

Human Health Risk Assessment Addendum
Kerr-McGee Chemical Corp – Navassa Superfund Site
Navassa, North Carolina

EPA ID #NCD980557805

Prepared for:



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Prepared by:



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List of Acronyms

bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CSEM	Conceptual Site Exposure Model
EarthCon	EarthCon Consultants of North Carolina, P.C.
EPC	Exposure Point Concentration
FI	Fraction of Intake
HHRA	Human Health Risk Assessment
HI	Hazard Index
mg/kg	Milligram per kilogram
Multistate Trust	Multistate Environmental Response Trust
NC DEQ	North Carolina Department of Environmental Quality
PAH	Polycyclic Aromatic Hydrocarbon
RAGS	Risk Assessment Guidance for Superfund
RME	Reasonable Maximum Exposure
RSLs	USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites
SVOC	Semi-volatile organic compound
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This document is an addendum to the baseline Human Health Risk Assessment (HHRA) (April 2019 HHRA; EarthCon, 2019a) for the Kerr-McGee Chemical Corp – Navassa Superfund Site (the Site) (EPA ID# NCD980557805) located in Navassa, Brunswick County, North Carolina. The April 2019 HHRA was prepared by EarthCon Consultants of North Carolina, P.C. (EarthCon) for Greenfield Environmental Multistate Trust, LLC, not individually but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust (the Multistate Trust) as part of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) characterization of the Site. The purpose of this HHRA Addendum is to provide an updated evaluation of the potential risk and hazard to humans from Site-related contaminants present in soils in the Treated and Untreated Wood Storage Areas based on new data collected at the Site in June 2019 and further parceling of these areas. The Site is zoned industrial at present and the reasonably anticipated future land uses are commercial, industrial and/or recreational. The residential scenario was evaluated to assess “no further action” under CERCLA and to establish the need for land use controls. Figures 1-1 and 1-2 show the Site location and the historical Site plan, respectively.

In May 2018, concurrent with the preparation of the baseline HHRA, a trench study was conducted to confirm whether Site conditions in the Treated and Untreated Wood Storage Areas supported the reasonably anticipated future land use. The trench study provided information that challenged the assumptions about the wood storage areas. Based on the results of the trench study, a decision was made to divide the Treated and Untreated Wood Storage Areas into five smaller exposure areas (subareas) based on anticipated future land use and arranged from the north to the south: three 8-acre exposure areas (Areas 1A, 1B, and 1C); one 5.7-acre exposure area (Area 1D); and one 2.6-acre exposure area (Area 2). Smaller exposure units were selected to reflect industrial size parcels similar to the parcels proposed in the conceptual redevelopment plans which were developed with the community’s involvement. This refinement effort included the collection of additional surface and subsurface soil samples to supplement the existing data and to address data gaps in each of the five exposure areas.

The April 2019 HHRA was finalized and accepted by the United States Environmental Protection Agency (USEPA) and North Carolina Department of Environmental Quality (NC DEQ) on June 28, 2019. This addendum to the April 2019 HHRA is prepared in response to a request from

USEPA and NC DEQ to refine the risk estimates for potential Site receptors exposed to creosote-related constituents in soil for the five smaller exposure areas of the Treated and Untreated Wood Storage Areas. For this HHRA Addendum, the additional soil data collected from each of the five exposure areas were combined with the existing soil data.

In summary, the designations and sample locations for the five exposure areas evaluated are shown on Figure 1-3 and include:

- Area 1A
- Area 1B
- Area 1C
- Area 1D
- Area 2

Site data not evaluated in the April 2019 HHRA (EarthCon, 2019a) are provided in the Revised Northern Area Trench Evaluation Memo (EarthCon, 2019b) and the 2019 Soil Sampling Technical Memorandum (EarthCon, 2019c). Additional soil samples were collected to further assess relative risk to potential receptors from chemicals of potential concern (COPCs) in Site soils. A comparison of the April 2019 HHRA risk results for the Treated and Untreated Wood Storage Areas to the updated risk estimates established in this HHRA Addendum is presented in Section 4.0.

The exposure point concentrations (EPCs) for soil in the Treated and Untreated Wood Storage Areas were updated based on regrouping of soil data into the five smaller exposure areas. With the exception of the changes, agreed upon with USEPA and NC DEQ, outlined in Section 3.1 for the construction worker, no additional components of the April 2019 HHRA, such as screening values, toxicity values, chemical-specific parameter values and intake equations, were revised or changed as part of this HHRA Addendum.

The HHRA Addendum was prepared in accordance with USEPA guidance (USEPA, 2018) for conducting a risk assessment and is consistent with the risk assessment procedures described in the April 2019 HHRA with a few updates. Specific modifications to the April 2019 HHRA procedures that were conducted in consultation with USEPA and NC DEQ (USEPA, 2019b) are discussed in Section 3.0. A complete list of references used in deriving the exposure intakes and risk estimates is provided in the April 2019 HHRA.

Consistent with the April 2019 HHRA, the HHRA Addendum was conducted for the anticipated commercial, industrial and recreational use scenarios. A hypothetical future residential exposure scenario was also evaluated to assess “no further action” and establish the need for land use controls. The future industrial/commercial scenario assumes exposure based on outdoor workers and construction workers. The future recreational scenario assumes exposure based on a teenage trespasser. The hypothetical future residential exposure scenario assumes exposure based on child (0 to 6 years) and lifetime (age-adjusted) residents. These receptors were evaluated for potential exposure to contaminants in Site soil for each of the five exposure areas.

The results of this assessment are intended to help inform risk managers and the public about potential human health risks attributable to creosote-related constituents and to help determine if there is a need for additional remedial action at the Site. The overall risk management goal is to ensure protection of humans from harmful exposures to Site-related constituents for current and future land uses.

In accordance with standard risk assessment practice, the results of the HHRA Addendum are presented in tabular format in accordance with the Risk Assessment Guidance for Superfund (RAGS) Part D (USEPA, 2001). Each component of the HHRA Addendum is addressed in the following discussion.

2.0 DATA REFINEMENT

As discussed in Section 1.0, additional soil samples were collected to refine the risk estimates for the five exposure areas. The analytical data used for this HHRA Addendum include soil samples used to calculate risk estimates in the April 2019 HHRA combined with soil samples collected from the Treated and Untreated Wood Storage Areas in 2018 and 2019. The laboratory analyses were performed by SGS Accutest of Orlando, Florida. The following sections present a summary of the sample locations and the COPCs selected within each exposure area. The background soil sample results used for comparison are provided in **Table 2-1**.

2.1 Surface Soil

The combined surface soil data sets for each of the five exposure areas show that surface soils are primarily impacted by creosote related SVOCs. Specifically, carcinogenic polycyclic aromatic hydrocarbons (PAHs) and dibenzofuran were consistently detected in these areas with the highest concentrations observed in Area 1C.

The selection of COPCs are further discussed in Section 2.4 and summarized in **Table 2-2**. The COPC selection process has been presented in RAGS Part D format.

2.2 Subsurface Soil

The combined subsurface soil data sets for each of the five exposure areas show that subsurface soils are primarily impacted by creosote related SVOCs. USEPA (Region 4) considers soil from the bottom of the defined depth of surface soil [i.e., 1 foot below ground surface (bgs)] up to 10 feet bgs or to groundwater, whichever is shallower as subsurface soil (USEPA, 2018a). Generally, the highest concentrations in subsurface soils were encountered in Area 1C. The selected COPCs in subsurface soil are summarized in **Table 2-3**.

The following table presents the surface and subsurface soil sample locations for each of the five exposure areas evaluated in this HHRA Addendum:

Exposure Area	Surface Soil Location IDs	Subsurface Soil Location IDs
Area 1A	BR SB01 RI SB01 RI SB02 SB-119 SB-119R SB-120 SB-121 SB-122 SB-123 SB-124 SB-144 SB-145 SS-101 SS12 TB-01 TB-02	AA-13-120 AA-31-310 BR SB01 RI SB01 RI SB02 SB-119 SB-119R SB-120 SB-121 SB-122 SB-123 SB-124 SB-144 SB-145 TB-01 TB-02
Area 1B	RI SB03 RI SB04 SB-125 SB-125R SB-126 SB-127 SB-146 SB-147 SB-148 SS08 SS-102 SS-103 SS-104 SS-105 SS-106 SS-107 SS-108 SS-109 TB-03 TB-04 TB-05 TB-06 TB-07 TB-27 TW SB24 TW SB25	BB-04-30 BB-11-100 BB-14-105 RI SB03 RI SB04 SB-125 SB-126 SB-127 SB-146 SB-147 SB-148 TB-03 TB-04 TB-05 TB-06 TB-07 TB-27 TW SB24 TW SB25

Exposure Area	Surface Soil Location IDs	Subsurface Soil Location IDs
Area 1C	RISB05 RISB06 RISB07 RISB08 SB-128 SB-129 SB-130 SB-131 SB-132 SB-149 SB-150 SD021 SD021R SD021R-061419 SS-110 SS-111 SS-112 TB-08 TB-09 TB-10 TB-11 TB-12 TB-13 TB-14 TB-15 TB-16 TB-17 TB-18 TB-19 TB-20 TB-21 TB-22 TWSB23	CC-11-100 CC-18-170 DD-10-90 DD-17-160 EE-02-10 EE-08-70 EE-14-130 EE-18-170 FF-11-100 FF-17-160 RISB05 RISB06 RISB07 RISB08 SB-128 SB-129 SB-130 SB-131 SB-132 SB-149 SB-150 TB-08 TB-09 TB-10 TB-11 TB-12 TB-13 TB-14 TB-15 TB-16 TB-17 TB-18 TB-19 TB-20 TB-21 TB-22 TWSB23

Exposure Area	Surface Soil Location IDs	Subsurface Soil Location IDs
Area 1D	RISB09 RISB10 SB-133 SB-134 SB-135 SB-136 SB-151 SB-152 SB-153 SS-113 SS-114 SS-115 SS-116 SS-117 SS-118 SS-119 SS-120 SS-121 SS-122 SS-123 SS-124 TB-23 TB-24 TB-25 TB-26 TWSB27	GG-16-140 GG-27-30 HH-01-10 HH-08-80 II-02-20 II-23-230 JJ-05-60 JJ-15-150 RISB09 RISB10 SB-133 SB-134 SB-135 SB-136 SB-151 SB-152 SB-153 TB-23 TB-24 TB-25 TB-26 TWSB27
Area 2	BKSB04 SO033 SO034 SO035 SO036 SO037 SO038 SO039 SO040 SO041 SO042 SO043 SO044 SO045 SO046 SO047 SO048	BKSB04 SO033 SO034 SO035 SO036 SO037 SO038 SO040 SO041 SO042 SO043 SO044 SO045 SO046 SO047 SO048

2.3 Sample Analysis

The analytical test methods used by the laboratories were generally consistent between the investigations with consistent quality assurance/quality control procedures. The analytical test methods used for the additional soil samples collected in 2018 and 2019 from the five exposure areas are listed below:

ANALYSIS	METHOD
PAH	SW8270D SIM, SW8270
Pentachlorophenol	SW8270D SIM, SW8151A
SVOC	SW8270D, SW8270D SIM

2.4 Identification of COPCs in Soil

The concentrations of constituents detected in soil in the five exposure areas were screened to determine whether the levels warranted further risk evaluation, indicating that the constituents should be selected as COPCs. In general, creosote-related constituents were analyzed and screened against the residential soil Regional Screening Levels (RSLs) (USEPA, 2019a). As an initial step, detected constituents were also compared to background values to evaluate whether more detailed evaluation of Site versus background attribution was warranted. A summary of the background results is provided in **Table 2-1**.

In summary, PAHs, dibenzofuran and the pesticide pentachlorophenol were detected in soils at the Site. Pentachlorophenol was detected in surface soil above the applicable soil screening criteria in one surface soil sample in Area 1B. The maximum detection limit for pentachlorophenol exceeded the soil screening value in one sample but was eliminated as a COPC and qualitatively discussed in the uncertainty analysis in Section 5.0. No detections of pentachlorophenol were reported in subsurface soil.

Table 2-2 presents a screening matrix for the initial selection of surface soil COPCs. The known detected SVOCs are presented with the percent of detections observed at each area, the minimum and maximum concentrations of each detected constituent, and whether the constituent has been detected in surface soil. **Table 2-3** lists the same information for COPCs in subsurface soil.

The following constituents were detected at concentrations greater than their respective residential soil RSL and were retained as COPCs in surface soil and/or subsurface soil for each of the five exposure areas evaluated in the HHRA Addendum:

Exposure Area	Surface Soil COPCs	Subsurface Soil COPCs
Area 1A	<p>PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene</p>	No COPCs
Area 1B	<p>PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene</p> <p>Pesticide Pentachlorophenol</p>	<p>PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene</p> <p>SVOCs Dibenzofuran</p>
Area 1C	<p>PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene</p> <p>SVOCs Dibenzofuran</p>	<p>PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Naphthalene Phenanthrene</p> <p>SVOCs Dibenzofuran</p>

Exposure Area	Surface Soil COPCs	Subsurface Soil COPCs
Area 1D	PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene	PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene
Area 2	PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene	No COPCs

3.0 UPDATES TO THE EXPOSURE ASSESSMENT

The exposure assessment conducted in this HHRA Addendum is based on direct exposure to COPCs in surface and subsurface soil only, and addresses potential risk posed to four potential on-Site receptors: future construction worker, future outdoor worker, current/future teenage trespasser, and future residents (child and lifetime adult). The indoor worker was not evaluated as part of this HHRA Addendum since this receptor was assumed to spend most of his/her time indoors (i.e., inside of the workplace), resulting in minimal exposure to soils during a typical workday. Further, potential risk to indoor workers from soil was considered insignificant when compared to other receptors evaluated in this HHRA Addendum and the indoor worker was evaluated for exposure via groundwater only in the April 2019 HHRA.

Exposure scenarios at the Site were developed to reflect representative current and anticipated future exposures for each of the five exposure areas. Because an individual may be exposed beginning as a child and extending into adulthood, exposure to an adult resident was calculated as the time-weighted average lifetime exposure assuming Reasonable Maximum Exposure (RME). The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure.

Appendix A presents the daily intake equations used in this HHRA Addendum together with the appropriate exposure factors. The age-adjustment equations for the lifetime adult resident exposure to carcinogenic PAHs that act via the mutagenic mode of action (USEPA, 2005) are also presented in **Appendix A**. The values used for each of the exposure factors are presented along with the source of that information and the abbreviation for the parameter used in the intake equations in **Tables A-1 through A-9 of Appendix A**. Default values are used for the remaining inputs, and the calculated volatilization and particulate emissions factors for each exposure scenario are presented in **Tables A-12 through A-15 of Appendix A**.

3.1 Exposure Pathway and Exposure Frequency – Construction Worker

The April 2019 HHRA evaluated surface and subsurface soil separately using a fraction intake (FI) term of 0.5 to offset “double counting” of the risk. Subsequent to the April 2019 HHRA and per direction from USEPA and NC DEQ during a meeting on April 11, 2019, potential risk to the construction worker receptor was calculated for subsurface soil only using an FI of 1.0 for this HHRA Addendum. The basis for limiting the construction worker exposure to subsurface soil was to avoid the potential for diluting contaminant concentrations at depth when computing the EPC

term. Based on this recommendation, the conceptual site exposure model (CSEM) for the Treated and Untreated Wood Storage Areas (referred to herein as Areas 1A, 1B, 1C, 1D and 2) was revised to reflect this update for the construction worker (Figure 3-1). No other receptors were quantitatively evaluated for exposure to subsurface soil consistent with the CSEM in the April 2019 HHRA and the Region 4 EPA HHRA Supplemental Guidance (USEPA, 2018).

Another deviation from the April 2019 HHRA is the update of the exposure frequency used to estimate risk to future construction workers. The exposure frequency for this receptor was adjusted from 250 to 130 days per year to reflect typical exposure conditions for this receptor group, which assumes that construction workers may contact subsurface soil at the Site five days a week over the course of twenty-six weeks. The previous exposure frequency used in the April 2019 HHRA was USEPA's default value for an outdoor worker (e.g., maintenance worker) (USEPA, 2014). This adjustment was made in consultation with the USEPA and NC DEQ (USEPA, 2019b). USEPA has not established exposure factors for construction workers. Therefore, these receptors are typically evaluated in a site-specific manner using exposure factors that best represent the construction worker exposure scenario. Further, the duration of construction activity is shorter than that of outdoor workers. Therefore, the evaluation of surface soil for outdoor workers would be protective of potential risks posed to construction workers from surface soil.

Table 3-1 presents a summary of the exposure factors used as input values in the receptor-specific daily intake calculations. These represent the frequency, duration, intake rates, and other factors associated with COPC exposure as they apply to the human receptors in the potentially completed exposure pathways. Exposure factors for the four potential on-Site receptors evaluated in this HHRA Addendum were also presented in the April 2019 HHRA. With the exception of the agreed upon changes outlined in Section 3.1 for the construction worker, no additional components of the April 2019 HHRA, such as screening values, toxicity values, and intake equations, were revised or changed as part of this HHRA Addendum. **Tables 3-2 through 3-5** present the toxicity values used to derive the risk estimates.

3.2 Exposure Point Concentrations

The EPCs for surface and subsurface soil were updated to account for subdividing the Treated and Untreated Wood Storage Areas into five smaller exposure areas and the collection of additional soil data in each exposure area. The ProUCL recommended value, which is typically

the 95% upper confidence limit (UCL), was generally used as the EPC. For soils in Area 1B, the arithmetic average concentration was used as the EPC for pentachlorophenol in surface soil and dibenzo(a,h)anthracene in subsurface soil. Based on information presented in the ProUCL User's Guide (USEPA, 2016) regarding minimum sample size and frequency of detection, UCLs were calculated where at least 10 samples and at least four detected results are available.

Where too few samples or detects are available (e.g., less than 5% frequency of detection), USEPA recommends applying the sample median or the sample mode in lieu of the sample average. Therefore, when the sample data set is dominated by non-detect results, as was the case with pentachlorophenol in Area 1B, the detection limit would become the EPC. However, due to uncertainty in the detection of pentachlorophenol in Area 1B, the arithmetic mean was used as the EPC. The uncertainty surrounding the isolated detection of pentachlorophenol is further discussed in the uncertainty analysis in Section 5.0. The EPCs for surface and subsurface soils are presented in **Tables 3-6 and 3-7**, respectively.

4.0 UPDATES TO RISK CHARACTERIZATION RESULTS

To characterize potential carcinogenic effects, the incremental probability of an individual developing cancer over a lifetime was calculated from projected intakes and chemical-specific carcinogenic potency factors. To characterize potential noncarcinogenic effects, comparisons were made between projected intakes of constituents and reference dose and reference concentrations. Consistent with the April 2019 HHRA, both a carcinogenic risk and a hazard quotient estimate (for noncarcinogenic effects) were calculated for each COPC that had available toxicity values.

USEPA defines unacceptable risk as that exceeding the incremental or excess lifetime cancer risk (ELCR) of 1×10^{-4} (one incident per ten thousand) or a Hazard Index (HI) of 1.0. Mutagenic risks are included with the total risk for the lifetime resident. Mutagenic risk refers to excess cancer risk derived from COPCs that interfere with the genetic material of the exposed receptor, thus increasing the frequency of mutations above the natural background level.

For comparison to the updated risk characterization results in Section 4.1, the following table presents a summary of the previous risk findings by receptor and area that were calculated for the Treated and Untreated Wood Storage Areas in the April 2019 HHRA (EarthCon, 2019a).

Receptor	Treated Wood Storage Area		Untreated Wood Storage Area	
	ELCR	HI	ELCR	HI
Outdoor Worker	2.2×10^{-6}	0.01	1.3×10^{-6}	0.009
Construction Worker	1.5×10^{-7}	0.06	1.3×10^{-7}	0.05
Teenage Trespasser	1.4×10^{-6}	0.007	8.2×10^{-7}	0.004
Lifetime Resident (Child and Age-Adjusted)	4.1×10^{-5}	0.2	2.5×10^{-5}	0.1

Tables 4-1 to 4-28 summarize the human health risk and noncarcinogenic hazard results for estimated exposures to soils by area and receptor for this HHRA Addendum. A summary of the calculated total ELCRs and Hazard Index (HI) to the target ELCR of 1×10^{-4} (1.0E-04) for carcinogenic COPCs and target HI of 1.0 for noncarcinogenic COPCs is discussed in the following subsections for each receptor per exposure area.

4.1 Summary of Risk Characterization Results - Area 1A

Five carcinogenic PAHs were retained as COPCs in surface soil and further evaluated in the risk assessment. No COPCs were identified in subsurface soil in Area 1A. Therefore, potential risks to the construction worker were not quantified in the HHRA Addendum for this area. The risk characterization results for other receptors potentially exposed to PAHs in Site surface soils in Area 1A are discussed below:

Future Outdoor Worker

Table 4-1 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site outdoor worker scenario. A total carcinogenic risk of 1.7×10^{-6} and HI of 0.01 were calculated for this receptor. The carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0. The primary contributor to the carcinogenic risk is incidental ingestion of and dermal contact with benzo(a)pyrene.

Future Construction Worker

No COPCs were identified in subsurface soil. Therefore, no unacceptable risk is posed to future construction workers in Area 1A.

Current/Future Teenage Trespasser

Table 4-2 presents the calculation of noncarcinogenic and carcinogenic risks associated with a current/future teenage trespasser scenario. A total carcinogenic risk of 1.1×10^{-6} and HI of 0.005 were calculated for this receptor. The total carcinogenic risk was primarily driven by incidental ingestion of and dermal contact with benzo(a)pyrene. The total HI was based solely on incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk and calculated HI are within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and below the target HI of 1.0, respectively.

Future Lifetime Resident (Child and Age-Adjusted)

Table 4-3 and Table 4-4 present the calculation of noncarcinogenic risk for the child and adult resident, respectively, and **Table 4-5** presents the total carcinogenic risk associated with a future lifetime adult resident. A total carcinogenic risk of 4.1×10^{-5} and HI of 0.1 were calculated for these receptors. The total carcinogenic risk was primarily driven by incidental ingestion of benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

4.2 Summary of Risk Characterization Results - Area 1B

Five carcinogenic PAHs and one pesticide were retained as COPCs in surface soil and seven PAHs and dibenzofuran were retained as COPCs in subsurface soil. The COPCs identified were further evaluated in the risk assessment. The risk characterization results for receptors potentially exposed to on-Site soils are summarized below:

Future Outdoor Worker

Table 4-6 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site outdoor worker scenario. A total carcinogenic risk of 3.0×10^{-6} and HI of 0.02 were calculated for this receptor. The primary contributor to the total carcinogenic risk was from incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Construction Worker

Table 4-7 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site construction worker scenario. A total carcinogenic risk of 1.5×10^{-7} and HI of 0.05 were calculated for this receptor. The total carcinogenic risk was primarily driven by incidental ingestion of and dermal contact with benzo(a)pyrene. The carcinogenic risk is below the acceptable risk range of 1×10^{-4} to 1×10^{-6} , and the calculated HI is below the target HI of 1.0.

Current/Future Teenage Trespasser

Table 4-8 presents the calculation of noncarcinogenic and carcinogenic risks associated with a current/future teenage trespasser scenario. A total carcinogenic risk of 1.8×10^{-6} and HI of 0.008

were calculated for this receptor. The total carcinogenic risk was primarily driven by incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Lifetime Resident (Child and Age-Adjusted)

Table 4-9 and Table 4-10 presents the calculation of noncarcinogenic risk for the child and lifetime adult resident, respectively, and **Table 4-11** presents the total carcinogenic risk associated with a future lifetime adult resident. A total carcinogenic risk of 6.7×10^{-5} and HI of 0.2 were calculated for this receptor. The total carcinogenic risk was primarily driven by incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} , and the calculated HI is below the target HI of 1.0.

4.3 Summary of Risk Characterization Results - Area 1C

Ten PAHs and dibenzofuran were retained as COPCs in surface soil, and eight PAHs and dibenzofuran were retained as COPCs in subsurface soil. The COPCs identified were further evaluated in the risk assessment. The risk characterization results for receptors potentially exposed to surface and subsurface soil are discussed below:

Future Outdoor Worker

Table 4-12 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-site outdoor worker scenario. A total carcinogenic risk of 9.1×10^{-6} and HI of 0.07 were calculated for this receptor. The primary contributor to the carcinogenic risk is benzo(a)pyrene via incidental ingestion and dermal contact. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} , and the calculated HI is below the target HI of 1.0.

Future Construction Worker

Table 4-13 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-site construction worker scenario. A total carcinogenic risk of 1.3×10^{-7} and HI of 0.05 were calculated for this receptor. The primary contributor to the total noncarcinogenic hazard is benzo(a)pyrene. The carcinogenic risk is below the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the target HI of 1.0.

Current/Future Teenage Trespasser

Table 4-14 presents the calculation of noncarcinogenic and carcinogenic risks associated with a current/future teenage trespasser scenario. A total carcinogenic risk of 5.6×10^{-6} and HI of 0.03 were calculated for the teenage trespasser. Benzo(a)pyrene was the primary contributor to the total carcinogenic risk via incidental ingestion and dermal contact. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Lifetime Resident (Child and Age-Adjusted)

Table 4-15 and Table 4-16 presents the calculation of noncarcinogenic risk for the child and adult resident, respectively, and **Table 4-17** presents the total carcinogenic risk associated with a future lifetime adult resident. A total carcinogenic risk of 1.7×10^{-4} and HI of 0.95 were calculated for the hypothetical future on-Site resident. The total carcinogenic risk was primarily driven by direct contact (predominantly incidental ingestion) with benzo(a)pyrene. The total carcinogenic risk is above the acceptable risk range of 1×10^{-4} to 1×10^{-6} while the calculated HI is below the target HI of 1.0.

4.4 Summary of Risk Characterization Results - Area 1D

Five carcinogenic PAHs were retained as COPCs in surface and subsurface soil. The COPCs identified were further evaluated in the risk assessment. The risk characterization results for receptors potentially exposed to soils are discussed below:

Future Outdoor Worker

Table 4-18 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site outdoor worker scenario. A total carcinogenic risk of 2.7×10^{-6} and HI of 0.02 were calculated for this receptor. The primary contributor to the total carcinogenic risk is benzo(a)pyrene via incidental ingestion and dermal contact. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Construction Worker

Table 4-19 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site construction worker scenario. A total carcinogenic risk of 8.0×10^{-8} and HI of 0.03 were

calculated for this receptor. The primary contributor to the total carcinogenic risk is benzo(a)pyrene via incidental ingestion and dermal contact. The total carcinogenic risk is below the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Current/Future Teenage Trespasser

Table 4-20 presents the calculation of noncarcinogenic and carcinogenic risks associated with a current/future teenage trespasser scenario. A total carcinogenic risk of 1.7×10^{-6} and HI of 0.008 were calculated for this receptor. The primary contributor to the total carcinogenic risk is benzo(a)pyrene via incidental ingestion and dermal contact. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Lifetime Resident (Child and Age-Adjusted)

Table 4-21 and Table 4-22 presents the calculation of noncarcinogenic risk for the child and adult resident, respectively, and **Table 4-23** presents the total carcinogenic risk associated with a future lifetime adult resident. A total carcinogenic risk of 6.4×10^{-5} and HI of 0.2 were calculated for these receptors. The total carcinogenic risk was primarily driven by incidental ingestion of benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

4.5 Summary of Risk Characterization Results - Area 2

Four PAHs were retained as COPCs in surface soil and further evaluated in the risk assessment. No COPCs were identified in subsurface soil; therefore, risk to the construction worker was not quantified in the HHRA Addendum, and no unacceptable risk is posed to future construction workers in Area 2. The risk characterization results for other receptors potentially exposed to PAHs in on-Site surface soils are discussed below:

Future Outdoor Worker

Table 4-24 presents the calculation of noncarcinogenic and carcinogenic risks associated with an on-Site outdoor worker scenario. A total carcinogenic risk of 3.8×10^{-7} and HI of 0.002 were calculated for this receptor. The primary contributor to the total carcinogenic risk is benzo(a)pyrene via incidental ingestion and dermal contact with surface soil. The total carcinogenic risk is below the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

Future Construction Worker

No COPCs were selected in subsurface soil. Therefore, no unacceptable risk is posed to future construction workers in Area 2.

Current/Future Teenage Trespasser

Table 4-25 presents the calculation of noncarcinogenic and carcinogenic risks associated with a current/future teenage trespasser scenario. A total carcinogenic risk of 2.3×10^{-7} and HI of 0.001 were calculated for this receptor. The total carcinogenic risk is driven primarily by incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk and calculated HI are below the acceptable risk range of 1×10^{-4} to 1×10^{-6} and target HI of 1.0, respectively.

Future Lifetime Resident (Child and Age-Adjusted)

Table 4-26 and Table 4-27 present the calculation of noncarcinogenic risk for the child and adult resident, respectively, and **Table 4-28** presents the total carcinogenic risk associated with a future lifetime adult resident. A total carcinogenic risk of 8.9×10^{-6} and HI of 0.03 were calculated for these receptors. The total carcinogenic risk was primarily driven by incidental ingestion of and dermal contact with benzo(a)pyrene. The total carcinogenic risk is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} and the calculated HI is below the target HI of 1.0.

5.0 UNCERTAINTY ANALYSIS

There is uncertainty inherent in the methods, inputs, and conclusions of any HHRA. This level of uncertainty results from the fact that most every step in the risk assessment process involves assumptions, professional and scientific judgments, and analytical data to varying degrees, contributing to the total uncertainty in the final estimates of risk and conclusions. This uncertainty is usually addressed by making conservative assumptions or estimates for uncertain parameters based on whatever limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is pertinent for risk managers and the public to consider this when interpreting the results of a risk assessment. However, while some uncertainty and variability in the processes used in this risk assessment exist, taken collectively these uncertainties should not undermine the utility of this document for decision-making purposes at the Site. Uncertainties specific to this HHRA Addendum are summarized below:

Elevated Detection Limits for Pentachlorophenol in Surface Soil (Areas 1B and 1C)

Elevated detection limits were a source of uncertainty for this HHRA Addendum. A few sample results from the SVOC analysis had elevated detection limits due to dilution, often above the screening criteria (residential soil RSLs) (USEPA, 2019a). In cases where the detection limit for a constituent exceeded its respective RSL, the constituent was further evaluated to determine its COPC selection status.

Although pentachlorophenol has not been detected previously in soil samples analyzed for the Site, Areas 1B and 1C each had a single detection limit that exceeded the residential soil RSL in one surface soil sample each. The higher detection limits for pentachlorophenol contribute uncertainty in the analytical data. There is no historic use of pentachlorophenol in the wood treating process conducted at the Site, and the elevated detection limits in Areas 1B and 1C and the single detection in Area 1B are presumed to be artifacts in the data set and most likely attributed to laboratory cross-contamination. The pentachlorophenol detection summary for surface soil in Areas 1B and 1C is summarized as follows:

- **Area 1B** - Of the 24 surface soil sample results, there was only one detected value reported above the RSL (4.09 mg/kg in SS-104 versus 1 mg/kg); however, the detection limit was also above the RSL (i.e., 1.8 mg/kg versus 1 mg/kg). As a result, pentachlorophenol was selected as a COPC and further evaluated in the risk assessment. The total carcinogenic risk and calculated HI for pentachlorophenol in Area 1B for the

receptors evaluated did not exceed the target risk levels. No other samples reported detections above the RSL. The elevated sample result for pentachlorophenol appears to be an artifact in the data set and may be attributed to contaminated glassware in the laboratory. Including pentachlorophenol as a COPC in Area 1B most likely overestimates the risk to Site receptors.

- **Area 1C** - Of the 29 surface soil sample results, none of the pentachlorophenol results were reported above the residential soil RSL. In fact, only one detected value was reported in surface soil at a concentration ten times below the RSL (i.e., 0.104 mg/kg versus 1 mg/kg); however, the maximum dilution-adjusted detection limit was reported above the RSL (i.e., 16 mg/kg versus 1 mg/kg). Considering the infrequent detection of pentachlorophenol in numerous samples analyzed across the Site (i.e., 3 of 161 surface soil samples Site-wide or 2 of 116 surface soil samples in the Treated and Untreated Wood Storage Areas), the lack of elevated detection limits in other samples analyzed, and no historic use of pentachlorophenol as part of the wood treating process conducted at the Site, the dilution-adjusted detection limit is most likely attributed to dilution associated with high concentrations of other constituents in this sample. Due to these limiting factors and USEPA policy to eliminate the constituent as a COPC if no detection is reported above the RSL, pentachlorophenol was eliminated as a COPC in Area 1C. Excluding pentachlorophenol from the risk evaluation avoids artificial inflation of the receptor-specific risk estimates.

In summary, pentachlorophenol was detected in one of twenty-four surface soil samples in Area 1B at a concentration four times the residential soil RSL. As a result, pentachlorophenol was retained as a COPC and further evaluated in the risk assessment for Area 1B. However, it is unlikely that pentachlorophenol is present in Site soils based on the weight of evidence approach described above. For Area 1C, pentachlorophenol was detected in one of twenty-nine surface soil samples at a concentration ten times below the residential soil RSL. However, a single dilution-adjusted detection limit was sixteen times above the RSL and is associated with high concentrations of other constituents in the sample. As per USEPA (Region 4) policy, in cases where the detection limit for a constituent exceeds the RSL but is otherwise not detected, the constituent is eliminated from further evaluation in the risk assessment. This policy-based approach is consistent with the April 2019 HHRA. Therefore, pentachlorophenol was eliminated as a COPC in surface soil in Area 1C. Other supporting lines of evidence include the low

frequency of pentachlorophenol detection across the Site, infrequent detection in other sample media, and no positive detections above the residential soil RSL in Area 1C.

6.0 SUMMARY AND CONCLUSIONS

As requested by USEPA, this HHRA Addendum updated the April 2019 HHRA risk calculations to reflect future land use development for the Treated and Untreated Wood Storage Areas. This was done by subdividing these two areas into five smaller exposure areas and incorporating additional soil investigation data collected within these areas into the risk calculations. As part of this HHRA Addendum and as directed by USEPA, the following updates to the accepted April 2019 HHRA were made:

- The surface soil exposure pathway was eliminated for the construction worker and the CSEM was updated to reflect this change;
- The exposure frequency used to assess risk from subsurface soil was updated from 250 to 130 days per year to best represent typical exposure conditions for on-Site construction workers;
- The FI term was changed from 0.5 to 1.0 as a result of limiting the construction worker's soil exposures to subsurface soil only; and
- The soil EPCs that were presented in the accepted April 2019 HHRA were updated to account for further parceling of the Treated and Untreated Wood Storage Areas and to incorporate additional data collected in the five smaller exposure areas.

Additional components of the accepted April 2019 HHRA, such as identification of COPCs and other exposure assumptions were not reviewed or revised as part of this HHRA Addendum. The indoor worker was not evaluated as part of this HHRA Addendum since this receptor was assumed to spend most of his/her time indoors (i.e., inside of the workplace) resulting in minimal exposure to soils during a typical workday. Consistent with the April 2019 HHRA, potential risk to indoor workers from soil was considered insignificant when compared to other exposure pathways and receptors evaluated.

Five exposure areas with complete exposure pathways were evaluated in this HHRA Addendum including Areas 1A, 1B, 1C, 1D, and 2. Each of the five exposure areas was evaluated for commercial, industrial, recreational, and hypothetical residential land use. Potentially exposed populations include future outdoor workers, future construction workers, current/future teenage trespassers, and hypothetical future child and lifetime adult residents. The planned future use of the Site is commercial, industrial or recreational land use. The hypothetical future residential

scenario was evaluated to establish the need for land use controls and to bound the risk posed to receptors from contaminated soils at the Site.

As shown in **Tables 4-1 to 4-35**, the estimates of noncarcinogenic and carcinogenic risks changed for most of the receptors as a result of the updates. However, most of the changes were of minimal magnitude and the conclusions for most of the receptors were not affected. The updates did affect the conclusions for one receptor group, future lifetime residents, in Area 1C based on exposure to surface soil. Benzo(a)pyrene was the only COC identified in surface soil for future lifetime residents. Although the noncarcinogenic HI was below the threshold, the total carcinogenic risk exceeded the target risk level of 1×10^{-4} . **Table 4-36** presents a summary of exposure area risks and hazards for COPCs by exposure area.

Based on the findings of this HHRA Addendum, the overall risk from soil is acceptable for the reasonably anticipated future land use (i.e., commercial, industrial or recreational) for the five exposure areas (Areas 1A, 1B, 1C, 1D and 2) evaluated. However, the overall risk from soils is unacceptable for lifetime residents in Area 1C based on exceedance of the target risk of 1×10^{-4} . Based on current and future expected land use (i.e., non-residential), no exposure area requires additional evaluation in the following step of the CERCLA process, the Feasibility Study.

7.0 REFERENCES

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TABLES

Table 2-1
Background Soil Sampling Results
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Sample Location	BG-SO-01	BG-SO-02	BG-SO-03	BG-SO-04	BG-SO-05	BG-SO-06	BG-SO-07	BG-SO-08	BG-SO-09	BG-SO-10	BG-SO-11	BG-SO-12	BG-SO-13	BG-SO-14	BG-SO-15	Arithmetic Mean	Background Level (2x Mean)
Sample Date	01/23/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17	01/24/17		
Sample Depth	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft		
Analyte																	
PAHs (µg/kg)																	
1-Methylnaphthalene	<29 J	<30 J	<31 J	<30 J	<32 J	<31 J	<30 J	<31 J	<30 J	<31 J	<30 J	<33 J	<32 J	<32 J	<36 J	31.2	62.4
2-Methylnaphthalene	<29 J	<30 J	<31 J	<30 J	<32 J	<31 J	<30 J	<31 J	<30 J	<31 J	<30 J	<33 J	<32 J	<32 J	<36 J	31.2	62.4
Acenaphthene	<29 J	<30 J	<31 J	<30 J	<32 J	<31 J	<30 J	<31 J	<30 J	<31 J	<30 J	<33 J	<32 J	<32 J	<36 J	31.2	62.4
Acenaphthylene	<29 J	<30	<31	<30	<32	<31	<30 J	<31	<30 J	<31	<30	<33 J	<32 J	<32	<36	31.2	62.4
Anthracene	<18 J	<19 J	<19 J	26.7 J	<20 J	<19 J	<19 J	<19 J	<19 J	<20 J	<19 J	<20 J	<20 J	<20 J	<22 J	19.28	38.56
Benzo(a)anthracene	<3.6 J	<3.8	<3.8	25.9	<4.0	<3.9	9.0 J	<3.9	<3.8 J	15.3 J	7.6 J	<4.1 J	5.9 J	<4.0	<4.5	6.873	13.75
Benzo(a)pyrene	<3.6 J	<3.8	<3.8	35.9	<4.0	4.0 J	8.3 J	4.2 J	<3.8 J	18.1	10.3 J	<4.1 J	6.9 J	<4.0	<4.5	7.953	15.91
Benzo(b)fluoranthene	<3.6 J	<3.8 J	<3.8 J	50.7	5.4 J	9.6 J	13.1 J	6.4 J	<3.8 J	25.1	14.2 J	<4.1 J	11.4 J	6.4 J	8.8 J	11.35	22.7
Benzo(g,h,i)perylene	<3.6 J	<3.8	<3.8	38.8	<4.0	4.4 J	5.5 J	<3.9	<3.8 J	13.2 J	10.8 J	<4.1 J	5.4 J	<4.0	<4.5	7.573	15.15
Benzo(k)fluoranthene	<3.6 J	<3.8	<3.8	18.3	<4.0	<3.9	5.1 J	<3.9	<3.8 J	10.4 J	4.2 J	<4.1 J	<4.0 J	<4.0	<4.5	5.427	10.85
Chrysene	<3.6 J	<3.8	<3.8	38.3	<4.0	4.9 J	7.8 J	4.7 J	<3.8 J	18.1	10.9 J	<4.1 J	7.5 J	<4.0	5.0 J	8.287	16.57
Dibenzo(a,h)anthracene	<3.6 J	<3.8	<3.8	6.7 J	<4.0	<3.9	<3.8 J	<3.9	<3.8 J	<3.9	<3.8	<4.1 J	<4.0 J	<4.0	<4.5	4.107	8.21
Fluoranthene	<18 J	<19	<19	66.4 J	<20	<19	<19 J	<19	<19 J	32.3 J	<19	<20 J	<20 J	<20	<22	23.45	46.9
Fluorene	<29 J	<30 J	<31 J	<30 J	<32 J	<31 J	<30 J	<31 J	<30 J	<31 J	<30 J	<33 J	<32 J	<32 J	<36 J	31.2	62.4
Indeno (1,2,3-cd) pyrene	<3.6 J	<3.8	<3.8	34.9	<4.0	<3.9	5.8 J	<3.9	<3.8 J	16.1	7.5 J	<4.1 J	6.8 J	<4.0	<4.5	7.367	14.73
Naphthalene	<29 UJ	<30 UJ	<31 J	<30 J	<32 J	<31 J	<30 J	<31 J	<30 J	<31 J	<30 J	<33 J	<32 J	<32 J	<36 J	31.2	62.4
Phenanthrene	<18 J	<19	<19	19.4 J	<20	<19	<19 J	<19	<19 J	<20	<19	<20 J	<20 J	<20	<22	19.49	38.98
Pyrene	<18 J	<19 J	<19 J	72.7 J	<20 J	<19 J	<19 J	<19 J	<19 J	26.1 J	<19 J	<20 J	<20 J	<20 J	<22 J	23.45	46.9

Notes:

- Non detected results are reported as less than the Method Detection Limit (<MDL). The MDL values are used to calculate the mean for non-detect results.

µg/kg - Micrograms per kilogram

ft - Feet

J - Estimated concentration

UJ - Estimated concentration that indicates potential low bias

PAHs - Polycyclic Aromatic Hydrocarbons

Prepared By: CDN 5/22/17

Checked By: MAB 6/6/17

Table 2-2
Occurrence, Distribution and Selection of COPCs in Surface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current/Future
 Medium: Surface Soil (0-1 foot bgs)

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾	
Area 1A		<i>Semi-volatile organic compounds</i>													
	117-81-7	Bis(2-ethylhexyl) phthalate	0.037	0.037	mg/kg	0.14	0.14	SB-123	1/14	0.035 - 0.14	39	NA	N	BSL	
	86-74-8	Carbazole	0.04	2.09	mg/kg	0.1	2.09	SS-101	13/16	0.018 - 0.1	180	NA	N	BSL	
	132-64-9	Dibenzofuran	0.0317	0.11	mg/kg	0.072	0.11	RISB02	5/16	0.014 - 0.072	7.3	NA	N	BSL	
		<i>PAHs</i>													
	90-12-0	1-Methylnaphthalene	0.0181	0.0181	mg/kg	0.017	0.0181	SB-124	1/12	0.017 - 0.072	18	0.0624	N	BSL	
	91-57-6	2-Methylnaphthalene	0.0243	0.085	mg/kg	0.072	0.085	RISB02	4/16	0.017 - 0.072	24	0.0624	N	BSL	
	83-32-9	Acenaphthene	0.0245	0.12	mg/kg	0.077	0.12	RISB02	5/15	0.019 - 0.077	360	0.0624	N	BSL	
	208-96-8	Acenaphthylene	0.0696	2.13	mg/kg	0.021	2.13	SS-101	10/14	0.017 - 0.072	180	0.0624	N	BSL	
	120-12-7	Anthracene	0.0253	5.84	mg/kg	0.021	5.84	SS-101	13/15	0.02 - 0.081	1,800	0.03856	N	BSL	
	56-55-3	Benzo(a)anthracene	0.0318	5.98	mg/kg	0.019	5.98	SS-101	15/16	0.012 - 0.072	1.1	0.01375	Y	ASL	
	50-32-8	Benzo(a)pyrene	0.0421	6.06	mg/kg	0.025	6.06	SS-101	14/16	0.021 - 0.085	0.11	0.01591	Y	ASL	
	205-99-2	Benzo(b)fluoranthene	0.0607	15.6	mg/kg	0.02	15.6	SS-101	15/16	0.019 - 0.17	1.1	0.0227	Y	ASL	
	191-24-2	Benzo(g,h,i)perylene	0.0246	3.39	mg/kg	0.022	3.39	SS-101	12/14	0.018 - 0.075	180	0.01515	N	BSL	
	207-08-9	Benzo(k)fluoranthene	0.0427	5	mg/kg	0.025	5	RISB02	15/16	0.018 - 0.18	11	0.01085	N	BSL	
	218-01-9	Chrysene	0.0579	9.69	mg/kg	0.019	9.69	SS-101	15/16	0.018 - 0.25	110	0.01657	N	BSL	
	53-70-3	Dibenzo(a,h)anthracene	0.0341	0.853	mg/kg	0.09	0.853	SS-101	11/16	0.022 - 0.09	0.11	0.00821	Y	ASL	
	206-44-0	Fluoranthene	0.06	12.4	mg/kg	0.019	12.4	SS-101	15/16	0.013 - 0.15	240	0.0469	N	BSL	
86-73-7	Fluorene	0.042	0.258	mg/kg	0.077	0.258	SS-101	6/16	0.011 - 0.077	240	0.0624	N	BSL		
193-39-5	Indeno (1,2,3-cd) pyrene	0.0314	5.28	mg/kg	0.026	5.28	SS-101	14/16	0.02 - 0.088	1.1	0.01473	Y	ASL		
91-20-3	Naphthalene	0.0238	0.062	mg/kg	0.072	0.072	SB-123	4/16	0.014 - 0.072	3.8	0.0624	N	BSL		
85-01-8	Phenanthrene	0.0222	1.38	mg/kg	0.021	1.38	SB-123	12/14	0.017 - 0.072	180	0.03898	N	BSL		
129-00-0	Pyrene	0.084	13.9	mg/kg	0.022	13.9	SS-101	15/16	0.015 - 0.17	180	0.0469	N	BSL		
Area 1B		<i>Semi-volatile organic compounds</i>													
	1319-77-3	(3-and/or 4-)Methylphenol	0.0349	0.0522	mg/kg	0.3	0.3	SB-125	3/23	0.03 - 0.3	320	NA	N	BSL	
	92-52-4	1,1-Biphenyl	0.0229	0.0402	mg/kg	0.18	0.18	SB-125	3/22	0.018 - 0.18	4.7	NA	N	BSL	
	105-67-9	2,4-Dimethylphenol	0.0488	0.0488	mg/kg	0.48	0.48	SB-125	1/24	0.033 - 0.48	130	NA	N	BSL	
	98-86-2	Acetophenone	0.0241	0.0396	mg/kg	0.18	0.18	SB-125	2/22	0.018 - 0.18	780	NA	N	BSL	
	62-53-3	Aniline	0.0856	0.0988	mg/kg	0.38	0.38	SB-125	3/21	0.039 - 0.38	44	NA	N	BSL	
	65-85-0	Benzoic acid	0.939	1.58	mg/kg	1.8	1.8	SB-125	3/21	0.18 - 1.8	25,000	NA	N	BSL	
	117-81-7	Bis(2-ethylhexyl) phthalate	0.0523	0.0906	mg/kg	0.36	0.36	SB-125	4/24	0.036 - 0.36	39	NA	N	BSL	
	86-74-8	Carbazole	0.0271	2.53	mg/kg	NA	2.53	SS-108	26/26	0.018 - 0.25	180	NA	N	BSL	
	132-64-9	Dibenzofuran	0.0211	0.244	mg/kg	0.18	0.244	TB-05	12/26	0.014 - 0.18	7.3	NA	N	BSL	
	108-95-2	Phenol	0.0329	0.0329	mg/kg	0.18	0.18	SB-125	1/24	0.018 - 0.18	1,900	NA	N	BSL	
		<i>PAHs</i>													
	90-12-0	1-Methylnaphthalene	0.0336	0.0985	mg/kg	0.18	0.18	SB-125	5/21	0.018 - 0.18	18	0.0624	N	BSL	
	91-57-6	2-Methylnaphthalene	0.034	0.187	mg/kg	0.18	0.187	TB-07	7/26	0.017 - 0.18	24	0.0624	N	BSL	
	83-32-9	Acenaphthene	0.0222	0.426	mg/kg	0.19	0.426	TB-05	16/26	0.019 - 0.19	360	0.0624	N	BSL	
	208-96-8	Acenaphthylene	0.0567	4.31	mg/kg	NA	4.31	SS-108	24/24	0.018 - 0.18	180	0.0624	N	BSL	
	120-12-7	Anthracene	0.1	7	mg/kg	NA	7	SS-108	24/24	0.021 - 0.41	1,800	0.03856	N	BSL	
	56-55-3	Benzo(a)anthracene	0.0758	13.9	mg/kg	NA	13.9	SS-108	26/26	0.012 - 0.36	1.1	0.01375	Y	ASL	
50-32-8	Benzo(a)pyrene	0.0852	11.1	mg/kg	NA	11.1	TB-05	26/26	0.021 - 0.43	0.11	0.01591	Y	ASL		
205-99-2	Benzo(b)fluoranthene	0.18	24.2	mg/kg	NA	24.2	SS-108	26/26	0.02 - 0.4	1.1	0.0227	Y	ASL		
191-24-2	Benzo(g,h,i)perylene	0.072	5.51	mg/kg	NA	5.51	SS-108	24/24	0.019 - 0.2	180	0.01515	N	BSL		
207-08-9	Benzo(k)fluoranthene	0.0602	8.92	mg/kg	NA	8.92	SB-125	26/26	0.018 - 0.25	11	0.01085	N	BSL		
218-01-9	Chrysene	0.0836	17.4	mg/kg	NA	17.4	SS-108	26/26	0.019 - 0.37	110	0.01657	N	BSL		
53-70-3	Dibenzo(a,h)anthracene	0.0412	2.05	mg/kg	0.23	2.05	SS-108	22/26	0.023 - 0.23	0.11	0.00821	Y	ASL		
206-44-0	Fluoranthene	0.0995	21.8	mg/kg	NA	21.8	SB-125	26/26	0.013 - 0.36	240	0.0469	N	BSL		

Table 2-2
Occurrence, Distribution and Selection of COPCs in Surface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾
Area 1B	86-73-7	Fluorene	0.024	0.568	mg/kg	0.19	0.568	SS-108	21/26	0.011 - 0.19	240	0.0624	N	BSL
	193-39-5	Indeno (1,2,3-cd) pyrene	0.062	7.79	mg/kg	NA	7.79	SS-108	26/26	0.02 - 0.44	1.1	0.01473	Y	ASL
	91-20-3	Naphthalene	0.021	0.181	mg/kg	0.18	0.181	TB-07	9/26	0.014 - 0.18	3.8	0.0624	N	BSL
	85-01-8	Phenanthrene	0.0233	5.67	mg/kg	NA	5.67	SS-109	24/24	0.018 - 0.18	180	0.03898	N	BSL
	129-00-0	Pyrene	0.0963	31.7	mg/kg	NA	31.7	SS-108	26/26	0.016 - 0.42	180	0.0469	N	BSL
	87-86-5	Pesticides Pentachlorophenol	4.09	4.09	mg/kg	1.8	4.09	SS-104	1/24	0.17 - 1.8	1	NA	Y	ASL
Area 1C	1319-77-3	Semi-volatile organic compounds (3-and/or 4-)Methylphenol	0.0715	0.0715	mg/kg	2.7	2.7	TB-16	1/29	0.03 - 2.7	320	NA	N	BSL
	92-52-4	1,1-Biphenyl	0.0302	0.0539	mg/kg	2.06	2.06	SD021	3/28	0.018 - 2.06	4.7	NA	N	BSL
	105-67-9	2,4-Dimethylphenol	0.058	0.058	mg/kg	4.4	4.4	TB-16	1/29	0.033 - 4.4	130	NA	N	BSL
	62-53-3	Aniline	0.0442	0.0442	mg/kg	3.5	3.5	TB-16	1/28	0.039 - 3.5	44	NA	N	BSL
	65-85-0	Benzoic acid	0.237	1.6	mg/kg	16	16	TB-16	3/28	0.18 - 16	25,000	NA	N	BSL
	117-81-7	Bis(2-ethylhexyl) phthalate	0.105	0.105	mg/kg	3.3	3.3	TB-16	1/29	0.036 - 3.3	39	NA	N	BSL
	86-74-8	Carbazole	0.0579	25.4	mg/kg	0.054	25.4	TB-16	27/33	0.018 - 2.3	180	NA	N	BSL
	132-64-9	Dibenzofuran	0.0223	21.4	mg/kg	0.312	21.4	TB-16	11/33	0.015 - 1.6	7.3	NA	Y	ASL
	108-95-2	Phenol	0.0446	0.0446	mg/kg	2.06	2.06	SD021	1/29	0.018 - 2.06	1,900	NA	N	BSL
	90-12-0	PAHs 1-Methylnaphthalene	0.0548	2.12	mg/kg	0.041	2.12	TB-16	6/28	0.018 - 1.6	18	0.0624	N	BSL
	91-57-6	2-Methylnaphthalene	0.02	2.78	mg/kg	0.041	2.78	TB-16	8/33	0.017 - 1.6	24	0.0624	N	BSL
	83-32-9	Acenaphthene	0.0222	52.7	mg/kg	0.043	52.7	TB-16	19/33	0.019 - 1.7	360	0.0624	N	BSL
	208-96-8	Acenaphthylene	0.0674	19.3	mg/kg	0.019	19.3	TB-16	27/29	0.018 - 1.6	180	0.0624	N	BSL
	120-12-7	Anthracene	0.0227	203	mg/kg	NA	203	TB-16	29/29	0.013 - 1.8	1,800	0.03856	N	BSL
	56-55-3	Benzo(a)anthracene	0.033	135	mg/kg	0.013	135	TB-16	32/33	0.013 - 1.6	1.1	0.01375	Y	ASL
	50-32-8	Benzo(a)pyrene	0.028	65.7	mg/kg	0.022	65.7	TB-16	32/33	0.013 - 1.9	0.11	0.01591	Y	ASL
	205-99-2	Benzo(b)fluoranthene	0.023	148	mg/kg	0.023	148	TB-16	32/33	0.02 - 1.8	1.1	0.0227	Y	ASL
	191-24-2	Benzo(g,h,i)perylene	0.029	28.3	mg/kg	NA	28.3	TB-16	29/29	0.019 - 1.7	180	0.01515	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.042	45.6	mg/kg	0.018	45.6	TB-16	32/33	0.013 - 2.2	11	0.01085	Y	ASL
	218-01-9	Chrysene	0.05	173	mg/kg	0.025	173	TB-16	32/33	0.018 - 1.7	110	0.01657	Y	ASL
	53-70-3	Dibenzo(a,h)anthracene	0.031	8.12	mg/kg	0.051	8.12	TB-16	22/33	0.023 - 2.1	0.11	0.00821	Y	ASL
	206-44-0	Fluoranthene	0.0528	761	mg/kg	0.014	761	TB-16	32/33	0.013 - 8.2	240	0.0469	Y	ASL
	86-73-7	Fluorene	0.021	60.1	mg/kg	0.044	60.1	TB-16	23/33	0.012 - 1.8	240	0.0624	N	BSL
	193-39-5	Indeno (1,2,3-cd) pyrene	0.0372	44.9	mg/kg	0.021	44.9	TB-16	31/33	0.013 - 2	1.1	0.01473	Y	ASL
	91-20-3	Naphthalene	0.023	2.46	mg/kg	0.041	2.46	TB-16	10/33	0.013 - 1.6	3.8	0.0624	N	BSL
	85-01-8	Phenanthrene	0.0413	319	mg/kg	0.041	319	TB-16	25/29	0.018 - 1.6	180	0.03898	Y	ASL
129-00-0	Pyrene	0.061	607	mg/kg	0.016	607	TB-16	32/33	0.016 - 9.5	180	0.0469	Y	ASL	
87-86-5	Pesticides Pentachlorophenol	0.104	0.104	mg/kg	16	16	TB-16	1/29	0.17 - 16	1	NA	N	CBSL	
Area 1D	92-52-4	Semi-volatile organic compounds 1,1-Biphenyl	0.0644	0.0644	mg/kg	0.19	0.19	SB-133	1/23	0.018 - 0.19	4.7	NA	N	BSL
	98-86-2	Acetophenone	0.0489	0.0489	mg/kg	0.19	0.19	SB-133	1/23	0.018 - 0.19	780	NA	N	BSL
	62-53-3	Aniline	0.0913	1.47	mg/kg	0.4	1.47	SB-134	2/23	0.038 - 0.4	44	NA	N	BSL
	65-85-0	Benzoic acid	0.209	1.44	mg/kg	1.9	1.9	SB-133	5/23	0.18 - 1.9	25,000	NA	N	BSL
	117-81-7	Bis(2-ethylhexyl) phthalate	0.0941	0.0941	mg/kg	1	1	TWSB27	1/24	0.036 - 1	39	NA	N	BSL
	86-74-8	Carbazole	0.0552	2.39	mg/kg	0.028	2.39	SS-114	22/26	0.018 - 0.33	180	NA	N	BSL
	132-64-9	Dibenzofuran	0.0269	0.334	mg/kg	0.33	0.334	SS-114	14/26	0.015 - 0.33	7.3	NA	N	BSL
	90-12-0	PAHs 1-Methylnaphthalene	0.0383	0.0961	mg/kg	0.19	0.19	SB-133	6/23	0.018 - 0.19	18	0.0624	N	BSL
	91-57-6	2-Methylnaphthalene	0.0199	0.19	mg/kg	0.33	0.33	TWSB27	12/26	0.017 - 0.33	24	0.0624	N	BSL
	83-32-9	Acenaphthene	0.0314	0.329	mg/kg	0.33	0.33	TWSB27	14/26	0.019 - 0.33	360	0.0624	N	BSL
	208-96-8	Acenaphthylene	0.0211	3.03	mg/kg	NA	3.03	SS-119	24/24	0.018 - 0.33	180	0.0624	N	BSL
	120-12-7	Anthracene	0.0374	9.22	mg/kg	NA	9.22	SS-117	24/24	0.02 - 0.46	1,800	0.03856	N	BSL

Table 2-2
Occurrence, Distribution and Selection of COPCs in Surface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾
Area 1D	56-55-3	Benzo(a)anthracene	0.0519	13.4	mg/kg	NA	13.4	SS-117	26/26	0.018 - 0.41	1.1	0.01375	Y	ASL
	50-32-8	Benzo(a)pyrene	0.0574	7.9	mg/kg	NA	7.9	SS-119	26/26	0.021 - 0.33	0.11	0.01591	Y	ASL
	205-99-2	Benzo(b)fluoranthene	0.144	22.8	mg/kg	NA	22.8	SS-119	26/26	0.02 - 0.45	1.1	0.0227	Y	ASL
	191-24-2	Benzo(g,h,i)perylene	0.0389	4.7	mg/kg	NA	4.7	SS-119	24/24	0.019 - 0.33	180	0.01515	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.0507	7.4	mg/kg	NA	7.4	RISB09	26/26	0.023 - 0.33	11	0.01085	N	BSL
	218-01-9	Chrysene	0.0842	16.3	mg/kg	NA	16.3	SS-117	26/26	0.018 - 0.42	110	0.01657	N	BSL
	53-70-3	Dibenzo(a,h)anthracene	0.0285	1.39	mg/kg	0.24	1.39	SS-119	21/26	0.022 - 0.33	0.11	0.00821	Y	ASL
	206-44-0	Fluoranthene	0.0781	30	mg/kg	NA	30	SS-117	26/26	0.018 - 0.41	240	0.0469	N	BSL
	86-73-7	Fluorene	0.0245	0.518	mg/kg	0.33	0.518	SS-114	16/26	0.011 - 0.33	240	0.0624	N	BSL
	193-39-5	Indeno (1,2,3-cd) pyrene	0.0506	6.43	mg/kg	NA	6.43	SS-119	26/26	0.022 - 0.33	1.1	0.01473	Y	ASL
	91-20-3	Naphthalene	0.022	0.27	mg/kg	0.33	0.33	TWSB27	13/26	0.015 - 0.33	3.8	0.0624	N	BSL
	85-01-8	Phenanthrene	0.021	10.9	mg/kg	0.019	10.9	SS-114	22/24	0.018 - 0.33	180	0.03898	N	BSL
129-00-0	Pyrene	0.107	30.7	mg/kg	NA	30.7	SS-117	26/26	0.021 - 0.47	180	0.0469	N	BSL	
Area 2	1319-77-3	Semi-volatile organic compounds (3-and/or 4-)Methylphenol	0.116	0.176	mg/kg	0.125	0.176	SO045	3/18	0.039 - 0.125	320	NA	N	BSL
	65-85-0	Benzoic acid	0.055	2.09	mg/kg	0.047	2.09	SO044	15/17	0.039 - 0.125	25,000	NA	N	BSL
	117-81-7	Bis(2-ethylhexyl) phthalate	0.013	0.013	mg/kg	0.1	0.1	BKSB04	1/18	0.00585 - 0.1	39	NA	N	BSL
	86-74-8	Carbazole	0.00926	0.26	mg/kg	0.019	0.26	BKSB04	8/18	0.00585 - 0.033	180	NA	N	BSL
	84-74-2	Di-n-butylphthalate	0.011	0.011	mg/kg	0.067	0.067	BKSB04	1/18	0.00585 - 0.067	630	NA	N	BSL
	90-12-0	PAHs 1-Methylnaphthalene	0.00136	0.00465	mg/kg	0.026	0.026	SO039	5/17	0.000989 - 0.026	18	0.0624	N	BSL
	91-57-6	2-Methylnaphthalene	0.00119	0.00394	mg/kg	0.033	0.033	BKSB04	7/18	0.00106 - 0.033	24	0.0624	N	BSL
	83-32-9	Acenaphthene	0.0039	0.029	mg/kg	0.051	0.051	SO039	3/18	0.00194 - 0.051	360	0.0624	N	BSL
	208-96-8	Acenaphthylene	0.00227	0.35	mg/kg	0.012	0.35	BKSB04	16/18	0.00194 - 0.051	180	0.0624	N	BSL
	120-12-7	Anthracene	0.00136	1.1	mg/kg	NA	1.1	BKSB04	18/18	0.000494 - 0.033	1,800	0.03856	N	BSL
	56-55-3	Benzo(a)anthracene	0.00307	1.19	mg/kg	0.012	1.19	SO039	17/18	0.00194 - 0.051	1.1	0.01375	Y	ASL
	50-32-8	Benzo(a)pyrene	0.00378	1.03	mg/kg	NA	1.03	SO039	18/18	0.000494 - 0.033	0.11	0.01591	Y	ASL
	205-99-2	Benzo(b)fluoranthene	0.01	3.51	mg/kg	NA	3.51	SO039	18/18	0.00194 - 0.051	1.1	0.0227	Y	ASL
	191-24-2	Benzo(g,h,i)perylene	0.00444	0.74	mg/kg	0.00116	0.74	BKSB04	16/18	0.000989 - 0.033	180	0.01515	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.00327	1.05	mg/kg	NA	1.05	SO039	18/18	0.000494 - 0.033	11	0.01085	N	BSL
	218-01-9	Chrysene	0.00517	1.96	mg/kg	NA	1.96	SO039	18/18	0.00194 - 0.051	110	0.01657	N	BSL
	53-70-3	Dibenzo(a,h)anthracene	0.00295	0.23	mg/kg	0.012	0.23	BKSB04	10/18	0.00194 - 0.051	0.11	0.00821	Y	ASL
	206-44-0	Fluoranthene	0.00553	2.37	mg/kg	NA	2.37	SO039	18/18	0.000494 - 0.033	240	0.0469	N	BSL
	86-73-7	Fluorene	0.000591	0.047	mg/kg	0.00303	0.047	BKSB04	15/18	0.000494 - 0.033	240	0.0624	N	BSL
	193-39-5	Indeno (1,2,3-cd) pyrene	0.00666	0.94	mg/kg	0.000578	0.94	BKSB04	16/18	0.000494 - 0.033	1.1	0.01473	N	BSL
85-01-8	Phenanthrene	0.00216	0.344	mg/kg	0.00109	0.344	SO046	17/18	0.000989 - 0.033	180	0.03898	N	BSL	
129-00-0	Pyrene	0.00575	4.61	mg/kg	NA	4.61	SO039	18/18	0.000989 - 0.033	180	0.0469	N	BSL	

Notes:
 (1) Minimum/maximum detected concentration.
 (2) Concentration used for screening is the higher of the maximum concentration or the maximum MDL for non-detected results.
 (3) Screening value is the residential soil value from the USEPA Regional Screening Level (RSL) Table, based on risk of 10⁻⁶ for carcinogens and a hazard quotient (HQ) of 0.1 for noncarcinogens (USEPA, April 2019).
 (4) Consistent with the COPC Technical Memorandum for the site (ENSR, 2006), two times average background has been used for semivolatiles. See Table 2-1 for derivation.
 (5) Rationale Codes:

Prepared By: RAH 7/10/2019
 Checked By: SMA 7/16/2019

Selection Reason: Above Screening Level (ASL)
 Deletion Reason: Below Screening Level (BSL); Maximum Detected Concentration Below Screening Level (CBSL)

bgs - Below Ground Surface
 COPC - Chemical of Potential Concern
 MDL - Method Detection Limit
 NA - Not Available
 PAHs - Polycyclic Aromatic Hydrocarbons
 mg/kg - Milligrams per Kilogram

Table 2-3
Occurrence, Distribution and Selection of COPCs in Subsurface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current/Future
 Medium: Subsurface Soils (>1 foot bgs)

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾
Area 1A	132-64-9	<i>Semi-volatile organic compounds</i> Dibenzofuran	0.017	0.017	mg/kg	0.033	0.033	BRSB01	1/16	0.015 - 0.033	7.3	NA	N	BSL
	91-57-6	<i>PAHs</i> 2-Methylnaphthalene	0.026	0.026	mg/kg	0.033	0.033	BRSB01	1/16	0.017 - 0.033	24	0.0624	N	BSL
	83-32-9	Acenaphthene	0.028	0.028	mg/kg	0.033	0.033	BRSB01	1/16	0.019 - 0.033	360	0.0624	N	BSL
	208-96-8	Acenaphthylene	0.0393	0.0393	mg/kg	0.033	0.0393	TB-01	1/14	0.018 - 0.033	180	0.0624	N	BSL
	120-12-7	Anthracene	0.024	0.0395	mg/kg	0.033	0.0395	TB-01	2/14	0.02 - 0.033	1,800	0.03856	N	BSL
	56-55-3	Benzo(a)anthracene	0.016	0.016	mg/kg	0.033	0.033	BRSB01	1/16	0.013 - 0.033	1.1	0.01375	N	BSL
	205-99-2	Benzo(b)fluoranthene	0.033	0.033	mg/kg	0.033	0.033	RISB02, BRSB01	1/16	0.019 - 0.033	1.1	0.0227	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.021	0.021	mg/kg	0.033	0.033	BRSB01	1/16	0.018 - 0.033	11	0.01085	N	BSL
	218-01-9	Chrysene	0.028	0.028	mg/kg	0.033	0.033	BRSB01	1/16	0.018 - 0.033	110	0.01657	N	BSL
	206-44-0	Fluoranthene	0.037	0.075	mg/kg	0.033	0.075	SB-119	2/16	0.014 - 0.033	240	0.0469	N	BSL
	86-73-7	Fluorene	0.0237	0.0237	mg/kg	0.033	0.033	BRSB01	1/16	0.012 - 0.033	240	0.0624	N	BSL
	91-20-3	Naphthalene	0.016	0.016	mg/kg	0.033	0.033	BRSB01	1/16	0.015 - 0.033	3.8	0.0624	N	BSL
85-01-8	Phenanthrene	0.119	0.119	mg/kg	0.033	0.119	SB-119	1/14	0.018 - 0.033	180	0.03898	N	BSL	
129-00-0	Pyrene	0.042	0.0503	mg/kg	0.033	0.0503	SB-119	2/16	0.016 - 0.033	180	0.0469	N	BSL	
Area 1B	92-52-4	<i>Semi-volatile organic compounds</i> 1,1-Biphenyl	0.0361	3.31	mg/kg	0.39	3.31	BB-04-30	2/15	0.018 - 0.98	4.7	NA	N	BSL
	105-60-2	Caprolactam	0.0994	0.0994	mg/kg	1.6	1.6	BB-04-30	1/15	0.028 - 1.6	3,100	NA	N	BSL
	86-74-8	Carbazole	0.04	0.733	mg/kg	1.4	1.4	BB-04-30	5/19	0.018 - 1.4	180	NA	N	BSL
	132-64-9	Dibenzofuran	0.027	33.2	mg/kg	0.033	33.2	BB-04-30	4/19	0.015 - 0.98	7.3	NA	Y	ASL
	90-12-0	<i>PAHs</i> 1-Methylnaphthalene	0.0977	4.37	mg/kg	0.39	4.37	BB-04-30	2/15	0.018 - 0.98	18	0.0624	N	BSL
	91-57-6	2-Methylnaphthalene	0.168	3.01	mg/kg	0.39	3.01	BB-04-30	2/19	0.017 - 0.98	24	0.0624	N	BSL
	83-32-9	Acenaphthene	0.043	163	mg/kg	0.033	163	BB-04-30	4/19	0.019 - 1	360	0.0624	N	BSL
	208-96-8	Acenaphthylene	0.0203	6.11	mg/kg	0.033	6.11	BB-04-30	11/17	0.018 - 0.98	180	0.0624	N	BSL
	120-12-7	Anthracene	0.0232	24	mg/kg	0.033	24	BB-04-30	8/17	0.02 - 1.1	1,800	0.03856	N	BSL
	56-55-3	Benzo(a)anthracene	0.019	37.2	mg/kg	0.033	37.2	TB-05	7/19	0.012 - 0.98	1.1	0.01375	Y	ASL
	50-32-8	Benzo(a)pyrene	0.0298	8.35	mg/kg	0.033	8.35	TB-05	6/19	0.021 - 1.2	0.11	0.01591	Y	ASL
	205-99-2	Benzo(b)fluoranthene	0.0317	21.3	mg/kg	0.033	21.3	TB-05	8/19	0.019 - 1.1	1.1	0.0227	Y	ASL
	191-24-2	Benzo(g,h,i)perylene	0.0208	3.36	mg/kg	0.033	3.36	TB-05	7/17	0.018 - 1	180	0.01515	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.034	8.93	mg/kg	0.033	8.93	BB-04-30	6/19	0.018 - 1.3	11	0.01085	N	BSL
	218-01-9	Chrysene	0.027	34.6	mg/kg	0.033	34.6	TB-05	7/19	0.018 - 1	110	0.01657	N	BSL
	53-70-3	Dibenzo(a,h)anthracene	0.551	1.09	mg/kg	1.2	1.2	BB-04-30	2/19	0.022 - 1.2	0.11	0.00821	Y	ASL
	206-44-0	Fluoranthene	0.0183	299	mg/kg	0.033	299	BB-04-30	9/19	0.014 - 2	240	0.0469	Y	ASL
	86-73-7	Fluorene	0.025	95.7	mg/kg	0.033	95.7	BB-04-30	5/19	0.011 - 1	240	0.0624	N	BSL
	193-39-5	Indeno (1,2,3-cd) pyrene	0.0349	5.46	mg/kg	0.033	5.46	TB-05	6/19	0.02 - 1.2	1.1	0.01473	Y	ASL
	91-20-3	Naphthalene	0.189	0.189	mg/kg	0.98	0.98	BB-04-30	1/19	0.015 - 0.98	3.8	0.0624	N	BSL
85-01-8	Phenanthrene	0.0252	297	mg/kg	0.033	297	BB-04-30	5/17	0.018 - 2	180	0.03898	Y	ASL	
129-00-0	Pyrene	0.025	175	mg/kg	0.033	175	TB-05	8/19	0.016 - 2.3	180	0.0469	N	BSL	

Table 2-3
Occurrence, Distribution and Selection of COPCs in Subsurface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾	
Area 1C		<i>Semi-volatile organic compounds</i>													
	92-52-4	1,1-Biphenyl	0.0197	2.21	mg/kg	0.08	2.21	EE-18-170	5/32	0.017 - 0.97	4.7	NA	N	BSL	
	117-81-7	Bis(2-ethylhexyl) phthalate	0.0414	0.222	mg/kg	1.9	1.9	EE-18-170	2/33	0.033 - 1.9	39	NA	N	BSL	
	105-60-2	Caprolactam	0.044	0.044	mg/kg	1.6	1.6	EE-18-170	1/32	0.026 - 1.6	3,100	NA	N	BSL	
	86-74-8	Carbazole	0.0846	20.3	mg/kg	0.033	20.3	EE-18-170	9/37	0.019 - 1.4	180	NA	N	BSL	
	132-64-9	Dibenzofuran	0.055	28.1	mg/kg	0.042	28.1	EE-18-170	7/37	0.015 - 0.97	7.3	NA	Y	ASL	
	84-74-2	Di-n-butylphthalate	0.128	0.128	mg/kg	3.9	3.9	EE-18-170	1/33	0.066 - 3.9	630	NA	N	BSL	
		<i>PAHs</i>													
	90-12-0	1-Methylnaphthalene	0.0283	5.62	mg/kg	0.08	5.62	EE-18-170	5/32	0.017 - 0.97	18	0.0624	N	BSL	
	91-57-6	2-Methylnaphthalene	0.033	8.37	mg/kg	0.08	8.37	EE-18-170	6/37	0.017 - 0.97	24	0.0624	N	BSL	
	83-32-9	Acenaphthene	0.0335	39.5	mg/kg	0.044	39.5	EE-18-170	9/37	0.018 - 1	360	0.0624	N	BSL	
	208-96-8	Acenaphthylene	0.0217	2.36	mg/kg	0.033	2.36	EE-18-170	18/33	0.017 - 0.97	180	0.0624	N	BSL	
	120-12-7	Anthracene	0.0329	60.3	mg/kg	0.033	60.3	EE-18-170	10/33	0.019 - 1.1	1,800	0.03856	N	BSL	
	56-55-3	Benzo(a)anthracene	0.0244	30.9	mg/kg	0.022	30.9	TB-11	15/37	0.013 - 0.97	1.1	0.01375	Y	ASL	
	50-32-8	Benzo(a)pyrene	0.0301	9.75	mg/kg	0.026	9.75	TB-11	14/37	0.019 - 1.1	0.11	0.01591	Y	ASL	
	205-99-2	Benzo(b)fluoranthene	0.0224	25	mg/kg	0.024	25	TB-11	16/37	0.018 - 1.1	1.1	0.0227	Y	ASL	
	191-24-2	Benzo(g,h,i)perylene	0.0621	4.68	mg/kg	0.033	4.68	TB-11	10/33	0.017 - 1	180	0.01515	N	BSL	
	207-08-9	Benzo(k)fluoranthene	0.0285	11.8	mg/kg	0.029	11.8	EE-18-170	14/37	0.019 - 1.3	11	0.01085	Y	ASL	
	218-01-9	Chrysene	0.051	37.7	mg/kg	0.026	37.7	TB-11	14/37	0.017 - 0.99	110	0.01657	N	BSL	
	53-70-3	Dibenzo(a,h)anthracene	0.0624	1.45	mg/kg	0.033	1.45	TB-11	10/37	0.021 - 1.2	0.11	0.00821	Y	ASL	
206-44-0	Fluoranthene	0.0252	215	mg/kg	0.022	215	TB-11	17/37	0.014 - 3	240	0.0469	N	BSL		
86-73-7	Fluorene	0.0508	51.2	mg/kg	0.033	51.2	EE-18-170	10/37	0.012 - 1	240	0.0624	N	BSL		
193-39-5	Indeno (1,2,3-cd) pyrene	0.0276	5.17	mg/kg	0.033	5.17	TB-11	13/37	0.02 - 1.2	1.1	0.01473	Y	ASL		
91-20-3	Naphthalene	0.019	4.12	mg/kg	0.042	4.12	EE-18-170	8/37	0.015 - 0.97	3.8	0.0624	Y	ASL		
85-01-8	Phenanthrene	0.0183	240	mg/kg	0.033	240	EE-18-170	12/33	0.017 - 1.9	180	0.03898	Y	ASL		
129-00-0	Pyrene	0.0245	159	mg/kg	0.025	159	TB-11	18/37	0.016 - 3.5	180	0.0469	N	BSL		
Area 1D		<i>Semi-volatile organic compounds</i>													
	92-52-4	1,1-Biphenyl	0.0627	0.0627	mg/kg	0.039	0.0627	GG-16-140	1/20	0.018 - 0.039	4.7	NA	N	BSL	
	86-74-8	Carbazole	0.025	0.797	mg/kg	0.033	0.797	GG-16-140	5/23	0.019 - 0.054	180	NA	N	BSL	
	132-64-9	Dibenzofuran	0.0687	0.244	mg/kg	0.033	0.244	GG-16-140	3/23	0.016 - 0.039	7.3	NA	N	BSL	
	84-74-2	Di-n-butylphthalate	0.0864	0.097	mg/kg	0.15	0.15	TB-24	3/21	0.067 - 0.15	630	NA	N	BSL	
		<i>PAHs</i>													
	90-12-0	1-Methylnaphthalene	0.0916	0.0916	mg/kg	0.039	0.0916	GG-16-140	1/20	0.018 - 0.039	18	0.0624	N	BSL	
	91-57-6	2-Methylnaphthalene	0.0529	0.32	mg/kg	0.033	0.32	RISB10	3/23	0.018 - 0.039	24	0.0624	N	BSL	
	83-32-9	Acenaphthene	0.0724	0.156	mg/kg	0.033	0.156	GG-16-140	3/23	0.019 - 0.041	360	0.0624	N	BSL	
	208-96-8	Acenaphthylene	0.0342	1.72	mg/kg	0.033	1.72	GG-16-140	6/21	0.018 - 0.039	180	0.0624	N	BSL	
	120-12-7	Anthracene	0.0224	3.67	mg/kg	0.033	3.67	GG-16-140	6/21	0.02 - 0.043	1,800	0.03856	N	BSL	
	56-55-3	Benzo(a)anthracene	0.0213	9.49	mg/kg	0.033	9.49	GG-16-140	9/23	0.018 - 0.2	1.1	0.01375	Y	ASL	
	50-32-8	Benzo(a)pyrene	0.0255	5.42	mg/kg	0.033	5.42	GG-16-140	8/23	0.022 - 0.24	0.11	0.01591	Y	ASL	
	205-99-2	Benzo(b)fluoranthene	0.0391	8.72	mg/kg	0.023	8.72	GG-16-140	11/23	0.02 - 0.22	1.1	0.0227	Y	ASL	
	191-24-2	Benzo(g,h,i)perylene	0.084	2.24	mg/kg	0.033	2.24	GG-16-140	5/21	0.019 - 0.04	180	0.01515	N	BSL	
	207-08-9	Benzo(k)fluoranthene	0.033	6.67	mg/kg	0.033	6.67	GG-16-140	8/23	0.019 - 0.26	11	0.01085	N	BSL	
	218-01-9	Chrysene	0.0239	11	mg/kg	0.033	11	GG-16-140	9/23	0.019 - 0.2	110	0.01657	N	BSL	
	53-70-3	Dibenzo(a,h)anthracene	0.0302	1.2	mg/kg	0.033	1.2	GG-16-140	6/23	0.023 - 0.048	0.11	0.00821	Y	ASL	
	206-44-0	Fluoranthene	0.0298	25	mg/kg	0.021	25	GG-16-140	9/23	0.015 - 0.2	240	0.0469	N	BSL	
	86-73-7	Fluorene	0.0288	0.238	mg/kg	0.033	0.238	GG-16-140	5/23	0.013 - 0.041	240	0.0624	N	BSL	
193-39-5	Indeno (1,2,3-cd) pyrene	0.11	3.06	mg/kg	0.033	3.06	GG-16-140	6/23	0.022 - 0.047	1.1	0.01473	Y	ASL		
91-20-3	Naphthalene	0.0831	0.332	mg/kg	0.033	0.332	GG-16-140	3/23	0.016 - 0.039	3.8	0.0624	N	BSL		
85-01-8	Phenanthrene	0.0228	2.05	mg/kg	0.033	2.05	GG-16-140	6/21	0.018 - 0.039	180	0.03898	N	BSL		
129-00-0	Pyrene	0.0225	22.6	mg/kg	0.024	22.6	GG-16-140	11/23	0.017 - 0.23	180	0.0469	N	BSL		

Table 2-3
Occurrence, Distribution and Selection of COPCs in Subsurface Soil
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Area	CAS Number	Chemical	Minimum ⁽¹⁾ Concentration	Maximum ⁽¹⁾ Concentration	Units	Max. MDL for Non-detected Results	Concentration Used for Screening ⁽²⁾	Location of Maximum Value	Detection Frequency	Range of Reporting Limits	Screening Toxicity Value ⁽³⁾	Background Value ⁽⁴⁾	COPC Flag (Y/N)	Rationale for Selection or Deletion ⁽⁵⁾	
Area 2		<i>Semi-volatile organic compounds</i>													
	65-85-0	Benzoic acid	0.047	0.104	mg/kg	0.043	0.104	SO047	5/15	0.039 - 0.046	25,000	NA	N	BSL	
	86-74-8	Carbazole	0.01	0.01	mg/kg	0.033	0.033	BKSB04	1/16	0.00596 - 0.033	180	NA	N	BSL	
	84-74-2	Di-n-butylphthalate	0.011	0.011	mg/kg	0.067	0.067	BKSB04	2/16	0.00596 - 0.067	630	NA	N	BSL	
		<i>PAHs</i>													
	90-12-0	1-Methylnaphthalene	0.00114	0.00114	mg/kg	0.00118	0.00118	SO038	1/15	0.00101 - 0.00118	18	0.0624	N	BSL	
	91-57-6	2-Methylnaphthalene	0.0014	0.0014	mg/kg	0.033	0.033	BKSB04	1/16	0.00101 - 0.033	24	0.0624	N	BSL	
	208-96-8	Acenaphthylene	0.00285	0.00802	mg/kg	0.033	0.033	BKSB04	3/16	0.00199 - 0.033	180	0.0624	N	BSL	
	120-12-7	Anthracene	0.000655	0.056	mg/kg	0.033	0.056	SO047	6/16	0.000507 - 0.033	1,800	0.03856	N	BSL	
	56-55-3	Benzo(a)anthracene	0.00322	0.012	mg/kg	0.033	0.033	BKSB04	4/16	0.00199 - 0.033	1.1	0.01375	N	BSL	
	50-32-8	Benzo(a)pyrene	0.00409	0.017	mg/kg	0.033	0.033	BKSB04	7/16	0.000507 - 0.033	0.11	0.01591	N	BSL	
	205-99-2	Benzo(b)fluoranthene	0.00409	0.057	mg/kg	0.033	0.057	SO047	6/16	0.00199 - 0.033	1.1	0.0227	N	BSL	
	191-24-2	Benzo(g,h,i)perylene	0.00409	0.03	mg/kg	0.033	0.033	BKSB04	5/16	0.00101 - 0.033	180	0.01515	N	BSL	
	207-08-9	Benzo(k)fluoranthene	0.00054	0.034	mg/kg	0.033	0.034	SO042	10/16	0.000507 - 0.033	11	0.01085	N	BSL	
	218-01-9	Chrysene	0.00332	0.024	mg/kg	0.033	0.033	BKSB04	4/16	0.00199 - 0.033	110	0.01657	N	BSL	
	53-70-3	Dibenzo(a,h)anthracene	0.00286	0.00503	mg/kg	0.033	0.033	BKSB04	2/16	0.00199 - 0.033	0.11	0.00821	N	BSL	
	206-44-0	Fluoranthene	0.000617	0.084	mg/kg	0.000588	0.084	BKSB04	9/16	0.000507 - 0.033	240	0.0469	N	BSL	
	86-73-7	Fluorene	0.000655	0.00142	mg/kg	0.033	0.033	BKSB04	3/16	0.000507 - 0.033	240	0.0624	N	BSL	
193-39-5	Indeno (1,2,3-cd) pyrene	0.00409	0.033	mg/kg	0.033	0.033	SO047, BKSB04	6/16	0.000507 - 0.033	1.1	0.01473	N	BSL		
85-01-8	Phenanthrene	0.00165	0.074	mg/kg	0.00118	0.074	BKSB04	5/16	0.00101 - 0.033	180	0.03898	N	BSL		
129-00-0	Pyrene	0.00178	0.069	mg/kg	0.00118	0.069	BKSB04	8/16	0.00101 - 0.033	180	0.0469	N	BSL		

- Notes:
- (1) Minimum/maximum detected concentration.
 - (2) Concentration used for screening is the higher of the maximum concentration or the maximum MDL for non-detected results.
 - (3) Screening value is the residential soil value from the USEPA Regional Screening Level (RSL) Table, based on risk of 10⁻⁶ for carcinogens and a hazard quotient (HQ) of 0.1 for noncarcinogens (USEPA, April 2019).
 - (4) Consistent with the COPC Technical Memorandum for the site (ENSR, 2006), two times average background has been used for semivolatiles. See Tables 2-1 for derivation.
 - (5) Rationale Codes:
 Selection Reason: Above Screening Level (ASL)
 Deletion Reason: Below Screening Level (BSL)
 bgs - Below Ground Surface
 COPC - Chemical of Potential Concern
 MDL - Method Detection Limit
 NA - Not Available
 PAHs - Polycyclic Aromatic Hydrocarbons
 mg/kg - Milligrams per Kilogram

Prepared By: RAH 7/18/2019
 Checked By: SMA 7/19/2019

Table 3-1
Summary of Exposure Factors
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Parameter	Code	Units	Receptor	Exposure Factor	Comment
General					
Concentration in Soil	CS	mg/kg	All receptors	Chemical-specific	---
Exposure Frequency	EF _a	days/year	Resident Adult	350	USEPA, February 2014
	EF _c		Resident Child	350	USEPA, February 2014
	EF ₀₋₂		Resident Age 0-2, Mutagenic	350	USEPA, February 2014
	EF ₂₋₆		Resident Age 2-6, Mutagenic	350	USEPA, February 2014
	EF ₆₋₁₆		Resident Age 6-16, Mutagenic	350	USEPA, February 2014
	EF ₁₆₋₂₆		Resident Age 16-26, Mutagenic	350	USEPA, February 2014
	EF		Teenage Trespasser	45	USEPA RSL User's Guide and Region 4 EPA, March 2018 state that this parameter is site specific, based on proximity of residents and attractiveness of the site. This site has no improvements and is not considered attractive.
	EF		Outdoor Worker	225	USEPA, February 2014
	EF		Construction Worker	130	Best professional judgement; assumes construction activity lasts for 5 days per week for 26 weeks
Exposure Duration	ED _a	years	Resident Adult	20	USEPA, February 2014
	ED _c		Resident Child	6	USEPA RSL User's Guide, 2017/USEPA, February 2014
	ED ₀₋₂		Resident Age 0-2, Mutagenic	2	USEPA RSL User's Guide, 2017/USEPA, February 2014
	ED ₂₋₆		Resident Age 2-6, Mutagenic	4	USEPA RSL User's Guide, 2017/USEPA, February 2014
	ED ₆₋₁₆		Resident Age 6-16, Mutagenic	10	No value provided in references; value based on email communication with Tim Frederick of USEPA dated 10/17/2017
	ED ₁₆₋₂₆		Resident Age 16-26, Mutagenic	10	USEPA, February 2014
	ED		Teenage Trespasser	10	No value provided in references; value based on email communication with Tim Frederick of USEPA dated 10/17/2017
	ED		Outdoor Worker	25	USEPA, February 2014
	ED		Construction Worker	1	USEPA, RSL User's Guide
Body Weight	BW _a	kg	Resident Adult	80	USEPA, February 2014
	BW _c		Resident Child	15	USEPA RSL User's Guide, 2017/USEPA, February 2014
	BW ₀₋₂		Resident Age 0-2, Mutagenic	15	USEPA RSL User's Guide, 2017/USEPA, February 2014
	BW ₂₋₆		Resident Age 2-6, Mutagenic	15	USEPA RSL User's Guide, 2017/USEPA, February 2014
	BW ₆₋₁₆		Resident Age 6-16, Mutagenic	45	No value provided in references; value based on email communication with Tim Frederick of USEPA dated 10/17/2017
	BW ₁₆₋₂₆		Resident Age 16-26, Mutagenic	80	USEPA, February 2014
	BW		Teenage Trespasser	45	No value provided in references; value based on email communication with Tim Frederick of USEPA dated 10/17/2017
	BW		Outdoor Worker	80	USEPA, February 2014
	BW		Construction Worker	80	USEPA, February 2014
Averaging Time (Cancer)	AT-C	days	All receptors	25,550	USEPA, RSL User's Guide
		hrs	All receptors	613,200	
Averaging Time (Non-Cancer)	AT-NC	days	Resident Adult	7,300	USEPA, February 2014 and USEPA, RSL User's Guide. Teenage trespassor value obtained by multiplying 10-years by 365 days per year.
			Resident Child	2,190	
			Teenage Trespasser	3,650	
			Outdoor Worker	9,125	
			Construction Worker	365	
		hours	Resident Adult	175,200	USEPA, February 2014 and USEPA, RSL User's Guide. Teenage trespassor value obtained by multiplying 10-years by 365 days per year by 24 hours per day.
			Resident Child	52,560	
			Teenage Trespasser	87,600	
			Outdoor Worker	219,000	
			Construction Worker	8,760	
Age-Dependent Adjustment Factor	ADAF	unitless	Resident Age 0-2, Mutagenic	10	USEPA, March 2005
			Resident Age 2-6, Mutagenic	3	
			Resident Age 6-16, Mutagenic	3	
			Resident Age 16-26, Mutagenic	1	

Table 3-1
Summary of Exposure Factors
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Parameter	Code	Units	Receptor	Exposure Factor	Comment
Ingestion					
<i>Soil</i>					
Ingestion Rate of Soil	SIR _a	mg/day	Resident Adult	100	USEPA, February 2014
	SIR _c		Resident Child	200	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SIR ₀₋₂		Resident Age 0-2, Mutagenic	200	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SIR ₂₋₆		Resident Age 2-6, Mutagenic	200	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SIR ₆₋₁₆		Resident Age 6-16, Mutagenic	150	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	SIR ₁₆₋₂₆		Resident Age 16-26, Mutagenic	100	USEPA, February 2014
	SIR		Teenage Trespasser	150	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	SIR		Outdoor Worker	100	USEPA, February 2014
	SIR		Construction Worker	330	USEPA, RSL User's Guide
Conversion Factor	CF	kg/mg	All receptors	1.00E-06	---
Fraction Ingested	FI	unitless	All receptors (with exception of construction worker)	1	USEPA, February 2014
			Construction Worker	1	Default value
Dermal Contact					
<i>Soil</i>					
Surface Area available for contact	SA _a	cm ²	Resident Adult	6,032	USEPA, February 2014
	SA _c		Resident Child	2,373	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SA ₀₋₂		Resident Age 0-2, Mutagenic	2,373	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SA ₂₋₆		Resident Age 2-6, Mutagenic	2,373	USEPA RSL User's Guide, 2017/USEPA, February 2014
	SA ₆₋₁₆		Resident Age 6-16, Mutagenic	4,203	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	SA ₁₆₋₂₆		Resident Age 16-26, Mutagenic	6,032	USEPA, February 2014
	SA		Teenage Trespasser	4,203	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	SA		Outdoor Worker	3,527	USEPA, RSL User's Guide
	SA		Construction Worker	3,527	USEPA, RSL User's Guide
Soil to Skin Adherence Factor	AF _a	mg/cm ²	Resident Adult	0.07	USEPA, February 2014
	AF _c		Resident Child	0.2	USEPA RSL User's Guide, 2017/USEPA, February 2014
	AF ₀₋₂		Resident Age 0-2, Mutagenic	0.2	USEPA RSL User's Guide, 2017/USEPA, February 2014
	AF ₂₋₆		Resident Age 2-6, Mutagenic	0.2	USEPA RSL User's Guide, 2017/USEPA, February 2014
	AF ₆₋₁₆		Resident Age 6-16, Mutagenic	0.135	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	AF ₁₆₋₂₆		Resident Age 16-26, Mutagenic	0.07	USEPA, February 2014
	AF		Teenage Trespasser	0.135	Average of Resident Adult and Child, based on email communication with Tim Frederick of USEPA dated 10/17/2017
	AF		Outdoor Worker	0.12	USEPA, February 2014
	AF		Construction Worker	0.3	USEPA, RSL User's Guide
Conversion Factor	CF	kg/mg	All receptors	1.00E-06	---

Table 3-1
Summary of Exposure Factors
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Parameter	Code	Units	Receptor	Exposure Factor	Comment
Inhalation					
<i>Soil</i>					
Chemical Concentration in Air	CA	mg/m ³	All receptors	Calculated	---
Exposure Time	ET _a	hours/day	Resident Adult	24	USEPA, February 2014
	ET _c		Resident Child	24	USEPA, February 2014
	ET		Teenage Trespasser	2	USEPA RSL User's Guide indicates this parameter is site specific. Estimate is based on site-specific information and professional judgement.
	ET		Outdoor Worker	8	USEPA, February 2014
	ET		Construction Worker	8	USEPA, February 2014 for soil; Virginia DEQ Unified Risk Assessment Model (VURAM) default value for time spent in a trench
Fraction Inhaled	FI _{inh}	unitless	All receptors (with exception of construction worker)	1	USEPA, February 2014
			Construction Worker	1.0	Default value
Volatilization Factor	VF	m ³ /kg	All receptors	Chemical-specific	USEPA, December 2002, Appendix E
Particulate Emission Factor	PEF	m ³ /kg	All receptors	Scenario-specific	USEPA, December 2002, Appendix D

Notes:

NA - Pathway was not evaluated as part of the HHRA and an exposure factor for this parameter is not needed.

--- Parameter is chemical-specific or standard (no reference needed).

mg/kg - milligrams per kilogram

kg - kilogram

hrs - hours

mg/day - milligrams per day

kg/mg - kilograms per milligram

cm² - square centimeters

mg/cm² - milligrams per square centimeter

mg/m³ - milligrams per cubic meter

m³/kg - cubic meters per kilogram

Prepared By: SMA 7/19/2019

Checked By: RAH 7/19/2019

References:

USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, February 2014

USEPA, *Regional Screening Levels (RSLs) - User's Guide*, April 2019

USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, March 2018

USEPA, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*, March 2005

VADEQ, Virginia Unified Risk Assessment Model, 2016

Table 3-2
Chronic and Sub-Chronic Non-Cancer Toxicity Data - Oral/Dermal
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Chemicals of Potential Concern	Chronic						Sub-Chronic							
	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal ⁽¹⁾		Primary Target Organ(s)	RfD and Target Organ Source(s)	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal ⁽¹⁾		Primary Target Organ(s)	RfD and Target Organ Source(s)
	Value	Units		Value	Units			Value	Units		Value	Units		
<u>SVOCs</u>														
Dibenzofuran	1.0E-03	mg/kg-day	1	1.0E-03	mg/kg-day	Hepatic	Appendix PPRTV Screen	4.0E-03	mg/kg-day	1	4.0E-03	mg/kg-day	Hepatic	PPRTV
<u>PAHs</u>														
Benzo(a)anthracene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Benzo(a)pyrene	3.0E-04	mg/kg-day	1	3.0E-04	mg/kg-day	Developmental	IRIS	NA	NA	1	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Chrysene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Fluoranthene	4.0E-02	mg/kg-day	1	4.0E-02	mg/kg-day	Hepatic, Renal	IRIS	1.0E-01	mg/kg-day	1	1.0E-01	mg/kg-day	Hepatic, Renal	PPRTV
Indeno(1,2,3-cd)pyrene	NA	NA	1	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
Naphthalene	2.0E-02	mg/kg-day	1	2.0E-02	mg/kg-day	Other	IRIS	6.0E-01	mg/kg-day	1	6.0E-01	mg/kg-day	Other	ATSDR
Phenanthrene	3.0E-02	mg/kg-day	1	3.0E-02	mg/kg-day	Renal	IRIS	3.0E-01	mg/kg-day	1	3.0E-01	mg/kg-day	Renal	PPRTV
Pyrene	3.0E-02	mg/kg-day	1	3.0E-02	mg/kg-day	Renal	IRIS	3.0E-01	mg/kg-day	1	3.0E-01	mg/kg-day	Renal	PPRTV
<u>Pesticides</u>														
Pentachlorophenol	5.0E-03	mg/kg-day	1	5.0E-03	mg/kg-day	Hepatic	IRIS	1.0E-03	mg/kg-day	1	1.0E-03	mg/kg-day	Hepatic	ATSDR

Notes:
 RfD - Reference Dose
 NA - Not Applicable
 mg/kg-day - milligrams per kilogram-day
 PPRTV - Provisional Peer Reviewed Toxicity Values for Superfund
 IRIS - Integrated Risk Information System
 ATSDR - Agency for Toxic Substances and Disease Registry
 (1) Absorbed RfD for Dermal = (Oral RfD) x (Oral Absorption Efficiency)
 Pyrene used as a surrogate for phenanthrene.
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons

Prepared by: RAH 3/29/2019
 Checked by: SMA 3/29/2019

Table 3-3
Chronic Non-Cancer Toxicity Data - Inhalation
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Human Health Risk Assessment Addendum
August 2019

Chemicals of Potential Concern	Inhalation RfC		Primary Target Organ(s)	RfC and Target Organ Source(s)
	Value	Units		
<u>SVOCs</u>				
Dibenzofuran	NA	NA	NA	NA
<u>PAHs</u>				
Benzo(a)anthracene	NA	NA	NA	NA
Benzo(a)pyrene	2.0E-06	mg/m ³	Developmental	IRIS
Benzo(b)fluoranthene	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA
Naphthalene	3.0E-03	mg/m ³	Nervous, Respiratory	IRIS
Phenanthrene	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA
<u>Pesticides</u>				
Pentachlorophenol	NA	NA	NA	NA

Notes:

RfC - Reference Concentration

NA - Not Applicable

mg/m³ - milligrams per cubic meter

IRIS - Integrated Risk Information System

Pyrene used as a surrogate for phenanthrene.

SVOCs - Semi-Volatile Organic Compounds

PAHs - Polycyclic Aromatic Hydrocarbons

Prepared by: DME 5/18/2018

Checked by: DAR 5/18/2018

Table 3-4
Cancer Toxicity Data - Oral/Dermal
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Chemicals of Potential Concern	Oral CSF		Oral Absorption Efficiency for Dermal ⁽¹⁾	Absorbed CSF for Dermal		Weight of Evidence (WOE) / Cancer Guideline Description ⁽²⁾	CSF and WOE Source(s)
	Value	Units		Value	Units		
<u>SVOCs</u>							
Dibenzofuran	NA	NA	1	NA	NA	NA	NA
<u>PAHs</u>							
Benzo(a)anthracene	1.0E-01	(mg/kg-day) ⁻¹	1	1.0E-01	(mg/kg-day) ⁻¹	B2	IRIS
Benzo(a)pyrene	1.0E+00	(mg/kg-day) ⁻¹	1	1.0E+00	(mg/kg-day) ⁻¹	CH	IRIS
Benzo(b)fluoranthene	1.0E-01	(mg/kg-day) ⁻¹	1	1.0E-01	(mg/kg-day) ⁻¹	B2	IRIS
Benzo(k)fluoranthene	1.0E-02	(mg/kg-day) ⁻¹	1	1.0E-02	(mg/kg-day) ⁻¹	B2	IRIS
Chrysene	1.0E-03	(mg/kg-day) ⁻¹	1	1.0E-03	(mg/kg-day) ⁻¹	B2	IRIS
Dibenzo(a,h)anthracene	1.0E+00	(mg/kg-day) ⁻¹	1	1.0E+00	(mg/kg-day) ⁻¹	B2	IRIS
Fluoranthene	NA	NA	1	NA	NA	D	IRIS
Indeno(1,2,3-cd)pyrene	1.0E-01	(mg/kg-day) ⁻¹	1	1.0E-01	(mg/kg-day) ⁻¹	B2	IRIS
Naphthalene	NA	NA	1	NA	NA	C	Cal EPA and IRIS
Phenanthrene	NA	NA	1	NA	NA	NA	NA
Pyrene	NA	NA	1	NA	NA	D	IRIS
<u>Pesticides</u>							
Pentachlorophenol	4.0E-01	(mg/kg-day) ⁻¹	1	4.0E-01	(mg/kg-day) ⁻¹	LH	IRIS

Notes:

CSF - Cancer Slope Factor

NA - Not Applicable

(mg/kg-day)⁻¹ - 1/milligrams per kilogram-day

Cal EPA - California Environmental Protection Agency

IRIS - Integrated Risk Information System

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. Section 4.2 and Exhibit 4-1.

(2) EPA WOE (2005 Guidelines) = weight of evidence for carcinogenicity under 2005 EPA cancer guidelines: CH - carcinogenic to humans; LH - likely to be carcinogenic; SE - suggestive evidence of carcinogenic potential; InI - inadequate information to assess carcinogenic potential; NH - not likely to be carcinogenic. EPA WOE (1986 Guidelines) = weight-of-evidence for carcinogenicity under the 1986 EPA cancer guidelines: A - human carcinogen; B1 - probable carcinogen, limited human evidence; B2 - probable carcinogen, sufficient evidence in animals; C - possible human carcinogen; D - not classifiable; E - evidence of noncarcinogenicity.

Pyrene used as a surrogate for phenanthrene.

SVOCs - Semi-Volatile Organic Compounds

PAHs - Polycyclic Aromatic Hydrocarbons

Prepared by: DME 5/18/2018

Checked by: DAR 5/18/2018

Table 3-5
Cancer Toxicity Data - Inhalation
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Human Health Risk Assessment Addendum
August 2019

Chemicals of Potential Concern	Inhalation Unit Risk		Weight of Evidence (WOE) ⁽¹⁾ / Cancer Guideline Description	Inhalation Unit Risk and WOE
	Value	Units		Source(s)
<u>SVOCs</u>				
Dibenzofuran	NA	NA	NA	NA
<u>PAHs</u>				
Benzo(a)anthracene	6.0E-05	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Benzo(a)pyrene	6.0E-04	($\mu\text{g}/\text{m}^3$) ⁻¹	CH	IRIS
Benzo(b)fluoranthene	6.0E-05	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Benzo(k)fluoranthene	6.0E-06	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Chrysene	6.0E-07	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Dibenzo(a,h)anthracene	6.0E-04	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Fluoranthene	NA	NA	D	IRIS
Indeno(1,2,3-cd)pyrene	6.0E-05	($\mu\text{g}/\text{m}^3$) ⁻¹	B2	IRIS
Naphthalene	3.4E-05	($\mu\text{g}/\text{m}^3$) ⁻¹	C	Cal EPA and IRIS
Phenanthrene	NA	NA	NA	NA
Pyrene	NA	NA	D	IRIS
<u>Pesticides</u>				
Pentachlorophenol	5.1E-06	($\mu\text{g}/\text{m}^3$) ⁻¹	LH	IRIS

Notes:

IUR - Inhalation Unit Risk

NA - Not Applicable

($\mu\text{g}/\text{m}^3$)⁻¹ - 1/micrograms per cubic meter

Cal EPA - California Environmental Protection Agency

IRIS - Integrated Risk Information System

(1) EPA WOE (2005 Guidelines) = weight of evidence for carcinogenicity under 2005 EPA cancer guidelines:

CH - carcinogenic to humans; LH - likely to be carcinogenic; SE - suggestive evidence of carcinogenic potential; InI - inadequate information to assess carcinogenic potential; NH - not likely to be carcinogenic).

EPA WOE (1986 Guidelines) = weight-of-evidence for carcinogenicity under the 1986 EPA cancer guidelines:

A - human carcinogen; B1 - probable carcinogen, limited human evidence; B2 - probable carcinogen, sufficient evidence in animals; C - possible human carcinogen; D - not classifiable; E - evidence of noncarcinogenicity.

Pyrene used as a surrogate for phenanthrene.

SVOCs - Semi-Volatile Organic Compounds

PAHs - Polycyclic Aromatic Hydrocarbons

Prepared by: DME 5/18/2018

Checked by: DAR 5/18/2018

Table 3-6
Surface Soil (0-1 foot) Exposure Point Concentrations
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Exposure Point		Chemical of Potential Concern (COPC)	Screening Toxicity Value ⁽¹⁾ (mg/kg)	# of Detections	# of Samples	% of NDs	Arithmetic Mean (mg/kg)	Maximum Concentration (mg/kg)	95% Upper Confidence Level (UCL) (mg/kg)	Background Level (2x Mean) (mg/kg)	Exposure Point Concentration	
Area	Medium										Value (mg/kg)	Statistical Test
1A	Surface Soils	Benzo(a)anthracene	1.1	15	16	6%	1.03	5.98	2.830	0.01375	2.830	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	14	16	13%	0.96	6.06	2.612	0.01591	2.612	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	15	16	6%	2.15	15.6	6.005	0.02270	6.005	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	11	16	31%	0.16	0.85	0.381	0.00821	0.381	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	14	16	13%	0.78	5.28	2.042	0.01473	2.042	95% Gamma Adjusted KM-UCL
1B	Surface Soils	Benzo(a)anthracene	1.1	26	26	0%	2.81	13.9	4.646	0.01375	4.646	95% Adjusted Gamma UCL
		Benzo(a)pyrene	0.11	26	26	0%	2.54	11.1	4.131	0.01591	4.131	95% Adjusted Gamma UCL
		Benzo(b)fluoranthene	1.1	26	26	0%	6.40	24.2	10.34	0.02270	10.34	95% Adjusted Gamma UCL
		Dibenzo(a,h)anthracene	0.11	22	26	15%	0.42	2.05	0.676	0.00821	0.676	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	26	26	0%	2.19	7.79	3.498	0.01473	3.498	95% Adjusted Gamma UCL
		Pentachlorophenol	1.0	1	24	96%	0.47	4.09	--	NA	0.474	Arithmetic Mean
1C	Surface Soils	Benzo(a)anthracene	1.1	32	33	3%	6.80	135	24.62	0.01375	24.62	95% KM Chebyshev UCL
		Benzo(a)pyrene	0.11	32	33	3%	4.38	65.7	13.18	0.01591	13.18	95% KM Chebyshev UCL
		Benzo(b)fluoranthene	1.1	32	33	3%	11.29	148	31.59	0.02270	31.59	95% KM Chebyshev UCL
		Benzo(k)fluoranthene	11	32	33	3%	3.24	45.6	9.347	0.01085	9.347	95% KM Chebyshev UCL
		Chrysene	110	32	33	3%	9.09	173	31.90	0.01657	31.90	95% KM Chebyshev UCL
		Dibenzo(a,h)anthracene	0.11	22	33	33%	0.69	8.12	1.513	0.00821	1.513	95% Gamma Adjusted KM-UCL
		Dibenzofuran	7.3	11	33	67%	0.75	21.4	3.644	NA	3.644	95% KM Chebyshev UCL
		Fluoranthene	240	32	33	3%	29.24	761	129.8	0.04690	129.8	95% KM Chebyshev UCL
		Indeno(1,2,3-cd)pyrene	1.1	31	33	6%	3.41	44.9	9.536	0.01473	9.536	95% KM Chebyshev UCL
		Phenanthrene	180	25	29	14%	12.99	319	61.21	0.03898	61.21	95% KM Chebyshev UCL
		Pyrene	180	32	33	3%	27.46	607	107.9	0.04690	107.9	95% KM Chebyshev UCL
1D	Surface Soils	Benzo(a)anthracene	1.1	26	26	0%	3.19	13.4	5.366	0.01375	5.366	95% Adjusted Gamma UCL
		Benzo(a)pyrene	0.11	26	26	0%	2.46	7.9	3.933	0.01591	3.933	95% Adjusted Gamma UCL
		Benzo(b)fluoranthene	1.1	26	26	0%	5.84	22.8	9.364	0.02270	9.364	95% Adjusted Gamma UCL
		Dibenzo(a,h)anthracene	0.11	21	26	19%	0.46	1.39	0.682	0.00821	0.682	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	26	26	0%	1.95	6.43	3.078	0.01473	3.078	95% Adjusted Gamma UCL
2	Surface Soils	Benzo(a)anthracene	1.1	17	18	6%	0.19	1.19	0.552	0.01375	0.552	95% KM Chebyshev UCL
		Benzo(a)pyrene	0.11	18	18	0%	0.20	1.03	0.562	0.01591	0.562	95% Chebyshev (Mean, Sd) UCL
		Benzo(b)fluoranthene	1.1	18	18	0%	0.62	3.51	1.720	0.02270	1.720	95% Chebyshev (Mean, Sd) UCL
		Dibenzo(a,h)anthracene	0.11	10	18	44%	0.03	0.23	0.099	0.00821	0.099	95% Gamma Adjusted KM-UCL

Notes

Surface soil samples collected 0-1 foot below ground surface (bgs).

(1) - Resident Soil RSL THQ=0.1 from RSL Tables, April 2019

RSL - Risk Screening Level

THQ - Total Hazard Quotient

ND - Not detected above the method detection limit

NA - Not Applicable

mg/kg - milligrams per kilogram

Duplicates were not included as individual samples. Instead, the average concentration was used.

Method Detection Limit (MDL) was used for non-detects.

According to the ProUCL User Guide (USEPA, 2015), for data sets with low detection frequencies, use of the median or mode represent better estimates (with lesser uncertainty) of the mean. To be conservative, the arithmetic mean is used as the exposure point concentration when the the detection frequency was low (e.g., ≤ 10% or less than 4 detections).

Prepared By: RAH 7/3/2019

Reviewed By: SMA 7/3/2019

Table 3-7
Subsurface Soil Exposure Point Concentrations
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Exposure Point		Chemical of Potential Concern (COPC)	Screening Toxicity Value ⁽¹⁾ (mg/kg)	# of Detections	# of Samples	% of NDs	Arithmetic Mean (mg/kg)	Maximum Concentration (mg/kg)	95% Upper Confidence Level (UCL) (mg/kg)	Background Level (2x Mean) (mg/kg)	Exposure Point Concentration	
Area	Medium										Value (mg/kg)	Statistical Test
1B	Subsurface Soils	Benzo(a)anthracene	1.1	7	19	63%	3.95	37.2	17.59	0.01375	17.59	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	6	19	68%	1.06	8.35	2.128	0.01591	2.128	95% KM (t) UCL
		Benzo(b)fluoranthene	1.1	8	19	58%	2.16	21.3	8.194	0.02270	8.194	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	2	19	89%	0.17	1.2	--	0.00821	0.171	Arithmetic Mean
		Dibenzofuran	7.3	4	19	79%	1.81	33.2	15.76	NA	15.76	95% Gamma Adjusted KM-UCL
		Fluoranthene	240	9	19	53%	27.94	299	135.5	0.04690	135.5	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	6	19	68%	0.59	5.46	1.192	0.01473	1.192	95% KM (t) UCL
Phenanthrene	180	5	17	71%	18.42	297	163.1	0.03898	163.1	95% Gamma Adjusted KM-UCL		
1C	Subsurface Soils	Benzo(a)anthracene	1.1	15	37	59%	2.30	30.9	6.192	0.01375	6.192	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	14	37	62%	1.10	9.75	2.337	0.01591	2.337	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	16	37	57%	2.42	25	5.175	0.02270	5.175	95% Gamma Adjusted KM-UCL
		Benzo(k)fluoranthene	11	14	37	62%	0.97	11.8	2.191	0.01085	2.191	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	10	37	73%	0.20	1.45	0.306	0.00821	0.306	95% KM (t) UCL
		Dibenzofuran	7.3	7	37	81%	1.14	28.1	5.007	NA	5.007	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	13	37	65%	0.67	5.17	1.364	0.01473	1.364	95% Gamma Adjusted KM-UCL
		Naphthalene	3.8	8	37	78%	0.15	4.12	0.6586	0.06240	0.6586	95% KM Chebyshev UCL
Phenanthrene	180	12	33	64%	13.35	240	51.12	0.03898	51.12	95% KM Chebyshev UCL		
1D	Subsurface Soils	Benzo(a)anthracene	1.1	9	23	61%	0.62	9.49	2.913	0.01375	2.913	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	8	23	65%	0.44	5.42	1.627	0.01591	1.627	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	11	23	52%	0.82	8.72	2.886	0.02270	2.886	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	6	23	74%	0.11	1.2	0.337	0.00821	0.337	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	6	23	74%	0.31	3.06	1.007	0.01473	1.007	95% Gamma Adjusted KM-UCL

Notes

Subsurface soil collected at greater than 1-foot below ground surface (bgs).

(1) - Resident Soil RSL THQ=0.1 from RSL Tables, April 2019

RSL - Risk Screening Level

THQ - Total Hazard Quotient

ND - Not detected above the method detection limit

NA - Not Applicable

mg/kg - milligrams per kilogram

1.2 - Maximum concentration was non-detect due to elevated detection limits.

Duplicates were not included as individual samples. Instead, the average concentration was used.

Method Detection Limit (MDL) was used for non-detects.

According to the ProUCL User Guide (USEPA, 2015), for data sets with low detection frequencies, use of the median or mode represent better estimates (with lesser uncertainty) of the mean. To be conservative, the arithmetic mean is used as the exposure point concentration when the the detection frequency was low (e.g., ≤ 10% or less than 4 detections).

Prepared By: RAH 7/24/2019

Checked By: SMA 7/24/2019

**Table 4-1
Risk Calculations for Outdoor Worker - Area 1A
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina**

Scenario Timeframe: Future
Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	7.79E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.8E-08	2.2E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	7.19E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	7.2E-07	2.0E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.007	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	1.65E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.7E-07	4.6E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	1.05E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.0E-07	2.9E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	5.62E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.6E-08	1.6E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total																0.007		
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	4.29E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.3E-08	1.20E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	3.95E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.0E-07	1.11E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.004	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	9.09E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	9.1E-08	2.55E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	5.76E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	5.8E-08	1.61E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	3.09E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.1E-08	8.66E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total																0.004		
		Inhalation (via Particulate and Vapor Emissions)	PAHs																	
			Benzo(a)anthracene	4.63E-07	mg/m ³	3.40E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.0E-09	9.52E-08	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.16E-09	mg/m ³	3.05E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.8E-10	8.54E-10	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0004	NA	NA	
			Benzo(b)fluoranthene	9.56E-09	mg/m ³	7.02E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.2E-11	1.96E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	6.06E-10	mg/m ³	4.45E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.7E-11	1.25E-10	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.25E-09	mg/m ³	2.39E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.4E-11	6.68E-10	mg/kg-day	NA	NA	NA	NA	NA	NA	
Exposure Route Total																0.0004				
Exposure Medium Total																0.01				
Surface Soil (0 to 1 foot bgs) Total																0.01				
Total Area 1A Receptor Risk																0.01				

Notes:
EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
SF - Carcinogenic Slope Factor
RfD - Reference Dose (Non-Carcinogenic)
RfC - Reference Concentration (Non-Carcinogenic)
PAHs - Polycyclic Aromatic Hydrocarbons
NA - Not Applicable
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram-day
(mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
(ug/m³)⁻¹ - 1/micrograms per meter cubed
mg/m³ - milligrams per meter cubed
bgs - below ground surface

Prepared By: RAH 7/2/2019
Checked By: SMA 7/3/2019

Table 4-2
Risk Calculations for Teenage Trespasser - Area 1A
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	ADAF ⁽¹⁾	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	1.66E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	5.0E-08	1.2E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	1.53E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	4.6E-07	1.1E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.004	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	3.53E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.1E-07	2.5E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	2.23E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	6.7E-08	1.6E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	1.20E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	3.6E-08	8.4E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										7.2E-07							0.004	
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	8.17E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	2.5E-08	5.72E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	7.54E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	2.3E-07	5.28E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.002	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	1.73E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	5.2E-08	1.21E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	1.10E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	3.3E-08	7.69E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	5.89E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.8E-08	4.13E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										3.5E-07							0.002	
Exposure Medium Total										1.1E-06							0.005			
Surface Soil (0 to 1 foot bgs) Total											1.1E-06	Surface Soil HI					0.005			
Total Area 1A Receptor Risk											1.1E-06						0.005			

Notes:

EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.

SF - Carcinogenic Slope Factor

(1) Age-Dependent Adjustment Factor (ADAF) is used for chemicals with a mutagenic mode of action for carcinogenesis. The cancer risk is adjusted by multiplying the calculated risk by the ADAF. See April 2019 HHRA for explanation.

RfD - Reference Dose (Non-Carcinogenic)

RfC - Reference Concentration (Non-Carcinogenic)

PAHs - Polycyclic Aromatic Hydrocarbons

NA - Not Applicable

mg/kg - milligrams per kilogram

mg/kg-day - milligrams per kilogram-day

(mg/kg-day)⁻¹ - 1/milligrams per kilogram-day

(ug/m³)⁻¹ - 1/micrograms per meter cubed

mg/m³ - milligrams per meter cubed

bgs - below ground surface

Prepared By: RAH 7/2/2019

Checked By: SMA 7/3/2019

Table 4-3
Risk Calculations for Child Resident - Area 1A
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	3.10E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.6E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	2.86E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.3E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.1	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	6.58E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	7.7E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	4.18E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	4.9E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	2.24E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.6E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.1		
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	2.830	mg/kg	9.57E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.12E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	8.83E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.03E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.03	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	2.03E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.37E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	1.29E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.50E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	6.90E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	8.05E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.03		
		Inhalation (via Particulate and Vapor Emissions)	PAHs																	
			Benzo(a)anthracene	4.63E-07	mg/m ³	3.81E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.44E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.16E-09	mg/m ³	3.42E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.99E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.002	NA	NA	
			Benzo(b)fluoranthene	9.56E-09	mg/m ³	7.86E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	9.17E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	6.07E-10	mg/m ³	4.99E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.82E-10	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.25E-09	mg/m ³	2.67E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.12E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
Exposure Route Total											NA					0.002				
Exposure Medium Total											NA					0.1				
Surface Soil (0 to 1 foot bgs) Total											NA					0.1				
Total Area 1A Receptor Risk											NA					0.1				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA- Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-4
Risk Calculations for Adult Resident - Area 1A
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3$) ⁻¹	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}$) ⁻¹	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}$) ⁻¹			Value	Units	Oral $\text{mg}/\text{kg}\text{-day}$	Abs. Dermal $\text{mg}/\text{kg}\text{-day}$	Inhalation mg/m^3				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	<i>PAHs</i>																	
			Benzo(a)anthracene	2.830	mg/kg	9.69E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.4E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	8.95E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.1E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	2.06E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	7.2E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	1.30E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	4.6E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	6.99E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.4E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.01		
		Dermal Contact	<i>PAHs</i>																	
			Benzo(a)anthracene	2.830	mg/kg	5.32E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.86E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.612	mg/kg	4.91E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.72E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.006	NA	NA	
			Benzo(b)fluoranthene	6.005	mg/kg	1.13E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.95E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.381	mg/kg	7.16E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.51E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	3.84E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.34E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.006		
		Inhalation (via Particulate and Vapor Emissions)	<i>PAHs</i>																	
			Benzo(a)anthracene	4.63E-07	mg/m ³	1.27E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.44E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.16E-09	mg/m ³	1.14E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.99E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.002	NA	NA	
			Benzo(b)fluoranthene	9.56E-09	mg/m ³	2.62E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	9.17E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	6.07E-10	mg/m ³	1.66E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.82E-10	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.25E-09	mg/m ³	8.91E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.12E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.002		
Exposure Medium Total											NA					0.02				
Surface Soil (0 to 1 foot bgs) Total											NA					Surface Soil HI	0.02			
Total Area 1A Receptor Risk											NA					0.02				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-5
Risk Calculations for Lifetime Resident, Mutagenic Carcinogens - Area 1A
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Resident

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Cancer Risk	
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs									
			Benzo(a)anthracene	2.830	mg/kg	2.09E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.1E-06	
			Benzo(a)pyrene	2.612	mg/kg	1.93E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.9E-05	
			Benzo(b)fluoranthene	6.005	mg/kg	4.44E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.4E-06	
			Dibenzo(a,h)anthracene	0.381	mg/kg	2.81E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.8E-06	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	1.51E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.5E-06	
		Exposure Route Total										3.0E-05
		Dermal Contact	PAHs									
			Benzo(a)anthracene	2.830	mg/kg	7.27E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.3E-07	
			Benzo(a)pyrene	2.612	mg/kg	6.71E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.7E-06	
			Benzo(b)fluoranthene	6.005	mg/kg	1.54E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.5E-06	
			Dibenzo(a,h)anthracene	0.381	mg/kg	9.79E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	9.8E-07	
			Indeno(1,2,3-cd)pyrene	2.042	mg/kg	5.25E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.2E-07	
		Exposure Route Total										1.0E-05
		Inhalation (via Particulate and Vapor Emissions)	PAHs									
			Benzo(a)anthracene	4.63E-07	mg/m ³	4.57E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.7E-08	
			Benzo(a)pyrene	4.16E-09	mg/m ³	4.10E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.5E-09	
			Benzo(b)fluoranthene	9.56E-09	mg/m ³	9.43E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.7E-10	
			Dibenzo(a,h)anthracene	6.07E-10	mg/m ³	5.98E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.6E-10	
			Indeno(1,2,3-cd)pyrene	3.25E-09	mg/m ³	3.21E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.9E-10	
Exposure Route Total										3.1E-08		
Exposure Medium Total										4.1E-05		
Surface Soil (0 to 1 foot bgs) Total										4.1E-05		
Total Area 1A Receptor Risk										4.1E-05		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 PAHs - Polycyclic Aromatic Hydrocarbons
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-6
Risk Calculations for Outdoor Worker - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	4.646	mg/kg	1.28E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.3E-07	3.6E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.131	mg/kg	1.14E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.1E-06	3.2E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01	NA	NA	NA
			Benzo(b)fluoranthene	10.34	mg/kg	2.85E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.8E-07	8.0E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	0.676	mg/kg	1.86E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.9E-07	5.2E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	9.63E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	9.6E-08	2.7E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Pesticides																	
		Pentachlorophenol	0.474	mg/kg	1.30E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	5.2E-08	5.7E-07	mg/kg-day	5.00E-03	5.00E-03	NA	NA	0.00005	NA	NA	
		Exposure Route Total											1.9E-06					0.01		
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	4.646	mg/kg	7.03E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.0E-08	1.97E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	4.131	mg/kg	6.25E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.3E-07	1.75E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.006	NA	NA	NA
			Benzo(b)fluoranthene	10.34	mg/kg	1.57E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.6E-07	4.38E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	0.676	mg/kg	1.02E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.0E-07	2.86E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	5.30E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.3E-08	1.48E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Pesticides																	
		Pentachlorophenol	0.474	mg/kg	1.38E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	5.5E-08	3.86E-07	mg/kg-day	5.00E-03	5.00E-03	NA	NA	0.00006	NA	NA	
		Exposure Route Total											1.1E-06					0.006		
		Inhalation (via Particulate and Vapor Emissions)	PAHs																	
			Benzo(a)anthracene	7.61E-07	mg/m ³	5.58E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.3E-09	1.56E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	6.58E-09	mg/m ³	4.83E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.9E-10	1.35E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0007	NA	NA	NA
			Benzo(b)fluoranthene	1.65E-08	mg/m ³	1.21E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.2E-11	3.38E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	1.08E-09	mg/m ³	7.89E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.7E-11	2.21E-10	mg/kg-day	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.57E-09		mg/m ³	4.09E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.5E-11	1.14E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	NA		
Pesticides																				
Pentachlorophenol	7.55E-10	mg/m ³	5.54E-11	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	2.8E-13	1.55E-10	mg/kg-day	5.00E-03	5.00E-03	NA	NA	NA	NA	NA			
Exposure Route Total											3.8E-09					0.0007				
Exposure Medium Total											3.0E-06					0.02				
Surface Soil (0 to 1 foot bgs) Total											3.0E-06					0.02				
Total Area 1B Receptor Risk											3.0E-06					0.02				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-7
Risk Calculations for Construction Worker - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations									
				Value	Units	Intake/Exposure Concentration		SF		Inhalation (ug/m ³) ⁻¹	Cancer Risk	Intake/Exposure Concentration (1)		Subchronic RfD		Subchronic RfC	Hazard Quotient				
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day						
Subsurface Soil	Subsurface Soil	Incidental Ingestion	<u>SVOCs</u>																		
			Dibenzofuran	15.76	mg/kg	3.31E-07	mg/kg-day	NA	NA	NA	NA	2.3E-05	mg/kg-day	4.0E-03	4.0E-03	NA	NA	0.006			
			<u>PAHs</u>																		
			Benzo(a)anthracene	17.59	mg/kg	3.69E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.7E-08	2.6E-05	mg/kg-day	NA	NA	NA	NA	NA			
			Benzo(a)pyrene	2.128	mg/kg	4.47E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.5E-08	3.1E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01				
			Benzo(b)fluoranthene	8.194	mg/kg	1.72E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.7E-08	1.2E-05	mg/kg-day	NA	NA	NA	NA				
			Dibenzo(a,h)anthracene	0.171	mg/kg	3.59E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.6E-09	2.5E-07	mg/kg-day	NA	NA	NA	NA				
			Fluoranthene	135.5	mg/kg	2.84E-06	mg/kg-day	NA	NA	NA	NA	2.0E-04	mg/kg-day	1.0E-01	1.0E-01	NA	0.002				
		Indeno(1,2,3-cd)pyrene	1.192	mg/kg	2.50E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.5E-09	1.8E-06	mg/kg-day	NA	NA	NA	NA					
		Phenanthrene	163.1	mg/kg	3.42E-06	mg/kg-day	NA	NA	NA	NA	2.4E-04	mg/kg-day	3.0E-01	3.0E-01	NA	0.0008					
		Exposure Route Total											1.0E-07					0.02			
		Dermal Contact	<u>SVOCs</u>																		
			Dibenzofuran	15.76	mg/kg	1.06E-07	mg/kg-day	NA	NA	NA	NA	7.42E-06	mg/kg-day	4.0E-03	4.0E-03	NA	NA	0.002			
			<u>PAHs</u>																		
			Benzo(a)anthracene	17.59	mg/kg	1.54E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.5E-08	1.08E-05	mg/kg-day	NA	NA	NA	NA				
			Benzo(a)pyrene	2.128	mg/kg	1.86E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.9E-08	1.30E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.004				
			Benzo(b)fluoranthene	8.194	mg/kg	7.17E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.2E-09	5.02E-06	mg/kg-day	NA	NA	NA	NA				
			Dibenzo(a,h)anthracene	0.171	mg/kg	1.50E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.5E-09	1.05E-07	mg/kg-day	NA	NA	NA	NA				
			Fluoranthene	135.5	mg/kg	1.19E-06	mg/kg-day	NA	NA	NA	NA	8.30E-05	mg/kg-day	1.0E-01	1.0E-01	NA	0.0008				
		Indeno(1,2,3-cd)pyrene	1.192	mg/kg	1.04E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.0E-09	7.30E-07	mg/kg-day	NA	NA	NA	NA					
		Phenanthrene	163.1	mg/kg	1.43E-06	mg/kg-day	NA	NA	NA	NA	9.99E-05	mg/kg-day	3.0E-01	3.0E-01	NA	0.0003					
		Exposure Route Total											4.4E-08					0.007			
		Inhalation (via Particulate and Vapor Emissions)	<u>SVOCs</u>																		
Dibenzofuran	7.87E-04		mg/m ³	1.34E-06	mg/kg-day	NA	NA	NA	NA	9.35E-05	mg/kg-day	4.0E-03	4.0E-03	NA	NA						
<u>PAHs</u>																					
Benzo(a)anthracene	3.01E-05		mg/m ³	5.10E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.1E-09	3.57E-06	mg/kg-day	NA	NA	NA	NA						
Benzo(a)pyrene	4.64E-07		mg/m ³	7.88E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.7E-10	5.51E-08	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.03						
Benzo(b)fluoranthene	1.79E-06		mg/m ³	3.03E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.8E-10	2.12E-07	mg/kg-day	NA	NA	NA	NA						
Dibenzo(a,h)anthracene	3.73E-08		mg/m ³	6.33E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.8E-11	4.43E-09	mg/kg-day	NA	NA	NA	NA						
Fluoranthene	2.96E-05		mg/m ³	5.02E-08	mg/kg-day	NA	NA	NA	NA	3.51E-06	mg/kg-day	1.0E-01	1.0E-01	NA	NA						
Indeno(1,2,3-cd)pyrene	2.60E-07	mg/m ³	4.41E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.6E-11	3.09E-08	mg/kg-day	NA	NA	NA	NA							
Phenanthrene	1.96E-03	mg/m ³	3.32E-06	mg/kg-day	NA	NA	NA	NA	2.33E-04	mg/kg-day	3.0E-01	3.0E-01	NA	NA							
Exposure Route Total											3.8E-09					0.03					
Exposure Medium Total											1.5E-07					0.05					
Subsurface Soil Total											1.5E-07					Subsurface Soil HI	0.05				
Total Area 1B Receptor Risk											1.5E-07					0.05					

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-7.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/9/2019

**Table 4-8
Risk Calculations for Teenage Trespasser - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina**

Scenario Timeframe: Current and Future
Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	ADAF ⁽¹⁾	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	4.646	mg/kg	2.73E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	8.2E-08	1.9E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.131	mg/kg	2.43E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	7.3E-07	1.7E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.006	0.006	
			Benzo(b)fluoranthene	10.34	mg/kg	6.07E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.8E-07	4.2E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.676	mg/kg	3.97E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	1.2E-07	2.8E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	2.05E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	6.2E-08	1.4E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Pesticides																		
		Pentachlorophenol	0.474	mg/kg	2.78E-08	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	3	5.3E-09	1.9E-07	mg/kg-day	5.00E-03	5.00E-03	NA	0.00002	0.00002		
		Exposure Route Total											1.2E-06					0.006		
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	4.646	mg/kg	1.34E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	4.0E-08	9.39E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.131	mg/kg	1.19E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	3.6E-07	8.35E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	0.003	
			Benzo(b)fluoranthene	10.34	mg/kg	2.98E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	9.0E-08	2.09E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.676	mg/kg	1.95E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	5.9E-08	1.37E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	1.01E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	3.0E-08	7.07E-07	mg/kg-day	NA	NA	NA	NA	NA	
Pesticides																				
Pentachlorophenol	0.474	mg/kg	2.63E-08	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	3	6.4E-14	1.84E-07	mg/kg-day	5.00E-03	5.00E-03	NA	0.00002	0.00002				
Exposure Route Total											5.8E-07					0.003				
Exposure Medium Total											1.8E-06					0.008				
Surface Soil (0 to 1 foot bgs) Total											1.8E-06					0.008				
Total Area 1B Receptor Risk											1.8E-06					0.008				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 (1) Age-Dependent Adjustment Factor (ADAF) is used for chemicals with a mutagenic mode of action for carcinogenesis. The cancer risk is adjusted by multiplying the calculated risk by the ADAF. See April 2019 HHRA for explanation.
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-9
Risk Calculations for Child Resident - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	4.646	mg/kg	5.09E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	5.9E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	4.131	mg/kg	4.53E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.3E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.2	NA	NA	
			Benzo(b)fluoranthene	10.34	mg/kg	1.13E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.3E-04	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.676	mg/kg	7.41E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.6E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	3.83E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.5E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
				Pesticides																
				Pentachlorophenol	0.474	mg/kg	5.19E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	2.1E-07	6.1E-06	mg/kg-day	5.0E-03	5.0E-03	NA	0.001	NA	
				Exposure Route Total																0.2
				Dermal Contact	PAHs															
					Benzo(a)anthracene	4.646	mg/kg	1.57E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.83E-05	mg/kg-day	NA	NA	NA	NA	NA
					Benzo(a)pyrene	4.131	mg/kg	1.40E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.63E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.05	NA
					Benzo(b)fluoranthene	10.34	mg/kg	3.50E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.08E-05	mg/kg-day	NA	NA	NA	NA	NA
					Dibenzo(a,h)anthracene	0.676	mg/kg	2.29E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.67E-06	mg/kg-day	NA	NA	NA	NA	NA
					Indeno(1,2,3-cd)pyrene	3.498	mg/kg	1.18E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.38E-05	mg/kg-day	NA	NA	NA	NA	NA
					Pesticides															
					Pentachlorophenol	0.474	mg/kg	3.08E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	1.2E-07	3.6E-06	mg/kg-day	5.0E-03	5.0E-03	NA	0.0007	NA
				Exposure Route Total																0.06
				Inhalation (via Particulate and Vapor Emissions)	PAHs															
					Benzo(a)anthracene	7.61E-07	mg/m ³	6.25E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	7.29E-07	mg/kg-day	NA	NA	NA	NA	NA
					Benzo(a)pyrene	6.58E-09	mg/m ³	5.41E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.31E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	NA
		Benzo(b)fluoranthene	1.65E-08		mg/m ³	1.35E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.58E-08	mg/kg-day	NA	NA	NA	NA	NA		
		Dibenzo(a,h)anthracene	1.08E-09		mg/m ³	8.85E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.03E-09	mg/kg-day	NA	NA	NA	NA	NA		
		Indeno(1,2,3-cd)pyrene	5.57E-09		mg/m ³	4.58E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	5.34E-09	mg/kg-day	NA	NA	NA	NA	NA		
			Pesticides																	
			Pentachlorophenol	7.55E-10	mg/m ³	6.20E-11	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	3.2E-13	7.24E-10	mg/kg-day	5.0E-03	5.0E-03	NA	NA			
		Exposure Route Total																0.003		
		Exposure Medium Total																0.2		
		Surface Soil (0 to 1 foot bgs) Total																0.2		
		Total Area 1B Receptor Risk																0.2		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/16/2019
 Checked By: SMA 7/17/2019

Table 4-10
Risk Calculations for Adult Resident - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations									
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient				
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³					
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	<i>PAHs</i>																		
			Benzo(a)anthracene	4.646	mg/kg	1.59E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	5.6E-06	mg/kg-day	NA	NA	NA	NA	NA	NA		
			Benzo(a)pyrene	4.131	mg/kg	1.41E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.0E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02	NA	NA		
			Benzo(b)fluoranthene	10.34	mg/kg	3.54E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.2E-05	mg/kg-day	NA	NA	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	0.676	mg/kg	2.32E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.1E-07	mg/kg-day	NA	NA	NA	NA	NA	NA		
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	1.20E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.2E-06	mg/kg-day	NA	NA	NA	NA	NA	NA		
			<i>Pesticides</i>																		
			Pentachlorophenol	0.474	mg/kg	1.62E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	3.1E-08	3.1E-08	5.7E-07	mg/kg-day	5.00E-03	5.00E-03	NA	NA	0.00005	0.00005	
			Exposure Route Total									3.1E-08							0.02		
			Dermal Contact	<i>PAHs</i>																	
				Benzo(a)anthracene	4.646	mg/kg	8.73E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.06E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Benzo(a)pyrene		4.131	mg/kg	7.77E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.72E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.009	NA	NA		
		Benzo(b)fluoranthene		10.34	mg/kg	1.94E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.80E-06	mg/kg-day	NA	NA	NA	NA	NA	NA		
		Dibenzo(a,h)anthracene		0.676	mg/kg	1.27E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	4.45E-07	mg/kg-day	NA	NA	NA	NA	NA	NA		
		Indeno(1,2,3-cd)pyrene		3.498	mg/kg	6.58E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.30E-06	mg/kg-day	NA	NA	NA	NA	NA	NA		
		<i>Pesticides</i>																			
		Pentachlorophenol		0.474	mg/kg	1.71E-07	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	4.1E-13	4.1E-13	6.00E-07	mg/kg-day	5.00E-03	5.00E-03	NA	NA	0.00006		
		Exposure Route Total									4.1E-13							0.009			
				<i>PAHs</i>																	
				Benzo(a)anthracene	7.61E-07	mg/m ³	2.08E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	7.29E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	6.58E-09	mg/m ³	1.80E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.31E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	NA	NA		
			Benzo(b)fluoranthene	1.65E-08	mg/m ³	4.51E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.58E-08	mg/kg-day	NA	NA	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	1.08E-09	mg/m ³	2.95E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.03E-09	mg/kg-day	NA	NA	NA	NA	NA	NA		
			Indeno(1,2,3-cd)pyrene	5.57E-09	mg/m ³	1.53E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	5.34E-09	mg/kg-day	NA	NA	NA	NA	NA	NA		
			<i>Pesticides</i>																		
			Pentachlorophenol	7.55E-10	mg/m ³	2.07E-10	mg/kg-day	4.0E-01	4.0E-01	5.1E-06	6.2E-17	6.2E-17	7.24E-10	mg/kg-day	5.00E-03	5.00E-03	NA	NA	NA		
			Exposure Route Total									6.2E-17							0.003		
			Exposure Medium Total									3.1E-08							0.03		
			Surface Soil (0 to 1 foot bgs) Total									3.1E-08	Surface Soil HI						0.03		
		Total Area 1B Receptor Risk									3.1E-08							0.03			

Notes:

- EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
- SF - Carcinogenic Slope Factor
- RfD - Reference Dose (Non-Carcinogenic)
- RfC - Reference Concentration (Non-Carcinogenic)
- PAHs - Polycyclic Aromatic Hydrocarbons
- NA - Not Applicable
- mg/kg - milligrams per kilogram
- mg/kg-day - milligrams per kilogram-day
- (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
- (ug/m³)⁻¹ - 1/micrograms per meter cubed
- mg/m³ - milligrams per meter cubed
- bgs - below ground surface
- Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
Checked By: SMA 7/2/2019

Table 4-11
Risk Calculations for Lifetime Resident, Mutagenic Carcinogens - Area 1B
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Resident

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Cancer Risk	
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs									
			Benzo(a)anthracene	4.646	mg/kg	3.43E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.4E-06	
			Benzo(a)pyrene	4.131	mg/kg	3.05E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.1E-05	
			Benzo(b)fluoranthene	10.34	mg/kg	7.64E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.6E-06	
			Dibenzo(a,h)anthracene	0.676	mg/kg	4.99E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	5.0E-06	
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	2.58E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.6E-06	
		Exposure Route Total										4.9E-05
		Dermal Contact	PAHs									
			Benzo(a)anthracene	4.646	mg/kg	1.19E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.2E-06	
			Benzo(a)pyrene	4.131	mg/kg	1.06E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.1E-05	
			Benzo(b)fluoranthene	10.34	mg/kg	2.66E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.7E-06	
			Dibenzo(a,h)anthracene	0.676	mg/kg	1.74E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.7E-06	
			Indeno(1,2,3-cd)pyrene	3.498	mg/kg	8.99E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	9.0E-07	
		Exposure Route Total										1.7E-05
		Inhalation (via Particulate and Vapor Emissions)	PAHs									
			Benzo(a)anthracene	7.61E-07	mg/m ³	7.50E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.5E-08	
			Benzo(a)pyrene	6.58E-09	mg/m ³	6.49E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.9E-09	
			Benzo(b)fluoranthene	1.65E-08	mg/m ³	1.62E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	9.7E-10	
			Dibenzo(a,h)anthracene	1.08E-09	mg/m ³	1.06E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.4E-10	
			Indeno(1,2,3-cd)pyrene	5.57E-09	mg/m ³	5.49E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.3E-10	
Exposure Route Total										5.1E-08		
Exposure Medium Total										6.6E-05		
Surface Soil (0 to 1 foot bgs) Total										6.6E-05		
Total Area 1B Receptor Risk										6.6E-05		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 PAHs - Polycyclic Aromatic Hydrocarbons
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-12
Risk Calculations for Outdoor Worker - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	SVOCs																
			Dibenzofuran	3.644	mg/kg	1.00E-06	mg/kg-day	NA	NA	NA	NA	2.8E-06	mg/kg-day	1.0E-03	1.0E-03	NA	0.003		
			PAHs																
			Benzo(a)anthracene	24.62	mg/kg	6.78E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.8E-07	1.9E-05	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	13.18	mg/kg	3.63E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.6E-06	1.0E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.03		
			Benzo(b)fluoranthene	31.59	mg/kg	8.69E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.7E-07	2.4E-05	mg/kg-day	NA	NA	NA	NA		
			Benzo(k)fluoranthene	9.347	mg/kg	2.57E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	2.6E-08	7.2E-06	mg/kg-day	NA	NA	NA	NA		
			Chrysene	31.90	mg/kg	8.78E-06	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	8.8E-09	2.5E-05	mg/kg-day	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	1.513	mg/kg	4.16E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.2E-07	1.2E-06	mg/kg-day	NA	NA	NA	NA		
			Fluoranthene	129.8	mg/kg	3.57E-05	mg/kg-day	NA	NA	NA	NA	1.0E-04	mg/kg-day	4.0E-02	4.0E-02	NA	0.003		
		Indeno(1,2,3-cd)pyrene	9.536	mg/kg	2.62E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.6E-07	7.3E-06	mg/kg-day	NA	NA	NA	NA			
		Phenanthrene	61.21	mg/kg	1.68E-05	mg/kg-day	NA	NA	NA	NA	4.7E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.002			
		Pyrene	107.9	mg/kg	2.97E-05	mg/kg-day	NA	NA	NA	NA	8.3E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.003			
		Exposure Route Total																0.04	
		Dermal Contact	SVOCs																
			Dibenzofuran	3.644	mg/kg	4.24E-07	mg/kg-day	NA	NA	NA	NA	1.19E-06	mg/kg-day	1.0E-03	1.0E-03	NA	0.001		
			PAHs																
			Benzo(a)anthracene	24.62	mg/kg	3.73E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.7E-07	1.04E-05	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	13.18	mg/kg	2.00E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.0E-06	5.59E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02		
			Benzo(b)fluoranthene	31.59	mg/kg	4.78E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.8E-07	1.34E-05	mg/kg-day	NA	NA	NA	NA		
Benzo(k)fluoranthene	9.347		mg/kg	1.42E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	1.4E-08	3.96E-06	mg/kg-day	NA	NA	NA	NA				
Chrysene	31.90		mg/kg	4.83E-06	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	4.8E-09	1.35E-05	mg/kg-day	NA	NA	NA	NA				
Dibenzo(a,h)anthracene	1.513		mg/kg	2.29E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.3E-07	6.41E-07	mg/kg-day	NA	NA	NA	NA				
Fluoranthene	129.8		mg/kg	1.97E-05	mg/kg-day	NA	NA	NA	NA	5.50E-05	mg/kg-day	4.0E-02	4.0E-02	NA	0.001				
Indeno(1,2,3-cd)pyrene	9.536	mg/kg	1.44E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.4E-07	4.04E-06	mg/kg-day	NA	NA	NA	NA					
Phenanthrene	61.21	mg/kg	9.27E-06	mg/kg-day	NA	NA	NA	NA	2.60E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.0009					
Pyrene	107.9	mg/kg	1.63E-05	mg/kg-day	NA	NA	NA	NA	4.57E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.002					
Exposure Route Total																0.02			

Table 4-12
Risk Calculations for Outdoor Worker - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Inhalation (via Particulate and Volatile Emissions)	SVOCs																
			Dibenzofuran	1.74E-05	mg/m ³	1.28E-06	mg/kg-day	NA	NA	NA	NA	3.58E-06	mg/kg-day	1.0E-03	1.0E-03	NA	NA	NA	
			PAHs																
			Benzo(a)anthracene	4.03E-06	mg/m ³	2.96E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.8E-08	8.28E-07	mg/kg-day	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	2.10E-08	mg/m ³	1.54E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	9.2E-10	4.31E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.002	0.002	0.002
			Benzo(b)fluoranthene	5.03E-08	mg/m ³	3.69E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.2E-10	1.03E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Benzo(k)fluoranthene	1.49E-08	mg/m ³	1.09E-09	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	6.6E-12	3.06E-09	mg/kg-day	NA	NA	NA	NA	NA	NA
			Chrysene	5.08E-08	mg/m ³	3.73E-09	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	2.2E-12	1.04E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	2.41E-09	mg/m ³	1.77E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.1E-10	4.95E-10	mg/kg-day	NA	NA	NA	NA	NA	NA
			Fluoranthene	2.07E-07	mg/m ³	1.52E-08	mg/kg-day	NA	NA	NA	NA	4.25E-08	mg/kg-day	4.0E-02	4.0E-02	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	1.52E-08	mg/m ³	1.11E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.7E-11	3.12E-09	mg/kg-day	NA	NA	NA	NA	NA	NA
			Phenanthrene	7.03E-05	mg/m ³	5.16E-06	mg/kg-day	NA	NA	NA	NA	1.45E-05	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	NA
			Pyrene	8.16E-06	mg/m ³	5.99E-07	mg/kg-day	NA	NA	NA	NA	1.68E-06	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	NA
Exposure Route Total																1.9E-08		0.002	
Exposure Medium Total																9.1E-06		0.07	
Soil (0 to 1 foot bgs) Total																9.1E-06		0.07	Surface Soil HI
Total Area 1C Receptor Risk																9.1E-06		0.07	

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/3/2019
 Checked By: SMA 7/3/2019

Table 4-13
Risk Calculations for Construction Worker - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3\text{-day}^{-1}$)	Cancer Risk	Intake/Exposure Concentration		Subchronic RfD		Subchronic RfC (mg/m^3)	Hazard Quotient		
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}^{-1}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}^{-1}$)			Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}$)				
Subsurface Soil	Subsurface Soil	Incidental Ingestion	SVOCs																
			Dibenzofuran	5.007	mg/kg	1.05E-07	mg/kg-day	NA	NA	NA	NA	7.4E-06	mg/kg-day	4.0E-03	4.0E-03	NA	0.002		
			PAHs																
			Benzo(a)anthracene	6.192	mg/kg	1.30E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.3E-08	9.1E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	2.337	mg/kg	4.90E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.9E-08	3.4E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01		
			Benzo(b)fluoranthene	5.175	mg/kg	1.09E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.1E-08	7.6E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(k)fluoranthene	2.191	mg/kg	4.60E-08	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	4.6E-10	3.2E-06	mg/kg-day	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	0.306	mg/kg	6.42E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.4E-09	4.5E-07	mg/kg-day	NA	NA	NA	NA		
			Indeno(1,2,3-cd)pyrene	1.364	mg/kg	2.86E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.9E-09	2.0E-06	mg/kg-day	NA	NA	NA	NA		
		Naphthalene	0.6586	mg/kg	1.38E-08	mg/kg-day	NA	NA	3.4E-05	NA	9.7E-07	mg/kg-day	6.0E-01	6.0E-01	3.0E-03	0.000002			
		Phenanthrene	51.12	mg/kg	1.07E-06	mg/kg-day	NA	NA	NA	NA	7.5E-05	mg/kg-day	3.0E-01	3.0E-01	NA	0.0003			
		Exposure Route Total											8.3E-08					0.01	
		Dermal Contact	SVOCs																
			Dibenzofuran	5.007	mg/kg	3.37E-08	mg/kg-day	NA	NA	NA	NA	2.36E-06	mg/kg-day	4.0E-03	4.0E-03	NA	0.0006		
			PAHs																
			Benzo(a)anthracene	6.192	mg/kg	5.42E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.4E-09	3.79E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	2.337	mg/kg	2.04E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.0E-08	1.43E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.005		
			Benzo(b)fluoranthene	5.175	mg/kg	4.53E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.5E-09	3.17E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(k)fluoranthene	2.191	mg/kg	1.92E-08	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	1.9E-10	1.34E-06	mg/kg-day	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	0.306	mg/kg	2.68E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.7E-09	1.87E-07	mg/kg-day	NA	NA	NA	NA		
			Indeno(1,2,3-cd)pyrene	1.364	mg/kg	1.19E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.2E-09	8.35E-07	mg/kg-day	NA	NA	NA	NA		
		Naphthalene	0.6586	mg/kg	5.76E-09	mg/kg-day	NA	NA	3.4E-05	NA	4.03E-07	mg/kg-day	6.0E-01	6.0E-01	3.0E-03	0.000007			
		Phenanthrene	51.12	mg/kg	4.47E-07	mg/kg-day	NA	NA	NA	NA	3.13E-05	mg/kg-day	3.0E-01	3.0E-01	NA	0.0001			
		Exposure Route Total											3.4E-08					0.005	
Inhalation (via Particulate and Vapor Emissions)	SVOCs																		
	Dibenzofuran	2.50E-04	mg/m ³	4.24E-07	mg/kg-day	NA	NA	NA	NA	2.97E-05	mg/kg-day	4.0E-03	4.0E-03	NA	NA				
	PAHs																		
	Benzo(a)anthracene	1.06E-05	mg/m ³	1.80E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.1E-09	1.26E-06	mg/kg-day	NA	NA	NA	NA				
	Benzo(a)pyrene	5.10E-07	mg/m ³	8.65E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	5.2E-10	6.06E-08	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.03				
	Benzo(b)fluoranthene	1.13E-06	mg/m ³	1.92E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.1E-10	1.34E-07	mg/kg-day	NA	NA	NA	NA				
Benzo(k)fluoranthene	4.78E-07	mg/m ³	8.11E-10	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	4.9E-12	5.68E-08	mg/kg-day	NA	NA	NA	NA					
Dibenzo(a,h)anthracene	6.68E-08	mg/m ³	1.13E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.8E-11	7.93E-09	mg/kg-day	NA	NA	NA	NA					

Table 4-13
Risk Calculations for Construction Worker - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations						
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3$) ⁻¹	Cancer Risk	Intake/Exposure Concentration		Subchronic RfD		Subchronic RfC (mg/m^3)	Hazard Quotient	
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}$) ⁻¹	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}$) ⁻¹			Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}$)			
Subsurface Soil	Subsurface Soil	Inhalation (via Particulate and Vapor Emissions)	Indeno(1,2,3-cd)pyrene	2.98E-07	mg/m^3	5.05E-10	$\text{mg}/\text{kg}\text{-day}$	1.0E-01	1.0E-01	6.0E-05	3.0E-11	3.53E-08	$\text{mg}/\text{kg}\text{-day}$	NA	NA	NA	NA	
			Naphthalene	1.11E-04	mg/m^3	1.87E-07	$\text{mg}/\text{kg}\text{-day}$	NA	NA	3.4E-05	6.4E-09	1.31E-05	$\text{mg}/\text{kg}\text{-day}$	6.0E-01	6.0E-01	3.0E-03	0.004	
			Phenanthrene	6.14E-04	mg/m^3	1.04E-06	$\text{mg}/\text{kg}\text{-day}$	NA	NA	NA	NA	7.29E-05	$\text{mg}/\text{kg}\text{-day}$	3.0E-01	3.0E-01	NA	NA	
		Exposure Route Total																0.03
	Exposure Medium Total																	0.05
Subsurface Soil Total																		0.05
Total Area 1C Receptor Risk																		0.05

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-7.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 ($\text{mg}/\text{kg}\text{-day}$)⁻¹ - 1/milligrams per kilogram-day
 ($\mu\text{g}/\text{m}^3$)⁻¹ - 1/micrograms per meter cubed
 mg/m^3 - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/24/2019
 Checked By: SMA 7/24/2019

Table 4-14
Risk Calculations for Teenage Trespasser - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations							Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	ADAF ⁽¹⁾	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	SVOCs																	
			Dibenzofuran	3.644	mg/kg	2.14E-07	mg/kg-day	NA	NA	NA	3	NA	1.5E-06	mg/kg-day	1.0E-03	1.0E-03	NA	0.001		
			PAHs																	
			Benzo(a)anthracene	24.62	mg/kg	1.45E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	4.3E-07	1.0E-05	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	13.18	mg/kg	7.74E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	2.3E-06	5.4E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02		
			Benzo(b)fluoranthene	31.59	mg/kg	1.85E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	5.6E-07	1.3E-05	mg/kg-day	NA	NA	NA	NA		
			Benzo(k)fluoranthene	9.347	mg/kg	5.49E-07	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	3	1.6E-08	3.8E-06	mg/kg-day	NA	NA	NA	NA		
			Chrysene	31.90	mg/kg	1.87E-06	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	3	5.6E-09	1.3E-05	mg/kg-day	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	1.513	mg/kg	8.88E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	2.7E-07	6.2E-07	mg/kg-day	NA	NA	NA	NA		
			Fluoranthene	129.8	mg/kg	7.62E-06	mg/kg-day	NA	NA	NA	3	NA	5.3E-05	mg/kg-day	4.0E-02	4.0E-02	NA	0.001		
			Indeno(1,2,3-cd)pyrene	9.536	mg/kg	5.60E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.7E-07	3.9E-06	mg/kg-day	NA	NA	NA	NA		
			Phenanthrene	61.21	mg/kg	3.59E-06	mg/kg-day	NA	NA	NA	3	NA	2.5E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.0008		
			Pyrene	107.9	mg/kg	6.33E-06	mg/kg-day	NA	NA	NA	3	NA	4.4E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.001		
		Exposure Route Total											3.8E-06					0.02		
		Dermal Contact	SVOCs																	
			Dibenzofuran	3.644	mg/kg	8.09E-08	mg/kg-day	NA	NA	NA	3	NA	5.66E-07	mg/kg-day	1.0E-03	1.0E-03	NA	0.0006		
			PAHs																	
			Benzo(a)anthracene	24.62	mg/kg	7.11E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	2.1E-07	4.98E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(a)pyrene	13.18	mg/kg	3.80E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	1.1E-06	2.66E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.009		
			Benzo(b)fluoranthene	31.59	mg/kg	9.12E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	2.7E-07	6.38E-06	mg/kg-day	NA	NA	NA	NA		
			Benzo(k)fluoranthene	9.347	mg/kg	2.70E-07	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	3	8.1E-09	1.89E-06	mg/kg-day	NA	NA	NA	NA		
			Chrysene	31.90	mg/kg	9.21E-07	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	3	2.8E-09	6.45E-06	mg/kg-day	NA	NA	NA	NA		
			Dibenzo(a,h)anthracene	1.513	mg/kg	4.37E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	1.3E-07	3.06E-07	mg/kg-day	NA	NA	NA	NA		
			Fluoranthene	129.8	mg/kg	3.75E-06	mg/kg-day	NA	NA	NA	3	NA	2.62E-05	mg/kg-day	4.0E-02	4.0E-02	NA	0.0007		
			Indeno(1,2,3-cd)pyrene	9.536	mg/kg	2.75E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	8.3E-08	1.93E-06	mg/kg-day	NA	NA	NA	NA		
			Phenanthrene	61.21	mg/kg	1.77E-06	mg/kg-day	NA	NA	NA	3	NA	1.24E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.0004		
Pyrene	107.9		mg/kg	3.11E-06	mg/kg-day	NA	NA	NA	3	NA	2.18E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.0007				
Exposure Route Total											1.9E-06					0.01				
Exposure Medium Total											5.6E-06					0.03				
Surface Soil (0 to 1 foot bgs) Total											5.6E-06					Surface Soil HI	0.03			
Total Area 1C Receptor Risk											5.6E-06					0.03				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 (1) Age-Dependent Adjustment Factor (ADAF) is used for chemicals with a mutagenic mode of action for carcinogenesis. The cancer risk is adjusted by multiplying the calculated risk by the ADAF. See April 2019 HHRA for explanation.
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/3/2019
 Checked By: SMA 7/3/2019

Table 4-15
Risk Calculations for Child Resident - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	SVOCs																	
			Dibenzofuran	3.644	mg/kg	3.99E-06	mg/kg-day	NA	NA	NA	NA	4.7E-05	mg/kg-day	1.0E-03	1.0E-03	NA	0.05			
			PAHs																	
			Benzo(a)anthracene	24.62	mg/kg	2.70E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.1E-04	mg/kg-day	NA	NA	NA	NA			
			Benzo(a)pyrene	13.18	mg/kg	1.44E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.7E-04	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.6			
			Benzo(b)fluoranthene	31.59	mg/kg	3.46E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.0E-04	mg/kg-day	NA	NA	NA	NA			
			Benzo(k)fluoranthene	9.347	mg/kg	1.02E-05	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	1.2E-04	mg/kg-day	NA	NA	NA	NA			
			Chrysene	31.90	mg/kg	3.50E-05	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	4.1E-04	mg/kg-day	NA	NA	NA	NA			
			Dibenzo(a,h)anthracene	1.513	mg/kg	1.66E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.9E-05	mg/kg-day	NA	NA	NA	NA			
			Fluoranthene	129.8	mg/kg	1.42E-04	mg/kg-day	NA	NA	NA	NA	1.7E-03	mg/kg-day	4.0E-02	4.0E-02	NA	0.04			
		Indeno(1,2,3-cd)pyrene	9.536	mg/kg	1.05E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.2E-04	mg/kg-day	NA	NA	NA	NA				
		Phenanthrene	61.21	mg/kg	6.71E-05	mg/kg-day	NA	NA	NA	NA	7.8E-04	mg/kg-day	3.0E-02	3.0E-02	NA	0.03				
		Pyrene	107.9	mg/kg	1.18E-04	mg/kg-day	NA	NA	NA	NA	1.4E-03	mg/kg-day	3.0E-02	3.0E-02	NA	0.05				
		Exposure Route Total											NA					0.7		
		Dermal Contact	SVOCs																	
			Dibenzofuran	3.644	mg/kg	9.48E-07	mg/kg-day	NA	NA	NA	NA	1.11E-05	mg/kg-day	1.0E-03	1.0E-03	NA	0.01			
			PAHs																	
			Benzo(a)anthracene	24.62	mg/kg	8.32E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	9.71E-05	mg/kg-day	NA	NA	NA	NA			
			Benzo(a)pyrene	13.18	mg/kg	4.45E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.20E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.2			
			Benzo(b)fluoranthene	31.59	mg/kg	1.07E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.25E-04	mg/kg-day	NA	NA	NA	NA			
Benzo(k)fluoranthene	9.347		mg/kg	3.16E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	3.69E-05	mg/kg-day	NA	NA	NA	NA					
Chrysene	31.90		mg/kg	1.08E-05	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	1.26E-04	mg/kg-day	NA	NA	NA	NA					
Dibenzo(a,h)anthracene	1.513		mg/kg	5.11E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.97E-06	mg/kg-day	NA	NA	NA	NA					
Fluoranthene	129.8		mg/kg	4.39E-05	mg/kg-day	NA	NA	NA	NA	5.12E-04	mg/kg-day	4.0E-02	4.0E-02	NA	0.01					
Indeno(1,2,3-cd)pyrene	9.536	mg/kg	3.22E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.76E-05	mg/kg-day	NA	NA	NA	NA						
Phenanthrene	61.21	mg/kg	2.07E-05	mg/kg-day	NA	NA	NA	NA	2.41E-04	mg/kg-day	3.0E-02	3.0E-02	NA	0.008						
Pyrene	107.9	mg/kg	3.65E-05	mg/kg-day	NA	NA	NA	NA	4.26E-04	mg/kg-day	3.0E-02	3.0E-02	NA	0.01						
Exposure Route Total											NA					0.2				

Table 4-15
Risk Calculations for Child Resident - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Inhalation (via Particulate and Vapor Emissions)	SVOCs																
			Dibenzofuran	1.74E-05	mg/m ³	1.43E-06	mg/kg-day	NA	NA	NA	NA	1.67E-05	mg/kg-day	1.0E-03	1.0E-03	NA	NA	NA	
			PAHs																
			Benzo(a)anthracene	4.03E-06	mg/m ³	3.31E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.87E-06	mg/kg-day	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	2.10E-08	mg/m ³	1.72E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.01E-08	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01	NA	0.01
			Benzo(b)fluoranthene	5.03E-08	mg/m ³	4.13E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.82E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Benzo(k)fluoranthene	1.49E-08	mg/m ³	1.22E-09	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	1.43E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Chrysene	5.08E-08	mg/m ³	4.17E-09	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	4.87E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	2.41E-09	mg/m ³	1.98E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.31E-09	mg/kg-day	NA	NA	NA	NA	NA	NA
			Fluoranthene	2.07E-07	mg/m ³	1.70E-08	mg/kg-day	NA	NA	NA	NA	1.98E-07	mg/kg-day	4.0E-02	4.0E-02	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	1.52E-08	mg/m ³	1.25E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.46E-08	mg/kg-day	NA	NA	NA	NA	NA	NA
			Phenanthrene	7.03E-05	mg/m ³	5.78E-06	mg/kg-day	NA	NA	NA	NA	6.75E-05	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	NA
			Pyrene	8.16E-06	mg/m ³	6.71E-07	mg/kg-day	NA	NA	NA	NA	7.83E-06	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	NA
Exposure Route Total											NA					0.01			
Exposure Medium Total											NA					0.95			
Surface Soil (0 to 1 foot bgs) Total											NA					Surface Soil HI	0.95		
Total Area 1C Receptor Risk											NA					0.95			

Notes:

EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/3/2019
 Checked By: SMA 7/3/2019

Table 4-16
Risk Calculations for Adult Resident - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3$) ⁻¹	Cancer Risk	Intake/Exposure Concentration		RfD		RfC mg/m^3	Hazard Quotient			
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-day}$) ⁻¹	Abs. Dermal ($\text{mg}/\text{kg}\text{-day}$) ⁻¹			Value	Units	Oral $\text{mg}/\text{kg}\text{-day}$	Abs. Dermal $\text{mg}/\text{kg}\text{-day}$					
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	<u>SVOCs</u>																	
			Dibenzofuran	3.644	mg/kg	1.25E-06	mg/kg-day	NA	NA	NA	NA	4.4E-06	mg/kg-day	1.0E-03	1.0E-03	NA	0.004			
			<u>PAHs</u>																	
			Benzo(a)anthracene	24.62	mg/kg	8.43E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.0E-05	mg/kg-day	NA	NA	NA	NA			
			Benzo(a)pyrene	13.18	mg/kg	4.51E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.6E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.05			
			Benzo(b)fluoranthene	31.59	mg/kg	1.08E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.8E-05	mg/kg-day	NA	NA	NA	NA			
			Benzo(k)fluoranthene	9.347	mg/kg	3.20E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	1.1E-05	mg/kg-day	NA	NA	NA	NA			
			Chrysene	31.90	mg/kg	1.09E-05	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	3.8E-05	mg/kg-day	NA	NA	NA	NA			
			Dibenzo(a,h)anthracene	1.513	mg/kg	5.18E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.8E-06	mg/kg-day	NA	NA	NA	NA			
			Fluoranthene	129.8	mg/kg	4.45E-05	mg/kg-day	NA	NA	NA	NA	1.6E-04	mg/kg-day	4.0E-02	4.0E-02	NA	0.004			
			Indeno(1,2,3-cd)pyrene	9.536	mg/kg	3.27E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.1E-05	mg/kg-day	NA	NA	NA	NA			
		Phenanthrene	61.21	mg/kg	2.10E-05	mg/kg-day	NA	NA	NA	NA	7.3E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.002				
		Pyrene	107.9	mg/kg	3.69E-05	mg/kg-day	NA	NA	NA	NA	1.3E-04	mg/kg-day	3.0E-02	3.0E-02	NA	0.004				
		Exposure Route Total											NA					0.07		
		Dermal Contact	<u>SVOCs</u>																	
			Dibenzofuran	3.644	mg/kg	5.27E-07	mg/kg-day	NA	NA	NA	NA	1.84E-06	mg/kg-day	1.0E-03	1.0E-03	NA	0.002			
			<u>PAHs</u>																	
			Benzo(a)anthracene	24.62	mg/kg	4.63E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.62E-05	mg/kg-day	NA	NA	NA	NA			
			Benzo(a)pyrene	13.18	mg/kg	2.48E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.67E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.03			
			Benzo(b)fluoranthene	31.59	mg/kg	5.94E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.08E-05	mg/kg-day	NA	NA	NA	NA			
			Benzo(k)fluoranthene	9.347	mg/kg	1.76E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	6.15E-06	mg/kg-day	NA	NA	NA	NA			
			Chrysene	31.90	mg/kg	6.00E-06	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	2.10E-05	mg/kg-day	NA	NA	NA	NA			
Dibenzo(a,h)anthracene	1.513		mg/kg	2.84E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	9.95E-07	mg/kg-day	NA	NA	NA	NA					
Fluoranthene	129.8		mg/kg	2.44E-05	mg/kg-day	NA	NA	NA	NA	8.54E-05	mg/kg-day	4.0E-02	4.0E-02	NA	0.002					
Indeno(1,2,3-cd)pyrene	9.536		mg/kg	1.79E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.27E-06	mg/kg-day	NA	NA	NA	NA					
Phenanthrene	61.21	mg/kg	1.15E-05	mg/kg-day	NA	NA	NA	NA	4.03E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.001						
Pyrene	107.9	mg/kg	2.03E-05	mg/kg-day	NA	NA	NA	NA	7.10E-05	mg/kg-day	3.0E-02	3.0E-02	NA	0.002						
Exposure Route Total											NA					0.04				

Table 4-16
Risk Calculations for Adult Resident - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3$) ⁻¹	Cancer Risk	Intake/Exposure Concentration		RfD		RfC mg/m ³	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Inhalation (via Particulate and Vapor Emissions)	SVOCs																
			Dibenzofuran	1.74E-05	mg/m ³	4.77E-06	mg/kg-day	NA	NA	NA	NA	1.67E-05	mg/kg-day	1.0E-03	1.0E-03	NA	NA	NA	
			PAHs																
			Benzo(a)anthracene	4.03E-06	mg/m ³	1.10E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.87E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	2.10E-08	mg/m ³	5.75E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.01E-08	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01	NA	
			Benzo(b)fluoranthene	5.03E-08	mg/m ³	1.38E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.82E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(k)fluoranthene	1.49E-08	mg/m ³	4.08E-09	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	NA	1.43E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Chrysene	5.08E-08	mg/m ³	1.39E-08	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	NA	4.87E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	2.41E-09	mg/m ³	6.60E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.31E-09	mg/kg-day	NA	NA	NA	NA	NA	
			Fluoranthene	2.07E-07	mg/m ³	5.66E-08	mg/kg-day	NA	NA	NA	NA	1.98E-07	mg/kg-day	4.0E-02	4.0E-02	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	1.52E-08	mg/m ³	4.16E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.46E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Phenanthrene	7.03E-05	mg/m ³	1.93E-05	mg/kg-day	NA	NA	NA	NA	6.75E-05	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	
			Pyrene	8.16E-06	mg/m ³	2.24E-06	mg/kg-day	NA	NA	NA	NA	7.83E-06	mg/kg-day	3.0E-02	3.0E-02	NA	NA	NA	
Exposure Route Total											NA					0.01			
Exposure Medium Total											NA					0.1			
Surface Soil (0 to 1 foot bgs) Total											NA					Surface Soil HI	0.1		
Total Area 1C Receptor Risk											NA					0.1			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/3/2019
 Checked By: SMA 7/3/2019

Table 4-17
Risk Calculations for Lifetime Resident, Mutagenic Carcinogens - Area 1C
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Resident

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Cancer Risk	
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs									
			Benzo(a)anthracene	24.62	mg/kg	1.82E-04	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.8E-05	
			Benzo(a)pyrene	13.18	mg/kg	9.73E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	9.7E-05	
			Benzo(b)fluoranthene	31.59	mg/kg	2.33E-04	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.3E-05	
			Benzo(k)fluoranthene	9.347	mg/kg	6.90E-05	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	6.9E-07	
			Chrysene	31.90	mg/kg	2.36E-04	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	2.4E-07	
			Dibenzo(a,h)anthracene	1.513	mg/kg	1.12E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.1E-05	
		Indeno(1,2,3-cd)pyrene	9.536	mg/kg	7.04E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.0E-06		
		Exposure Route Total										1.6E-04
		Dermal Contact	PAHs									
			Benzo(a)anthracene	24.62	mg/kg	1.62E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.6E-06	
			Benzo(a)pyrene	13.18	mg/kg	8.65E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	8.7E-06	
			Benzo(b)fluoranthene	31.59	mg/kg	2.07E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.1E-06	
			Benzo(k)fluoranthene	9.347	mg/kg	6.14E-06	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	6.1E-08	
			Chrysene	31.90	mg/kg	2.09E-05	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	2.1E-08	
			Dibenzo(a,h)anthracene	1.513	mg/kg	9.93E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	9.9E-07	
		Indeno(1,2,3-cd)pyrene	9.536	mg/kg	6.26E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.3E-07		
		Exposure Route Total										1.4E-05
		Inhalation (via Particulate and Vapor Emissions)	PAHs									
			Benzo(a)anthracene	4.03E-06	mg/m ³	3.98E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.4E-07	
			Benzo(a)pyrene	2.10E-08	mg/m ³	2.07E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.2E-08	
Benzo(b)fluoranthene	5.03E-08		mg/m ³	4.96E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.0E-09			
Benzo(k)fluoranthene	1.49E-08		mg/m ³	1.47E-08	mg/kg-day	1.0E-02	1.0E-02	6.0E-06	8.8E-11			
Chrysene	5.08E-08		mg/m ³	5.01E-08	mg/kg-day	1.0E-03	1.0E-03	6.0E-07	3.0E-11			
Dibenzo(a,h)anthracene	2.41E-09		mg/m ³	2.38E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.4E-09			
Indeno(1,2,3-cd)pyrene	1.52E-08	mg/m ³	1.50E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	9.0E-10				
Exposure Route Total										2.6E-07		
Exposure Medium Total										1.7E-04		
Surface Soil (0 to 1 feet bgs) Total										1.7E-04		
Total Area 1C Receptor Risk										1.7E-04		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/3/2019
 Checked By: SMA 7/3/2019

Table 4-18
Risk Calculations for Outdoor Worker - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
						Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Value	Units	Oral (mg/kg-day) ⁻¹		Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹	Value	Units	Oral mg/kg-day		Abs. Dermal mg/kg-day	Inhalation mg/m ³
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																
			Benzo(a)anthracene	5.366	mg/kg	1.48E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.5E-07	4.1E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	1.08E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.1E-06	3.0E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.01	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	2.58E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.6E-07	7.2E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	1.88E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.9E-07	5.3E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Indeno(1,2,3-cd)pyrene	3.078	mg/kg	8.47E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.5E-08	2.4E-06	mg/kg-day	NA	NA	NA	NA	NA		
		Exposure Route Total														1.8E-06		0.01	
		Dermal Contact	PAHs																
			Benzo(a)anthracene	5.366	mg/kg	8.12E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.1E-08	2.27E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	5.96E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.0E-07	1.67E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.006	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	1.42E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.4E-07	3.97E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	1.03E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.0E-07	2.89E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Indeno(1,2,3-cd)pyrene	3.078	mg/kg	4.66E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.7E-08	1.30E-06	mg/kg-day	NA	NA	NA	NA	NA		
		Exposure Route Total														9.7E-07		0.006	
		Inhalation (via Particulate and Vapor Emissions)	PAHs																
			Benzo(a)anthracene	8.78E-07	mg/m ³	6.45E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3.9E-09	1.81E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	6.26E-09	mg/m ³	4.60E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.8E-10	1.29E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0006	NA	
			Benzo(b)fluoranthene	1.49E-08	mg/m ³	1.09E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.6E-11	3.06E-09	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.09E-09	mg/m ³	7.96E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.8E-11	2.23E-10	mg/kg-day	NA	NA	NA	NA	NA	
		Indeno(1,2,3-cd)pyrene	4.90E-09	mg/m ³	3.60E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.2E-11	1.01E-09	mg/kg-day	NA	NA	NA	NA	NA		
		Exposure Route Total														4.3E-09		0.0006	
Exposure Medium Total														2.7E-06		0.02			
Surface Soil (0 to 1 foot bgs) Total														2.7E-06		0.02			
Total Area 1D Receptor Risk														2.7E-06		0.02			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-19
Risk Calculations for Construction Worker - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations						
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration (1)		Subchronic RfD		Subchronic RfC	Hazard Quotient	
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³		
Subsurface Soil	Subsurface Soil	Incidental Ingestion	PAHs															
			Benzo(a)anthracene	2.913	mg/kg	6.11E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.1E-09	4.3E-06	mg/kg-day	NA	NA	NA	NA	NA
			Benzo(a)pyrene	1.627	mg/kg	3.41E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.4E-08	2.4E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.008	0.008
			Benzo(b)fluoranthene	2.886	mg/kg	6.06E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.1E-09	4.2E-06	mg/kg-day	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	0.337	mg/kg	7.06E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	7.1E-09	4.9E-07	mg/kg-day	NA	NA	NA	NA	NA
		Indeno(1,2,3-cd)pyrene	1.007	mg/kg	2.11E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.1E-09	1.5E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										5.5E-08					0.008	
		Dermal Contact	PAHs															
			Benzo(a)anthracene	2.913	mg/kg	2.55E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.5E-09	1.78E-06	mg/kg-day	NA	NA	NA	NA	NA
			Benzo(a)pyrene	1.627	mg/kg	1.42E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.4E-08	9.96E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	0.003
			Benzo(b)fluoranthene	2.886	mg/kg	2.52E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.5E-09	1.77E-06	mg/kg-day	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	0.337	mg/kg	2.94E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.9E-09	2.06E-07	mg/kg-day	NA	NA	NA	NA	NA
		Indeno(1,2,3-cd)pyrene	1.007	mg/kg	8.81E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.8E-10	6.17E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										2.3E-08					0.003	
		Inhalation (via Particulate and Vapor Emissions)	PAHs															
			Benzo(a)anthracene	4.98E-06	mg/m ³	8.45E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.1E-10	5.92E-07	mg/kg-day	NA	NA	NA	NA	NA
			Benzo(a)pyrene	3.55E-07	mg/m ³	6.02E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.6E-10	4.22E-08	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02	0.02
			Benzo(b)fluoranthene	6.30E-07	mg/m ³	1.07E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.4E-11	7.48E-08	mg/kg-day	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	7.34E-08	mg/m ³	1.25E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	7.5E-11	8.72E-09	mg/kg-day	NA	NA	NA	NA	NA
		Indeno(1,2,3-cd)pyrene	2.20E-07	mg/m ³	3.73E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.2E-11	2.61E-08	mg/kg-day	NA	NA	NA	NA	NA	
Exposure Route Total										1.0E-09					0.02			
Exposure Medium Total										8.0E-08					0.03			
Subsurface Soil Total										8.0E-08					0.03			
Total Area 1D Receptor Risk										8.0E-08					0.03			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-7.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg- milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-20
Risk Calculations for Teenage Trespasser - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	ADAF ⁽¹⁾	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	5.366	mg/kg	3.15E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	9.5E-08	2.2E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	2.31E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	6.9E-07	1.6E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.005	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	5.50E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.6E-07	3.8E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	4.00E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	1.2E-07	2.8E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	1.81E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	5.4E-08	1.3E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											1.1E-06					0.005		
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	5.366	mg/kg	1.55E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	4.6E-08	1.08E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	1.14E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	3.4E-07	7.95E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	2.70E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	8.1E-08	1.89E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	1.97E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	5.9E-08	1.38E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	8.89E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	2.7E-08	6.22E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											5.5E-07					0.003		
Exposure Medium Total											1.7E-06					0.008				
Surface Soil (0 to 1 foot bgs) Total											1.7E-06					Surface Soil HI	0.008			
Total Area 1D Receptor Risk											1.7E-06					0.008				

Notes:

EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.

SF - Carcinogenic Slope Factor

(1) Age-Dependent Adjustment Factor (ADAF) is used for chemicals with a mutagenic mode of action for carcinogenesis. The cancer risk is adjusted by multiplying the calculated risk by the ADAF. See April 2019 HHRA for explanation.

RfD - Reference Dose (Non-Carcinogenic)

RfC - Reference Concentration (Non-Carcinogenic)

PAHs - Polycyclic Aromatic Hydrocarbons

NA - Not Applicable

mg/kg- milligrams per kilogram

mg/kg-day - milligrams per kilogram-day

(mg/kg-day)⁻¹ - 1/milligrams per kilogram-day

(ug/m³)⁻¹ - 1/micrograms per meter cubed

mg/m³ - milligrams per meter cubed

bgs - below ground surface

Prepared By: RAH 7/2/2019

Checked By: SMA 7/3/2019

Table 4-21
Risk Calculations for Child Resident - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient			
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	5.366	mg/kg	5.88E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.9E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	4.31E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	5.0E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.2	NA	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	1.03E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.2E-04	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	7.47E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.7E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	3.37E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.9E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA						0.2	
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	5.366	mg/kg	1.81E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.12E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	1.33E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.55E-05	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.05	NA	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	3.17E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.69E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	2.30E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.69E-06	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	1.04E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.21E-05	mg/kg-day	NA	NA	NA	NA	NA	NA	
		Exposure Route Total											NA						0.05	
		Inhalation (via Particulate and Vapor Emissions)	PAHs																	
			Benzo(a)anthracene	8.78E-07	mg/m ³	7.22E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	8.42E-07	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	6.26E-09	mg/m ³	5.15E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.00E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	NA	NA	
			Benzo(b)fluoranthene	1.49E-08	mg/m ³	1.23E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.43E-08	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.09E-09	mg/m ³	8.92E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.04E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	4.90E-09	mg/m ³	4.03E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.70E-09	mg/kg-day	NA	NA	NA	NA	NA	NA	
Exposure Route Total											NA						0.003			
Exposure Medium Total											NA						0.2			
Surface Soil (0 to 1 foot bgs) Total											NA	Surface Soil HI					0.2			
Total Area 1D Receptor Risk											NA						0.2			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-22
Risk Calculations for Adult Resident - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3\text{-}1$)	Cancer Risk	Intake/Exposure Concentration		RfD		RfC (mg/m^3)	Hazard Quotient		
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-}\text{day}^{-1}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-}\text{day}^{-1}$)			Value	Units	Oral ($\text{mg}/\text{kg}\text{-}\text{day}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-}\text{day}$)				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																
			Benzo(a)anthracene	5.366	mg/kg	1.84E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.4E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	1.35E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	4.7E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	3.21E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.1E-05	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	2.33E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.2E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	1.05E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.7E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										NA		0.02					
		Dermal Contact	PAHs																
			Benzo(a)anthracene	5.366	mg/kg	1.01E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.53E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	3.933	mg/kg	7.39E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.59E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.009	NA	
			Benzo(b)fluoranthene	9.364	mg/kg	1.76E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.16E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.682	mg/kg	1.28E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	4.48E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	5.79E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.03E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										NA		0.009					
		Inhalation (via Particulate and Vapor Emissions)	PAHs																
			Benzo(a)anthracene	8.78E-07	mg/m^3	2.41E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	8.42E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	6.26E-09	mg/m^3	1.72E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.00E-09	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.003	NA	
			Benzo(b)fluoranthene	1.49E-08	mg/m^3	4.08E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.43E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.09E-09	mg/m^3	2.97E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.04E-09	mg/kg-day	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	4.90E-09	mg/m^3	1.34E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	4.70E-09	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										NA		0.003					
Exposure Medium Total										NA		0.03							
Surface Soil (0 to 1 foot bgs) Total										NA		Surface Soil HI 0.03							
Total Area 1D Receptor Risk										NA		0.03							

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 $(\text{mg}/\text{kg}\text{-}\text{day})^{-1}$ - 1/milligrams per kilogram-day
 $(\mu\text{g}/\text{m}^3)^{-1}$ - 1/micrograms per meter cubed
 mg/m^3 - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-23
Risk Calculations for Lifetime Resident, Mutagenic Carcinogens - Area 1D
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Resident

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Cancer Risk	
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk (ug/m ³) ⁻¹		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs									
			Benzo(a)anthracene	5.366	mg/kg	3.96E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.0E-06	
			Benzo(a)pyrene	3.933	mg/kg	2.90E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.9E-05	
			Benzo(b)fluoranthene	9.364	mg/kg	6.92E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	6.9E-06	
			Dibenzo(a,h)anthracene	0.682	mg/kg	5.03E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	5.0E-06	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	2.27E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.3E-06	
		Exposure Route Total										4.7E-05
		Dermal Contact	PAHs									
			Benzo(a)anthracene	5.366	mg/kg	1.38E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.4E-06	
			Benzo(a)pyrene	3.933	mg/kg	1.01E-05	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.0E-05	
			Benzo(b)fluoranthene	9.364	mg/kg	2.41E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.4E-06	
			Dibenzo(a,h)anthracene	0.682	mg/kg	1.75E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.8E-06	
			Indeno(1,2,3-cd)pyrene	3.078	mg/kg	7.91E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	7.9E-07	
		Exposure Route Total										1.6E-05
		Inhalation (via Particulate and Vapor Emissions)	PAHs									
			Benzo(a)anthracene	8.78E-07	mg/m ³	8.66E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.2E-08	
			Benzo(a)pyrene	6.26E-09	mg/m ³	6.18E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.7E-09	
			Benzo(b)fluoranthene	1.49E-08	mg/m ³	1.47E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.8E-10	
			Dibenzo(a,h)anthracene	1.09E-09	mg/m ³	1.07E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.4E-10	
			Indeno(1,2,3-cd)pyrene	4.90E-09	mg/m ³	4.83E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.9E-10	
		Exposure Route Total										5.8E-08
Exposure Medium Total										6.4E-05		
Surface Soil (0 to 1 foot bgs) Total										6.4E-05		
Total Area 1D Receptor Risk										6.4E-05		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-24
Risk Calculations for Outdoor Worker - Area 2
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations						
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient	
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³		
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs															
			Benzo(a)anthracene	0.552	mg/kg	1.52E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.5E-08	4.2E-07	mg/kg-day	NA	NA	NA	NA	NA
			Benzo(a)pyrene	0.562	mg/kg	1.55E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.5E-07	4.3E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.001	0.001
			Benzo(b)fluoranthene	1.720	mg/kg	4.73E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.7E-08	1.3E-06	mg/kg-day	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	0.099	mg/kg	2.72E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.7E-08	7.6E-08	mg/kg-day	NA	NA	NA	NA	NA
		Exposure Route Total										2.4E-07					0.001	
		Dermal Contact	PAHs															
			Benzo(a)anthracene	0.552	mg/kg	8.35E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	8.4E-09	2.34E-07	mg/kg-day	NA	NA	NA	NA	NA
			Benzo(a)pyrene	0.562	mg/kg	8.52E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	8.5E-08	2.38E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0008	
			Benzo(b)fluoranthene	1.720	mg/kg	2.60E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	2.6E-08	7.29E-07	mg/kg-day	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	1.50E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.5E-08	4.19E-08	mg/kg-day	NA	NA	NA	NA	
		Exposure Route Total										1.3E-07					0.0008	
		Inhalation (via Particulate and Vapor Emissions)	PAHs															
			Benzo(a)anthracene	9.03E-08	mg/m ³	6.63E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.0E-10	1.86E-08	mg/kg-day	NA	NA	NA	NA	
			Benzo(a)pyrene	8.95E-10	mg/m ³	6.57E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3.9E-11	1.84E-10	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.00009	
Benzo(b)fluoranthene	2.74E-09		mg/m ³	2.01E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.2E-11	5.63E-10	mg/kg-day	NA	NA	NA	NA			
Dibenzo(a,h)anthracene	1.57E-10		mg/m ³	1.16E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	6.9E-12	3.23E-11	mg/kg-day	NA	NA	NA	NA			
Exposure Route Total										4.6E-10					0.00009			
Exposure Medium Total										3.8E-07					0.002			
Surface Soil (0 to 1 foot bgs) Total										3.8E-07					Surface Soil HI	0.002		
Total Area 2 Receptor Risk										3.8E-07					0.002			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-25
Risk Calculations for Teenage Trespasser - Area 2
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations								
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	ADAF ⁽¹⁾	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹			Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																	
			Benzo(a)anthracene	0.552	mg/kg	3.24E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	9.7E-09	2.3E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	3.30E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	9.9E-08	2.3E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0008	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	1.01E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	3.0E-08	7.1E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	5.80E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	1.7E-08	4.1E-08	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										1.6E-07								0.0008
		Dermal Contact	PAHs																	
			Benzo(a)anthracene	0.552	mg/kg	1.59E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	4.8E-09	1.11E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	1.62E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	4.9E-08	1.14E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0004	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	4.97E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	3	1.5E-08	3.48E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	2.85E-09	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	3	8.6E-09	2.00E-08	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total										7.7E-08								0.0004
		Exposure Medium Total										2.3E-07								0.001
		Surface Soil (0 to 1 foot bgs) Total											2.3E-07				Surface Soil HI	0.001		
Total Area 2 Receptor Risk											2.3E-07					0.001				

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 (1) Age-Dependent Adjustment Factor (ADAF) is used for chemicals with a mutagenic mode of action for carcinogenesis. The cancer risk is adjusted by multiplying the calculated risk by the ADAF. See April 2019 HHRA for explanation.
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-26
Risk Calculations for Child Resident - Area 2
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk	Cancer Risk	Intake/Exposure Concentration		RfD		RfC	Hazard Quotient		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		Value	Units	Oral mg/kg-day	Abs. Dermal mg/kg-day	Inhalation mg/m ³			
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	<u>PAHs</u>																
			Benzo(a)anthracene	0.552	mg/kg	6.04E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	7.1E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	6.16E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	7.2E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.02	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	1.88E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.2E-05	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	1.08E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.3E-06	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											NA						0.02
		Dermal Contact	<u>PAHs</u>																
			Benzo(a)anthracene	0.552	mg/kg	1.86E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.18E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	1.90E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	2.22E-06	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.007	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	5.81E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.78E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	3.34E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.90E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											NA						0.007
		Inhalation (via Particulate and Vapor Emissions)	<u>PAHs</u>																
			Benzo(a)anthracene	9.03E-08	mg/m ³	7.42E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	8.66E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	8.95E-10	mg/m ³	7.36E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.59E-10	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0004	NA	
Benzo(b)fluoranthene	2.74E-09		mg/m ³	2.25E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.63E-09	mg/kg-day	NA	NA	NA	NA	NA			
Dibenzo(a,h)anthracene	1.57E-10		mg/m ³	1.29E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.51E-10	mg/kg-day	NA	NA	NA	NA	NA			
Exposure Route Total											NA						0.0004		
Exposure Medium Total											NA						0.03		
Surface Soil (0 to 1 foot bgs) Total											NA	Surface Soil HI					0.03		
Total Area 2 Receptor Risk											NA						0.03		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-27
Risk Calculations for Adult Resident - Area 2
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Noncancer Hazard Calculations							
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk ($\mu\text{g}/\text{m}^3\text{-}1$)	Cancer Risk	Intake/Exposure Concentration		RfD		RfC mg/m^3	Hazard Quotient		
						Value	Units	Oral ($\text{mg}/\text{kg}\text{-}\text{day}^{-1}$)	Abs. Dermal ($\text{mg}/\text{kg}\text{-}\text{day}^{-1}$)			Value	Units	Oral $\text{mg}/\text{kg}\text{-}\text{day}$	Abs. Dermal $\text{mg}/\text{kg}\text{-}\text{day}$				
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs																
			Benzo(a)anthracene	0.552	mg/kg	1.89E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	6.6E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	1.93E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.7E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.002	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	5.89E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.1E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	3.39E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.2E-07	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.002	
		Dermal Contact	PAHs																
			Benzo(a)anthracene	0.552	mg/kg	1.04E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	3.63E-07	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	0.562	mg/kg	1.06E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	3.70E-07	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.001	NA	
			Benzo(b)fluoranthene	1.720	mg/kg	3.23E-07	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	1.13E-06	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	0.099	mg/kg	1.86E-08	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	6.50E-08	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.001	
		Inhalation (via Particulate and Vapor Emissions)	PAHs																
			Benzo(a)anthracene	9.03E-08	mg/m^3	2.47E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	8.66E-08	mg/kg-day	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	8.95E-10	mg/m^3	2.45E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	8.59E-10	mg/kg-day	3.0E-04	3.0E-04	2.0E-06	0.0004	NA	
			Benzo(b)fluoranthene	2.74E-09	mg/m^3	7.50E-10	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	NA	2.63E-09	mg/kg-day	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.57E-10	mg/m^3	4.31E-11	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	NA	1.51E-10	mg/kg-day	NA	NA	NA	NA	NA	
		Exposure Route Total											NA					0.0004	
		Exposure Medium Total											NA					0.004	
		Surface Soil (0 to 1 foot bgs) Total											NA					Surface Soil HI	0.004
Total Area 2 Receptor Risk											NA					0.004			

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 RfD - Reference Dose (Non-Carcinogenic)
 RfC - Reference Concentration (Non-Carcinogenic)
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 ($\text{mg}/\text{kg}\text{-}\text{day}^{-1}$) - 1/milligrams per kilogram-day
 ($\mu\text{g}/\text{m}^3\text{-}1$) - 1/micrograms per meter cubed
 mg/m^3 - milligrams per meter cubed
 bgs - below ground surface
 Carcinogenic risk for mutagenic carcinogens is included on Tables 4-5, 4-11, 4-17, 4-23 and 4-28.

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/2/2019

Table 4-28
Risk Calculations for Lifetime Resident, Mutagenic Carcinogens - Area 2
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Resident

Medium	Exposure Medium	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Cancer Risk	
				Value	Units	Intake/Exposure Concentration		SF		Unit Risk		
						Value	Units	Oral (mg/kg-day) ⁻¹	Abs. Dermal (mg/kg-day) ⁻¹	Inhalation (ug/m ³) ⁻¹		
Surface Soil (0-1 foot bgs)	Surface Soil (0-1 foot bgs)	Incidental Ingestion	PAHs									
			Benzo(a)anthracene	0.552	mg/kg	4.07E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.1E-07	
			Benzo(a)pyrene	0.562	mg/kg	4.15E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	4.2E-06	
			Benzo(b)fluoranthene	1.720	mg/kg	1.27E-05	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.3E-06	
			Dibenzo(a,h)anthracene	0.099	mg/kg	7.30E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	7.3E-07	
		Exposure Route Total										6.6E-06
		Dermal Contact	PAHs									
			Benzo(a)anthracene	0.552	mg/kg	1.42E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.4E-07	
			Benzo(a)pyrene	0.562	mg/kg	1.45E-06	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	1.4E-06	
			Benzo(b)fluoranthene	1.720	mg/kg	4.42E-06	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	4.4E-07	
			Dibenzo(a,h)anthracene	0.099	mg/kg	2.54E-07	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	2.5E-07	
		Exposure Route Total										2.3E-06
		Inhalation (via Particulate and Vapor Emissions)	PAHs									
			Benzo(a)anthracene	9.03E-08	mg/m ³	8.90E-08	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	5.3E-09	
			Benzo(a)pyrene	8.95E-10	mg/m ³	8.83E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	5.3E-10	
Benzo(b)fluoranthene	2.74E-09		mg/m ³	2.70E-09	mg/kg-day	1.0E-01	1.0E-01	6.0E-05	1.6E-10			
Dibenzo(a,h)anthracene	1.57E-10		mg/m ³	1.55E-10	mg/kg-day	1.0E+00	1.0E+00	6.0E-04	9.3E-11			
Exposure Route Total										6.1E-09		
Exposure Medium Total										8.9E-06		
Surface Soil (0 to 1 foot bgs) Total										8.9E-06		
Total Area 2 Receptor Risk										8.9E-06		

Notes:
 EPC - Exposure Point Concentration. Concentrations obtained from Table 3-6.
 SF - Carcinogenic Slope Factor
 PAHs - Polycyclic Aromatic Hydrocarbons
 mg/kg - milligrams per kilogram
 mg/kg-day - milligrams per kilogram-day
 (mg/kg-day)⁻¹ - 1/milligrams per kilogram-day
 (ug/m³)⁻¹ - 1/micrograms per meter cubed
 mg/m³ - milligrams per meter cubed
 bgs - below ground surface

Prepared By: RAH 7/2/2019
 Checked By: SMA 7/3/2019

Table 4-29
Summary of Receptor Risks and Hazards for COPCs - Outdoor Worker
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient										
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total						
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	<u>PAHs</u>															
			Benzo(a)anthracene	7.8E-08	4.3E-08	2.0E-09	1.2E-07	NA	NA	NA	NA	NA						
			Benzo(a)pyrene	7.2E-07	4.0E-07	1.8E-10	1.1E-06	Developmental	0.007	0.004	0.0004	0.01						
			Benzo(b)fluoranthene	1.7E-07	9.1E-08	4.2E-11	2.6E-07	NA	NA	NA	NA	NA						
			Dibenzo(a,h)anthracene	1.0E-07	5.8E-08	2.7E-11	1.6E-07	NA	NA	NA	NA	NA						
			Indeno(1,2,3-cd)pyrene	5.6E-08	3.1E-08	1.4E-11	8.7E-08	NA	NA	NA	NA	NA						
			Chemical Total	1.1E-06	6.2E-07	2.3E-09	1.7E-06		0.007	0.004	0.0004	0.01						
Exposure Point Total				1.7E-06					0.01									
Receptor Total - Area 1A												1.7E-06						0.01
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	<u>PAHs</u>															
			Benzo(a)anthracene	1.3E-07	7.0E-08	3.3E-09	2.0E-07	NA	NA	NA	NA	NA						
			Benzo(a)pyrene	1.1E-06	6.3E-07	2.9E-10	1.8E-06	Developmental	0.01	0.006	0.0007	0.02						
			Benzo(b)fluoranthene	2.8E-07	1.6E-07	7.2E-11	4.4E-07	NA	NA	NA	NA	NA						
			Dibenzo(a,h)anthracene	1.9E-07	1.0E-07	4.7E-11	2.9E-07	NA	NA	NA	NA	NA						
			Indeno(1,2,3-cd)pyrene	9.6E-08	5.3E-08	2.5E-11	1.5E-07	NA	NA	NA	NA	NA						
			<u>Pesticides</u>															
Pentachlorophenol	5.2E-08	5.5E-08	2.8E-13	1.1E-07	Hepatic	0.00005	0.00006	NA	0.0001									
Chemical Total	1.9E-06	1.1E-06	3.8E-09	3.0E-06		0.01	0.006	0.0007	0.02									
Exposure Point Total				3.0E-06					0.02									
Receptor Total - Area 1B													3.0E-06					0.02
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	<u>SVOCs</u>															
			Dibenzofuran	NA	NA	NA	NA	Hepatic	0.003	0.001	NA	0.004						
			<u>PAHs</u>															
			Benzo(a)anthracene	6.8E-07	3.7E-07	1.8E-08	1.1E-06	NA	NA	NA	NA	NA						
			Benzo(a)pyrene	3.6E-06	2.0E-06	9.2E-10	5.6E-06	Developmental	0.03	0.02	0.002	0.05						
			Benzo(b)fluoranthene	8.7E-07	4.8E-07	2.2E-10	1.3E-06	NA	NA	NA	NA	NA						
			Benzo(k)fluoranthene	2.6E-08	1.4E-08	6.6E-12	4.0E-08	NA	NA	NA	NA	NA						
			Chrysene	8.8E-09	4.8E-09	2.2E-12	1.4E-08	NA	NA	NA	NA	NA						
			Dibenzo(a,h)anthracene	4.2E-07	2.3E-07	1.1E-10	6.5E-07	NA	NA	NA	NA	NA						
			Fluoranthene	NA	NA	NA	NA	Hepatic, Renal	0.003	0.001	NA	0.004						
			Indeno(1,2,3-cd)pyrene	2.6E-07	1.4E-07	6.7E-11	4.1E-07	NA	NA	NA	NA	NA						
			Phenanthrene	NA	NA	NA	NA	Renal	0.002	0.0009	NA	0.002						
			Pyrene	NA	NA	NA	NA	Renal	0.003	0.002	NA	0.004						
			Chemical Total	5.9E-06	3.2E-06	1.9E-08	9.1E-06		0.04	0.02	0.002	0.07						
Exposure Point Total				9.1E-06					0.07									
Receptor Total - Area 1C													9.1E-06					0.07

Table 4-29
Summary of Receptor Risks and Hazards for COPCs - Outdoor Worker
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Outdoor Worker

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	PAHs									
			Benzo(a)anthracene	1.5E-07	8.1E-08	3.9E-09	2.3E-07	NA	NA	NA	NA	NA
			Benzo(a)pyrene	1.1E-06	6.0E-07	2.8E-10	1.7E-06	Developmental	0.01	0.006	0.0006	0.02
			Benzo(b)fluoranthene	2.6E-07	1.4E-07	6.6E-11	4.0E-07	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	1.9E-07	1.0E-07	4.8E-11	2.9E-07	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	8.5E-08	4.7E-08	2.2E-11	1.3E-07	NA	NA	NA	NA	NA
			Chemical Total	1.8E-06	9.7E-07	4.3E-09	2.7E-06		0.01	0.006	0.0006	0.02
Exposure Point Total				2.7E-06				0.02				
Receptor Total - Area 1D				2.7E-06				0.02				
Soil	Surface Soil (0 -1 foot bgs)	Area 2	PAHs									
			Benzo(a)anthracene	1.5E-08	8.4E-09	4.0E-10	2.4E-08	NA	NA	NA	NA	NA
			Benzo(a)pyrene	1.5E-07	8.5E-08	3.9E-11	2.4E-07	Developmental	0.001	0.0008	0.00009	0.002
			Benzo(b)fluoranthene	4.7E-08	2.6E-08	1.2E-11	7.3E-08	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	2.7E-08	1.5E-08	6.9E-12	4.2E-08	NA	NA	NA	NA	NA
			Chemical Total	2.4E-07	1.3E-07	4.6E-10	3.8E-07		0.001	0.0008	0.00009	0.002
			Exposure Point Total				3.8E-07				0.002	
Receptor Total - Area 2				3.8E-07				0.002				

Notes:
 COPCs - Chemicals of Potential Concern
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 bgs - below ground surface

Prepared By: RAH 7/19/2019
 Checked By: SMA 7/19/2019

Table 4-30
Summary of Receptor Risks and Hazards for COPCs - Construction Worker
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient																								
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total																				
Soil	Subsurface Soil (greater than 1 foot bgs)	Area 1B	<u>SVOCs</u>					Hepatic	0.006	0.002	NA	0.008																				
			Dibenzofuran	NA	NA	NA	NA																									
			<u>PAHs</u>										NA	NA	NA	NA																
			Benzo(a)anthracene	3.7E-08	1.5E-08	3.1E-09	5.5E-08																									
			Benzo(a)pyrene	4.5E-08	1.9E-08	4.7E-10	6.4E-08										Developmental	0.01	0.004	0.03	0.04											
			Benzo(b)fluoranthene	1.7E-08	7.2E-09	1.8E-10	2.5E-08																									
			Dibenzo(a,h)anthracene	3.6E-09	1.5E-09	3.8E-11	5.1E-09															NA	NA	NA	NA							
			Fluoranthene	NA	NA	NA	NA																									
			Indeno(1,2,3-cd)pyrene	2.5E-09	1.0E-09	2.6E-11	3.6E-09																			Hepatic, Renal	0.002	0.0008	NA	0.003		
			Phenanthrene	NA	NA	NA	NA																									
Chemical Total	1.0E-07	4.4E-08	3.8E-09	1.5E-07	NA	NA	NA	NA																								
Exposure Point Total				1.5E-07					Renal	0.0008	0.0003	NA																			0.001	
Receptor Total - Area 1B				1.5E-07																												0.05
Soil	Subsurface Soil (greater than 1 foot bgs)	Area 1C	<u>SVOCs</u>													Hepatic																0.002
			Dibenzofuran	NA									NA	NA	NA																	
			<u>PAHs</u>														NA	NA	NA	NA												
			Benzo(a)anthracene	1.3E-08									5.4E-09	1.1E-09	1.9E-08																	
			Benzo(a)pyrene	4.9E-08									2.0E-08	5.2E-10	7.0E-08						Developmental	0.01	0.005	0.03	0.05							
			Benzo(b)fluoranthene	1.1E-08									4.5E-09	1.1E-10	1.6E-08																	
			Benzo(k)fluoranthene	4.6E-10									1.9E-10	4.9E-12	6.6E-10											NA	NA	NA	NA			
			Dibenzo(a,h)anthracene	6.4E-09	2.7E-09	6.8E-11	9.2E-09																									
			Indeno(1,2,3-cd)pyrene	2.9E-09	1.2E-09	3.0E-11	4.1E-09	NA	NA	NA	NA																					
			Naphthalene	NA	NA	6.4E-09	6.4E-09					Nervous, Respiratory	0.000002	0.000007	0.004															0.004		
Phenanthrene	NA	NA	NA	NA																												
Chemical Total	8.3E-08	3.4E-08	8.2E-09	1.3E-07	Renal	0.0003	0.0001									NA															0.0004	
Exposure Point Total				1.3E-07																												0.05
Receptor Total - Area 1C				1.3E-07																												0.05

Table 4-30
Summary of Receptor Risks and Hazards for COPCs - Construction Worker
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Construction Worker

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil (greater than 1 foot bgs)	Area 1D	PAHs									
			Benzo(a)anthracene	6.1E-09	2.5E-09	5.1E-10	9.2E-09	NA	NA	NA	NA	NA
			Benzo(a)pyrene	3.4E-08	1.4E-08	3.6E-10	4.9E-08	Developmental	0.008	0.003	0.02	0.03
			Benzo(b)fluoranthene	6.1E-09	2.5E-09	6.4E-11	8.6E-09	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	7.1E-09	2.9E-09	7.5E-11	1.0E-08	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	2.1E-09	8.8E-10	2.2E-11	3.0E-09	NA	NA	NA	NA	NA
			Chemical Total	5.5E-08	2.3E-08	1.0E-09	8.0E-08		0.008	0.003	0.02	0.03
Exposure Point Total								8.0E-08				
Receptor Total - Area 2								8.0E-08				

Notes:
 COPCs - Chemicals of Potential Concern
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 bgs - below ground surface

Prepared By: RAH 7/24/2019
 Checked By: SMA 7/24/2019

Table 4-31
Summary of Receptor Risks and Hazards for COPCs - Teenage Trespasser
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	PAHs									
			Benzo(a)anthracene	5.0E-08	2.5E-08	NA	7.4E-08	NA	NA	NA	NA	NA
			Benzo(a)pyrene	4.6E-07	2.3E-07	NA	6.9E-07	Developmental	0.004	0.002	NA	0.005
			Benzo(b)fluoranthene	1.1E-07	5.2E-08	NA	1.6E-07	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	6.7E-08	3.3E-08	NA	1.0E-07	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	3.6E-08	1.8E-08	NA	5.4E-08	NA	NA	NA	NA	NA
			Chemical Total	7.2E-07	3.5E-07	NA	1.1E-06		0.004	0.002	NA	0.005
			Exposure Point Total				1.1E-06					0.005
			Receptor Total - Area 1A				1.1E-06					0.005
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	PAHs									
			Benzo(a)anthracene	8.2E-08	4.0E-08	NA	1.2E-07	NA	NA	NA	NA	NA
			Benzo(a)pyrene	7.3E-07	3.6E-07	NA	1.1E-06	Developmental	0.006	0.003	NA	0.008
			Benzo(b)fluoranthene	1.8E-07	9.0E-08	NA	2.7E-07	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	1.2E-07	5.9E-08	NA	1.8E-07	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	6.2E-08	3.0E-08	NA	9.2E-08	NA	NA	NA	NA	NA
			Pesticides									
			Pentachlorophenol	5.3E-09	6.4E-14	NA	5.3E-09	Hepatic	0.00002	0.00002	NA	0.00004
			Chemical Total	1.2E-06	5.8E-07	NA	1.8E-06		0.006	0.003	NA	0.008
			Exposure Point Total				1.8E-06					0.008
			Receptor Total - Area 1B				1.8E-06					0.008
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	SVOCs									
			Dibenzofuran	NA	NA	NA	NA	Hepatic	0.001	0.0006	NA	0.002
			PAHs									
			Benzo(a)anthracene	4.3E-07	2.1E-07	NA	6.5E-07	NA	NA	NA	NA	NA
			Benzo(a)pyrene	2.3E-06	1.1E-06	NA	3.5E-06	Developmental	0.02	0.009	NA	0.03
			Benzo(b)fluoranthene	5.6E-07	2.7E-07	NA	8.3E-07	NA	NA	NA	NA	NA
			Benzo(k)fluoranthene	1.6E-08	8.1E-09	NA	2.5E-08	NA	NA	NA	NA	NA
			Chrysene	5.6E-09	2.8E-09	NA	8.4E-09	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	2.7E-07	1.3E-07	NA	4.0E-07	NA	NA	NA	NA	NA
			Fluoranthene	NA	NA	NA	NA	Hepatic, Renal	0.001	0.0007	NA	0.002
			Indeno(1,2,3-cd)pyrene	1.7E-07	8.3E-08	NA	2.5E-07	NA	NA	NA	NA	NA
			Phenanthrene	NA	NA	NA	NA	Renal	0.0008	0.0004	NA	0.001
			Pyrene	NA	NA	NA	NA	Renal	0.001	0.0007	NA	0.002
			Chemical Total	3.8E-06	1.9E-06	NA	5.6E-06		0.02	0.01	NA	0.03
			Exposure Point Total				5.6E-06					0.03
			Receptor Total - Area 1C				5.6E-06					0.03

Table 4-31
Summary of Receptor Risks and Hazards for COPCs - Teenage Trespasser
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Current and Future
 Receptor Population: Teenage Trespasser

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total	
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	<u>PAHs</u>										
			Benzo(a)anthracene	9.5E-08	4.6E-08	NA	1.4E-07	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	6.9E-07	3.4E-07	NA	1.0E-06	Developmental	0.005	0.003	NA	0.008	
			Benzo(b)fluoranthene	1.6E-07	8.1E-08	NA	2.5E-07	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.2E-07	5.9E-08	NA	1.8E-07	NA	NA	NA	NA	NA	
			Indeno(1,2,3-cd)pyrene	5.4E-08	2.7E-08	NA	8.1E-08	NA	NA	NA	NA	NA	
		Chemical Total	1.1E-06	5.5E-07	NA	1.7E-06		0.005	0.003	NA	0.008		
Exposure Point Total				1.7E-06				0.008					
Receptor Total - Area 1D				1.7E-06				0.008					
Soil	Surface Soil (0 -1 foot bgs)	Area 2	<u>PAHs</u>										
			Benzo(a)anthracene	9.7E-09	4.8E-09	NA	1.4E-08	NA	NA	NA	NA	NA	
			Benzo(a)pyrene	9.9E-08	4.9E-08	NA	1.5E-07	Developmental	0.0008	0.0004	NA	0.001	
			Benzo(b)fluoranthene	3.0E-08	1.5E-08	NA	4.5E-08	NA	NA	NA	NA	NA	
			Dibenzo(a,h)anthracene	1.7E-08	8.6E-09	NA	2.6E-08	NA	NA	NA	NA	NA	
			Chemical Total	1.6E-07	7.7E-08	NA	2.3E-07		0.0008	0.0004	NA	0.001	
		Exposure Point Total				2.3E-07				0.001			
Receptor Total - Area 2				2.3E-07				0.001					

Notes:
 COPCs - Chemicals of Potential Concern
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 bgs - below ground surface

Prepared By: RAH 7/19/2019
 Checked By: SMA 7/19/2019

Table 4-32
Summary of Receptor Risks and Hazards for COPCs - Child Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.1	0.03	0.002	0.1
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.1	0.03	0.002	0.1
Exposure Point Total				NA					0.1			
Receptor Total - Area 1A							NA				0.1	
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.2	0.05	0.003	0.2
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Pesticides									
Pentachlorophenol	2.1E-07	1.2E-07	3.2E-13	3.3E-07	Hepatic	0.001	0.0007	NA	0.002			
Chemical Total	2.1E-07	1.2E-07	3.2E-13	3.3E-07		0.2	0.06	0.003	0.2			
Exposure Point Total				3.3E-07					0.2			
Receptor Total - Area 1B							3.3E-07				0.2	
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	SVOCs									
			Dibenzofuran	NA	NA	NA	NA	Hepatic	0.05	0.01	NA	0.06
			PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.6	0.2	0.01	0.7
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Fluorene	NA	NA	NA	NA	Hematologic	0.04	0.01	NA	0.05
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Phenanthrene	NA	NA	NA	NA	Renal	0.03	0.008	NA	0.03
			Pyrene	NA	NA	NA	NA	Renal	0.05	0.01	NA	0.06
			Chemical Total	NA	NA	NA	NA		0.7	0.2	0.01	0.95
Exposure Point Total				NA					0.95			
Receptor Total - Area 1C							NA				0.95	

Table 4-32
Summary of Receptor Risks and Hazards for COPCs - Child Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Child Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.2	0.05	0.003	0.2
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.2	0.05	0.003	0.2
Exposure Point Total							NA					0.2
Receptor Total - Area 1D							NA					0.2
Soil	Surface Soil (0 -1 foot bgs)	Area 2	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.02	0.007	0.0004	0.03
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.02	0.007	0.0004	0.03
			Exposure Point Total							NA		
Receptor Total - Area 2							NA					0.03

Notes:
 COPCs - Chemicals of Potential Concern
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 bgs - below ground surface

Prepared By: RAH 7/19/2019
 Checked By: SMA 7/19/2019

Table 4-33
Summary of Receptor Risks and Hazards for COPCs - Adult Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.01	0.006	0.002	0.02
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.01	0.006	0.002	0.02
Exposure Point Total				NA					0.02			
Receptor Total - Area 1A							NA				0.02	
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.02	0.009	0.003	0.03
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Pesticides									
Pentachlorophenol	3.1E-08	4.1E-13	6.2E-17	3.1E-08	Hepatic	0.00005	0.00006	NA	0.0001			
Chemical Total	3.1E-08	4.1E-13	6.2E-17	3.1E-08		0.02	0.009	0.003	0.03			
Exposure Point Total				3.1E-08					0.03			
Receptor Total - Area 1B							3.1E-08				0.03	
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	SVOCs									
			Dibenzofuran	NA	NA	NA	NA	Hepatic	0.004	0.002	NA	0.006
			PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.05	0.03	0.01	0.09
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Fluorene	NA	NA	NA	NA	Hematologic	0.004	0.002	NA	0.006
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Phenanthrene	NA	NA	NA	NA	Renal	0.002	0.001	NA	0.004
			Pyrene	NA	NA	NA	NA	Renal	0.004	0.002	NA	0.007
			Chemical Total	NA	NA	NA	NA		0.07	0.04	0.01	0.1
Exposure Point Total				NA					0.1			
Receptor Total - Area 1C							NA			0.1		

Table 4-33
Summary of Receptor Risks and Hazards for COPCs - Adult Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Adult Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.02	0.009	0.003	0.03
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.02	0.009	0.003	0.03
Exposure Point Total							NA					0.03
Receptor Total - Area 1D							NA					0.03
Soil	Surface Soil (0 -1 foot bgs)	Area 2	PAHs									
			Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Benzo(a)pyrene	NA	NA	NA	NA	Developmental	0.002	0.001	0.0004	0.004
			Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		0.002	0.001	0.0004	0.004
			Exposure Point Total							NA		
Receptor Total - Area 2							NA					0.004

Notes:
 COPCs - Chemicals of Potential Concern
 SVOCs - Semi-Volatile Organic Compounds
 PAHs - Polycyclic Aromatic Hydrocarbons
 NA - Not Applicable
 NC - Not Calculated, Included in the Lifetime Resident
 bgs - below ground surface

Prepared By: RAH 7/19/2019
 Checked By: SMA 7/19/2019

Table 4-34

**Summary of Receptor Risks and Hazards for Mutagenic COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina**

August 2019

Scenario Timeframe: Future Receptor Population: Lifetime Resident
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Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	<u>PAHs</u>				
			Benzo(a)anthracene	2.1E-06	7.3E-07	2.7E-08	2.8E-06
			Benzo(a)pyrene	1.9E-05	6.7E-06	2.5E-09	2.6E-05
			Benzo(b)fluoranthene	4.4E-06	1.5E-06	5.7E-10	6.0E-06
			Dibenzo(a,h)anthracene	2.8E-06	9.8E-07	3.6E-10	3.8E-06
			Indeno(1,2,3-cd)pyrene	1.5E-06	5.2E-07	1.9E-10	2.0E-06
		Chemical Total	3.0E-05	1.0E-05	3.1E-08	4.1E-05	
Exposure Point Total				4.1E-05			
Receptor Total - Area 1A				4.1E-05			
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	<u>PAHs</u>				
			Benzo(a)anthracene	3.4E-06	1.2E-06	4.5E-08	4.7E-06
			Benzo(a)pyrene	3.1E-05	1.1E-05	3.9E-09	4.1E-05
			Benzo(b)fluoranthene	7.6E-06	2.7E-06	9.7E-10	1.0E-05
			Dibenzo(a,h)anthracene	5.0E-06	1.7E-06	6.4E-10	6.7E-06
			Indeno(1,2,3-cd)pyrene	2.6E-06	9.0E-07	3.3E-10	3.5E-06
		Chemical Total	4.9E-05	1.7E-05	5.1E-08	6.6E-05	
Exposure Point Total				6.6E-05			
Receptor Total - Area 1B				6.6E-05			

Table 4-34

**Summary of Receptor Risks and Hazards for Mutagenic COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina**

August 2019

Scenario Timeframe: Future Receptor Population: Lifetime Resident
--

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	<u>PAHs</u>				
			Benzo(a)anthracene	1.8E-05	1.6E-06	2.4E-07	2.0E-05
			Benzo(a)pyrene	9.7E-05	8.7E-06	1.2E-08	1.1E-04
			Benzo(b)fluoranthene	2.3E-05	2.1E-06	3.0E-09	2.5E-05
			Benzo(k)fluoranthene	6.9E-07	6.1E-08	8.8E-11	7.5E-07
			Chrysene	2.4E-07	2.1E-08	3.0E-11	2.6E-07
			Dibenzo(a,h)anthracene	1.1E-05	9.9E-07	1.4E-09	1.2E-05
			Indeno(1,2,3-cd)pyrene	7.0E-06	6.3E-07	9.0E-10	7.7E-06
		Chemical Total	1.6E-04	1.4E-05	2.6E-07	1.7E-04	
		Exposure Point Total				1.7E-04	
Receptor Total - Area 1C				1.7E-04			
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	<u>PAHs</u>				
			Benzo(a)anthracene	4.0E-06	1.4E-06	5.2E-08	5.4E-06
			Benzo(a)pyrene	2.9E-05	1.0E-05	3.7E-09	3.9E-05
			Benzo(b)fluoranthene	6.9E-06	2.4E-06	8.8E-10	9.3E-06
			Dibenzo(a,h)anthracene	5.0E-06	1.8E-06	6.4E-10	6.8E-06
			Indeno(1,2,3-cd)pyrene	2.3E-06	7.9E-07	2.9E-10	3.1E-06
		Chemical Total	4.7E-05	1.6E-05	5.8E-08	6.4E-05	
		Exposure Point Total				6.4E-05	
Receptor Total - Area 1D				6.4E-05			

Table 4-34

**Summary of Receptor Risks and Hazards for Mutagenic COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina**

August 2019

Scenario Timeframe: Future Receptor Population: Lifetime Resident
--

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 2	<i>PAHs</i>				
			Benzo(a)anthracene	4.1E-07	1.4E-07	5.3E-09	5.5E-07
			Benzo(a)pyrene	4.2E-06	1.4E-06	5.3E-10	5.6E-06
			Benzo(b)fluoranthene	1.3E-06	4.4E-07	1.6E-10	1.7E-06
			Dibenzo(a,h)anthracene	7.3E-07	2.5E-07	9.3E-11	9.8E-07
			Chemical Total	6.6E-06	2.3E-06	6.1E-09	8.9E-06
Exposure Point Total				8.9E-06			
Receptor Total - Area 2				8.9E-06			

Notes:

- COPCs - Chemicals of Potential Concern
- SVOCs - Semi-Volatile Organic Compounds
- PAHs - Polycyclic Aromatic Hydrocarbons
- NA - Not Applicable
- bgs - below ground surface

Prepared By: RAH 7/19/2019

Checked By: SMA 7/19/2019

Table 4-35
Summary of Receptor Risks and Hazards for COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Human Health Risk Assessment Addendum
 August 2019

Scenario Timeframe: Future
 Receptor Population: Aggregate Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1A	<u>PAHs</u>				
			Benzo(a)anthracene	2.1E-06	7.3E-07	2.7E-08	2.8E-06
			Benzo(a)pyrene	1.9E-05	6.7E-06	2.5E-09	2.6E-05
			Benzo(b)fluoranthene	4.4E-06	1.5E-06	5.7E-10	6.0E-06
			Dibenzo(a,h)anthracene	2.8E-06	9.8E-07	3.6E-10	3.8E-06
			Indeno(1,2,3-cd)pyrene	1.5E-06	5.2E-07	1.9E-10	2.0E-06
		Chemical Total	3.0E-05	1.0E-05	3.1E-08	4.1E-05	
Exposure Point Total				4.1E-05			
Receptor Total - Area 1A							4.1E-05
Soil	Surface Soil (0 -1 foot bgs)	Area 1B	<u>PAHs</u>				
			Benzo(a)anthracene	3.4E-06	1.2E-06	4.5E-08	4.7E-06
			Benzo(a)pyrene	3.1E-05	1.1E-05	3.9E-09	4.1E-05
			Benzo(b)fluoranthene	7.6E-06	2.7E-06	9.7E-10	1.0E-05
			Dibenzo(a,h)anthracene	5.0E-06	1.7E-06	6.4E-10	6.7E-06
			Indeno(1,2,3-cd)pyrene	2.6E-06	9.0E-07	3.3E-10	3.5E-06
		<u>Pesticides</u>					
Pentachlorophenol	2.4E-07	1.2E-07	3.2E-13	3.6E-07			
Chemical Total	4.9E-05	1.7E-05	5.1E-08	6.7E-05			
Exposure Point Total				6.7E-05			
Receptor Total - Area 1B							6.7E-05

Table 4-35
Summary of Receptor Risks and Hazards for COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Scenario Timeframe: Future
 Receptor Population: Aggregate Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 1C	<u>SVOCs</u>				
			Dibenzofuran	NA	NA	NA	NA
			<u>PAHs</u>				
			Benzo(a)anthracene	1.8E-05	1.6E-06	2.4E-07	2.0E-05
			Benzo(a)pyrene	9.7E-05	8.7E-06	1.2E-08	1.1E-04
			Benzo(b)fluoranthene	2.3E-05	2.1E-06	3.0E-09	2.5E-05
			Benzo(k)fluoranthene	6.9E-07	6.1E-08	8.8E-11	7.5E-07
			Chrysene	2.4E-07	2.1E-08	3.0E-11	2.6E-07
			Dibenzo(a,h)anthracene	1.1E-05	9.9E-07	1.4E-09	1.2E-05
			Fluoranthene	NA	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	7.0E-06	6.3E-07	9.0E-10	7.7E-06
			Phenanthrene	NA	NA	NA	NA
			Pyrene	NA	NA	NA	NA
			Chemical Total	1.6E-04	1.4E-05	2.6E-07	1.7E-04
Exposure Point Total				1.7E-04			
Receptor Total - Area 1C				1.7E-04			
Soil	Surface Soil (0 -1 foot bgs)	Area 1D	<u>PAHs</u>				
			Benzo(a)anthracene	4.0E-06	1.4E-06	5.2E-08	5.4E-06
			Benzo(a)pyrene	2.9E-05	1.0E-05	3.7E-09	3.9E-05
			Benzo(b)fluoranthene	6.9E-06	2.4E-06	8.8E-10	9.3E-06
			Dibenzo(a,h)anthracene	5.0E-06	1.8E-06	6.4E-10	6.8E-06
			Indeno(1,2,3-cd)pyrene	2.3E-06	7.9E-07	2.9E-10	3.1E-06
			Chemical Total	4.7E-05	1.6E-05	5.8E-08	6.4E-05
Exposure Point Total				6.4E-05			
Receptor Total - Area 1D				6.4E-05			

Table 4-35
Summary of Receptor Risks and Hazards for COPCs - Lifetime Resident
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Human Health Risk Assessment Addendum
August 2019

Scenario Timeframe: Future Receptor Population: Aggregate Resident

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			
				Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0 -1 foot bgs)	Area 2	<u>PAHs</u>				
			Benzo(a)anthracene	4.1E-07	1.4E-07	5.3E-09	5.5E-07
			Benzo(a)pyrene	4.2E-06	1.4E-06	5.3E-10	5.6E-06
			Benzo(b)fluoranthene	1.3E-06	4.4E-07	1.6E-10	1.7E-06
			Dibenzo(a,h)anthracene	7.3E-07	2.5E-07	9.3E-11	9.8E-07
		Chemical Total	6.6E-06	2.3E-06	6.1E-09	8.9E-06	
		Exposure Point Total				8.9E-06	
		Receptor Total - Area 2				8.9E-06	

Notes:

- COPCs - Chemicals of Potential Concern
- SVOCs - Semi-Volatile Organic Compounds
- PAHs - Polycyclic Aromatic Hydrocarbons
- NA - Not Applicable
- bgs - below ground surface

Prepared By: RAH 7/19/2019

Checked By: SMA 7/19/2019

Table 4-36
Summary of Exposure Area Risks and Hazards for COPCs
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Receptor	Exposure Area	Carcinogenic Risk			Non-Carcinogenic Risk		
		Exposure Medium		Total Carcinogenic Risk	Exposure Medium		Total Non-Carcinogenic Risk
		Surface Soil	Subsurface Soil		Surface Soil	Subsurface Soil	
Outdoor Worker	Area 1A	1.7E-06	--	1.7E-06	0.01	--	0.01
	Area 1B	3.0E-06	--	3.0E-06	0.02	--	0.02
	Area 1C	9.1E-06	--	9.1E-06	0.07	--	0.07
	Area 1D	2.7E-06	--	2.7E-06	0.02	--	0.02
	Area 2	3.8E-07	--	3.8E-07	0.002	--	0.002
Construction Worker	Area 1A	--	--	--	--	--	--
	Area 1B	--	1.5E-07	1.5E-07	--	0.05	0.05
	Area 1C	--	1.3E-07	1.3E-07	--	0.05	0.05
	Area 1D	--	8.0E-08	8.0E-08	--	0.03	0.03
	Area 2	--	--	--	--	--	--
Teenage Trespasser	Area 1A	1.1E-06	--	1.1E-06	0.005	--	0.005
	Area 1B	1.8E-06	--	1.8E-06	0.008	--	0.008
	Area 1C	5.6E-06	--	5.6E-06	0.03	--	0.03
	Area 1D	1.7E-06	--	1.7E-06	0.008	--	0.008
	Area 2	2.3E-07	--	2.3E-07	0.001	--	0.001
Lifetime Resident* (Child and Age-Adjusted)	Area 1A	4.1E-05	--	4.1E-05	0.1	--	0.1
	Area 1B	6.7E-05	--	6.7E-05	0.2	--	0.2
	Area 1C	1.7E-04	--	1.7E-04	0.95	--	0.95
	Area 1D	6.4E-05	--	6.4E-05	0.2	--	0.2
	Area 2	8.9E-06	--	8.9E-06	0.03	--	0.03

Notes:

COPCs - Chemicals of Potential Concern

* Non-carcinogenic hazard index for the lifetime resident is based on the child hazard index.

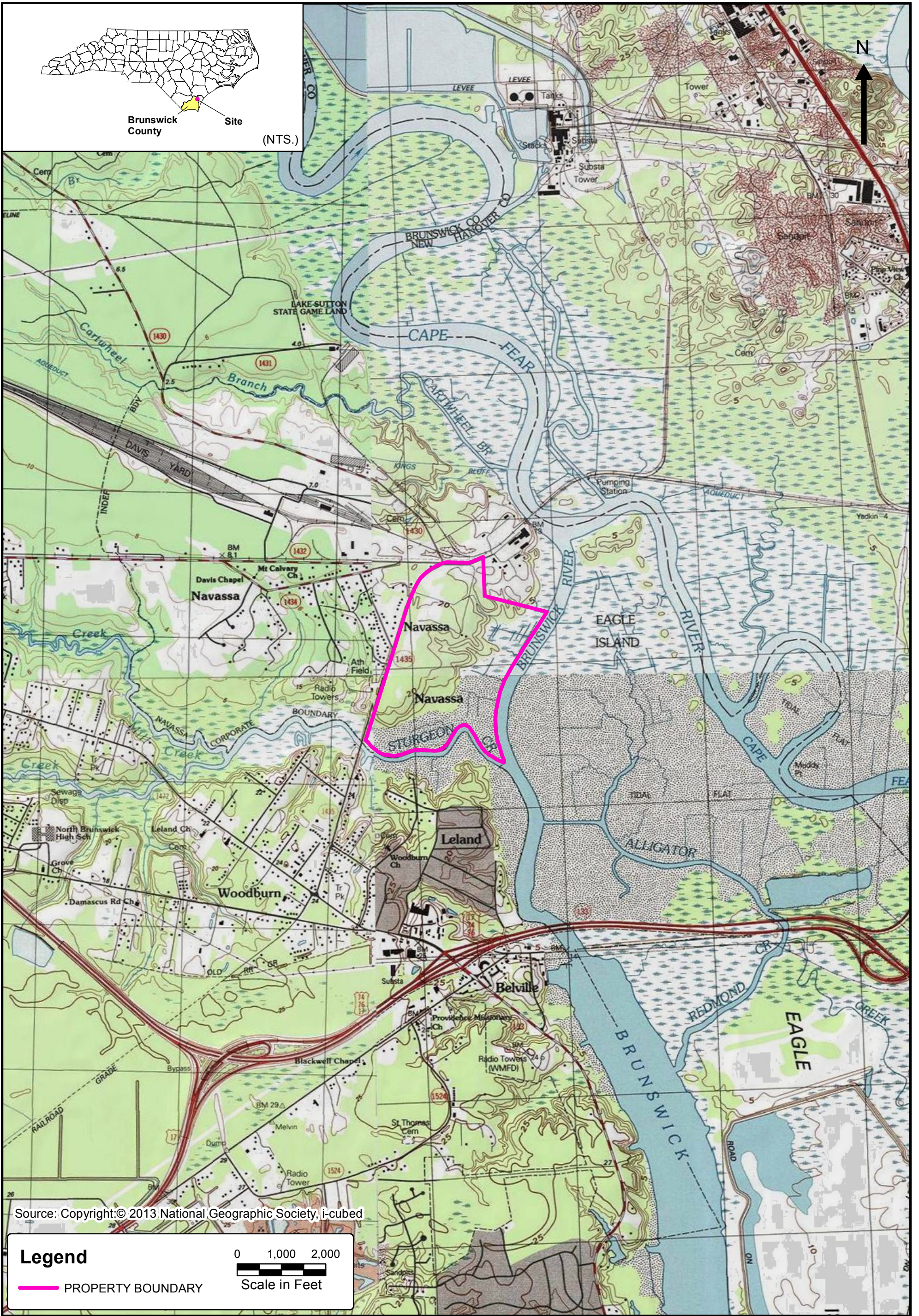
-- - Not Applicable. Exposure pathway is incomplete or risk not calculable.

Shading indicates excess lifetime cancer risk greater than 1E-4 or a total hazard index greater than 1.0.

Prepared By: RAH 7/24/2019

Checked By: SMA 7/24/2019

FIGURES



Brunswick County Site

(NTS.)

Source: Copyright:© 2013 National Geographic Society, i-cubed

Legend

— PROPERTY BOUNDARY

0 1,000 2,000



Scale in Feet



Greenfield Environmental Multistate Trust, LLC
Trustee of the Multistate Environmental Response Trust

PREPARED BY:



EARTHCON CONSULTANTS OF NORTH CAROLINA, P.C.

SITE LOCATION

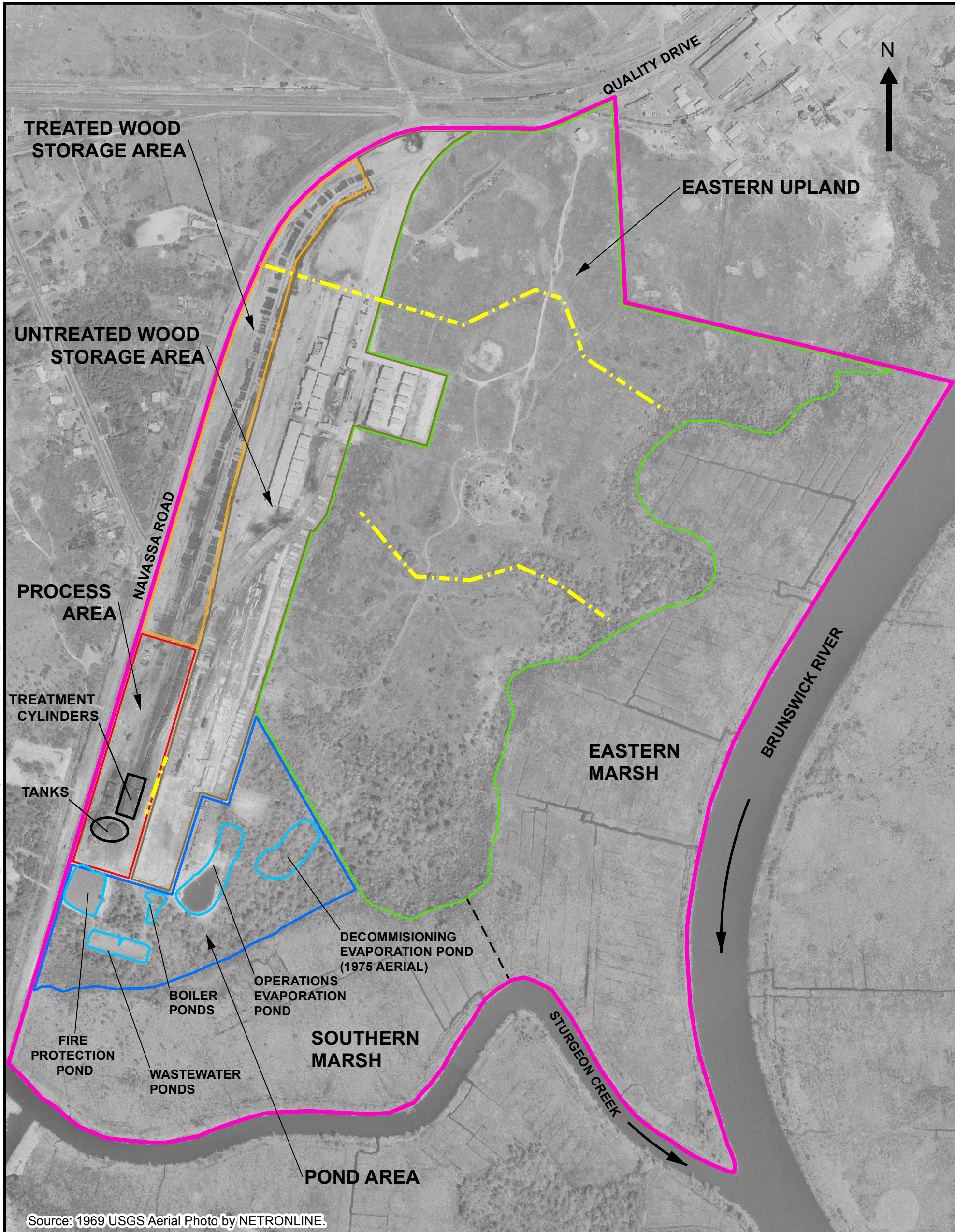
Human Health Risk Assessment Addendum

Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

DRAWN	CHECKED	DATE	FIGURE
HVP	CDN	AUG 2018	1-1

S:\Premier\Projects\Greenfield Environmental Multistate Trust\KMGCC Navassa NC Superfund Site\CAD GIS Data\EARTHCON_GIS\MXD\HHRRA\Fig 1-1 Navassa Site Location_HHRA.mxd

S:\Premier\Projects\Greenfield Environmental Multistate Trust\KMCC Navassa NC Superfund Site\CAD GIS Data\EARTHCON_GIS\IMXD\HHR\Fig 1-2 Navassa Historical Site Plan_HHRA.mxd



Source: 1969 USGS Aerial Photo by NETRONLINE.

Legend

	PROPERTY BOUNDARY		POND AREA
	PROCESS AREA		FORMER POND
	TREATED WOOD STORAGE AREA		EASTERN UPLAND
	UNTREATED WOOD STORAGE AREA		DRAINAGE SWALE

Scale in Feet



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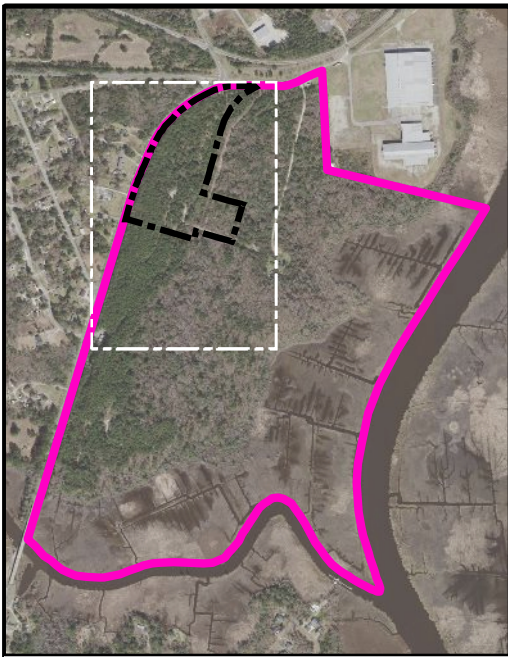
EARTHCON CONSULTANTS OF NORTH CAROLINA, P.C.

HISTORICAL SITE PLAN
Human Health Risk Assessment Addendum

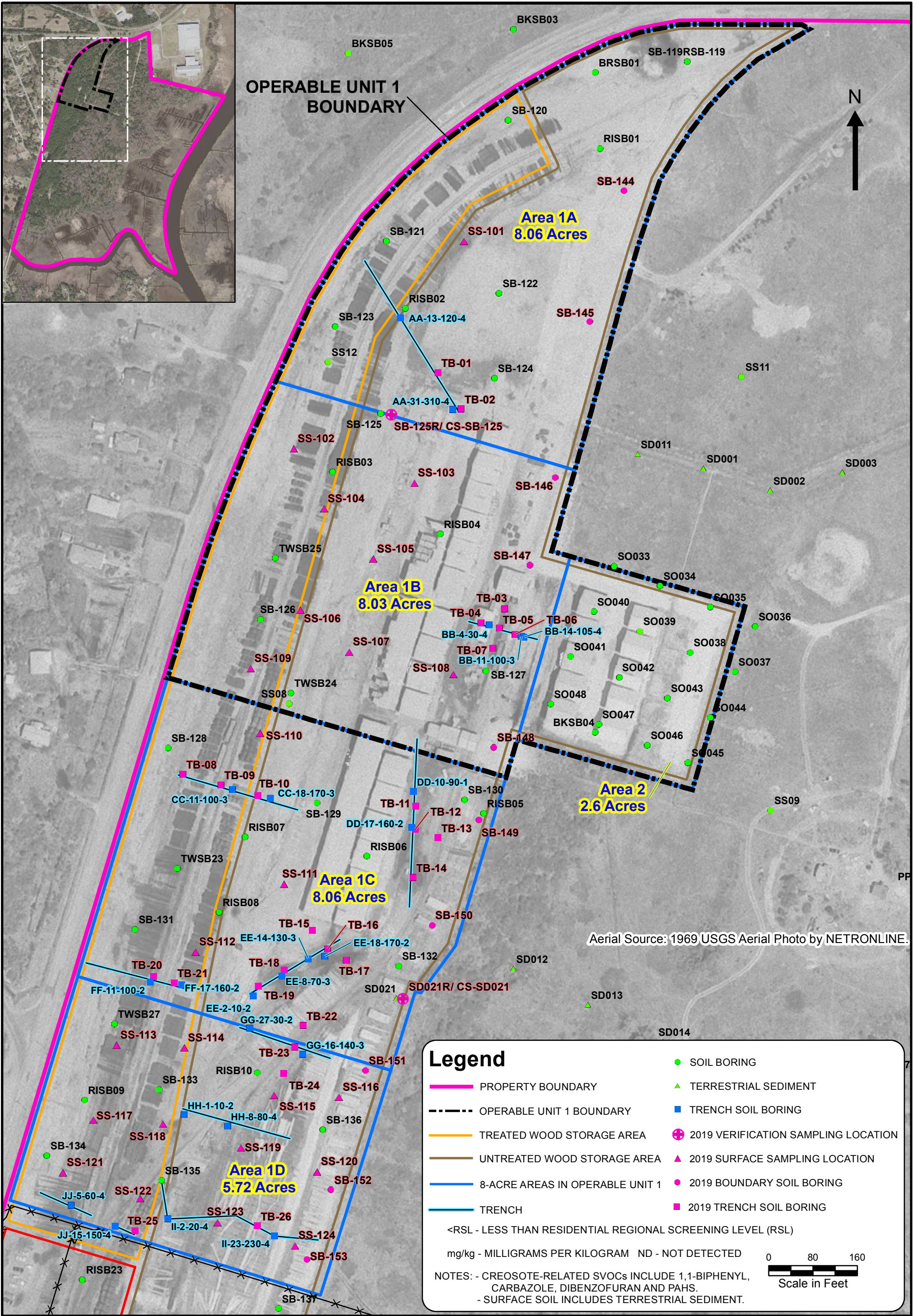
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

DRAWN	HVP	CHECKED	CDN	DATE	AUG 2018	FIGURE	1-2
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S:\Premier\Projects\Greenfield Environmental Multistate Trust\KMCC Navassa NC Superfund Site\CAD GIS Data\EARTHCON_GIS Data\EARTHCON_GIS Data\OU1\Fig 5 Soil Sampling w Exposure Area - Proposed Plan OU1\Fig 5 Soil Sampling w Exposure Area - Proposed Plan OU1.mxd 7/19/2019 12:06:17 PM



OPERABLE UNIT 1 BOUNDARY



Greenfield Environmental Multistate Trust LLC
Trustee of the Multistate Environmental Response Trust

PREPARED BY:



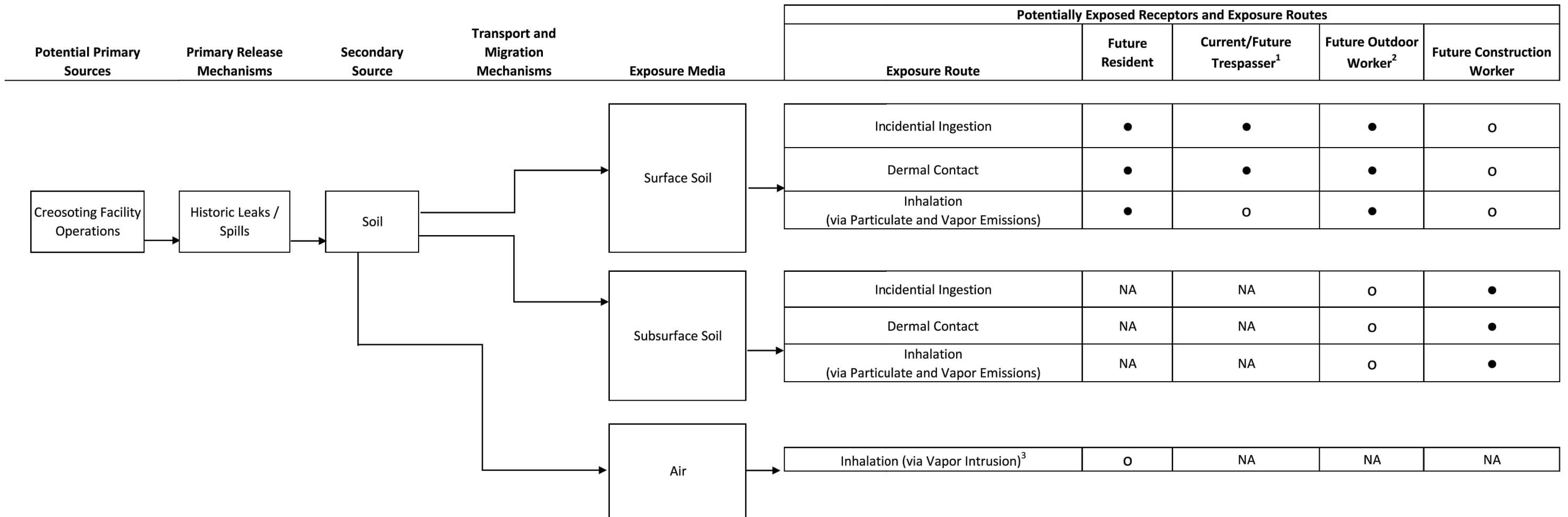
EARTHCON CONSULTANTS OF NORTH CAROLINA, P.C.

SOIL SAMPLING LOCATION MAP
Human Health Risk Assessment Addendum

Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

DRAWN	CHECKED	DATE	FIGURE
HVP	CDN	JULY 2019	1-3

TREATED AND UNTREATED WOOD STORAGE AREAS (Areas 1A, 1B, 1C, 1D and 2)



Notes:

- Complete exposure route. Pathway evaluated and quantified in the Human Health Risk Assessment (HHRA) Addendum.
- Exposure route complete, but insignificant. Pathway not evaluated or quantified in the HHRA Addendum.
- NA Not Applicable. Exposure pathway is considered incomplete.

¹Exposure to teenage trespassers via the inhalation pathway would be less than the resident and insignificant compared to other exposure routes evaluated for this receptor. Therefore, the inhalation pathway is considered insignificant.

²Exposures to subsurface soil for the outdoor worker is considered insignificant compared to other exposure pathways evaluated for this receptor.

³Given the technical difficulty in collecting representative soil gas samples at sites with shallow groundwater, an evaluation of soil gas migration to indoor air pathway was not conducted. Instead, the potential for vapor intrusion is assessed via the groundwater-to-indoor air pathway. See April 2019 HHRA (EarthCon, 2019) for further details.



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EARTHCON CONSULTANTS OF NORTH CAROLINA, P.C.

UPDATED HUMAN HEALTH CONCEPTUAL SITE EXPOSURE MODEL - TREATED AND UNTREATED WOOD STORAGE AREAS (AREAS 1A, 1B, 1C, 1D AND 2)
Human Health Risk Assessment Addendum
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

DRAWN: HVP	CHECKED: CDN	DATE: JULY 2019	FIGURE: 3-1
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APPENDICES

**APPENDIX A
EXPOSURE AND RISK CALCULATIONS**

APPENDIX A – Exposure and Risk Calculations

Tables

Table A-1	Daily Intake Calculations – Surface Soil via Ingestion
Table A-2	Daily Intake Calculations – Surface Soil via Dermal Contact
Table A-3	Daily Intake Calculations – Surface Soil via Inhalation
Table A-4	Daily Intake Calculations – Subsurface Soil via Ingestion
Table A-5	Daily Intake Calculations – Subsurface Soil via Dermal Contact
Table A-6	Daily Intake Calculations – Subsurface Soil via Inhalation
Table A-7	Daily Intake Calculations – Surface Soil via Ingestion - Mutagenic
Table A-8	Daily Intake Calculations – Surface Soil via Dermal Contact - Mutagenic
Table A-9	Daily Intake Calculations – Surface Soil via Inhalation - Mutagenic
Table A-10	Physical and Chemical Properties of Organic COPCs
Table A-11	Volatilization Factor Calculations for Organic COPCs
Table A-12	Particulate Emission Factor for Construction Worker
Table A-13	Particulate Emission Factor for Resident, Teenage Trespasser, Indoor Worker and Outdoor Worker
Table A-14	Volatilization from Soil to Ambient Air
Table A-15	Volatilization Factors

TABLE A-1
Daily Intake Calculations - Surface Soil via Ingestion
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

			Future Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
Parameter	Code	Units	Child	Adult				
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Ingestion Rate of Soil	SIR	mg/day	200	100	150	100	NA	NA
Conversion Factor	CF	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06	NA	NA
Fraction Ingested	FI _{ing}	unitless	1	1	1	1	NA	NA
Exposure Frequency	EF	days/year	350	350	45	225	NA	NA
Exposure Duration	ED	years	6	20	10	25	NA	NA
Body Weight	BW	kg	15	80	45	80	NA	NA
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550	25,550	NA	NA
Averaging Time (Non-Cancer)	AT-NC	days	2,190	7,300	3,650	9,125	NA	NA
Total excluding CS	C		1.10E-06	3.42E-07	5.87E-08	2.75E-07	NA	NA
	NC		1.28E-05	1.20E-06	4.11E-07	7.71E-07	NA	NA

NA - Not Applicable

Calculated Daily Intake

$$CDI \left(\frac{mg}{kg \cdot day} \right) = \frac{CS \left(\frac{mg}{kg} \right) \times SIR \left(\frac{mg}{day} \right) \times CF \left(\frac{kg}{mg} \right) \times FI_{ing} (unitless) \times EF \left(\frac{days}{year} \right) \times ED (years)}{BW (kg) \times AT (days)}$$

Notes: As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018

TABLE A-2
Daily Intake Calculations - Surface Soil via Dermal Contact
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Parameter	Code	Units	Future Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
			Child	Adult				
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion Factor	CF	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06	NA	NA
Fraction Dermally Contacted	FC	unitless	1	1	1	1	NA	NA
Surface Area Available for Contact	SA	cm ²	2,373	6,032	4,203	3,527	NA	NA
Soil to Skin Adherence Factor	AF	mg/cm ² -event	0.2	0.07	0.135	0.12	NA	NA
Dermal Absorption Fraction	ABS _d	Dimensionless	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Exposure Frequency	EF	days/year	350	350	45	225	NA	NA
Exposure Duration	ED	years	6	20	10	25	NA	NA
Event Frequency	EV	events/day	1	1	1	1	NA	NA
Body Weight	BW	kg	15	80	45	80	NA	NA
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550	25,550	NA	NA
Averaging Time (Non-Cancer)	AT-NC	days	2,190	7,300	3,650	9,125	NA	NA
Total excluding CS and ABS	C		2.60E-06	1.45E-06	2.22E-07	1.16E-06	NA	NA
	NC		3.03E-05	5.06E-06	1.55E-06	3.26E-06	NA	NA

NA - Not Applicable

Dermal Absorbed Dose

$$DAD \left(\frac{mg}{kg \cdot day} \right) = \frac{DA_{event} \left(\frac{mg}{cm^2 \cdot event} \right) \times FC (unitless) \times EF \left(\frac{days}{year} \right) \times ED (years) \times EV \left(\frac{events}{day} \right) \times SA (cm^2)}{BW (kg) \times AT (days)}$$

Where $DA_{event} = CS \left(\frac{mg}{kg} \right) \times CF \left(\frac{kg}{mg} \right) \times AF \left(\frac{mg}{cm^2 \cdot event} \right) \times ABS$

Chemical	ABS _d
Arsenic	0.03
Benzo(a)pyrene and other Polynuclear Aromatic Hydrocarbons	0.13
Pentachlorophenol	0.25
Semi-Volatile Organic Compounds	0.1

- Notes: (1) Per USEPA RAGS Part E, ABS_d values are provided in Exhibit 3-4. Dermal exposure to other compounds that are not listed in Exhibit 3-4 are excluded from the dermal evaluation.
(2) As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018
USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, 2004

TABLE A-3
 Daily Intake Calculations - Surface Soil via Inhalation
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

			Future Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
Parameter	Code	Units	Child	Adult				
Chemical Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Chemical Concentration in Air	CA	mg/m ³	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
Fraction Inhaled	FI _{inh}	unitless	1	1	1	1	NA	NA
Exposure Time	ET	hrs/day	24	24	2	8	NA	NA
Exposure Frequency	EF	days/year	350	350	45	225	NA	NA
Exposure Duration	ED	years	6	20	10	25	NA	NA
Volatilization Factor	VF	m ³ /kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Particulate Emission Factor	PEF	m ³ /kg	6.28E+08	6.28E+08	6.28E+08	6.28E+08	6.28E+08	4.58E+06
Averaging Time (Cancer)	AT-C	hrs	613,200	613,200	613,200	613,200	NA	NA
Averaging Time (Non-Cancer)	AT-NC	hrs	52,560	175,200	87,600	219,000	NA	NA
Total excluding CA	C		8.22E-02	2.74E-01	1.47E-03	7.34E-02	NA	NA
	NC		9.59E-01	9.59E-01	1.03E-02	2.05E-01	NA	NA

NA - Not Applicable

Exposure Concentration

$$EC \left(\frac{mg}{m^3} \right) = CA \left(\frac{mg}{m^3} \right) \times FI_{inh} (unitless) \times ET \left(\frac{hours}{day} \right) \times EF \left(\frac{days}{year} \right) \times ED (years) \times \frac{1}{AT (hours)}$$

Where

$$CA \left(\frac{mg}{m^3} \right) = \frac{CS \left(\frac{mg}{kg} \right)}{VF \text{ or } PEF \left(\frac{m^3}{kg} \right)}$$

Notes: (1) Supporting information for the derivation of the scenario-specific PEFs is provided in Table A-12 for the construction worker and Table A-13 for other receptors shown.

(2) As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
 USEPA, *Regional Screening Levels (RSLs) - User's Guide*, April 2019
 USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018
 USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*, 2009

TABLE A-4
 Daily Intake Calculations - Subsurface Soil via Ingestion
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

			Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
Parameter	Code	Units	Child	Adult				
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Ingestion Rate of Soil	SIR	mg/day	NA	NA	NA	NA	NA	330
Conversion Factor	CF	kg/mg	NA	NA	NA	NA	NA	1.00E-06
Fraction Ingested	FI _{ing}	unitless	NA	NA	NA	NA	NA	1.0
Exposure Frequency	EF	days/year	NA	NA	NA	NA	NA	130
Exposure Duration	ED	years	NA	NA	NA	NA	NA	1
Body Weight	BW	kg	NA	NA	NA	NA	NA	80
Averaging Time (Cancer)	AT-C	days	NA	NA	NA	NA	NA	25,550
Averaging Time (Non-Cancer)	AT-NC	days	NA	NA	NA	NA	NA	365
Total excluding CS	C		NA	NA	NA	NA	NA	2.10E-08
	NC		NA	NA	NA	NA	NA	1.47E-06

NA - Not Applicable

Calculated Daily Intake

$$CDI \left(\frac{mg}{kg \cdot day} \right) = \frac{CS \left(\frac{mg}{kg} \right) \times SIR \left(\frac{mg}{day} \right) \times CF \left(\frac{kg}{mg} \right) \times FI_{ing} (unitless) \times EF \left(\frac{days}{year} \right) \times ED (years)}{BW (kg) \times AT (days)}$$

Note: As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
 USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
 USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018

TABLE A-5
Daily Intake Calculations - Subsurface Soil via Dermal Contact
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

			Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
Parameter	Code	Units	Child	Adult				
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion Factor	CF	kg/mg	NA	NA	NA	NA	NA	1.00E-06
Fraction Dermal Contacted	FC	unitless	NA	NA	NA	NA	NA	1
Surface Area Available for Contact	SA	cm ²	NA	NA	NA	NA	NA	3,527
Soil to Skin Adherence Factor	AF	mg/cm ² -event	NA	NA	NA	NA	NA	0.3
Dermal Absorption Fraction	ABS _d	Dimensionless	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Exposure Frequency	EF	days/year	NA	NA	NA	NA	NA	130
Exposure Duration	ED	years	NA	NA	NA	NA	NA	1
Event Frequency	EV	events/day	NA	NA	NA	NA	NA	1
Body Weight	BW	kg	NA	NA	NA	NA	NA	80
Averaging Time (Cancer)	AT-C	days	NA	NA	NA	NA	NA	25,550
Averaging Time (Non-Cancer)	AT-NC	days	NA	NA	NA	NA	NA	365
Total excluding CS and ABS	C	NA	NA	NA	NA	NA	NA	6.73E-08
	NC	NA	NA	NA	NA	NA	NA	4.71E-06

NA - Not Applicable

Dermal Absorbed Dose

$$DAD \left(\frac{mg}{kg - day} \right) = \frac{DA_{event} \left(\frac{mg}{cm^2 - event} \right) \times FC (unitless) \times EF \left(\frac{days}{year} \right) \times ED (years) \times EV \left(\frac{events}{day} \right) \times SA (cm^2)}{BW (kg) \times AT (days)}$$

Where $DA_{event} = CS \left(\frac{mg}{kg} \right) \times CF \left(\frac{kg}{mg} \right) \times AF \left(\frac{mg}{cm^2 - event} \right) \times ABS$

Chemical	ABS _d
Arsenic	0.03
Benzo(a)pyrene and other Polynuclear Aromatic Hydrocarbons	0.13
Pentachlorophenol	0.25
Semi-Volatile Organic Compounds	0.1

Notes: (1) Per USEPA RAGS Part E, ABS_d values are provided in Exhibit 3-4. Dermal exposure to other compounds that are not listed in Exhibit 3-4 are excluded from the dermal evaluation.

(2) As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018
USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, 2004

TABLE A-6

Daily Intake Calculations - Subsurface Soil via Inhalation
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Parameter	Code	Units	Resident		Current and Future Teenage Trespasser	Future Outdoor Worker	Future Indoor Worker	Future Construction Worker
			Child	Adult				
Chemical Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Chemical Concentration in Air	CA	mg/m ³	NA	NA	NA	NA	NA	Calculated
Fraction Inhaled	FI _{inh}	unitless	NA	NA	NA	NA	NA	1
Exposure Time	ET	hrs/day	NA	NA	NA	NA	NA	8
Exposure Frequency	EF	days/year	NA	NA	NA	NA	NA	130
Exposure Duration	ED	years	NA	NA	NA	NA	NA	1
Volatilization Factor	VF	m ³ /kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Particulate Emission Factor	PEF	m ³ /kg	NA	NA	NA	NA	NA	4.58E+06
Averaging Time (Cancer)	AT-C	hrs	NA	NA	NA	NA	NA	613,200
Averaging Time (Non-Cancer)	AT-NC	hrs	NA	NA	NA	NA	NA	8,760
Total excluding CA		C	NA	NA	NA	NA	NA	1.70E-03
		NC	NA	NA	NA	NA	NA	1.19E-01

NA - Not Applicable

Exposure Concentration

$$EC \left(\frac{mg}{m^3} \right) = CA \left(\frac{mg}{m^3} \right) \times FI_{inh} (unitless) \times ET \left(\frac{hours}{day} \right) \times EF \left(\frac{days}{year} \right) \times ED (years) \times \frac{1}{AT (hours)}$$

Where

$$CA \left(\frac{mg}{m^3} \right) = \frac{CS \left(\frac{mg}{kg} \right)}{VF \text{ or } PEF \left(\frac{m^3}{kg} \right)}$$

Notes: (1) Supporting information for the derivation of the scenario-specific PEF for the future on-site construction worker is provided in Table A-12.

(2) As directed by NC DEQ and USEPA Region 4, construction workers were evaluated for exposure to subsurface soil only.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014

USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)

USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018

USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*, 2009

TABLE A-7
Daily Intake Calculations - Surface Soil via Ingestion Mutagenic
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

			Mutagenic Resident			
Parameter	Code	Units	Age 0-2	Age 2-6	Age 6-16	Age 16-26
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Ingestion Rate of Soil	SIR _{mut}	mg/day	200	200	150	100
Conversion Factor	CF	kg/mg	1.00E-06			
Fraction Ingested	FI _{ing}	unitless	1			
Exposure Frequency	EF	days/year	350			
Exposure Duration	ED	years	2	4	10	10
Body Weight	BW	kg	15	15	45	80
Averaging Time (Cancer)	AT-C	days	25,550			
Age-Dependent Adjustment Factor	ADAF	unitless	10	3	3	1
Total excluding CS			7.39E-06			

Mutagenic Resident Ingestion Factor

$$SIR_{mut} = \frac{ED_{0-2} \text{ (years)} \times SIR_{0-2} \left(\frac{mg}{day}\right) \times ADAF_{0-2}}{BW_{0-2} \text{ (kg)}} + \frac{ED_{2-6} \text{ (years)} \times SIR_{2-6} \left(\frac{mg}{day}\right) \times ADAF_{2-6}}{BW_{2-6} \text{ (kg)}} +$$

$$\frac{ED_{6-16} \text{ (years)} \times SIR_{6-16} \left(\frac{mg}{day}\right) \times ADAF_{6-16}}{BW_{6-16} \text{ (kg)}} + \frac{ED_{16-26} \text{ (years)} \times SIR_{16-26} \left(\frac{mg}{day}\right) \times ADAF_{16-26}}{BW_{16-26} \text{ (kg)}}$$

Mutagenic Resident Calculated Daily Intake

$$CDI \left(\frac{mg}{kg \cdot day}\right) = \frac{CS \left(\frac{mg}{kg}\right) \times SIR_{mu} \left(\frac{mg}{kg \cdot day}\right) \times CF \left(\frac{kg}{mg}\right) \times FI \times EF \left(\frac{days}{year}\right)}{AT \text{ (days)}}$$

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018

TABLE A-8

Daily Intake Calculations - Surface Soil via Dermal Contact Mutagenic
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

			Mutagenic Resident			
Parameter	Code	Units	Age 0-2	Age 2-6	Age 6-16	Age 16-26
Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion Factor	CF	kg/mg	1.00E-06			
Fraction Dermally Contacted	FC	unitless	1			
Surface Area Available for Contact	SA	cm ²	2,373	2,373	4,203	6,032
Soil to Skin Adherence Factor	AF	mg/cm ²	0.2	0.2	0.135	0.07
Fraction of Contaminant Absorbed in Gastrointestinal tract	ABS _{GI}	Dimensionless	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Exposure Frequency	EF	days/yr	350			
Exposure Duration	ED	years	2	4	10	10
Event Frequency	EV	events/day	1			
Body Weight	BW	kg	15	15	45	80
Averaging Time (Cancer)	AT-C	days	25,550			
Age-Dependent Adjustment Factor	ADAF	unitless	10	3	3	1
Total excluding CS and ABS			1.98E-05			

Mutagenic Resident Dermal Factor

$$DF_{mut} = \frac{ED_{0-2} (years) \times SA_{0-2} (cm^2) \times AF_{0-2} \left(\frac{mg}{cm^2}\right) \times ADAF_{0-2}}{BW_{0-2} (kg)} + \frac{ED_{2-6} (years) \times SA_{2-6} (cm^2) \times AF_{2-6} \left(\frac{mg}{cm^2}\right) \times ADAF_{2-6}}{BW_{2-6} (kg)} + \frac{ED_{6-16} (years) \times SA_{6-16} (cm^2) \times AF_{6-16} \left(\frac{mg}{cm^2}\right) \times ADAF_{6-16}}{BW_{6-16} (kg)} + \frac{ED_{16-26} (years) \times SA_{16-26} (cm^2) \times AF_{16-26} \left(\frac{mg}{cm^2}\right) \times ADAF_{16-26}}{BW_{16-26} (kg)}$$

Mutagenic Resident Dermal Absorbed Dose

$$DAD \left(\frac{mg}{kg \cdot day}\right) = \frac{DF_{mut} \times EF \left(\frac{days}{year}\right) \times EV \left(\frac{events}{day}\right) \times CS \left(\frac{mg}{kg}\right) \times CF \left(\frac{kg}{mg}\right) \times ABS}{AT (days)}$$

Where

$$DA_{event} = CS \left(\frac{mg}{kg}\right) \times CF \left(\frac{kg}{mg}\right) \times AF \left(\frac{mg}{cm^2 \cdot event}\right) \times ABS$$

Constituent	ABS _d
Arsenic	0.03
Polynuclear Aromatic Hydrocarbons	0.13
Pentachlorophenol	0.25
Semi-Volatile Organic Compounds	0.1

Note: Per USEPA RAGS Part E, ABS_d values are provided in Exhibit 3-4. Dermal exposure to other compounds that are not listed in Exhibit 3-4 are excluded from the dermal evaluation.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014
 USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)
 USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018
 USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, 2004

TABLE A-9
Daily Intake Calculations - Surface Soil via Inhalation Mutagenic
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

			Mutagenic Resident			
Parameter	Code	Units	Age 0-2	Age 2-6	Age 6-16	Age 16-26
Chemical Concentration in Soil	CS	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Chemical Concentration in Air	CA	mg/m ³	Calculated	Calculated	Calculated	Calculated
Fraction Inhaled	FI _{inh}	unitless	1			
Exposure Time	ET	hrs/day	24			
Exposure Frequency	EF	days/year	350			
Exposure Duration	ED	years	2	4	10	10
Volatilization Factor	VF	m ³ /kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Particulate Emission Factor	PEF	m ³ /kg	6.28E+08	6.28E+08	6.28E+08	6.28E+08
Averaging Time (Cancer)	AT-C	hrs	613,200			
Age-Dependent Adjustment Factor	ADAF	unitless	10	3	3	1
Total excluding CA			9.86E-01			

Mutagenic Resident Exposure Concentration

$$EC \left(\frac{mg}{m^3} \right) = CA \left(\frac{mg}{m^3} \right) \times ET \left(\frac{hours}{day} \right) \times EF \left(\frac{days}{year} \right) \times (ED_{0-2}(years) \times ADAF_{0-2} + ED_{2-6}(years) \times ADAF_{2-6} + ED_{6-16}(years) \times ADAF_{6-16} + ED_{16-26}(years) \times ADAF_{16-26}) \times \frac{1}{AT (hours)}$$

Exposure Concentration

$$EC \left(\frac{mg}{m^3} \right) = CA \left(\frac{mg}{m^3} \right) \times ET \left(\frac{hours}{day} \right) \times EF \left(\frac{days}{year} \right) \times ED(years) \times \frac{1}{AT (hours)}$$

Where

$$CA \left(\frac{mg}{m^3} \right) = \frac{CS \left(\frac{mg}{kg} \right)}{VF \text{ or } PEF \left(\frac{m^3}{kg} \right)}$$

Note: Supporting information for the derivation of the scenario-specific PEF is provided in Table A-13.

References: USEPA, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, 2014

USEPA, *Regional Screening Levels (RSLs) - User's Guide* (April 2019)

USEPA Region 4, *Human Health Risk Assessment Supplemental Guidance*, 2018

USEPA, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*, 2009

TABLE A-10
 Physical and Chemical Properties for Organic COPCs
 Kerr-McK Gee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Organic COPC	CAS No.	MW (g/mol)	S (mg/L @ 25 °C)	VP (mmHg @ 25 °C)	H' (unitless)	K _{oc} (L/kg)	log K _{ow} (L/kg)	D _i (cm ² /sec)	D _w (cm ² /sec)
SVOCs/PAHs									
Benzo(a)anthracene	56-55-3	228	9.4E-03	2.1E-07	4.9E-04	1.8E+05	5.8E+00	2.6E-02	6.7E-06
Benzo(a)pyrene	50-32-8	252	1.6E-03	5.5E-09	1.9E-05	5.9E+05	6.1E+00	4.8E-02	5.6E-06
Benzo(b)fluoranthene	205-99-2	252	1.5E-03	5.0E-07	2.7E-05	6.0E+05	5.8E+00	4.8E-02	5.6E-06
Benzo(k)fluoranthene	207-08-9	252	8.0E-04	9.7E-10	2.4E-05	5.9E+05	6.1E+00	4.8E-02	5.6E-06
Chrysene	218-01-9	228	2.0E-03	6.2E-09	2.1E-04	1.8E+05	5.8E+00	2.6E-02	6.8E-06
Dibenzo(a,h)anthracene	53-70-3	278	2.5E-03	9.6E-10	5.8E-06	1.9E+06	6.8E+00	4.5E-02	5.2E-06
Dibenzofuran	132-64-9	168	3.1E+00	2.5E-03	8.7E-03	9.2E+03	4.1E+00	6.5E-02	7.4E-06
Fluoranthene	206-44-0	202	2.6E-01	9.2E-06	3.6E-04	5.5E+04	5.2E+00	2.8E-02	7.2E-06
Indeno[1,2,3-cd]pyrene	193-39-5	276	1.9E-04	1.3E-10	1.4E-05	2.0E+06	6.7E+00	4.5E-02	5.2E-06
Naphthalene	91-20-3	128	3.1E+01	8.5E-02	1.8E-02	1.5E+03	3.3E+00	6.0E-02	8.4E-06
Pentachlorophenol	87-86-5	266	1.4E+01	1.1E-04	1.0E-06	5.9E+02	5.1E+00	3.0E-02	8.0E-06
Phenanthrene	85-01-8	178	1.2E+00	1.2E-04	1.7E-03	1.7E+04	4.5E+00	3.4E-02	6.7E-06
Pyrene	129-00-0	202	1.4E-01	4.5E-06	4.9E-04	5.4E+04	4.9E+00	2.8E-02	7.2E-06

NOTES: Data obtained from Regional Screening Level (RSL) Chemical-Specific Parameters Supporting Table April 2019

MW = molecular weight

S = water solubility

VP = vapor pressure

COPC - Chemical of Potential Concern

SVOCs - Semi-Volatile Organic Compounds

PAHs - Polycyclic Aromatic Hydrocarbons

H' = unitless Henry's Law constant

K_{oc} = organic carbon partition coefficient

K_{ow} = octanol-water partition coefficient

D_i = diffusivity constant in air

D_w = diffusivity constant in water

TABLE A-11
 Volatilization Factor Calculations for Organic COPCs
 Kerr-McKGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Organic COPC	foc (g/g)	S (mg/L @ 25 °C)	App. Diffusivity (cm ² /sec)	H' (unitless)	K _{oc} (L/kg)	K _D (L/kg)	D _i (cm ² /sec)	D _w (cm ² /sec)
SVOCs/PAHs								
Benzo(a)anthracene	0.006	9.4E-03	3.4E-10	4.9E-04	1.8E+05	1.1E+03	2.6E-02	6.7E-06
Dibenzofuran	0.006	3.1E+00	2.9E-07	8.7E-03	9.2E+03	5.5E+01	6.5E-02	7.4E-06
Naphthalene	0.006	3.1E+01	3.3E-06	1.8E-02	1.5E+03	9.3E+00	6.0E-02	8.4E-06
Phenanthrene	0.006	1.2E+00	1.7E-08	1.7E-03	1.7E+04	1.0E+02	3.4E-02	6.7E-06
Pyrene	0.006	1.4E-01	7.3E-11	4.9E-04	5.4E+04	3.3E+02	2.8E-02	7.2E-06

NOTES: Data obtained from Regional Screening Level (RSL) Chemical-Specific Parameters Supporting Table, April 2019

foc = fraction of organic carbon

H' = unitless Henry's Law constant

D_i = diffusivity constant in air

S = water solubility

K_{oc} = organic carbon partition coefficient

D_w = diffusivity constant in water

App. Diffusivity = apparent diffusivity

K_D = soil-water partition coefficient

COPC - Chemical of Potential Concern

SVOCs - Semi-Volatile Organic Compounds

PAHs - Polycyclic Aromatic Hydrocarbons

TABLE A-12
 Particulate Emission Factor for Construction Worker
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Parameter		Value	Source / Comment
A	Constant	12.3675 (unitless)	Default value (USEPA, 2002).
A _R	Surface area of contaminated road segment	274.213 m ²	USEPA, 2002.
A _{site}	Aerial extent of site surface soil contamination	10 acres	Default value (USEPA, 2002).
B	Constant	18.6337 (unitless)	Default value (USEPA, 2002).
C	Constant	212.7284 (unitless)	Default value (USEPA, 2002).
F _D	Dispersion correction factor	0.185 (unitless)	Default value (USEPA, 2002).
p	Number of days with ≥ 0.01 inches of precipitation	110 days/year	Interpolated value.
PEF _{sc}	Subchronic particulate emission factor	4.58E+06 m ³ /kg	Calculated value.
Q/C _{sr}	Inverse of the ratio of the 1-hour geometric mean air concentration to the emission flux along a straight road segment bisecting a square site	g/m ² -sec 43.33 per kg/m ³	$A * \exp \left[\frac{(\ln A_{site} - B)^2}{C} \right]$
T	Total time (250 days/yr * 8hrs * 3600)	7.20E+06 sec	Calculated value for construction worker exposure (assumes 1 year).
ΣVKT	Sum of fleet vehicle kilometers traveled during the exposure	175.5 km	Default value (USEPA, 2002).
W	Mean vehicle weight	8 tons	Default value (USEPA, 2002).

$$PEF_{sc} (m^3 / kg) = Q / C_{sr} * \frac{1}{F_D} * \frac{T * A_R}{556 * \left(\frac{W}{3}\right)^{0.4} * \frac{365 - p}{365} * \sum VKT}$$

Reference: USEPA, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24, 2002.

TABLE A-13

Particulate Emission Factor for Resident, Teenage Trespasser, Indoor Worker and Outdoor Worker
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Parameter		Value	Source / Comment
A	Constant	12.3675 (unitless)	Region-specific value for SE USA (USEPA, 2002).
A _{site}	Aerial extent of site surface soil contamination	10 acres	Default value (USEPA, 2002).
B	Constant	18.6337 (unitless)	Region-specific value for SE USA (USEPA, 2002).
C	Constant	212.7284 (unitless)	Region-specific value for SE USA (USEPA, 2002).
CF	Units conversion factor	3,600 sec/hour	--
F(x)	Function dependent on U _m /U _t	0.194 (unitless)	Default value (USEPA, 2002).
PEF	Particulate emission factor	6.28E+08 m ³ /kg	Calculated region-specific value.
Q/C _{wind}	Inverse of the ratio of the geometric mean air concentration to the emission flux at the center of a square site	g/m ² -sec 43.33 per kg/m ³	$A * \exp\left[\frac{(\ln A_{site} - B)^2}{C}\right]$
U _m	Mean annual windspeed	4.69 m/s	Default value (USEPA, 2002).
U _t	Equivalent threshold value of windspeed at 7m	11.32 m/s	Default value (USEPA, 2002).
V	Fraction of vegetative cover	0.5 (unitless)	Default value (USEPA, 2002).

$$PEF(m^3 / kg) = Q / C_{wind} * \frac{CF}{0.036 * (1 - V) * \left(\frac{U_m}{U_t}\right)^3 * F(x)}$$

Reference: USEPA, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24, 2002.

TABLE A-14
 Volatilization from Soil to Ambient Air
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

Parameter		Value	Source / Comment
CF	Units conversion factor	0.0001 m ² /cm ²	--
D _A	Apparent diffusivity	-- cm ² /sec	$\frac{(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)}{\rho_b K_d + \theta_w + \theta_a H'} \cdot n^2$
Q/C	Inverse of the mean concentration at the center of a 0.5-acre-square.	68.18 g/m ² -sec per kg/m ³	Default value from Equation 4-8.
T	Exposure interval	7.86E+08 sec	Value for residential exposure (assumes 24 hr/d, 350 days/yr for 26 years)
		7.20E+06 sec	Value for construction worker exposure (assumes 8 hr/d, 250 days/year for 1 year)
VF	Volatilization factor	-- m ³ /kg	Chemical- and receptor-specific values
D _i	Diffusivity in air	-- cm ² /sec	Chemical-specific values.
D _w	Diffusivity in water	-- cm ² /sec	Chemical-specific values.
f _{oc}	Fraction organic carbon in soil	0.006 g/g	Default value from Equation 4-8.
H'	Henry's Law Constant	-- (unitless)	Chemical-specific values.
K _d	Soil-water partition coefficient	-- cm ³ /g	Chemical-specific values; K _{oc} * f _{oc}
K _{oc}	Soil-organic carbon partition coefficient	-- cm ³ /g	Chemical-specific values.
π	pi	3.14 (unitless)	--
ρ _b	Soil bulk density	1.5 g/cm ³	Default value from Equation 4-8.
θ _a	Air-filled soil porosity	0.21 L _{air} /L _{soil}	n - θ _w
n	Total soil porosity	0.36 L _{pore} /L _{soil}	Average from Table 3-1 of the RI Report.
θ _w	Water-filled soil porosity	0.15 L _{water} /L _{soil}	Default value from Equation 4-8.

$$VF (m^3 / kg) = Q / C * \frac{(\pi * D_A * T)^{1/2}}{(2 * \rho_b * D_A)} * CF$$

Reference: USEPA, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24, 2002.

TABLE A-15
 Volatilization Factors
 Kerr-McGee Chemical Corp - Navassa Superfund Site
 Navassa, North Carolina

		Resident/ Teenage Trespasser / Indoor and Outdoor Worker	Construction Worker
Organic COPC	App. Diffusivity (cm ² /sec)	Volatilization Factor (m ³ /kg)	Volatilization Factor (m ³ /kg)
<u>SVOCs/PAHs</u>			
Benzo(a)anthracene	3.4E-10	6.1E+06	5.8E+05
Dibenzofuran	2.9E-07	2.1E+05	2.0E+04
Naphthalene	3.3E-06	6.2E+04	6.0E+03
Phenanthrene	1.7E-08	8.7E+05	8.3E+04
Pyrene	7.3E-11	1.3E+07	1.3E+06

**APPENDIX B
STATISTICAL RESULTS**

APPENDIX B – Statistical Results

Tables

Table B-1 Surface Soil (0 – 1 foot) Exposure Point Concentrations

Table B-2 Subsurface Soil Exposure Point Concentrations

Table B-1
Surface Soil (0-1 foot) Exposure Point Concentrations
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Exposure Point		Chemical of Potential Concern (COPC)	Screening Toxicity Value ⁽¹⁾ (mg/kg)	# of Detections	# of Samples	% of NDs	Arithmetic Mean (mg/kg)	Maximum Concentration (mg/kg)	95% Upper Confidence Level (UCL) (mg/kg)	Background Level (2x Mean) (mg/kg)	Exposure Point Concentration	
Area	Medium										Value (mg/kg)	Statistical Test
1A	Surface Soils	Benzo(a)anthracene	1.1	15	16	6%	1.03	5.98	2.830	0.01375	2.830	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	14	16	13%	0.96	6.06	2.612	0.01591	2.612	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	15	16	6%	2.15	15.6	6.005	0.02270	6.005	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	11	16	31%	0.16	0.85	0.381	0.00821	0.381	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	14	16	13%	0.78	5.28	2.042	0.01473	2.042	95% Gamma Adjusted KM-UCL
1B	Surface Soils	Benzo(a)anthracene	1.1	26	26	0%	2.81	13.9	4.646	0.01375	4.646	95% Adjusted Gamma UCL
		Benzo(a)pyrene	0.11	26	26	0%	2.54	11.1	4.131	0.01591	4.131	95% Adjusted Gamma UCL
		Benzo(b)fluoranthene	1.1	26	26	0%	6.40	24.2	10.34	0.02270	10.34	95% Adjusted Gamma UCL
		Dibenzo(a,h)anthracene	0.11	22	26	15%	0.42	2.05	0.676	0.00821	0.676	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	26	26	0%	2.19	7.79	3.498	0.01473	3.498	95% Adjusted Gamma UCL
		Pentachlorophenol	1.0	1	24	96%	0.47	4.09	--	NA	0.474	Arithmetic Mean
1C	Surface Soils	Benzo(a)anthracene	1.1	32	33	3%	6.80	135	24.62	0.01375	24.62	95% KM Chebyshev UCL
		Benzo(a)pyrene	0.11	32	33	3%	4.38	65.7	13.18	0.01591	13.18	95% KM Chebyshev UCL
		Benzo(b)fluoranthene	1.1	32	33	3%	11.29	148	31.59	0.02270	31.59	95% KM Chebyshev UCL
		Benzo(k)fluoranthene	11	32	33	3%	3.24	45.6	9.347	0.01085	9.347	95% KM Chebyshev UCL
		Chrysene	110	32	33	3%	9.09	173	31.90	0.01657	31.90	95% KM Chebyshev UCL
		Dibenzo(a,h)anthracene	0.11	22	33	33%	0.69	8.12	1.513	0.00821	1.513	95% Gamma Adjusted KM-UCL
		Dibenzofuran	7.3	11	33	67%	0.75	21.4	3.644	NA	3.644	95% KM Chebyshev UCL
		Fluoranthene	240	32	33	3%	29.24	761	129.8	0.04690	129.8	95% KM Chebyshev UCL
		Indeno(1,2,3-cd)pyrene	1.1	31	33	6%	3.41	44.9	9.536	0.01473	9.536	95% KM Chebyshev UCL
		Phenanthrene	180	25	29	14%	12.99	319	61.21	0.03898	61.21	95% KM Chebyshev UCL
		Pyrene	180	32	33	3%	27.46	607	107.9	0.04690	107.9	95% KM Chebyshev UCL
1D	Surface Soils	Benzo(a)anthracene	1.1	26	26	0%	3.19	13.4	5.366	0.01375	5.366	95% Adjusted Gamma UCL
		Benzo(a)pyrene	0.11	26	26	0%	2.46	7.9	3.933	0.01591	3.933	95% Adjusted Gamma UCL
		Benzo(b)fluoranthene	1.1	26	26	0%	5.84	22.8	9.364	0.02270	9.364	95% Adjusted Gamma UCL
		Dibenzo(a,h)anthracene	0.11	21	26	19%	0.46	1.39	0.682	0.00821	0.682	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	26	26	0%	1.95	6.43	3.078	0.01473	3.078	95% Adjusted Gamma UCL
2	Surface Soils	Benzo(a)anthracene	1.1	17	18	6%	0.19	1.19	0.552	0.01375	0.552	95% KM Chebyshev UCL
		Benzo(a)pyrene	0.11	18	18	0%	0.20	1.03	0.562	0.01591	0.562	95% Chebyshev (Mean, Sd) UCL
		Benzo(b)fluoranthene	1.1	18	18	0%	0.62	3.51	1.720	0.02270	1.720	95% Chebyshev (Mean, Sd) UCL
		Dibenzo(a,h)anthracene	0.11	10	18	44%	0.03	0.23	0.099	0.00821	0.099	95% Gamma Adjusted KM-UCL

Notes

Surface soil samples collected 0-1 foot below ground surface (bgs)

(1) -Resident Soil RSL THQ=0.1 from RSL Tables, April 2019

RSL - Risk Screening Level

THQ - Total Hazard Quotient

ND - Not detected above the method detection limit

NA - Not Applicable

mg/kg - milligrams per kilogram

Duplicates were not included as individual samples. Instead, the average concentration was used.

Method Detection Limit (MDL) was used for non-detects.

According to the ProUCL User Guide (USEPA, 2015), for data sets with low detection frequencies, use of the median or mode represent better estimates (with lesser uncertainty) of the mean. To be conservative, the arithmetic mean is used as the exposure point concentration when the the detection frequency was low (e.g., ≤ 10% or less than 4 detections).

Prepared By: RAH 7/3/2019

Reviewed By: SMA 7/3/2019

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 1:37:12 PM									
5	From File		OU1 1A Surface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			16			Number of Distinct Observations			15		
14	Number of Detects			15			Number of Non-Detects			1		
15	Number of Distinct Detects			14			Number of Distinct Non-Detects			1		
16	Minimum Detect			31.8			Minimum Non-Detect			19		
17	Maximum Detect			5980			Maximum Non-Detect			19		
18	Variance Detects			3349455			Percent Non-Detects			6.25%		
19	Mean Detects			1101			SD Detects			1830		
20	Median Detects			370			CV Detects			1.663		
21	Skewness Detects			2.266			Kurtosis Detects			4.111		
22	Mean of Logged Detects			6			SD of Logged Detects			1.462		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.591			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.881			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.337			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.22			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			1033			KM Standard Error of Mean			448.2		
33	KM SD			1732			95% KM (BCA) UCL			1800		
34	95% KM (t) UCL			1819			95% KM (Percentile Bootstrap) UCL			1807		
35	95% KM (z) UCL			1770			95% KM Bootstrap t UCL			4174		
36	90% KM Chebyshev UCL			2377			95% KM Chebyshev UCL			2986		
37	97.5% KM Chebyshev UCL			3832			99% KM Chebyshev UCL			5492		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.861			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.785			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.22			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.232			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.614			k star (bias corrected MLE)			0.535		
48	Theta hat (MLE)			1794			Theta star (bias corrected MLE)			2056		
49	nu hat (MLE)			18.41			nu star (bias corrected)			16.06		
50	Mean (detects)			1101								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	1032						
59		Maximum	5980		Median	347.5						
60		SD	1789		CV	1.734						
61		k hat (MLE)	0.409		k star (bias corrected MLE)	0.374						
62		Theta hat (MLE)	2521		Theta star (bias corrected MLE)	2757						
63		nu hat (MLE)	13.1		nu star (bias corrected)	11.97						
64		Adjusted Level of Significance (β)	0.0335									
65		Approximate Chi Square Value (11.97, α)	5.209		Adjusted Chi Square Value (11.97, β)	4.71						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2371		95% Gamma Adjusted UCL (use when $n < 50$)	2623						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	1033		SD (KM)	1732						
70		Variance (KM)	2999311		SE of Mean (KM)	448.2						
71		k hat (KM)	0.356		k star (KM)	0.331						
72		nu hat (KM)	11.38		nu star (KM)	10.58						
73		theta hat (KM)	2904		theta star (KM)	3123						
74		80% gamma percentile (KM)	1619		90% gamma percentile (KM)	3008						
75		95% gamma percentile (KM)	4577		99% gamma percentile (KM)	8609						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (10.58, α)	4.309		Adjusted Chi Square Value (10.58, β)	3.863						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2537		95% Gamma Adjusted KM-UCL (use when $n < 50$)	2830						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.962		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.881		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.124		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.22		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	1032		Mean in Log Scale	5.776						
90		SD in Original Scale	1789		SD in Log Scale	1.672						
91		95% t UCL (assumes normality of ROS data)	1816		95% Percentile Bootstrap UCL	1803						
92		95% BCA Bootstrap UCL	2052		95% Bootstrap t UCL	4231						
93		95% H-UCL (Log ROS)	6888									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.809		KM Geo Mean	333.2						
97		KM SD (logged)	1.555		95% Critical H Value (KM-Log)	3.643						
98		KM Standard Error of Mean (logged)	0.402		95% H-UCL (KM -Log)	4820						
99		KM SD (logged)	1.555		95% Critical H Value (KM-Log)	3.643						
100		KM Standard Error of Mean (logged)	0.402									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	1032		Mean in Log Scale	5.765						
105		SD in Original Scale	1789		SD in Log Scale	1.695						
106		95% t UCL (Assumes normality)	1816		95% H-Stat UCL	7399						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	2830										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 1:39:42 PM									
5	From File		OU1 1A Surface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			16		Number of Distinct Observations			16			
14	Number of Detects			14		Number of Non-Detects			2			
15	Number of Distinct Detects			14		Number of Distinct Non-Detects			2			
16	Minimum Detect			42.1		Minimum Non-Detect			22			
17	Maximum Detect			6060		Maximum Non-Detect			25			
18	Variance Detects			2993377		Percent Non-Detects			12.5%			
19	Mean Detects			1089		SD Detects			1730			
20	Median Detects			408		CV Detects			1.589			
21	Skewness Detects			2.422		Kurtosis Detects			5.419			
22	Mean of Logged Detects			6.161		SD of Logged Detects			1.296			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.604		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.874		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.343		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.226		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		955.2		KM Standard Error of Mean			414.8				
33	KM SD		1599		95% KM (BCA) UCL			1703				
34	95% KM (t) UCL		1682		95% KM (Percentile Bootstrap) UCL			1688				
35	95% KM (z) UCL		1638		95% KM Bootstrap t UCL			3890				
36	90% KM Chebyshev UCL		2200		95% KM Chebyshev UCL			2763				
37	97.5% KM Chebyshev UCL		3546		99% KM Chebyshev UCL			5083				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.838		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.773		Detected Data Not Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.212		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.238		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.723		k star (bias corrected MLE)			0.616				
48	Theta hat (MLE)		1505		Theta star (bias corrected MLE)			1767				
49	nu hat (MLE)		20.25		nu star (bias corrected)			17.25				
50	Mean (detects)		1089									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	952.4					
59		Maximum	6060			Median	343					
60		SD	1653			CV	1.736					
61		k hat (MLE)	0.332			k star (bias corrected MLE)	0.311					
62		Theta hat (MLE)	2870			Theta star (bias corrected MLE)	3059					
63		nu hat (MLE)	10.62			nu star (bias corrected)	9.962					
64		Adjusted Level of Significance (β)	0.0335									
65		Approximate Chi Square Value (9.96, α)	3.918			Adjusted Chi Square Value (9.96, β)	3.497					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2422			95% Gamma Adjusted UCL (use when $n < 50$)	2713					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	955.2			SD (KM)	1599					
70		Variance (KM)	2556526			SE of Mean (KM)	414.8					
71		k hat (KM)	0.357			k star (KM)	0.332					
72		nu hat (KM)	11.42			nu star (KM)	10.61					
73		theta hat (KM)	2676			theta star (KM)	2880					
74		80% gamma percentile (KM)	1498			90% gamma percentile (KM)	2780					
75		95% gamma percentile (KM)	4229			99% gamma percentile (KM)	7948					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (10.61, α)	4.328			Adjusted Chi Square Value (10.61, β)	3.881					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2342			95% Gamma Adjusted KM-UCL (use when $n < 50$)	2612					
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.966			Shapiro Wilk GOF Test						
83		5% Shapiro Wilk Critical Value	0.874			Detected Data appear Lognormal at 5% Significance Level						
84		Lilliefors Test Statistic	0.118			Lilliefors GOF Test						
85		5% Lilliefors Critical Value	0.226			Detected Data appear Lognormal at 5% Significance Level						
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	955.4			Mean in Log Scale	5.784					
90		SD in Original Scale	1651			SD in Log Scale	1.586					
91		95% t UCL (assumes normality of ROS data)	1679			95% Percentile Bootstrap UCL	1682					
92		95% BCA Bootstrap UCL	1947			95% Bootstrap t UCL	4056					
93		95% H-UCL (Log ROS)	5203									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.777			KM Geo Mean	322.8					
97		KM SD (logged)	1.548			95% Critical H Value (KM-Log)	3.63					
98		KM Standard Error of Mean (logged)	0.402			95% H-UCL (KM -Log)	4563					
99		KM SD (logged)	1.548			95% Critical H Value (KM-Log)	3.63					
100		KM Standard Error of Mean (logged)	0.402									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	953.9			Mean in Log Scale	5.699					
105		SD in Original Scale	1652			SD in Log Scale	1.747					
106		95% t UCL (Assumes normality)	1678			95% H-Stat UCL	8328					

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	2612										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 1:40:23 PM									
5	From File		OU1 1A Surface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(b)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			16			Number of Distinct Observations			15		
14	Number of Detects			15			Number of Non-Detects			1		
15	Number of Distinct Detects			14			Number of Distinct Non-Detects			1		
16	Minimum Detect			60.7			Minimum Non-Detect			20		
17	Maximum Detect			15600			Maximum Non-Detect			20		
18	Variance Detects			15026646			Percent Non-Detects			6.25%		
19	Mean Detects			2292			SD Detects			3876		
20	Median Detects			990			CV Detects			1.691		
21	Skewness Detects			3.273			Kurtosis Detects			11.55		
22	Mean of Logged Detects			6.857			SD of Logged Detects			1.442		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.552			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.881			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.285			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.22			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			2150			KM Standard Error of Mean			949.1		
33	KM SD			3668			95% KM (BCA) UCL			3971		
34	95% KM (t) UCL			3814			95% KM (Percentile Bootstrap) UCL			3801		
35	95% KM (z) UCL			3711			95% KM Bootstrap t UCL			6818		
36	90% KM Chebyshev UCL			4997			95% KM Chebyshev UCL			6287		
37	97.5% KM Chebyshev UCL			8077			99% KM Chebyshev UCL			11593		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.489			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.78			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.146			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.231			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.689			k star (bias corrected MLE)			0.595		
48	Theta hat (MLE)			3328			Theta star (bias corrected MLE)			3850		
49	nu hat (MLE)			20.66			nu star (bias corrected)			17.86		
50	Mean (detects)			2292								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	2149						
59		Maximum	15600		Median	828.5						
60		SD	3789		CV	1.763						
61		k hat (MLE)	0.425		k star (bias corrected MLE)	0.387						
62		Theta hat (MLE)	5051		Theta star (bias corrected MLE)	5547						
63		nu hat (MLE)	13.61		nu star (bias corrected)	12.39						
64		Adjusted Level of Significance (β)	0.0335									
65		Approximate Chi Square Value (12.39, α)	5.488		Adjusted Chi Square Value (12.39, β)	4.973						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	4853		95% Gamma Adjusted UCL (use when $n < 50$)	5355						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	2150		SD (KM)	3668						
70		Variance (KM)	13450745		SE of Mean (KM)	949.1						
71		k hat (KM)	0.344		k star (KM)	0.321						
72		nu hat (KM)	11		nu star (KM)	10.27						
73		theta hat (KM)	6256		theta star (KM)	6700						
74		80% gamma percentile (KM)	3348		90% gamma percentile (KM)	6287						
75		95% gamma percentile (KM)	9622		99% gamma percentile (KM)	18221						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (10.27, α)	4.11		Adjusted Chi Square Value (10.27, β)	3.676						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	5371		95% Gamma Adjusted KM-UCL (use when $n < 50$)	6005						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.96		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.881		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.169		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.22		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	2150		Mean in Log Scale	6.64						
90		SD in Original Scale	3787		SD in Log Scale	1.643						
91		95% t UCL (assumes normality of ROS data)	3810		95% Percentile Bootstrap UCL	3852						
92		95% BCA Bootstrap UCL	4791		95% Bootstrap t UCL	7083						
93		95% H-UCL (Log ROS)	14779									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	6.616		KM Geo Mean	747						
97		KM SD (logged)	1.641		95% Critical H Value (KM-Log)	3.799						
98		KM Standard Error of Mean (logged)	0.425		95% H-UCL (KM -Log)	14364						
99		KM SD (logged)	1.641		95% Critical H Value (KM-Log)	3.799						
100		KM Standard Error of Mean (logged)	0.425									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	2149		Mean in Log Scale	6.573						
105		SD in Original Scale	3788		SD in Log Scale	1.799						
106		95% t UCL (Assumes normality)	3809		95% H-Stat UCL	24158						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	6005										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 1:41:12 PM									
5	From File		OU1 1A Surface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			16		Number of Distinct Observations			15			
14	Number of Detects			11		Number of Non-Detects			5			
15	Number of Distinct Detects			11		Number of Distinct Non-Detects			4			
16	Minimum Detect			34.1		Minimum Non-Detect			22			
17	Maximum Detect			853		Maximum Non-Detect			90			
18	Variance Detects			74029		Percent Non-Detects			31.25%			
19	Mean Detects			222.8		SD Detects			272.1			
20	Median Detects			110		CV Detects			1.221			
21	Skewness Detects			1.791		Kurtosis Detects			2.283			
22	Mean of Logged Detects			4.834		SD of Logged Detects			1.085			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.713		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.85		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.299		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.251		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			161.1		KM Standard Error of Mean			61.33			
33	KM SD			233.8		95% KM (BCA) UCL			263.9			
34	95% KM (t) UCL			268.6		95% KM (Percentile Bootstrap) UCL			265.7			
35	95% KM (z) UCL			261.9		95% KM Bootstrap t UCL			467.3			
36	90% KM Chebyshev UCL			345		95% KM Chebyshev UCL			428.4			
37	97.5% KM Chebyshev UCL			544		99% KM Chebyshev UCL			771.2			
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.633		Anderson-Darling GOF Test						
41	5% A-D Critical Value			0.751		Detected data appear Gamma Distributed at 5% Significance Level						
42	K-S Test Statistic			0.196		Kolmogorov-Smirnov GOF						
43	5% K-S Critical Value			0.262		Detected data appear Gamma Distributed at 5% Significance Level						
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			1.008		k star (bias corrected MLE)			0.793			
48	Theta hat (MLE)			221.1		Theta star (bias corrected MLE)			280.8			
49	nu hat (MLE)			22.17		nu star (bias corrected)			17.46			
50	Mean (detects)			222.8								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	153.2						
59		Maximum	853		Median	51.95						
60		SD	246.4		CV	1.609						
61		k hat (MLE)	0.229		k star (bias corrected MLE)	0.228						
62		Theta hat (MLE)	669.1		Theta star (bias corrected MLE)	672.8						
63		nu hat (MLE)	7.325		nu star (bias corrected)	7.285						
64		Adjusted Level of Significance (β)	0.0335									
65		Approximate Chi Square Value (7.28, α)	2.328		Adjusted Chi Square Value (7.28, β)	2.022						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	479.2		95% Gamma Adjusted UCL (use when $n < 50$)	551.8						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	161.1		SD (KM)	233.8						
70		Variance (KM)	54681		SE of Mean (KM)	61.33						
71		k hat (KM)	0.474		k star (KM)	0.427						
72		nu hat (KM)	15.18		nu star (KM)	13.67						
73		theta hat (KM)	339.5		theta star (KM)	377.1						
74		80% gamma percentile (KM)	261.7		90% gamma percentile (KM)	449.5						
75		95% gamma percentile (KM)	654.1		99% gamma percentile (KM)	1165						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (13.67, α)	6.344		Adjusted Chi Square Value (13.67, β)	5.784						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	347		95% Gamma Adjusted KM-UCL (use when $n < 50$)	380.6						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.923		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.85		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.155		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.251		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	157.3		Mean in Log Scale	4.098						
90		SD in Original Scale	243.8		SD in Log Scale	1.458						
91		95% t UCL (assumes normality of ROS data)	264.2		95% Percentile Bootstrap UCL	262.1						
92		95% BCA Bootstrap UCL	281.6		95% Bootstrap t UCL	459.5						
93		95% H-UCL (Log ROS)	642.6									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.317		KM Geo Mean	75						
97		KM SD (logged)	1.16		95% Critical H Value (KM-Log)	2.958						
98		KM Standard Error of Mean (logged)	0.306		95% H-UCL (KM -Log)	356.5						
99		KM SD (logged)	1.16		95% Critical H Value (KM-Log)	2.958						
100		KM Standard Error of Mean (logged)	0.306									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	158.9		Mean in Log Scale	4.174						
105		SD in Original Scale	242.9		SD in Log Scale	1.381						
106		95% t UCL (Assumes normality)	265.3		95% H-Stat UCL	552.8						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	380.6										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 1:42:00 PM									
5	From File		OU1 1A Surface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Indeno (1,2,3-cd) pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			16		Number of Distinct Observations			16			
14	Number of Detects			14		Number of Non-Detects			2			
15	Number of Distinct Detects			14		Number of Distinct Non-Detects			2			
16	Minimum Detect			31.4		Minimum Non-Detect			23			
17	Maximum Detect			5280		Maximum Non-Detect			26			
18	Variance Detects			1835006		Percent Non-Detects			12.5%			
19	Mean Detects			886.8		SD Detects			1355			
20	Median Detects			350		CV Detects			1.528			
21	Skewness Detects			2.985		Kurtosis Detects			9.774			
22	Mean of Logged Detects			6.061		SD of Logged Detects			1.253			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.595		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.874		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.269		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.226		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		778.8		KM Standard Error of Mean			325.3				
33	KM SD		1254		95% KM (BCA) UCL			1377				
34	95% KM (t) UCL		1349		95% KM (Percentile Bootstrap) UCL			1306				
35	95% KM (z) UCL		1314		95% KM Bootstrap t UCL			2240				
36	90% KM Chebyshev UCL		1755		95% KM Chebyshev UCL			2197				
37	97.5% KM Chebyshev UCL		2811		99% KM Chebyshev UCL			4016				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.656		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.768		Detected data appear Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.207		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.237		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.815		k star (bias corrected MLE)			0.688				
48	Theta hat (MLE)		1088		Theta star (bias corrected MLE)			1289				
49	nu hat (MLE)		22.81		nu star (bias corrected)			19.26				
50	Mean (detects)		886.8									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	776						
59		Maximum	5280		Median	265						
60		SD	1297		CV	1.671						
61		k hat (MLE)	0.349		k star (bias corrected MLE)	0.325						
62		Theta hat (MLE)	2222		Theta star (bias corrected MLE)	2385						
63		nu hat (MLE)	11.17		nu star (bias corrected)	10.41						
64		Adjusted Level of Significance (β)	0.0335									
65		Approximate Chi Square Value (10.41, α)	4.201		Adjusted Chi Square Value (10.41, β)	3.762						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	1923		95% Gamma Adjusted UCL (use when $n < 50$)	2148						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	778.8		SD (KM)	1254						
70		Variance (KM)	1572556		SE of Mean (KM)	325.3						
71		k hat (KM)	0.386		k star (KM)	0.355						
72		nu hat (KM)	12.34		nu star (KM)	11.36						
73		theta hat (KM)	2019		theta star (KM)	2193						
74		80% gamma percentile (KM)	1236		90% gamma percentile (KM)	2244						
75		95% gamma percentile (KM)	3370		99% gamma percentile (KM)	6240						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (11.36, α)	4.81		Adjusted Chi Square Value (11.36, β)	4.334						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	1840		95% Gamma Adjusted KM-UCL (use when $n < 50$)	2042						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.959		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.874		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.152		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.226		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	779		Mean in Log Scale	5.702						
90		SD in Original Scale	1295		SD in Log Scale	1.524						
91		95% t UCL (assumes normality of ROS data)	1347		95% Percentile Bootstrap UCL	1363						
92		95% BCA Bootstrap UCL	1679		95% Bootstrap t UCL	2242						
93		95% H-UCL (Log ROS)	3922									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.695		KM Geo Mean	297.4						
97		KM SD (logged)	1.487		95% Critical H Value (KM-Log)	3.521						
98		KM Standard Error of Mean (logged)	0.386		95% H-UCL (KM -Log)	3472						
99		KM SD (logged)	1.487		95% Critical H Value (KM-Log)	3.521						
100		KM Standard Error of Mean (logged)	0.386									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	777.5		Mean in Log Scale	5.616						
105		SD in Original Scale	1296		SD in Log Scale	1.684						
106		95% t UCL (Assumes normality)	1345		95% H-Stat UCL	6132						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	2042										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 11:38:22 AM									
5	From File		OU1 1B Surface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(a)anthracene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			25		
15							Number of Missing Observations			0		
16	Minimum			75.8			Mean			2808		
17	Maximum			13900			Median			1100		
18	SD			3473			Std. Error of Mean			681.1		
19	Coefficient of Variation			1.237			Skewness			1.622		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.768			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.26			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			3971			95% Adjusted-CLT UCL (Chen-1995)			4160		
31							95% Modified-t UCL (Johnson-1978)			4007		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.624			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.794			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.125			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.179			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.653			k star (bias corrected MLE)			0.603		
42	Theta hat (MLE)			4299			Theta star (bias corrected MLE)			4653		
43	nu hat (MLE)			33.97			nu star (bias corrected)			31.38		
44	MLE Mean (bias corrected)			2808			MLE Sd (bias corrected)			3615		
45							Approximate Chi Square Value (0.05)			19.58		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			18.96		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			4500			95% Adjusted Gamma UCL (use when n<50)			4646		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.939			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.13		Lilliefors Lognormal GOF Test				
55				5% Lilliefors Critical Value		0.17		Data appear Lognormal at 5% Significance Level				
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		4.328				Mean of logged Data		7.006
60				Maximum of Logged Data		9.54				SD of logged Data		1.572
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		10789				90% Chebyshev (MVUE) UCL		7444
64				95% Chebyshev (MVUE) UCL		9253				97.5% Chebyshev (MVUE) UCL		11765
65				99% Chebyshev (MVUE) UCL		16697						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		3928				95% Jackknife UCL		3971
72				95% Standard Bootstrap UCL		3936				95% Bootstrap-t UCL		4287
73				95% Hall's Bootstrap UCL		4298				95% Percentile Bootstrap UCL		3914
74				95% BCA Bootstrap UCL		4306						
75				90% Chebyshev(Mean, Sd) UCL		4851				95% Chebyshev(Mean, Sd) UCL		5777
76				97.5% Chebyshev(Mean, Sd) UCL		7061				99% Chebyshev(Mean, Sd) UCL		9585
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		4646						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 11:39:23 AM									
5	From File		OU1 1B Surface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(a)pyrene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			26		
15							Number of Missing Observations			0		
16	Minimum			85.2			Mean			2536		
17	Maximum			11100			Median			1240		
18	SD			3105			Std. Error of Mean			608.9		
19	Coefficient of Variation			1.224			Skewness			1.647		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.772			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.215			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			3576			95% Adjusted-CLT UCL (Chen-1995)			3747		
31							95% Modified-t UCL (Johnson-1978)			3609		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.444			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.79			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.14			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.179			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.692			k star (bias corrected MLE)			0.637		
42	Theta hat (MLE)			3666			Theta star (bias corrected MLE)			3978		
43	nu hat (MLE)			35.97			nu star (bias corrected)			33.15		
44	MLE Mean (bias corrected)			2536			MLE Sd (bias corrected)			3176		
45							Approximate Chi Square Value (0.05)			20.99		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			20.35		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			4005			95% Adjusted Gamma UCL (use when n<50)			4131		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.948			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.107	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.17	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		4.445				Mean of logged Data		6.963
60				Maximum of Logged Data		9.315				SD of logged Data		1.501
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		8575				90% Chebyshev (MVUE) UCL		6291
64				95% Chebyshev (MVUE) UCL		7781				97.5% Chebyshev (MVUE) UCL		9849
65				99% Chebyshev (MVUE) UCL		13910						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		3537				95% Jackknife UCL		3576
72				95% Standard Bootstrap UCL		3517				95% Bootstrap-t UCL		3949
73				95% Hall's Bootstrap UCL		3990				95% Percentile Bootstrap UCL		3609
74				95% BCA Bootstrap UCL		3755						
75				90% Chebyshev(Mean, Sd) UCL		4362				95% Chebyshev(Mean, Sd) UCL		5190
76				97.5% Chebyshev(Mean, Sd) UCL		6338				99% Chebyshev(Mean, Sd) UCL		8594
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		4131						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 11:40:05 AM									
5	From File		OU1 1B Surface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(b)fluoranthene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			25		
15							Number of Missing Observations			0		
16	Minimum			180			Mean			6395		
17	Maximum			24200			Median			2420		
18	SD			7142			Std. Error of Mean			1401		
19	Coefficient of Variation			1.117			Skewness			1.152		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.817			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.246			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			8788			95% Adjusted-CLT UCL (Chen-1995)			9037		
31							95% Modified-t UCL (Johnson-1978)			8841		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.499			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.788			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.144			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.179			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.712			k star (bias corrected MLE)			0.656		
42	Theta hat (MLE)			8976			Theta star (bias corrected MLE)			9750		
43	nu hat (MLE)			37.05			nu star (bias corrected)			34.11		
44	MLE Mean (bias corrected)			6395			MLE Sd (bias corrected)			7896		
45							Approximate Chi Square Value (0.05)			21.75		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			21.1		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			10029			95% Adjusted Gamma UCL (use when n<50)			10339		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.94			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.118		Lilliefors Lognormal GOF Test				
55				5% Lilliefors Critical Value		0.17		Data appear Lognormal at 5% Significance Level				
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		5.193				Mean of logged Data		7.917
60				Maximum of Logged Data		10.09				SD of logged Data		1.516
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		23154				90% Chebyshev (MVUE) UCL		16773
64				95% Chebyshev (MVUE) UCL		20768				97.5% Chebyshev (MVUE) UCL		26313
65				99% Chebyshev (MVUE) UCL		37204						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		8699				95% Jackknife UCL		8788
72				95% Standard Bootstrap UCL		8631				95% Bootstrap-t UCL		9297
73				95% Hall's Bootstrap UCL		9020				95% Percentile Bootstrap UCL		8712
74				95% BCA Bootstrap UCL		9178						
75				90% Chebyshev(Mean, Sd) UCL		10597				95% Chebyshev(Mean, Sd) UCL		12501
76				97.5% Chebyshev(Mean, Sd) UCL		15143				99% Chebyshev(Mean, Sd) UCL		20332
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		10339						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 11:40:40 AM									
5	From File		OU1 1B Surface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			26		Number of Distinct Observations			24			
14	Number of Detects			22		Number of Non-Detects			4			
15	Number of Distinct Detects			22		Number of Distinct Non-Detects			2			
16	Minimum Detect			41.2		Minimum Non-Detect			24			
17	Maximum Detect			2050		Maximum Non-Detect			230			
18	Variance Detects			274447		Percent Non-Detects			15.38%			
19	Mean Detects			484.3		SD Detects			523.9			
20	Median Detects			306		CV Detects			1.082			
21	Skewness Detects			1.572		Kurtosis Detects			2.45			
22	Mean of Logged Detects			5.575		SD of Logged Detects			1.193			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.808		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.911		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.199		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.184		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		415.5		KM Standard Error of Mean		99.95					
33	KM SD		497.9		95% KM (BCA) UCL		599.2					
34	95% KM (t) UCL		586.2		95% KM (Percentile Bootstrap) UCL		584.4					
35	95% KM (z) UCL		579.9		95% KM Bootstrap t UCL		634.2					
36	90% KM Chebyshev UCL		715.3		95% KM Chebyshev UCL		851.1					
37	97.5% KM Chebyshev UCL		1040		99% KM Chebyshev UCL		1410					
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.561		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.773		Detected data appear Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.178		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.191		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.955		k star (bias corrected MLE)		0.855					
48	Theta hat (MLE)		507.4		Theta star (bias corrected MLE)		566.6					
49	nu hat (MLE)		42		nu star (bias corrected)		37.6					
50	Mean (detects)		484.3									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	410.1						
59		Maximum	2050		Median	141.5						
60		SD	511.9		CV	1.248						
61		k hat (MLE)	0.379		k star (bias corrected MLE)	0.361						
62		Theta hat (MLE)	1082		Theta star (bias corrected MLE)	1136						
63		nu hat (MLE)	19.71		nu star (bias corrected)	18.77						
64		Adjusted Level of Significance (β)	0.0398									
65		Approximate Chi Square Value (18.77, α)	9.951		Adjusted Chi Square Value (18.77, β)	9.527						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	773.6		95% Gamma Adjusted UCL (use when $n < 50$)	808						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	415.5		SD (KM)	497.9						
70		Variance (KM)	247869		SE of Mean (KM)	99.95						
71		k hat (KM)	0.696		k star (KM)	0.642						
72		nu hat (KM)	36.21		nu star (KM)	33.37						
73		theta hat (KM)	596.6		theta star (KM)	647.5						
74		80% gamma percentile (KM)	684.4		90% gamma percentile (KM)	1064						
75		95% gamma percentile (KM)	1459		99% gamma percentile (KM)	2409						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (33.37, α)	21.16		Adjusted Chi Square Value (33.37, β)	20.52						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	655.2		95% Gamma Adjusted KM-UCL (use when $n < 50$)	675.7						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.945		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.911		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.136		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.184		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	414.6		Mean in Log Scale	5.207						
90		SD in Original Scale	508.3		SD in Log Scale	1.431						
91		95% t UCL (assumes normality of ROS data)	584.9		95% Percentile Bootstrap UCL	580.6						
92		95% BCA Bootstrap UCL	608.9		95% Bootstrap t UCL	638.9						
93		95% H-UCL (Log ROS)	1237									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.243		KM Geo Mean	189.2						
97		KM SD (logged)	1.34		95% Critical H Value (KM-Log)	2.977						
98		KM Standard Error of Mean (logged)	0.27		95% H-UCL (KM -Log)	1032						
99		KM SD (logged)	1.34		95% Critical H Value (KM-Log)	2.977						
100		KM Standard Error of Mean (logged)	0.27									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	415.6		Mean in Log Scale	5.186						
105		SD in Original Scale	507.8		SD in Log Scale	1.487						
106		95% t UCL (Assumes normality)	585.7		95% H-Stat UCL	1397						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	675.7										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 11:41:25 AM									
5	From File		OU1 1B Surface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Indeno (1,2,3-cd) pyrene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			25		
15							Number of Missing Observations			0		
16	Minimum			62			Mean			2189		
17	Maximum			7790			Median			994.5		
18	SD			2441			Std. Error of Mean			478.8		
19	Coefficient of Variation			1.115			Skewness			1.129		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.808			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.217			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			3007			95% Adjusted-CLT UCL (Chen-1995)			3090		
31							95% Modified-t UCL (Johnson-1978)			3024		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.739			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.785			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.19			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.178			Data Not Gamma Distributed at 5% Significance Level					
38	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.745			k star (bias corrected MLE)			0.684		
42	Theta hat (MLE)			2939			Theta star (bias corrected MLE)			3198		
43	nu hat (MLE)			38.73			nu star (bias corrected)			35.59		
44	MLE Mean (bias corrected)			2189			MLE Sd (bias corrected)			2646		
45							Approximate Chi Square Value (0.05)			22.94		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			22.27		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			3396			95% Adjusted Gamma UCL (use when n<50)			3498		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.938			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.142		Lilliefors Lognormal GOF Test				
55				5% Lilliefors Critical Value		0.17		Data appear Lognormal at 5% Significance Level				
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		4.127				Mean of logged Data		6.887
60				Maximum of Logged Data		8.961				SD of logged Data		1.434
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		6695				90% Chebyshev (MVUE) UCL		5185
64				95% Chebyshev (MVUE) UCL		6380				97.5% Chebyshev (MVUE) UCL		8039
65				99% Chebyshev (MVUE) UCL		11298						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		2976				95% Jackknife UCL		3007
72				95% Standard Bootstrap UCL		2968				95% Bootstrap-t UCL		3161
73				95% Hall's Bootstrap UCL		3068				95% Percentile Bootstrap UCL		3013
74				95% BCA Bootstrap UCL		3123						
75				90% Chebyshev(Mean, Sd) UCL		3625				95% Chebyshev(Mean, Sd) UCL		4276
76				97.5% Chebyshev(Mean, Sd) UCL		5179				99% Chebyshev(Mean, Sd) UCL		6953
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		3498						
80												
81	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
82	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
83												
84	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
85	Recommendations are based upon data size, data distribution, and skewness.											
86	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:38:46 AM									
5	From File		OU1 1C Surface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			33		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			32			Number of Distinct Non-Detects			1		
16	Minimum Detect			33			Minimum Non-Detect			13		
17	Maximum Detect			135000			Maximum Non-Detect			13		
18	Variance Detects			5.677E+8			Percent Non-Detects			3.03%		
19	Mean Detects			7009			SD Detects			23826		
20	Median Detects			806			CV Detects			3.399		
21	Skewness Detects			5.325			Kurtosis Detects			29.3		
22	Mean of Logged Detects			6.9			SD of Logged Detects			1.877		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.303			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.385			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			6797			KM Standard Error of Mean			4090		
33	KM SD			23124			95% KM (BCA) UCL			15574		
34	95% KM (t) UCL			13725			95% KM (Percentile Bootstrap) UCL			14659		
35	95% KM (z) UCL			13524			95% KM Bootstrap t UCL			39976		
36	90% KM Chebyshev UCL			19066			95% KM Chebyshev UCL			24624		
37	97.5% KM Chebyshev UCL			32337			99% KM Chebyshev UCL			47489		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			2.448			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.845			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.259			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.168			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.345			k star (bias corrected MLE)			0.333		
48	Theta hat (MLE)			20330			Theta star (bias corrected MLE)			21031		
49	nu hat (MLE)			22.06			nu star (bias corrected)			21.33		
50	Mean (detects)			7009								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	6797						
59		Maximum	135000		Median	733						
60		SD	23482		CV	3.455						
61		k hat (MLE)	0.303		k star (bias corrected MLE)	0.296						
62		Theta hat (MLE)	22440		Theta star (bias corrected MLE)	22997						
63		nu hat (MLE)	19.99		nu star (bias corrected)	19.51						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (19.51, α)	10.49		Adjusted Chi Square Value (19.51, β)	10.15						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	12641		95% Gamma Adjusted UCL (use when $n < 50$)	13066						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	6797		SD (KM)	23124						
70		Variance (KM)	5.347E+8		SE of Mean (KM)	4090						
71		k hat (KM)	0.0864		k star (KM)	0.0988						
72		nu hat (KM)	5.703		nu star (KM)	6.518						
73		theta hat (KM)	78666		theta star (KM)	68830						
74		80% gamma percentile (KM)	4631		90% gamma percentile (KM)	17995						
75		95% gamma percentile (KM)	39480		99% gamma percentile (KM)	108650						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (6.52, α)	1.91		Adjusted Chi Square Value (6.52, β)	1.785						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	23196		95% Gamma Adjusted KM-UCL (use when $n < 50$)	24825						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.972		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.129		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	6797		Mean in Log Scale	6.756						
91		SD in Original Scale	23482		SD in Log Scale	2.023						
92		95% t UCL (assumes normality of ROS data)	13721		95% Percentile Bootstrap UCL	14788						
93		95% BCA Bootstrap UCL	19650		95% Bootstrap t UCL	39048						
94		95% H-UCL (Log ROS)	26728									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	6.768		KM Geo Mean	869.9						
98		KM SD (logged)	1.965		95% Critical H Value (KM-Log)	3.797						
99		KM Standard Error of Mean (logged)	0.348		95% H-UCL (KM -Log)	22448						
100		KM SD (logged)	1.965		95% Critical H Value (KM-Log)	3.797						
101		KM Standard Error of Mean (logged)	0.348									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	6797		Mean in Log Scale	6.747						
106		SD in Original Scale	23482		SD in Log Scale	2.045						

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					13721	95% H-Stat UCL					28397
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Lognormal Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	95% KM (Chebyshev) UCL					24624						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:40:02 AM									
5	From File		OU1 1C Surface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			33		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			32			Number of Distinct Non-Detects			1		
16	Minimum Detect			28			Minimum Non-Detect			22		
17	Maximum Detect			65700			Maximum Non-Detect			22		
18	Variance Detects			1.380E+8			Percent Non-Detects			3.03%		
19	Mean Detects			4513			SD Detects			11748		
20	Median Detects			636.5			CV Detects			2.603		
21	Skewness Detects			4.85			Kurtosis Detects			25.52		
22	Mean of Logged Detects			6.762			SD of Logged Detects			1.876		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.393			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.351			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			4377			KM Standard Error of Mean			2019		
33	KM SD			11413			95% KM (BCA) UCL			8241		
34	95% KM (t) UCL			7796			95% KM (Percentile Bootstrap) UCL			7952		
35	95% KM (z) UCL			7697			95% KM Bootstrap t UCL			14331		
36	90% KM Chebyshev UCL			10433			95% KM Chebyshev UCL			13176		
37	97.5% KM Chebyshev UCL			16983			99% KM Chebyshev UCL			24461		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.732			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.833			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.226			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.167			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.398			k star (bias corrected MLE)			0.382		
48	Theta hat (MLE)			11330			Theta star (bias corrected MLE)			11820		
49	nu hat (MLE)			25.49			nu star (bias corrected)			24.44		
50	Mean (detects)			4513								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	4377						
59		Maximum	65700		Median	609						
60		SD	11590		CV	2.648						
61		k hat (MLE)	0.343		k star (bias corrected MLE)	0.332						
62		Theta hat (MLE)	12759		Theta star (bias corrected MLE)	13181						
63		nu hat (MLE)	22.64		nu star (bias corrected)	21.92						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (21.92, α)	12.27		Adjusted Chi Square Value (21.92, β)	11.9						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	7814		95% Gamma Adjusted UCL (use when $n < 50$)	8058						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	4377		SD (KM)	11413						
70		Variance (KM)	1.303E+8		SE of Mean (KM)	2019						
71		k hat (KM)	0.147		k star (KM)	0.154						
72		nu hat (KM)	9.709		nu star (KM)	10.16						
73		theta hat (KM)	29757		theta star (KM)	28437						
74		80% gamma percentile (KM)	4865		90% gamma percentile (KM)	13024						
75		95% gamma percentile (KM)	23969		99% gamma percentile (KM)	55564						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (10.16, α)	4.042		Adjusted Chi Square Value (10.16, β)	3.844						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	11003		95% Gamma Adjusted KM-UCL (use when $n < 50$)	11568						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.963		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.125		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	4377		Mean in Log Scale	6.619						
90		SD in Original Scale	11590		SD in Log Scale	2.021						
91		95% t UCL (assumes normality of ROS data)	7794		95% Percentile Bootstrap UCL	8007						
92		95% BCA Bootstrap UCL	11275		95% Bootstrap t UCL	14580						
93		95% H-UCL (Log ROS)	23139									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	6.651		KM Geo Mean	773.2						
97		KM SD (logged)	1.924		95% Critical H Value (KM-Log)	3.733						
98		KM Standard Error of Mean (logged)	0.34		95% H-UCL (KM -Log)	17517						
99		KM SD (logged)	1.924		95% Critical H Value (KM-Log)	3.733						
100		KM Standard Error of Mean (logged)	0.34									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	4377		Mean in Log Scale	6.63						
105		SD in Original Scale	11590		SD in Log Scale	1.996						
106		95% t UCL (Assumes normality)	7794		95% H-Stat UCL	21581						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Lognormal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (Chebyshev) UCL 13176											
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:40:50 AM									
5	From File		OU1 1C Surface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(b)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			32		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			31			Number of Distinct Non-Detects			1		
16	Minimum Detect			49			Minimum Non-Detect			23		
17	Maximum Detect			148000			Maximum Non-Detect			23		
18	Variance Detects			7.336E+8			Percent Non-Detects			3.03%		
19	Mean Detects			11641			SD Detects			27085		
20	Median Detects			1515			CV Detects			2.327		
21	Skewness Detects			4.408			Kurtosis Detects			21.92		
22	Mean of Logged Detects			7.743			SD of Logged Detects			1.913		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.452			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.334			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			11289			KM Standard Error of Mean			4656		
33	KM SD			26327			95% KM (BCA) UCL			21326		
34	95% KM (t) UCL			19176			95% KM (Percentile Bootstrap) UCL			19957		
35	95% KM (z) UCL			18948			95% KM Bootstrap t UCL			30115		
36	90% KM Chebyshev UCL			25258			95% KM Chebyshev UCL			31585		
37	97.5% KM Chebyshev UCL			40367			99% KM Chebyshev UCL			57618		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.52			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.831			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.203			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.166			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.406			k star (bias corrected MLE)			0.388		
48	Theta hat (MLE)			28707			Theta star (bias corrected MLE)			29977		
49	nu hat (MLE)			25.95			nu star (bias corrected)			24.85		
50	Mean (detects)			11641								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	11288						
59		Maximum	148000		Median	1500						
60		SD	26735		CV	2.368						
61		k hat (MLE)	0.344		k star (bias corrected MLE)	0.333						
62		Theta hat (MLE)	32848		Theta star (bias corrected MLE)	33938						
63		nu hat (MLE)	22.68		nu star (bias corrected)	21.95						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (21.95, α)	12.3		Adjusted Chi Square Value (21.95, β)	11.93						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	20143		95% Gamma Adjusted UCL (use when $n < 50$)	20772						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	11289		SD (KM)	26327						
70		Variance (KM)	6.931E+8		SE of Mean (KM)	4656						
71		k hat (KM)	0.184		k star (KM)	0.187						
72		nu hat (KM)	12.14		nu star (KM)	12.37						
73		theta hat (KM)	61395		theta star (KM)	60252						
74		80% gamma percentile (KM)	14348		90% gamma percentile (KM)	34102						
75		95% gamma percentile (KM)	59141		99% gamma percentile (KM)	128832						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (12.37, α)	5.469		Adjusted Chi Square Value (12.37, β)	5.233						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	25526		95% Gamma Adjusted KM-UCL (use when $n < 50$)	26675						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.97		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.121		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	11289		Mean in Log Scale	7.597						
90		SD in Original Scale	26735		SD in Log Scale	2.062						
91		95% t UCL (assumes normality of ROS data)	19172		95% Percentile Bootstrap UCL	19979						
92		95% BCA Bootstrap UCL	24715		95% Bootstrap t UCL	30302						
93		95% H-UCL (Log ROS)	70388									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	7.604		KM Geo Mean	2005						
97		KM SD (logged)	2.015		95% Critical H Value (KM-Log)	3.874						
98		KM Standard Error of Mean (logged)	0.356		95% H-UCL (KM -Log)	60763						
99		KM SD (logged)	2.015		95% Critical H Value (KM-Log)	3.874						
100		KM Standard Error of Mean (logged)	0.356									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	11289		Mean in Log Scale	7.583						
105		SD in Original Scale	26735		SD in Log Scale	2.097						
106		95% t UCL (Assumes normality)	19172		95% H-Stat UCL	77950						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Lognormal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (Chebyshev) UCL 31585											
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:41:45 AM									
5	From File		OU1 1C Surface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(k)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33		Number of Distinct Observations			33			
14	Number of Detects			32		Number of Non-Detects			1			
15	Number of Distinct Detects			32		Number of Distinct Non-Detects			1			
16	Minimum Detect			42		Minimum Non-Detect			18			
17	Maximum Detect			45600		Maximum Non-Detect			18			
18	Variance Detects			66505797		Percent Non-Detects			3.03%			
19	Mean Detects			3338		SD Detects			8155			
20	Median Detects			748.5		CV Detects			2.443			
21	Skewness Detects			4.792		Kurtosis Detects			24.97			
22	Mean of Logged Detects			6.753		SD of Logged Detects			1.68			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.408		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.93		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.343		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.154		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			3237		KM Standard Error of Mean			1402			
33	KM SD			7925		95% KM (BCA) UCL			5804			
34	95% KM (t) UCL			5611		95% KM (Percentile Bootstrap) UCL			5950			
35	95% KM (z) UCL			5543		95% KM Bootstrap t UCL			10579			
36	90% KM Chebyshev UCL			7442		95% KM Chebyshev UCL			9347			
37	97.5% KM Chebyshev UCL			11990		99% KM Chebyshev UCL			17183			
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.341		Anderson-Darling GOF Test						
41	5% A-D Critical Value			0.817		Detected Data Not Gamma Distributed at 5% Significance Level						
42	K-S Test Statistic			0.208		Kolmogorov-Smirnov GOF						
43	5% K-S Critical Value			0.165		Detected Data Not Gamma Distributed at 5% Significance Level						
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.471		k star (bias corrected MLE)			0.448			
48	Theta hat (MLE)			7083		Theta star (bias corrected MLE)			7452			
49	nu hat (MLE)			30.16		nu star (bias corrected)			28.67			
50	Mean (detects)			3338								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	3237						
59		Maximum	45600		Median	720						
60		SD	8048		CV	2.486						
61		k hat (MLE)	0.394		k star (bias corrected MLE)	0.378						
62		Theta hat (MLE)	8213		Theta star (bias corrected MLE)	8552						
63		nu hat (MLE)	26.01		nu star (bias corrected)	24.98						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (24.98, α)	14.6		Adjusted Chi Square Value (24.98, β)	14.19						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	5539		95% Gamma Adjusted UCL (use when $n < 50$)	5699						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	3237		SD (KM)	7925						
70		Variance (KM)	62799021		SE of Mean (KM)	1402						
71		k hat (KM)	0.167		k star (KM)	0.172						
72		nu hat (KM)	11.01		nu star (KM)	11.35						
73		theta hat (KM)	19398		theta star (KM)	18831						
74		80% gamma percentile (KM)	3899		90% gamma percentile (KM)	9736						
75		95% gamma percentile (KM)	17311		99% gamma percentile (KM)	38716						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (11.35, α)	4.8		Adjusted Chi Square Value (11.35, β)	4.581						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	7653		95% Gamma Adjusted KM-UCL (use when $n < 50$)	8018						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.976		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.0894		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	3237		Mean in Log Scale	6.624						
90		SD in Original Scale	8048		SD in Log Scale	1.812						
91		95% t UCL (assumes normality of ROS data)	5610		95% Percentile Bootstrap UCL	5772						
92		95% BCA Bootstrap UCL	7346		95% Bootstrap t UCL	10352						
93		95% H-UCL (Log ROS)	12170									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	6.636		KM Geo Mean	761.8						
97		KM SD (logged)	1.758		95% Critical H Value (KM-Log)	3.481						
98		KM Standard Error of Mean (logged)	0.311		95% H-UCL (KM -Log)	10534						
99		KM SD (logged)	1.758		95% Critical H Value (KM-Log)	3.481						
100		KM Standard Error of Mean (logged)	0.311									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	3237		Mean in Log Scale	6.615						
105		SD in Original Scale	8048		SD in Log Scale	1.834						
106		95% t UCL (Assumes normality)	5610		95% H-Stat UCL	12861						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Lognormal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (Chebyshev) UCL		9347									
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:42:32 AM									
5	From File		OU1 1C Surface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Chrysene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			32		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			31			Number of Distinct Non-Detects			1		
16	Minimum Detect			50			Minimum Non-Detect			25		
17	Maximum Detect			173000			Maximum Non-Detect			25		
18	Variance Detects			9.293E+8			Percent Non-Detects			3.03%		
19	Mean Detects			9376			SD Detects			30484		
20	Median Detects			1190			CV Detects			3.251		
21	Skewness Detects			5.308			Kurtosis Detects			29.19		
22	Mean of Logged Detects			7.28			SD of Logged Detects			1.877		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.312			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.38			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			9093			KM Standard Error of Mean			5233		
33	KM SD			29589			95% KM (BCA) UCL			19786		
34	95% KM (t) UCL			17957			95% KM (Percentile Bootstrap) UCL			19146		
35	95% KM (z) UCL			17701			95% KM Bootstrap t UCL			48594		
36	90% KM Chebyshev UCL			24792			95% KM Chebyshev UCL			31904		
37	97.5% KM Chebyshev UCL			41774			99% KM Chebyshev UCL			61163		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			2.147			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.842			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.252			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.167			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.359			k star (bias corrected MLE)			0.346		
48	Theta hat (MLE)			26120			Theta star (bias corrected MLE)			27088		
49	nu hat (MLE)			22.97			nu star (bias corrected)			22.15		
50	Mean (detects)			9376								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	9092					
59		Maximum	173000			Median	1170					
60		SD	30048			CV	3.305					
61		k hat (MLE)	0.312			k star (bias corrected MLE)	0.304					
62		Theta hat (MLE)	29129			Theta star (bias corrected MLE)	29912					
63		nu hat (MLE)	20.6			nu star (bias corrected)	20.06					
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (20.06, α)	10.9			Adjusted Chi Square Value (20.06, β)	10.55					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	16739			95% Gamma Adjusted UCL (use when $n < 50$)	17292					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	9093			SD (KM)	29589					
70		Variance (KM)	8.755E+8			SE of Mean (KM)	5233					
71		k hat (KM)	0.0944			k star (KM)	0.106					
72		nu hat (KM)	6.232			nu star (KM)	6.999					
73		theta hat (KM)	96289			theta star (KM)	85741					
74		80% gamma percentile (KM)	6848			90% gamma percentile (KM)	24762					
75		95% gamma percentile (KM)	52561			99% gamma percentile (KM)	140227					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (7.00, α)	2.17			Adjusted Chi Square Value (7.00, β)	2.034					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	29326			95% Gamma Adjusted KM-UCL (use when $n < 50$)	31283					
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.973			Shapiro Wilk GOF Test						
84		5% Shapiro Wilk Critical Value	0.93			Detected Data appear Lognormal at 5% Significance Level						
85		Lilliefors Test Statistic	0.123			Lilliefors GOF Test						
86		5% Lilliefors Critical Value	0.154			Detected Data appear Lognormal at 5% Significance Level						
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	9092			Mean in Log Scale	7.137					
91		SD in Original Scale	30048			SD in Log Scale	2.023					
92		95% t UCL (assumes normality of ROS data)	17952			95% Percentile Bootstrap UCL	19232					
93		95% BCA Bootstrap UCL	24587			95% Bootstrap t UCL	47962					
94		95% H-UCL (Log ROS)	39088									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	7.157			KM Geo Mean	1283					
98		KM SD (logged)	1.948			95% Critical H Value (KM-Log)	3.77					
99		KM Standard Error of Mean (logged)	0.344			95% H-UCL (KM -Log)	31313					
100		KM SD (logged)	1.948			95% Critical H Value (KM-Log)	3.77					
101		KM Standard Error of Mean (logged)	0.344									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	9092			Mean in Log Scale	7.136					
106		SD in Original Scale	30048			SD in Log Scale	2.024					

	A	B	C	D	E	F	G	H	I	J	K	L	
107	95% t UCL (Assumes normality)					17952						95% H-Stat UCL	39181
108	DL/2 is not a recommended method, provided for comparisons and historical reasons												
109													
110	Nonparametric Distribution Free UCL Statistics												
111	Detected Data appear Lognormal Distributed at 5% Significance Level												
112													
113	Suggested UCL to Use												
114	95% KM (Chebyshev) UCL					31904							
115													
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
117	Recommendations are based upon data size, data distribution, and skewness.												
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).												
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.												
120													

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:43:14 AM									
5	From File		OU1 1C Surface_f.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33		Number of Distinct Observations			29			
14	Number of Detects			22		Number of Non-Detects			11			
15	Number of Distinct Detects			22		Number of Distinct Non-Detects			7			
16	Minimum Detect			31		Minimum Non-Detect			23			
17	Maximum Detect			8120		Maximum Non-Detect			51			
18	Variance Detects			3095909		Percent Non-Detects			33.33%			
19	Mean Detects			1024		SD Detects			1760			
20	Median Detects			295.5		CV Detects			1.718			
21	Skewness Detects			3.405		Kurtosis Detects			13.39			
22	Mean of Logged Detects			5.94		SD of Logged Detects			1.452			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.565		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.911		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.286		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.184		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		690.5		KM Standard Error of Mean			263.8				
33	KM SD		1481		95% KM (BCA) UCL			1124				
34	95% KM (t) UCL		1137		95% KM (Percentile Bootstrap) UCL			1167				
35	95% KM (z) UCL		1124		95% KM Bootstrap t UCL			1648				
36	90% KM Chebyshev UCL		1482		95% KM Chebyshev UCL			1841				
37	97.5% KM Chebyshev UCL		2338		99% KM Chebyshev UCL			3316				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.944		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.794		Detected Data Not Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.189		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.194		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.62		k star (bias corrected MLE)			0.566				
48	Theta hat (MLE)		1652		Theta star (bias corrected MLE)			1810				
49	nu hat (MLE)		27.28		nu star (bias corrected)			24.89				
50	Mean (detects)		1024									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	682.7						
59		Maximum	8120		Median	104						
60		SD	1507		CV	2.208						
61		k hat (MLE)	0.182		k star (bias corrected MLE)	0.186						
62		Theta hat (MLE)	3750		Theta star (bias corrected MLE)	3676						
63		nu hat (MLE)	12.02		nu star (bias corrected)	12.26						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (12.26, α)	5.397		Adjusted Chi Square Value (12.26, β)	5.163						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	1551		95% Gamma Adjusted UCL (use when $n < 50$)	1621						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	690.5		SD (KM)	1481						
70		Variance (KM)	2192722		SE of Mean (KM)	263.8						
71		k hat (KM)	0.217		k star (KM)	0.218						
72		nu hat (KM)	14.35		nu star (KM)	14.38						
73		theta hat (KM)	3176		theta star (KM)	3169						
74		80% gamma percentile (KM)	948.7		90% gamma percentile (KM)	2087						
75		95% gamma percentile (KM)	3477		99% gamma percentile (KM)	7254						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (14.38, α)	6.831		Adjusted Chi Square Value (14.38, β)	6.564						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	1453		95% Gamma Adjusted KM-UCL (use when $n < 50$)	1513						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.952		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.911		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.148		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.184		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	687.2		Mean in Log Scale	4.792						
90		SD in Original Scale	1505		SD in Log Scale	2.045						
91		95% t UCL (assumes normality of ROS data)	1131		95% Percentile Bootstrap UCL	1162						
92		95% BCA Bootstrap UCL	1442		95% Bootstrap t UCL	1652						
93		95% H-UCL (Log ROS)	4030									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.008		KM Geo Mean	149.6						
97		KM SD (logged)	1.755		95% Critical H Value (KM-Log)	3.477						
98		KM Standard Error of Mean (logged)	0.313		95% H-UCL (KM -Log)	2050						
99		KM SD (logged)	1.755		95% Critical H Value (KM-Log)	3.477						
100		KM Standard Error of Mean (logged)	0.313									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	687.7		Mean in Log Scale	4.849						
105		SD in Original Scale	1505		SD in Log Scale	1.965						
106		95% t UCL (Assumes normality)	1132		95% H-Stat UCL	3290						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	1513										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 12:06:28 PM									
5	From File		OU1 1C Surface_g.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzofuran (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			23		
14	Number of Detects			11			Number of Non-Detects			22		
15	Number of Distinct Detects			11			Number of Distinct Non-Detects			12		
16	Minimum Detect			22.3			Minimum Non-Detect			15		
17	Maximum Detect			21400			Maximum Non-Detect			312		
18	Variance Detects			40834277			Percent Non-Detects			66.67%		
19	Mean Detects			2161			SD Detects			6390		
20	Median Detects			60.5			CV Detects			2.957		
21	Skewness Detects			3.299			Kurtosis Detects			10.91		
22	Mean of Logged Detects			5.165			SD of Logged Detects			1.992		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.381			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.85			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.468			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.251			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			731.5			KM Standard Error of Mean			668.2		
33	KM SD			3660			95% KM (BCA) UCL			2047		
34	95% KM (t) UCL			1863			95% KM (Percentile Bootstrap) UCL			2024		
35	95% KM (z) UCL			1831			95% KM Bootstrap t UCL			33632		
36	90% KM Chebyshev UCL			2736			95% KM Chebyshev UCL			3644		
37	97.5% KM Chebyshev UCL			4905			99% KM Chebyshev UCL			7380		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.763			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.829			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.339			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.277			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.278			k star (bias corrected MLE)			0.263		
48	Theta hat (MLE)			7779			Theta star (bias corrected MLE)			8228		
49	nu hat (MLE)			6.112			nu star (bias corrected)			5.778		
50	Mean (detects)			2161								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	720.3						
59		Maximum	21400		Median	0.01						
60		SD	3719		CV	5.163						
61		k hat (MLE)	0.102		k star (bias corrected MLE)	0.113						
62		Theta hat (MLE)	7051		Theta star (bias corrected MLE)	6371						
63		nu hat (MLE)	6.742		nu star (bias corrected)	7.463						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (7.46, α)	2.428		Adjusted Chi Square Value (7.46, β)	2.283						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2214		95% Gamma Adjusted UCL (use when $n < 50$)	2355						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	731.5		SD (KM)	3660						
70		Variance (KM)	13395863		SE of Mean (KM)	668.2						
71		k hat (KM)	0.0399		k star (KM)	0.0565						
72		nu hat (KM)	2.636		nu star (KM)	3.73						
73		theta hat (KM)	18313		theta star (KM)	12943						
74		80% gamma percentile (KM)	148.2		90% gamma percentile (KM)	1293						
75		95% gamma percentile (KM)	4041		99% gamma percentile (KM)	15137						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (3.73, α)	0.618		Adjusted Chi Square Value (3.73, β)	0.559						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	4415		95% Gamma Adjusted KM-UCL (use when $n < 50$)	4877						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.846		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.85		Detected Data Not Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.249		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.251		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Approximate Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	721.1		Mean in Log Scale	1.395						
91		SD in Original Scale	3719		SD in Log Scale	3.133						
92		95% t UCL (assumes normality of ROS data)	1818		95% Percentile Bootstrap UCL	2007						
93		95% BCA Bootstrap UCL	2704		95% Bootstrap t UCL	33610						
94		95% H-UCL (Log ROS)	12617									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	3.562		KM Geo Mean	35.23						
98		KM SD (logged)	1.589		95% Critical H Value (KM-Log)	3.232						
99		KM Standard Error of Mean (logged)	0.292		95% H-UCL (KM -Log)	308.7						
100		KM SD (logged)	1.589		95% Critical H Value (KM-Log)	3.232						
101		KM Standard Error of Mean (logged)	0.292									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	733.6		Mean in Log Scale	3.481						
106		SD in Original Scale	3716		SD in Log Scale	1.729						

	A	B	C	D	E	F	G	H	I	J	K	L
107			95% t UCL (Assumes normality)			1829					95% H-Stat UCL	414
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Approximate Lognormal Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114			95% KM (Chebyshev) UCL			3644						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:44:53 AM									
5	From File		OU1 1C Surface_h.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			33		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			32			Number of Distinct Non-Detects			1		
16	Minimum Detect			52.8			Minimum Non-Detect			14		
17	Maximum Detect			761000			Maximum Non-Detect			14		
18	Variance Detects			1.809E+10			Percent Non-Detects			3.03%		
19	Mean Detects			30151			SD Detects			134490		
20	Median Detects			1085			CV Detects			4.461		
21	Skewness Detects			5.517			Kurtosis Detects			30.84		
22	Mean of Logged Detects			7.334			SD of Logged Detects			2.091		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.236			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.449			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			29238			KM Standard Error of Mean			23072		
33	KM SD			130453			95% KM (BCA) UCL			74429		
34	95% KM (t) UCL			68320			95% KM (Percentile Bootstrap) UCL			74650		
35	95% KM (z) UCL			67188			95% KM Bootstrap t UCL			620812		
36	90% KM Chebyshev UCL			98455			95% KM Chebyshev UCL			129808		
37	97.5% KM Chebyshev UCL			173325			99% KM Chebyshev UCL			258805		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			4.336			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.885			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.297			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.171			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.24			k star (bias corrected MLE)			0.238		
48	Theta hat (MLE)			125670			Theta star (bias corrected MLE)			126545		
49	nu hat (MLE)			15.35			nu star (bias corrected)			15.25		
50	Mean (detects)			30151								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	29237						
59		Maximum	761000		Median	1080						
60		SD	132476		CV	4.531						
61		k hat (MLE)	0.219		k star (bias corrected MLE)	0.219						
62		Theta hat (MLE)	133449		Theta star (bias corrected MLE)	133276						
63		nu hat (MLE)	14.46		nu star (bias corrected)	14.48						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (14.48, α)	6.9		Adjusted Chi Square Value (14.48, β)	6.631						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	61347		95% Gamma Adjusted UCL (use when $n < 50$)	63837						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	29238		SD (KM)	130453						
70		Variance (KM)	1.702E+10		SE of Mean (KM)	23072						
71		k hat (KM)	0.0502		k star (KM)	0.0659						
72		nu hat (KM)	3.315		nu star (KM)	4.347						
73		theta hat (KM)	582062		theta star (KM)	443891						
74		80% gamma percentile (KM)	9044		90% gamma percentile (KM)	59996						
75		95% gamma percentile (KM)	166762		99% gamma percentile (KM)	566249						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (4.35, α)	0.863		Adjusted Chi Square Value (4.35, β)	0.789						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	147199		95% Gamma Adjusted KM-UCL (use when $n < 50$)	161078						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.947		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.138		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	29237		Mean in Log Scale	7.176						
91		SD in Original Scale	132476		SD in Log Scale	2.249						
92		95% t UCL (assumes normality of ROS data)	68300		95% Percentile Bootstrap UCL	74658						
93		95% BCA Bootstrap UCL	119435		95% Bootstrap t UCL	627994						
94		95% H-UCL (Log ROS)	88332									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	7.192		KM Geo Mean	1328						
98		KM SD (logged)	2.181		95% Critical H Value (KM-Log)	4.132						
99		KM Standard Error of Mean (logged)	0.386		95% H-UCL (KM -Log)	70414						
100		KM SD (logged)	2.181		95% Critical H Value (KM-Log)	4.132						
101		KM Standard Error of Mean (logged)	0.386									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	29237		Mean in Log Scale	7.171						
106		SD in Original Scale	132476		SD in Log Scale	2.262						

	A	B	C	D	E	F	G	H	I	J	K	L	
107	95% t UCL (Assumes normality)					68300						95% H-Stat UCL	92184
108	DL/2 is not a recommended method, provided for comparisons and historical reasons												
109													
110	Nonparametric Distribution Free UCL Statistics												
111	Detected Data appear Lognormal Distributed at 5% Significance Level												
112													
113	Suggested UCL to Use												
114	97.5% KM (Chebyshev) UCL					173325							
115													
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
117	Recommendations are based upon data size, data distribution, and skewness.												
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).												
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.												
120													

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:45:47 AM									
5	From File		OU1 1C Surface_i.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Indeno (1,2,3-cd) pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			31		
14	Number of Detects			31			Number of Non-Detects			2		
15	Number of Distinct Detects			30			Number of Distinct Non-Detects			1		
16	Minimum Detect			37.2			Minimum Non-Detect			21		
17	Maximum Detect			44900			Maximum Non-Detect			21		
18	Variance Detects			68665691			Percent Non-Detects			6.061%		
19	Mean Detects			3624			SD Detects			8286		
20	Median Detects			516			CV Detects			2.287		
21	Skewness Detects			4.408			Kurtosis Detects			21.8		
22	Mean of Logged Detects			6.739			SD of Logged Detects			1.756		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.451			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.929			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.333			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.156			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			3406			KM Standard Error of Mean			1406		
33	KM SD			7947			95% KM (BCA) UCL			5993		
34	95% KM (t) UCL			5788			95% KM (Percentile Bootstrap) UCL			5948		
35	95% KM (z) UCL			5719			95% KM Bootstrap t UCL			9343		
36	90% KM Chebyshev UCL			7625			95% KM Chebyshev UCL			9536		
37	97.5% KM Chebyshev UCL			12188			99% KM Chebyshev UCL			17399		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.567			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.822			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.225			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.168			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.444			k star (bias corrected MLE)			0.423		
48	Theta hat (MLE)			8159			Theta star (bias corrected MLE)			8573		
49	nu hat (MLE)			27.54			nu star (bias corrected)			26.21		
50	Mean (detects)			3624								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	3404						
59		Maximum	44900		Median	457						
60		SD	8071		CV	2.371						
61		k hat (MLE)	0.327		k star (bias corrected MLE)	0.317						
62		Theta hat (MLE)	10422		Theta star (bias corrected MLE)	10734						
63		nu hat (MLE)	21.56		nu star (bias corrected)	20.93						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (20.93, α)	11.54		Adjusted Chi Square Value (20.93, β)	11.18						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	6175		95% Gamma Adjusted UCL (use when $n < 50$)	6373						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	3406		SD (KM)	7947						
70		Variance (KM)	63162471		SE of Mean (KM)	1406						
71		k hat (KM)	0.184		k star (KM)	0.187						
72		nu hat (KM)	12.12		nu star (KM)	12.35						
73		theta hat (KM)	18546		theta star (KM)	18198						
74		80% gamma percentile (KM)	4326		90% gamma percentile (KM)	10287						
75		95% gamma percentile (KM)	17847		99% gamma percentile (KM)	38891						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (12.35, α)	5.459		Adjusted Chi Square Value (12.35, β)	5.224						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	7705		95% Gamma Adjusted KM-UCL (use when $n < 50$)	8052						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.962		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.929		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.143		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.156		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	3405		Mean in Log Scale	6.484						
90		SD in Original Scale	8071		SD in Log Scale	1.983						
91		95% t UCL (assumes normality of ROS data)	5785		95% Percentile Bootstrap UCL	5955						
92		95% BCA Bootstrap UCL	7456		95% Bootstrap t UCL	9504						
93		95% H-UCL (Log ROS)	17850									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	6.515		KM Geo Mean	675						
97		KM SD (logged)	1.892		95% Critical H Value (KM-Log)	3.685						
98		KM Standard Error of Mean (logged)	0.335		95% H-UCL (KM -Log)	13879						
99		KM SD (logged)	1.892		95% Critical H Value (KM-Log)	3.685						
100		KM Standard Error of Mean (logged)	0.335									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	3405		Mean in Log Scale	6.473						
105		SD in Original Scale	8071		SD in Log Scale	2.006						
106		95% t UCL (Assumes normality)	5785		95% H-Stat UCL	18996						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Lognormal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (Chebyshev) UCL		9536									
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:46:32 AM									
5	From File		OU1 1C Surface_j.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Phenanthrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			29			Number of Distinct Observations			28		
14	Number of Detects			25			Number of Non-Detects			4		
15	Number of Distinct Detects			25			Number of Distinct Non-Detects			3		
16	Minimum Detect			41.3			Minimum Non-Detect			19		
17	Maximum Detect			319000			Maximum Non-Detect			41		
18	Variance Detects			4.084E+9			Percent Non-Detects			13.79%		
19	Mean Detects			15068			SD Detects			63903		
20	Median Detects			201			CV Detects			4.241		
21	Skewness Detects			4.864			Kurtosis Detects			23.98		
22	Mean of Logged Detects			5.849			SD of Logged Detects			2.197		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.254			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.918			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.47			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.173			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			12992			KM Standard Error of Mean			11062		
33	KM SD			58365			95% KM (BCA) UCL			34816		
34	95% KM (t) UCL			31810			95% KM (Percentile Bootstrap) UCL			34620		
35	95% KM (z) UCL			31187			95% KM Bootstrap t UCL			598905		
36	90% KM Chebyshev UCL			46177			95% KM Chebyshev UCL			61209		
37	97.5% KM Chebyshev UCL			82072			99% KM Chebyshev UCL			123054		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			4.809			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.904			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.374			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.194			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.196			k star (bias corrected MLE)			0.199		
48	Theta hat (MLE)			76961			Theta star (bias corrected MLE)			75734		
49	nu hat (MLE)			9.79			nu star (bias corrected)			9.948		
50	Mean (detects)			15068								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	12990						
59		Maximum	319000		Median	169						
60		SD	59399		CV	4.573						
61		k hat (MLE)	0.152		k star (bias corrected MLE)	0.159						
62		Theta hat (MLE)	85726		Theta star (bias corrected MLE)	81779						
63		nu hat (MLE)	8.789		nu star (bias corrected)	9.213						
64		Adjusted Level of Significance (β)	0.0407									
65		Approximate Chi Square Value (9.21, α)	3.456		Adjusted Chi Square Value (9.21, β)	3.248						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	34628		95% Gamma Adjusted UCL (use when $n < 50$)	36849						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	12992		SD (KM)	58365						
70		Variance (KM)	3.406E+9		SE of Mean (KM)	11062						
71		k hat (KM)	0.0496		k star (KM)	0.0674						
72		nu hat (KM)	2.874		nu star (KM)	3.91						
73		theta hat (KM)	262187		theta star (KM)	192720						
74		80% gamma percentile (KM)	4256		90% gamma percentile (KM)	27193						
75		95% gamma percentile (KM)	74364		99% gamma percentile (KM)	249024						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (3.91, α)	0.687		Adjusted Chi Square Value (3.91, β)	0.614						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	74000		95% Gamma Adjusted KM-UCL (use when $n < 50$)	82796						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.819		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.918		Detected Data Not Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.166		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.173		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Approximate Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	12990		Mean in Log Scale	5.198						
91		SD in Original Scale	59398		SD in Log Scale	2.627						
92		95% t UCL (assumes normality of ROS data)	31754		95% Percentile Bootstrap UCL	34675						
93		95% BCA Bootstrap UCL	46230		95% Bootstrap t UCL	598216						
94		95% H-UCL (Log ROS)	65732									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	5.449		KM Geo Mean	232.4						
98		KM SD (logged)	2.236		95% Critical H Value (KM-Log)	4.285						
99		KM Standard Error of Mean (logged)	0.424		95% H-UCL (KM -Log)	17290						
100		KM SD (logged)	2.236		95% Critical H Value (KM-Log)	4.285						
101		KM Standard Error of Mean (logged)	0.424									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	12992		Mean in Log Scale	5.398						
106		SD in Original Scale	59398		SD in Log Scale	2.339						

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					31755	95% H-Stat UCL					24341
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Approximate Lognormal Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	97.5% KM (Chebyshev) UCL					82072						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/3/2019 10:47:16 AM									
5	From File		OU1 1C Surface_k.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			31		
14	Number of Detects			32			Number of Non-Detects			1		
15	Number of Distinct Detects			30			Number of Distinct Non-Detects			1		
16	Minimum Detect			61			Minimum Non-Detect			16		
17	Maximum Detect			607000			Maximum Non-Detect			16		
18	Variance Detects			1.156E+10			Percent Non-Detects			3.03%		
19	Mean Detects			28317			SD Detects			107524		
20	Median Detects			1660			CV Detects			3.797		
21	Skewness Detects			5.36			Kurtosis Detects			29.54		
22	Mean of Logged Detects			7.752			SD of Logged Detects			2.084		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.28			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.93			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.405			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.154			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			27460			KM Standard Error of Mean			18452		
33	KM SD			104327			95% KM (BCA) UCL			64400		
34	95% KM (t) UCL			58715			95% KM (Percentile Bootstrap) UCL			62549		
35	95% KM (z) UCL			57810			95% KM Bootstrap t UCL			213580		
36	90% KM Chebyshev UCL			82814			95% KM Chebyshev UCL			107888		
37	97.5% KM Chebyshev UCL			142690			99% KM Chebyshev UCL			211051		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			3.156			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.865			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.264			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.17			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.279			k star (bias corrected MLE)			0.274		
48	Theta hat (MLE)			101423			Theta star (bias corrected MLE)			103401		
49	nu hat (MLE)			17.87			nu star (bias corrected)			17.53		
50	Mean (detects)			28317								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	27459						
59		Maximum	607000		Median	1420						
60		SD	105945		CV	3.858						
61		k hat (MLE)	0.25		k star (bias corrected MLE)	0.247						
62		Theta hat (MLE)	109884		Theta star (bias corrected MLE)	111001						
63		nu hat (MLE)	16.49		nu star (bias corrected)	16.33						
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (16.33, α)	8.193		Adjusted Chi Square Value (16.33, β)	7.896						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	54718		95% Gamma Adjusted UCL (use when $n < 50$)	56774						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	27460		SD (KM)	104327						
70		Variance (KM)	1.088E+10		SE of Mean (KM)	18452						
71		k hat (KM)	0.0693		k star (KM)	0.0832						
72		nu hat (KM)	4.572		nu star (KM)	5.49						
73		theta hat (KM)	396371		theta star (KM)	330116						
74		80% gamma percentile (KM)	14075		90% gamma percentile (KM)	66673						
75		95% gamma percentile (KM)	159899		99% gamma percentile (KM)	477375						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (5.49, α)	1.385		Adjusted Chi Square Value (5.49, β)	1.283						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	108845		95% Gamma Adjusted KM-UCL (use when $n < 50$)	117510						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.96		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.93		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.138		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.154		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	27459		Mean in Log Scale	7.594						
91		SD in Original Scale	105945		SD in Log Scale	2.245						
92		95% t UCL (assumes normality of ROS data)	58699		95% Percentile Bootstrap UCL	62271						
93		95% BCA Bootstrap UCL	84298		95% Bootstrap t UCL	202130						
94		95% H-UCL (Log ROS)	132334									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	7.601		KM Geo Mean	2001						
98		KM SD (logged)	2.193		95% Critical H Value (KM-Log)	4.151						
99		KM Standard Error of Mean (logged)	0.388		95% H-UCL (KM -Log)	110868						
100		KM SD (logged)	2.193		95% Critical H Value (KM-Log)	4.151						
101		KM Standard Error of Mean (logged)	0.388									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	27459		Mean in Log Scale	7.58						
106		SD in Original Scale	105945		SD in Log Scale	2.277						

	A	B	C	D	E	F	G	H	I	J	K	L	
107	95% t UCL (Assumes normality)					58699						95% H-Stat UCL	146752
108	DL/2 is not a recommended method, provided for comparisons and historical reasons												
109													
110	Nonparametric Distribution Free UCL Statistics												
111	Detected Data appear Lognormal Distributed at 5% Significance Level												
112													
113	Suggested UCL to Use												
114	97.5% KM (Chebyshev) UCL					142690							
115													
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
117	Recommendations are based upon data size, data distribution, and skewness.												
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).												
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.												
120													

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:18:16 PM									
5	From File		OU1 1D Surface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(a)anthracene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			26		
15							Number of Missing Observations			0		
16	Minimum			51.9			Mean			3191		
17	Maximum			13400			Median			1255		
18	SD			3824			Std. Error of Mean			749.9		
19	Coefficient of Variation			1.198			Skewness			1.266		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.799			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.221			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			4472			95% Adjusted-CLT UCL (Chen-1995)			4623		
31							95% Modified-t UCL (Johnson-1978)			4503		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.537			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.797			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.163			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.18			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.616			k star (bias corrected MLE)			0.571		
42	Theta hat (MLE)			5178			Theta star (bias corrected MLE)			5591		
43	nu hat (MLE)			32.05			nu star (bias corrected)			29.68		
44	MLE Mean (bias corrected)			3191			MLE Sd (bias corrected)			4224		
45							Approximate Chi Square Value (0.05)			18.24		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			17.65		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			5192			95% Adjusted Gamma UCL (use when n<50)			5366		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.946			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.119	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.17	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		3.949				Mean of logged Data		7.069
60				Maximum of Logged Data		9.503				SD of logged Data		1.663
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		14856				90% Chebyshev (MVUE) UCL		9386
64				95% Chebyshev (MVUE) UCL		11739				97.5% Chebyshev (MVUE) UCL		15004
65				99% Chebyshev (MVUE) UCL		21419						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		4424				95% Jackknife UCL		4472
72				95% Standard Bootstrap UCL		4390				95% Bootstrap-t UCL		4825
73				95% Hall's Bootstrap UCL		4632				95% Percentile Bootstrap UCL		4474
74				95% BCA Bootstrap UCL		4591						
75				90% Chebyshev(Mean, Sd) UCL		5441				95% Chebyshev(Mean, Sd) UCL		6460
76				97.5% Chebyshev(Mean, Sd) UCL		7874				99% Chebyshev(Mean, Sd) UCL		10653
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		5366						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:19:17 PM									
5	From File		OU1 1D Surface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(a)pyrene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			26		
15							Number of Missing Observations			0		
16	Minimum			57.4			Mean			2459		
17	Maximum			7900			Median			1300		
18	SD			2549			Std. Error of Mean			499.9		
19	Coefficient of Variation			1.036			Skewness			0.915		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.837			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.224			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			3313			95% Adjusted-CLT UCL (Chen-1995)			3377		
31							95% Modified-t UCL (Johnson-1978)			3328		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.49			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.785			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.119			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.178			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.743			k star (bias corrected MLE)			0.682		
42	Theta hat (MLE)			3312			Theta star (bias corrected MLE)			3603		
43	nu hat (MLE)			38.61			nu star (bias corrected)			35.49		
44	MLE Mean (bias corrected)			2459			MLE Sd (bias corrected)			2977		
45							Approximate Chi Square Value (0.05)			22.86		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			22.19		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			3818			95% Adjusted Gamma UCL (use when n<50)			3933		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.929			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.137	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.17	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		4.05				Mean of logged Data		7
60				Maximum of Logged Data		8.975				SD of logged Data		1.521
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		9360				90% Chebyshev (MVUE) UCL		6756
64				95% Chebyshev (MVUE) UCL		8368				97.5% Chebyshev (MVUE) UCL		10605
65				99% Chebyshev (MVUE) UCL		14999						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		3281				95% Jackknife UCL		3313
72				95% Standard Bootstrap UCL		3291				95% Bootstrap-t UCL		3439
73				95% Hall's Bootstrap UCL		3347				95% Percentile Bootstrap UCL		3332
74				95% BCA Bootstrap UCL		3319						
75				90% Chebyshev(Mean, Sd) UCL		3959				95% Chebyshev(Mean, Sd) UCL		4638
76				97.5% Chebyshev(Mean, Sd) UCL		5581				99% Chebyshev(Mean, Sd) UCL		7433
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		3933						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:20:06 PM									
5	From File		OU1 1D Surface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(b)fluoranthene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			26		
15							Number of Missing Observations			0		
16	Minimum			144			Mean			5839		
17	Maximum			22800			Median			3380		
18	SD			6642			Std. Error of Mean			1303		
19	Coefficient of Variation			1.138			Skewness			1.369		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.795			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.201			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			8064			95% Adjusted-CLT UCL (Chen-1995)			8355		
31							95% Modified-t UCL (Johnson-1978)			8122		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.467			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.786			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.166			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.178			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.735			k star (bias corrected MLE)			0.676		
42	Theta hat (MLE)			7947			Theta star (bias corrected MLE)			8643		
43	nu hat (MLE)			38.2			nu star (bias corrected)			35.13		
44	MLE Mean (bias corrected)			5839			MLE Sd (bias corrected)			7104		
45							Approximate Chi Square Value (0.05)			22.57		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			21.9		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			9088			95% Adjusted Gamma UCL (use when n<50)			9364		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.947			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.145	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.17	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		4.97				Mean of logged Data		7.855
60				Maximum of Logged Data		10.03				SD of logged Data		1.484
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		20006				90% Chebyshev (MVUE) UCL		14891
64				95% Chebyshev (MVUE) UCL		18394				97.5% Chebyshev (MVUE) UCL		23255
65				99% Chebyshev (MVUE) UCL		32805						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		7981				95% Jackknife UCL		8064
72				95% Standard Bootstrap UCL		7939				95% Bootstrap-t UCL		8450
73				95% Hall's Bootstrap UCL		8354				95% Percentile Bootstrap UCL		8029
74				95% BCA Bootstrap UCL		8392						
75				90% Chebyshev(Mean, Sd) UCL		9746				95% Chebyshev(Mean, Sd) UCL		11517
76				97.5% Chebyshev(Mean, Sd) UCL		13973				99% Chebyshev(Mean, Sd) UCL		18799
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		9364						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:21:06 PM									
5	From File		OU1 1D Surface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			26		Number of Distinct Observations			25			
14	Number of Detects			21		Number of Non-Detects			5			
15	Number of Distinct Detects			21		Number of Distinct Non-Detects			4			
16	Minimum Detect			28.5		Minimum Non-Detect			22			
17	Maximum Detect			1390		Maximum Non-Detect			240			
18	Variance Detects			223974		Percent Non-Detects			19.23%			
19	Mean Detects			552.1		SD Detects			473.3			
20	Median Detects			510		CV Detects			0.857			
21	Skewness Detects			0.491		Kurtosis Detects			-1.239			
22	Mean of Logged Detects			5.738		SD of Logged Detects			1.282			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.886		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.908		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.201		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.188		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		452.4		KM Standard Error of Mean			93.07				
33	KM SD		462.9		95% KM (BCA) UCL			598				
34	95% KM (t) UCL		611.4		95% KM (Percentile Bootstrap) UCL			602.4				
35	95% KM (z) UCL		605.5		95% KM Bootstrap t UCL			626.9				
36	90% KM Chebyshev UCL		731.6		95% KM Chebyshev UCL			858.1				
37	97.5% KM Chebyshev UCL		1034		99% KM Chebyshev UCL			1378				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.566		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.77		Detected data appear Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.13		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.195		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		1.002		k star (bias corrected MLE)			0.891				
48	Theta hat (MLE)		550.9		Theta star (bias corrected MLE)			619.8				
49	nu hat (MLE)		42.09		nu star (bias corrected)			37.41				
50	Mean (detects)		552.1									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	449.9						
59		Maximum	1390		Median	192						
60		SD	474.5		CV	1.055						
61		k hat (MLE)	0.337		k star (bias corrected MLE)	0.324						
62		Theta hat (MLE)	1333		Theta star (bias corrected MLE)	1388						
63		nu hat (MLE)	17.54		nu star (bias corrected)	16.85						
64		Adjusted Level of Significance (β)	0.0398									
65		Approximate Chi Square Value (16.85, α)	8.568		Adjusted Chi Square Value (16.85, β)	8.178						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	885		95% Gamma Adjusted UCL (use when $n < 50$)	927.1						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	452.4		SD (KM)	462.9						
70		Variance (KM)	214306		SE of Mean (KM)	93.07						
71		k hat (KM)	0.955		k star (KM)	0.871						
72		nu hat (KM)	49.67		nu star (KM)	45.27						
73		theta hat (KM)	473.7		theta star (KM)	519.7						
74		80% gamma percentile (KM)	735.6		90% gamma percentile (KM)	1078						
75		95% gamma percentile (KM)	1424		99% gamma percentile (KM)	2236						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (45.27, α)	30.83		Adjusted Chi Square Value (45.27, β)	30.05						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	664.2		95% Gamma Adjusted KM-UCL (use when $n < 50$)	681.6						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.905		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.908		Detected Data Not Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.174		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.188		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Approximate Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	451.6		Mean in Log Scale	5.252						
90		SD in Original Scale	472.6		SD in Log Scale	1.552						
91		95% t UCL (assumes normality of ROS data)	609.9		95% Percentile Bootstrap UCL	605						
92		95% BCA Bootstrap UCL	615.6		95% Bootstrap t UCL	627.9						
93		95% H-UCL (Log ROS)	1772									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	5.265		KM Geo Mean	193.4						
97		KM SD (logged)	1.503		95% Critical H Value (KM-Log)	3.222						
98		KM Standard Error of Mean (logged)	0.304		95% H-UCL (KM -Log)	1578						
99		KM SD (logged)	1.503		95% Critical H Value (KM-Log)	3.222						
100		KM Standard Error of Mean (logged)	0.304									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	452.3		Mean in Log Scale	5.196						
105		SD in Original Scale	472.3		SD in Log Scale	1.665						
106		95% t UCL (Assumes normality)	610.6		95% H-Stat UCL	2297						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	681.6										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:22:09 PM									
5	From File		OU1 1D Surface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Indeno (1,2,3-cd) pyrene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			26			Number of Distinct Observations			26		
15							Number of Missing Observations			0		
16	Minimum			50.6			Mean			1950		
17	Maximum			6430			Median			875		
18	SD			2037			Std. Error of Mean			399.4		
19	Coefficient of Variation			1.044			Skewness			0.948		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.831			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.92			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.222			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.17			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			2633			95% Adjusted-CLT UCL (Chen-1995)			2687		
31							95% Modified-t UCL (Johnson-1978)			2645		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			0.467			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.783			Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.129			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.178			Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.783			k star (bias corrected MLE)			0.718		
42	Theta hat (MLE)			2490			Theta star (bias corrected MLE)			2715		
43	nu hat (MLE)			40.72			nu star (bias corrected)			37.36		
44	MLE Mean (bias corrected)			1950			MLE Sd (bias corrected)			2301		
45							Approximate Chi Square Value (0.05)			24.36		
46	Adjusted Level of Significance			0.0398			Adjusted Chi Square Value			23.67		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			2990			95% Adjusted Gamma UCL (use when n<50)			3078		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.942			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.92			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.106	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.17	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		3.924				Mean of logged Data		6.816
60				Maximum of Logged Data		8.769				SD of logged Data		1.443
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		6372				90% Chebyshev (MVUE) UCL		4902
64				95% Chebyshev (MVUE) UCL		6036				97.5% Chebyshev (MVUE) UCL		7611
65				99% Chebyshev (MVUE) UCL		10703						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		2607				95% Jackknife UCL		2633
72				95% Standard Bootstrap UCL		2607				95% Bootstrap-t UCL		2708
73				95% Hall's Bootstrap UCL		2685				95% Percentile Bootstrap UCL		2596
74				95% BCA Bootstrap UCL		2631						
75				90% Chebyshev(Mean, Sd) UCL		3149				95% Chebyshev(Mean, Sd) UCL		3691
76				97.5% Chebyshev(Mean, Sd) UCL		4445				99% Chebyshev(Mean, Sd) UCL		5925
77												
78	Suggested UCL to Use											
79				95% Adjusted Gamma UCL		3078						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 1:37:34 PM									
5	From File		OU1 2 Surface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			18		Number of Distinct Observations			17			
14	Number of Detects			17		Number of Non-Detects			1			
15	Number of Distinct Detects			17		Number of Distinct Non-Detects			1			
16	Minimum Detect			3.07		Minimum Non-Detect			12			
17	Maximum Detect			1190		Maximum Non-Detect			12			
18	Variance Detects			129192		Percent Non-Detects			5.556%			
19	Mean Detects			200.3		SD Detects			359.4			
20	Median Detects			19		CV Detects			1.794			
21	Skewness Detects			1.963		Kurtosis Detects			2.948			
22	Mean of Logged Detects			3.621		SD of Logged Detects			1.897			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.618		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.892		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.374		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.207		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			189.6		KM Standard Error of Mean			83.03			
33	KM SD			341.8		95% KM (BCA) UCL			319.7			
34	95% KM (t) UCL			334		95% KM (Percentile Bootstrap) UCL			328			
35	95% KM (z) UCL			326.1		95% KM Bootstrap t UCL			424.7			
36	90% KM Chebyshev UCL			438.7		95% KM Chebyshev UCL			551.5			
37	97.5% KM Chebyshev UCL			708.1		99% KM Chebyshev UCL			1016			
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.54		Anderson-Darling GOF Test						
41	5% A-D Critical Value			0.821		Detected Data Not Gamma Distributed at 5% Significance Level						
42	K-S Test Statistic			0.286		Kolmogorov-Smirnov GOF						
43	5% K-S Critical Value			0.224		Detected Data Not Gamma Distributed at 5% Significance Level						
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.393		k star (bias corrected MLE)			0.363			
48	Theta hat (MLE)			509.6		Theta star (bias corrected MLE)			551.9			
49	nu hat (MLE)			13.36		nu star (bias corrected)			12.34			
50	Mean (detects)			200.3								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	189.2						
59		Maximum	1190		Median	17.5						
60		SD	351.9		CV	1.86						
61		k hat (MLE)	0.327		k star (bias corrected MLE)	0.31						
62		Theta hat (MLE)	578.4		Theta star (bias corrected MLE)	611						
63		nu hat (MLE)	11.78		nu star (bias corrected)	11.15						
64		Adjusted Level of Significance (β)	0.0357									
65		Approximate Chi Square Value (11.15, α)	4.67		Adjusted Chi Square Value (11.15, β)	4.274						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	451.5		95% Gamma Adjusted UCL (use when $n < 50$)	493.4						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	189.6		SD (KM)	341.8						
70		Variance (KM)	116805		SE of Mean (KM)	83.03						
71		k hat (KM)	0.308		k star (KM)	0.293						
72		nu hat (KM)	11.07		nu star (KM)	10.56						
73		theta hat (KM)	616.2		theta star (KM)	646.1						
74		80% gamma percentile (KM)	289.1		90% gamma percentile (KM)	560.5						
75		95% gamma percentile (KM)	873.3		99% gamma percentile (KM)	1689						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (10.56, α)	4.296		Adjusted Chi Square Value (10.56, β)	3.919						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	466		95% Gamma Adjusted KM-UCL (use when $n < 50$)	510.9						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.888		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.892		Detected Data Not Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.189		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.207		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Approximate Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	189.5		Mean in Log Scale	3.508						
90		SD in Original Scale	351.7		SD in Log Scale	1.902						
91		95% t UCL (assumes normality of ROS data)	333.7		95% Percentile Bootstrap UCL	326.3						
92		95% BCA Bootstrap UCL	379.4		95% Bootstrap t UCL	444.1						
93		95% H-UCL (Log ROS)	1373									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.521		KM Geo Mean	33.83						
97		KM SD (logged)	1.837		95% Critical H Value (KM-Log)	4.021						
98		KM Standard Error of Mean (logged)	0.447		95% H-UCL (KM -Log)	1097						
99		KM SD (logged)	1.837		95% Critical H Value (KM-Log)	4.021						
100		KM Standard Error of Mean (logged)	0.447									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	189.5		Mean in Log Scale	3.519						
105		SD in Original Scale	351.7		SD in Log Scale	1.89						
106		95% t UCL (Assumes normality)	333.7		95% H-Stat UCL	1328						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Lognormal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	97.5% KM (Chebyshev) UCL			708.1			99% KM (Chebyshev) UCL			1016		
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 1:38:32 PM									
5	From File		OU1 2 Surface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(a)pyrene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			18			Number of Distinct Observations			16		
15							Number of Missing Observations			0		
16	Minimum			3.78			Mean			203.3		
17	Maximum			1030			Median			23		
18	SD			349.5			Std. Error of Mean			82.38		
19	Coefficient of Variation			1.719			Skewness			1.678		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.612			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.897			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.389			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.202			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			346.6			95% Adjusted-CLT UCL (Chen-1995)			373.6		
31							95% Modified-t UCL (Johnson-1978)			352.1		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			1.765			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.817			Data Not Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.291			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.217			Data Not Gamma Distributed at 5% Significance Level					
38	Data Not Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.42			k star (bias corrected MLE)			0.387		
42	Theta hat (MLE)			484.1			Theta star (bias corrected MLE)			525.3		
43	nu hat (MLE)			15.12			nu star (bias corrected)			13.93		
44	MLE Mean (bias corrected)			203.3			MLE Sd (bias corrected)			326.8		
45							Approximate Chi Square Value (0.05)			6.525		
46	Adjusted Level of Significance			0.0357			Adjusted Chi Square Value			6.043		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			434.1			95% Adjusted Gamma UCL (use when n<50)			468.7		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.88			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.897			Data Not Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.213		Lilliefors Lognormal GOF Test				
55				5% Lilliefors Critical Value		0.202		Data Not Lognormal at 5% Significance Level				
56	Data Not Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		1.33				Mean of logged Data		3.76
60				Maximum of Logged Data		6.937				SD of logged Data		1.802
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		1228				90% Chebyshev (MVUE) UCL		452.9
64				95% Chebyshev (MVUE) UCL		576.8				97.5% Chebyshev (MVUE) UCL		748.9
65				99% Chebyshev (MVUE) UCL		1087						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data do not follow a Discernible Distribution (0.05)											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		338.8				95% Jackknife UCL		346.6
72				95% Standard Bootstrap UCL		338.4				95% Bootstrap-t UCL		406.9
73				95% Hall's Bootstrap UCL		319.5				95% Percentile Bootstrap UCL		336.6
74				95% BCA Bootstrap UCL		371.6						
75				90% Chebyshev(Mean, Sd) UCL		450.5				95% Chebyshev(Mean, Sd) UCL		562.4
76				97.5% Chebyshev(Mean, Sd) UCL		717.8				99% Chebyshev(Mean, Sd) UCL		1023
77												
78	Suggested UCL to Use											
79				99% Chebyshev (Mean, Sd) UCL		1023						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 1:39:10 PM									
5	From File		OU1 2 Surface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10												
11	Benzo(b)fluoranthene (ug/kg)											
12												
13	General Statistics											
14	Total Number of Observations			18			Number of Distinct Observations			18		
15							Number of Missing Observations			0		
16	Minimum			10			Mean			620		
17	Maximum			3510			Median			69.5		
18	SD			1071			Std. Error of Mean			252.4		
19	Coefficient of Variation			1.727			Skewness			1.84		
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic			0.629			Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value			0.897			Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic			0.386			Lilliefors GOF Test					
25	5% Lilliefors Critical Value			0.202			Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL			1059			95% Adjusted-CLT UCL (Chen-1995)			1152		
31							95% Modified-t UCL (Johnson-1978)			1077		
32												
33	Gamma GOF Test											
34	A-D Test Statistic			1.552			Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value			0.816			Data Not Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic			0.286			Kolmogorov-Smirnov Gamma GOF Test					
37	5% K-S Critical Value			0.217			Data Not Gamma Distributed at 5% Significance Level					
38	Data Not Gamma Distributed at 5% Significance Level											
39												
40	Gamma Statistics											
41	k hat (MLE)			0.423			k star (bias corrected MLE)			0.389		
42	Theta hat (MLE)			1467			Theta star (bias corrected MLE)			1593		
43	nu hat (MLE)			15.21			nu star (bias corrected)			14.01		
44	MLE Mean (bias corrected)			620			MLE Sd (bias corrected)			993.9		
45							Approximate Chi Square Value (0.05)			6.577		
46	Adjusted Level of Significance			0.0357			Adjusted Chi Square Value			6.093		
47												
48	Assuming Gamma Distribution											
49	95% Approximate Gamma UCL (use when n>=50)			1321			95% Adjusted Gamma UCL (use when n<50)			1425		
50												
51	Lognormal GOF Test											
52	Shapiro Wilk Test Statistic			0.901			Shapiro Wilk Lognormal GOF Test					
53	5% Shapiro Wilk Critical Value			0.897			Data appear Lognormal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
54				Lilliefors Test Statistic		0.187	Lilliefors Lognormal GOF Test					
55				5% Lilliefors Critical Value		0.202	Data appear Lognormal at 5% Significance Level					
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59				Minimum of Logged Data		2.303				Mean of logged Data		4.886
60				Maximum of Logged Data		8.163				SD of logged Data		1.816
61												
62	Assuming Lognormal Distribution											
63				95% H-UCL		3977				90% Chebyshev (MVUE) UCL		1432
64				95% Chebyshev (MVUE) UCL		1826				97.5% Chebyshev (MVUE) UCL		2372
65				99% Chebyshev (MVUE) UCL		3444						
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71				95% CLT UCL		1035				95% Jackknife UCL		1059
72				95% Standard Bootstrap UCL		1026				95% Bootstrap-t UCL		1321
73				95% Hall's Bootstrap UCL		1061				95% Percentile Bootstrap UCL		1043
74				95% BCA Bootstrap UCL		1119						
75				90% Chebyshev(Mean, Sd) UCL		1377				95% Chebyshev(Mean, Sd) UCL		1720
76				97.5% Chebyshev(Mean, Sd) UCL		2196				99% Chebyshev(Mean, Sd) UCL		3131
77												
78	Suggested UCL to Use											
79				99% Chebyshev (Mean, Sd) UCL		3131						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 1:39:42 PM									
5	From File		OU1 2 Surface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			18		Number of Distinct Observations			18			
14	Number of Detects			10		Number of Non-Detects			8			
15	Number of Distinct Detects			10		Number of Distinct Non-Detects			8			
16	Minimum Detect			2.95		Minimum Non-Detect			2.06			
17	Maximum Detect			230		Maximum Non-Detect			12			
18	Variance Detects			6995		Percent Non-Detects			44.44%			
19	Mean Detects			58.17		SD Detects			83.64			
20	Median Detects			13		CV Detects			1.438			
21	Skewness Detects			1.364		Kurtosis Detects			0.459			
22	Mean of Logged Detects			2.847		SD of Logged Detects			1.718			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.715		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.842		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.367		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.262		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		33.3		KM Standard Error of Mean			16.24				
33	KM SD		65.36		95% KM (BCA) UCL			62.02				
34	95% KM (t) UCL		61.55		95% KM (Percentile Bootstrap) UCL			60.17				
35	95% KM (z) UCL		60.01		95% KM Bootstrap t UCL			85.27				
36	90% KM Chebyshev UCL		82.01		95% KM Chebyshev UCL			104.1				
37	97.5% KM Chebyshev UCL		134.7		99% KM Chebyshev UCL			194.9				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.834		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.775		Detected Data Not Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.246		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.28		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.519		k star (bias corrected MLE)			0.43				
48	Theta hat (MLE)		112		Theta star (bias corrected MLE)			135.2				
49	nu hat (MLE)		10.38		nu star (bias corrected)			8.602				
50	Mean (detects)		58.17									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	32.32						
59		Maximum	230		Median	3.17						
60		SD	67.73		CV	2.096						
61		k hat (MLE)	0.188		k star (bias corrected MLE)	0.194						
62		Theta hat (MLE)	171.5		Theta star (bias corrected MLE)	166.5						
63		nu hat (MLE)	6.785		nu star (bias corrected)	6.987						
64		Adjusted Level of Significance (β)	0.0357									
65		Approximate Chi Square Value (6.99, α)	2.164		Adjusted Chi Square Value (6.99, β)	1.915						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	104.4		95% Gamma Adjusted UCL (use when $n < 50$)	117.9						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	33.3		SD (KM)	65.36						
70		Variance (KM)	4271		SE of Mean (KM)	16.24						
71		k hat (KM)	0.26		k star (KM)	0.253						
72		nu hat (KM)	9.345		nu star (KM)	9.121						
73		theta hat (KM)	128.3		theta star (KM)	131.4						
74		80% gamma percentile (KM)	48.59		90% gamma percentile (KM)	99.85						
75		95% gamma percentile (KM)	160.5		99% gamma percentile (KM)	321.8						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (9.12, α)	3.4		Adjusted Chi Square Value (9.12, β)	3.072						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	89.32		95% Gamma Adjusted KM-UCL (use when $n < 50$)	98.86						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.856		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.842		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.211		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.262		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	32.47		Mean in Log Scale	1.044						
90		SD in Original Scale	67.66		SD in Log Scale	2.439						
91		95% t UCL (assumes normality of ROS data)	60.21		95% Percentile Bootstrap UCL	59.94						
92		95% BCA Bootstrap UCL	64.48		95% Bootstrap t UCL	85.99						
93		95% H-UCL (Log ROS)	1152									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	1.92		KM Geo Mean	6.821						
97		KM SD (logged)	1.602		95% Critical H Value (KM-Log)	3.608						
98		KM Standard Error of Mean (logged)	0.399		95% H-UCL (KM -Log)	100						
99		KM SD (logged)	1.602		95% Critical H Value (KM-Log)	3.608						
100		KM Standard Error of Mean (logged)	0.399									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	33.09		Mean in Log Scale	1.725						
105		SD in Original Scale	67.36		SD in Log Scale	1.837						
106		95% t UCL (Assumes normality)	60.7		95% H-Stat UCL	181.9						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	98.86										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

Table B-2
Subsurface Soil Exposure Point Concentrations
Kerr-McGee Chemical Corp - Navassa Superfund Site
Navassa, North Carolina

Exposure Point		Chemical of Potential Concern (COPC)	Screening Toxicity Value ⁽¹⁾ (mg/kg)	# of Detections	# of Samples	% of NDs	Arithmetic Mean (mg/kg)	Maximum Concentration (mg/kg)	95% Upper Confidence Level (UCL) (mg/kg)	Background Level (2x Mean) (mg/kg)	Exposure Point Concentration	
Area	Medium										Value (mg/kg)	Statistical Test
1B	Subsurface Soils	Benzo(a)anthracene	1.1	7	19	63%	3.95	37.2	17.59	0.01375	17.59	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	6	19	68%	1.06	8.35	2.128	0.01591	2.128	95% KM (t) UCL
		Benzo(b)fluoranthene	1.1	8	19	58%	2.16	21.3	8.194	0.02270	8.194	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	2	19	89%	0.17	1.2	--	0.00821	0.171	Arithmetic Mean
		Dibenzofuran	7.3	4	19	79%	1.81	33.2	15.76	NA	15.76	95% Gamma Adjusted KM-UCL
		Fluoranthene	240	9	19	53%	27.94	299	135.5	0.04690	135.5	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	6	19	68%	0.59	5.46	1.192	0.01473	1.192	95% KM (t) UCL
		Phenanthrene	180	5	17	71%	18.42	297	163.1	0.03898	163.1	95% Gamma Adjusted KM-UCL
1C	Subsurface Soils	Benzo(a)anthracene	1.1	15	37	59%	2.30	30.9	6.192	0.01375	6.192	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	14	37	62%	1.10	9.75	2.337	0.01591	2.337	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	16	37	57%	2.42	25	5.175	0.02270	5.175	95% Gamma Adjusted KM-UCL
		Benzo(k)fluoranthene	11	14	37	62%	0.97	11.8	2.191	0.01085	2.191	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	10	37	73%	0.20	1.45	0.306	0.00821	0.306	95% KM (t) UCL
		Dibenzofuran	7.3	7	37	81%	1.14	28.1	5.007	NA	5.007	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	13	37	65%	0.67	5.17	1.364	0.01473	1.364	95% Gamma Adjusted KM-UCL
		Naphthalene	3.8	8	37	78%	0.15	4.12	0.6586	0.06240	0.6586	95% KM Chebyshev UCL
Phenanthrene	180	12	33	64%	13.35	240	51.12	0.03898	51.12	95% KM Chebyshev UCL		
1D	Subsurface Soils	Benzo(a)anthracene	1.1	9	23	61%	0.62	9.49	2.913	0.01375	2.913	95% Gamma Adjusted KM-UCL
		Benzo(a)pyrene	0.11	8	23	65%	0.44	5.42	1.627	0.01591	1.627	95% Gamma Adjusted KM-UCL
		Benzo(b)fluoranthene	1.1	11	23	52%	0.82	8.72	2.886	0.02270	2.886	95% Gamma Adjusted KM-UCL
		Dibenzo(a,h)anthracene	0.11	6	23	74%	0.11	1.2	0.337	0.00821	0.337	95% Gamma Adjusted KM-UCL
		Indeno(1,2,3-cd)pyrene	1.1	6	23	74%	0.31	3.06	1.007	0.01473	1.007	95% Gamma Adjusted KM-UCL

Notes

Subsurface soil collected at greater than 1-foot below ground surface (bgs)

(1) - Resident Soil RSL THQ=0.1 from RSL Tables, April 2019

RSL - Risk Screening Level

THQ - Total Hazard Quotient

ND - Not detected above the method detection limit

NA - Not Applicable

mg/kg - milligrams per kilogram

1.2 - Maximum concentration was non-detect due to elevated detection limits.

Duplicates were not included as individual samples. Instead, the average concentration was used.

Method Detection Limit (MDL) was used for non-detects.

According to the ProUCL User Guide (USEPA, 2015), for data sets with low detection frequencies, use of the median or mode represent better estimates (with lesser uncertainty) of the mean. To be conservative, the arithmetic mean is used as the exposure point concentration when the the detection frequency was low (e.g., ≤ 10% or less than 4 detections).

Prepared By: RAH 7/24/2019

Checked By: SMA 7/24/2019

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:10:29 PM									
5	From File		OU1 1B Subsurface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			13		
14	Number of Detects			7			Number of Non-Detects			12		
15	Number of Distinct Detects			7			Number of Distinct Non-Detects			7		
16	Minimum Detect			19			Minimum Non-Detect			13		
17	Maximum Detect			37200			Maximum Non-Detect			33		
18	Variance Detects			2.889E+8			Percent Non-Detects			63.16%		
19	Mean Detects			10686			SD Detects			16997		
20	Median Detects			190			CV Detects			1.591		
21	Skewness Detects			1.221			Kurtosis Detects			-0.77		
22	Mean of Logged Detects			6.332			SD of Logged Detects			3.344		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.662			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.803			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.375			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.304			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			3946			KM Standard Error of Mean			2689		
33	KM SD			10850			95% KM (BCA) UCL			8041		
34	95% KM (t) UCL			8608			95% KM (Percentile Bootstrap) UCL			7869		
35	95% KM (z) UCL			8368			95% KM Bootstrap t UCL			52615		
36	90% KM Chebyshev UCL			12012			95% KM Chebyshev UCL			15665		
37	97.5% KM Chebyshev UCL			20737			99% KM Chebyshev UCL			30698		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.624			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.806			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.278			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.339			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.242			k star (bias corrected MLE)			0.234		
48	Theta hat (MLE)			44082			Theta star (bias corrected MLE)			45714		
49	nu hat (MLE)			3.394			nu star (bias corrected)			3.273		
50	Mean (detects)			10686								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	3937						
59		Maximum	37200		Median	0.01						
60		SD	11151		CV	2.832						
61		k hat (MLE)	0.0926		k star (bias corrected MLE)	0.113						
62		Theta hat (MLE)	42516		Theta star (bias corrected MLE)	34820						
63		nu hat (MLE)	3.519		nu star (bias corrected)	4.297						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.30, α)	0.842		Adjusted Chi Square Value (4.30, β)	0.721						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	20084		95% Gamma Adjusted UCL (use when $n < 50$)	23465						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	3946		SD (KM)	10850						
70		Variance (KM)	1.177E+8		SE of Mean (KM)	2689						
71		k hat (KM)	0.132		k star (KM)	0.146						
72		nu hat (KM)	5.025		nu star (KM)	5.565						
73		theta hat (KM)	29837		theta star (KM)	26943						
74		80% gamma percentile (KM)	4210		90% gamma percentile (KM)	11660						
75		95% gamma percentile (KM)	21817		99% gamma percentile (KM)	51438						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (5.57, α)	1.422		Adjusted Chi Square Value (5.57, β)	1.249						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	15444		95% Gamma Adjusted KM-UCL (use when $n < 50$)	17588						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.854		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.803		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.199		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.304		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	3937		Mean in Log Scale	0.535						
90		SD in Original Scale	11151		SD in Log Scale	5.213						
91		95% t UCL (assumes normality of ROS data)	8373		95% Percentile Bootstrap UCL	8061						
92		95% BCA Bootstrap UCL	9802		95% Bootstrap t UCL	54246						
93		95% H-UCL (Log ROS)	4.178E+11									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.984		KM Geo Mean	53.73						
97		KM SD (logged)	2.6		95% Critical H Value (KM-Log)	5.335						
98		KM Standard Error of Mean (logged)	0.645		95% H-UCL (KM -Log)	41446						
99		KM SD (logged)	2.6		95% Critical H Value (KM-Log)	5.335						
100		KM Standard Error of Mean (logged)	0.645									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	3943		Mean in Log Scale	3.779						
105		SD in Original Scale	11149		SD in Log Scale	2.787						
106		95% t UCL (Assumes normality)	8379		95% H-Stat UCL	88884						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	17588										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:12:06 PM									
5	From File		OU1 1B Subsurface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			13		
14	Number of Detects			6			Number of Non-Detects			13		
15	Number of Distinct Detects			6			Number of Distinct Non-Detects			7		
16	Minimum Detect			29.8			Minimum Non-Detect			21		
17	Maximum Detect			8350			Maximum Non-Detect			33		
18	Variance Detects			14026038			Percent Non-Detects			68.42%		
19	Mean Detects			3306			SD Detects			3745		
20	Median Detects			2270			CV Detects			1.133		
21	Skewness Detects			0.421			Kurtosis Detects			-2.243		
22	Mean of Logged Detects			6.514			SD of Logged Detects			2.514		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.827			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.788			Detected Data appear Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.3			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.325			Detected Data appear Normal at 5% Significance Level					
29	Detected Data appear Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			1059			KM Standard Error of Mean			616.8		
33	KM SD			2454			95% KM (BCA) UCL			2075		
34	95% KM (t) UCL			2128			95% KM (Percentile Bootstrap) UCL			2078		
35	95% KM (z) UCL			2073			95% KM Bootstrap t UCL			2979		
36	90% KM Chebyshev UCL			2909			95% KM Chebyshev UCL			3747		
37	97.5% KM Chebyshev UCL			4910			99% KM Chebyshev UCL			7195		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.576			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.749			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.277			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.352			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.412			k star (bias corrected MLE)			0.317		
48	Theta hat (MLE)			8027			Theta star (bias corrected MLE)			10428		
49	nu hat (MLE)			4.943			nu star (bias corrected)			3.805		
50	Mean (detects)			3306								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	1044						
59		Maximum	8350		Median	0.01						
60		SD	2528		CV	2.421						
61		k hat (MLE)	0.101		k star (bias corrected MLE)	0.12						
62		Theta hat (MLE)	10354		Theta star (bias corrected MLE)	8701						
63		nu hat (MLE)	3.832		nu star (bias corrected)	4.56						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.56, α)	0.955		Adjusted Chi Square Value (4.56, β)	0.822						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	4987		95% Gamma Adjusted UCL (use when $n < 50$)	5791						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	1059		SD (KM)	2454						
70		Variance (KM)	6023226		SE of Mean (KM)	616.8						
71		k hat (KM)	0.186		k star (KM)	0.192						
72		nu hat (KM)	7.069		nu star (KM)	7.286						
73		theta hat (KM)	5690		theta star (KM)	5521						
74		80% gamma percentile (KM)	1363		90% gamma percentile (KM)	3200						
75		95% gamma percentile (KM)	5514		99% gamma percentile (KM)	11928						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (7.29, α)	2.329		Adjusted Chi Square Value (7.29, β)	2.092						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	3312		95% Gamma Adjusted KM-UCL (use when $n < 50$)	3688						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.844		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.788		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.272		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.325		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	1045		Mean in Log Scale	0.813						
90		SD in Original Scale	2528		SD in Log Scale	4.465						
91		95% t UCL (assumes normality of ROS data)	2050		95% Percentile Bootstrap UCL	2044						
92		95% BCA Bootstrap UCL	2404		95% Bootstrap t UCL	3074						
93		95% H-UCL (Log ROS)	5.138E+8									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.141		KM Geo Mean	62.89						
97		KM SD (logged)	2.064		95% Critical H Value (KM-Log)	4.365						
98		KM Standard Error of Mean (logged)	0.519		95% H-UCL (KM -Log)	4429						
99		KM SD (logged)	2.064		95% Critical H Value (KM-Log)	4.365						
100		KM Standard Error of Mean (logged)	0.519									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	1052		Mean in Log Scale	3.743						
105		SD in Original Scale	2524		SD in Log Scale	2.346						
106		95% t UCL (Assumes normality)	2056		95% H-Stat UCL	9808						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Normal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (t) UCL 2128											
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:12:51 PM									
5	From File		OU1 1B Subsurface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(b)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			15		
14	Number of Detects			8			Number of Non-Detects			11		
15	Number of Distinct Detects			8			Number of Distinct Non-Detects			7		
16	Minimum Detect			31.7			Minimum Non-Detect			19		
17	Maximum Detect			21300			Maximum Non-Detect			33		
18	Variance Detects			59920227			Percent Non-Detects			57.89%		
19	Mean Detects			5107			SD Detects			7741		
20	Median Detects			375			CV Detects			1.516		
21	Skewness Detects			1.559			Kurtosis Detects			2.011		
22	Mean of Logged Detects			6.419			SD of Logged Detects			2.648		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.728			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.818			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.346			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.283			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			2161			KM Standard Error of Mean			1307		
33	KM SD			5328			95% KM (BCA) UCL			4418		
34	95% KM (t) UCL			4427			95% KM (Percentile Bootstrap) UCL			4398		
35	95% KM (z) UCL			4311			95% KM Bootstrap t UCL			6384		
36	90% KM Chebyshev UCL			6082			95% KM Chebyshev UCL			7857		
37	97.5% KM Chebyshev UCL			10322			99% KM Chebyshev UCL			15163		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.623			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.793			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.243			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.316			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.322			k star (bias corrected MLE)			0.284		
48	Theta hat (MLE)			15878			Theta star (bias corrected MLE)			17960		
49	nu hat (MLE)			5.146			nu star (bias corrected)			4.55		
50	Mean (detects)			5107								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	2150						
59		Maximum	21300		Median	0.01						
60		SD	5478		CV	2.548						
61		k hat (MLE)	0.106		k star (bias corrected MLE)	0.124						
62		Theta hat (MLE)	20362		Theta star (bias corrected MLE)	17339						
63		nu hat (MLE)	4.013		nu star (bias corrected)	4.713						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.71, α)	1.022		Adjusted Chi Square Value (4.71, β)	0.883						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	9918		95% Gamma Adjusted UCL (use when $n < 50$)	11477						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	2161		SD (KM)	5328						
70		Variance (KM)	28386602		SE of Mean (KM)	1307						
71		k hat (KM)	0.165		k star (KM)	0.174						
72		nu hat (KM)	6.254		nu star (KM)	6.6						
73		theta hat (KM)	13133		theta star (KM)	12445						
74		80% gamma percentile (KM)	2621		90% gamma percentile (KM)	6505						
75		95% gamma percentile (KM)	11531		99% gamma percentile (KM)	25706						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (6.60, α)	1.954		Adjusted Chi Square Value (6.60, β)	1.741						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	7302		95% Gamma Adjusted KM-UCL (use when $n < 50$)	8194						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.874		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.818		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.221		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.283		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	2151		Mean in Log Scale	1.88						
90		SD in Original Scale	5478		SD in Log Scale	4.442						
91		95% t UCL (assumes normality of ROS data)	4330		95% Percentile Bootstrap UCL	4314						
92		95% BCA Bootstrap UCL	5056		95% Bootstrap t UCL	6515						
93		95% H-UCL (Log ROS)	1.202E+9									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.41		KM Geo Mean	82.25						
97		KM SD (logged)	2.349		95% Critical H Value (KM-Log)	4.878						
98		KM Standard Error of Mean (logged)	0.576		95% H-UCL (KM -Log)	19364						
99		KM SD (logged)	2.349		95% Critical H Value (KM-Log)	4.878						
100		KM Standard Error of Mean (logged)	0.576									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	2157		Mean in Log Scale	4.104						
105		SD in Original Scale	5476		SD in Log Scale	2.618						
106		95% t UCL (Assumes normality)	4335		95% H-Stat UCL	51196						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k <= 1$)	8194										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:14:46 PM									
5	From File		OU1 1B Subsurface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzofuran (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			11		
14	Number of Detects			4			Number of Non-Detects			15		
15	Number of Distinct Detects			4			Number of Distinct Non-Detects			7		
16	Minimum Detect			27			Minimum Non-Detect			15		
17	Maximum Detect			33200			Maximum Non-Detect			33		
18	Variance Detects			2.712E+8			Percent Non-Detects			78.95%		
19	Mean Detects			8503			SD Detects			16467		
20	Median Detects			391.5			CV Detects			1.937		
21	Skewness Detects			1.998			Kurtosis Detects			3.994		
22	Mean of Logged Detects			6.261			SD of Logged Detects			3.057		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.644			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.748			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.433			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.375			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			1802			KM Standard Error of Mean			1961		
33	KM SD			7402			95% KM (BCA) UCL			N/A		
34	95% KM (t) UCL			5202			95% KM (Percentile Bootstrap) UCL			N/A		
35	95% KM (z) UCL			5027			95% KM Bootstrap t UCL			N/A		
36	90% KM Chebyshev UCL			7684			95% KM Chebyshev UCL			10349		
37	97.5% KM Chebyshev UCL			14047			99% KM Chebyshev UCL			21312		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.465			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.717			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.345			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.421			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.254			k star (bias corrected MLE)			0.23		
48	Theta hat (MLE)			33455			Theta star (bias corrected MLE)			36935		
49	nu hat (MLE)			2.033			nu star (bias corrected)			1.842		
50	Mean (detects)			8503								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	1790						
59		Maximum	33200		Median	0.01						
60		SD	7608		CV	4.25						
61		k hat (MLE)	0.0845		k star (bias corrected MLE)	0.106						
62		Theta hat (MLE)	21180		Theta star (bias corrected MLE)	16846						
63		nu hat (MLE)	3.212		nu star (bias corrected)	4.038						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.04, α)	0.737		Adjusted Chi Square Value (4.04, β)	0.626						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	9811		95% Gamma Adjusted UCL (use when $n < 50$)	N/A						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	1802		SD (KM)	7402						
70		Variance (KM)	54789334		SE of Mean (KM)	1961						
71		k hat (KM)	0.0593		k star (KM)	0.085						
72		nu hat (KM)	2.252		nu star (KM)	3.23						
73		theta hat (KM)	30406		theta star (KM)	21201						
74		80% gamma percentile (KM)	960.7		90% gamma percentile (KM)	4430						
75		95% gamma percentile (KM)	10497		99% gamma percentile (KM)	31004						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (3.23, α)	0.444		Adjusted Chi Square Value (3.23, β)	0.369						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	13119		95% Gamma Adjusted KM-UCL (use when $n < 50$)	15763						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.95		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.748		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.221		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.375		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	1790		Mean in Log Scale	-4.025						
91		SD in Original Scale	7608		SD in Log Scale	6.317						
92		95% t UCL (assumes normality of ROS data)	4817		95% Percentile Bootstrap UCL	5279						
93		95% BCA Bootstrap UCL	7051		95% Bootstrap t UCL	463865						
94		95% H-UCL (Log ROS)	8.666E+14									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	3.46		KM Geo Mean	31.83						
98		KM SD (logged)	1.889		95% Critical H Value (KM-Log)	4.055						
99		KM Standard Error of Mean (logged)	0.501		95% H-UCL (KM -Log)	1154						
100		KM SD (logged)	1.889		95% Critical H Value (KM-Log)	4.055						
101		KM Standard Error of Mean (logged)	0.501									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	1798		Mean in Log Scale	3.153						
106		SD in Original Scale	7606		SD in Log Scale	2.076						

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					4824	95% H-Stat UCL					1731
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Gamma Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	Justified KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)					15763						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:15:35 PM									
5	From File		OU1 1B Subsurface_f.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			15		
14	Number of Detects			9			Number of Non-Detects			10		
15	Number of Distinct Detects			9			Number of Distinct Non-Detects			7		
16	Minimum Detect			18.3			Minimum Non-Detect			14		
17	Maximum Detect			299000			Maximum Non-Detect			33		
18	Variance Detects			1.354E+10			Percent Non-Detects			52.63%		
19	Mean Detects			58963			SD Detects			116370		
20	Median Detects			48.1			CV Detects			1.974		
21	Skewness Detects			1.73			Kurtosis Detects			1.477		
22	Mean of Logged Detects			6.363			SD of Logged Detects			3.947		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.577			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.829			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.45			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.274			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			27938			KM Standard Error of Mean			19721		
33	KM SD			81044			95% KM (BCA) UCL			63716		
34	95% KM (t) UCL			62134			95% KM (Percentile Bootstrap) UCL			60827		
35	95% KM (z) UCL			60375			95% KM Bootstrap t UCL			1491275		
36	90% KM Chebyshev UCL			87100			95% KM Chebyshev UCL			113898		
37	97.5% KM Chebyshev UCL			151093			99% KM Chebyshev UCL			224156		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.114			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.879			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.306			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.312			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.164		k star (bias corrected MLE)		0.183					
48	Theta hat (MLE)		359309		Theta star (bias corrected MLE)		321368					
49	nu hat (MLE)		2.954		nu star (bias corrected)		3.303					
50	Mean (detects)		58963									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	27930						
59		Maximum	299000		Median	0.01						
60		SD	83268		CV	2.981						
61		k hat (MLE)	0.0858		k star (bias corrected MLE)	0.107						
62		Theta hat (MLE)	325635		Theta star (bias corrected MLE)	260259						
63		nu hat (MLE)	3.259		nu star (bias corrected)	4.078						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.08, α)	0.753		Adjusted Chi Square Value (4.08, β)	0.641						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	151309		95% Gamma Adjusted UCL (use when $n < 50$)	177747						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	27938		SD (KM)	81044						
70		Variance (KM)	6.568E+9		SE of Mean (KM)	19721						
71		k hat (KM)	0.119		k star (KM)	0.135						
72		nu hat (KM)	4.516		nu star (KM)	5.136						
73		theta hat (KM)	235103		theta star (KM)	206706						
74		80% gamma percentile (KM)	27730		90% gamma percentile (KM)	81407						
75		95% gamma percentile (KM)	156675		99% gamma percentile (KM)	380033						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (5.14, α)	1.216		Adjusted Chi Square Value (5.14, β)	1.059						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	118046		95% Gamma Adjusted KM-UCL (use when $n < 50$)	135454						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.806		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.829		Detected Data Not Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.291		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.274		Detected Data Not Lognormal at 5% Significance Level							
86	Detected Data Not Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	27930		Mean in Log Scale	1.207						
90		SD in Original Scale	83268		SD in Log Scale	5.812						
91		95% t UCL (assumes normality of ROS data)	61055		95% Percentile Bootstrap UCL	62902						
92		95% BCA Bootstrap UCL	74811		95% Bootstrap t UCL	1480876						
93		95% H-UCL (Log ROS)	4.582E+14									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.431		KM Geo Mean	84.02						
97		KM SD (logged)	3.15		95% Critical H Value (KM-Log)	6.359						
98		KM Standard Error of Mean (logged)	0.767		95% H-UCL (KM -Log)	1349404						
99		KM SD (logged)	3.15		95% Critical H Value (KM-Log)	6.359						
100		KM Standard Error of Mean (logged)	0.767									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	27935		Mean in Log Scale	4.23						
105		SD in Original Scale	83266		SD in Log Scale	3.357						
106		95% t UCL (Assumes normality)	61060		95% H-Stat UCL	4004623						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	135454										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:16:24 PM									
5	From File		OU1 1B Subsurface_g.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Indeno (1,2,3-cd) pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			19			Number of Distinct Observations			14		
14	Number of Detects			6			Number of Non-Detects			13		
15	Number of Distinct Detects			5			Number of Distinct Non-Detects			9		
16	Minimum Detect			34.9			Minimum Non-Detect			20		
17	Maximum Detect			5460			Maximum Non-Detect			33		
18	Variance Detects			4712221			Percent Non-Detects			68.42%		
19	Mean Detects			1811			SD Detects			2171		
20	Median Detects			1355			CV Detects			1.198		
21	Skewness Detects			0.992			Kurtosis Detects			0.219		
22	Mean of Logged Detects			6.161			SD of Logged Detects			2.186		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.826			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.788			Detected Data appear Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.282			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.325			Detected Data appear Normal at 5% Significance Level					
29	Detected Data appear Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			585.7			KM Standard Error of Mean			349.4		
33	KM SD			1390			95% KM (BCA) UCL			1146		
34	95% KM (t) UCL			1192			95% KM (Percentile Bootstrap) UCL			1160		
35	95% KM (z) UCL			1161			95% KM Bootstrap t UCL			1582		
36	90% KM Chebyshev UCL			1634			95% KM Chebyshev UCL			2109		
37	97.5% KM Chebyshev UCL			2768			99% KM Chebyshev UCL			4063		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.545			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.739			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.285			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.35			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.477			k star (bias corrected MLE)			0.35		
48	Theta hat (MLE)			3797			Theta star (bias corrected MLE)			5181		
49	nu hat (MLE)			5.725			nu star (bias corrected)			4.196		
50	Mean (detects)			1811								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	572						
59		Maximum	5460		Median	0.01						
60		SD	1434		CV	2.507						
61		k hat (MLE)	0.107		k star (bias corrected MLE)	0.125						
62		Theta hat (MLE)	5365		Theta star (bias corrected MLE)	4581						
63		nu hat (MLE)	4.052		nu star (bias corrected)	4.745						
64		Adjusted Level of Significance (β)	0.0369									
65		Approximate Chi Square Value (4.75, α)	1.036		Adjusted Chi Square Value (4.75, β)	0.896						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2619		95% Gamma Adjusted UCL (use when $n < 50$)	3029						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	585.7		SD (KM)	1390						
70		Variance (KM)	1933466		SE of Mean (KM)	349.4						
71		k hat (KM)	0.177		k star (KM)	0.185						
72		nu hat (KM)	6.742		nu star (KM)	7.011						
73		theta hat (KM)	3301		theta star (KM)	3175						
74		80% gamma percentile (KM)	737.7		90% gamma percentile (KM)	1768						
75		95% gamma percentile (KM)	3080		99% gamma percentile (KM)	6741						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (7.01, α)	2.177		Adjusted Chi Square Value (7.01, β)	1.949						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	1887		95% Gamma Adjusted KM-UCL (use when $n < 50$)	2107						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.854		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.788		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.281		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.325		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	572.4		Mean in Log Scale	1.006						
90		SD in Original Scale	1434		SD in Log Scale	3.942						
91		95% t UCL (assumes normality of ROS data)	1143		95% Percentile Bootstrap UCL	1141						
92		95% BCA Bootstrap UCL	1411		95% Bootstrap t UCL	1611						
93		95% H-UCL (Log ROS)	7737186									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.995		KM Geo Mean	54.34						
97		KM SD (logged)	1.85		95% Critical H Value (KM-Log)	3.986						
98		KM Standard Error of Mean (logged)	0.465		95% H-UCL (KM -Log)	1710						
99		KM SD (logged)	1.85		95% Critical H Value (KM-Log)	3.986						
100		KM Standard Error of Mean (logged)	0.465									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	580.3		Mean in Log Scale	3.642						
105		SD in Original Scale	1431		SD in Log Scale	2.104						
106		95% t UCL (Assumes normality)	1150		95% H-Stat UCL	3157						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Normal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (t) UCL 1192											
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/1/2019 2:17:20 PM									
5	From File		OU1 1B Subsurface_h.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Phenanthrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			17			Number of Distinct Observations			11		
14	Number of Detects			5			Number of Non-Detects			12		
15	Number of Distinct Detects			5			Number of Distinct Non-Detects			6		
16	Minimum Detect			25.2			Minimum Non-Detect			18		
17	Maximum Detect			297000			Maximum Non-Detect			33		
18	Variance Detects			1.722E+10			Percent Non-Detects			70.59%		
19	Mean Detects			62590			SD Detects			131208		
20	Median Detects			343			CV Detects			2.096		
21	Skewness Detects			2.222			Kurtosis Detects			4.947		
22	Mean of Logged Detects			7.147			SD of Logged Detects			3.89		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.587			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.762			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.44			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.343			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			18422			KM Standard Error of Mean			18911		
33	KM SD			69739			95% KM (BCA) UCL			53364		
34	95% KM (t) UCL			51437			95% KM (Percentile Bootstrap) UCL			53345		
35	95% KM (z) UCL			49527			95% KM Bootstrap t UCL			12316810		
36	90% KM Chebyshev UCL			75154			95% KM Chebyshev UCL			100851		
37	97.5% KM Chebyshev UCL			136519			99% KM Chebyshev UCL			206581		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.464			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.785			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.306			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.39			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.19			k star (bias corrected MLE)			0.209		
48	Theta hat (MLE)			328944			Theta star (bias corrected MLE)			298840		
49	nu hat (MLE)			1.903			nu star (bias corrected)			2.094		
50	Mean (detects)			62590								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	18409						
59		Maximum	297000		Median	0.01						
60		SD	71889		CV	3.905						
61		k hat (MLE)	0.0764		k star (bias corrected MLE)	0.102						
62		Theta hat (MLE)	240835		Theta star (bias corrected MLE)	180189						
63		nu hat (MLE)	2.599		nu star (bias corrected)	3.474						
64		Adjusted Level of Significance (β)	0.0346									
65		Approximate Chi Square Value (3.47, α)	0.526		Adjusted Chi Square Value (3.47, β)	0.425						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	121675		95% Gamma Adjusted UCL (use when $n < 50$)	150591						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	18422		SD (KM)	69739						
70		Variance (KM)	4.864E+9		SE of Mean (KM)	18911						
71		k hat (KM)	0.0698		k star (KM)	0.0967						
72		nu hat (KM)	2.372		nu star (KM)	3.287						
73		theta hat (KM)	264013		theta star (KM)	190547						
74		80% gamma percentile (KM)	12157		90% gamma percentile (KM)	48324						
75		95% gamma percentile (KM)	107110		99% gamma percentile (KM)	297595						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (3.29, α)	0.462		Adjusted Chi Square Value (3.29, β)	0.371						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	130981		95% Gamma Adjusted KM-UCL (use when $n < 50$)	163052						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.927		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.762		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.232		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.343		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	18409		Mean in Log Scale	-2.98						
91		SD in Original Scale	71889		SD in Log Scale	7.562						
92		95% t UCL (assumes normality of ROS data)	48849		95% Percentile Bootstrap UCL	52494						
93		95% BCA Bootstrap UCL	87378		95% Bootstrap t UCL	36790697						
94		95% H-UCL (Log ROS)	5.507E+23									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	4.144		KM Geo Mean	63.05						
98		KM SD (logged)	2.705		95% Critical H Value (KM-Log)	5.721						
99		KM Standard Error of Mean (logged)	0.734		95% H-UCL (KM -Log)	117296						
100		KM SD (logged)	2.705		95% Critical H Value (KM-Log)	5.721						
101		KM Standard Error of Mean (logged)	0.734									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	18416		Mean in Log Scale	3.74						
106		SD in Original Scale	71887		SD in Log Scale	2.99						

	A	B	C	D	E	F	G	H	I	J	K	L	
107	95% t UCL (Assumes normality)					48856						95% H-Stat UCL	399716
108	DL/2 is not a recommended method, provided for comparisons and historical reasons												
109													
110	Nonparametric Distribution Free UCL Statistics												
111	Detected Data appear Gamma Distributed at 5% Significance Level												
112													
113	Suggested UCL to Use												
114	Suggested KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)					163052							
115													
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
117	Recommendations are based upon data size, data distribution, and skewness.												
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).												
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.												
120													

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:24:03 AM									
5	From File		OU1 1C Subsurface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			22		
14	Number of Detects			15			Number of Non-Detects			22		
15	Number of Distinct Detects			15			Number of Distinct Non-Detects			7		
16	Minimum Detect			24.4			Minimum Non-Detect			13		
17	Maximum Detect			30900			Maximum Non-Detect			22		
18	Variance Detects			92974529			Percent Non-Detects			59.46%		
19	Mean Detects			5640			SD Detects			9642		
20	Median Detects			1600			CV Detects			1.71		
21	Skewness Detects			2.079			Kurtosis Detects			3.477		
22	Mean of Logged Detects			6.691			SD of Logged Detects			2.447		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.636			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.881			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.319			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.22			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			2294			KM Standard Error of Mean			1113		
33	KM SD			6543			95% KM (BCA) UCL			4075		
34	95% KM (t) UCL			4174			95% KM (Percentile Bootstrap) UCL			4176		
35	95% KM (z) UCL			4125			95% KM Bootstrap t UCL			7806		
36	90% KM Chebyshev UCL			5634			95% KM Chebyshev UCL			7147		
37	97.5% KM Chebyshev UCL			9247			99% KM Chebyshev UCL			13372		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.599			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.826			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.175			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.239			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.346			k star (bias corrected MLE)			0.321		
48	Theta hat (MLE)			16295			Theta star (bias corrected MLE)			17551		
49	nu hat (MLE)			10.38			nu star (bias corrected)			9.64		
50	Mean (detects)			5640								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	2286						
59		Maximum	30900		Median	0.01						
60		SD	6636		CV	2.903						
61		k hat (MLE)	0.104		k star (bias corrected MLE)	0.114						
62		Theta hat (MLE)	21959		Theta star (bias corrected MLE)	20109						
63		nu hat (MLE)	7.705		nu star (bias corrected)	8.413						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.41, α)	2.977		Adjusted Chi Square Value (8.41, β)	2.837						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	6462		95% Gamma Adjusted UCL (use when $n < 50$)	6779						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	2294		SD (KM)	6543						
70		Variance (KM)	42810651		SE of Mean (KM)	1113						
71		k hat (KM)	0.123		k star (KM)	0.131						
72		nu hat (KM)	9.096		nu star (KM)	9.692						
73		theta hat (KM)	18662		theta star (KM)	17515						
74		80% gamma percentile (KM)	2208		90% gamma percentile (KM)	6641						
75		95% gamma percentile (KM)	12930		99% gamma percentile (KM)	31726						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (9.69, α)	3.75		Adjusted Chi Square Value (9.69, β)	3.591						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	5929		95% Gamma Adjusted KM-UCL (use when $n < 50$)	6192						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.916		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.881		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.176		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.22		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	2288		Mean in Log Scale	2.383						
90		SD in Original Scale	6636		SD in Log Scale	4.213						
91		95% t UCL (assumes normality of ROS data)	4129		95% Percentile Bootstrap UCL	4109						
92		95% BCA Bootstrap UCL	4864		95% Bootstrap t UCL	7726						
93		95% H-UCL (Log ROS)	12062499									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.238		KM Geo Mean	69.25						
97		KM SD (logged)	2.524		95% Critical H Value (KM-Log)	4.518						
98		KM Standard Error of Mean (logged)	0.429		95% H-UCL (KM -Log)	11191						
99		KM SD (logged)	2.524		95% Critical H Value (KM-Log)	4.518						
100		KM Standard Error of Mean (logged)	0.429									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	2292		Mean in Log Scale	4.047						
105		SD in Original Scale	6634		SD in Log Scale	2.691						
106		95% t UCL (Assumes normality)	4133		95% H-Stat UCL	18171						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k <= 1$)	6192										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:25:38 AM									
5	From File		OU1 1C Subsurface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			21		
14	Number of Detects			14			Number of Non-Detects			23		
15	Number of Distinct Detects			14			Number of Distinct Non-Detects			7		
16	Minimum Detect			30.1			Minimum Non-Detect			19		
17	Maximum Detect			9750			Maximum Non-Detect			26		
18	Variance Detects			11457059			Percent Non-Detects			62.16%		
19	Mean Detects			2881			SD Detects			3385		
20	Median Detects			1780			CV Detects			1.175		
21	Skewness Detects			1.203			Kurtosis Detects			0.18		
22	Mean of Logged Detects			6.786			SD of Logged Detects			2.034		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.801			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.874			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.282			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.226			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			1102			KM Standard Error of Mean			416.2		
33	KM SD			2440			95% KM (BCA) UCL			1778		
34	95% KM (t) UCL			1805			95% KM (Percentile Bootstrap) UCL			1834		
35	95% KM (z) UCL			1787			95% KM Bootstrap t UCL			2177		
36	90% KM Chebyshev UCL			2351			95% KM Chebyshev UCL			2916		
37	97.5% KM Chebyshev UCL			3701			99% KM Chebyshev UCL			5243		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.384			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.79			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.125			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.241			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.533			k star (bias corrected MLE)			0.467		
48	Theta hat (MLE)			5404			Theta star (bias corrected MLE)			6175		
49	nu hat (MLE)			14.93			nu star (bias corrected)			13.06		
50	Mean (detects)			2881								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	1090						
59		Maximum	9750		Median	0.01						
60		SD	2479		CV	2.274						
61		k hat (MLE)	0.11		k star (bias corrected MLE)	0.119						
62		Theta hat (MLE)	9905		Theta star (bias corrected MLE)	9149						
63		nu hat (MLE)	8.144		nu star (bias corrected)	8.817						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.82, α)	3.217		Adjusted Chi Square Value (8.82, β)	3.071						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2988		95% Gamma Adjusted UCL (use when $n < 50$)	3130						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	1102		SD (KM)	2440						
70		Variance (KM)	5952159		SE of Mean (KM)	416.2						
71		k hat (KM)	0.204		k star (KM)	0.205						
72		nu hat (KM)	15.1		nu star (KM)	15.21						
73		theta hat (KM)	5401		theta star (KM)	5363						
74		80% gamma percentile (KM)	1472		90% gamma percentile (KM)	3333						
75		95% gamma percentile (KM)	5638		99% gamma percentile (KM)	11955						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (15.21, α)	7.405		Adjusted Chi Square Value (15.21, β)	7.168						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2263		95% Gamma Adjusted KM-UCL (use when $n < 50$)	2337						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.89		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.874		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.207		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.226		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	1094		Mean in Log Scale	3.13						
90		SD in Original Scale	2477		SD in Log Scale	3.415						
91		95% t UCL (assumes normality of ROS data)	1782		95% Percentile Bootstrap UCL	1792						
92		95% BCA Bootstrap UCL	2039		95% Bootstrap t UCL	2147						
93		95% H-UCL (Log ROS)	226074									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.398		KM Geo Mean	81.3						
97		KM SD (logged)	2.219		95% Critical H Value (KM-Log)	4.056						
98		KM Standard Error of Mean (logged)	0.379		95% H-UCL (KM -Log)	4277						
99		KM SD (logged)	2.219		95% Critical H Value (KM-Log)	4.056						
100		KM Standard Error of Mean (logged)	0.379									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	1097		Mean in Log Scale	4.087						
105		SD in Original Scale	2475		SD in Log Scale	2.461						
106		95% t UCL (Assumes normality)	1784		95% H-Stat UCL	7541						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k <= 1$)	2337										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:27:15 AM									
5	From File		OU1 1C Subsurface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(b)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			22		
14	Number of Detects			16			Number of Non-Detects			21		
15	Number of Distinct Detects			16			Number of Distinct Non-Detects			6		
16	Minimum Detect			22.4			Minimum Non-Detect			18		
17	Maximum Detect			25000			Maximum Non-Detect			24		
18	Variance Detects			53587567			Percent Non-Detects			56.76%		
19	Mean Detects			5567			SD Detects			7320		
20	Median Detects			3290			CV Detects			1.315		
21	Skewness Detects			1.583			Kurtosis Detects			2.094		
22	Mean of Logged Detects			7.084			SD of Logged Detects			2.34		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.779			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.887			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.248			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.213			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			2418			KM Standard Error of Mean			918.8		
33	KM SD			5411			95% KM (BCA) UCL			4136		
34	95% KM (t) UCL			3969			95% KM (Percentile Bootstrap) UCL			3968		
35	95% KM (z) UCL			3929			95% KM Bootstrap t UCL			4983		
36	90% KM Chebyshev UCL			5174			95% KM Chebyshev UCL			6423		
37	97.5% KM Chebyshev UCL			8156			99% KM Chebyshev UCL			11560		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.484			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.812			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.166			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.229			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.423			k star (bias corrected MLE)			0.386		
48	Theta hat (MLE)			13152			Theta star (bias corrected MLE)			14438		
49	nu hat (MLE)			13.55			nu star (bias corrected)			12.34		
50	Mean (detects)			5567								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	2407						
59		Maximum	25000		Median	0.01						
60		SD	5491		CV	2.281						
61		k hat (MLE)	0.109		k star (bias corrected MLE)	0.119						
62		Theta hat (MLE)	22002		Theta star (bias corrected MLE)	20304						
63		nu hat (MLE)	8.097		nu star (bias corrected)	8.774						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.77, α)	3.191		Adjusted Chi Square Value (8.77, β)	3.046						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	6620		95% Gamma Adjusted UCL (use when $n < 50$)	6935						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	2418		SD (KM)	5411						
70		Variance (KM)	29282547		SE of Mean (KM)	918.8						
71		k hat (KM)	0.2		k star (KM)	0.201						
72		nu hat (KM)	14.77		nu star (KM)	14.91						
73		theta hat (KM)	12112		theta star (KM)	12001						
74		80% gamma percentile (KM)	3198		90% gamma percentile (KM)	7313						
75		95% gamma percentile (KM)	12434		99% gamma percentile (KM)	26517						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (14.91, α)	7.197		Adjusted Chi Square Value (14.91, β)	6.964						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	5008		95% Gamma Adjusted KM-UCL (use when $n < 50$)	5175						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.905		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.887		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.226		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.213		Detected Data Not Lognormal at 5% Significance Level							
86	Detected Data appear Approximate Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	2411		Mean in Log Scale	3.44						
90		SD in Original Scale	5489		SD in Log Scale	3.802						
91		95% t UCL (assumes normality of ROS data)	3934		95% Percentile Bootstrap UCL	3913						
92		95% BCA Bootstrap UCL	4450		95% Bootstrap t UCL	4953						
93		95% H-UCL (Log ROS)	2687725									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.706		KM Geo Mean	110.6						
97		KM SD (logged)	2.556		95% Critical H Value (KM-Log)	4.567						
98		KM Standard Error of Mean (logged)	0.434		95% H-UCL (KM -Log)	20262						
99		KM SD (logged)	2.556		95% Critical H Value (KM-Log)	4.567						
100		KM Standard Error of Mean (logged)	0.434									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	2414		Mean in Log Scale	4.412						
105		SD in Original Scale	5488		SD in Log Scale	2.806						
106		95% t UCL (Assumes normality)	3937		95% H-Stat UCL	42934						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	5175										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:28:33 AM									
5	From File		OU1 1C Subsurface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(k)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			22		
14	Number of Detects			14			Number of Non-Detects			23		
15	Number of Distinct Detects			14			Number of Distinct Non-Detects			8		
16	Minimum Detect			28.5			Minimum Non-Detect			19		
17	Maximum Detect			11800			Maximum Non-Detect			29		
18	Variance Detects			10985792			Percent Non-Detects			62.16%		
19	Mean Detects			2528			SD Detects			3314		
20	Median Detects			1500			CV Detects			1.311		
21	Skewness Detects			2.016			Kurtosis Detects			4.212		
22	Mean of Logged Detects			6.747			SD of Logged Detects			1.885		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.753			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.874			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.252			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.226			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			968.3			KM Standard Error of Mean			394.2		
33	KM SD			2311			95% KM (BCA) UCL			1692		
34	95% KM (t) UCL			1634			95% KM (Percentile Bootstrap) UCL			1657		
35	95% KM (z) UCL			1617			95% KM Bootstrap t UCL			2318		
36	90% KM Chebyshev UCL			2151			95% KM Chebyshev UCL			2687		
37	97.5% KM Chebyshev UCL			3430			99% KM Chebyshev UCL			4891		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.228			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.787			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.115			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.24			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.572			k star (bias corrected MLE)			0.497		
48	Theta hat (MLE)			4420			Theta star (bias corrected MLE)			5086		
49	nu hat (MLE)			16.01			nu star (bias corrected)			13.91		
50	Mean (detects)			2528								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	956.5					
59		Maximum	11800			Median	0.01					
60		SD	2348			CV	2.455					
61		k hat (MLE)	0.112			k star (bias corrected MLE)	0.121					
62		Theta hat (MLE)	8568			Theta star (bias corrected MLE)	7931					
63		nu hat (MLE)	8.26			nu star (bias corrected)	8.924					
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.92, α)	3.281			Adjusted Chi Square Value (8.92, β)	3.134					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2601			95% Gamma Adjusted UCL (use when $n < 50$)	2724					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	968.3			SD (KM)	2311					
70		Variance (KM)	5340211			SE of Mean (KM)	394.2					
71		k hat (KM)	0.176			k star (KM)	0.179					
72		nu hat (KM)	12.99			nu star (KM)	13.27					
73		theta hat (KM)	5515			theta star (KM)	5399					
74		80% gamma percentile (KM)	1199			90% gamma percentile (KM)	2920					
75		95% gamma percentile (KM)	5127			99% gamma percentile (KM)	11317					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (13.27, α)	6.076			Adjusted Chi Square Value (13.27, β)	5.864					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2115			95% Gamma Adjusted KM-UCL (use when $n < 50$)	2191					
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.927			Shapiro Wilk GOF Test						
83		5% Shapiro Wilk Critical Value	0.874			Detected Data appear Lognormal at 5% Significance Level						
84		Lilliefors Test Statistic	0.199			Lilliefors GOF Test						
85		5% Lilliefors Critical Value	0.226			Detected Data appear Lognormal at 5% Significance Level						
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	961.5			Mean in Log Scale	3.33					
90		SD in Original Scale	2346			SD in Log Scale	3.161					
91		95% t UCL (assumes normality of ROS data)	1612			95% Percentile Bootstrap UCL	1679					
92		95% BCA Bootstrap UCL	1876			95% Bootstrap t UCL	2403					
93		95% H-UCL (Log ROS)	75224									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.384			KM Geo Mean	80.13					
97		KM SD (logged)	2.156			95% Critical H Value (KM-Log)	3.961					
98		KM Standard Error of Mean (logged)	0.368			95% H-UCL (KM -Log)	3398					
99		KM SD (logged)	2.156			95% Critical H Value (KM-Log)	3.961					
100		KM Standard Error of Mean (logged)	0.368									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	964.3			Mean in Log Scale	4.124					
105		SD in Original Scale	2344			SD in Log Scale	2.365					
106		95% t UCL (Assumes normality)	1615			95% H-Stat UCL	5464					

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	2191										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:29:36 AM									
5	From File		OU1 1C Subsurface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37		Number of Distinct Observations			17			
14	Number of Detects			10		Number of Non-Detects			27			
15	Number of Distinct Detects			10		Number of Distinct Non-Detects			7			
16	Minimum Detect			62.4		Minimum Non-Detect			21			
17	Maximum Detect			1450		Maximum Non-Detect			33			
18	Variance Detects			283910		Percent Non-Detects			72.97%			
19	Mean Detects			657.7		SD Detects			532.8			
20	Median Detects			377		CV Detects			0.81			
21	Skewness Detects			0.578		Kurtosis Detects			-1.631			
22	Mean of Logged Detects			6.105		SD of Logged Detects			1.012			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.843		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.842		Detected Data appear Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.296		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.262		Detected Data Not Normal at 5% Significance Level						
29	Detected Data appear Approximate Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			193.1		KM Standard Error of Mean			66.9			
33	KM SD			386		95% KM (BCA) UCL			297			
34	95% KM (t) UCL			306		95% KM (Percentile Bootstrap) UCL			302.6			
35	95% KM (z) UCL			303.1		95% KM Bootstrap t UCL			350.1			
36	90% KM Chebyshev UCL			393.8		95% KM Chebyshev UCL			484.7			
37	97.5% KM Chebyshev UCL			610.9		99% KM Chebyshev UCL			858.7			
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.464		Anderson-Darling GOF Test						
41	5% A-D Critical Value			0.74		Detected data appear Gamma Distributed at 5% Significance Level						
42	K-S Test Statistic			0.22		Kolmogorov-Smirnov GOF						
43	5% K-S Critical Value			0.271		Detected data appear Gamma Distributed at 5% Significance Level						
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			1.448		k star (bias corrected MLE)			1.08			
48	Theta hat (MLE)			454.1		Theta star (bias corrected MLE)			608.7			
49	nu hat (MLE)			28.97		nu star (bias corrected)			21.61			
50	Mean (detects)			657.7								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	177.8						
59		Maximum	1450		Median	0.01						
60		SD	398.3		CV	2.241						
61		k hat (MLE)	0.116		k star (bias corrected MLE)	0.124						
62		Theta hat (MLE)	1537		Theta star (bias corrected MLE)	1430						
63		nu hat (MLE)	8.558		nu star (bias corrected)	9.198						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (9.20, α)	3.447		Adjusted Chi Square Value (9.20, β)	3.295						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	474.4		95% Gamma Adjusted UCL (use when $n < 50$)	496.2						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	193.1		SD (KM)	386						
70		Variance (KM)	149021		SE of Mean (KM)	66.9						
71		k hat (KM)	0.25		k star (KM)	0.248						
72		nu hat (KM)	18.51		nu star (KM)	18.35						
73		theta hat (KM)	771.8		theta star (KM)	778.8						
74		80% gamma percentile (KM)	279.6		90% gamma percentile (KM)	579.9						
75		95% gamma percentile (KM)	937		99% gamma percentile (KM)	1889						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (18.35, α)	9.642		Adjusted Chi Square Value (18.35, β)	9.367						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	367.4		95% Gamma Adjusted KM-UCL (use when $n < 50$)	378.2						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.915		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.842		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.162		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.262		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	193.8		Mean in Log Scale	3.535						
90		SD in Original Scale	391.4		SD in Log Scale	1.92						
91		95% t UCL (assumes normality of ROS data)	302.5		95% Percentile Bootstrap UCL	310.3						
92		95% BCA Bootstrap UCL	330.2		95% Bootstrap t UCL	354.3						
93		95% H-UCL (Log ROS)	687.8									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.872		KM Geo Mean	48.03						
97		KM SD (logged)	1.448		95% Critical H Value (KM-Log)	2.948						
98		KM Standard Error of Mean (logged)	0.251		95% H-UCL (KM -Log)	279.2						
99		KM SD (logged)	1.448		95% Critical H Value (KM-Log)	2.948						
100		KM Standard Error of Mean (logged)	0.251									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	186.9		Mean in Log Scale	3.492						
105		SD in Original Scale	394.2		SD in Log Scale	1.691						
106		95% t UCL (Assumes normality)	296.3		95% H-Stat UCL	346.5						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Normal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	95% KM (t) UCL		306									
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:31:19 AM									
5	From File		OU1 1C Subsurface_f.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzofuran (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			17		
14	Number of Detects			7			Number of Non-Detects			30		
15	Number of Distinct Detects			7			Number of Distinct Non-Detects			10		
16	Minimum Detect			55			Minimum Non-Detect			15		
17	Maximum Detect			28100			Maximum Non-Detect			42		
18	Variance Detects			1.043E+8			Percent Non-Detects			81.08%		
19	Mean Detects			5918			SD Detects			10214		
20	Median Detects			343			CV Detects			1.726		
21	Skewness Detects			2.221			Kurtosis Detects			5.171		
22	Mean of Logged Detects			6.647			SD of Logged Detects			2.554		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.659			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.803			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.33			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.304			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			1132			KM Standard Error of Mean			837.9		
33	KM SD			4718			95% KM (BCA) UCL			2804		
34	95% KM (t) UCL			2546			95% KM (Percentile Bootstrap) UCL			2481		
35	95% KM (z) UCL			2510			95% KM Bootstrap t UCL			5521		
36	90% KM Chebyshev UCL			3645			95% KM Chebyshev UCL			4784		
37	97.5% KM Chebyshev UCL			6364			99% KM Chebyshev UCL			9468		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.545			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.779			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.272			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.334			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.333			k star (bias corrected MLE)			0.285		
48	Theta hat (MLE)			17792			Theta star (bias corrected MLE)			20743		
49	nu hat (MLE)			4.657			nu star (bias corrected)			3.994		
50	Mean (detects)			5918								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	1120						
59		Maximum	28100		Median	0.01						
60		SD	4786		CV	4.275						
61		k hat (MLE)	0.087		k star (bias corrected MLE)	0.0979						
62		Theta hat (MLE)	12872		Theta star (bias corrected MLE)	11431						
63		nu hat (MLE)	6.437		nu star (bias corrected)	7.248						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (7.25, α)	2.308		Adjusted Chi Square Value (7.25, β)	2.189						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	3516		95% Gamma Adjusted UCL (use when $n < 50$)	3708						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	1132		SD (KM)	4718						
70		Variance (KM)	22263853		SE of Mean (KM)	837.9						
71		k hat (KM)	0.0575		k star (KM)	0.0709						
72		nu hat (KM)	4.257		nu star (KM)	5.245						
73		theta hat (KM)	19672		theta star (KM)	15966						
74		80% gamma percentile (KM)	417.2		90% gamma percentile (KM)	2466						
75		95% gamma percentile (KM)	6519		99% gamma percentile (KM)	21205						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (5.25, α)	1.267		Adjusted Chi Square Value (5.25, β)	1.186						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	4685		95% Gamma Adjusted KM-UCL (use when $n < 50$)	5007						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.869		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.803		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.22		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.304		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	1120		Mean in Log Scale	-2.595						
91		SD in Original Scale	4786		SD in Log Scale	5.663						
92		95% t UCL (assumes normality of ROS data)	2448		95% Percentile Bootstrap UCL	2629						
93		95% BCA Bootstrap UCL	3565		95% Bootstrap t UCL	5618						
94		95% H-UCL (Log ROS)	5.641E+9									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	3.453		KM Geo Mean	31.6						
98		KM SD (logged)	1.854		95% Critical H Value (KM-Log)	3.517						
99		KM Standard Error of Mean (logged)	0.329		95% H-UCL (KM -Log)	522.7						
100		KM SD (logged)	1.854		95% Critical H Value (KM-Log)	3.517						
101		KM Standard Error of Mean (logged)	0.329									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	1128		Mean in Log Scale	3.128						
106		SD in Original Scale	4784		SD in Log Scale	2.022						

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					2456	95% H-Stat UCL					625.6
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Gamma Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)					5007						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:32:12 AM									
5	From File		OU1 1C Subsurface_g.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Indeno (1,2,3-cd) pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			21		
14	Number of Detects			13			Number of Non-Detects			24		
15	Number of Distinct Detects			13			Number of Distinct Non-Detects			9		
16	Minimum Detect			27.6			Minimum Non-Detect			20		
17	Maximum Detect			5170			Maximum Non-Detect			33		
18	Variance Detects			3780743			Percent Non-Detects			64.86%		
19	Mean Detects			1855			SD Detects			1944		
20	Median Detects			1140			CV Detects			1.048		
21	Skewness Detects			0.839			Kurtosis Detects			-1.06		
22	Mean of Logged Detects			6.578			SD of Logged Detects			1.826		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.81			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.866			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.285			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.234			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		664.8		KM Standard Error of Mean		241.6					
33	KM SD		1412		95% KM (BCA) UCL		1082					
34	95% KM (t) UCL		1073		95% KM (Percentile Bootstrap) UCL		1077					
35	95% KM (z) UCL		1062		95% KM Bootstrap t UCL		1306					
36	90% KM Chebyshev UCL		1390		95% KM Chebyshev UCL		1718					
37	97.5% KM Chebyshev UCL		2174		99% KM Chebyshev UCL		3069					
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.44		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.779		Detected data appear Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.156		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.248		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.645		k star (bias corrected MLE)		0.547					
48	Theta hat (MLE)		2877		Theta star (bias corrected MLE)		3390					
49	nu hat (MLE)		16.77		nu star (bias corrected)		14.23					
50	Mean (detects)		1855									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	651.8					
59		Maximum	5170			Median	0.01					
60		SD	1437			CV	2.205					
61		k hat (MLE)	0.112			k star (bias corrected MLE)	0.121					
62		Theta hat (MLE)	5827			Theta star (bias corrected MLE)	5395					
63		nu hat (MLE)	8.278			nu star (bias corrected)	8.94					
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.94, α)	3.291			Adjusted Chi Square Value (8.94, β)	3.143					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	1771			95% Gamma Adjusted UCL (use when $n < 50$)	1854					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	664.8			SD (KM)	1412					
70		Variance (KM)	1993733			SE of Mean (KM)	241.6					
71		k hat (KM)	0.222			k star (KM)	0.222					
72		nu hat (KM)	16.4			nu star (KM)	16.41					
73		theta hat (KM)	2999			theta star (KM)	2998					
74		80% gamma percentile (KM)	920.6			90% gamma percentile (KM)	2008					
75		95% gamma percentile (KM)	3331			99% gamma percentile (KM)	6917					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (16.41, α)	8.25			Adjusted Chi Square Value (16.41, β)	7.999					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	1322			95% Gamma Adjusted KM-UCL (use when $n < 50$)	1364					
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.876			Shapiro Wilk GOF Test						
83		5% Shapiro Wilk Critical Value	0.866			Detected Data appear Lognormal at 5% Significance Level						
84		Lilliefors Test Statistic	0.238			Lilliefors GOF Test						
85		5% Lilliefors Critical Value	0.234			Detected Data Not Lognormal at 5% Significance Level						
86	Detected Data appear Approximate Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	657			Mean in Log Scale	3.136					
90		SD in Original Scale	1435			SD in Log Scale	3.013					
91		95% t UCL (assumes normality of ROS data)	1055			95% Percentile Bootstrap UCL	1074					
92		95% BCA Bootstrap UCL	1169			95% Bootstrap t UCL	1266					
93		95% H-UCL (Log ROS)	30495									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.255			KM Geo Mean	70.43					
97		KM SD (logged)	2.001			95% Critical H Value (KM-Log)	3.732					
98		KM Standard Error of Mean (logged)	0.342			95% H-UCL (KM -Log)	1811					
99		KM SD (logged)	2.001			95% Critical H Value (KM-Log)	3.732					
100		KM Standard Error of Mean (logged)	0.342									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	659.6			Mean in Log Scale	3.923					
105		SD in Original Scale	1434			SD in Log Scale	2.245					
106		95% t UCL (Assumes normality)	1058			95% H-Stat UCL	2907					

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	1364										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:33:07 AM									
5	From File		OU1 1C Subsurface_h.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Naphthalene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			37			Number of Distinct Observations			17		
14	Number of Detects			8			Number of Non-Detects			29		
15	Number of Distinct Detects			8			Number of Distinct Non-Detects			10		
16	Minimum Detect			19			Minimum Non-Detect			15		
17	Maximum Detect			4120			Maximum Non-Detect			42		
18	Variance Detects			1996493			Percent Non-Detects			78.38%		
19	Mean Detects			633.8			SD Detects			1413		
20	Median Detects			101.4			CV Detects			2.229		
21	Skewness Detects			2.794			Kurtosis Detects			7.853		
22	Mean of Logged Detects			4.993			SD of Logged Detects			1.648		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.487			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.818			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.461			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.283			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			149			KM Standard Error of Mean			116.9		
33	KM SD			665.2			95% KM (BCA) UCL			373.8		
34	95% KM (t) UCL			346.4			95% KM (Percentile Bootstrap) UCL			362.3		
35	95% KM (z) UCL			341.3			95% KM Bootstrap t UCL			1863		
36	90% KM Chebyshev UCL			499.7			95% KM Chebyshev UCL			658.6		
37	97.5% KM Chebyshev UCL			879.1			99% KM Chebyshev UCL			1312		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.957			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.772			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.327			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.311			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.444			k star (bias corrected MLE)			0.361		
48	Theta hat (MLE)			1429			Theta star (bias corrected MLE)			1758		
49	nu hat (MLE)			7.098			nu star (bias corrected)			5.769		
50	Mean (detects)			633.8								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	137						
59		Maximum	4120		Median	0.01						
60		SD	676.9		CV	4.939						
61		k hat (MLE)	0.108		k star (bias corrected MLE)	0.117						
62		Theta hat (MLE)	1270		Theta star (bias corrected MLE)	1169						
63		nu hat (MLE)	7.988		nu star (bias corrected)	8.674						
64		Adjusted Level of Significance (β)	0.0431									
65		Approximate Chi Square Value (8.67, α)	3.131		Adjusted Chi Square Value (8.67, β)	2.988						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	379.6		95% Gamma Adjusted UCL (use when $n < 50$)	397.8						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	149		SD (KM)	665.2						
70		Variance (KM)	442551		SE of Mean (KM)	116.9						
71		k hat (KM)	0.0501		k star (KM)	0.0641						
72		nu hat (KM)	3.711		nu star (KM)	4.743						
73		theta hat (KM)	2971		theta star (KM)	2324						
74		80% gamma percentile (KM)	42.99		90% gamma percentile (KM)	298.4						
75		95% gamma percentile (KM)	845.8		99% gamma percentile (KM)	2920						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (4.74, α)	1.035		Adjusted Chi Square Value (4.74, β)	0.964						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	682.4		95% Gamma Adjusted KM-UCL (use when $n < 50$)	732.9						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.916		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.818		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.206		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.283		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	137.9		Mean in Log Scale	-0.0151						
91		SD in Original Scale	676.7		SD in Log Scale	3.3						
92		95% t UCL (assumes normality of ROS data)	325.8		95% Percentile Bootstrap UCL	356.5						
93		95% BCA Bootstrap UCL	480.2		95% Bootstrap t UCL	2032						
94		95% H-UCL (Log ROS)	5331									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	3.212		KM Geo Mean	24.84						
98		KM SD (logged)	1.179		95% Critical H Value (KM-Log)	2.602						
99		KM Standard Error of Mean (logged)	0.208		95% H-UCL (KM -Log)	83.03						
100		KM SD (logged)	1.179		95% Critical H Value (KM-Log)	2.602						
101		KM Standard Error of Mean (logged)	0.208									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	145.1		Mean in Log Scale	2.893						
106		SD in Original Scale	675.2		SD in Log Scale	1.344						

	A	B	C	D	E	F	G	H	I	J	K	L
107			95% t UCL (Assumes normality)			332.5					95% H-Stat UCL	83.56
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Lognormal Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114			95% KM (Chebyshev) UCL			658.6						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 10:34:00 AM									
5	From File		OU1 1C Subsurface_i.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Phenanthrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			33			Number of Distinct Observations			19		
14	Number of Detects			12			Number of Non-Detects			21		
15	Number of Distinct Detects			12			Number of Distinct Non-Detects			7		
16	Minimum Detect			18.3			Minimum Non-Detect			17		
17	Maximum Detect			240000			Maximum Non-Detect			33		
18	Variance Detects			5.880E+9			Percent Non-Detects			63.64%		
19	Mean Detects			36676			SD Detects			76683		
20	Median Detects			333.5			CV Detects			2.091		
21	Skewness Detects			2.222			Kurtosis Detects			4.408		
22	Mean of Logged Detects			6.688			SD of Logged Detects			3.36		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.568			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.859			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.421			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.243			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			13348			KM Standard Error of Mean			8665		
33	KM SD			47656			95% KM (BCA) UCL			29460		
34	95% KM (t) UCL			28025			95% KM (Percentile Bootstrap) UCL			29249		
35	95% KM (z) UCL			27600			95% KM Bootstrap t UCL			787965		
36	90% KM Chebyshev UCL			39342			95% KM Chebyshev UCL			51116		
37	97.5% KM Chebyshev UCL			67459			99% KM Chebyshev UCL			99560		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			1.165			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.877			Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.295			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.273			Detected Data Not Gamma Distributed at 5% Significance Level					
44	Detected Data Not Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.194			k star (bias corrected MLE)			0.201		
48	Theta hat (MLE)			189505			Theta star (bias corrected MLE)			182733		
49	nu hat (MLE)			4.645			nu star (bias corrected)			4.817		
50	Mean (detects)			36676								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	13337					
59		Maximum	240000			Median	0.01					
60		SD	48398			CV	3.629					
61		k hat (MLE)	0.0831			k star (bias corrected MLE)	0.0957					
62		Theta hat (MLE)	160528			Theta star (bias corrected MLE)	139316					
63		nu hat (MLE)	5.483			nu star (bias corrected)	6.318					
64		Adjusted Level of Significance (β)	0.0419									
65		Approximate Chi Square Value (6.32, α)	1.805			Adjusted Chi Square Value (6.32, β)	1.684					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	46695			95% Gamma Adjusted UCL (use when $n < 50$)	50049					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	13348			SD (KM)	47656					
70		Variance (KM)	2.271E+9			SE of Mean (KM)	8665					
71		k hat (KM)	0.0784			k star (KM)	0.0915					
72		nu hat (KM)	5.178			nu star (KM)	6.04					
73		theta hat (KM)	170146			theta star (KM)	145846					
74		80% gamma percentile (KM)	8080			90% gamma percentile (KM)	34125					
75		95% gamma percentile (KM)	77744			99% gamma percentile (KM)	221545					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (6.04, α)	1.66			Adjusted Chi Square Value (6.04, β)	1.546					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	48555			95% Gamma Adjusted KM-UCL (use when $n < 50$)	52159					
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.884			Shapiro Wilk GOF Test						
84		5% Shapiro Wilk Critical Value	0.859			Detected Data appear Lognormal at 5% Significance Level						
85		Lilliefors Test Statistic	0.176			Lilliefors GOF Test						
86		5% Lilliefors Critical Value	0.243			Detected Data appear Lognormal at 5% Significance Level						
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	13337			Mean in Log Scale	0.574					
91		SD in Original Scale	48398			SD in Log Scale	5.636					
92		95% t UCL (assumes normality of ROS data)	27608			95% Percentile Bootstrap UCL	29168					
93		95% BCA Bootstrap UCL	36247			95% Bootstrap t UCL	75247					
94		95% H-UCL (Log ROS)	2.620E+11									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	4.25			KM Geo Mean	70.09					
98		KM SD (logged)	2.676			95% Critical H Value (KM-Log)	4.921					
99		KM Standard Error of Mean (logged)	0.487			95% H-UCL (KM -Log)	25781					
100		KM SD (logged)	2.676			95% Critical H Value (KM-Log)	4.921					
101		KM Standard Error of Mean (logged)	0.487									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	13343			Mean in Log Scale	3.901					
106		SD in Original Scale	48396			SD in Log Scale	2.91					

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					27614	95% H-Stat UCL					52122
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Lognormal Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	99% KM (Chebyshev) UCL					99560						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:36:38 PM									
5	From File		OU1 1D Subsurface_a.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			23			Number of Distinct Observations			14		
14	Number of Detects			9			Number of Non-Detects			14		
15	Number of Distinct Detects			9			Number of Distinct Non-Detects			5		
16	Minimum Detect			21.3			Minimum Non-Detect			18		
17	Maximum Detect			9490			Maximum Non-Detect			33		
18	Variance Detects			9888038			Percent Non-Detects			60.87%		
19	Mean Detects			1554			SD Detects			3145		
20	Median Detects			251			CV Detects			2.024		
21	Skewness Detects			2.511			Kurtosis Detects			6.392		
22	Mean of Logged Detects			5.488			SD of Logged Detects			2.142		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.568			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.829			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.414			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.274			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			618.9			KM Standard Error of Mean			442.4		
33	KM SD			2000			95% KM (BCA) UCL			1320		
34	95% KM (t) UCL			1379			95% KM (Percentile Bootstrap) UCL			1425		
35	95% KM (z) UCL			1347			95% KM Bootstrap t UCL			10502		
36	90% KM Chebyshev UCL			1946			95% KM Chebyshev UCL			2547		
37	97.5% KM Chebyshev UCL			3382			99% KM Chebyshev UCL			5021		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.722			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.796			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.29			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.299			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.36			k star (bias corrected MLE)			0.314		
48	Theta hat (MLE)			4317			Theta star (bias corrected MLE)			4947		
49	nu hat (MLE)			6.478			nu star (bias corrected)			5.652		
50	Mean (detects)			1554								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	607.9						
59		Maximum	9490		Median	0.01						
60		SD	2049		CV	3.37						
61		k hat (MLE)	0.113		k star (bias corrected MLE)	0.127						
62		Theta hat (MLE)	5374		Theta star (bias corrected MLE)	4773						
63		nu hat (MLE)	5.204		nu star (bias corrected)	5.858						
64		Adjusted Level of Significance (β)	0.0389									
65		Approximate Chi Square Value (5.86, α)	1.568		Adjusted Chi Square Value (5.86, β)	1.414						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2271		95% Gamma Adjusted UCL (use when $n < 50$)	2519						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	618.9		SD (KM)	2000						
70		Variance (KM)	4000891		SE of Mean (KM)	442.4						
71		k hat (KM)	0.0957		k star (KM)	0.112						
72		nu hat (KM)	4.404		nu star (KM)	5.163						
73		theta hat (KM)	6464		theta star (KM)	5514						
74		80% gamma percentile (KM)	501.5		90% gamma percentile (KM)	1719						
75		95% gamma percentile (KM)	3559		99% gamma percentile (KM)	9273						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (5.16, α)	1.228		Adjusted Chi Square Value (5.16, β)	1.097						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2602		95% Gamma Adjusted KM-UCL (use when $n < 50$)	2913						
80	95% Gamma Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$)											
81												
82	Lognormal GOF Test on Detected Observations Only											
83		Shapiro Wilk Test Statistic	0.907		Shapiro Wilk GOF Test							
84		5% Shapiro Wilk Critical Value	0.829		Detected Data appear Lognormal at 5% Significance Level							
85		Lilliefors Test Statistic	0.18		Lilliefors GOF Test							
86		5% Lilliefors Critical Value	0.274		Detected Data appear Lognormal at 5% Significance Level							
87	Detected Data appear Lognormal at 5% Significance Level											
88												
89	Lognormal ROS Statistics Using Imputed Non-Detects											
90		Mean in Original Scale	608.6		Mean in Log Scale	1.503						
91		SD in Original Scale	2048		SD in Log Scale	3.803						
92		95% t UCL (assumes normality of ROS data)	1342		95% Percentile Bootstrap UCL	1386						
93		95% BCA Bootstrap UCL	1985		95% Bootstrap t UCL	10645						
94		95% H-UCL (Log ROS)	2103401									
95												
96	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
97		KM Mean (logged)	3.909		KM Geo Mean	49.86						
98		KM SD (logged)	1.789		95% Critical H Value (KM-Log)	3.706						
99		KM Standard Error of Mean (logged)	0.396		95% H-UCL (KM -Log)	1015						
100		KM SD (logged)	1.789		95% Critical H Value (KM-Log)	3.706						
101		KM Standard Error of Mean (logged)	0.396									
102												
103	DL/2 Statistics											
104	DL/2 Normal						DL/2 Log-Transformed					
105		Mean in Original Scale	614.2		Mean in Log Scale	3.56						
106		SD in Original Scale	2047		SD in Log Scale	2.045						

	A	B	C	D	E	F	G	H	I	J	K	L
107	95% t UCL (Assumes normality)					1347	95% H-Stat UCL					1718
108	DL/2 is not a recommended method, provided for comparisons and historical reasons											
109												
110	Nonparametric Distribution Free UCL Statistics											
111	Detected Data appear Gamma Distributed at 5% Significance Level											
112												
113	Suggested UCL to Use											
114	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)					2913						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness.											
118	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:37:52 PM									
5	From File		OU1 1D Subsurface_b.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(a)pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			23		Number of Distinct Observations			13			
14	Number of Detects			8		Number of Non-Detects			15			
15	Number of Distinct Detects			8		Number of Distinct Non-Detects			5			
16	Minimum Detect			25.5		Minimum Non-Detect			22			
17	Maximum Detect			5420		Maximum Non-Detect			33			
18	Variance Detects			3721158		Percent Non-Detects			65.22%			
19	Mean Detects			1226		SD Detects			1929			
20	Median Detects			380		CV Detects			1.574			
21	Skewness Detects			1.898		Kurtosis Detects			3.093			
22	Mean of Logged Detects			5.77		SD of Logged Detects			1.948			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.692		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.818		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.377		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.283		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			440.7		KM Standard Error of Mean			269.5			
33	KM SD			1209		95% KM (BCA) UCL			928.7			
34	95% KM (t) UCL			903.4		95% KM (Percentile Bootstrap) UCL			896.6			
35	95% KM (z) UCL			884		95% KM Bootstrap t UCL			3100			
36	90% KM Chebyshev UCL			1249		95% KM Chebyshev UCL			1615			
37	97.5% KM Chebyshev UCL			2124		99% KM Chebyshev UCL			3122			
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.377		Anderson-Darling GOF Test						
41	5% A-D Critical Value			0.766		Detected data appear Gamma Distributed at 5% Significance Level						
42	K-S Test Statistic			0.225		Kolmogorov-Smirnov GOF						
43	5% K-S Critical Value			0.31		Detected data appear Gamma Distributed at 5% Significance Level						
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.477		k star (bias corrected MLE)			0.381			
48	Theta hat (MLE)			2570		Theta star (bias corrected MLE)			3214			
49	nu hat (MLE)			7.631		nu star (bias corrected)			6.102			
50	Mean (detects)			1226								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01			Mean	426.4					
59		Maximum	5420			Median	0.01					
60		SD	1241			CV	2.911					
61		k hat (MLE)	0.113			k star (bias corrected MLE)	0.128					
62		Theta hat (MLE)	3763			Theta star (bias corrected MLE)	3343					
63		nu hat (MLE)	5.213			nu star (bias corrected)	5.866					
64		Adjusted Level of Significance (β)	0.0389									
65		Approximate Chi Square Value (5.87, α)	1.572			Adjusted Chi Square Value (5.87, β)	1.417					
66		95% Gamma Approximate UCL (use when $n \geq 50$)	1591			95% Gamma Adjusted UCL (use when $n < 50$)	1765					
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	440.7			SD (KM)	1209					
70		Variance (KM)	1461238			SE of Mean (KM)	269.5					
71		k hat (KM)	0.133			k star (KM)	0.145					
72		nu hat (KM)	6.115			nu star (KM)	6.651					
73		theta hat (KM)	3315			theta star (KM)	3048					
74		80% gamma percentile (KM)	465.1			90% gamma percentile (KM)	1300					
75		95% gamma percentile (KM)	2443			99% gamma percentile (KM)	5785					
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (6.65, α)	1.981			Adjusted Chi Square Value (6.65, β)	1.802					
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	1480			95% Gamma Adjusted KM-UCL (use when $n < 50$)	1627					
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.941			Shapiro Wilk GOF Test						
83		5% Shapiro Wilk Critical Value	0.818			Detected Data appear Lognormal at 5% Significance Level						
84		Lilliefors Test Statistic	0.145			Lilliefors GOF Test						
85		5% Lilliefors Critical Value	0.283			Detected Data appear Lognormal at 5% Significance Level						
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	427.5			Mean in Log Scale	1.575					
90		SD in Original Scale	1241			SD in Log Scale	3.648					
91		95% t UCL (assumes normality of ROS data)	871.7			95% Percentile Bootstrap UCL	879.7					
92		95% BCA Bootstrap UCL	1149			95% Bootstrap t UCL	3091					
93		95% H-UCL (Log ROS)	811802									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.024			KM Geo Mean	55.91					
97		KM SD (logged)	1.668			95% Critical H Value (KM-Log)	3.511					
98		KM Standard Error of Mean (logged)	0.372			95% H-UCL (KM -Log)	782.6					
99		KM SD (logged)	1.668			95% Critical H Value (KM-Log)	3.511					
100		KM Standard Error of Mean (logged)	0.372									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	434.2			Mean in Log Scale	3.623					
105		SD in Original Scale	1238			SD in Log Scale	1.945					
106		95% t UCL (Assumes normality)	877.6			95% H-Stat UCL	1284					

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	1627										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:39:23 PM									
5	From File		OU1 1D Subsurface_c.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Benzo(b)fluoranthene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			23		Number of Distinct Observations			15			
14	Number of Detects			11		Number of Non-Detects			12			
15	Number of Distinct Detects			11		Number of Distinct Non-Detects			4			
16	Minimum Detect			39.1		Minimum Non-Detect			20			
17	Maximum Detect			8720		Maximum Non-Detect			23			
18	Variance Detects			9250009		Percent Non-Detects			52.17%			
19	Mean Detects			1694		SD Detects			3041			
20	Median Detects			267		CV Detects			1.795			
21	Skewness Detects			1.938		Kurtosis Detects			2.515			
22	Mean of Logged Detects			5.763		SD of Logged Detects			1.987			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.609		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.85		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.374		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.251		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		820.6		KM Standard Error of Mean			475.2				
33	KM SD		2173		95% KM (BCA) UCL			1630				
34	95% KM (t) UCL		1637		95% KM (Percentile Bootstrap) UCL			1620				
35	95% KM (z) UCL		1602		95% KM Bootstrap t UCL			5754				
36	90% KM Chebyshev UCL		2246		95% KM Chebyshev UCL			2892				
37	97.5% KM Chebyshev UCL		3788		99% KM Chebyshev UCL			5549				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.889		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.802		Detected Data Not Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.226		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.273		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data follow Appr. Gamma Distribution at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.395		k star (bias corrected MLE)			0.348				
48	Theta hat (MLE)		4294		Theta star (bias corrected MLE)			4875				
49	nu hat (MLE)		8.679		nu star (bias corrected)			7.645				
50	Mean (detects)		1694									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01							Mean	810.2	
59		Maximum	8720							Median	0.01	
60		SD	2226							CV	2.747	
61		k hat (MLE)	0.124							k star (bias corrected MLE)	0.137	
62		Theta hat (MLE)	6513							Theta star (bias corrected MLE)	5907	
63		nu hat (MLE)	5.722							nu star (bias corrected)	6.309	
64		Adjusted Level of Significance (β)	0.0389									
65		Approximate Chi Square Value (6.31, α)	1.8							Adjusted Chi Square Value (6.31, β)	1.631	
66		95% Gamma Approximate UCL (use when $n \geq 50$)	2840							95% Gamma Adjusted UCL (use when $n < 50$)	3133	
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	820.6							SD (KM)	2173	
70		Variance (KM)	4721011							SE of Mean (KM)	475.2	
71		k hat (KM)	0.143							k star (KM)	0.153	
72		nu hat (KM)	6.562							nu star (KM)	7.039	
73		theta hat (KM)	5753							theta star (KM)	5363	
74		80% gamma percentile (KM)	907.8							90% gamma percentile (KM)	2440	
75		95% gamma percentile (KM)	4499							99% gamma percentile (KM)	10450	
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (7.04, α)	2.192							Adjusted Chi Square Value (7.04, β)	2.001	
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	2635							95% Gamma Adjusted KM-UCL (use when $n < 50$)	2886	
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.877							Shapiro Wilk GOF Test		
83		5% Shapiro Wilk Critical Value	0.85							Detected Data appear Lognormal at 5% Significance Level		
84		Lilliefors Test Statistic	0.219							Lilliefors GOF Test		
85		5% Lilliefors Critical Value	0.251							Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	811.4							Mean in Log Scale	2.766	
90		SD in Original Scale	2225							SD in Log Scale	3.408	
91		95% t UCL (assumes normality of ROS data)	1608							95% Percentile Bootstrap UCL	1640	
92		95% BCA Bootstrap UCL	1948							95% Bootstrap t UCL	5959	
93		95% H-UCL (Log ROS)	589969									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	4.319							KM Geo Mean	75.13	
97		KM SD (logged)	1.905							95% Critical H Value (KM-Log)	3.895	
98		KM Standard Error of Mean (logged)	0.417							95% H-UCL (KM -Log)	2241	
99		KM SD (logged)	1.905							95% Critical H Value (KM-Log)	3.895	
100		KM Standard Error of Mean (logged)	0.417									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	815.8							Mean in Log Scale	3.993	
105		SD in Original Scale	2223							SD in Log Scale	2.191	
106		95% t UCL (Assumes normality)	1612							95% H-Stat UCL	4597	

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k > 1$)	2886										
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:40:23 PM									
5	From File		OU1 1D Subsurface_d.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Dibenzo(a,h)anthracene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			23			Number of Distinct Observations			12		
14	Number of Detects			6			Number of Non-Detects			17		
15	Number of Distinct Detects			6			Number of Distinct Non-Detects			6		
16	Minimum Detect			30.2			Minimum Non-Detect			23		
17	Maximum Detect			1200			Maximum Non-Detect			33		
18	Variance Detects			218242			Percent Non-Detects			73.91%		
19	Mean Detects			346.4			SD Detects			467.2		
20	Median Detects			109.5			CV Detects			1.349		
21	Skewness Detects			1.616			Kurtosis Detects			1.971		
22	Mean of Logged Detects			4.998			SD of Logged Detects			1.456		
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.756			Shapiro Wilk GOF Test					
26	5% Shapiro Wilk Critical Value			0.788			Detected Data Not Normal at 5% Significance Level					
27	Lilliefors Test Statistic			0.345			Lilliefors GOF Test					
28	5% Lilliefors Critical Value			0.325			Detected Data Not Normal at 5% Significance Level					
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean			107.4			KM Standard Error of Mean			59.39		
33	KM SD			260			95% KM (BCA) UCL			208.9		
34	95% KM (t) UCL			209.3			95% KM (Percentile Bootstrap) UCL			205		
35	95% KM (z) UCL			205.1			95% KM Bootstrap t UCL			779.6		
36	90% KM Chebyshev UCL			285.5			95% KM Chebyshev UCL			366.2		
37	97.5% KM Chebyshev UCL			478.3			99% KM Chebyshev UCL			698.3		
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic			0.435			Anderson-Darling GOF Test					
41	5% A-D Critical Value			0.723			Detected data appear Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic			0.281			Kolmogorov-Smirnov GOF					
43	5% K-S Critical Value			0.344			Detected data appear Gamma Distributed at 5% Significance Level					
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)			0.71			k star (bias corrected MLE)			0.466		
48	Theta hat (MLE)			487.8			Theta star (bias corrected MLE)			743.1		
49	nu hat (MLE)			8.52			nu star (bias corrected)			5.593		
50	Mean (detects)			346.4								
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	90.36						
59		Maximum	1200		Median	0.01						
60		SD	271.6		CV	3.006						
61		k hat (MLE)	0.12		k star (bias corrected MLE)	0.133						
62		Theta hat (MLE)	752.5		Theta star (bias corrected MLE)	677.4						
63		nu hat (MLE)	5.523		nu star (bias corrected)	6.136						
64		Adjusted Level of Significance (β)	0.0389									
65		Approximate Chi Square Value (6.14, α)	1.71		Adjusted Chi Square Value (6.14, β)	1.547						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	324.3		95% Gamma Adjusted UCL (use when $n < 50$)	358.5						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	107.4		SD (KM)	260						
70		Variance (KM)	67601		SE of Mean (KM)	59.39						
71		k hat (KM)	0.171		k star (KM)	0.177						
72		nu hat (KM)	7.845		nu star (KM)	8.155						
73		theta hat (KM)	629.6		theta star (KM)	605.7						
74		80% gamma percentile (KM)	131.9		90% gamma percentile (KM)	323.5						
75		95% gamma percentile (KM)	570.1		99% gamma percentile (KM)	1263						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (8.15, α)	2.825		Adjusted Chi Square Value (8.15, β)	2.602						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	309.9		95% Gamma Adjusted KM-UCL (use when $n < 50$)	336.5						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.926		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.788		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.202		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.325		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	91.39		Mean in Log Scale	0.777						
90		SD in Original Scale	271.3		SD in Log Scale	3.035						
91		95% t UCL (assumes normality of ROS data)	188.5		95% Percentile Bootstrap UCL	190						
92		95% BCA Bootstrap UCL	251.5		95% Bootstrap t UCL	715.6						
93		95% H-UCL (Log ROS)	9439									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.622		KM Geo Mean	37.41						
97		KM SD (logged)	1.063		95% Critical H Value (KM-Log)	2.609						
98		KM Standard Error of Mean (logged)	0.243		95% H-UCL (KM -Log)	118.9						
99		KM SD (logged)	1.063		95% Critical H Value (KM-Log)	2.609						
100		KM Standard Error of Mean (logged)	0.243									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	99.68		Mean in Log Scale	3.175						
105		SD in Original Scale	268.4		SD in Log Scale	1.309						
106		95% t UCL (Assumes normality)	195.8		95% H-Stat UCL	128.6						

	A	B	C	D	E	F	G	H	I	J	K	L
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	336.5										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation		ProUCL 5.17/2/2019 5:41:13 PM									
5	From File		OU1 1D Subsurface_e.xls									
6	Full Precision		OFF									
7	Confidence Coefficient		95%									
8	Number of Bootstrap Operations		2000									
9												
10	Indeno (1,2,3-cd) pyrene (ug/kg)											
11												
12	General Statistics											
13	Total Number of Observations			23		Number of Distinct Observations			11			
14	Number of Detects			6		Number of Non-Detects			17			
15	Number of Distinct Detects			6		Number of Distinct Non-Detects			5			
16	Minimum Detect			110		Minimum Non-Detect			22			
17	Maximum Detect			3060		Maximum Non-Detect			33			
18	Variance Detects			1675683		Percent Non-Detects			73.91%			
19	Mean Detects			1111		SD Detects			1294			
20	Median Detects			468		CV Detects			1.165			
21	Skewness Detects			1.001		Kurtosis Detects			-1.298			
22	Mean of Logged Detects			6.267		SD of Logged Detects			1.423			
23												
24	Normal GOF Test on Detects Only											
25	Shapiro Wilk Test Statistic			0.779		Shapiro Wilk GOF Test						
26	5% Shapiro Wilk Critical Value			0.788		Detected Data Not Normal at 5% Significance Level						
27	Lilliefors Test Statistic			0.347		Lilliefors GOF Test						
28	5% Lilliefors Critical Value			0.325		Detected Data Not Normal at 5% Significance Level						
29	Detected Data Not Normal at 5% Significance Level											
30												
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
32	KM Mean		306.1		KM Standard Error of Mean			175.9				
33	KM SD		770		95% KM (BCA) UCL			592.3				
34	95% KM (t) UCL		608.1		95% KM (Percentile Bootstrap) UCL			601.5				
35	95% KM (z) UCL		595.4		95% KM Bootstrap t UCL			1369				
36	90% KM Chebyshev UCL		833.7		95% KM Chebyshev UCL			1073				
37	97.5% KM Chebyshev UCL		1405		99% KM Chebyshev UCL			2056				
38												
39	Gamma GOF Tests on Detected Observations Only											
40	A-D Test Statistic		0.468		Anderson-Darling GOF Test							
41	5% A-D Critical Value		0.72		Detected data appear Gamma Distributed at 5% Significance Level							
42	K-S Test Statistic		0.257		Kolmogorov-Smirnov GOF							
43	5% K-S Critical Value		0.343		Detected data appear Gamma Distributed at 5% Significance Level							
44	Detected data appear Gamma Distributed at 5% Significance Level											
45												
46	Gamma Statistics on Detected Data Only											
47	k hat (MLE)		0.797		k star (bias corrected MLE)			0.509				
48	Theta hat (MLE)		1395		Theta star (bias corrected MLE)			2181				
49	nu hat (MLE)		9.558		nu star (bias corrected)			6.112				
50	Mean (detects)		1111									
51												
52	Gamma ROS Statistics using Imputed Non-Detects											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											

	A	B	C	D	E	F	G	H	I	J	K	L
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58		Minimum	0.01		Mean	289.8						
59		Maximum	3060		Median	0.01						
60		SD	793.5		CV	2.738						
61		k hat (MLE)	0.108		k star (bias corrected MLE)	0.123						
62		Theta hat (MLE)	2681		Theta star (bias corrected MLE)	2357						
63		nu hat (MLE)	4.973		nu star (bias corrected)	5.657						
64		Adjusted Level of Significance (β)	0.0389									
65		Approximate Chi Square Value (5.66, α)	1.467		Adjusted Chi Square Value (5.66, β)	1.32						
66		95% Gamma Approximate UCL (use when $n \geq 50$)	1117		95% Gamma Adjusted UCL (use when $n < 50$)	1243						
67												
68	Estimates of Gamma Parameters using KM Estimates											
69		Mean (KM)	306.1		SD (KM)	770						
70		Variance (KM)	592944		SE of Mean (KM)	175.9						
71		k hat (KM)	0.158		k star (KM)	0.166						
72		nu hat (KM)	7.268		nu star (KM)	7.654						
73		theta hat (KM)	1937		theta star (KM)	1840						
74		80% gamma percentile (KM)	360.5		90% gamma percentile (KM)	918.2						
75		95% gamma percentile (KM)	1649		99% gamma percentile (KM)	3726						
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78		Approximate Chi Square Value (7.65, α)	2.536		Adjusted Chi Square Value (7.65, β)	2.327						
79		95% Gamma Approximate KM-UCL (use when $n \geq 50$)	923.7		95% Gamma Adjusted KM-UCL (use when $n < 50$)	1007						
80												
81	Lognormal GOF Test on Detected Observations Only											
82		Shapiro Wilk Test Statistic	0.887		Shapiro Wilk GOF Test							
83		5% Shapiro Wilk Critical Value	0.788		Detected Data appear Lognormal at 5% Significance Level							
84		Lilliefors Test Statistic	0.193		Lilliefors GOF Test							
85		5% Lilliefors Critical Value	0.325		Detected Data appear Lognormal at 5% Significance Level							
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89		Mean in Original Scale	293.8		Mean in Log Scale	2.099						
90		SD in Original Scale	792		SD in Log Scale	3.011						
91		95% t UCL (assumes normality of ROS data)	577.4		95% Percentile Bootstrap UCL	591.3						
92		95% BCA Bootstrap UCL	707.7		95% Bootstrap t UCL	1804						
93		95% H-UCL (Log ROS)	31167									
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96		KM Mean (logged)	3.92		KM Geo Mean	50.38						
97		KM SD (logged)	1.545		95% Critical H Value (KM-Log)	3.317						
98		KM Standard Error of Mean (logged)	0.353		95% H-UCL (KM -Log)	495.2						
99		KM SD (logged)	1.545		95% Critical H Value (KM-Log)	3.317						
100		KM Standard Error of Mean (logged)	0.353									
101												
102	DL/2 Statistics											
103	DL/2 Normal						DL/2 Log-Transformed					
104		Mean in Original Scale	298.8		Mean in Log Scale	3.476						
105		SD in Original Scale	790.1		SD in Log Scale	1.828						
106		95% t UCL (Assumes normality)	581.7		95% H-Stat UCL	746.9						

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107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113	Adjusted KM-UCL (use when $k \leq 1$ and $15 < n < 50$ but $k \leq 1$)	1007										
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												