S. EPA sources and are chosen based on the most current and best peer-reviewed source available. The California EPA Office of Environmental Health Hazard Assessment Toxicity Criteria Database (California Environmental Protection Agency 2011) is the Tier 3 source utilized for this HHRA.

2.3.1 Toxicity Assessment for Non-Carcinogens

The methodology used by U.S. EPA for deriving non-cancer reference values for non-carcinogens and site-specific considerations for modifying or using these concentrations are discussed in detail in U.S. EPA guidance (U.S. EPA 2012b). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens (i.e., an RfD), the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect); (2) identify the threshold dose in either an animal or human study; and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty factors (UFs) and modifying factors (MFs).

UFs are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The MF accounts for the confidence in the scientific studies from which toxicity values are derived, according to such parameters as study quality and study reproducibility. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data, although UFs of less than 10 can also be used. For example, a UF of 3 can be used in place of one-half power ($10^{0.5}$) when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability); (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty); (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure); (4) uncertainty in extrapolating from a lowest-observed-adverse-effect-level (LOAEL) rather than from a

NOAEL; and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfC is 3,000. The theoretical maximum UF for the derivation of the RfD is 10,000. However, the U.S. EPA has recently begun limiting the total UFs applied to 3,000.

A MF ranging from 0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database not addressed by the UFs. The default value for the MF is 1. The U.S. EPA discontinued the use of the MF in 2004. However, toxicity values for some chemicals, derived before 2004, still contain a MF. The use of these factors is a conservative approach for protection of human health and is likely to overestimate the toxic potency associated with chemical exposure. The RfDs and RfCs provided in this HHRA take into account the associated UFs/MFs identified by the U.S. EPA. To calculate the RfD/RfC, the appropriate NOAEL is divided by the product of all the applicable UFs and the MF.
This is expressed as:

$$RfD/RfC = NOAEL / (UF_1 \times UF_2 \ldots \times MF) \qquad \text{(Equation 5)}$$

The resulting RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-bw/day). The RfC is expressed in units of mg/m^3. Tables 6 and 7 present the oral/dermal and inhalation non-carcinogenic toxicity data, respectively. Only the chronic RfDs and RfCs are evaluated in this HHRA. The construction worker exposure to Marsh Run Park is indicative of a subchronic exposure (more than 30 days, up to approximately 10% of the life span in humans or 7 years). However, the construction worker is evaluated against chronic toxicity values to provide a conservative evaluation.

2.3.2 Toxicity Assessment for Carcinogenicity

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This “non-threshold” concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. U.S. EPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration. Quantification is expressed as an SF or an inhalation unit risk (IUR), which reflects the dose-response data for the carcinogenic endpoint(s) (U.S. EPA 2012b).

The weight-of-evidence classification system assigns a letter or alphanumeric designation (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen.[1] The weight-of-evidence classification is based on a thorough scientific examination of the body of available data. U.S. EPA has recently established five recommended standard hazard descriptors: "*Carcinogenic to Humans*," "*Likely to Be Carcinogenic to Humans*," "*Suggestive Evidence of Carcinogenic Potential*," "*Inadequate Information to Assess Carcinogenic Potential*," and "*Not Likely to Be Carcinogenic to Humans*" (U.S. EPA 2005a). The weight-of-evidence classification is based on a thorough scientific examination of the body of available data.

The SF and the IUR is the upper 95th percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. Typically, the SF and IUR is used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high-dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. U.S. EPA recommends the linear multistage model to derive an SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk. Tables 9 and 10 present the oral/dermal and inhalation carcinogenic toxicity data, respectively.

Chemicals that are determined to have sufficient weight of evidence for carcinogenic endpoints are also assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (U.S. EPA 2005a). Some of the PAHs evaluated in this HHRA have been identified as mutagenic pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates are adjusted. U.S. EPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-life stage exposure (U.S. EPA 2005a,b). A modification for early-life stage exposure to mutagenic

[1] A = a known human carcinogen; B1 = a probable human carcinogen, based on sufficient animal data and limited human data; B2 = a probable human carcinogen based on sufficient animal data and inadequate or no human data; C = a possible human carcinogen; D = not classifiable as to human carcinogenicity; and E = evidence of non-carcinogenicity for humans.

PAHs is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (U.S. EPA 2005a). For this HHRA, the carcinogenic intakes for PAHs identified with a mutagenic mode of action are modified based on the following (U.S. EPA 2005b and 2012):

- For exposures between 3 and <16 years of age, a 3-fold adjustment is made.

2.3.3 Modifications for Dermal Contact

Toxicity values specific to dermal exposures are not available and require adjustment of the oral toxicity values (oral RfDs or SFs). This adjustment accounts for the difference between the daily intake doses through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (U.S. EPA 1989 and 2004a). U.S. EPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (U.S. EPA 2004a). This adjustment accounts for the absorption efficiency in the "critical study," which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1 percent), the absorbed dose is smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS). Table 8 presents the GIABS values used in this HHRA.

The CSF_o and RfD_o are adjusted to an absorbed dose using different methods. The dermal CSF (CSF_d) is derived by dividing the oral CSF by the ABS_{GI} as shown below.

$$CSF_d = \frac{CSF_o}{GIABS}$$

(Equation 6)

where:

CSF_d = Dermal cancer slope factor $(mg/kg\text{-}day)^{-1}$

CSF_o = Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$

GIABS = Fraction of chemical absorbed in the gastrointestinal tract (unitless).

The dermal reference dose (RfD_d) was derived by multiplying the oral RfD by the ABS_{GI} as shown below:

$$RfD_d = RfD_o \times GIABS \qquad \text{(Equation 7)}$$

where:

RfD_d	=	Dermal reference dose (mg/kg-day).
RfD_o	=	Oral reference dose (mg/kg-day).
GIABS	=	Fraction of chemical absorbed in the gastrointestinal tract (unitless).

2.3.4 Special Chemicals – Lead

According to the U.S. EPA, lead is classified as a B2, probable human carcinogen. However, the U.S. EPA has not identified a toxicity value for use in quantifying carcinogenic risks. In the absence of U.S. EPA-published toxicity value for lead, it is currently not possible to perform a quantitative risk estimate for lead exposures using standard U.S. EPA methodology.

Blood lead levels are the indicator of excess lead exposure in humans. Modeled blood level results are compared to the established cutoff value or acceptable blood-lead threshold of 10 micrograms of lead per deciliter (10 µg/dL). This blood level is considered protective of human health for children. Lead risks are evaluated using the U.S. EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) Lead Model (U.S. EPA 2010) and the Adult Lead Model developed by the *Recommendations of the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (U.S. EPA 2003b). Both models use an average lead concentration in soil (U.S. EPA 1994).

2.4 RISK CHARACTERIZATION

Risk characterization is the fourth step of the HHRA process. In this step, the toxicity values are combined with the estimated chemical intakes for the receptor populations to quantitatively estimate both carcinogenic risks and non-carcinogenic hazards. Effects are estimated for each receptor of concern.

2.4.1 Hazard Index for Non-Carcinogenic Effects

The potential human health hazards associated with exposures to non-carcinogenic chemicals are estimated by comparing the ADI with the chemical-specific RfD, as per U.S. EPA Guidance (U.S. EPA 1989).

An HQ is derived for each chemical, as shown in the equation below:

$$HQ = \frac{ADI}{RfD} \quad \text{or} \quad EC = \frac{ADI}{(RfC\ x 1{,}000\ \mu g / mg)} \qquad \text{(Equation 8)}$$

where:

HQ	=	Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI	=	Estimated non-carcinogenic average daily intake (mg/kg-day)
EC	=	Exposure concentration (µg/m^3)
RfD	=	Reference dose (mg/kg-day)
RfC	=	Reference concentration (mg/m^3).

If the average daily dose exceeds the RfD, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds 1.0, and the chemicals affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall HI. If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

2.4.2 Carcinogenic Risks

Carcinogenic risk is estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the LADI by the risk per unit dose (SF).

This is shown in the following equation:

$$Risk = LADI \times SF \quad or \quad EC \times IUR \qquad \text{(Equation 9)}$$

where:

Risk	=	Unitless probability of an exposed individual developing cancer
LADI	=	Lifetime cancer average daily intake (mg/kg-day)
EC	=	Exposure concentration ($\mu g/m^3$)
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$
IUR	=	Inhalation Unit Risk $(\mu g/m^3)^{-1}$

Because the SF is the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. U.S. EPA in the National Contingency Plan (40 Code of Federal Regulation Part 300) (U.S. EPA 1990) states that:

> *"...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}."*

2.4.3 Lead

Infants and young children are the most vulnerable populations exposed to lead and have been the focus of U.S. EPA's risk assessment efforts. The relatively high vulnerability of infants and children results from a combination of factors: (1) an apparent intrinsic sensitivity of developing organs to lead; (2) behavioral characteristics that increase contact with lead from soil and dust (e.g., mouthing behavior); (3) various physiologic factors resulting in a greater deposition of airborne lead in the respiratory tract and greater absorption efficiency from the gastrointestinal tract in children than in adults; and (4) transplacental transfer of lead that establishes a lead

burden in the fetus, thus increasing the risk associated with additional exposure during infancy and childhood.

For resident children, the risks associated with lead are estimated using the U.S. EPA's IEUBK Model. While no residents are expected within the site, a resident child represents the most conservative receptor. Evaluation of the resident child will indicate any risk concerns for other receptors, especially children, who may use the site. The IEUBK Model is used to estimate blood lead concentrations resulting from exposure to environmental sources. The most current software is IEUBKwin32v1.1 build 11 (U.S. EPA 2010). The IEUBK Model is a three-stage method for estimating total blood lead levels. First, the intake of lead from each source is assessed. Second, the uptake of lead from each source is determined. Finally, the relationship between the uptake of lead and blood lead concentration is applied using the "Integrated Metabolic Model for Humans of All Ages," as revised by Harley and Kneip (1985).

The Harley and Kneip model incorporates total uptake of lead derived from all exposures and the distribution of lead to the four body compartments (blood, bone, liver, and kidney) in which 95 percent of the lead is found. The model is based on the distribution and equilibrium of stable lead and a naturally occurring radioactive lead isotope in the bodies of infant and child baboons and in humans during continuous lead exposure. The model was validated through data collected from lead smelter sites, experimental data on blood lead concentrations in infants, and studies of lead accumulation in bones under controlled conditions in adults. The model predicts a linear increase in blood lead levels with increasing lead uptake. However, above a blood lead concentration of 30 μg/dL, the relationship is not linear. Therefore, this model may only be applied for moderately low lead uptakes.

Standard default values used as input parameters for the model are described in U.S. EPA guidance (U.S. EPA 2007). The model output is a probability distribution function describing the percentage of children predicted to have blood-lead levels exceeding 10 μg/dL. To achieve a specific level of protectiveness, the U.S. EPA has established a limit to exposure to soil lead levels such that a typical (or hypothetical) child would have an estimated risk of no more than 5 percent exceeding the 10 μg/L blood lead level (U.S. EPA 1994). The 10 μg/dL blood lead level is based upon analyses by the Centers for Disease Control and the U.S. EPA that have concluded that blood lead levels of 10 μg/L and higher result in health effects in children (U.S. EPA 1994). More specific information on this model is contained in U.S. EPA's *Guidance Manual for the IEUBK Model for Lead in Children*, December 1994.

For estimating blood-lead levels in adults, workers are used as a surrogate receptor. The U.S. EPA using *Recommendations of the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* developed a model to predict blood-lead levels in adult workers (U.S. EPA 2003b and 2009b). This model assesses potential workers under a commercial setting. Model default parameters are used to predict blood lead impacts for female workers and their potential children (embryonic) due to site exposure. Results of the model (both adult and fetus blood lead level) are compared to the blood lead level of 10 μg/dL. In addition, the model predicts the probability that the fetus blood lead level will exceed the 10 μg/L target.

2.4.4 Groundwater

The 1990 RI determined potential risk concerns for residential exposure to groundwater as a tap water source (EA 1990). No groundwater wells were identified downgradient of the site or within the groundwater plume at the time of the 1990 RI report. Groundwater remediation was undertaken for the site, but it was determined that affected groundwater was not used as a tap water source. Therefore, this exposure pathway was essentially considered incomplete. However, potential receptor exposure to groundwater has changed since completion of the 1990 RI. Two groundwater wells are present downgradient of the site and one was used for a recreational cabin. This well was identified as the Mifflin Avenue Cabin Well. The initial cabin well was replaced with the MADW 41-52 well in 2011 by USACE. While the new well is used infrequently, it is used as a water source for the cabin. Groundwater samples for the new 2011 well (MADW 41-52) were analyzed for VOCs and data from two rounds of sampling conducted in May and October 2011 was used for the risk evaluation. TCE is the only VOC detected in this well during the May and October 2011 sampling events. The TCE results were evaluated qualitatively in this HHRA to determine potential risk to receptors.

In addition, the 1990 RI risk assessment only evaluated ingestion of groundwater because it was considered the most significant route of exposure. Dermal contact with groundwater and inhalation of volatile organic compounds from groundwater was not evaluated in the 1990 HHRA. VOCs are the primary concern for groundwater in which inhalation can also contribute to risk results. An additional modification for VOCs in groundwater is a revision to toxicity values. The U.S. EPA tap water RSLs take into account both the revision to exposure pathways and toxicity values (U.S. EPA 2012a).

Therefore, a qualitative evaluation of groundwater was performed through the use of a risk ratio to determine potential risks. The risk ratio comparison was completed by taking the maximum

detected VOC concentration and dividing by the U.S. EPA tap water RSL (U.S. EPA 2012a). For chemicals that have a carcinogenic endpoint, the resulting ratio was multiplied by $1x10^{-6}$ to represent a carcinogenic risk. For chemicals that have a non-carcinogenic endpoint, the resulting ratio was evaluated as an HQ. Based upon the identified exposure pathways, two separate exposure areas exist for groundwater use. These areas include onsite groundwater and offsite groundwater. Onsite groundwater is represented with monitoring wells MW-1, MW-1A, MW-2, MW-2A, MW-3, MW-3A, MW-4, MW-4A, MW-7, MW-7A, MW-8, MW-8A, MW-9, MW-9A, EW-1, EW-2, EW-3, and EW-4. For the evaluation in this HHRA, offsite groundwater was represented by the Mifflin Avenue Cabin Well. Onsite groundwater is evaluated in two separate scenarios. The groundwater results from the 1990 HHRA were evaluated to determine any notable differences from the 1990 RI conclusions and in addition, both the onsite and offsite groundwater sample results collected since the shutdown of onsite treatment systems (collected from October 2004 through 2011) were also evaluated.

3 RISK ASSESSMENT RESULTS

3.1 RISK CHARACTERIZATION

The methodologies used to estimate carcinogenic risks and chronic hazards for non-carcinogens are described in Section 2.3. Calculations are presented in Tables 11 through 13 for the recreational user, trespassers, and construction worker. Table 14 presents the estimation of PAH air concentrations of particulate from soil for the recreational area. Table 15 presents the estimation of PAH air concentrations of particulate from soil for the FUDS Boundary. Table 16 presents the estimation of PAH air concentrations of particulate from soil for the construction worker within the recreational area.

Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for the recreational user, trespasser, and construction worker are presented in Tables 19 through 21. A summary of significant contributors to risk is presented in Tables 22 through 24. Chemicals are only identified on Tables 22 through 24 if cumulative carcinogenic risks are greater than the lower bound of the U.S. EPA's "acceptable risk range" (i.e., 10^{-6}) or cumulative non-carcinogenic risks are greater than 1.0. Only chemicals with carcinogenic risks greater than 10^{-6} or non-carcinogenic risks greater than 0.1 are shown on these tables.

Appendix B presents the Johnson and Ettinger Model for vapor intrusion from groundwater to indoor air. Appendix D presents the outputs for the IEUBK blood-lead model.

3.1.1 Recreational User Results

The recreational user is evaluated for exposure to surface soil within the recreational fields. The exposure scenario calculations are presented in Table 11. The carcinogenic and non-carcinogenic risk assessment results are summarized in Table 19.

Non-Carcinogenic Results

The total non-carcinogenic HI for the recreational user is 0.008, which is below the acceptable threshold of 1.0 (Table 19).

Carcinogenic Results

The cumulative carcinogenic risk for the recreational user is 7×10^{-5}, which is within U.S. EPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 19). Benzo(a)pyrene and dibenz(a,h)anthracene

have carcinogenic risks greater than 10^{-5}. Benz(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene have carcinogenic risks greater than 10^{-6}.

3.1.2 Adolescent Trespasser Results

The adolescent trespasser receptor is evaluated for exposure to surface soil. The trespasser is evaluated for contact with surface soil within the entire FUDS boundary of the site. The exposure scenario calculations are presented in Table 12. The carcinogenic and non-carcinogenic risk assessment results for the adolescent trespasser are summarized in Table 20.

Non-Carcinogenic Results

The total non-carcinogenic HI for the adolescent trespasser is 0.002, which is below the acceptable threshold of 1.0 (Table 20).

Carcinogenic Results

The cumulative carcinogenic risk for the adolescent trespasser is 2×10^{-5}, which is within the U.S. EPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 20). Benz(a)anthracene and benzo(a)pyrene have carcinogenic risks greater than 10^{-6}.

3.1.3 Construction Worker Results

The construction worker is evaluated for exposure to surface soil within the recreational fields. The exposure scenario calculations are presented in Table 13. The carcinogenic and non-carcinogenic risk assessment results for the construction worker are summarized in Table 21.

Non-Carcinogenic Results

The total non-carcinogenic HI for the construction worker is 0.008, which is below the acceptable threshold of 1.0 (Table 21).

Carcinogenic Results

The cumulative carcinogenic risk for the construction worker is 6×10^{-7}, which is below the U.S. EPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 21).

3.1.4 Lead Evaluation

Lead is a concern in surface soil at the site based upon the maximum detected concentration of 1,080 mg/kg in surface soil. The maximum detected concentration exceeds the U.S. EPA's RSL of 400 mg/kg for residential soil and 800 mg/kg for industrial soil. Therefore, the U.S. EPA

IEUBK model and Technical Review Workgroup Adult Lead Model are used to estimate any concerns with lead in surface soil. The highest lead concentrations also exceed PADEP's Chapter 250 Statewide Health Medium-Specific Concentrations for lead in soil (i.e., 450 mg/kg for potential leaching to groundwater and 500 mg/kg for residential direct contact).

Reported surface soil concentrations exceed both screening criteria in two locations, sample location S-3 at 1,080 mg/kg and S-52 at 1,020 mg/kg. In addition, the averaged lead concentration (475 mg/kg) for replicate samples collected at location MW-2 exceeds the residential screening criteria. The arithmetic mean for lead in surface soil is 138 mg/kg. It is noted that the mean concentrations of lead for the entire FUDS boundary and the recreational fields without the wetlands are almost identical at 138 mg/kg and 137.6 mg/kg, respectively. Results of the lead modeling for resident children are presented in Table 17. Outputs of the IEUBK model are presented in Appendix D including probability density graphs. The results indicate an average blood lead level of 2.16 µg/dL with 0.056% above the target level. Results of the Technical Review Workgroup Adult Lead Model are presented in Table 18. The Adult Lead Model calculated an adult worker blood lead level of 1.2 µg/dL and a fetus blood lead level of 2.8 µg/dL. There is only a 0.008% probability that the fetus blood lead level will exceed the target level of 10 µg/dL. Both exposures revealed average blood-lead levels below 10 µg/dL with less than 5% probability of exceedance. Therefore, lead is not a concern in surface soil for both children and adults at the site.

3.1.5 Groundwater

Groundwater was qualitatively evaluated in this HHRA through the use of a risk ratio comparison to estimate potential risk. Groundwater was evaluated due to changes in exposure pathways and toxicity values since completion of the 1990 HHRA. The risk ratio comparison is presented on Table 25. The risk ratio is a comparison of detected concentrations in groundwater to the U.S. EPA tap water RSL. The concentration of a COPC in groundwater is divided by the tap water RSL to determine a ratio. For COPCs with a non-carcinogenic endpoint, the resulting ratio represents an HQ. For COPCs with a carcinogenic endpoint, the resulting ratio is multiplied by 10^{-6} to represent a potential carcinogenic risk. The risk ratios are considered a qualitative evaluation because they do not use site-specific exposure parameters to determine potential risk concerns. However, the risk ratio presents a conservative estimation of any potential concerns because the RSL is based upon a residential exposure to groundwater as a tap water source.

For the onsite monitoring wells, the carcinogenic risk is $2x10^{-3}$, which is above the acceptable risk range, confirming the previous1990 HHRA conclusions. The carcinogenic risks for the onsite monitoring wells are the same for both the sample results presented in the 1990 HHRA and recent sample results (2004 to 2011). TCE contributes significantly to carcinogenic risks for both exposures. The total non-carcinogenic HI for groundwater based sample results presented in the 1990 HHRA is 0.5, which is below the acceptable threshold of 1.0. The total non-carcinogenic HI for this hypothetical use of onsite groundwater based on sample results obtained from recent sample events (2004 to 2011) is 22, which is above the acceptable threshold of 1.0. Cis-1,2-DCE is the primary contributor to non-carcinogenic risks for the hypothetical use of onsite groundwater.

In addition, offsite groundwater results were also evaluated. For the former Mifflin Avenue Cabin Well, the carcinogenic risk result from the highest reported concentration of TCE (30.1 ug/L from March 2006) was $7x10^{-5}$, which is within the acceptable risk range. However, this concentration exceeded both the Federal MCL and the PA MSC so the Mifflin Avenue Cabin Well has been abandoned and replaced with the MADW 41-52. For the MADW 41-52, the carcinogenic risk results from the highest reported concentration of TCE (2.3 ug/L in May 2011) are $5x10^{-6}$, which is within the acceptable risk range. No concentrations of VOCs were measured in the adjacent property's hand-dug well, so no risk is posed from contamination from Marsh Run Park at this well. However, groundwater from deeper intervals result in carcinogenic risk ranging up to $1x10^{-3}$, which is greater than the accepted risk range and indicates that consumption of groundwater from these deeper intervals may result in adverse health effects.

3.1.5.1 Vapor Intrusion From Groundwater to Indoor Air

Both onsite and offsite groundwater was evaluated for potential vapor intrusion of TCE from groundwater to indoor air. Vapor intrusion was evaluated through the use of the Johnson and Ettinger Model (U.S. EPA 2004b). The model calculations are provided in Appendix B.

For onsite groundwater, potential recreational user exposure to TCE in indoor air results in a carcinogenic risk of $1.4x10^{-7}$ and non-carcinogenic hazard index of 0.12. For offsite groundwater, a conservative residential exposure to TCE in indoor air results in a carcinogenic risk of $1.9x10^{-7}$ and non-carcinogenic hazard index of 0.053. Both exposures are within the acceptable risk range and below the target HI of 1.

3.2 RISK ASSESSMENT UNCERTAINTY

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

3.2.1 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment. The exposure assessment assumes potential receptors that may use or trespass onto certain areas of the site. Homogeneous use of the entire site was assumed based on the characteristics of the principal receptor populations (i.e., recreational user and trespasser). However, sample results indicated elevated concentrations of PAHs along the western boundary of the recreational fields. This area is outside the fields and not expected to have as frequent or high impact as the actual fields. The high concentrations of PAHs along the western boundary elevate the EPCs. Actual risks to recreational users are expected to be lower. Additionally, the site is evaluated without regard to vegetative cover or additional soil cover placement over the recreational fields. Both of these would limit contact with surface soil and result in lower risks.

3.2.2 Uncertainties of Toxicity Assessment

There are numerous uncertainties associated with the toxicity assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of chemicals. These uncertainties are described in more detail in the following sections.

3.2.2.1 Uncertainties Associated with Non-Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of chemical exposures to humans. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

Intraspecies Extrapolation

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. U.S. EPA uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects at given doses.

Exposure Routes

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, when data are limited, these extrapolations are made and may result in overestimates of human toxicity.

3.2.2.2 Uncertainties Associated with Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species but not in others raises the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This policy decision, designed to prevent underestimation of risk, introduces the potential to overestimate carcinogenic risk.

High-Dose to Low-Dose Extrapolation

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. The usual dose regime involves

three dose groups per assay. The first dose group is given the highest dose that can be tolerated, the second is exposed to one-half that dose, and the third group is unexposed (control group) (National Research Council [NRC] 1983). Because this dosing method does not reflect how animals would react to much lower doses of a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling that incorporates to varying degrees information about physiologic processes in the body (NRC 1983).

A central problem with the low-dose extrapolation models is that they all too often fit the data from animal bioassays equally well, and it is not possible to determine their validity based on goodness of fit. Several models may fit experimental data equally well, but all may not be equally plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (NRC 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

Mutagenic Adjustment Factors

The primary class of chemicals evaluated in this HHRA is PAHs. Most of the cPAHs have a mutagenic mode of action for early-life exposures. Some chemicals with a mutagenic mode of action, which would be expected to cause irreversible changes to DNA, would exhibit a greater effect in early-life versus later-life exposure (U.S. EPA 2005b). For chemicals with a mutagenic mode of action, a default adjustment factor is applied to the cPAHs to address the potential for differential risk of early-life stage exposure. Default adjustment factors are used because chemical-specific data are not available to assess directly cancer susceptibility from early-life exposure to cPAHs acting through a mutagenic mode of action. The two receptors evaluated in this HHRA are assumed younger than 16 years of age, which is considered early-life exposures. As a result, a default adjustment factor of 3 is applied to the risk results for cPAHs. The default adjustment factor of 3 is based upon limited data and information on human biology regarding 2 to < 16 years (U.S. EPA 2005b). As a result, data are not available to refine 2 to <16 years age group. The default adjustment factor results in an uncertainty in accessing cancer risks for receptors that span the 2 to <16 years age group. The 3-fold adjustment represents an intermediate level of adjustment that is applied after 2 years of age through <16 years of age (U.S. EPA 2005b). This upper age limit represents middle adolescence following the period of rapid developmental changes in puberty and the conclusion of growth in body height (U.S. EPA 2005b). The U.S. EPA selected the 3-fold adjustment because it reflects a midpoint, i.e., approximately half the difference between 1 and 10 on a logarithmic scale ($10^{1/2}$), between the 10-fold adjustment for the first two years of life and no adjustment (i.e., 1-fold) for adult

exposure (U.S. EPA 2005b). Therefore, the adjustment to the carcinogenic risk results for cPAHs is an arbitrary adjustment to ensure a conservative assessment when evaluating chemicals with mutagenic modes of action. As a result, carcinogenic risk results for this HHRA are most likely overestimated.

3.2.3 Uncertainties in Risk Characterization

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process, including any modeling of exposure point concentrations in secondary media from primary media, and the toxicity assessment process. The individual uncertainties in these respective processes are addressed in previous sections.

3.3 HHRA CONCLUSIONS

A RI was conducted by the USACE-Omaha District between 1988 and 1990 for the Marsh Run Park. An HHRA was conducted as part of the 1990 RI to evaluate the risk for potential future exposure at Marsh Run Park (EA 1990). Exposure to surface soil, surface water, sediment, and groundwater were evaluated in the 1990 HHRA. It was concluded that there was no risk above acceptable levels for surface soil, surface water, and sediment exposures, even under conservative worst case concentration scenarios. Exposure of future hypothetical residents to groundwater via direct ingestion from onsite wells was also evaluated in the 1990 HHRA. Risk results for groundwater were above potential acceptable risk ranges. Based on these findings, it was determined that there was potential risk from ingestion of onsite groundwater.

Potential risks for ncPAHs, cPAHs, and lead could not be determined in the 1990 HHRA due to a lack of toxicity values available for these chemicals. Based upon reported concentrations, ncPAHs, cPAHs, and lead in surface soil may be a potential concern for potential receptors at Marsh Run Park and were therefore further evaluated in this 2012 HHRA.

This 2012 HHRA represents the baseline HHRA for ncPAHs, cPAHs, and lead in surface soil at Marsh Run Park. Surface soil within the entire FUDS boundary of Marsh Run Park is taken into account in this HHRA. The exposure areas evaluated within the FUDS boundary differ according to the potential receptors evaluated. The Exposure Assessment in Section 2.2 details the exposure areas evaluated. Furthermore, additional surface soil and wetlands surface soil samples have been collected since completion of the 1990 RI. These samples were collected in June and December 2011 to confirm and further delineate the PAH and lead results from 1988 and 1989. These 2011 samples were included in the evaluation for surface soil exposure in this HHRA.

A recreational user, trespasser, and construction worker potential exposure to surface soil within the Marsh Run Park were evaluated in this HHRA. The recreational user and construction worker were evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates from surface soil within the area of site near the recreational fields. The trespasser was evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates from surface soil within the FUDS boundary of Marsh Run Park. Non-carcinogenic hazards did not exceed 1.0 for any of the receptors. Carcinogenic risks for the recreational user, trespasser, and construction worker were $7x10^{-5}$, $2x10^{-5}$, and $6x10^{-7}$, respectively, and were within the acceptable risk range. An evaluation of lead in surface soil indicates that lead is not a site-wide concern.

It is noted that a conservative evaluation is performed in the HHRA that most likely overestimates potential carcinogenic risks to the recreational user. The HHRA assumes the recreational user would have full exposure to surface soil. The recreational fields will be maintained and vegetated, which limits contact to soil. Additionally, the recreational fields and adjacent areas are expected to have a minimum 1 ft of fill placement for site grading and restoration purposes. This additional fill material will further limit contact with surface soil. As a result, the exposures modeled in this HHRA and the resulting risk results are most likely over-estimated. Therefore, it is concluded from this 2012 HHRA and 1990 HHRA evaluation that there are no risk concerns for potential receptors from exposure to surface soil at Marsh Run Park.

As noted above, potential risk concerns for ingestion of groundwater were identified in the 1990 HHRA. The 1990 HHRA only evaluated onsite groundwater for ingestion. However, exposure pathways and toxicity values have changed since completion of the 1990 HHRA. Dermal contact with and inhalation of VOCs were not evaluated because they were not considered significant exposure pathways in comparison to potential groundwater ingestion. Therefore, groundwater was evaluated qualitatively in this HHRA to determine impact to risk results from the changes in exposure pathways and toxicity values. The qualitative evaluation confirmed there are potential risk concerns for use of onsite groundwater as a tap water source. TCE, vinyl chloride, and cis-1,2-DCE are the primary contributors to this concern.

Furthermore, the Mifflin Avenue Cabin Well was identified downgradient of the site in 2003. While this well was only used infrequently by recreational users in a cabin, it represented a complete exposure pathway for groundwater as a tap water source.. For the former Mifflin Avenue Cabin Well, the carcinogenic risk result from the highest reported concentration of TCE

(30.1 ug/L from March 2006) was $7x10^{-5}$, which is within the acceptable risk range. However, it is noted that the highest reported concentration of TCE in the Mifflin Avenue Cabin Well was above the Federally promulgated MCL and the PA MSC. As a result, the Mifflin Avenue Cabin Well has been abandoned and replaced with the MADW 41-52. For the MADW 41-52, the carcinogenic risk results from the highest reported concentration of TCE (2.3 ug/L in May 2011) are $5x10^{-6}$, which is within the acceptable risk range. However, groundwater from deeper intervals result in carcinogenic risk ranging up to $1x10^{-3}$, which is greater than the accepted risk range and indicates that consumption of groundwater from these deeper intervals could result in adverse health effects.

Because chlorinated VOCs in groundwater are the primary concern at the site, an evaluation was performed for potential volatilization to ambient air within the recreational fields and indoor air to structures. Onsite, the bedrock aquifer (>40 ft bgs) has the highest reported concentrations of these chemicals. However, if volatilization from groundwater to soil vapor and/or to ambient air was occurring, it would occur from the overburden aquifer and not the bedrock aquifer. VOCs were detected within two overburden aquifer monitoring wells (MW-1A, and MW-2A) at very low concentrations below or near drinking water standards. Low levels of chlorinated VOCs (e.g., up to 2.6 mg/kg TCE) have also been detected within some subsurface soil samples within the recreational fields. These concentrations do not represent levels that would pose an inhalation risk from volatilization.

Because the chlorinated VOCs reported in subsurface soil and overburden aquifer are low in concentration and limited to only a few locations, it is not expected that the ambient air within the recreational fields will contain chlorinated VOCs. Therefore, no volatilization of VOCs to ambient air is expected during normal site use or during surface soil grading activities, and inhalation of VOCs in ambient air is considered an incomplete exposure pathway for the Marsh Run Park.

TCE was detected in shallow groundwater at concentrations in excess of the Residential Statewide Health MSCs for groundwater at the site and in offsite areas. As a result, the volatilization of TCE from groundwater and subsequent vapor intrusion to indoor air in onsite and offsite areas was evaluated through the use of the Johnson and Ettinger Model (U.S. EPA 2004b). The results of the model, based conservatively only the highest detected concentration in groundwater, determined there are no concerns for human health for exposure to TCE within indoor air.

In summary, there are no risk concerns for the trespasser, recreational users or a construction worker exposure to surface soil and potential exposure to VOC volatization to ambient and indoor air from groundwater at Marsh Run Park. Groundwater used as a potable water supply is a potential concern for the deeper bedrock aquifer both onsite and offsite of Marsh Run Park

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4 REFERENCES

California Environmental Protection Agency. 2011. *Toxicity Criteria Database*. Found online at: http://www.oehha.org/risk.html.

EA Engineering Science and Technology, Inc. (EA). 1990. *Final Remedial Investigation Report of the New Cumberland Army Depot's Former Landfill (Marsh Run Field). Fairview Township, Pennsylvania.* DACW45-88-D-0009, Delivery Order 5008. January.

Harley, N.H., and T.H. Kneip. 1985. *An Integrated Metabolic Model for Lead in Humans of All Ages.* Final report to U.S. EPA, Contract B44899, New York University Department of Environmental Medicine.

National Resource Council (NRC). 1983. *Risk Assessment in the Federal Government: Managing the Process.* National Academy Press, Washington, D.C. 191 pp.

Pennsylvania Department of Environmental Protection (PADEP). 1995. *Act 1995-2 (Act 2).* http://www.palrb.us/pamphletlaws/19001999/1995/0/act/0002.pdf Accessed 2/27/2012.

U.S. Environmental Protection Agency (U.S. EPA). 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) (Interim Final).* Report No. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, DC. December.

U.S. EPA. 1990. *National Oil and Hazardous Substances Pollution Contingency Plan* (40 Code of Federal Regulation Part 300).

U.S. EPA. 1991a. *Risk Assessment Guidance For Superfund, Volume I, Human Health Evaluation Manual (Part B - Development of Risk-Based Preliminary Remediation Goals).* Publication 9285.7-01B. Interim. December.

U.S. EPA. 1991b. *Memorandum: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors".* Office of Solid Waste and Emergency Response. OSWER Directive: 9285.6-03. March 25.

U.S. EPA. 1994**.** *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.* Office of Emergency and Remedial Response, Washington DC. U.S. EPA/540/R-93/081. February.

U.S. EPA. 1997. *Exposure Factors Handbook: Volumes I, II, and III*. EPA/600/P-95/002a,b,c. August.

U.S. EPA. 2002a. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D).* Office of Emergency and Remedial Response, Washington, DC. December.

U.S. EPA. 2002b. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* EPA530-D-02-004. November.

U.S. EPA. 2002c. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. OSWER 9355.4-24. December 2002.

U.S. EPA. 2003a. *Memorandum: Human Health Toxicity Values in Superfund Risk Assessments*. Office of Solid Waste and Emergency Response, OSWER Directive 9285.7-53.

U.S. EPA. 2003b. *Final Recommendations of the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.* Technical Workgroup for Lead. December.

U.S. EPA. 2004a. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment) Final*. EPA/540/R/99/005 OSWER 9285.7-02EP. Office of Emergency and Remedial Response. July.

U.S. EPA. 2004b. Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings, Groundwater Advanced, Version 3.1. February.

U.S. EPA. 2005a. *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. EPA/630/P-03/001F. March.

U.S. EPA. 2005b. *Supplemental Guidance for Assessing Susceptibility From Early-Life Exposure to Carcinogens*. Risk Assessment Forum. EPA/630/R-03/003F. March.

U.S. EPA. 2007. *User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) Windows® 32-bit version*. EPA 9285.7-42. May.

U.S. EPA. 2009a. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final*. Office of Superfund Remediation and Technology Innovation. EPA-540-R-070-002. January.

U.S. EPA. 2009b. *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters*. OSWER 9200.2-82. June.

U.S. EPA. 2010. *Integrated Exposure Uptake Biokinetic Model for Lead in Children*, Windows® version (IEUBKwin v1.1 build 11). http://www.epa.gov/superfund/lead/products.htm#user. February.

U.S. EPA. 2011a. *Exposure Factors Handbook: 2011 Edition*. Office of Research and Development, National Center for Environmental Assessment. EPA/600/R-090/052F. September.

U.S. EPA. 2011b. *ProUCL Version 4.1*. Software developed by U.S. EPA. Obtained on the Internet at http://www.epa.gov/osp/hstl/tsc/software.htm. Site Characterization and Monitoring Technical Support Center.

U.S. EPA. 2012a. *Regional Screening Levels for Superfund*. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm. April.

U.S. EPA. 2012b. *IRIS* database maintained at http://www.epa.gov/ iris. U.S. EPA National Center for Environmental Assessment.

Woodward-Clyde Consultants (Woodward-Clyde). 1987. *Confirmation Study of Former New Cumberland Army Depot Landfill (Marsh Run Field)*.

"Quitclaim Deed", April 23, 1976, Recorder of Deeds, County of York, State of Pennsylvania, Record Book 70E.

FIGURES

FIGURE 1
HUMAN HEALTH CONCEPTUAL SITE MODEL
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PENNSYLVANIA

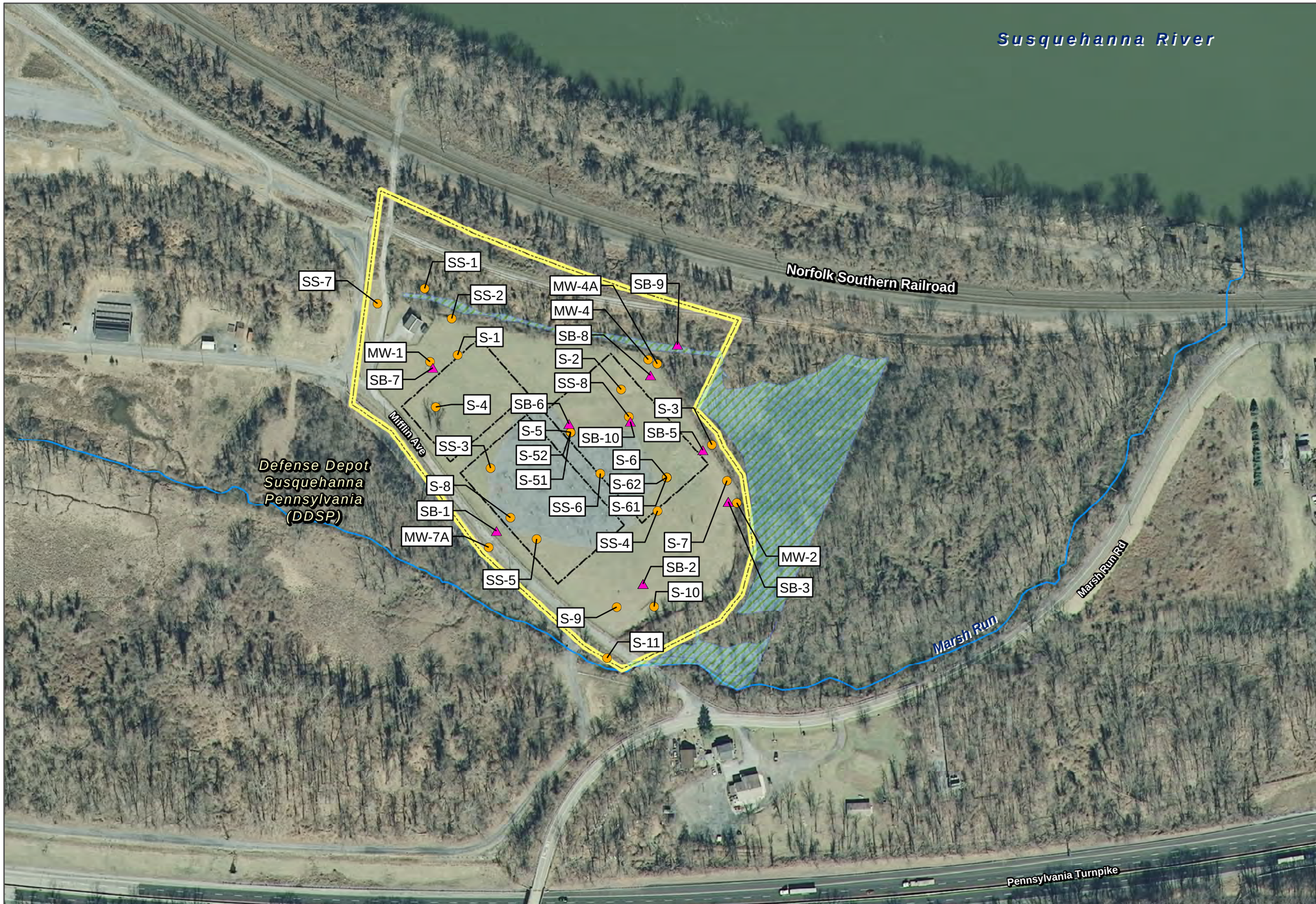
PRIMARY SOURCE	PRIMARY RELEASE MECHANISM	SECONDARY SOURCE	SECONDARY RELEASE MECHANISM	TERTIARY SOURCE	EXPOSURE ROUTE	POTENTIAL RECEPTORS: Off-Site Residents	Trespasser	Recreational Users	Construction Worker
Landfill	Infiltration/Percolation	Groundwater			Ingestion	C*	I	I	I
					Dermal Contact	I	I	I	I
			Volatilization	Air	Inhalation of VOCs	I	I	I	I
			Volatilization	Air	Inhalation of VOCs (Ambient Air)	I	I	I	I
					Inhalation of VOCs (Vapor Intrusion to Indoor Air)	C	I	C	I
			Migration	Surface Water	Ingestion	I	C*	C*	I
					Dermal Contact	I	C*	C*	I
				Sediment	Ingestion	I	C*	C*	I
					Dermal Contact	I	C*	C*	I
		Surface Soil			Ingestion	I	C	C	C
					Dermal Contact	I	C	C	C
			Particulate Emission/Suspension	Air	Inhalation of Particulate	I	C	C	C
			Volatilization	Air	Inhalation of VOCs (Ambient Air)	I	I	I	I
		Subsurface Soil			Ingestion	I	I	I	I
					Dermal Contact	I	I	I	I
			Particulate Emission/Suspension	Air	Inhalation of Particulate	I	I	I	I
			Volatilzation	Air	Inhalation of VOCs (Ambient Air)	I	I	I	I

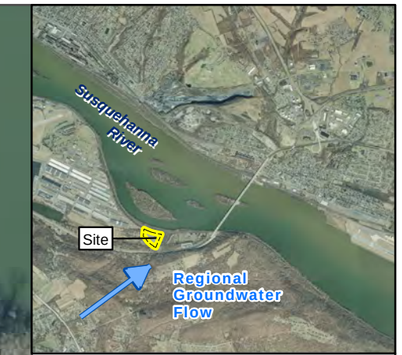
LEGEND

I — Incomplete or negligible exposure pathway.

C — Potentially complete exposure pathway.

C* — Potentially complete exposure pathway evaluated in 1990 RI report, not evaluated quantitatively in this HHRA.





Legend

- Exposure Area 1
- 2011 Surface Soil Sample Location
- Historical Surface Soil Sample Location
- Proposed Soccer Fields
- Wetlands Within FUDS Boundary
- Stream

Notes:
1. Surface soil sample locations are approximate, georeferenced data are not available.

Aerial Photograph Source:
PAMAP Program, PA Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey, 2008

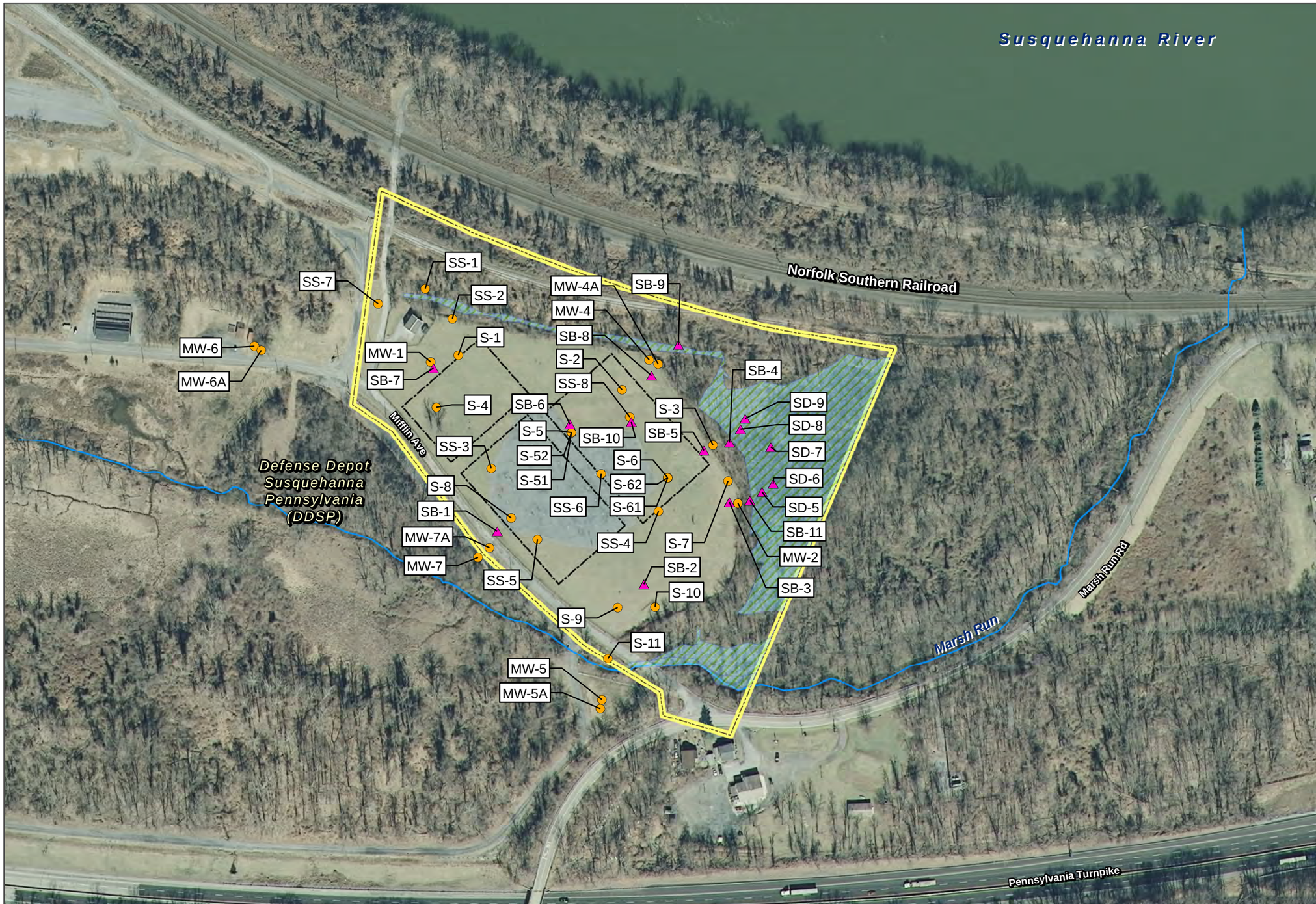
Marsh Run Park FUDS
Fairview Township, New Cumberland, Pennsylvania
FUDS Project No. C03PA040301

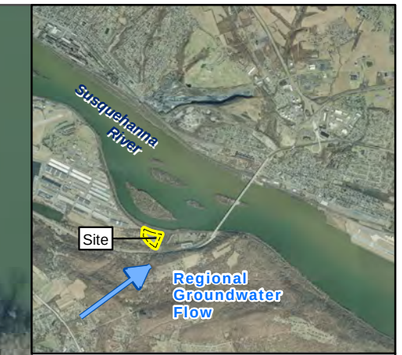
Project Number: 6233003
Date: May 2012

0 100 200
Feet
1 inch = 200 feet

Figure 2
Exposure Area 1
Recreational User

Path: \\LOVETON\FEDERAL\GIS\Data\Northeast\Pennsylvania\MarshRun\Mxd\RevisionsSAR\HHRA\ExposureArea1.mxd





Legend

- Exposure Area 2
- 2011 Surface Soil Sample Location
- Historical Surface Soil Sample Location
- Proposed Soccer Fields
- Wetlands Within FUDS Boundary
- Stream

Notes:
1. Surface soil sample locations are approximate, georeferenced data are not available.

Aerial Photograph Source:
PAMAP Program, PA Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey, 2008

Marsh Run Park FUDS

Fairview Township, New Cumberland, Pennsylvania
FUDS Project No. C03PA040301

Project Number: 6233003

Date: May 2012

0 100 200
Feet
1 inch = 200 feet

Figure 3
Exposure Area 2
Trespasser

Path: \\LOVETONFEDERAL\GIS\Data\Northeast\Pennsylvania\MarshRun\Mxd\RevisionsSAR\HHRA\ExposureArea2.mxd

TABLES

TABLE 1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
MARSH RUN PARK, RECREATIONAL AREA
MIFFLIN AVENUE, NEW CUMBERLAND, PENNSYLVANIA

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Marsh Run Park, Recreational Area

Constituent of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
METALS									
LEAD	mg/kg	1.38E+02	NA	1.02E+03		mg/kg	1.38E+02	Mean	U.S. EPA 1994
PAHS									
2-METHYLNAPHTHALENE	mg/kg	7.21E+00	1.95E+01	4.70E+01		mg/kg	1.95E+01	95%UCLM-KMC	U.S. EPA ProUCL
ACENAPHTHENE	mg/kg	2.11E+01	2.99E+01	6.12E+01		mg/kg	2.99E+01	95%UCLM-KMC	U.S. EPA ProUCL
ACENAPHTHYLENE	mg/kg	1.72E-01	3.16E-01	3.92E-01		mg/kg	3.16E-01	95%UCLM-KMt	U.S. EPA ProUCL
ANTHRACENE	mg/kg	2.17E+01	9.82E+01	1.28E+02		mg/kg	9.82E+01	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(A)ANTHRACENE	mg/kg	2.94E+01	3.29E+01	1.70E+02		mg/kg	3.29E+01	95%UCLM-KMt	U.S. EPA ProUCL
BENZO(A)PYRENE	mg/kg	3.19E+01	2.46E+01	1.23E+02		mg/kg	2.46E+01	95%UCLM-KMt	U.S. EPA ProUCL
BENZO(B)FLUORANTHENE	mg/kg	2.24E+01	1.19E+01	1.22E+02		mg/kg	1.19E+01	95%UCLM-KMt	U.S. EPA ProUCL
BENZO(GHI)PERYLENE	mg/kg	3.35E+01	9.58E+01	9.90E+01		mg/kg	9.58E+01	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(K)FLUORANTHENE	mg/kg	1.99E+01	8.85E+00	8.81E+01		mg/kg	8.85E+00	95%UCLM-KMt	U.S. EPA ProUCL
CHRYSENE	mg/kg	2.36E+01	1.48E+01	1.54E+02		mg/kg	1.48E+01	95%UCLM-KMt	U.S. EPA ProUCL
DIBENZ(A,H)ANTHRACENE	mg/kg	1.24E+01	2.34E+01	2.40E+01		mg/kg	2.34E+01	95%UCLM-KMC	U.S. EPA ProUCL
FLUORANTHENE	mg/kg	3.32E+01	1.41E+02	3.76E+02		mg/kg	1.41E+02	95%UCLM-KMC	U.S. EPA ProUCL
FLUORENE	mg/kg	4.40E+01	8.44E+01	8.68E+01		mg/kg	8.44E+01	95%UCLM-KMC	U.S. EPA ProUCL
INDENO(1,2,3-CD)PYRENE	mg/kg	1.23E+01	1.17E+01	5.97E+01		mg/kg	1.17E+01	95%UCLM-KMt	U.S. EPA ProUCL
NAPHTHALENE	mg/kg	1.11E+01	4.31E+00	4.34E+01		mg/kg	4.31E+00	95%UCLM-KMt	U.S. EPA ProUCL
PHENANTHRENE	mg/kg	4.04E+01	1.48E+02	3.90E+02		mg/kg	1.48E+02	95%UCLM-KMC	U.S. EPA ProUCL
PYRENE	mg/kg	2.29E+01	1.04E+02	2.76E+02		mg/kg	1.04E+02	95%UCLM-KMC	U.S. EPA ProUCL

Note: Statistics calculated by the U.S. EPA program ProUCL (U.S. EPA 2011c).
95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.
U.S. EPA 1994 = The arithmetic mean is used per U.S. EPA lead model guidance (U.S. EPA 1994).
NA = Not Applicable
95%UCLM = 95 percent upper confidence limit on the mean
EPC = exposure point concentration
PAHS = Polycyclic Aromatic Hydrocarbons
mg/kg = milligrams per kilogram
U.S.EPA = United States Environmental Protection Agency

TABLE 2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
MARSH RUN PARK, FUDS BOUNDARY
MIFFLIN AVENUE, NEW CUMBERLAND, PENNSYLVANIA

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Marsh Run Park, FUDS Boundary

Constituent of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
METALS									
LEAD	mg/kg	1.38E+02	NA	1.08E+03		mg/kg	1.38E+02	Mean	U.S. EPA 1994
PAHS									
2-METHYLNAPHTHALENE	mg/kg	4.22E+00	1.61E+01	4.70E+01		mg/kg	1.61E+01	95%UCLM-KMC	U.S. EPA ProUCL
ACENAPHTHENE	mg/kg	1.61E+01	7.43E+00	6.12E+01		mg/kg	7.43E+00	95%UCLM-KMt	U.S. EPA ProUCL
ACENAPHTHYLENE	mg/kg	1.01E-01	1.58E-01	3.92E-01		mg/kg	1.58E-01	95%UCLM-BCA	U.S. EPA ProUCL
ANTHRACENE	mg/kg	2.14E+01	1.00E+02	1.47E+02		mg/kg	1.00E+02	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(A)ANTHRACENE	mg/kg	3.25E+01	1.53E+02	2.44E+02		mg/kg	1.53E+02	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(A)PYRENE	mg/kg	3.06E+01	1.24E+02	2.06E+02		mg/kg	1.24E+02	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(B)FLUORANTHENE	mg/kg	2.31E+01	6.30E+01	1.61E+02		mg/kg	6.30E+01	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(GHI)PERYLENE	mg/kg	1.27E+01	6.25E+01	9.90E+01		mg/kg	6.25E+01	95%UCLM-KMC	U.S. EPA ProUCL
BENZO(K)FLUORANTHENE	mg/kg	2.37E+01	6.30E+01	1.82E+02		mg/kg	6.30E+01	95%UCLM-KMC	U.S. EPA ProUCL
CHRYSENE	mg/kg	2.83E+01	8.52E+01	2.27E+02		mg/kg	8.52E+01	95%UCLM-KMC	U.S. EPA ProUCL
DIBENZ(A,H)ANTHRACENE	mg/kg	1.04E+01	6.52E+00	3.74E+01		mg/kg	6.52E+00	95%UCLM-KMt	U.S. EPA ProUCL
FLUORANTHENE	mg/kg	5.35E+01	2.21E+02	6.12E+02		mg/kg	2.21E+02	95%UCLM-KMC	U.S. EPA ProUCL
FLUORENE	mg/kg	2.01E+01	5.95E+01	8.68E+01		mg/kg	5.95E+01	95%UCLM-KMC	U.S. EPA ProUCL
INDENO(1,2,3-CD)PYRENE	mg/kg	1.21E+01	5.23E+01	8.22E+01		mg/kg	5.23E+01	95%UCLM-KMC	U.S. EPA ProUCL
NAPHTHALENE	mg/kg	1.22E+01	4.57E+00	4.34E+01		mg/kg	4.57E+00	95%UCLM-KMt	U.S. EPA ProUCL
PHENANTHRENE	mg/kg	5.35E+01	1.96E+02	5.03E+02		mg/kg	1.96E+02	95%UCLM-KMC	U.S. EPA ProUCL
PYRENE	mg/kg	3.72E+01	1.51E+02	4.06E+02		mg/kg	1.51E+02	95%UCLM-KMC	U.S. EPA ProUCL

Note: Statistics calculated by the U.S. EPA program ProUCL (U.S. EPA 2011c).
95%UCLM-BCA indicates that the 95 percent upper confidence limit on the mean is based on the Kaplan-Meier (KM) Bias-Corrected Accelerated (BCA) percentile bootstrap test.
95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.
U.S. EPA 1994 = The arithmetic mean is used per U.S. EPA lead model guidance (U.S. EPA 1994).
NA = Not Applicable
95%UCLM = 95 percent upper confidence limit on the mean
EPC = exposure point concentration
PAHS = Polycyclic Aromatic Hydrocarbons
mg/kg = milligrams per kilogram
U.S. EPA = United States Environmental Protection Agency

TABLE 3
VALUES USED FOR ADOLESCENT RECREATIONAL USER DAILY SURFACE SOIL INTAKE EQUATIONS
MARSH RUN PARK, RECREATIONAL AREA
MIFFLIN AVE, NEW CUMBERLAND, PA

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: Marsh Run Park
Receptor Population: Recreational User
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	U.S. EPA 2011a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	52	BPJ (1)	
	ED	Exposure Duration	yr	10	BPJ (2)	For chemicals considered mutagenic:
	BW	Body Weight	kg	45	U.S. EPA 2011a (3)	CDI (mg/kg/day) =
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CS x CR x EF x ED x CF x MADF / (BW x AT-C)
	AT-NC	Averaging time - Noncancer	days	3,650	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,800	U.S. EPA 2011a (4)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.08	U.S. EPA 2004 and 2011a (5)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (6)	
	EF	Exposure Frequency	event/yr	52	BPJ (1)	For chemicals considered mutagenic:
	ED	Exposure Duration	yr	10	BPJ (2)	CDI (mg/kg/day) =
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CS x SA x AF x ABS x EF x ED x CF x MADF / (BW x AT-C)
	BW	Body Weight	kg	45	U.S. EPA 2011a (3)	
	AT-NC	Averaging time - Noncancer	days	3,650	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$) =
	ET	Exposure Time	hours/day	2	BPJ (3)	CA x ET x EF x CF_1 x ED / AT x CF_2
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	52	BPJ (1)	
	ED	Exposure Duration	yr	10	BPJ (2)	
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009a	For chemicals considered mutagenic:
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CA x ET x EF x ED x CF_1 x MADF / AT x CF_2
	AT-NC	Averaging time - Noncancer	days	3,650	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

(1) The exposure frequency is based on best professional judgment, assuming that the recreational user would visit the site approximately 2 days/week for 6 months of the year for 2 hours per day.
The exposure duration is based on the age range evaluated (6 - 16 years of age).
(2) Age range of adolescent recreational user is assumed to be 6 to 16 years of age.
(3) Body weight is the average of the following age ranges: 6 to <11 years and 11 to <16 years.
(4) Skin surface area is taken from Table 7-17 and Table 7-9 of 2011 EFH. Table 7-17 notes 29% of exposed skin surface available for 5 to 17 year old during outdoor activities. Table 7-9 presents the total skin surface area for 6 to <11 years of age and 11 to <16 years of age for male and female combined.
(5) Weighted Soil Adherence Factor for soccer players as noted in U.S. EPA 2004, Exhibit 3-3 and U.S. EPA 2011a.
(6) Taken from Exhibit 3-4 in U.S. EPA 2004.

BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
$\mu g/m^3$ = micrograms per cubic meter
mg/day = milligrams per day
cm^2 /event = square centimeters per event
mg/µg = miligrams per microgram
kg = kilogram
hr/day = hours per day

TABLE 4
VALUES USED FOR ADOLESCENT TRESPASSER DAILY SURFACE SOIL INTAKE EQUATIONS
MARSH RUN PARK, FUDS BOUNDARY
MIFFLIN AVE, NEW CUMBERLAND, PA

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: Marsh Run Park, Inside Fence
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	U.S. EPA 2011a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	26	BPJ (1)	
	ED	Exposure Duration	yr	4	BPJ (2)	For chemicals considered mutagenic:
	BW	Body Weight	kg	57	U.S. EPA 2011a (3)	CDI (mg/kg/day) =
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CS x CR x EF x ED x CF x MADF / (BW x AT-C)
	AT-NC	Averaging time - Noncancer	days	1,460	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	5,181	U.S. EPA 2011a (4)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.04	U.S. EPA 2004 (5)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (6)	
	EF	Exposure Frequency	event/yr	26	BPJ (1)	For chemicals considered mutagenic:
	ED	Exposure Duration	yr	4	BPJ (2)	CDI (mg/kg/day) =
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CS x SA x AF x ABS x EF x ED x CF x MADF / (BW x AT-C)
	BW	Body Weight	kg	57	U.S. EPA 2011b (3)	
	AT-NC	Averaging time - Noncancer	days	1,460	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$) =
	ET	Exposure Time	hours	2	U.S. EPA 2009a	CA x ET x EF x CF_1 x ED / AT x CF_2
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	26	BPJ (1)	
	ED	Exposure Duration	yr	4	BPJ (2)	
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009a	For chemicals considered mutagenic:
	MADF	Mutagenic Age-Dependent Factor	unitless	3	U.S. EPA 2005b	CA x ET x EF x ED x CF_1 x MADF / AT x CF_2
	AT-NC	Averaging time - Noncancer	days	1,460	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

(1) The exposure frequency is based on best professional judgment, assuming that the trespasser would visit the site approximately 1 day/week for 6 months of the year for 2 hours per day.
The exposure duration is based on the age range evaluated (6 - 16 years of age).
(2) Age range of adolescent trespasser is assumed to be 12 to 16 years of age.
(3) Body weight taken from Table 8-1 of 2011 EFH for 11 to <16 years.
(4) Skin surface area is taken from Table 7-17 and Table 7-9 of 2011 EFH. Table 7-17 notes 33% of exposed skin surface available for 5 to 17 year old during outdoor gardening/yardwork activities. Table 7-9 presents the total skin surface area of $1.57m^2$ for 11 to <16 years of age for male and female combined.
(5) Weighted Soil Adherence Factor for children playing in dry soil as noted in U.S. EPA 2004, Exhibit 3-3.
(6) Taken from Exhibit 3-4 in U.S. EPA 2004.
BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection agency
CDI = chronic daily intake

mg/kg = milligrams per kilogram
day/yr = days per year
kg/mg = kilograms per milligram
cm^2/event = square centimeters per event
hr/day = hours per day

$\mu g/m^3$ = micrograms per cubic meter
mg/day = milligrams per day
kg = kilograms
mg/µg = milligrams per microgram
mg/cm^2 = milligrams per square centimeter

TABLE 5
VALUES USED FOR CONSTRUCTION WORKER DAILY SURFACE SOIL INTAKE EQUATIONS
MARSH RUN PARK, RECREATIONAL AREA
MIFFLIN AVE, NEW CUMBERLAND, PA

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: Marsh Run Park
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	U.S. EPA 1991b, 2011b	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	60	BPJ (1)	
	ED	Exposure Duration	yr	0.25	BPJ (2)	
	BW	Body Weight	kg	70	U.S. EPA 2011a	
	AT-NC	Averaging time - Noncancer	days	91	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,300	U.S. EPA 2004	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.2	U.S. EPA 2004	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (3)	
	EF	Exposure Frequency	event/yr	60	BPJ (1)	
	ED	Exposure Duration	yr	0.25	BPJ (2)	
	BW	Body Weight	kg	70	U.S. EPA 2011a	
	AT-NC	Averaging time - Noncancer	days	91	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration ($\mu g/m^3$) =
	ET	Exposure Time	hours/day	8	BPJ (4)	CA x ET x EF x CF_1 x ED / AT x CF_2
	CF_1	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	60	BPJ (1)	
	ED	Exposure Duration	yr	0.25	BPJ (2)	
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009a	
	AT-NC	Averaging time - Noncancer	days	91	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

(1) The exposure frequency is based on best professional judgment, assuming construction activities at the site will last for 60 days.
(2) Exposure duration assumes construction worker will work at the site for 3 months.
(3) Taken from Exhibit 3-4 in U.S. EPA 2004.
(4) The typical work day is expected to last 8 hours.

BPJ = Best Professional Judgment
U.S. EPA = United States Environmental Protection Agency

CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year

$\mu g/m^3$ = micrograms per cubic meter
mg/day = milligrams per day
cm^2 /event = square centimeters per event
mg/µg = miiligrams per microgram
kg = kilogram
hr/day = hours per day

TABLE 6
NON-CANCER TOXICITY DATA - ORAL/DERMAL
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PA

Constituent of Potential Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Oral to Dermal Adjustment Factor (GI ABS) (1)	Adjusted Dermal RfD (2) (mg/kg bw-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (mm/dd/yy)
PAHs								
ACENAPHTHENE	Chronic	6.00E-02	1	6.00E-02	Liver	3000/1	IRIS	2/15/2012
ACENAPHTHYLENE	Chronic	6.00E-02	1	6.00E-02	NA	NA/NA	IRIS	2/15/2012
ANTHRACENE	Chronic	3.00E-01	1	3.00E-01	None	3000/1	IRIS	2/15/2012
BENZ(A)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
BENZO(B)FLUORANTHENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
BENZO(G,H,I)PERYLENE	Chronic	3.00E-02	1	3.00E-02	Kidneys	3000/1	IRIS	2/15/2012
BENZO(K)FLUORANTHENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
BENZO(A)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
CHRYSENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
DIBENZ(A,H)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
FLUORANTHENE	Chronic	4.00E-02	1	4.00E-02	Liver	3000/1	IRIS	2/15/2012
FLUORENE	Chronic	4.00E-02	1	4.00E-02	Blood	3000/1	IRIS	2/15/2012
INDENO(1,2,3-C,D)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	2/15/2012
2-METHYLNAPHTHALENE	Chronic	4.00E-03	1	4.00E-03	Lungs	1000/1	IRIS	2/15/2012
NAPHTHALENE	Chronic	2.00E-02	1	2.00E-02	Body Weight	3000/1	IRIS	2/15/2012
PHENANTHRENE	Chronic	3.00E-01	1	3.00E-01	None	3000/1	IRIS	2/15/2012
PYRENE	Chronic	3.00E-02	1	3.00E-02	Kidneys	3000/1	IRIS	2/15/2012

(1) Taken from U.S. EPA 2004 Guidance.
(2) Dermal toxicological values adjusted from oral values using U.S. EPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). RfDs are multiplied by the GI ABS.
(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
NA = Not Applicable
mg/kg bw-day = milligrams per kilogram body weight-day
mg/kg-day = milligrams per kilogram-day
U.S. EPA = United States Environmental Protection Agency
RfD = Reference dose
PAH = Polycyclic Aromatic Hydrocarbon

TABLE 7
NON-CANCER TOXICITY DATA - INHALATION
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PA

Constituent of Potential Concern	Chronic/ Subchronic	Value Inhalation (RfC) (mg/m^3)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC Target Organ	Dates (1) (mm/dd/yy)
PAHs						
ACENAPHTHENE	NA	NA	NA	NA	IRIS	2/15/2012
ACENAPHTHYLENE	NA	NA	NA	NA	IRIS	2/15/2012
ANTHRACENE	NA	NA	NA	NA	IRIS	2/15/2012
BENZ(A)ANTHRACENE	NA	NA	NA	NA	IRIS	2/15/2012
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	IRIS	2/15/2012
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	IRIS	2/15/2012
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	IRIS	2/15/2012
BENZO(A)PYRENE	NA	NA	NA	NA	IRIS	2/15/2012
CHRYSENE	NA	NA	NA	NA	IRIS	2/15/2012
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	IRIS	2/15/2012
FLUORANTHENE	NA	NA	NA	NA	IRIS	2/15/2012
FLUORENE	NA	NA	NA	NA	IRIS	2/15/2012
INDENO(1,2,3-C,D)PYRENE	NA	NA	NA	NA	IRIS	2/15/2012
2-METHYLNAPHTHALENE	NA	NA	NA	NA	IRIS	2/15/2012
NAPHTHALENE	Chronic	3.00E-03	Respiratory System	3000/1	IRIS	2/15/2012
PHENANTHRENE	NA	NA	NA	NA	IRIS	2/15/2012
PYRENE	NA	NA	NA	NA	IRIS	2/15/2012

(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
NA = Not applicable
RfC = Reference concentration
PAH = Polycyclic Aromatic Hydrocarbon
mg/m^3 = milligrams per cubic meter

TABLE 8
CHEMICAL-SPECIFIC PARAMETERS
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PA

Constituent of Potential Concern	Absorption Factor	Reference	GI ABS	Reference
PAHs				
ACENAPHTHENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
ACENAPHTHYLENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
ANTHRACENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
BENZ(A)ANTHRACENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
BENZO(B)FLUORANTHENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
BENZO(G,H,I)PERYLENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
BENZO(K)FLUORANTHENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
BENZO(A)PYRENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
CHRYSENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
DIBENZ(A,H)ANTHRACENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
FLUORANTHENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
FLUORENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
INDENO(1,2,3-C,D)PYRENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
2-METHYLNAPHTHALENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
NAPHTHALENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
PHENANTHRENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004
PYRENE	0.13	U.S. EPA 2004	1	U.S. EPA 2004

NA = Data not available.
PAH = Polycyclic Aromatic Hydrocarbon
GI ABS = Gastrointestional Absorption factors
U.S. EPA 2004 = U.S. Environmental Protection Agency. 2004. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final Guidance.

TABLE 9
CANCER TOXICITY DATA - ORAL/DERMAL
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PA

Constituent of Potential Concern	Oral Cancer Slope Factor	Oral Absorption Efficiency for Dermal (GI ABS)(1)	Absorbed Cancer Slope Factor for Dermal (2)	Units	Mutagen	Weight of Evidence/Cancer Guideline Description	Source	Date (3) (mm/dd/yy)
PAHs								
ACENAPHTHENE	NA	1	NA	per (mg/kg-day)		NA	IRIS	2/15/2012
ACENAPHTHYLENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
ANTHRACENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
BENZ(A)ANTHRACENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
BENZO(B)FLUORANTHENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
BENZO(G,H,I)PERYLENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
BENZO(K)FLUORANTHENE	7.30E-02	1	7.30E-02	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
BENZO(A)PYRENE	7.30E+00	1	7.30E+00	per (mg/kg-day)	M	B2	IRIS	2/15/2012
CHRYSENE	7.30E-03	1	7.30E-03	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
DIBENZ(A,H)ANTHRACENE	7.30E+00	1	7.30E+00	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
FLUORANTHENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
FLUORENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
INDENO(1,2,3-C,D)PYRENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	M	B2	EPA-NCEA	5/23/2001
2-METHYLNAPHTHALENE	NA	1	NA	per (mg/kg-day)		NA	IRIS	2/15/2012
NAPHTHALENE	NA	1	NA	per (mg/kg-day)		C	IRIS	2/15/2012
PHENANTHRENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012
PYRENE	NA	1	NA	per (mg/kg-day)		D	IRIS	2/15/2012

(1) Taken from U.S. EPA 2004 Guidance.
(2) Dermal Toxicological values adjusted from oral values using U.S. EPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). CSFs are divided by the GI ABS.
(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
CAL EPA - California Environmental Protection Agency
EPA-NCEA - National Center for Environmental Assessment. For EPA-NCEA values, the date of the article provided by EPA-NCEA is provided.
NA = Not Applicable
U.S. EPA = United States Environmental Protection Agency
mg/kg-day = milligrams per kilogram-day
PAH = Polycyclic Aromatic Hydrocarbon

Weight of Evidence: A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 10
CANCER TOXICITY DATA - INHALATION
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PA

Constituent of Potential Concern	Unit Risk		Weight of Evidence/Cancer Guideline Description	Unit Risk - Inhalation CSF	
	Value	Units		Source	Date (1)
PAHs					
ACENAPHTHENE	NA	per ($\mu g/m^3$)	NA	IRIS	2/15/2012
ACENAPHTHYLENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
ANTHRACENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
BENZ(A)ANTHRACENE	1.10E-04	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
BENZO(B)FLUORANTHENE	1.10E-04	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
BENZO(G,H,I)PERYLENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
BENZO(K)FLUORANTHENE	1.10E-04	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
BENZO(A)PYRENE	1.10E-03	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
CHRYSENE	1.10E-05	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
DIBENZ(A,H)ANTHRACENE	1.10E-03	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
FLUORANTHENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
FLUORENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
INDENO(1,2,3-C,D)PYRENE	1.10E-04	per ($\mu g/m^3$)	B2	CalEPA	5/1/2009
2-METHYLNAPHTHALENE	NA	per ($\mu g/m^3$)	NA	IRIS	2/15/2012
NAPHTHALENE	3.40E-05	per ($\mu g/m^3$)	C	CalEPA	5/1/2009
PHENANTHRENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012
PYRENE	NA	per ($\mu g/m^3$)	D	IRIS	2/15/2012

NA = Not Applicable
(1)IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.

CAL EPA - California Environmental Protection Agency
$\mu g/m^3$ = micrograms per cubic meter
PAH = Polcyclic Aromatic Hydrocarbon

Weight of Evidence: A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 11

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	Recreational Fields	Ingestion	**PAHs**												
				ACENAPHTHENE	2.99E+01	(mg/kg)	1.35E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	9.47E-06	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.6E-04
				ACENAPHTHYLENE	3.16E-01	(mg/kg)	1.43E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.00E-07	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.7E-06
				ANTHRACENE	9.82E+01	(mg/kg)	4.44E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.11E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	1.0E-04
				BENZ(A)ANTHRACENE	3.29E+01	(mg/kg)	4.46E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	3.3E-06	1.04E-05	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	1.19E+01	(mg/kg)	1.61E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.2E-06	3.77E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	9.58E+01	(mg/kg)	4.33E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.03E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	1.0E-03
				BENZO(K)FLUORANTHENE	8.85E+00	(mg/kg)	1.20E-06	(mg/kg-day)	7.30E-02	per (mg/kg-day)	8.8E-08	2.80E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	2.46E+01	(mg/kg)	3.34E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.4E-05	7.79E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	1.48E+01	(mg/kg)	2.01E-06	(mg/kg-day)	7.30E-03	per (mg/kg-day)	1.5E-08	4.69E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	2.34E+01	(mg/kg)	3.17E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.3E-05	7.41E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	1.41E+02	(mg/kg)	6.38E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	4.46E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	1.1E-03
				FLUORENE	8.44E+01	(mg/kg)	3.82E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.67E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	6.7E-04
				INDENO(1,2,3-C,D)PYRENE	1.17E+01	(mg/kg)	1.59E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.2E-06	3.70E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.95E+01	(mg/kg)	8.82E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	6.17E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.5E-03
				NAPHTHALENE	4.31E+00	(mg/kg)	1.95E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.36E-06	(mg/kg-day)	2.00E-02	(mg/kg-day)	6.8E-05
				PHENANTHRENE	1.48E+02	(mg/kg)	6.69E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	4.69E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	1.6E-04
				PYRENE	1.04E+02	(mg/kg)	4.70E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.29E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	1.1E-03
			Exp. Route Total								**5.3E-05**					**5.9E-03**
			Dermal[1]	**PAHs**												
				ACENAPHTHENE	2.99E+01	(mg/kg)	5.34E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.74E-06	(mg/kg-day)	6.00E-02	(mg/kg-day)	6.2E-05
				ACENAPHTHYLENE	3.16E-01	(mg/kg)	5.65E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	3.95E-08	(mg/kg-day)	6.00E-02	(mg/kg-day)	6.6E-07
				ANTHRACENE	9.82E+01	(mg/kg)	5.27E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.23E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	4.1E-05
				BENZ(A)ANTHRACENE	3.29E+01	(mg/kg)	1.76E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.3E-06	4.12E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	1.19E+01	(mg/kg)	6.38E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.7E-07	1.49E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	9.58E+01	(mg/kg)	5.14E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.20E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	4.0E-04
				BENZO(K)FLUORANTHENE	8.85E+00	(mg/kg)	4.75E-07	(mg/kg-day)	7.30E-02	per (mg/kg-day)	3.5E-08	1.11E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	2.46E+01	(mg/kg)	1.32E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	9.6E-06	3.08E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	1.48E+01	(mg/kg)	7.94E-07	(mg/kg-day)	7.30E-03	per (mg/kg-day)	5.8E-09	1.85E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	2.34E+01	(mg/kg)	1.25E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	9.2E-06	2.93E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	1.41E+02	(mg/kg)	2.52E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.76E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	4.4E-04
				FLUORENE	8.44E+01	(mg/kg)	1.51E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.06E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	2.6E-04
				INDENO(1,2,3-C,D)PYRENE	1.17E+01	(mg/kg)	6.27E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.6E-07	1.46E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.95E+01	(mg/kg)	3.49E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.44E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	6.1E-04
				NAPHTHALENE	4.31E+00	(mg/kg)	7.70E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	5.39E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	2.7E-05
				PHENANTHRENE	1.48E+02	(mg/kg)	2.65E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.85E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	6.2E-05
				PYRENE	1.04E+02	(mg/kg)	1.86E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.30E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	4.3E-04
			Exp. Route Total								**2.1E-05**					**2.3E-03**
		Exposure Point Total									**7.4E-05**					**8.3E-03**
	Exposure Medium Total										**7.4E-05**					**8.3E-03**

TABLE 11

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Recreational Fields	Inhalation	**PAHs**												
				ACENAPHTHENE	2.20E-08	(mg/m^3)	3.73E-08	(µg/m^3)	NA	per (µg/m^3)	--	2.61E-07	(µg/m^3)	NA	(mg/m^3)	--
				ACENAPHTHYLENE	2.32E-10	(mg/m^3)	3.94E-10	(µg/m^3)	NA	per (µg/m^3)	--	2.76E-09	(µg/m^3)	NA	(mg/m^3)	--
				ANTHRACENE	7.22E-08	(mg/m^3)	1.22E-07	(µg/m^3)	NA	per (µg/m^3)	--	8.57E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZ(A)ANTHRACENE	2.42E-08	(mg/m^3)	1.23E-07	(µg/m^3)	1.10E-04	per (µg/m^3)	1.4E-11	2.87E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	8.75E-09	(mg/m^3)	4.45E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	4.9E-12	1.04E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(G,H,I)PERYLENE	7.04E-08	(mg/m^3)	1.19E-07	(µg/m^3)	NA	per (µg/m^3)	--	8.36E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(K)FLUORANTHENE	6.51E-09	(mg/m^3)	3.31E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	3.6E-12	7.73E-08	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	1.81E-08	(mg/m^3)	9.20E-08	(µg/m^3)	1.10E-03	per (µg/m^3)	1.0E-10	2.15E-07	(µg/m^3)	NA	(mg/m^3)	--
				CHRYSENE	1.09E-08	(mg/m^3)	5.54E-08	(µg/m^3)	1.10E-05	per (µg/m^3)	6.1E-13	1.29E-07	(µg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	1.72E-08	(mg/m^3)	8.75E-08	(µg/m^3)	1.10E-03	per (µg/m^3)	9.6E-11	2.04E-07	(µg/m^3)	NA	(mg/m^3)	--
				FLUORANTHENE	1.04E-07	(mg/m^3)	1.76E-07	(µg/m^3)	NA	per (µg/m^3)	--	1.23E-06	(µg/m^3)	NA	(mg/m^3)	--
				FLUORENE	6.21E-08	(mg/m^3)	1.05E-07	(µg/m^3)	NA	per (µg/m^3)	--	7.37E-07	(µg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	8.60E-09	(mg/m^3)	4.38E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	4.8E-12	1.02E-07	(µg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.43E-08	(mg/m^3)	2.43E-08	(µg/m^3)	NA	per (µg/m^3)	--	1.70E-07	(µg/m^3)	NA	(mg/m^3)	--
				NAPHTHALENE	3.17E-09	(mg/m^3)	5.37E-09	(µg/m^3)	3.40E-05	per (µg/m^3)	1.8E-13	3.76E-08	(µg/m^3)	3.00E-03	(mg/m^3)	1.3E-08
				PHENANTHRENE	1.09E-07	(mg/m^3)	1.85E-07	(µg/m^3)	NA	per (µg/m^3)	--	1.29E-06	(µg/m^3)	NA	(mg/m^3)	--
				PYRENE	7.65E-08	(mg/m^3)	1.30E-07	(µg/m^3)	NA	per (µg/m^3)	--	9.08E-07	(µg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**2.3E-10**					**1.3E-08**
		Exposure Point Total									**2.3E-10**					**1.3E-08**
	Exposure Medium Total										**2.3E-10**					**1.3E-08**
Soil Total											**7.4E-05**					**8.3E-03**
										Total of Receptor Risks Across All Media	**7E-05**				Total of Receptor Hazards Across All Media	**8E-03**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see U.S. EPA 2004 guidance and Table 8.
2) Inhalation Hazard Quotient = EC (µg/m^3) / Toxicity Value (mg/m^3) x 1,000 µg/mg [U.S. EPA RAGS Part F, Inhalation Guidance (2009)]
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration
PAH = Polycyclic Aromatic Hydrocarbon
NA = Not Applicable
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram-day
mg/m^3 = milligrams per cubic meter
µg/m^3 = micrograms per cubic meter

TABLE 12

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, FUDS BOUNDARY

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	FUDS Boundary	Ingestion	**PAHs**												
				ACENAPHTHENE	7.43E+00	(mg/kg)	2.66E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	4.66E-07	(mg/kg-day)	6.00E-02	(mg/kg-day)	7.8E-06
				ACENAPHTHYLENE	1.58E-01	(mg/kg)	5.66E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	9.91E-09	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.7E-07
				ANTHRACENE	1.00E+02	(mg/kg)	3.58E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	6.27E-06	(mg/kg-day)	3.00E-01	(mg/kg-day)	2.1E-05
				BENZ(A)ANTHRACENE	1.53E+02	(mg/kg)	1.64E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.2E-06	9.57E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	6.30E+01	(mg/kg)	6.77E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.9E-07	3.95E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	6.25E+01	(mg/kg)	2.24E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.92E-06	(mg/kg-day)	3.00E-02	(mg/kg-day)	1.3E-04
				BENZO(K)FLUORANTHENE	6.30E+01	(mg/kg)	6.78E-07	(mg/kg-day)	7.30E-02	per (mg/kg-day)	4.9E-08	3.95E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.24E+02	(mg/kg)	1.33E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	9.7E-06	7.76E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	8.52E+01	(mg/kg)	9.15E-07	(mg/kg-day)	7.30E-03	per (mg/kg-day)	6.7E-09	5.34E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.52E+00	(mg/kg)	7.00E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	5.1E-07	4.09E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	2.21E+02	(mg/kg)	7.90E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.38E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	3.5E-04
				FLUORENE	5.95E+01	(mg/kg)	2.13E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.73E-06	(mg/kg-day)	4.00E-02	(mg/kg-day)	9.3E-05
				INDENO(1,2,3-C,D)PYRENE	5.23E+01	(mg/kg)	5.62E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.1E-07	3.28E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.61E+01	(mg/kg)	5.77E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.01E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.5E-04
				NAPHTHALENE	4.57E+00	(mg/kg)	1.64E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.86E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	1.4E-05
				PHENANTHRENE	1.96E+02	(mg/kg)	7.03E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.23E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	4.1E-05
				PYRENE	1.51E+02	(mg/kg)	5.41E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	9.47E-06	(mg/kg-day)	3.00E-02	(mg/kg-day)	3.2E-04
			Exp. Route Total								**1.2E-05**					**1.2E-03**
			Dermal[1]	**PAHs**												
				ACENAPHTHENE	7.43E+00	(mg/kg)	1.43E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.51E-07	(mg/kg-day)	6.00E-02	(mg/kg-day)	4.2E-06
				ACENAPHTHYLENE	1.58E-01	(mg/kg)	3.05E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	5.34E-09	(mg/kg-day)	6.00E-02	(mg/kg-day)	8.9E-08
				ANTHRACENE	1.00E+02	(mg/kg)	5.79E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.38E-06	(mg/kg-day)	3.00E-01	(mg/kg-day)	1.1E-05
				BENZ(A)ANTHRACENE	1.53E+02	(mg/kg)	8.84E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	6.5E-07	5.16E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	6.30E+01	(mg/kg)	3.65E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.7E-07	2.13E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	6.25E+01	(mg/kg)	3.62E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.11E-06	(mg/kg-day)	3.00E-02	(mg/kg-day)	7.0E-05
				BENZO(K)FLUORANTHENE	6.30E+01	(mg/kg)	3.65E-07	(mg/kg-day)	7.30E-02	per (mg/kg-day)	2.7E-08	2.13E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.24E+02	(mg/kg)	7.17E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	5.2E-06	4.18E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	8.52E+01	(mg/kg)	4.93E-07	(mg/kg-day)	7.30E-03	per (mg/kg-day)	3.6E-09	2.88E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	6.52E+00	(mg/kg)	3.77E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.8E-07	2.20E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	2.21E+02	(mg/kg)	4.26E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	7.45E-06	(mg/kg-day)	4.00E-02	(mg/kg-day)	1.9E-04
				FLUORENE	5.95E+01	(mg/kg)	1.15E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.01E-06	(mg/kg-day)	4.00E-02	(mg/kg-day)	5.0E-05
				INDENO(1,2,3-C,D)PYRENE	5.23E+01	(mg/kg)	3.03E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.2E-07	1.77E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.61E+01	(mg/kg)	3.11E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	5.44E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.4E-04
				NAPHTHALENE	4.57E+00	(mg/kg)	8.82E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	1.54E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	7.7E-06
				PHENANTHRENE	1.96E+02	(mg/kg)	3.79E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	6.63E-06	(mg/kg-day)	3.00E-01	(mg/kg-day)	2.2E-05
				PYRENE	1.51E+02	(mg/kg)	2.92E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	5.10E-06	(mg/kg-day)	3.00E-02	(mg/kg-day)	1.7E-04
			Exp. Route Total								**6.7E-06**					**6.6E-04**
		Exposure Point Total									**1.9E-05**					**1.9E-03**
	Exposure Medium Total										**1.9E-05**					**1.9E-03**

TABLE 12

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, FUDS BOUNDARY

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Inside Fence	Inhalation	**PAHs**												
				ACENAPHTHENE	5.46E-09	(mg/m^3)	1.85E-09	(µg/m^3)	NA	per (µg/m^3)	--	3.24E-08	(µg/m^3)	NA	(mg/m^3)	--
				ACENAPHTHYLENE	1.16E-10	(mg/m^3)	3.94E-11	(µg/m^3)	NA	per (µg/m^3)	--	6.90E-10	(µg/m^3)	NA	(mg/m^3)	--
				ANTHRACENE	7.35E-08	(mg/m^3)	2.49E-08	(µg/m^3)	NA	per (µg/m^3)	--	4.36E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZ(A)ANTHRACENE	1.12E-07	(mg/m^3)	1.14E-07	(µg/m^3)	1.10E-04	per (µg/m^3)	1.3E-11	6.66E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	4.63E-08	(mg/m^3)	4.71E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	5.2E-12	2.75E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(G,H,I)PERYLENE	4.59E-08	(mg/m^3)	1.56E-08	(µg/m^3)	NA	per (µg/m^3)	--	2.73E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(K)FLUORANTHENE	4.63E-08	(mg/m^3)	4.72E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	5.2E-12	2.75E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	9.10E-08	(mg/m^3)	9.26E-08	(µg/m^3)	1.10E-03	per (µg/m^3)	1.0E-10	5.40E-07	(µg/m^3)	NA	(mg/m^3)	--
				CHRYSENE	6.26E-08	(mg/m^3)	6.37E-08	(µg/m^3)	1.10E-05	per (µg/m^3)	7.0E-13	3.72E-07	(µg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	4.79E-09	(mg/m^3)	4.87E-09	(µg/m^3)	1.10E-03	per (µg/m^3)	5.4E-12	2.84E-08	(µg/m^3)	NA	(mg/m^3)	--
				FLUORANTHENE	1.62E-07	(mg/m^3)	5.50E-08	(µg/m^3)	NA	per (µg/m^3)	--	9.62E-07	(µg/m^3)	NA	(mg/m^3)	--
				FLUORENE	4.38E-08	(mg/m^3)	1.49E-08	(µg/m^3)	NA	per (µg/m^3)	--	2.60E-07	(µg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	3.85E-08	(mg/m^3)	3.91E-08	(µg/m^3)	1.10E-04	per (µg/m^3)	4.3E-12	2.28E-07	(µg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.18E-08	(mg/m^3)	4.02E-09	(µg/m^3)	NA	per (µg/m^3)	--	7.03E-08	(µg/m^3)	NA	(mg/m^3)	--
				NAPHTHALENE	3.36E-09	(mg/m^3)	1.14E-09	(µg/m^3)	3.40E-05	per (µg/m^3)	3.9E-14	1.99E-08	(µg/m^3)	3.00E-03	(mg/m^3)	6.6E-09
				PHENANTHRENE	1.44E-07	(mg/m^3)	4.89E-08	(µg/m^3)	NA	per (µg/m^3)	--	8.56E-07	(µg/m^3)	NA	(mg/m^3)	--
				PYRENE	1.11E-07	(mg/m^3)	3.77E-08	(µg/m^3)	NA	per (µg/m^3)	--	6.59E-07	(µg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**1.4E-10**					**6.6E-09**
		Exposure Point Total									**1.4E-10**					**6.6E-09**
	Exposure Medium Total										**1.4E-10**					**6.6E-09**
Soil Total											**1.9E-05**					**1.9E-03**
										Total of Receptor Risks Across All Media	**2E-05**				Total of Receptor Hazards Across All Media	**2E-03**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see U.S. EPA 2004 guidance and Table 8.
2) Inhalation Hazard Quotient = EC (µg/m^3) / Toxicity Value (mg/m^3) x 1,000 µg/mg [U.S. EPA RAGS Part F, Inhalation Guidance (2009)]
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration
PAH = Polycyclic Aromatic Hydrocarbon
NA = Not applicable
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram-day
mg/m^3 = milligrams per cubic meter
µg/m^3 = micrograms per cubic meter

TABLE 13

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	Recreational Fields	Ingestion	**PAHs**												
				ACENAPHTHENE	2.99E+01	(mg/kg)	2.51E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	7.02E-06	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.2E-04
				ACENAPHTHYLENE	3.16E-01	(mg/kg)	2.65E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	7.42E-08	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.2E-06
				ANTHRACENE	9.82E+01	(mg/kg)	8.24E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.31E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	7.7E-05
				BENZ(A)ANTHRACENE	3.29E+01	(mg/kg)	2.76E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.0E-08	7.73E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	1.19E+01	(mg/kg)	9.98E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.3E-09	2.79E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	9.58E+01	(mg/kg)	8.03E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.25E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	7.5E-04
				BENZO(K)FLUORANTHENE	8.85E+00	(mg/kg)	7.42E-09	(mg/kg-day)	7.30E-02	per (mg/kg-day)	5.4E-10	2.08E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	2.46E+01	(mg/kg)	2.06E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.5E-07	5.78E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	1.48E+01	(mg/kg)	1.24E-08	(mg/kg-day)	7.30E-03	per (mg/kg-day)	9.1E-11	3.48E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	2.34E+01	(mg/kg)	1.96E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.4E-07	5.50E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	1.41E+02	(mg/kg)	1.18E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.31E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	8.3E-04
				FLUORENE	8.44E+01	(mg/kg)	7.08E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.98E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	5.0E-04
				INDENO(1,2,3-C,D)PYRENE	1.17E+01	(mg/kg)	9.81E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.2E-09	2.75E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.95E+01	(mg/kg)	1.64E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	4.58E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.1E-03
				NAPHTHALENE	4.31E+00	(mg/kg)	3.61E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	1.01E-06	(mg/kg-day)	2.00E-02	(mg/kg-day)	5.1E-05
				PHENANTHRENE	1.48E+02	(mg/kg)	1.24E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	3.48E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	1.2E-04
				PYRENE	1.04E+02	(mg/kg)	8.72E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.44E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	8.1E-04
			Exp. Route Total								**3.3E-07**					**4.4E-03**
			Dermal[1]	**PAHs**												
				ACENAPHTHENE	2.99E+01	(mg/kg)	2.15E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	6.02E-06	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.0E-04
				ACENAPHTHYLENE	3.16E-01	(mg/kg)	2.27E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	6.37E-08	(mg/kg-day)	6.00E-02	(mg/kg-day)	1.1E-06
				ANTHRACENE	9.82E+01	(mg/kg)	7.07E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.98E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	6.6E-05
				BENZ(A)ANTHRACENE	3.29E+01	(mg/kg)	2.37E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.7E-08	6.63E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	1.19E+01	(mg/kg)	8.56E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	6.3E-09	2.40E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(G,H,I)PERYLENE	9.58E+01	(mg/kg)	6.89E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.93E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	6.4E-04
				BENZO(K)FLUORANTHENE	8.85E+00	(mg/kg)	6.37E-09	(mg/kg-day)	7.30E-02	per (mg/kg-day)	4.6E-10	1.78E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	2.46E+01	(mg/kg)	1.77E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.3E-07	4.96E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CHRYSENE	1.48E+01	(mg/kg)	1.07E-08	(mg/kg-day)	7.30E-03	per (mg/kg-day)	7.8E-11	2.98E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	2.34E+01	(mg/kg)	1.68E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.2E-07	4.71E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				FLUORANTHENE	1.41E+02	(mg/kg)	1.01E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.84E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	7.1E-04
				FLUORENE	8.44E+01	(mg/kg)	6.07E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.70E-05	(mg/kg-day)	4.00E-02	(mg/kg-day)	4.3E-04
				INDENO(1,2,3-C,D)PYRENE	1.17E+01	(mg/kg)	8.42E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	6.1E-09	2.36E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.95E+01	(mg/kg)	1.40E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	3.93E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	9.8E-04
				NAPHTHALENE	4.31E+00	(mg/kg)	3.10E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	8.68E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	4.3E-05
				PHENANTHRENE	1.48E+02	(mg/kg)	1.07E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.98E-05	(mg/kg-day)	3.00E-01	(mg/kg-day)	9.9E-05
				PYRENE	1.04E+02	(mg/kg)	7.48E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.10E-05	(mg/kg-day)	3.00E-02	(mg/kg-day)	7.0E-04
			Exp. Route Total								**2.8E-07**					**3.8E-03**
		Exposure Point Total									**6.1E-07**					**8.2E-03**
	Exposure Medium Total										**6.1E-07**					**8.2E-03**

TABLE 13

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient[2]
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Recreational Fields	Inhalation	**PAHs**												
				ACENAPHTHENE	2.20E-08	(mg/m^3)	4.30E-09	(µg/m^3)	NA	per (µg/m^3)	--	1.20E-06	(µg/m^3)	NA	(mg/m^3)	--
				ACENAPHTHYLENE	2.32E-10	(mg/m^3)	4.55E-11	(µg/m^3)	NA	per (µg/m^3)	--	1.27E-08	(µg/m^3)	NA	(mg/m^3)	--
				ANTHRACENE	7.22E-08	(mg/m^3)	1.41E-08	(µg/m^3)	NA	per (µg/m^3)	--	3.96E-06	(µg/m^3)	NA	(mg/m^3)	--
				BENZ(A)ANTHRACENE	2.42E-08	(mg/m^3)	4.73E-09	(µg/m^3)	1.10E-04	per (µg/m^3)	5.2E-13	1.33E-06	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(B)FLUORANTHENE	8.75E-09	(mg/m^3)	1.71E-09	(µg/m^3)	1.10E-04	per (µg/m^3)	1.9E-13	4.79E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(G,H,I)PERYLENE	7.04E-08	(mg/m^3)	1.38E-08	(µg/m^3)	NA	per (µg/m^3)	--	3.86E-06	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(K)FLUORANTHENE	6.51E-09	(mg/m^3)	1.27E-09	(µg/m^3)	1.10E-04	per (µg/m^3)	1.4E-13	3.57E-07	(µg/m^3)	NA	(mg/m^3)	--
				BENZO(A)PYRENE	1.81E-08	(mg/m^3)	3.54E-09	(µg/m^3)	1.10E-03	per (µg/m^3)	3.9E-12	9.91E-07	(µg/m^3)	NA	(mg/m^3)	--
				CHRYSENE	1.09E-08	(mg/m^3)	2.13E-09	(µg/m^3)	1.10E-05	per (µg/m^3)	2.3E-14	5.96E-07	(µg/m^3)	NA	(mg/m^3)	--
				DIBENZ(A,H)ANTHRACENE	1.72E-08	(mg/m^3)	3.37E-09	(µg/m^3)	1.10E-03	per (µg/m^3)	3.7E-12	9.43E-07	(µg/m^3)	NA	(mg/m^3)	--
				FLUORANTHENE	1.04E-07	(mg/m^3)	2.03E-08	(µg/m^3)	NA	per (µg/m^3)	--	5.68E-06	(µg/m^3)	NA	(mg/m^3)	--
				FLUORENE	6.21E-08	(mg/m^3)	1.21E-08	(µg/m^3)	NA	per (µg/m^3)	--	3.40E-06	(µg/m^3)	NA	(mg/m^3)	--
				INDENO(1,2,3-C,D)PYRENE	8.60E-09	(mg/m^3)	1.68E-09	(µg/m^3)	1.10E-04	per (µg/m^3)	1.9E-13	4.71E-07	(µg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.43E-08	(mg/m^3)	2.81E-09	(µg/m^3)	NA	per (µg/m^3)	--	7.86E-07	(µg/m^3)	NA	(mg/m^3)	--
				NAPHTHALENE	3.17E-09	(mg/m^3)	6.20E-10	(µg/m^3)	3.40E-05	per (µg/m^3)	2.1E-14	1.74E-07	(µg/m^3)	3.00E-03	(mg/m^3)	5.8E-08
				PHENANTHRENE	1.09E-07	(mg/m^3)	2.13E-08	(µg/m^3)	NA	per (µg/m^3)	--	5.96E-06	(µg/m^3)	NA	(mg/m^3)	--
				PYRENE	7.65E-08	(mg/m^3)	1.50E-08	(µg/m^3)	NA	per (µg/m^3)	--	4.19E-06	(µg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**8.7E-12**					**5.8E-08**
		Exposure Point Total									**8.7E-12**					**5.8E-08**
	Exposure Medium Total										**8.7E-12**					**5.8E-08**
Soil Total											**6.1E-07**					**8.2E-03**
										Total of Receptor Risks Across All Media	**6E-07**				Total of Receptor Hazards Across All Media	**8E-03**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see U.S. EPA 2004 guidance and Table 8.
2) Inhalation Hazard Quotient = EC (µg/m^3) / Toxicity Value (mg/m^3) x 1,000 µg/mg [U.S. EPA RAGS Part F, Inhalation Guidance (2009)]
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration
PAH = Polycyclic Aromatic Hydrocarbon
NA = Not Applicable
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram-day
mg/m^3 = milligrams per cubic meter
µg/m^3 = micrograms per cubic meter

TABLE 14

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SURFACE SOIL - RECREATIONAL USER

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	1.36E+09
Air Concentration	Cair = Csoil/PEF	m^3/kg

Model Constants:				
	Q/C	9.38E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square, U.S. EPA 2011b
	V	5.00E-01	unitless	Default, U.S. EPA 2011b
	Um	4.69E+00	m/s	Mean annual wind speed, U.S. EPA 2011b
	Ut	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, U.S. EPA 2011b
	F(x)	1.94E-01	unitless	Default, U.S. EPA 2011b

Reference for the model: U.S. EPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA 1996.

Chemical	**Csoil, Surface Soil**	**Cair, Surface Soil Particulate**
	RME EPC	RME EPC
	mg/kg	mg/m^3
PAHs		
ACENAPHTHENE	2.99E+01	2.20E-08
ACENAPHTHYLENE	3.16E-01	2.32E-10
ANTHRACENE	9.82E+01	7.22E-08
BENZ(A)ANTHRACENE	3.29E+01	2.42E-08
BENZO(B)FLUORANTHENE	1.19E+01	8.75E-09
BENZO(G,H,I)PERYLENE	9.58E+01	7.04E-08
BENZO(K)FLUORANTHENE	8.85E+00	6.51E-09
BENZO(A)PYRENE	2.46E+01	1.81E-08
CHRYSENE	1.48E+01	1.09E-08
DIBENZ(A,H)ANTHRACENE	2.34E+01	1.72E-08
FLUORANTHENE	1.41E+02	1.04E-07
FLUORENE	8.44E+01	6.21E-08
INDENO(1,2,3-C,D)PYRENE	1.17E+01	8.60E-09
2-METHYLNAPHTHALENE	1.95E+01	1.43E-08
NAPHTHALENE	4.31E+00	3.17E-09
PHENANTHRENE	1.48E+02	1.09E-07
PYRENE	1.04E+02	7.65E-08

PAH = Polycyclic Aromatic Hydrocarbon

U.S. EPA = United States Environmental Protection Agency

RME = Reasonable maximum exposure

EPC = Exposure point concentration

m^3/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

mg/m^3 = milligrams per cubic meter

m/s = meters per second

g/m^2 -s per kg/m^3 = grams per square meter-second per kilogram per cubic meter

TABLE 15

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SURFACE SOIL - ADOLESCENT TRESPASSER

MARSH RUN PARK, FUDS BOUNDARY

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	1.36E+09
Air Concentration	Cair = Csoil/PEF	m^3/kg

Model Constants:

Q/C	9.38E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square, U.S. EPA 2011b
V	5.00E-01	unitless	Default, U.S. EPA 2011b
Um	4.69E+00	m/s	Mean annual wind speed, U.S. EPA 2011b
Ut	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, U.S. EPA 2011b
F(x)	1.94E-01	unitless	Default, U.S. EPA 2011b

Reference for the model: U.S. EPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA 1996.

Constituent of Potential Concern	**Csoil, Surface Soil**	**Cair, Surface Soil Particulate**
	RME EPC	RME EPC
	mg/kg	mg/m^3
PAHs		
ACENAPHTHENE	7.43E+00	5.46E-09
ACENAPHTHYLENE	1.58E-01	1.16E-10
ANTHRACENE	1.00E+02	7.35E-08
BENZ(A)ANTHRACENE	1.53E+02	1.12E-07
BENZO(B)FLUORANTHENE	6.30E+01	4.63E-08
BENZO(G,H,I)PERYLENE	6.25E+01	4.59E-08
BENZO(K)FLUORANTHENE	6.30E+01	4.63E-08
BENZO(A)PYRENE	1.24E+02	9.10E-08
CHRYSENE	8.52E+01	6.26E-08
DIBENZ(A,H)ANTHRACENE	6.52E+00	4.79E-09
FLUORANTHENE	2.21E+02	1.62E-07
FLUORENE	5.95E+01	4.38E-08
INDENO(1,2,3-C,D)PYRENE	5.23E+01	3.85E-08
2-METHYLNAPHTHALENE	1.61E+01	1.18E-08
NAPHTHALENE	4.57E+00	3.36E-09
PHENANTHRENE	1.96E+02	1.44E-07
PYRENE	1.51E+02	1.11E-07

PAH = Polycyclic Aromatic Hydrocarbon

RME = Reasonable maximum exposure

EPC = Exposure point concentration

m^3/kg = cubic meters per kilogram

m/s = meters per second

mg/kg = milligrams per kilogram

mg/m^3 = milligrams per cubic meters

g/m^2-s per kg/m^3 = grams per square meter-second per kilogram per cubic meter

TABLE 16

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SURFACE SOIL - CONSTRUCTION WORKER

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	1.36E+09
Air Concentration	Cair = Csoil/PEF	m^3/kg

Model Constants:

Q/C	9.38E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square, U.S. EPA 2011b
V	5.00E-01	unitless	Default, U.S. EPA 2011b
Um	4.69E+00	m/s	Mean annual wind speed, U.S. EPA 2011b
Ut	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, U.S. EPA 2011b
F(x)	1.94E-01	unitless	Default, U.S. EPA 2011b

Reference for the model: U.S. EPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA 1996.

Chemical	**Csoil, Surface Soil**	**Cair, Surface Soil Particulate**
	RME EPC	RME EPC
	mg/kg	mg/m^3
PAHs		
ACENAPHTHENE	2.99E+01	2.20E-08
ACENAPHTHYLENE	3.16E-01	2.32E-10
ANTHRACENE	9.82E+01	7.22E-08
BENZ(A)ANTHRACENE	3.29E+01	2.42E-08
BENZO(B)FLUORANTHENE	1.19E+01	8.75E-09
BENZO(G,H,I)PERYLENE	9.58E+01	7.04E-08
BENZO(K)FLUORANTHENE	8.85E+00	6.51E-09
BENZO(A)PYRENE	2.46E+01	1.81E-08
CHRYSENE	1.48E+01	1.09E-08
DIBENZ(A,H)ANTHRACENE	2.34E+01	1.72E-08
FLUORANTHENE	1.41E+02	1.04E-07
FLUORENE	8.44E+01	6.21E-08
INDENO(1,2,3-C,D)PYRENE	1.17E+01	8.60E-09
2-METHYLNAPHTHALENE	1.95E+01	1.43E-08
NAPHTHALENE	4.31E+00	3.17E-09
PHENANTHRENE	1.48E+02	1.09E-07
PYRENE	1.04E+02	7.65E-08

PAH = Polycyclic Aromatic Hydrocarbon

U.S. EPA = United States Environmental Protection Agency

RME = Reasonable maximum exposure

EPC = Exposure point concentration

m^3/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

mg/m^3 = milligrams per cubic meter

m/s = meters per second

g/m^2 -s per kg/m^3 = grams per square meter-second per kilogram per cubic meter

TABLE 17
SUMMARY OF RESIDENT CHILD LEAD MODELING
MARSH RUN PARK, RECREATIONAL AREA
MIFFLIN AVENUE, NEW CUMBERLAND, PA

IEUBK MODEL SUMMARY					
Medium	Mean Concentration	Units	Mean (µg/dL)	% Below[1]	% Above[1]
Surface Soil	138	mg/kg	2.16	99.944	0.056

(1) Compared to the blood-level threshold of 10 µg/dL. Exceeds threshold if % Above is greater than 5.
mg/kg = milligrams per kilogram
µg/dL = micrograms per deciliter
IEUBK = Integrated Exposure Uptake Biokinetic Model

TABLE 18
ADULT LEAD MODEL FOR SURFACE SOIL
MARSH RUN PARK
MIFFLIN AVENUE, NEW CUMBERLAND, PENNSYLVANIA

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004
PbS	Soil lead concentration	µg/g or ppm	138
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	1.0
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**µg/dL**	**1.2**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	**µg/dL**	**2.8**
PbB_t	Target PbB level of concern (e.g., 10 µg/dL)	**µg/dL**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.008%**

ppm = parts per million
µg/g = micrograms per gram
µg/dL per µg/day = micrograms per deciliter per micrograms per day
g/day = grams per day
days/yr = days per year
µg/dL = micrograms per day
NHANES = National Health and Nutrition Examination Survey

TABLE 19

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	Recreational Fields	**PAHs**					**PAHs**					
			ACENAPHTHENE	--	--	--	NA	ACENAPHTHENE	Liver	1.6E-04	6.2E-05	--	2.2E-04
			ACENAPHTHYLENE	--	--	--	NA	ACENAPHTHYLENE	NA	1.7E-06	6.6E-07	--	2.3E-06
			ANTHRACENE	--	--	--	NA	ANTHRACENE	None	1.0E-04	4.1E-05	--	1.4E-04
			BENZ(A)ANTHRACENE	3.3E-06	1.3E-06	1.4E-11	4.5E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	1.2E-06	4.7E-07	4.9E-12	1.6E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(G,H,I)PERYLENE	--	--	--	NA	BENZO(G,H,I)PERYLENE	Kidneys	1.0E-03	4.0E-04	--	1.4E-03
			BENZO(K)FLUORANTHENE	8.8E-08	3.5E-08	3.6E-12	1.2E-07	BENZO(K)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	2.4E-05	9.6E-06	1.0E-10	3.4E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			CHRYSENE	1.5E-08	5.8E-09	6.1E-13	2.0E-08	CHRYSENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	2.3E-05	9.2E-06	9.6E-11	3.2E-05	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			FLUORANTHENE	--	--	--	NA	FLUORANTHENE	Liver	1.1E-03	4.4E-04	--	1.6E-03
			FLUORENE	--	--	--	NA	FLUORENE	Blood	6.7E-04	2.6E-04	--	9.3E-04
			INDENO(1,2,3-C,D)PYRENE	1.2E-06	4.6E-07	4.8E-12	1.6E-06	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	1.5E-03	6.1E-04	--	2.2E-03
			NAPHTHALENE	--	--	1.8E-13	1.8E-13	NAPHTHALENE	Body Weight	6.8E-05	2.7E-05	1.3E-08	9.5E-05
			PHENANTHRENE	--	--	--	NA	PHENANTHRENE	None	1.6E-04	6.2E-05	--	2.2E-04
			PYRENE	--	--	--	NA	PYRENE	Kidneys	1.1E-03	4.3E-04	--	1.5E-03
			(Total)	5.3E-05	2.1E-05	2.3E-10	7.4E-05		(Total)	5.9E-03	2.3E-03	1.3E-08	8.3E-03
					Total Risk Across Surface Soil		**7.4E-05**				**Total Hazard Index Across Surface Soil**		**8.3E-03**
						Total Risk Across All Media and All Exposure Routes	**7E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.008**

PAH = Polycyclic Aromatic Hydrocarbon
NA = Not applicable

TABLE 20

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, FUDS BOUNDARY

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	FUDS Boundary	**PAHs**					**PAHs**					
			ACENAPHTHENE	--	--	--	NA	ACENAPHTHENE	Liver	7.8E-06	4.2E-06	--	1.2E-05
			ACENAPHTHYLENE	--	--	--	NA	ACENAPHTHYLENE	NA	1.7E-07	8.9E-08	--	2.5E-07
			ANTHRACENE	--	--	--	NA	ANTHRACENE	None	2.1E-05	1.1E-05	--	3.2E-05
			BENZ(A)ANTHRACENE	1.2E-06	6.5E-07	1.3E-11	1.8E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	4.9E-07	2.7E-07	5.2E-12	7.6E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(G,H,I)PERYLENE	--	--	--	NA	BENZO(G,H,I)PERYLENE	Kidneys	1.3E-04	7.0E-05	--	2.0E-04
			BENZO(K)FLUORANTHENE	4.9E-08	2.7E-08	5.2E-12	7.6E-08	BENZO(K)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	9.7E-06	5.2E-06	1.0E-10	1.5E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			CHRYSENE	6.7E-09	3.6E-09	7.0E-13	1.0E-08	CHRYSENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	5.1E-07	2.8E-07	5.4E-12	7.9E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			FLUORANTHENE	--	--	--	NA	FLUORANTHENE	Liver	3.5E-04	1.9E-04	--	5.3E-04
			FLUORENE	--	--	--	NA	FLUORENE	Blood	9.3E-05	5.0E-05	--	1.4E-04
			INDENO(1,2,3-C,D)PYRENE	4.1E-07	2.2E-07	4.3E-12	6.3E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	2.5E-04	1.4E-04	--	3.9E-04
			NAPHTHALENE	--	--	3.9E-14	3.9E-14	NAPHTHALENE	Body Weight	1.4E-05	7.7E-06	6.6E-09	2.2E-05
			PHENANTHRENE	--	--	--	NA	PHENANTHRENE	None	4.1E-05	2.2E-05	--	6.3E-05
			PYRENE	--	--	--	NA	PYRENE	Kidneys	3.2E-04	1.7E-04	--	4.9E-04
			(Total)	1.2E-05	6.7E-06	1.4E-10	1.9E-05		(Total)	1.2E-03	6.6E-04	6.6E-09	1.9E-03
					Total Risk Across Surface Soil		**1.9E-05**				**Total Hazard Index Across Surface Soil**		**1.9E-03**
						Total Risk Across All Media and All Exposure Routes	**2E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.002**

PAH = Polycyclci Aromatic Hydrocarbon

NA = Not applicable

TABLE 21

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

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

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	Recreational Fields	**PAHs**					**PAHs**					
			ACENAPHTHENE	--	--	--	NA	ACENAPHTHENE	Liver	1.2E-04	1.0E-04	--	2.2E-04
			ACENAPHTHYLENE	--	--	--	NA	ACENAPHTHYLENE	NA	1.2E-06	1.1E-06	--	2.3E-06
			ANTHRACENE	--	--	--	NA	ANTHRACENE	None	7.7E-05	6.6E-05	--	1.4E-04
			BENZ(A)ANTHRACENE	2.0E-08	1.7E-08	5.2E-13	3.7E-08	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	7.3E-09	6.3E-09	1.9E-13	1.4E-08	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(G,H,I)PERYLENE	--	--	--	NA	BENZO(G,H,I)PERYLENE	Kidneys	7.5E-04	6.4E-04	--	1.4E-03
			BENZO(K)FLUORANTHENE	5.4E-10	4.6E-10	1.4E-13	1.0E-09	BENZO(K)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	1.5E-07	1.3E-07	3.9E-12	2.8E-07	BENZO(A)PYRENE	NA	--	--	--	NA
			CHRYSENE	9.1E-11	7.8E-11	2.3E-14	1.7E-10	CHRYSENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	1.4E-07	1.2E-07	3.7E-12	2.7E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			FLUORANTHENE	--	--	--	NA	FLUORANTHENE	Liver	8.3E-04	7.1E-04	--	1.5E-03
			FLUORENE	--	--	--	NA	FLUORENE	Blood	5.0E-04	4.3E-04	--	9.2E-04
			INDENO(1,2,3-C,D)PYRENE	7.2E-09	6.1E-09	1.9E-13	1.3E-08	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	1.1E-03	9.8E-04	--	2.1E-03
			NAPHTHALENE	--	--	2.1E-14	2.1E-14	NAPHTHALENE	Body Weight	5.1E-05	4.3E-05	5.8E-08	9.4E-05
			PHENANTHRENE	--	--	--	NA	PHENANTHRENE	None	1.2E-04	9.9E-05	--	2.2E-04
			PYRENE	--	--	--	NA	PYRENE	Kidneys	8.1E-04	7.0E-04	--	1.5E-03
			(Total)	3.3E-07	2.8E-07	8.7E-12	6.1E-07		(Total)	4.4E-03	3.8E-03	5.8E-08	8.2E-03
					Total Risk Across Surface Soil		**6.1E-07**				**Total Hazard Index Across Surface Soil**		**8.2E-03**
						Total Risk Across All Media and All Exposure Routes	**6E-07**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.008**

PAH = Polycyclic Aromatic Hydrocarbon

NA = Not applicable

TABLE 22

SIGNIFICANT CONTRIBUTORS TO RISK

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	Recreational Fields	**PAHs**					**PAHs**					
			BENZ(A)ANTHRACENE	3.3E-06	1.3E-06	1.4E-11	4.5E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	1.2E-06	4.7E-07	4.9E-12	1.6E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	2.4E-05	9.6E-06	1.0E-10	3.4E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	2.3E-05	9.2E-06	9.6E-11	3.2E-05	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	1.2E-06	4.6E-07	4.8E-12	1.6E-06	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total)	5.3E-05	2.1E-05	2.2E-10	7.4E-05		(Total)	---	---	---	---
					Total Risk Across Surface Soil		**7.4E-05**			**Total Hazard Index Across Surface Soil**			**---**
						Total Risk Across All Media and All Exposure Routes	**7E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**0**

PAH = Polycyclic Aromatic Hydrocarbon

NA = Not applicable

TABLE 23

SIGNIFICANT CONTRIBUTORS TO RISK

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, FUDS BOUNDARY

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	FUDS Boundary	**PAHs**					**PAHs**					
			BENZ(A)ANTHRACENE	1.2E-06	6.5E-07	1.3E-11	1.8E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(A)PYRENE	9.7E-06	5.2E-06	1.0E-10	1.5E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			(Total)	1.1E-05	5.9E-06	1.1E-10	1.7E-05		(Total)	---	---	---	---
					Total Risk Across Surface Soil		**1.7E-05**					**Total Hazard Index Across Surface Soil**	---
						Total Risk Across All Media and All Exposure Routes	**2E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**0**

NA = Not applicable

PAH = Polycyclic Aromatic Hydrocarbon

TABLE 24

SIGNIFICANT CONTRIBUTORS TO RISK

REASONABLE MAXIMUM EXPOSURE

MARSH RUN PARK, RECREATIONAL AREA

MIFFLIN AVENUE, NEW CUMBERLAND, PA

Location: Marsh Run Park

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

Medium	Exposure Medium	Exposure Point	Constituent of Potential Concern	Carcinogenic Risk				Constituent of Potential Concern	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
					Total Risk Across Surface Soil		---			**Total Hazard Index Across Surface Soil**			---
				Total Risk Across All Media and All Exposure Routes			---		**Total Hazard Index Across All Media and All Exposure Routes**				---

TABLE 25
RISK RESULTS FOR VOCS IN GROUNDWATER
MARSH RUN PARK, NEW CUMBERLAND, PENNSYLVANIA

Chemical	Maximum Detected Concentration (µg/L)	U.S. EPA Tap Water RSL[1] (µg/L)		Carcinogenic Risk	Non-Carcinogenic Hazard
Data Evaluated in 1990 RI HHRA, On-Site Wells[2]					
Acetone	23	12,000	N	--	0.002
1,1-Dichloroethene	7.3	260	N	--	0.03
1,2-Dichloroethene (total)	67.3	130	N	--	0.5
Ethylbenzene	11.8	1.3	C	9.1.E-06	--
Methylene Chloride	6.8	9.9	C	6.9.E-07	--
1,1,2,2-Tetrachloroethane	39.5	0.066	C	6.0.E-04	--
1,1,2-Trichloroethane	6.3	0.24	C	2.6.E-05	--
Trichloroethene	387.5	0.44	C	8.8.E-04	--
		TOTAL		**2.E-03**	**0.5**
Sample Results from 2004 to 2011, On-Site Wells[2]					
Cis-1,2-Dichloroethene	570	28	N	--	20
Trans-1,2-Dichloroethene	126	86	N	--	1.5
Tetrachloroethene	2.8	9.74	C	2.9.E-07	--
Trichloroethene	434	0.44	C	9.9.E-04	--
Vinyl Chloride	14.9	0.015	C	9.9.E-04	--
		TOTAL		**2.E-03**	**22**
Former Mifflin Avenue Cabin Well					
Trichloroethene	30.1	0.44	C	6.8.E-05	--
		TOTAL		**7.E-05**	**NA**
Mifflin Avenue Deep Well 41-52 (new supply well for Mifflin Avenue Cabin)[3, 4, 5]					
Trichloroethene	2.3	0.44	C	5.2.E-06	--
		TOTAL		**5.E-06**	**NA**
Mifflin Avenue Deep Well 121-132 (sample collected from the 121 to 132 ft bgs at MADW)[4,5]					
Trichloroethene	18	0.44	C	4.1.E-05	--
Cis-1,2-Dichloroethene	0.59	28	N	--	0.02
		TOTAL		**4.E-05**	**0.02**
Mifflin Avenue Deep Well 170-181 (sample collected from the 170 to 181 ft bgs at MADW)[4, 5]					
Cis-1,2-Dichloroethene	9.1	28	N	--	0.3
Trans-1,2-Dichloroethene	4.4	86	N	--	0.05
Tetrachloroethene	3.8	9.74	C	3.9.E-07	--
Trichloroethene	580	0.44	C	1.3.E-03	--
		TOTAL		**1.E-03**	**0.4**
Mifflin Avenue Deep Well 184-195 (sample collected from the 184-195 ft bgs at MADW)[4, 5]					
Cis-1,2-Dichloroethene	7.7	28	N	--	0.3
Trans-1,2-Dichloroethene	3.5	86	N	--	0.04
Tetrachloroethene	1.9	9.74	C	2.0.E-07	--
Trichloroethene	351	0.44	C	8.0.E-04	--
		TOTAL		**8.E-04**	**0.3**

VOCs - Volatile Organic Compounds
RSL - Regional Screening Level
µg/L - micrograms per liter
N - Non-carcinogenic
C - Carcinogenic
NA - Not applicable
MADW - Mifflin Avenue Deep Well
bgs - below ground surface
Notes:

1) Taken from U.S. EPA, April 2012, Regional Screening Levels for Chemical Contaminants at Superfund Sites. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.
2) On-Site Wells includes monitoring wells MW-1, MW-1A, MW-2, MW-2A, MW-3, MW-3A, MW-4, MW-4A, MW-7A, MW-8, MW-8A, MW-9, MW-9A, MW-15, EW-1, EW-2, and EW-3.
3) Mifflin Avenue Deep Well (41-52 foot interval below ground surface) sample results are from 2011.
4) The results for the Mifflin Avenue Cabin well and the Mifflin Avenue Deep Well (all intervals) represent the sampling event
5) The numerical values following the Mifflin Avenue Deep Well name represent the depth range, in feet below ground surface,

APPENDIX A

DATA USED IN RISK ASSESSMENT

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
MW-01	1/1/1989	2-methylnaphthalene	0.52	mg/kg		1.2		CQL
MW-01	1/1/1989	Acenaphthylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Lead	1.8	mg/kg				CQL
MW-01	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Phenanthrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-01	1/1/1989	Pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-02	1/1/1989	2-methylnaphthalene	47	mg/kg		50		CQL
MW-02	1/1/1989	Acenaphthene	117	mg/kg		50		CQL
MW-02	1/1/1989	Anthracene	240	mg/kg		50		CQL
MW-02	1/1/1989	Benzo[a]anthracene	310	mg/kg		50		CQL
MW-02	1/1/1989	Benzo[a]pyrene	220.5	mg/kg		50		CQL
MW-02	1/1/1989	Benzo[b]fluoranthene	218	mg/kg		50		CQL
MW-02	1/1/1989	Benzo[g,h,i]perylene	99	mg/kg		50		CQL
MW-02	1/1/1989	Benzo[k]fluoranthene	153.5	mg/kg		50		CQL
MW-02	1/1/1989	Chrysene	280	mg/kg		50		CQL
MW-02	1/1/1989	Dibenz[a,h]anthracene	41.5	mg/kg		50		CQL
MW-02	1/1/1989	Fluoranthene	690	mg/kg		50		CQL
MW-02	1/1/1989	Fluorene	165.5	mg/kg		50		CQL
MW-02	1/1/1989	Indeno[1,2,3-c,d]pyrene	104.5	mg/kg		50		CQL
MW-02	1/1/1989	Lead	905.5	mg/kg				CQL
MW-02	1/1/1989	Naphthalene	83.5	mg/kg		50		CQL
MW-02	1/1/1989	Phenanthrene	725	mg/kg		50		CQL
MW-02	1/1/1989	Pyrene	500	mg/kg		50		CQL
MW-04	1/1/1989	2-methylnaphthalene	1.1	mg/kg	J	1.2		CQL
MW-04	1/1/1989	Acenaphthylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Fluoranthene	0.27	mg/kg	J	1.2		CQL
MW-04	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Lead	14.6	mg/kg				CQL
MW-04	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04	1/1/1989	Phenanthrene	0.2	mg/kg	J	1.2		CQL
MW-04	1/1/1989	Pyrene	0.21	mg/kg	J	1.2		CQL
MW-04A	1/1/1989	2-methylnaphthalene	1.4	mg/kg		1.2		CQL
MW-04A	1/1/1989	Acenaphthylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Benzo[b]fluoranthene	0.19	mg/kg	J	1.2		CQL
MW-04A	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Fluoranthene	0.24	mg/kg	J	1.2		CQL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
MW-04A	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Lead	13.7	mg/kg				CQL
MW-04A	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-04A	1/1/1989	Phenanthrene	0.16	mg/kg	J	1.2		CQL
MW-04A	1/1/1989	Pyrene	0.2	mg/kg	J	1.2		CQL
MW-05	1/1/1989	2-methylnaphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Acenaphthylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Lead	43.5	mg/kg				CQL
MW-05	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Phenanthrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05	1/1/1989	Pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05A	1/1/1989	2-methylnaphthalene	2.6	mg/kg		1.2		CQL
MW-05A	1/1/1989	Acenaphthylene	0.14	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Anthracene	0.25	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Benzo[a]anthracene	1.6	mg/kg		1.2		CQL
MW-05A	1/1/1989	Benzo[a]pyrene	1.7	mg/kg		1.2		CQL
MW-05A	1/1/1989	Benzo[b]fluoranthene	2.2	mg/kg		1.2		CQL
MW-05A	1/1/1989	Benzo[g,h,i]perylene	1.2	mg/kg		1.2		CQL
MW-05A	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-05A	1/1/1989	Chrysene	2.1	mg/kg		1.2		CQL
MW-05A	1/1/1989	Dibenz[a,h]anthracene	0.42	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Fluoranthene	2.3	mg/kg		1.2		CQL
MW-05A	1/1/1989	Fluorene	0.12	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.98	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Lead	20.1	mg/kg				CQL
MW-05A	1/1/1989	Naphthalene	0.21	mg/kg	J	1.2		CQL
MW-05A	1/1/1989	Phenanthrene	1.6	mg/kg		1.2		CQL
MW-05A	1/1/1989	Pyrene	2.9	mg/kg		1.2		CQL
MW-06	1/1/1989	2-methylnaphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Acenaphthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Benzo[a]anthracene	0.25	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Benzo[a]pyrene	0.24	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Benzo[b]fluoranthene	0.22	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Benzo[g,h,i]perylene	0.14	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Benzo[k]fluoranthene	0.2	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Chrysene	0.27	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Fluoranthene	0.56	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.13	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Lead	26.1	mg/kg				CQL
MW-06	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06	1/1/1989	Phenanthrene	0.33	mg/kg	J	1.2		CQL
MW-06	1/1/1989	Pyrene	0.37	mg/kg	J	1.2		CQL
MW-06A	1/1/1989	2-methylnaphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Acenaphthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
MW-06A	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Lead	15.5	mg/kg				CQL
MW-06A	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Phenanthrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-06A	1/1/1989	Pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	2-methylnaphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Acenaphthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Lead	14.9	mg/kg				CQL
MW-07	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Phenanthrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07	1/1/1989	Pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	2-methylnaphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Acenaphthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Benzo[a]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Benzo[a]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Benzo[b]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Benzo[g,h,i]perylene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Benzo[k]fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Chrysene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Dibenz[a,h]anthracene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Fluoranthene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Fluorene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Indeno[1,2,3-c,d]pyrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Lead	26.7	mg/kg				CQL
MW-07A	1/1/1989	Naphthalene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Phenanthrene	0.6	mg/kg	U	1.2		1/2 CQL
MW-07A	1/1/1989	Pyrene	0.13	mg/kg	J	1.2		CQL
S-01	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Lead	36	mg/kg		1		CRDL
S-01	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-01	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
S-02	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Lead	48	mg/kg		1		CRDL
S-02	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-02	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-03	6/23/1988	2-methylnaphthalene	0.22	mg/kg		0.33		CRDL
S-03	6/23/1988	Acenaphthene	0.92	mg/kg		0.33		CRDL
S-03	6/23/1988	Benzo[b]fluoranthene	8.3	mg/kg		0.33		CRDL
S-03	6/23/1988	Benzo[k]fluoranthene	7.3	mg/kg		0.33		CRDL
S-03	6/23/1988	Chrysene	4.6	mg/kg		0.33		CRDL
S-03	6/23/1988	Fluoranthene	7.3	mg/kg		0.33		CRDL
S-03	6/23/1988	Lead	1080	mg/kg		1		CRDL
S-03	6/23/1988	Naphthalene	0.4	mg/kg		0.33		CRDL
S-03	6/23/1988	Phenanthrene	1.9	mg/kg		0.33		CRDL
S-03	6/23/1988	Pyrene	6.6	mg/kg		0.33		CRDL
S-04	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Lead	32	mg/kg		1		CRDL
S-04	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-04	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Lead	175	mg/kg		1		CRDL
S-05	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-05	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Fluoranthene	0.36	mg/kg		0.33		CRDL
S-06	6/23/1988	Lead	38	mg/kg		1		CRDL
S-06	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-06	6/23/1988	Pyrene	0.32	mg/kg		0.33		CRDL
S-07	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Fluoranthene	1.1	mg/kg		0.33		CRDL
S-07	6/23/1988	Lead	44	mg/kg		1		CRDL
S-07	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-07	6/23/1988	Pyrene	0.79	mg/kg		0.33		CRDL
S-08	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
S-08	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Lead	28	mg/kg		1		CRDL
S-08	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-08	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Lead	35	mg/kg		1		CRDL
S-09	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-09	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Lead	66	mg/kg		1		CRDL
S-10	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-10	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Lead	55	mg/kg		1		CRDL
S-11	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-11	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Lead	68	mg/kg		1		CRDL
S-51	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-51	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Lead	1020	mg/kg		1		CRDL
S-52	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-52	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
S-61	6/23/1988	Lead	68	mg/kg		1		CRDL
S-61	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-61	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Lead	35	mg/kg		1		CRDL
S-62	6/23/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
S-62	6/23/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SB-01	6/2/2011	Acenaphthene	0.0382	mg/kg	U	38.2	23.1	RL=LOD
SB-01	6/2/2011	Acenaphthylene	0.0167	mg/kg	J	312	12.7	RL=LOD
SB-01	6/2/2011	Anthracene	0.0219	mg/kg	J	312	13.9	RL=LOD
SB-01	6/2/2011	Benzo[a]anthracene	0.0774	mg/kg	J	312	20.8	RL=LOD
SB-01	6/2/2011	Benzo[a]pyrene	0.071	mg/kg	J	312	9.2	RL=LOD
SB-01	6/2/2011	Benzo[b]fluoranthene	0.0724	mg/kg	J	312	16.2	RL=LOD
SB-01	6/2/2011	Benzo[k]fluoranthene	0.0709	mg/kg	J	312	15	RL=LOD
SB-01	6/2/2011	Chrysene	0.0928	mg/kg	J	312	10.4	RL=LOD
SB-01	6/2/2011	Dibenz[a,h]anthracene	0.0382	mg/kg	U	38.2	32.4	RL=LOD
SB-01	6/2/2011	Fluoranthene	0.0155	mg/kg	J	312	12.7	RL=LOD
SB-01	6/2/2011	Fluorene	0.0382	mg/kg	U	38.2	10.8	RL=LOD
SB-01	6/2/2011	Indeno[1,2,3-c,d]pyrene	0.0463	mg/kg	J	312	9.2	RL=LOD
SB-01	6/2/2011	Naphthalene	0.0382	mg/kg	U	38.2	20.8	RL=LOD
SB-01	6/2/2011	Phenanthrene	0.102	mg/kg	J	312	15	RL=LOD
SB-01	6/2/2011	Pyrene	0.162	mg/kg	J	312	11.6	RL=LOD
SB-02	6/2/2011	Lead	95.1	mg/kg	K	2.2	0.73	RL=LOD
SB-03	6/2/2011	Acenaphthene	5.455	mg/kg		308	22.8	RL=LOD
SB-03	6/2/2011	Acenaphthylene	0.392	mg/kg	J	308	12.6	RL=LOD
SB-03	6/2/2011	Anthracene	15.45	mg/kg		6160	274	RL=LOD
SB-03	6/2/2011	Benzo[a]anthracene	29.6	mg/kg		6160	411	RL=LOD
SB-03	6/2/2011	Benzo[a]pyrene	24.6	mg/kg		6160	183	RL=LOD
SB-03	6/2/2011	Benzo[b]fluoranthene	25.25	mg/kg		6160	319	RL=LOD
SB-03	6/2/2011	Benzo[k]fluoranthene	22.75	mg/kg		6160	297	RL=LOD
SB-03	6/2/2011	Chrysene	28.55	mg/kg		6160	205	RL=LOD
SB-03	6/2/2011	Dibenz[a,h]anthracene	6.46	mg/kg		6160	639	RL=LOD
SB-03	6/2/2011	Fluoranthene	61.15	mg/kg		6160	251	RL=LOD
SB-03	6/2/2011	Fluorene	8.005	mg/kg		6160	212	RL=LOD
SB-03	6/2/2011	Indeno[1,2,3-c,d]pyrene	14.85	mg/kg		6160	183	RL=LOD
SB-03	6/2/2011	Lead	46	mg/kg	K	2.1	0.71	RL=LOD
SB-03	6/2/2011	Naphthalene	3.21	mg/kg		308	20.5	RL=LOD
SB-03	6/2/2011	Phenanthrene	55.45	mg/kg		6160	297	RL=LOD
SB-03	6/2/2011	Pyrene	52.35	mg/kg		6160	228	RL=LOD
SB-04	6/2/2011	Acenaphthene	49	mg/kg		16500	1220	RL=LOD
SB-04	6/2/2011	Acenaphthylene	2.02	mg/kg	U	2020	673	RL=LOD
SB-04	6/2/2011	Anthracene	147	mg/kg		16500	734	RL=LOD
SB-04	6/2/2011	Benzo[a]anthracene	244	mg/kg		82600	5510	RL=LOD
SB-04	6/2/2011	Benzo[a]pyrene	206	mg/kg		16500	489	RL=LOD
SB-04	6/2/2011	Benzo[b]fluoranthene	161	mg/kg		82600	4280	RL=LOD
SB-04	6/2/2011	Benzo[k]fluoranthene	182	mg/kg		82600	3980	RL=LOD
SB-04	6/2/2011	Chrysene	227	mg/kg		82600	2750	RL=LOD
SB-04	6/2/2011	Dibenz[a,h]anthracene	37.4	mg/kg		16500	1710	RL=LOD
SB-04	6/2/2011	Fluoranthene	612	mg/kg		82600	3360	RL=LOD
SB-04	6/2/2011	Fluorene	72.9	mg/kg		16500	569	RL=LOD
SB-04	6/2/2011	Indeno[1,2,3-c,d]pyrene	82.2	mg/kg		16500	489	RL=LOD
SB-04	6/2/2011	Lead	627	mg/kg	K	2.3	0.76	RL=LOD
SB-04	6/2/2011	Naphthalene	29.2	mg/kg		16500	1100	RL=LOD
SB-04	6/2/2011	Phenanthrene	503	mg/kg		82600	3980	RL=LOD

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
SB-04	6/2/2011	Pyrene	406	mg/kg		82600	3060	RL=LOD
SB-05	6/2/2011	Lead	567	mg/kg	K	2.2	0.75	RL=LOD
SB-06	6/2/2011	Lead	36.6	mg/kg	K	2	0.68	RL=LOD
SB-09	6/2/2011	Acenaphthene	0.043	mg/kg	U	43	26.1	RL=LOD
SB-09	6/2/2011	Acenaphthylene	0.043	mg/kg	U	43	14.3	RL=LOD
SB-09	6/2/2011	Anthracene	0.0422	mg/kg	J	352	15.6	RL=LOD
SB-09	6/2/2011	Benzo[a]anthracene	0.0379	mg/kg	J	352	23.4	RL=LOD
SB-09	6/2/2011	Benzo[a]pyrene	0.0349	mg/kg	J	352	10.4	RL=LOD
SB-09	6/2/2011	Benzo[b]fluoranthene	0.0447	mg/kg	J	352	18.2	RL=LOD
SB-09	6/2/2011	Benzo[k]fluoranthene	0.0418	mg/kg	J	352	16.9	RL=LOD
SB-09	6/2/2011	Chrysene	0.0515	mg/kg	J	352	11.7	RL=LOD
SB-09	6/2/2011	Dibenz[a,h]anthracene	0.043	mg/kg	U	43	36.5	RL=LOD
SB-09	6/2/2011	Fluoranthene	0.0627	mg/kg	J	352	14.3	RL=LOD
SB-09	6/2/2011	Fluorene	0.043	mg/kg	U	43	12.1	RL=LOD
SB-09	6/2/2011	Indeno[1,2,3-c,d]pyrene	0.0308	mg/kg	J	352	10.4	RL=LOD
SB-09	6/2/2011	Lead	27.2	mg/kg	K	2.3	0.77	RL=LOD
SB-09	6/2/2011	Naphthalene	0.043	mg/kg	U	43	23.4	RL=LOD
SB-09	6/2/2011	Phenanthrene	0.043	mg/kg	J	352	16.9	RL=LOD
SB-09	6/2/2011	Pyrene	0.066	mg/kg	J	352	13	RL=LOD
SB-10	6/2/2011	Acenaphthene	1.78	mg/kg		324	24	RL=LOD
SB-10	6/2/2011	Acenaphthylene	0.108	mg/kg	J	324	13.2	RL=LOD
SB-10	6/2/2011	Anthracene	3.55	mg/kg		324	14.4	RL=LOD
SB-10	6/2/2011	Benzo[a]anthracene	8.72	mg/kg		3240	216	RL=LOD
SB-10	6/2/2011	Benzo[a]pyrene	7.29	mg/kg		3240	96.1	RL=LOD
SB-10	6/2/2011	Benzo[b]fluoranthene	7.06	mg/kg		3240	168	RL=LOD
SB-10	6/2/2011	Benzo[k]fluoranthene	6.71	mg/kg		3240	156	RL=LOD
SB-10	6/2/2011	Chrysene	8.06	mg/kg		3240	108	RL=LOD
SB-10	6/2/2011	Dibenz[a,h]anthracene	0.946	mg/kg		324	33.6	RL=LOD
SB-10	6/2/2011	Fluoranthene	17.5	mg/kg		3240	132	RL=LOD
SB-10	6/2/2011	Fluorene	1.84	mg/kg		324	11.2	RL=LOD
SB-10	6/2/2011	Indeno[1,2,3-c,d]pyrene	1.88	mg/kg		324	9.6	RL=LOD
SB-10	6/2/2011	Naphthalene	0.505	mg/kg		324	21.6	RL=LOD
SB-10	6/2/2011	Phenanthrene	14.9	mg/kg		3240	156	RL=LOD
SB-10	6/2/2011	Pyrene	15.4	mg/kg		3240	120	RL=LOD
SB-11	6/2/2011	Acenaphthene	0.0491	mg/kg	J	285	21.1	RL=LOD
SB-11	6/2/2011	Acenaphthylene	0.0349	mg/kg	U	34.9	11.6	RL=LOD
SB-11	6/2/2011	Anthracene	0.138	mg/kg	J	285	12.7	RL=LOD
SB-11	6/2/2011	Benzo[a]anthracene	0.378	mg/kg		285	19	RL=LOD
SB-11	6/2/2011	Benzo[a]pyrene	0.307	mg/kg		285	8.5	RL=LOD
SB-11	6/2/2011	Benzo[b]fluoranthene	0.302	mg/kg		285	14.8	RL=LOD
SB-11	6/2/2011	Benzo[k]fluoranthene	0.3	mg/kg		285	13.7	RL=LOD
SB-11	6/2/2011	Chrysene	0.357	mg/kg		285	9.5	RL=LOD
SB-11	6/2/2011	Dibenz[a,h]anthracene	0.061	mg/kg	J	285	29.6	RL=LOD
SB-11	6/2/2011	Fluoranthene	0.773	mg/kg		285	11.6	RL=LOD
SB-11	6/2/2011	Fluorene	0.0523	mg/kg	J	285	9.8	RL=LOD
SB-11	6/2/2011	Indeno[1,2,3-c,d]pyrene	0.205	mg/kg	J	285	8.5	RL=LOD
SB-11	6/2/2011	Lead	14.5	mg/kg	K	3.6	1.2	RL=LOD
SB-11	6/2/2011	Naphthalene	0.0349	mg/kg	U	34.9	19	RL=LOD
SB-11	6/2/2011	Phenanthrene	0.547	mg/kg		285	13.7	RL=LOD
SB-11	6/2/2011	Pyrene	0.625	mg/kg		285	10.6	RL=LOD
SD-5	12/9/2011	2-methylnaphthalene	0.0142	mg/kg	J	0.241		LOD
SD-5	12/9/2011	Acenaphthene	47.7	mg/kg	U	0.0477		LOD
SD-5	12/9/2011	Acenaphthylene	0.0255	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Anthracene	0.0424	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Benzo[a]anthracene	0.191	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Benzo[a]pyrene	0.221	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Benzo[b]fluoranthene	0.347	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Benzo[g,h,i]perylene	0.103	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Benzo[k]fluoranthene	0.151	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Chrysene	0.259	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Dibenz[a,h]anthracene	0.0477	mg/kg	U	0.0477		LOD

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
SD-5	12/9/2011	Fluoranthene	0.442	mg/kg		0.0477		LOD
SD-5	12/9/2011	Fluorene	0.0141	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Indeno[1,2,3-c,d]pyrene	0.104	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Lead	61	mg/kg		1.6		LOD
SD-5	12/9/2011	Naphthalene	0.0477	mg/kg	U	0.0477		LOD
SD-5	12/9/2011	Phenanthrene	0.177	mg/kg	J	0.0477		LOD
SD-5	12/9/2011	Pyrene	0.356	mg/kg	J	0.0477		LOD
SD-6	12/9/2011	2-methylnaphthalene	0.0182	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Acenaphthene	0.0551	mg/kg	U	0.0551		LOD
SD-6	12/9/2011	Acenaphthylene	0.0377	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Anthracene	0.0393	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Benzo[a]anthracene	0.18	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Benzo[a]pyrene	0.228	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Benzo[b]fluoranthene	0.389	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Benzo[g,h,i]perylene	0.1	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Benzo[k]fluoranthene	0.151	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Chrysene	0.273	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Dibenz[a,h]anthracene	0.0551	mg/kg	U	0.0551		LOD
SD-6	12/9/2011	Fluoranthene	0.441	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Fluorene	0.0551	mg/kg	U	0.0551		LOD
SD-6	12/9/2011	Indeno[1,2,3-c,d]pyrene	0.1	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Lead	69.2	mg/kg		1.6		LOD
SD-6	12/9/2011	Naphthalene	0.0551	mg/kg	U	0.0551		LOD
SD-6	12/9/2011	Phenanthrene	0.183	mg/kg	J	0.0551		LOD
SD-6	12/9/2011	Pyrene	0.364	mg/kg	J	0.0551		LOD
SD-7	12/9/2011	2-methylnaphthalene	0.0373	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Acenaphthene	0.0492	mg/kg	U	0.0492		LOD
SD-7	12/9/2011	Acenaphthylene	0.0416	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Anthracene	0.0523	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Benzo[a]anthracene	0.251	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Benzo[a]pyrene	0.293	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Benzo[b]fluoranthene	0.522	mg/kg		0.0492		LOD
SD-7	12/9/2011	Benzo[g,h,i]perylene	0.118	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Benzo[k]fluoranthene	0.51	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Chrysene	0.346	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Dibenz[a,h]anthracene	0.0492	mg/kg	U	0.0492		LOD
SD-7	12/9/2011	Fluoranthene	0.609	mg/kg		0.0492		LOD
SD-7	12/9/2011	Fluorene	0.0167	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Indeno[1,2,3-c,d]pyrene	0.119	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Lead	70.9	mg/kg		1.6		LOD
SD-7	12/9/2011	Naphthalene	0.0492	mg/kg	U	0.0492		LOD
SD-7	12/9/2011	Phenanthrene	0.241	mg/kg	J	0.0492		LOD
SD-7	12/9/2011	Pyrene	0.513	mg/kg		0.0492		LOD
SD-8	12/9/2011	2-methylnaphthalene	0.0392	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Acenaphthene	0.0356	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Acenaphthylene	0.0762	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Anthracene	0.124	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Benzo[a]anthracene	0.579	mg/kg		0.0571		LOD
SD-8	12/9/2011	Benzo[a]pyrene	0.659	mg/kg		0.0571		LOD
SD-8	12/9/2011	Benzo[b]fluoranthene	1.08	mg/kg		0.0571		LOD
SD-8	12/9/2011	Benzo[g,h,i]perylene	0.234	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Benzo[k]fluoranthene	0.472	mg/kg		0.0571		LOD
SD-8	12/9/2011	Chrysene	0.711	mg/kg		0.0571		LOD
SD-8	12/9/2011	Dibenz[a,h]anthracene	0.0797	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Fluoranthene	1.26	mg/kg		0.0571		LOD
SD-8	12/9/2011	Fluorene	0.0448	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Indeno[1,2,3-c,d]pyrene	0.242	mg/kg	J	0.0571		LOD
SD-8	12/9/2011	Lead	44.1	mg/kg		2.3		LOD
SD-8	12/9/2011	Naphthalene	0.0571	mg/kg	U	0.0571		LOD
SD-8	12/9/2011	Phenanthrene	0.508	mg/kg		0.0571		LOD
SD-8	12/9/2011	Pyrene	1.07	mg/kg		0.0571		LOD

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
SD-9	12/9/2011	2-methylnaphthalene	0.06385	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Acenaphthene	0.07225	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Acenaphthylene	0.1085	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Anthracene	0.2075	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Benzo[a]anthracene	0.948	mg/kg		0.0511		LOD
SD-9	12/9/2011	Benzo[a]pyrene	1.038	mg/kg		0.0511		LOD
SD-9	12/9/2011	Benzo[b]fluoranthene	1.7	mg/kg		0.0511		LOD
SD-9	12/9/2011	Benzo[g,h,i]perylene	0.5415	mg/kg		0.0511		LOD
SD-9	12/9/2011	Benzo[k]fluoranthene	0.623	mg/kg		0.0511		LOD
SD-9	12/9/2011	Chrysene	1.135	mg/kg		0.0511		LOD
SD-9	12/9/2011	Dibenz[a,h]anthracene	0.157	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Fluoranthene	1.945	mg/kg		0.0511		LOD
SD-9	12/9/2011	Fluorene	0.0915	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Indeno[1,2,3-c,d]pyrene	0.5025	mg/kg		0.0511		LOD
SD-9	12/9/2011	Lead	63.45	mg/kg		2		LOD
SD-9	12/9/2011	Naphthalene	0.0467	mg/kg	J	0.0511		LOD
SD-9	12/9/2011	Phenanthrene	0.909	mg/kg		0.0511		LOD
SD-9	12/9/2011	Pyrene	1.7	mg/kg		0.0511		LOD
SS-01	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Benzo[a]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Lead	10.8	mg/kg		1		CRDL
SS-01	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-01	5/25/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Benzo[a]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Lead	13.3	mg/kg		1		CRDL
SS-02	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-02	5/25/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Benzo[a]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
SS-03	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Lead	130	mg/kg		1		CRDL
SS-03	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-03	5/25/1988	Pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Anthracene	0.03	mg/kg		0.33		CRDL
SS-04	5/25/1988	Benzo[a]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Fluoranthene	0.16	mg/kg		0.33		CRDL
SS-04	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Lead	25.1	mg/kg		1		CRDL
SS-04	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-04	5/25/1988	Phenanthrene	0.16	mg/kg		0.33		CRDL
SS-04	5/25/1988	Pyrene	0.14	mg/kg		0.33		CRDL
SS-05	5/25/1988	2-methylnaphthalene	0.08	mg/kg		0.33		CRDL
SS-05	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Anthracene	0.03	mg/kg		0.33		CRDL
SS-05	5/25/1988	Benzo[a]anthracene	0.39	mg/kg		0.33		CRDL
SS-05	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Chrysene	0.52	mg/kg		0.33		CRDL
SS-05	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Fluoranthene	0.85	mg/kg		0.33		CRDL
SS-05	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-05	5/25/1988	Lead	73.7	mg/kg		1		CRDL
SS-05	5/25/1988	Naphthalene	0.06	mg/kg		0.33		CRDL
SS-05	5/25/1988	Phenanthrene	0.51	mg/kg		0.33		CRDL
SS-05	5/25/1988	Pyrene	1.16	mg/kg		0.33		CRDL
SS-06	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Benzo[a]anthracene	0.35	mg/kg		0.33		CRDL
SS-06	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Benzo[g,h,i]perylene	0.18	mg/kg		0.33		CRDL
SS-06	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Chrysene	0.39	mg/kg		0.33		CRDL
SS-06	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Fluoranthene	0.78	mg/kg		0.33		CRDL
SS-06	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.16	mg/kg		0.33		CRDL
SS-06	5/25/1988	Lead	21.9	mg/kg		1		CRDL
SS-06	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-06	5/25/1988	Phenanthrene	0.45	mg/kg		0.33		CRDL
SS-06	5/25/1988	Pyrene	0.64	mg/kg		0.33		CRDL
SS-07	5/25/1988	2-methylnaphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Acenaphthene	0.165	mg/kg	U	0.33		1/2 CRDL

TABLE A.1
DATA USED IN THE RISK ASSESSMENT

Sample Location	Sample Date	Constituent	Result	Result Units	Qualifier	Reported Detection Limit	Method Detection Limit	Non-Detect Value
SS-07	5/25/1988	Anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Benzo[a]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Benzo[a]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Benzo[b]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Benzo[g,h,i]perylene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Benzo[k]fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Chrysene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Dibenz[a,h]anthracene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Fluoranthene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Fluorene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Indeno[1,2,3-c,d]pyrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Lead	15.3	mg/kg		1		CRDL
SS-07	5/25/1988	Naphthalene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Phenanthrene	0.165	mg/kg	U	0.33		1/2 CRDL
SS-07	5/25/1988	Pyrene	0.165		U	0.33		1/2 CRDL
SS-08	5/25/1988	2-methylnaphthalene	0.16			0.33		CRDL
SS-08	5/25/1988	Acenaphthene	0.67			0.33		CRDL
SS-08	5/25/1988	Anthracene	1.095			0.33		CRDL
SS-08	5/25/1988	Benzo[a]anthracene	3.085			0.33		CRDL
SS-08	5/25/1988	Benzo[a]pyrene	2.37			0.33		CRDL
SS-08	5/25/1988	Benzo[b]fluoranthene	1.47			0.33		CRDL
SS-08	5/25/1988	Benzo[g,h,i]perylene	1.425			0.33		CRDL
SS-08	5/25/1988	Benzo[k]fluoranthene	1.33			0.33		CRDL
SS-08	5/25/1988	Chrysene	2.95			0.33		CRDL
SS-08	5/25/1988	Dibenz[a,h]anthracene	0.555			0.33		CRDL
SS-08	5/25/1988	Fluoranthene	6.47			0.33		CRDL
SS-08	5/25/1988	Fluorene	0.7			0.33		CRDL
SS-08	5/25/1988	Indeno[1,2,3-c,d]pyrene	1.34			0.33		CRDL
SS-08	5/25/1988	Lead	38.35			1		CRDL
SS-08	5/25/1988	Naphthalene	0.245			0.33		CRDL
SS-08	5/25/1988	Phenanthrene	5.39			0.33		CRDL
SS-08	5/25/1988	Pyrene	5.48			0.33		CRDL

TABLE A.2
DATA USED IN THE RISK ASSESSMENT

Constituent	MW-2 and SB-3 Results			SS-8 and SB-10 Results		
	MW-2 (1989) (mg/kg)	SB-3 (2011) (mg/kg)	Average (mg/kg)	SS-8 (1988) (mg/kg)	SB-10 (2011) (mg/kg)	Average (mg/kg)
Acenaphthene	117	5.455	61.2	0.67	1.78	1.23
Acenaphthylene	NA	NA	NA	NA	0.108	0.108
Anthracene	240	15.45	127.7	1.095	3.55	2.3
Benz(a)anthracene	310	29.6	169.8	3.085	8.72	5.9
Benzo(a)pyrene	220.5	24.6	122.6	2.37	7.29	4.8
Benzo(b)fluoranthene	218	25.25	121.5	1.47	7.06	4.3
Benzo(ghi)perylene	99	NA	99	1.425	NA	1.4
Benzo(k)fluoranthene	153.5	22.75	88.1	1.33	6.71	4
Chrysene	280	28.55	154.3	2.95	8.06	5.5
Dibenz(ah)anthracene	41.5	6.46	24	0.555	0.946	0.75
Fluoranthene	690	51.15	370.6	6.47	17.5	12
Fluorene	165.5	8.005	86.8	0.7	1.84	1.3
Indeno(123-cd)pyrene	104.5	14.85	59.7	1.34	1.88	1.6
Lead	905.5	46	475.8	38.35	NA	38.4
2-Methylnaphthalene	47	NA	47	0.16	NA	0.16
Naphthalene	83.5	3.21	43.4	0.245	0.505	0.38
Phenanthrene	725	55.45	390.2	5.39	14.9	10.1
Pyrene	500	52.35	276.2	5.48	15.4	10.4

mg/kg = milligrams per kilogram
NA = Not Analyzed

APPENDIX B

JOHNSON AND ETTINGER MODEL

APPENDIX B

VAPOR INTRUSION FROM GROUNDWATER TO INDOOR AIR SCREENING VALUES

Chemical	Target Indoor Air Concentration[1] (ug/m^3)	Conversoin Factor (m^3/L)	Henry's Law Constant[2] (unitless)	Attenuation Factor[3]	GW Conc at Risk Level[3] = 10^{-6} (ug/L)	GW Conc at Risk Level[3] = 10^{-5} (ug/L)	GW Conc at Risk Level[3] = 10^{-4} (ug/L)
Trichloroethene	0.43	0.001	0.402	0.001	1.1	10.7	107
Cis-1,2-dichloroethene	NA	0.001	0.1668	0.001	NA	NA	NA
Trans-1,2-dichloroethene[4]	63	0.001	0.1668	0.001	378	3,777	4,520
Vinyl Chloride	0.16	0.001	1.1365	0.001	0.14	1.4	14

NA = Inhalation toxicity value not set forth by USEPA; therefore, inhalation exposure cannot be determined.

Notes:

1) Taken from USEPA, 2012. Regional Screening Level (RSL) Summary Tables, April. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

2) Taken from USEPA, 2012. Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table, April. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.

3) Based upon guidance presented in USEPA, 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. EPA530-D-02-004. November.

GW Conc = Target Indoor Air Concentration * Conversion Factor * (1/Henry's Law Constant) * (1/Attenuation Factor)

4) The GW concentration at a risk level of 10-4 exceeds the aqueous solubility for tran-1,2-dichloroethene; therefore, solubility is used instead.

Vapor Intrusion for Onsite Snack Building
DATA ENTRY SHEET

GW-ADV
Reset to Defaults
3.1; 02/04

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	2.50E+01	Trichloroethylene

MORE

Lookup Soil

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
13	0	152.4	152.4	0	0	A	LS	LS		

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
LS	1.62	0.390	0.076								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	366	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	10	10	52	1.0E-05	1
				Used to calculate risk-based groundwater concentration.	

END

Vapor Intrusion for Onsite Snack Building
CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	4.1E-06	2.0E-03

END

Vapor Intrusion for Onsite Snack Building
INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
3.15E+08	152.4	0.314	ERROR	ERROR	0.079	1.63E-08	0.957	1.56E-08	18.75	0.39	0.087	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.54E+04	1.00E+06	4.00E-04	0	8,520	5.62E-03	2.39E-01	1.76E-04	1.10E-02	0.00E+00	0.00E+00	1.60E-04	1.18E-03	152.4

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
0	5.99E+03	0.10	8.33E+01	1.10E-02	4.00E+02	2.91E+82	2.78E-04	1.66E+00	4.1E-06	2.0E-03

END

Vapor Intrusion for Onsite Snack Building
RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.4E-07	1.2E-01

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

Vapor Intrusion for Off-site MACW Well
DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	3.00E+01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
13	0	426.72	426.72	0	0	A	SC	SC		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	366	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1
				Used to calculate risk-based groundwater concentration.	

END

Vapor Intrusion for Off-site MACW Well
CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	4.1E-06	2.0E-03

END

Vapor Intrusion for Off-site MACW Well
INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	426.72	0.188	ERROR	ERROR	0.299	1.75E-09	0.837	1.47E-09	30.00	0.385	0.030	0.355	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.54E+04	1.00E+06	4.00E-04	0	8,520	5.62E-03	2.39E-01	1.76E-04	2.04E-03	0.00E+00	0.00E+00	1.27E-05	1.67E-04	426.72

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
0	7.18E+03	0.10	8.33E+01	2.04E-03	4.00E+02	#NUM!	1.54E-05	1.10E-01	4.1E-06	2.0E-03

END

Vapor Intrusion for Off-site MACW Well
RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.9E-07	5.3E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

APPENDIX C

Pro UCL OUTPUTS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	All results_except marsh area.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

methylnaphthalene

General Statistics

Number of Valid Data	28	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	21
		Percent Non-Detects	75.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.08	Minimum Detected	-2.526
Maximum Detected	47	Maximum Detected	3.85
Mean of Detected	7.211	Mean of Detected	-0.321
SD of Detected	17.55	SD of Detected	2.109
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	25
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	89.29%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.479	Shapiro Wilk Test Statistic	0.884
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.873	Mean	-1.905
SD	8.85	SD	1.384
95% DL/2 (t) UCL	4.721	95% H-Stat (DL/2) UCL	0.853
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.124
		SD in Log Scale	1.862
		Mean in Original Scale	1.9
		SD in Original Scale	8.845
		95% t UCL	4.747
		95% Percentile Bootstrap UCL	5.231
		95% BCA Bootstrap UCL	7.082
		95% H-UCL	2.52

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.267	**Data appear Lognormal at 5% Significance Level**
Theta Star	27.03	
nu star	3.735	

A-D Test Statistic	1.027
5% A-D Critical Value	0.784
K-S Test Statistic	0.784
5% K-S Critical Value	0.335

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	47
Mean	2.035
Median	0.000001
SD	8.853
k star	0.101
Theta star	20.23
Nu star	5.634
AppChi2	1.456
95% Gamma Approximate UCL	7.877
95% Adjusted Gamma UCL	8.623

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.894
SD	8.686
SE of Mean	1.773
95% KM (t) UCL	4.914
95% KM (z) UCL	4.81
95% KM (jackknife) UCL	4.742
95% KM (bootstrap t) UCL	71.86
95% KM (BCA) UCL	5.328
95% KM (Percentile Bootstrap) UCL	5.226
95% KM (Chebyshev) UCL	9.623
97.5% KM (Chebyshev) UCL	12.97
99% KM (Chebyshev) UCL	19.54

Potential UCLs to Use

99% KM (Chebyshev) UCL	19.54

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.

acenaphthene

General Statistics

Number of Valid Data	27	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	24
		Percent Non-Detects	88.89%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.92	Minimum Detected	-0.0834
Maximum Detected	61.23	Maximum Detected	4.115
Mean of Detected	21.12	Mean of Detected	1.411
SD of Detected	34.73	SD of Detected	2.345
Minimum Non-Detect	0.0382	Minimum Non-Detect	-3.265
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	24
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	88.89%

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	0.754	Shapiro Wilk Test Statistic	0.801
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution	
DL/2 Substitution Method	
Mean	2.424
SD	11.76
95% DL/2 (t) UCL	6.282
Maximum Likelihood Estimate(MLE) Method	N/A
MLE yields a negative mean	

Assuming Lognormal Distribution	
DL/2 Substitution Method	
Mean	-2.117
SD	1.501
95% H-Stat (DL/2) UCL	0.963
Log ROS Method	
Mean in Log Scale	-11.91
SD in Log Scale	7.358
Mean in Original Scale	2.349
SD in Original Scale	11.77
95% t UCL	6.212
95% Percentile Bootstrap UCL	6.851
95% BCA Bootstrap UCL	9.197
95% H-UCL	1.21E+15

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	3.165
SD	11.39
SE of Mean	2.684
95% KM (t) UCL	7.743
95% KM (z) UCL	7.58
95% KM (jackknife) UCL	6.748
95% KM (bootstrap t) UCL	357.4
95% KM (BCA) UCL	61.23
95% KM (Percentile Bootstrap) UCL	61.23
95% KM (Chebyshev) UCL	14.86
97.5% KM (Chebyshev) UCL	19.93
99% KM (Chebyshev) UCL	29.87
Potential UCLs to Use	
99% KM (Chebyshev) UCL	29.87

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.

acenaphthylene

General Statistics

Number of Valid Data	7	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	4
		Percent Non-Detects	57.14%

Raw Statistics	
Minimum Detected	0.0167
Maximum Detected	0.392
Mean of Detected	0.172
SD of Detected	0.196

Log-transformed Statistics	
Minimum Detected	-4.092
Maximum Detected	-0.936
Mean of Detected	-2.418
SD of Detected	1.587

Minimum Non-Detect	0.043	Minimum Non-Detect	-3.147
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	7
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	0.919	Shapiro Wilk Test Statistic	0.989
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	0.205	Mean	-2.101
SD	0.153	SD	1.34
95% DL/2 (t) UCL	0.318	95% H-Stat (DL/2) UCL	3.919
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.86
		SD in Log Scale	1.324
		Mean in Original Scale	0.115
		SD in Original Scale	0.14
		95% t UCL	0.218
		95% Percentile Bootstrap UCL	0.203
		95% BCA Bootstrap UCL	0.23
		95% H-UCL	1.695

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	0.133
5% K-S Critical Value	N/A	SD	0.154
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0943
		95% KM (t) UCL	0.316
Assuming Gamma Distribution		95% KM (z) UCL	0.288
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.318
Minimum	N/A	95% KM (bootstrap t) UCL	0.534
Maximum	N/A	95% KM (BCA) UCL	0.392
Mean	N/A	95% KM (Percentile Bootstrap) UCL	0.392
Median	N/A	95% KM (Chebyshev) UCL	0.544
SD	N/A	97.5% KM (Chebyshev) UCL	0.722
k star	N/A	99% KM (Chebyshev) UCL	1.071
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	0.316

95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	0.392
95% Adjusted Gamma UCL	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.

anthracene

General Statistics

Number of Valid Data	15	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	9
		Percent Non-Detects	60.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0219	Minimum Detected	-3.821
Maximum Detected	127.7	Maximum Detected	4.85
Mean of Detected	21.7	Mean of Detected	-1.385
SD of Detected	51.95	SD of Detected	3.52
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	86.67%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.508	Shapiro Wilk Test Statistic	0.752
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
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	8.786	Mean	-1.707
SD	32.91	SD	2.182
95% DL/2 (t) UCL	23.75	95% H-Stat (DL/2) UCL	34.68
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.44
		SD in Log Scale	2.661
		Mean in Original Scale	8.756
		SD in Original Scale	32.92
		95% t UCL	23.73
		95% Percentile Bootstrap UCL	25.67
		95% BCA Bootstrap UCL	34.42
		95% H-UCL	197.3

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.196	**Data do not follow a Discernable Distribution (0.05)**
Theta Star	110.8	

nu star	2.349
A-D Test Statistic	1.024
5% A-D Critical Value	0.815
K-S Test Statistic	0.815
5% K-S Critical Value	0.365

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	127.7
Mean	10.14
Median	0.0219
SD	32.76
k star	0.117
Theta star	86.34
Nu star	3.523
AppChi2	0.543
95% Gamma Approximate UCL	65.8
95% Adjusted Gamma UCL	84.44

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	8.697
SD	31.82
SE of Mean	8.999
95% KM (t) UCL	24.55
95% KM (z) UCL	23.5
95% KM (jackknife) UCL	23.67
95% KM (bootstrap t) UCL	25660
95% KM (BCA) UCL	25.72
95% KM (Percentile Bootstrap) UCL	25.72
95% KM (Chebyshev) UCL	47.92
97.5% KM (Chebyshev) UCL	64.9
99% KM (Chebyshev) UCL	98.24

Potential UCLs to Use

99% KM (Chebyshev) UCL	98.24

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.

B(a)A

General Statistics

Number of Valid Data	15	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	9
		Percent Non-Detects	60.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0379	Minimum Detected	-3.273
Maximum Detected	169.8	Maximum Detected	5.135
Mean of Detected	29.43	Mean of Detected	-0.152
SD of Detected	68.81	SD of Detected	3.118
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	86.67%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.519	Shapiro Wilk Test Statistic	0.905
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	11.88
SD	43.71
95% DL/2 (t) UCL	31.76
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.214
SD	2.131
95% H-Stat (DL/2) UCL	44.88
Log ROS Method	
Mean in Log Scale	-1.932
SD in Log Scale	2.724
Mean in Original Scale	11.85
SD in Original Scale	43.72
95% t UCL	31.73
95% Percentile Bootstrap UCL	34.17
95% BCA Bootstrap UCL	46.15
95% H-UCL	471.1

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.215
Theta Star	137.1
nu star	2.576
A-D Test Statistic	0.742
5% A-D Critical Value	0.8
K-S Test Statistic	0.8
5% K-S Critical Value	0.363

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	169.8
Mean	12.09
Median	0.000001
SD	43.67
k star	0.112
Theta star	107.9
Nu star	3.36
AppChi2	0.487
95% Gamma Approximate UCL	83.48
95% Adjusted Gamma UCL	107.8

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	11.82
SD	42.25
SE of Mean	11.95
95% KM (t) UCL	32.87
95% KM (z) UCL	31.48
95% KM (jackknife) UCL	31.71
95% KM (bootstrap t) UCL	3033
95% KM (BCA) UCL	34.49
95% KM (Percentile Bootstrap) UCL	34.25
95% KM (Chebyshev) UCL	63.91
97.5% KM (Chebyshev) UCL	86.44
99% KM (Chebyshev) UCL	130.7
Potential UCLs to Use	
95% KM (t) UCL	32.87

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.

B(a)P

General Statistics

Number of Valid Data	15	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	11
		Percent Non-Detects	73.33%

Raw Statistics

Minimum Detected	0.0349
Maximum Detected	122.6
Mean of Detected	31.87
SD of Detected	60.49
Minimum Non-Detect	0.165

Log-transformed Statistics

Minimum Detected	-3.355
Maximum Detected	4.809
Mean of Detected	0.0958
SD of Detected	3.822
Minimum Non-Detect	-1.802

Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	13
Number treated as Detected	2
Single DL Non-Detect Percentage	86.67%

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.658
5% Shapiro Wilk Critical Value	0.748

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	8.618
SD	31.54
95% DL/2 (t) UCL	22.96
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.911
5% Shapiro Wilk Critical Value	0.748

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.46
SD	2.092
95% H-Stat (DL/2) UCL	29.37
Log ROS Method	
Mean in Log Scale	-2.152
SD in Log Scale	2.915
Mean in Original Scale	8.674
SD in Original Scale	31.53
95% t UCL	23.01
95% Percentile Bootstrap UCL	24.8
95% BCA Bootstrap UCL	33.44
95% H-UCL	1184

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.221
Theta Star	144.4
nu star	1.765
A-D Test Statistic	0.394
5% A-D Critical Value	0.728
K-S Test Statistic	0.728
5% K-S Critical Value	0.423

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	122.6
Mean	10.92
Median	0.000001
SD	31.42
k star	0.116
Theta star	94.45
Nu star	3.468
AppChi2	0.523
95% Gamma Approximate UCL	72.32
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	8.538
SD	30.49
SE of Mean	9.092
95% KM (t) UCL	24.55
95% KM (z) UCL	23.49
95% KM (jackknife) UCL	22.89
95% KM (bootstrap t) UCL	228.7
95% KM (BCA) UCL	122.6
95% KM (Percentile Bootstrap) UCL	28.37
95% KM (Chebyshev) UCL	48.17
97.5% KM (Chebyshev) UCL	65.32
99% KM (Chebyshev) UCL	99

Potential UCLs to Use

95% KM (t) UCL	24.55

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.

B(b)F

General Statistics

Number of Valid Data	30	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	24
		Percent Non-Detects	80.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0447	Minimum Detected	-3.108
Maximum Detected	121.6	Maximum Detected	4.801
Mean of Detected	22.42	Mean of Detected	0.162
SD of Detected	48.71	SD of Detected	3.124
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	27
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	90.00%

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.551	Shapiro Wilk Test Statistic	0.917
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.571	Mean	-1.834
SD	22.17	SD	1.692
95% DL/2 (t) UCL	11.45	95% H-Stat (DL/2) UCL	1.98
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.578
		SD in Log Scale	2.637
		Mean in Original Scale	4.61
		SD in Original Scale	22.16
		95% t UCL	11.49
		95% Percentile Bootstrap UCL	12.58
		95% BCA Bootstrap UCL	17.53
		95% H-UCL	28.09

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.232	**Data appear Gamma Distributed at 5% Significance Level**
Theta Star	96.53	
nu star	2.787	
A-D Test Statistic	0.486	**Nonparametric Statistics**

5% A-D Critical Value	0.787
K-S Test Statistic	0.787
5% K-S Critical Value	0.361

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	121.6
Mean	5.676
Median	0.000001
SD	22.25
k star	0.0928
Theta star	61.15
Nu star	5.57
AppChi2	1.424
95% Gamma Approximate UCL	22.2
95% Adjusted Gamma UCL	24.17

Kaplan-Meier (KM) Method	
Mean	4.531
SD	21.81
SE of Mean	4.361
95% KM (t) UCL	11.94
95% KM (z) UCL	11.7
95% KM (jackknife) UCL	11.41
95% KM (bootstrap t) UCL	123.1
95% KM (BCA) UCL	12.91
95% KM (Percentile Bootstrap) UCL	12.75
95% KM (Chebyshev) UCL	23.54
97.5% KM (Chebyshev) UCL	31.77
99% KM (Chebyshev) UCL	47.92

Potential UCLs to Use

95% KM (t) UCL	11.94

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.

B(ghi)P

General Statistics

Number of Valid Data	13	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	10
		Percent Non-Detects	76.92%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.18	Minimum Detected	-1.715
Maximum Detected	99	Maximum Detected	4.595
Mean of Detected	33.54	Mean of Detected	1.078
SD of Detected	56.7	SD of Detected	3.217
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	11
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	84.62%

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	0.759	Shapiro Wilk Test Statistic	0.962
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution **Assuming Lognormal Distribution**

DL/2 Substitution Method	
Mean	7.869
SD	27.38
95% DL/2 (t) UCL	21.41

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

DL/2 Substitution Method	
Mean	-1.273
SD	1.963
95% H-Stat (DL/2) UCL	27.79

Log ROS Method	
Mean in Log Scale	-7.759
SD in Log Scale	6.315
Mean in Original Scale	7.74
SD in Original Scale	27.42
95% t UCL	21.3
95% Percentile Bootstrap UCL	22.89
95% BCA Bootstrap UCL	30.61
95% H-UCL	3.971E+16

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	7.877
SD	26.31
SE of Mean	8.936
95% KM (t) UCL	23.8
95% KM (z) UCL	22.58
95% KM (jackknife) UCL	20.7
95% KM (bootstrap t) UCL	647.2
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	46.83
97.5% KM (Chebyshev) UCL	63.68
99% KM (Chebyshev) UCL	96.79

Potential UCLs to Use

99% KM (Chebyshev) UCL	96.79

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.

B(k)F

General Statistics

Number of Valid Data	30	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	25
		Percent Non-Detects	83.33%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0418	Minimum Detected	-3.175
Maximum Detected	88.13	Maximum Detected	4.479
Mean of Detected	19.91	Mean of Detected	0.407
SD of Detected	38.25	SD of Detected	3.248
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	27
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.00%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.621
5% Shapiro Wilk Critical Value	0.762

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	3.416
SD	16.07
95% DL/2 (t) UCL	8.4
Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.912
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.839
SD	1.641
95% H-Stat (DL/2) UCL	1.709
Log ROS Method	
Mean in Log Scale	-2.384
SD in Log Scale	2.666
Mean in Original Scale	3.552
SD in Original Scale	16.04
95% t UCL	8.529
95% Percentile Bootstrap UCL	9.346
95% BCA Bootstrap UCL	12.81
95% H-UCL	38.74

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.242
Theta Star	82.33
nu star	2.418
A-D Test Statistic	0.345
5% A-D Critical Value	0.75
K-S Test Statistic	0.75
5% K-S Critical Value	0.382

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	88.13
Mean	5.586
Median	0.000001
SD	16.44
k star	0.101
Theta star	55.48
Nu star	6.041
AppChi2	1.661
95% Gamma Approximate UCL	20.32
95% Adjusted Gamma UCL	22.02

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	3.366
SD	15.81
SE of Mean	3.227
95% KM (t) UCL	8.848
95% KM (z) UCL	8.673
95% KM (jackknife) UCL	8.353
95% KM (bootstrap t) UCL	50.43
95% KM (BCA) UCL	15.38
95% KM (Percentile Bootstrap) UCL	9.994
95% KM (Chebyshev) UCL	17.43
97.5% KM (Chebyshev) UCL	23.52
99% KM (Chebyshev) UCL	35.47

Potential UCLs to Use

95% KM (t) UCL	8.848

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.

Chrysene

General Statistics

Number of Valid Data	30	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	23
		Percent Non-Detects	76.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0515	Minimum Detected	-2.966
Maximum Detected	154.3	Maximum Detected	5.039
Mean of Detected	23.63	Mean of Detected	0.19
SD of Detected	57.65	SD of Detected	2.773
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	27
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	90.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.485	Shapiro Wilk Test Statistic	0.936
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5.607	Mean	-1.696
SD	28.11	SD	1.703
95% DL/2 (t) UCL	14.33	95% H-Stat (DL/2) UCL	2.345
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.394
		SD in Log Scale	2.524
		Mean in Original Scale	5.621
		SD in Original Scale	28.1
		95% t UCL	14.34
		95% Percentile Bootstrap UCL	15.85
		95% BCA Bootstrap UCL	21.32
		95% H-UCL	20.81

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.233	**Data appear Gamma Distributed at 5% Significance Level**
Theta Star	101.6	
nu star	3.257	
A-D Test Statistic	0.73	**Nonparametric Statistics**
5% A-D Critical Value	0.806	Kaplan-Meier (KM) Method

K-S Test Statistic	0.806	Mean	5.574
5% K-S Critical Value	0.339	SD	27.64
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	5.451
		95% KM (t) UCL	14.84
Assuming Gamma Distribution		95% KM (z) UCL	14.54
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	14.3
Minimum	0.000001	95% KM (bootstrap t) UCL	182.7
Maximum	154.3	95% KM (BCA) UCL	16.05
Mean	5.981	95% KM (Percentile Bootstrap) UCL	15.85
Median	0.000001	95% KM (Chebyshev) UCL	29.33
SD	28.09	97.5% KM (Chebyshev) UCL	39.62
k star	0.0917	99% KM (Chebyshev) UCL	59.81
Theta star	65.19		
Nu star	5.505	**Potential UCLs to Use**	
AppChi2	1.392	95% KM (t) UCL	14.84
95% Gamma Approximate UCL	23.65		
95% Adjusted Gamma UCL	25.76		

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.

Dibenz

General Statistics

Number of Valid Data	15	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	13
		Percent Non-Detects	86.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.751	Minimum Detected	-0.287
Maximum Detected	23.98	Maximum Detected	3.177
Mean of Detected	12.37	Mean of Detected	1.445
SD of Detected	16.43	SD of Detected	2.45
Minimum Non-Detect	0.0382	Minimum Non-Detect	-3.265
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	86.67%

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	1.77	Mean	-1.813
SD	6.147	SD	1.705
95% DL/2 (t) UCL	4.565	95% H-Stat (DL/2) UCL	4.306
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	2.299
5% K-S Critical Value	N/A	SD	5.794
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.116
		95% KM (t) UCL	6.026
Assuming Gamma Distribution		95% KM (z) UCL	5.779
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	17.92
Minimum	N/A	95% KM (bootstrap t) UCL	N/A
Maximum	N/A	95% KM (BCA) UCL	23.98
Mean	N/A	95% KM (Percentile Bootstrap) UCL	23.98
Median	N/A	95% KM (Chebyshev) UCL	11.52
SD	N/A	97.5% KM (Chebyshev) UCL	15.51
k star	N/A	99% KM (Chebyshev) UCL	23.35
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	99% KM (Chebyshev) UCL	23.35
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	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.

Fluoranthene

General Statistics

Number of Valid Data	30	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	18
		Percent Non-Detects	60.00%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0155	Minimum Detected	-4.167
Maximum Detected	375.6	Maximum Detected	5.928

Mean of Detected	33.22	Mean of Detected	-0.204
SD of Detected	107.9	SD of Detected	2.664
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	24
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	6
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	80.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.349	Shapiro Wilk Test Statistic	0.935
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	13.35	Mean	-1.492
SD	68.46	SD	1.985
95% DL/2 (t) UCL	34.59	95% H-Stat (DL/2) UCL	6.812
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.294
		SD in Log Scale	2.743
		Mean in Original Scale	13.33
		SD in Original Scale	68.46
		95% t UCL	34.57
		95% Percentile Bootstrap UCL	38.14
		95% BCA Bootstrap UCL	51.45
		95% H-UCL	59.87

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.205	**Data appear Lognormal at 5% Significance Level**
Theta Star	162.4	
nu star	4.91	
A-D Test Statistic	1.718	**Nonparametric Statistics**
5% A-D Critical Value	0.866	Kaplan-Meier (KM) Method
K-S Test Statistic	0.866	Mean 13.34
5% K-S Critical Value	0.271	SD 67.31
Data not Gamma Distributed at 5% Significance Level		SE of Mean 12.84
		95% KM (t) UCL 35.15
Assuming Gamma Distribution		95% KM (z) UCL 34.45
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 34.58
Minimum	0.000001	95% KM (bootstrap t) UCL 684
Maximum	375.6	95% KM (BCA) UCL 38.45
Mean	13.29	95% KM (Percentile Bootstrap) UCL 38.2
Median	0.000001	95% KM (Chebyshev) UCL 69.29
SD	68.47	97.5% KM (Chebyshev) UCL 93.5
k star	0.0911	99% KM (Chebyshev) UCL 141.1
Theta star	145.9	
Nu star	5.465	**Potential UCLs to Use**
AppChi2	1.373	99% KM (Chebyshev) UCL 141.1
95% Gamma Approximate UCL	52.9	
95% Adjusted Gamma UCL	57.67	

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.

Fluorene

General Statistics

Number of Valid Data	15	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	13
		Percent Non-Detects	86.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.27	Minimum Detected	0.239
Maximum Detected	86.75	Maximum Detected	4.463
Mean of Detected	44.01	Mean of Detected	2.351
SD of Detected	60.45	SD of Detected	2.987
Minimum Non-Detect	0.0382	Minimum Non-Detect	-3.265
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	86.67%

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	5.989	Mean	-1.692
SD	22.34	SD	2.015
95% DL/2 (t) UCL	16.15	95% H-Stat (DL/2) UCL	16.62
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
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	6.969
SD	21.32
SE of Mean	7.786
95% KM (t) UCL	20.68
95% KM (z) UCL	19.78
95% KM (jackknife) UCL	64.47
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	40.91
97.5% KM (Chebyshev) UCL	55.59
99% KM (Chebyshev) UCL	84.44

Potential UCLs to Use

99% KM (Chebyshev) UCL	84.44

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.

Indeno

General Statistics

Number of Valid Data	15	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	10
		Percent Non-Detects	66.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0308	Minimum Detected	-3.48
Maximum Detected	59.68	Maximum Detected	4.089
Mean of Detected	12.3	Mean of Detected	-0.764
SD of Detected	26.49	SD of Detected	3.12
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	86.67%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.571	Shapiro Wilk Test Statistic	0.89
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	4.214
SD	15.35
95% DL/2 (t) UCL	11.19
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.574
SD	1.849
95% H-Stat (DL/2) UCL	9.445
Log ROS Method	
Mean in Log Scale	-2.074
SD in Log Scale	2.364
Mean in Original Scale	4.223
SD in Original Scale	15.35
95% t UCL	11.2
95% Percentile Bootstrap UCL	12.12
95% BCA Bootstrap UCL	16.16
95% H-UCL	57.81

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.222
Theta Star	55.47
nu star	2.218
A-D Test Statistic	0.62
5% A-D Critical Value	0.768
K-S Test Statistic	0.768
5% K-S Critical Value	0.387

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	59.68
Mean	5.153
Median	0.0308
SD	15.3
k star	0.125
Theta star	41.22
Nu star	3.75
AppChi2	0.625
95% Gamma Approximate UCL	30.89
95% Adjusted Gamma UCL	39.31

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	4.154
SD	14.84
SE of Mean	4.285
95% KM (t) UCL	11.7
95% KM (z) UCL	11.2
95% KM (jackknife) UCL	11.14
95% KM (bootstrap t) UCL	584.5
95% KM (BCA) UCL	12.12
95% KM (Percentile Bootstrap) UCL	12.08
95% KM (Chebyshev) UCL	22.83
97.5% KM (Chebyshev) UCL	30.91
99% KM (Chebyshev) UCL	46.79
Potential UCLs to Use	
95% KM (t) UCL	11.7

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.

Lead

General Statistics

Number of Valid Observations	32	Number of Distinct Observations	30

Raw Statistics

Minimum	1.8
Maximum	1080
Mean	138
Median	37.3
SD	268.9
Std. Error of Mean	47.54
Coefficient of Variation	1.949

Log-transformed Statistics

Minimum of Log Data	0.588
Maximum of Log Data	6.985
Mean of log Data	3.889
SD of log Data	1.34

Skewness	2.848

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.5	Shapiro Wilk Test Statistic	0.922
Shapiro Wilk Critical Value	0.93	Shapiro Wilk Critical Value	0.93
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	218.6	95% H-UCL	239
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	259.5
95% Adjusted-CLT UCL (Chen-1995)	241.7	97.5% Chebyshev (MVUE) UCL	322.5
95% Modified-t UCL (Johnson-1978)	222.6	99% Chebyshev (MVUE) UCL	446.1

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.561	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	246		
MLE of Mean	138		
MLE of Standard Deviation	184.2		
nu star	35.9		
Approximate Chi Square Value (.05)	23.19	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0416	95% CLT UCL	216.2
Adjusted Chi Square Value	22.64	95% Jackknife UCL	218.6
		95% Standard Bootstrap UCL	214.8
Anderson-Darling Test Statistic	3.007	95% Bootstrap-t UCL	311.4
Anderson-Darling 5% Critical Value	0.802	95% Hall's Bootstrap UCL	241
Kolmogorov-Smirnov Test Statistic	0.276	95% Percentile Bootstrap UCL	220
Kolmogorov-Smirnov 5% Critical Value	0.163	95% BCA Bootstrap UCL	247.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	345.2
		97.5% Chebyshev(Mean, Sd) UCL	434.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	611
95% Approximate Gamma UCL	213.6		
95% Adjusted Gamma UCL	218.8		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	345.2

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, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Naphthalene

General Statistics

Number of Valid Data	30	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	26
		Percent Non-Detects	86.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.06	Minimum Detected	-2.813
Maximum Detected	43.36	Maximum Detected	3.769
Mean of Detected	11.05	Mean of Detected	-0.235
SD of Detected	21.54	SD of Detected	2.811
Minimum Non-Detect	0.0382	Minimum Non-Detect	-3.265
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	29
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	96.67%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.636
5% Shapiro Wilk Critical Value	0.748

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	1.569
SD	7.893
95% DL/2 (t) UCL	4.018
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.867
5% Shapiro Wilk Critical Value	0.748

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-2.115
SD	1.319
95% H-Stat (DL/2) UCL	0.586
Log ROS Method	
Mean in Log Scale	-6.216
SD in Log Scale	3.806
Mean in Original Scale	1.485
SD in Original Scale	7.909
95% t UCL	3.938
95% Percentile Bootstrap UCL	4.37
95% BCA Bootstrap UCL	5.836
95% H-UCL	380.7

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.233
Theta Star	47.35
nu star	1.866
A-D Test Statistic	0.632
5% A-D Critical Value	0.714
K-S Test Statistic	0.714
5% K-S Critical Value	0.42

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	43.36
Mean	1.553
Median	0.000001
SD	7.908
k star	0.0859
Theta star	18.08
Nu star	5.153
AppChi2	1.223
95% Gamma Approximate UCL	6.54
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1.528
SD	7.767
SE of Mean	1.638
95% KM (t) UCL	4.311
95% KM (z) UCL	4.222
95% KM (jackknife) UCL	3.768
95% KM (bootstrap t) UCL	162.5
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	5.872
95% KM (Chebyshev) UCL	8.666
97.5% KM (Chebyshev) UCL	11.75
99% KM (Chebyshev) UCL	17.82

Potential UCLs to Use

95% KM (t) UCL	4.311

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.

Phenanthrene

General Statistics

Number of Valid Data	30	Number of Detected Data	10
Number of Distinct Detected Data	9	Number of Non-Detect Data	20
		Percent Non-Detects	66.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.043	Minimum Detected	-3.147
Maximum Detected	390.2	Maximum Detected	5.967
Mean of Detected	40.39	Mean of Detected	-0.325
SD of Detected	123	SD of Detected	2.705
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	27
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	90.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.381	Shapiro Wilk Test Statistic	0.843
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
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	13.53	Mean	-1.686
SD	71.17	SD	1.825
95% DL/2 (t) UCL	35.61	95% H-Stat (DL/2) UCL	3.389
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.88
		SD in Log Scale	2.252
		Mean in Original Scale	13.57
		SD in Original Scale	71.16
		95% t UCL	35.65
		95% Percentile Bootstrap UCL	39.51
		95% BCA Bootstrap UCL	65.24
		95% H-UCL	11.82

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.196	**Data appear Lognormal at 5% Significance Level**
Theta Star	205.8	
nu star	3.925	
A-D Test Statistic	1.75	**Nonparametric Statistics**
5% A-D Critical Value	0.859	Kaplan-Meier (KM) Method
K-S Test Statistic	0.859	Mean 13.54
5% K-S Critical Value	0.295	SD 69.97
Data not Gamma Distributed at 5% Significance Level		SE of Mean 13.47
		95% KM (t) UCL 36.42
Assuming Gamma Distribution		95% KM (z) UCL 35.69
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 35.62
Minimum	0.000001	95% KM (bootstrap t) UCL 2851
Maximum	390.2	95% KM (BCA) UCL 39.51
Mean	13.85	95% KM (Percentile Bootstrap) UCL 39.5
Median	0.000001	95% KM (Chebyshev) UCL 72.24
SD	71.14	97.5% KM (Chebyshev) UCL 97.64
k star	0.0886	99% KM (Chebyshev) UCL 147.5

Theta star	156.3
Nu star	5.319
AppChi2	1.302
95% Gamma Approximate UCL	56.57
95% Adjusted Gamma UCL	61.77

Potential UCLs to Use

99% KM (Chebyshev) UCL	147.5

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.

Pyrene

General Statistics

Number of Valid Data	30	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	17
		Percent Non-Detects	56.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.066	Minimum Detected	-2.718
Maximum Detected	276.2	Maximum Detected	5.621
Mean of Detected	22.85	Mean of Detected	-0.272
SD of Detected	76.18	SD of Detected	2.328
Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	24
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	6
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	80.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.337	Shapiro Wilk Test Statistic	0.843
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
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	9.955	Mean	-1.489
SD	50.33	SD	1.862
95% DL/2 (t) UCL	25.57	95% H-Stat (DL/2) UCL	4.622
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.662
		SD in Log Scale	2.186
		Mean in Original Scale	9.972
		SD in Original Scale	50.32
		95% t UCL	25.58
		95% Percentile Bootstrap UCL	28.21
		95% BCA Bootstrap UCL	37.91
		95% H-UCL	11.54

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.216	**Data do not follow a Discernable Distribution (0.05)**
Theta Star	105.8	
nu star	5.615	
A-D Test Statistic	2.2	**Nonparametric Statistics**
5% A-D Critical Value	0.863	Kaplan-Meier (KM) Method

K-S Test Statistic	0.863
5% K-S Critical Value	0.261

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	276.2
Mean	9.901
Median	0.000001
SD	50.34
k star	0.0954
Theta star	103.8
Nu star	5.724
AppChi2	1.501
95% Gamma Approximate UCL	37.77
95% Adjusted Gamma UCL	41.05

Note: DL/2 is not a recommended method.

Mean	9.972
SD	49.48
SE of Mean	9.402
95% KM (t) UCL	25.95
95% KM (z) UCL	25.44
95% KM (jackknife) UCL	25.58
95% KM (bootstrap t) UCL	415
95% KM (BCA) UCL	28.4
95% KM (Percentile Bootstrap) UCL	28.2
95% KM (Chebyshev) UCL	50.96
97.5% KM (Chebyshev) UCL	68.69
99% KM (Chebyshev) UCL	103.5

Potential UCLs to Use

99% KM (Chebyshev) UCL	103.5

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.

	A	B	C	D	E	F	G	H	I	J	K	L
1				General UCL Statistics for Data Sets with Non-Detects								
2		User Selected Options										
3			From File	FUDS Boundary w_Dec 2011 data.wst								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	10000								
7												
8												
9	methylnaphthalene											
10												
11				General Statistics								
12			Number of Valid Data			33			Number of Detected Data			12
13			Number of Distinct Detected Data			12			Number of Non-Detect Data			21
14									Percent Non-Detects			63.64%
15												
16			Raw Statistics						Log-transformed Statistics			
17			Minimum Detected			0.0142			Minimum Detected			-4.255
18			Maximum Detected			47			Maximum Detected			3.85
19			Mean of Detected			4.221			Mean of Detected			-1.649
20			SD of Detected			13.48			SD of Detected			2.293
21			Minimum Non-Detect			0.165			Minimum Non-Detect			-1.802
22			Maximum Non-Detect			0.6			Maximum Non-Detect			-0.511
23												
24	Note: Data have multiple DLs - Use of KM Method is recommended								Number treated as Non-Detect			30
25	For all methods (except KM, DL/2, and ROS Methods),								Number treated as Detected			3
26	Observations < Largest ND are treated as NDs								Single DL Non-Detect Percentage			90.91%
27												
28				UCL Statistics								
29			Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only			
30			Shapiro Wilk Test Statistic			0.352			Shapiro Wilk Test Statistic			0.902
31			5% Shapiro Wilk Critical Value			0.859			5% Shapiro Wilk Critical Value			0.859
32			Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level			
33												
34			Assuming Normal Distribution						Assuming Lognormal Distribution			
35			DL/2 Substitution Method						DL/2 Substitution Method			
36			Mean			1.594			Mean			-2.148
37			SD			8.156			SD			1.415
38			95% DL/2 (t) UCL			3.999			95% H-Stat (DL/2) UCL			0.671
39												
40			Maximum Likelihood Estimate(MLE) Method			N/A			Log ROS Method			
41			MLE yields a negative mean						Mean in Log Scale			-2.593
42									SD in Log Scale			1.9
43									Mean in Original Scale			1.595
44									SD in Original Scale			8.157
45									95% t UCL			4
46									95% Percentile Bootstrap UCL			4.416
47									95% BCA Bootstrap UCL			5.915
48									95% H-UCL			1.575
49												
50			Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only			
51			k star (bias corrected)			0.23			Data appear Lognormal at 5% Significance Level			

	A	B	C	D	E	F	G	H	I	J	K	L
52					Theta Star	18.35						
53					nu star	5.521						
54												
55					A-D Test Statistic	1.745	**Nonparametric Statistics**					
56					5% A-D Critical Value	0.852					Kaplan-Meier (KM) Method	
57					K-S Test Statistic	0.852					Mean	1.573
58					5% K-S Critical Value	0.269					SD	8.036
59	**Data not Gamma Distributed at 5% Significance Level**										SE of Mean	1.461
60											95% KM (t) UCL	4.048
61			**Assuming Gamma Distribution**								95% KM (z) UCL	3.976
62				Gamma ROS Statistics using Extrapolated Data							95% KM (jackknife) UCL	3.98
63					Minimum	0.000001					95% KM (bootstrap t) UCL	62.95
64					Maximum	47					95% KM (BCA) UCL	4.434
65					Mean	1.922					95% KM (Percentile Bootstrap) UCL	4.406
66					Median	0.0142					95% KM (Chebyshev) UCL	7.942
67					SD	8.175					97.5% KM (Chebyshev) UCL	10.7
68					k star	0.114					99% KM (Chebyshev) UCL	16.11
69					Theta star	16.9						
70					Nu star	7.507	**Potential UCLs to Use**					
71					AppChi2	2.453					99% KM (Chebyshev) UCL	16.11
72					95% Gamma Approximate UCL	5.883						
73					95% Adjusted Gamma UCL	6.256						
74	**Note: DL/2 is not a recommended method.**											
75												
76	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
77	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
78	**For additional insight, the user may want to consult a statistician.**											
79												
80												
81	**acenaphthene**											
82												
83					**General Statistics**							
84					Number of Valid Data	34					Number of Detected Data	7
85					Number of Distinct Detected Data	7					Number of Non-Detect Data	27
86											Percent Non-Detects	79.41%
87												
88					**Raw Statistics**		**Log-transformed Statistics**					
89					Minimum Detected	0.0356					Minimum Detected	-3.335
90					Maximum Detected	61.23					Maximum Detected	4.115
91					Mean of Detected	16.08					Mean of Detected	-0.122
92					SD of Detected	26.9					SD of Detected	3.139
93					Minimum Non-Detect	0.0382					Minimum Non-Detect	-3.265
94					Maximum Non-Detect	47.7					Maximum Non-Detect	3.865
95												
96	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	32
97	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	2
98	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	94.12%
99												
100	**Warning: There are only 7 Detected Values in this data**											
101	**Note: It should be noted that even though bootstrap may be performed on this data set**											
102	**the resulting calculations may not be reliable enough to draw conclusions**											

	A	B	C	D	E	F	G	H	I	J	K	L
103												
104	It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.											
105												
106												
107	UCL Statistics											
108	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
109					Shapiro Wilk Test Statistic	0.65			Shapiro Wilk Test Statistic			0.86
110					5% Shapiro Wilk Critical Value	0.803			5% Shapiro Wilk Critical Value			0.803
111	Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level					
112												
113	Assuming Normal Distribution						Assuming Lognormal Distribution					
114					DL/2 Substitution Method				DL/2 Substitution Method			
115					Mean	4.074			Mean			-1.952
116					SD	13.66			SD			1.977
117					95% DL/2 (t) UCL	8.038			95% H-Stat (DL/2) UCL			3.746
118												
119					Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method			
120	MLE method failed to converge properly								Mean in Log Scale			-3.226
121									SD in Log Scale			2.782
122									Mean in Original Scale			3.382
123									SD in Original Scale			13.22
124									95% t UCL			7.218
125									95% Percentile Bootstrap UCL			7.094
126									95% BCA Bootstrap UCL			9.444
127									95% H-UCL			22.72
128												
129	Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only					
130					k star (bias corrected)	0.236	Data appear Gamma Distributed at 5% Significance Level					
131					Theta Star	68.22						
132					nu star	3.299						
133												
134					A-D Test Statistic	0.7	Nonparametric Statistics					
135					5% A-D Critical Value	0.804			Kaplan-Meier (KM) Method			
136					K-S Test Statistic	0.804			Mean			3.346
137					5% K-S Critical Value	0.339			SD			13.03
138	Data appear Gamma Distributed at 5% Significance Level								SE of Mean			2.414
139									95% KM (t) UCL			7.43
140	Assuming Gamma Distribution								95% KM (z) UCL			7.315
141					Gamma ROS Statistics using Extrapolated Data				95% KM (jackknife) UCL			7.178
142					Minimum	0.000001			95% KM (bootstrap t) UCL			162.7
143					Maximum	61.23			95% KM (BCA) UCL			8.002
144					Mean	4.066			95% KM (Percentile Bootstrap) UCL			7.635
145					Median	0.000001			95% KM (Chebyshev) UCL			13.87
146					SD	13.31			97.5% KM (Chebyshev) UCL			18.42
147					k star	0.0913			99% KM (Chebyshev) UCL			27.36
148					Theta star	44.51						
149					Nu star	6.211	Potential UCLs to Use					
150					AppChi2	1.749			95% KM (t) UCL			7.43
151					95% Gamma Approximate UCL	14.44						
152					95% Adjusted Gamma UCL	15.45						
153	Note: DL/2 is not a recommended method.											

	A	B	C	D	E	F	G	H	I	J	K	L
154												
155	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
156	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
157	For additional insight, the user may want to consult a statistician.											
158												
159												
160	acenaphthylene											
161												
162	General Statistics											
163					Number of Valid Data	14			Number of Detected Data			8
164					Number of Distinct Detected Data	8			Number of Non-Detect Data			6
165									Percent Non-Detects			42.86%
166												
167	Raw Statistics						Log-transformed Statistics					
168					Minimum Detected	0.0167			Minimum Detected			-4.092
169					Maximum Detected	0.392			Maximum Detected			-0.936
170					Mean of Detected	0.101			Mean of Detected			-2.772
171					SD of Detected	0.123			SD of Detected			0.999
172					Minimum Non-Detect	0.0349			Minimum Non-Detect			-3.355
173					Maximum Non-Detect	2.02			Maximum Non-Detect			0.703
174												
175	Note: Data have multiple DLs - Use of KM Method is recommended								Number treated as Non-Detect			14
176	For all methods (except KM, DL/2, and ROS Methods),								Number treated as Detected			0
177	Observations < Largest ND are treated as NDs								Single DL Non-Detect Percentage			100.00%
178												
179	Warning: There are only 8 Detected Values in this data											
180	Note: It should be noted that even though bootstrap may be performed on this data set											
181	the resulting calculations may not be reliable enough to draw conclusions											
182												
183	It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.											
184												
185												
186	UCL Statistics											
187	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
188					Shapiro Wilk Test Statistic	0.677			Shapiro Wilk Test Statistic			0.958
189					5% Shapiro Wilk Critical Value	0.818			5% Shapiro Wilk Critical Value			0.818
190	Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level					
191												
192	Assuming Normal Distribution						Assuming Lognormal Distribution					
193					DL/2 Substitution Method				DL/2 Substitution Method			
194					Mean	0.197			Mean			-2.405
195					SD	0.268			SD			1.329
196					95% DL/2 (t) UCL	0.324			95% H-Stat (DL/2) UCL			0.757
197												
198					Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method			
199	MLE method failed to converge properly								Mean in Log Scale			-2.981
200									SD in Log Scale			0.871
201									Mean in Original Scale			0.0773
202									SD in Original Scale			0.0966
203									95% t UCL			0.123
204									95% Percentile Bootstrap UCL			0.123

	A–E	F	G–K	L
205			95% BCA Bootstrap UCL	0.149
206			95% H-UCL	0.138
207				
208	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
209	k star (bias corrected)	0.825	**Data appear Gamma Distributed at 5% Significance Level**	
210	Theta Star	0.122		
211	nu star	13.2		
212				
213	A-D Test Statistic	0.445	**Nonparametric Statistics**	
214	5% A-D Critical Value	0.733	Kaplan-Meier (KM) Method	
215	K-S Test Statistic	0.733	Mean	0.0856
216	5% K-S Critical Value	0.301	SD	0.107
217	**Data appear Gamma Distributed at 5% Significance Level**		SE of Mean	0.0363
218			95% KM (t) UCL	0.15
219	**Assuming Gamma Distribution**		95% KM (z) UCL	0.145
220	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.15
221	Minimum	0.000001	95% KM (bootstrap t) UCL	0.262
222	Maximum	0.392	95% KM (BCA) UCL	0.158
223	Mean	0.0805	95% KM (Percentile Bootstrap) UCL	0.15
224	Median	0.058	95% KM (Chebyshev) UCL	0.244
225	SD	0.101	97.5% KM (Chebyshev) UCL	0.312
226	k star	0.373	99% KM (Chebyshev) UCL	0.447
227	Theta star	0.216		
228	Nu star	10.44	**Potential UCLs to Use**	
229	AppChi2	4.218	95% KM (BCA) UCL	0.158
230	95% Gamma Approximate UCL	0.199		
231	95% Adjusted Gamma UCL	0.227		
232	**Note: DL/2 is not a recommended method.**			
233				
234	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
235	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**			
236	**For additional insight, the user may want to consult a statistician.**			
237				
238				
239	**anthracene**			
240				
241	**General Statistics**			
242	Number of Valid Data	22	Number of Detected Data	13
243	Number of Distinct Detected Data	12	Number of Non-Detect Data	9
244			Percent Non-Detects	40.91%
245				
246	**Raw Statistics**		**Log-transformed Statistics**	
247	Minimum Detected	0.0219	Minimum Detected	-3.821
248	Maximum Detected	147	Maximum Detected	4.99
249	Mean of Detected	21.37	Mean of Detected	-1.408
250	SD of Detected	51.63	SD of Detected	3.062
251	Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
252	Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511
253				
254	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	19
255	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3

	A	B	C	D	E	F	G	H	I	J	K	L
256	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	86.36%
257												
258						UCL Statistics						
259					Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only	
260						Shapiro Wilk Test Statistic	0.464				Shapiro Wilk Test Statistic	0.724
261						5% Shapiro Wilk Critical Value	0.866				5% Shapiro Wilk Critical Value	0.866
262					Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level	
263												
264					Assuming Normal Distribution						Assuming Lognormal Distribution	
265						DL/2 Substitution Method					DL/2 Substitution Method	
266						Mean	12.7				Mean	-1.618
267						SD	40.46				SD	2.366
268						95% DL/2 (t) UCL	27.54				95% H-Stat (DL/2) UCL	39.51
269												
270						Maximum Likelihood Estimate(MLE) Method	N/A				Log ROS Method	
271					MLE yields a negative mean						Mean in Log Scale	-1.915
272											SD in Log Scale	2.574
273											Mean in Original Scale	12.69
274											SD in Original Scale	40.46
275											95% t UCL	27.54
276											95% Percentile Bootstrap UCL	26.77
277											95% BCA Bootstrap UCL	32.62
278											95% H-UCL	75.3
279												
280					Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only	
281						k star (bias corrected)	0.181				Data do not follow a Discernable Distribution (0.05)	
282						Theta Star	117.9					
283						nu star	4.712					
284												
285						A-D Test Statistic	2.463				Nonparametric Statistics	
286						5% A-D Critical Value	0.88				Kaplan-Meier (KM) Method	
287						K-S Test Statistic	0.88				Mean	12.65
288						5% K-S Critical Value	0.263				SD	39.55
289					Data not Gamma Distributed at 5% Significance Level						SE of Mean	8.776
290											95% KM (t) UCL	27.75
291					Assuming Gamma Distribution						95% KM (z) UCL	27.09
292						Gamma ROS Statistics using Extrapolated Data					95% KM (jackknife) UCL	27.5
293						Minimum	0.000001				95% KM (bootstrap t) UCL	1058
294						Maximum	147				95% KM (BCA) UCL	30.81
295						Mean	13.37				95% KM (Percentile Bootstrap) UCL	26.8
296						Median	0.0408				95% KM (Chebyshev) UCL	50.9
297						SD	40.32				97.5% KM (Chebyshev) UCL	67.46
298						k star	0.122				99% KM (Chebyshev) UCL	99.97
299						Theta star	110					
300						Nu star	5.349				Potential UCLs to Use	
301						AppChi2	1.317				99% KM (Chebyshev) UCL	99.97
302						95% Gamma Approximate UCL	54.3					
303						95% Adjusted Gamma UCL	60.85					
304	Note: DL/2 is not a recommended method.											
305												
306	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											

	A	B	C	D	E	F	G	H	I	J	K	L
307	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
308	For additional insight, the user may want to consult a statistician.											
309												
310												
311	B(a)A											
312												
313	General Statistics											
314					Number of Valid Data	22			Number of Detected Data			13
315					Number of Distinct Detected Data	13			Number of Non-Detect Data			9
316									Percent Non-Detects			40.91%
317												
318	Raw Statistics						Log-transformed Statistics					
319					Minimum Detected	0.0379			Minimum Detected			-3.273
320					Maximum Detected	244			Maximum Detected			5.497
321					Mean of Detected	32.54			Mean of Detected			-0.134
322					SD of Detected	78.86			SD of Detected			2.702
323					Minimum Non-Detect	0.165			Minimum Non-Detect			-1.802
324					Maximum Non-Detect	0.6			Maximum Non-Detect			-0.511
325												
326	Note: Data have multiple DLs - Use of KM Method is recommended								Number treated as Non-Detect			18
327	For all methods (except KM, DL/2, and ROS Methods),								Number treated as Detected			4
328	Observations < Largest ND are treated as NDs								Single DL Non-Detect Percentage			81.82%
329												
330	UCL Statistics											
331	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
332					Shapiro Wilk Test Statistic	0.477			Shapiro Wilk Test Statistic			0.819
333					5% Shapiro Wilk Critical Value	0.866			5% Shapiro Wilk Critical Value			0.866
334	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
335												
336	Assuming Normal Distribution						Assuming Lognormal Distribution					
337					DL/2 Substitution Method				DL/2 Substitution Method			
338					Mean	19.3			Mean			-0.865
339					SD	61.8			SD			2.271
340					95% DL/2 (t) UCL	41.98			95% H-Stat (DL/2) UCL			55.82
341												
342					Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method			
343	MLE yields a negative mean								Mean in Log Scale			-1.425
344									SD in Log Scale			2.791
345									Mean in Original Scale			19.28
346									SD in Original Scale			61.81
347									95% t UCL			41.96
348									95% Percentile Bootstrap UCL			42.39
349									95% BCA Bootstrap UCL			53.24
350									95% H-UCL			356.3
351												
352	Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only					
353					k star (bias corrected)	0.207	Data do not follow a Discernable Distribution (0.05)					
354					Theta Star	156.9						
355					nu star	5.394						
356												
357					A-D Test Statistic	2.138	Nonparametric Statistics					

	A	B	C	D	E	F	G	H	I	J	K	L
358					5% A-D Critical Value	0.867					Kaplan-Meier (KM) Method	
359					K-S Test Statistic	0.867					Mean	19.28
360					5% K-S Critical Value	0.261					SD	60.39
361				Data not Gamma Distributed at 5% Significance Level							SE of Mean	13.4
362											95% KM (t) UCL	42.34
363				Assuming Gamma Distribution							95% KM (z) UCL	41.32
364				Gamma ROS Statistics using Extrapolated Data							95% KM (jackknife) UCL	41.96
365					Minimum	0.000001					95% KM (bootstrap t) UCL	964.8
366					Maximum	244					95% KM (BCA) UCL	44.56
367					Mean	19.39					95% KM (Percentile Bootstrap) UCL	41.74
368					Median	0.186					95% KM (Chebyshev) UCL	77.69
369					SD	61.78					97.5% KM (Chebyshev) UCL	103
370					k star	0.118					99% KM (Chebyshev) UCL	152.6
371					Theta star	164.7						
372					Nu star	5.18					Potential UCLs to Use	
373					AppChi2	1.236					99% KM (Chebyshev) UCL	152.6
374					95% Gamma Approximate UCL	81.26						
375					95% Adjusted Gamma UCL	91.29						
376	Note: DL/2 is not a recommended method.											
377												
378	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
379	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
380	For additional insight, the user may want to consult a statistician.											
381												
382												
383	B(a)P											
384												
385				General Statistics								
386					Number of Valid Data	22					Number of Detected Data	11
387					Number of Distinct Detected Data	11					Number of Non-Detect Data	11
388											Percent Non-Detects	50.00%
389												
390				Raw Statistics							Log-transformed Statistics	
391					Minimum Detected	0.0349					Minimum Detected	-3.355
392					Maximum Detected	206					Maximum Detected	5.328
393					Mean of Detected	30.57					Mean of Detected	-0.00594
394					SD of Detected	68.7					SD of Detected	2.825
395					Minimum Non-Detect	0.165					Minimum Non-Detect	-1.802
396					Maximum Non-Detect	0.6					Maximum Non-Detect	-0.511
397												
398	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	17
399	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	5
400	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	77.27%
401												
402				UCL Statistics								
403				Normal Distribution Test with Detected Values Only							Lognormal Distribution Test with Detected Values Only	
404					Shapiro Wilk Test Statistic	0.523					Shapiro Wilk Test Statistic	0.864
405					5% Shapiro Wilk Critical Value	0.85					5% Shapiro Wilk Critical Value	0.85
406				Data not Normal at 5% Significance Level							Data appear Lognormal at 5% Significance Level	
407												
408				Assuming Normal Distribution							Assuming Lognormal Distribution	

	A	B	C	D	E	F	G	H	I	J	K	L
409					DL/2 Substitution Method						DL/2 Substitution Method	
410					Mean	15.36					Mean	-1.016
411					SD	49.9					SD	2.252
412					95% DL/2 (t) UCL	33.67					95% H-Stat (DL/2) UCL	44.34
413												
414				Maximum Likelihood Estimate(MLE) Method		N/A					Log ROS Method	
415				**MLE yields a negative mean**							Mean in Log Scale	-1.872
416											SD in Log Scale	2.97
417											Mean in Original Scale	15.32
418											SD in Original Scale	49.91
419											95% t UCL	33.63
420											95% Percentile Bootstrap UCL	34.2
421											95% BCA Bootstrap UCL	43.29
422											95% H-UCL	586.5
423												
424				**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**		
425					k star (bias corrected)	0.215				**Data appear Lognormal at 5% Significance Level**		
426					Theta Star	142						
427					nu star	4.737						
428												
429					A-D Test Statistic	1.483				**Nonparametric Statistics**		
430					5% A-D Critical Value	0.855					Kaplan-Meier (KM) Method	
431					K-S Test Statistic	0.855					Mean	15.32
432					5% K-S Critical Value	0.281					SD	48.76
433				**Data not Gamma Distributed at 5% Significance Level**							SE of Mean	10.9
434											95% KM (t) UCL	34.08
435				**Assuming Gamma Distribution**							95% KM (z) UCL	33.26
436					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	33.63
437					Minimum	0.000001					95% KM (bootstrap t) UCL	752.1
438					Maximum	206					95% KM (BCA) UCL	35.61
439					Mean	15.28					95% KM (Percentile Bootstrap) UCL	34.02
440					Median	0.0175					95% KM (Chebyshev) UCL	62.85
441					SD	49.92					97.5% KM (Chebyshev) UCL	83.42
442					k star	0.104					99% KM (Chebyshev) UCL	123.8
443					Theta star	146.3						
444					Nu star	4.596				**Potential UCLs to Use**		
445					AppChi2	0.97					99% KM (Chebyshev) UCL	123.8
446					95% Gamma Approximate UCL	72.4						
447					95% Adjusted Gamma UCL	82.16						
448	**Note: DL/2 is not a recommended method.**											
449												
450				**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**								
451				**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**								
452				**For additional insight, the user may want to consult a statistician.**								
453												
454												
455	**B(b)F**											
456												
457					**General Statistics**							
458					Number of Valid Data	37					Number of Detected Data	13
459					Number of Distinct Detected Data	13					Number of Non-Detect Data	24

	A	B	C	D	E	F	G	H	I	J	K	L
460											Percent Non-Detects	64.86%
461												
462				**Raw Statistics**						**Log-transformed Statistics**		
463					Minimum Detected	0.0447					Minimum Detected	-3.108
464					Maximum Detected	161					Maximum Detected	5.081
465					Mean of Detected	23.06					Mean of Detected	0.216
466					SD of Detected	53.14					SD of Detected	2.555
467					Minimum Non-Detect	0.165					Minimum Non-Detect	-1.802
468					Maximum Non-Detect	0.6					Maximum Non-Detect	-0.511
469												
470	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	31
471	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	6
472	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	83.78%
473												
474						**UCL Statistics**						
475				**Normal Distribution Test with Detected Values Only**						**Lognormal Distribution Test with Detected Values Only**		
476					Shapiro Wilk Test Statistic	0.495					Shapiro Wilk Test Statistic	0.912
477					5% Shapiro Wilk Critical Value	0.866					5% Shapiro Wilk Critical Value	0.866
478				**Data not Normal at 5% Significance Level**						**Data appear Lognormal at 5% Significance Level**		
479												
480				**Assuming Normal Distribution**						**Assuming Lognormal Distribution**		
481					DL/2 Substitution Method						DL/2 Substitution Method	
482					Mean	8.175					Mean	-1.438
483					SD	32.63					SD	1.954
484					95% DL/2 (t) UCL	17.23					95% H-Stat (DL/2) UCL	5.288
485												
486					Maximum Likelihood Estimate(MLE) Method	N/A					Log ROS Method	
487					**MLE yields a negative mean**						Mean in Log Scale	-2.555
488											SD in Log Scale	2.989
489											Mean in Original Scale	8.142
490											SD in Original Scale	32.64
491											95% t UCL	17.2
492											95% Percentile Bootstrap UCL	17.83
493											95% BCA Bootstrap UCL	22.51
494											95% H-UCL	92.03
495												
496				**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**		
497					k star (bias corrected)	0.239				**Data appear Lognormal at 5% Significance Level**		
498					Theta Star	96.5						
499					nu star	6.214						
500												
501					A-D Test Statistic	1.455				**Nonparametric Statistics**		
502					5% A-D Critical Value	0.851					Kaplan-Meier (KM) Method	
503					K-S Test Statistic	0.851					Mean	8.146
504					5% K-S Critical Value	0.259					SD	32.19
505				**Data not Gamma Distributed at 5% Significance Level**							SE of Mean	5.509
506											95% KM (t) UCL	17.45
507				**Assuming Gamma Distribution**							95% KM (z) UCL	17.21
508					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	17.2
509					Minimum	0.000001					95% KM (bootstrap t) UCL	189.8
510					Maximum	161					95% KM (BCA) UCL	17.79

	A	B	C	D	E	F	G	H	I	J	K	L
511					Mean	8.104			95% KM (Percentile Bootstrap) UCL			17.23
512					Median	0.000001			95% KM (Chebyshev) UCL			32.16
513					SD	32.65			97.5% KM (Chebyshev) UCL			42.55
514					k star	0.0882			99% KM (Chebyshev) UCL			62.96
515					Theta star	91.87						
516					Nu star	6.528			**Potential UCLs to Use**			
517					AppChi2	1.915			99% KM (Chebyshev) UCL			62.96
518					95% Gamma Approximate UCL	27.62						
519					95% Adjusted Gamma UCL	29.24						
520	**Note: DL/2 is not a recommended method.**											
521												
522	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
523	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
524	**For additional insight, the user may want to consult a statistician.**											
525												
526												
527	**B(ghi)P**											
528												
529	**General Statistics**											
530					Number of Valid Data	18			Number of Detected Data			8
531					Number of Distinct Detected Data	8			Number of Non-Detect Data			10
532									Percent Non-Detects			55.56%
533												
534	**Raw Statistics**						**Log-transformed Statistics**					
535					Minimum Detected	0.1			Minimum Detected			-2.303
536					Maximum Detected	99			Maximum Detected			4.595
537					Mean of Detected	12.71			Mean of Detected			-0.693
538					SD of Detected	34.87			SD of Detected			2.326
539					Minimum Non-Detect	0.165			Minimum Non-Detect			-1.802
540					Maximum Non-Detect	0.6			Maximum Non-Detect			-0.511
541												
542	Note: Data have multiple DLs - Use of KM Method is recommended								Number treated as Non-Detect			16
543	For all methods (except KM, DL/2, and ROS Methods),								Number treated as Detected			2
544	Observations < Largest ND are treated as NDs								Single DL Non-Detect Percentage			88.89%
545												
546	**Warning: There are only 8 Detected Values in this data**											
547	**Note: It should be noted that even though bootstrap may be performed on this data set**											
548	**the resulting calculations may not be reliable enough to draw conclusions**											
549												
550	**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**											
551												
552												
553	**UCL Statistics**											
554	**Normal Distribution Test with Detected Values Only**						**Lognormal Distribution Test with Detected Values Only**					
555					Shapiro Wilk Test Statistic	0.428			Shapiro Wilk Test Statistic			0.738
556					5% Shapiro Wilk Critical Value	0.818			5% Shapiro Wilk Critical Value			0.818
557	**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**					
558												
559	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
560					DL/2 Substitution Method				DL/2 Substitution Method			
561					Mean	5.744			Mean			-1.407

	A	B	C	D	E	F	G	H	I	J	K	L
562					SD	23.28					SD	1.701
563					95% DL/2 (t) UCL	15.29					95% H-Stat (DL/2) UCL	4.954
564												
565				Maximum Likelihood Estimate(MLE) Method		N/A					Log ROS Method	
566				**MLE method failed to converge properly**							Mean in Log Scale	-1.658
567											SD in Log Scale	1.922
568											Mean in Original Scale	5.732
569											SD in Original Scale	23.28
570											95% t UCL	15.28
571											95% Percentile Bootstrap UCL	16.68
572											95% BCA Bootstrap UCL	22.29
573											95% H-UCL	8.459
574												
575				**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**		
576					k star (bias corrected)	0.223				**Data do not follow a Discernable Distribution (0.05)**		
577					Theta Star	57						
578					nu star	3.568						
579												
580					A-D Test Statistic	1.638				**Nonparametric Statistics**		
581					5% A-D Critical Value	0.827					Kaplan-Meier (KM) Method	
582					K-S Test Statistic	0.827					Mean	5.721
583					5% K-S Critical Value	0.322					SD	22.63
584				**Data not Gamma Distributed at 5% Significance Level**							SE of Mean	5.701
585											95% KM (t) UCL	15.64
586				**Assuming Gamma Distribution**							95% KM (z) UCL	15.1
587					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	15.27
588					Minimum	0.000001					95% KM (bootstrap t) UCL	990.6
589					Maximum	99					95% KM (BCA) UCL	16.7
590					Mean	5.924					95% KM (Percentile Bootstrap) UCL	16.68
591					Median	0.05					95% KM (Chebyshev) UCL	30.57
592					SD	23.26					97.5% KM (Chebyshev) UCL	41.32
593					k star	0.114					99% KM (Chebyshev) UCL	62.45
594					Theta star	52.06						
595					Nu star	4.097				**Potential UCLs to Use**		
596					AppChi2	0.76					99% KM (Chebyshev) UCL	62.45
597					95% Gamma Approximate UCL	31.92						
598					95% Adjusted Gamma UCL	38.09						
599	**Note: DL/2 is not a recommended method.**											
600												
601				**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**								
602				**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**								
603				**For additional insight, the user may want to consult a statistician.**								
604												
605												
606	**B(k)F**											
607												
608						**General Statistics**						
609					Number of Valid Data	37					Number of Detected Data	12
610					Number of Distinct Detected Data	11					Number of Non-Detect Data	25
611											Percent Non-Detects	67.57%
612												

	A–E	F	G–K	L
613	**Raw Statistics**		**Log-transformed Statistics**	
614	Minimum Detected	0.0418	Minimum Detected	-3.175
615	Maximum Detected	182	Maximum Detected	5.204
616	Mean of Detected	23.65	Mean of Detected	0.0299
617	SD of Detected	55.8	SD of Detected	2.696
618	Minimum Non-Detect	0.165	Minimum Non-Detect	-1.802
619	Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511
620				
621	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	32
622	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	5
623	Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	86.49%
624				
625	**UCL Statistics**			
626	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
627	Shapiro Wilk Test Statistic	0.503	Shapiro Wilk Test Statistic	0.895
628	5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
629	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
630				
631	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
632	DL/2 Substitution Method		DL/2 Substitution Method	
633	Mean	7.749	Mean	-1.537
634	SD	32.8	SD	1.894
635	95% DL/2 (t) UCL	16.85	95% H-Stat (DL/2) UCL	3.995
636				
637	Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
638	**MLE yields a negative mean**		Mean in Log Scale	-1.887
639			SD in Log Scale	2.441
640			Mean in Original Scale	7.78
641			SD in Original Scale	32.8
642			95% t UCL	16.88
643			95% Percentile Bootstrap UCL	17.5
644			95% BCA Bootstrap UCL	24.72
645			95% H-UCL	17.8
646				
647	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
648	k star (bias corrected)	0.228	**Data appear Lognormal at 5% Significance Level**	
649	Theta Star	103.8		
650	nu star	5.469		
651				
652	A-D Test Statistic	1.351	**Nonparametric Statistics**	
653	5% A-D Critical Value	0.853	Kaplan-Meier (KM) Method	
654	K-S Test Statistic	0.853	Mean	7.743
655	5% K-S Critical Value	0.269	SD	32.36
656	**Data not Gamma Distributed at 5% Significance Level**		SE of Mean	5.556
657			95% KM (t) UCL	17.12
658	**Assuming Gamma Distribution**		95% KM (z) UCL	16.88
659	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	16.85
660	Minimum	0.000001	95% KM (bootstrap t) UCL	211
661	Maximum	182	95% KM (BCA) UCL	17.68
662	Mean	7.856	95% KM (Percentile Bootstrap) UCL	17.53
663	Median	0.000001	95% KM (Chebyshev) UCL	31.96

	A	B	C	D	E	F	G	H	I	J	K	L
664					SD	32.79				97.5% KM (Chebyshev) UCL		42.44
665					k star	0.0905				99% KM (Chebyshev) UCL		63.03
666					Theta star	86.84						
667					Nu star	6.695				**Potential UCLs to Use**		
668					AppChi2	2.005				99% KM (Chebyshev) UCL		63.03
669					95% Gamma Approximate UCL	26.24						
670					95% Adjusted Gamma UCL	27.75						
671	**Note: DL/2 is not a recommended method.**											
672												
673	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
674	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
675	**For additional insight, the user may want to consult a statistician.**											
676												
677												
678	**Chrysene**											
679												
680	**General Statistics**											
681					Number of Valid Data	37				Number of Detected Data		14
682					Number of Distinct Detected Data	14				Number of Non-Detect Data		23
683										Percent Non-Detects		62.16%
684												
685	**Raw Statistics**						**Log-transformed Statistics**					
686					Minimum Detected	0.0515				Minimum Detected		-2.966
687					Maximum Detected	227				Maximum Detected		5.425
688					Mean of Detected	28.25				Mean of Detected		0.129
689					SD of Detected	70.28				SD of Detected		2.503
690					Minimum Non-Detect	0.165				Minimum Non-Detect		-1.802
691					Maximum Non-Detect	0.6				Maximum Non-Detect		-0.511
692												
693	Note: Data have multiple DLs - Use of KM Method is recommended									Number treated as Non-Detect		31
694	For all methods (except KM, DL/2, and ROS Methods),									Number treated as Detected		6
695	Observations < Largest ND are treated as NDs									Single DL Non-Detect Percentage		83.78%
696												
697	**UCL Statistics**											
698	**Normal Distribution Test with Detected Values Only**						**Lognormal Distribution Test with Detected Values Only**					
699					Shapiro Wilk Test Statistic	0.464				Shapiro Wilk Test Statistic		0.853
700					5% Shapiro Wilk Critical Value	0.874				5% Shapiro Wilk Critical Value		0.874
701	**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**					
702												
703	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
704					DL/2 Substitution Method					DL/2 Substitution Method		
705					Mean	10.76				Mean		-1.363
706					SD	44.44				SD		1.951
707					95% DL/2 (t) UCL	23.1				95% H-Stat (DL/2) UCL		5.639
708												
709					Maximum Likelihood Estimate(MLE) Method	N/A				Log ROS Method		
710	**MLE yields a negative mean**									Mean in Log Scale		-2.393
711										SD in Log Scale		2.885
712										Mean in Original Scale		10.73
713										SD in Original Scale		44.45
714										95% t UCL		23.06

	A–E	F	G–K	L
715			95% Percentile Bootstrap UCL	23.39
716			95% BCA Bootstrap UCL	31.16
717			95% H-UCL	67.37
718				
719	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
720	k star (bias corrected)	0.224	**Data do not follow a Discernable Distribution (0.05)**	
721	Theta Star	125.9		
722	nu star	6.281		
723				
724	A-D Test Statistic	2.102	**Nonparametric Statistics**	
725	5% A-D Critical Value	0.863	Kaplan-Meier (KM) Method	
726	K-S Test Statistic	0.863	Mean	10.74
727	5% K-S Critical Value	0.252	SD	43.84
728	**Data not Gamma Distributed at 5% Significance Level**		SE of Mean	7.479
729			95% KM (t) UCL	23.37
730	**Assuming Gamma Distribution**		95% KM (z) UCL	23.04
731	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	23.08
732	Minimum	0.000001	95% KM (bootstrap t) UCL	448.9
733	Maximum	227	95% KM (BCA) UCL	25.23
734	Mean	10.69	95% KM (Percentile Bootstrap) UCL	23.25
735	Median	0.000001	95% KM (Chebyshev) UCL	43.34
736	SD	44.46	97.5% KM (Chebyshev) UCL	57.45
737	k star	0.0886	99% KM (Chebyshev) UCL	85.16
738	Theta star	120.6		
739	Nu star	6.557	**Potential UCLs to Use**	
740	AppChi2	1.931	99% KM (Chebyshev) UCL	85.16
741	95% Gamma Approximate UCL	36.3		
742	95% Adjusted Gamma UCL	38.43		
743	**Note: DL/2 is not a recommended method.**			
744				
745	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
746	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**			
747	**For additional insight, the user may want to consult a statistician.**			
748				
749				
750	**Dibenz**			
751				
752	**General Statistics**			
753	Number of Valid Data	22	Number of Detected Data	6
754	Number of Distinct Detected Data	6	Number of Non-Detect Data	16
755			Percent Non-Detects	72.73%
756				
757	**Raw Statistics**		**Log-transformed Statistics**	
758	Minimum Detected	0.061	Minimum Detected	-2.797
759	Maximum Detected	37.4	Maximum Detected	3.622
760	Mean of Detected	10.4	Mean of Detected	-0.111
761	SD of Detected	16.28	SD of Detected	2.859
762	Minimum Non-Detect	0.0382	Minimum Non-Detect	-3.265
763	Maximum Non-Detect	0.6	Maximum Non-Detect	-0.511
764				
765	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	19

	A	B	C	D	E	F	G	H	I	J	K	L
766	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	3
767	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	86.36%
768												
769	Warning: There are only 6 Detected Values in this data											
770	Note: It should be noted that even though bootstrap may be performed on this data set											
771	the resulting calculations may not be reliable enough to draw conclusions											
772												
773	It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.											
774												
775												
776	UCL Statistics											
777	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
778					Shapiro Wilk Test Statistic	0.715					Shapiro Wilk Test Statistic	0.842
779					5% Shapiro Wilk Critical Value	0.788					5% Shapiro Wilk Critical Value	0.788
780	Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level					
781												
782	Assuming Normal Distribution						Assuming Lognormal Distribution					
783					DL/2 Substitution Method						DL/2 Substitution Method	
784					Mean	2.924					Mean	-1.899
785					SD	9.224					SD	1.976
786					95% DL/2 (t) UCL	6.308					95% H-Stat (DL/2) UCL	6.292
787												
788					Maximum Likelihood Estimate(MLE) Method	N/A					Log ROS Method	
789	MLE yields a negative mean										Mean in Log Scale	-4.711
790											SD in Log Scale	3.842
791											Mean in Original Scale	2.853
792											SD in Original Scale	9.246
793											95% t UCL	6.245
794											95% Percentile Bootstrap UCL	6.254
795											95% BCA Bootstrap UCL	7.935
796											95% H-UCL	7963
797												
798	Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only					
799					k star (bias corrected)	0.253	Data appear Gamma Distributed at 5% Significance Level					
800					Theta Star	41.13						
801					nu star	3.035						
802												
803					A-D Test Statistic	0.654	Nonparametric Statistics					
804					5% A-D Critical Value	0.773					Kaplan-Meier (KM) Method	
805					K-S Test Statistic	0.773					Mean	2.889
806					5% K-S Critical Value	0.358					SD	9.022
807	Data appear Gamma Distributed at 5% Significance Level										SE of Mean	2.107
808											95% KM (t) UCL	6.515
809	Assuming Gamma Distribution										95% KM (z) UCL	6.355
810					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	6.267
811					Minimum	0.000001					95% KM (bootstrap t) UCL	164.2
812					Maximum	37.4					95% KM (BCA) UCL	7.372
813					Mean	2.938					95% KM (Percentile Bootstrap) UCL	6.758
814					Median	0.000001					95% KM (Chebyshev) UCL	12.07
815					SD	9.231					97.5% KM (Chebyshev) UCL	16.05
816					k star	0.099					99% KM (Chebyshev) UCL	23.86

	A	B	C	D	E	F	G	H	I	J	K	L
817					Theta star	29.67						
818					Nu star	4.357	Potential UCLs to Use					
819					AppChi2	0.867					95% KM (t) UCL	6.515
820				95% Gamma Approximate UCL		14.76						
821				95% Adjusted Gamma UCL		16.83						
822	Note: DL/2 is not a recommended method.											
823												
824	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
825	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
826	For additional insight, the user may want to consult a statistician.											
827												
828												
829	Fluoranthene											
830												
831	General Statistics											
832				Number of Valid Data		37				Number of Detected Data		19
833				Number of Distinct Detected Data		19				Number of Non-Detect Data		18
834										Percent Non-Detects		48.65%
835												
836	Raw Statistics						Log-transformed Statistics					
837				Minimum Detected		0.0155				Minimum Detected		-4.167
838				Maximum Detected		612				Maximum Detected		6.417
839				Mean of Detected		53.48				Mean of Detected		0.131
840				SD of Detected		160.1				SD of Detected		2.599
841				Minimum Non-Detect		0.165				Minimum Non-Detect		-1.802
842				Maximum Non-Detect		0.6				Maximum Non-Detect		-0.511
843												
844	Note: Data have multiple DLs - Use of KM Method is recommended									Number treated as Non-Detect		26
845	For all methods (except KM, DL/2, and ROS Methods),									Number treated as Detected		11
846	Observations < Largest ND are treated as NDs									Single DL Non-Detect Percentage		70.27%
847												
848	UCL Statistics											
849	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
850				Shapiro Wilk Test Statistic		0.383				Shapiro Wilk Test Statistic		0.877
851				5% Shapiro Wilk Critical Value		0.901				5% Shapiro Wilk Critical Value		0.901
852	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
853												
854	Assuming Normal Distribution						Assuming Lognormal Distribution					
855				DL/2 Substitution Method						DL/2 Substitution Method		
856				Mean		27.52				Mean		-1.077
857				SD		116.4				SD		2.245
858				95% DL/2 (t) UCL		59.82				95% H-Stat (DL/2) UCL		19.6
859												
860				Maximum Likelihood Estimate(MLE) Method		N/A				Log ROS Method		
861	MLE yields a negative mean									Mean in Log Scale		-1.852
862										SD in Log Scale		3.005
863										Mean in Original Scale		27.49
864										SD in Original Scale		116.4
865										95% t UCL		59.8
866										95% Percentile Bootstrap UCL		60.87
867										95% BCA Bootstrap UCL		77.07

	A	B	C	D	E	F	G	H	I	J	K	L
868											95% H-UCL	199.8
869												
870	**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**					
871					k star (bias corrected)	0.197	**Data do not follow a Discernable Distribution (0.05)**					
872					Theta Star	271.4						
873					nu star	7.489						
874												
875					A-D Test Statistic	3.202	**Nonparametric Statistics**					
876					5% A-D Critical Value	0.891					Kaplan-Meier (KM) Method	
877					K-S Test Statistic	0.891					Mean	27.51
878					5% K-S Critical Value	0.22					SD	114.8
879	**Data not Gamma Distributed at 5% Significance Level**										SE of Mean	19.39
880											95% KM (t) UCL	60.25
881	**Assuming Gamma Distribution**										95% KM (z) UCL	59.41
882					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	59.81
883					Minimum	0.000001					95% KM (bootstrap t) UCL	1612
884					Maximum	612					95% KM (BCA) UCL	64.49
885					Mean	27.46					95% KM (Percentile Bootstrap) UCL	60.81
886					Median	0.0155					95% KM (Chebyshev) UCL	112
887					SD	116.4					97.5% KM (Chebyshev) UCL	148.6
888					k star	0.0946					99% KM (Chebyshev) UCL	220.5
889					Theta star	290.4						
890					Nu star	6.998	**Potential UCLs to Use**					
891					AppChi2	2.169					99% KM (Chebyshev) UCL	220.5
892					95% Gamma Approximate UCL	88.59						
893					95% Adjusted Gamma UCL	93.54						
894	**Note: DL/2 is not a recommended method.**											
895												
896	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
897	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
898	**For additional insight, the user may want to consult a statistician.**											
899												
900												
901	**Fluorene**											
902												
903	**General Statistics**											
904					Number of Valid Data	22					Number of Detected Data	8
905					Number of Distinct Detected Data	8					Number of Non-Detect Data	14
906											Percent Non-Detects	63.64%
907												
908	**Raw Statistics**						**Log-transformed Statistics**					
909					Minimum Detected	0.0141					Minimum Detected	-4.262
910					Maximum Detected	86.75					Maximum Detected	4.463
911					Mean of Detected	20.14					Mean of Detected	-0.976
912					SD of Detected	37.03					SD of Detected	3.58
913					Minimum Non-Detect	0.0382					Minimum Non-Detect	-3.265
914					Maximum Non-Detect	0.6					Maximum Non-Detect	-0.511
915												
916	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	19
917	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	3
918	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	86.36%

	A	B	C	D	E	F	G	H	I	J	K	L
919												
920	Warning: There are only 8 Detected Values in this data											
921	Note: It should be noted that even though bootstrap may be performed on this data set											
922	the resulting calculations may not be reliable enough to draw conclusions											
923												
924	It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.											
925												
926												
927	UCL Statistics											
928	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
929					Shapiro Wilk Test Statistic	0.598			Shapiro Wilk Test Statistic			0.814
930					5% Shapiro Wilk Critical Value	0.818			5% Shapiro Wilk Critical Value			0.818
931	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
932												
933	Assuming Normal Distribution						Assuming Lognormal Distribution					
934					DL/2 Substitution Method				DL/2 Substitution Method			
935					Mean	7.409			Mean			-1.885
936					SD	23.54			SD			2.308
937					95% DL/2 (t) UCL	16.04			95% H-Stat (DL/2) UCL			23.49
938												
939					Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method			
940	MLE yields a negative mean								Mean in Log Scale			-2.796
941									SD in Log Scale			2.9
942									Mean in Original Scale			7.38
943									SD in Original Scale			23.55
944									95% t UCL			16.02
945									95% Percentile Bootstrap UCL			15.36
946									95% BCA Bootstrap UCL			19.18
947									95% H-UCL			159.8
948												
949	Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only					
950					k star (bias corrected)	0.2	Data do not follow a Discernable Distribution (0.05)					
951					Theta Star	100.6						
952					nu star	3.202						
953												
954					A-D Test Statistic	1.041	Nonparametric Statistics					
955					5% A-D Critical Value	0.841			Kaplan-Meier (KM) Method			
956					K-S Test Statistic	0.841			Mean			7.345
957					5% K-S Critical Value	0.324			SD			23.02
958	Data not Gamma Distributed at 5% Significance Level								SE of Mean			5.246
959									95% KM (t) UCL			16.37
960	Assuming Gamma Distribution								95% KM (z) UCL			15.97
961					Gamma ROS Statistics using Extrapolated Data				95% KM (jackknife) UCL			15.99
962					Minimum	0.000001			95% KM (bootstrap t) UCL			648
963					Maximum	86.75			95% KM (BCA) UCL			17.85
964					Mean	8.062			95% KM (Percentile Bootstrap) UCL			15.34
965					Median	0.00705			95% KM (Chebyshev) UCL			30.21
966					SD	23.48			97.5% KM (Chebyshev) UCL			40.11
967					k star	0.107			99% KM (Chebyshev) UCL			59.54
968					Theta star	75.32						
969					Nu star	4.71	Potential UCLs to Use					

	A	B	C	D	E	F	G	H	I	J	K	L
970					AppChi2	1.02				99% KM (Chebyshev) UCL		59.54
971				95% Gamma Approximate UCL		37.21						
972				95% Adjusted Gamma UCL		42.14						
973	Note: DL/2 is not a recommended method.											
974												
975	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
976	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
977	For additional insight, the user may want to consult a statistician.											
978												
979												
980	Indeno											
981												
982	General Statistics											
983				Number of Valid Data		22				Number of Detected Data		12
984				Number of Distinct Detected Data		12				Number of Non-Detect Data		10
985										Percent Non-Detects		45.45%
986												
987	Raw Statistics						Log-transformed Statistics					
988				Minimum Detected		0.0308				Minimum Detected		-3.48
989				Maximum Detected		82.2				Maximum Detected		4.409
990				Mean of Detected		12.08				Mean of Detected		-0.816
991				SD of Detected		27.91				SD of Detected		2.581
992				Minimum Non-Detect		0.165				Minimum Non-Detect		-1.802
993				Maximum Non-Detect		0.6				Maximum Non-Detect		-0.511
994												
995	Note: Data have multiple DLs - Use of KM Method is recommended									Number treated as Non-Detect		19
996	For all methods (except KM, DL/2, and ROS Methods),									Number treated as Detected		3
997	Observations < Largest ND are treated as NDs									Single DL Non-Detect Percentage		86.36%
998												
999	UCL Statistics											
1000	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
1001				Shapiro Wilk Test Statistic		0.497				Shapiro Wilk Test Statistic		0.804
1002				5% Shapiro Wilk Critical Value		0.859				5% Shapiro Wilk Critical Value		0.859
1003	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
1004												
1005	Assuming Normal Distribution						Assuming Lognormal Distribution					
1006				DL/2 Substitution Method						DL/2 Substitution Method		
1007				Mean		6.668				Mean		-1.345
1008				SD		21.09				SD		2.007
1009				95% DL/2 (t) UCL		14.41				95% H-Stat (DL/2) UCL		12.29
1010												
1011				Maximum Likelihood Estimate(MLE) Method		N/A				Log ROS Method		
1012	MLE yields a negative mean									Mean in Log Scale		-1.554
1013										SD in Log Scale		2.215
1014										Mean in Original Scale		6.667
1015										SD in Original Scale		21.09
1016										95% t UCL		14.41
1017										95% Percentile Bootstrap UCL		14.29
1018										95% BCA Bootstrap UCL		17.84
1019										95% H-UCL		22.28
1020												

	A	B	C	D	E	F	G	H	I	J	K	L
1021	**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**					
1022					k star (bias corrected)	0.22	**Data do not follow a Discernable Distribution (0.05)**					
1023					Theta Star	54.92						
1024					nu star	5.28						
1025												
1026					A-D Test Statistic	1.966	**Nonparametric Statistics**					
1027					5% A-D Critical Value	0.858					Kaplan-Meier (KM) Method	
1028					K-S Test Statistic	0.858					Mean	6.641
1029					5% K-S Critical Value	0.27					SD	20.62
1030	**Data not Gamma Distributed at 5% Significance Level**										SE of Mean	4.591
1031											95% KM (t) UCL	14.54
1032	**Assuming Gamma Distribution**										95% KM (z) UCL	14.19
1033				Gamma ROS Statistics using Extrapolated Data							95% KM (jackknife) UCL	14.38
1034					Minimum	0.000001					95% KM (bootstrap t) UCL	414.1
1035					Maximum	82.2					95% KM (BCA) UCL	15.14
1036					Mean	6.849					95% KM (Percentile Bootstrap) UCL	14.17
1037					Median	0.0732					95% KM (Chebyshev) UCL	26.65
1038					SD	21.07					97.5% KM (Chebyshev) UCL	35.31
1039					k star	0.118					99% KM (Chebyshev) UCL	52.32
1040					Theta star	57.85						
1041					Nu star	5.209	**Potential UCLs to Use**					
1042					AppChi2	1.25					99% KM (Chebyshev) UCL	52.32
1043					95% Gamma Approximate UCL	28.54						
1044					95% Adjusted Gamma UCL	32.05						
1045	**Note: DL/2 is not a recommended method.**											
1046												
1047	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
1048	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
1049	**For additional insight, the user may want to consult a statistician.**											
1050												
1051												
1052	**Lead**											
1053												
1054	**General Statistics**											
1055					Number of Valid Observations	39					Number of Distinct Observations	37
1056												
1057	**Raw Statistics**						**Log-transformed Statistics**					
1058					Minimum	1.8					Minimum of Log Data	0.588
1059					Maximum	1080					Maximum of Log Data	6.985
1060					Mean	137.6					Mean of log Data	3.952
1061					Median	44					SD of log Data	1.296
1062					SD	257.8						
1063					Std. Error of Mean	41.28						
1064					Coefficient of Variation	1.874						
1065					Skewness	2.793						
1066												
1067	**Relevant UCL Statistics**											
1068	**Normal Distribution Test**						**Lognormal Distribution Test**					
1069					Shapiro Wilk Test Statistic	0.513					Shapiro Wilk Test Statistic	0.923
1070					Shapiro Wilk Critical Value	0.939					Shapiro Wilk Critical Value	0.939
1071	**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**					

	A	B	C	D	E	F	G	H	I	J	K	L
1072												
1073	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
1074					95% Student's-t UCL	207.2					95% H-UCL	215.6
1075	**95% UCLs (Adjusted for Skewness)**										95% Chebyshev (MVUE) UCL	246.8
1076					95% Adjusted-CLT UCL (Chen-1995)	225.2					97.5% Chebyshev (MVUE) UCL	303.4
1077					95% Modified-t UCL (Johnson-1978)	210.2					99% Chebyshev (MVUE) UCL	414.5
1078												
1079	**Gamma Distribution Test**						**Data Distribution**					
1080					k star (bias corrected)	0.599	**Data do not follow a Discernable Distribution (0.05)**					
1081					Theta Star	229.5						
1082					MLE of Mean	137.6						
1083					MLE of Standard Deviation	177.7						
1084					nu star	46.75						
1085					Approximate Chi Square Value (.05)	32.06	**Nonparametric Statistics**					
1086					Adjusted Level of Significance	0.0437					95% CLT UCL	205.5
1087					Adjusted Chi Square Value	31.58					95% Jackknife UCL	207.2
1088											95% Standard Bootstrap UCL	203.9
1089					Anderson-Darling Test Statistic	3.561					95% Bootstrap-t UCL	255.3
1090					Anderson-Darling 5% Critical Value	0.8					95% Hall's Bootstrap UCL	222.7
1091					Kolmogorov-Smirnov Test Statistic	0.299					95% Percentile Bootstrap UCL	208.9
1092					Kolmogorov-Smirnov 5% Critical Value	0.148					95% BCA Bootstrap UCL	226.4
1093	**Data not Gamma Distributed at 5% Significance Level**										95% Chebyshev(Mean, Sd) UCL	317.5
1094											97.5% Chebyshev(Mean, Sd) UCL	395.4
1095	**Assuming Gamma Distribution**										99% Chebyshev(Mean, Sd) UCL	548.3
1096					95% Approximate Gamma UCL	200.6						
1097					95% Adjusted Gamma UCL	203.7						
1098												
1099	**Potential UCL to Use**										Use 95% Chebyshev (Mean, Sd) UCL	317.5
1100												
1101	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
1102	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
1103	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
1104												
1105												
1106	**Naphthalene**											
1107												
1108	**General Statistics**											
1109					Number of Valid Data	37					Number of Detected Data	6
1110					Number of Distinct Detected Data	6					Number of Non-Detect Data	31
1111											Percent Non-Detects	83.78%
1112												
1113	**Raw Statistics**						**Log-transformed Statistics**					
1114					Minimum Detected	0.0467					Minimum Detected	-3.064
1115					Maximum Detected	43.36					Maximum Detected	3.769
1116					Mean of Detected	12.24					Mean of Detected	-0.105
1117					SD of Detected	19.15					SD of Detected	2.988
1118					Minimum Non-Detect	0.0349					Minimum Non-Detect	-3.355
1119					Maximum Non-Detect	0.6					Maximum Non-Detect	-0.511
1120												
1121	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	35
1122	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	2

	A–F	G–L
1123	Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage 94.59%
1124		
1125	**Warning: There are only 6 Detected Values in this data**	
1126	**Note: It should be noted that even though bootstrap may be performed on this data set**	
1127	**the resulting calculations may not be reliable enough to draw conclusions**	
1128		
1129	**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**	
1130		
1131		
1132	**UCL Statistics**	
1133	**Normal Distribution Test with Detected Values Only**	**Lognormal Distribution Test with Detected Values Only**
1134	Shapiro Wilk Test Statistic 0.708	Shapiro Wilk Test Statistic 0.844
1135	5% Shapiro Wilk Critical Value 0.788	5% Shapiro Wilk Critical Value 0.788
1136	**Data not Normal at 5% Significance Level**	**Data appear Lognormal at 5% Significance Level**
1137		
1138	**Assuming Normal Distribution**	**Assuming Lognormal Distribution**
1139	DL/2 Substitution Method	DL/2 Substitution Method
1140	Mean 2.066	Mean -2.21
1141	SD 8.458	SD 1.618
1142	95% DL/2 (t) UCL 4.414	95% H-Stat (DL/2) UCL 0.958
1143		
1144	Maximum Likelihood Estimate(MLE) Method N/A	Log ROS Method
1145	**MLE method failed to converge properly**	Mean in Log Scale -6.503
1146		SD in Log Scale 4.201
1147		Mean in Original Scale 1.995
1148		SD in Original Scale 8.474
1149		95% t UCL 4.347
1150		95% Percentile Bootstrap UCL 4.372
1151		95% BCA Bootstrap UCL 5.514
1152		95% H-UCL 1541
1153		
1154	**Gamma Distribution Test with Detected Values Only**	**Data Distribution Test with Detected Values Only**
1155	k star (bias corrected) 0.246	**Data appear Gamma Distributed at 5% Significance Level**
1156	Theta Star 49.84	
1157	nu star 2.947	
1158		
1159	A-D Test Statistic 0.687	**Nonparametric Statistics**
1160	5% A-D Critical Value 0.778	Kaplan-Meier (KM) Method
1161	K-S Test Statistic 0.778	Mean 2.027
1162	5% K-S Critical Value 0.359	SD 8.351
1163	**Data appear Gamma Distributed at 5% Significance Level**	SE of Mean 1.504
1164		95% KM (t) UCL 4.566
1165	**Assuming Gamma Distribution**	95% KM (z) UCL 4.501
1166	Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL 4.368
1167	Minimum 0.000001	95% KM (bootstrap t) UCL 164.6
1168	Maximum 43.36	95% KM (BCA) UCL 5.551
1169	Mean 2.099	95% KM (Percentile Bootstrap) UCL 4.775
1170	Median 0.000001	95% KM (Chebyshev) UCL 8.583
1171	SD 8.478	97.5% KM (Chebyshev) UCL 11.42
1172	k star 0.0832	99% KM (Chebyshev) UCL 16.99
1173	Theta star 25.23	

	A	B	C	D	E	F	G	H	I	J	K	L
1174					Nu star	6.156	Potential UCLs to Use					
1175					AppChi2	1.72					95% KM (t) UCL	4.566
1176					95% Gamma Approximate UCL	7.512						
1177					95% Adjusted Gamma UCL	7.973						
1178	Note: DL/2 is not a recommended method.											
1179												
1180	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1181	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1182	For additional insight, the user may want to consult a statistician.											
1183												
1184												
1185	Phenanthrene											
1186												
1187	General Statistics											
1188					Number of Valid Data	37					Number of Detected Data	17
1189					Number of Distinct Detected Data	16					Number of Non-Detect Data	20
1190											Percent Non-Detects	54.05%
1191												
1192	Raw Statistics						Log-transformed Statistics					
1193					Minimum Detected	0.043					Minimum Detected	-3.147
1194					Maximum Detected	503					Maximum Detected	6.221
1195					Mean of Detected	53.5					Mean of Detected	-0.192
1196					SD of Detected	149.3					SD of Detected	2.666
1197					Minimum Non-Detect	0.165					Minimum Non-Detect	-1.802
1198					Maximum Non-Detect	0.6					Maximum Non-Detect	-0.511
1199												
1200	Note: Data have multiple DLs - Use of KM Method is recommended										Number treated as Non-Detect	32
1201	For all methods (except KM, DL/2, and ROS Methods),										Number treated as Detected	5
1202	Observations < Largest ND are treated as NDs										Single DL Non-Detect Percentage	86.49%
1203												
1204	UCL Statistics											
1205	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
1206					Shapiro Wilk Test Statistic	0.406					Shapiro Wilk Test Statistic	0.771
1207					5% Shapiro Wilk Critical Value	0.892					5% Shapiro Wilk Critical Value	0.892
1208	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
1209												
1210	Assuming Normal Distribution						Assuming Lognormal Distribution					
1211					DL/2 Substitution Method						DL/2 Substitution Method	
1212					Mean	24.64					Mean	-1.367
1213					SD	103.1					SD	2.109
1214					95% DL/2 (t) UCL	53.26					95% H-Stat (DL/2) UCL	9.254
1215												
1216					Maximum Likelihood Estimate(MLE) Method	N/A					Log ROS Method	
1217	MLE yields a negative mean										Mean in Log Scale	-1.875
1218											SD in Log Scale	2.629
1219											Mean in Original Scale	24.62
1220											SD in Original Scale	103.1
1221											95% t UCL	53.25
1222											95% Percentile Bootstrap UCL	54.67
1223											95% BCA Bootstrap UCL	72.56
1224											95% H-UCL	37.78

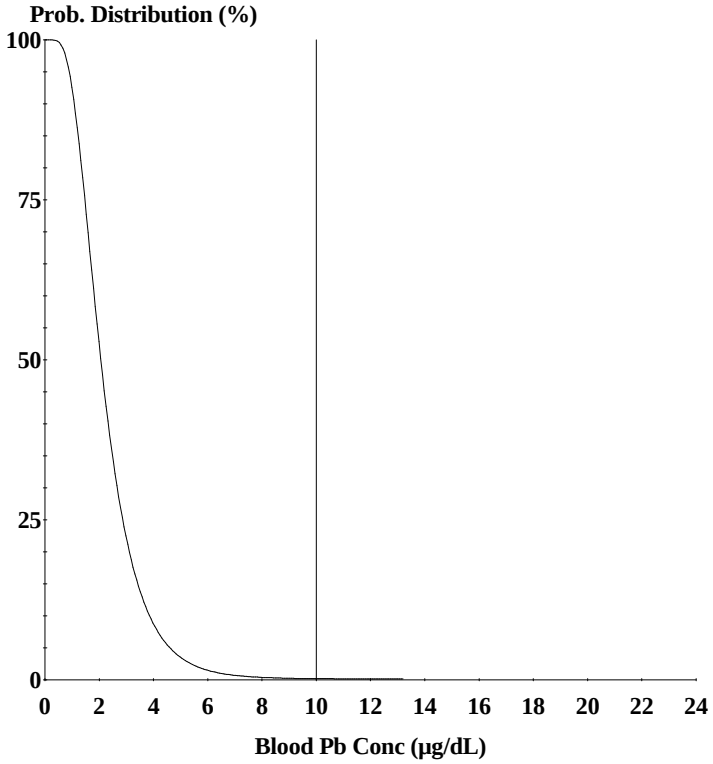
	A–F	G–L
1225		
1226	**Gamma Distribution Test with Detected Values Only**	**Data Distribution Test with Detected Values Only**
1227	k star (bias corrected) 0.187	**Data do not follow a Discernable Distribution (0.05)**
1228	Theta Star 286.1	
1229	nu star 6.357	
1230		
1231	A-D Test Statistic 3.33	**Nonparametric Statistics**
1232	5% A-D Critical Value 0.89	Kaplan-Meier (KM) Method
1233	K-S Test Statistic 0.89	Mean 24.65
1234	5% K-S Critical Value 0.232	SD 101.7
1235	**Data not Gamma Distributed at 5% Significance Level**	SE of Mean 17.24
1236		95% KM (t) UCL 53.75
1237	**Assuming Gamma Distribution**	95% KM (z) UCL 53
1238	Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL 53.27
1239	Minimum 0.000001	95% KM (bootstrap t) UCL 1534
1240	Maximum 503	95% KM (BCA) UCL 59.27
1241	Mean 24.58	95% KM (Percentile Bootstrap) UCL 54.85
1242	Median 0.000001	95% KM (Chebyshev) UCL 99.79
1243	SD 103.2	97.5% KM (Chebyshev) UCL 132.3
1244	k star 0.0895	99% KM (Chebyshev) UCL 196.2
1245	Theta star 274.6	
1246	Nu star 6.623	**Potential UCLs to Use**
1247	AppChi2 1.966	99% KM (Chebyshev) UCL 196.2
1248	95% Gamma Approximate UCL 82.8	
1249	95% Adjusted Gamma UCL 87.61	
1250	**Note: DL/2 is not a recommended method.**	
1251		
1252	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**	
1253	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**	
1254	**For additional insight, the user may want to consult a statistician.**	
1255		
1256		
1257	**Pyrene**	
1258		
1259	**General Statistics**	
1260	Number of Valid Data 37	Number of Detected Data 19
1261	Number of Distinct Detected Data 19	Number of Non-Detect Data 18
1262		Percent Non-Detects 48.65%
1263		
1264	**Raw Statistics**	**Log-transformed Statistics**
1265	Minimum Detected 0.066	Minimum Detected -2.718
1266	Maximum Detected 406	Maximum Detected 6.006
1267	Mean of Detected 37.24	Mean of Detected 0.102
1268	SD of Detected 109.3	SD of Detected 2.366
1269	Minimum Non-Detect 0.165	Minimum Non-Detect -1.802
1270	Maximum Non-Detect 0.6	Maximum Non-Detect -0.511
1271		
1272	Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect 27
1273	For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected 10
1274	Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage 72.97%
1275		

	A	B	C	D	E	F	G	H	I	J	K	L
1276	UCL Statistics											
1277	Normal Distribution Test with Detected Values Only						Lognormal Distribution Test with Detected Values Only					
1278					Shapiro Wilk Test Statistic	0.388					Shapiro Wilk Test Statistic	0.821
1279					5% Shapiro Wilk Critical Value	0.901					5% Shapiro Wilk Critical Value	0.901
1280	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
1281												
1282	Assuming Normal Distribution						Assuming Lognormal Distribution					
1283					DL/2 Substitution Method						DL/2 Substitution Method	
1284					Mean	19.17					Mean	-1.092
1285					SD	79.52					SD	2.104
1286					95% DL/2 (t) UCL	41.25					95% H-Stat (DL/2) UCL	11.97
1287												
1288					Maximum Likelihood Estimate(MLE) Method	N/A					Log ROS Method	
1289	MLE yields a negative mean										Mean in Log Scale	-1.601
1290											SD in Log Scale	2.642
1291											Mean in Original Scale	19.16
1292											SD in Original Scale	79.53
1293											95% t UCL	41.23
1294											95% Percentile Bootstrap UCL	41.66
1295											95% BCA Bootstrap UCL	52.87
1296											95% H-UCL	52.31
1297												
1298	Gamma Distribution Test with Detected Values Only						Data Distribution Test with Detected Values Only					
1299					k star (bias corrected)	0.21	Data do not follow a Discernable Distribution (0.05)					
1300					Theta Star	177.1						
1301					nu star	7.99						
1302												
1303					A-D Test Statistic	3.398	Nonparametric Statistics					
1304					5% A-D Critical Value	0.884					Kaplan-Meier (KM) Method	
1305					K-S Test Statistic	0.884					Mean	19.18
1306					5% K-S Critical Value	0.219					SD	78.44
1307	Data not Gamma Distributed at 5% Significance Level										SE of Mean	13.25
1308											95% KM (t) UCL	41.55
1309	Assuming Gamma Distribution										95% KM (z) UCL	40.98
1310					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	41.26
1311					Minimum	0.000001					95% KM (bootstrap t) UCL	883.3
1312					Maximum	406					95% KM (BCA) UCL	44.72
1313					Mean	19.12					95% KM (Percentile Bootstrap) UCL	41.95
1314					Median	0.066					95% KM (Chebyshev) UCL	76.93
1315					SD	79.54					97.5% KM (Chebyshev) UCL	101.9
1316					k star	0.097					99% KM (Chebyshev) UCL	151
1317					Theta star	197.1						
1318					Nu star	7.181	Potential UCLs to Use					
1319					AppChi2	2.27					99% KM (Chebyshev) UCL	151
1320					95% Gamma Approximate UCL	60.48						
1321					95% Adjusted Gamma UCL	63.8						
1322	Note: DL/2 is not a recommended method.											
1323												
1324	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1325	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1326	For additional insight, the user may want to consult a statistician.											

	A	B	C	D	E	F	G	H	I	J	K	L
1327												

APPENDIX D

LEAD MODELING



Cutoff = 10.000 µg/dl
Geo Mean = 2.160
GSD = 1.600
% Above = 0.056

Age Range = 0 to 84 months

Run Mode = Research

LEAD MODEL FOR WINDOWS Version 1.1

==========
Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research
==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 106.600 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	138.000	106.600
1-2	138.000	106.600
2-3	138.000	106.600
3-4	138.000	106.600
4-5	138.000	106.600
5-6	138.000	106.600
6-7	138.000	106.600

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.075	0.000	0.381
1-2	0.034	0.926	0.000	0.945
2-3	0.062	1.014	0.000	0.990
3-4	0.067	0.978	0.000	1.016
4-5	0.067	0.946	0.000	1.067
5-6	0.093	0.999	0.000	1.131
6-7	0.093	1.084	0.000	1.153

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	2.929	4.406	2.4
1-2	4.620	6.525	2.7
2-3	4.654	6.719	2.5
3-4	4.687	6.747	2.4
4-5	3.514	5.594	2.0
5-6	3.177	5.400	1.7
6-7	3.008	5.338	1.5