Appendix D

Risk Assessment

LOWER EIGHT MILES OF THE LOWER PASSAIC RIVER
RISK ASSESSMENT

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1 INTRODUCTION

This document presents the human health and ecological risk assessments to support the Focused Feasibility Study (FFS) of the lower eight miles of the Lower Passaic River. The FFS was undertaken to evaluate remedial alternatives to address contamination in the first eight miles of sediments in the Lower Passaic River (FFS Study Area). The FFS Study Area is part of the Lower Passaic River Study Area (LPRSA), which is the 17-mile, tidal portion of the Passaic River, from Dundee Dam to the confluence with Newark Bay, and its watershed, including the Saddle River, Third River and Second River. The FFS Study Area is an operable unit of the Diamond Alkali Superfund Site. The FFS Study Area sediments were identified as the major source of contamination to the rest of the Lower Passaic River and Newark Bay during the 17-mile LPRSA remedial investigation and feasibility study (RI/FS), which is still ongoing. The 17-mile LPRSA RI/FS will have its own risk assessments to support decision making.

Human health and ecological risk assessments are designed to aid in risk management decisions regarding the potential actions necessary to address the hazardous substances at a site. This document assesses baseline risks posed by the sediments of the FFS Study Area, including current and future conditions assuming no remediation, in the absence of remedial action or institutional controls, such as fish advisories, that might alter the behavior of receptors to help the United States Environmental Protection Agency (USEPA) evaluate the need for taking action in the FFS Study Area.

In addition, this document assesses potential future risks associated with predicted conditions following implementation of each of the FFS remedial alternatives (including No Action). Future conditions are predicted using chemical fate and transport model outputs.

As part of the FFS, this document follows USEPA Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989; 1997a; 1998). Consistent with RAGS and USEPA's risk assessment guidelines and policies, this risk assessment focuses on providing information necessary to determine whether an action at the site is necessary and to select an appropriate remedy. It relies on data and analytical tools that existed at the time that the FFS was undertaken, *i.e.*, it provides the information necessary to develop a remedial action for the FFS Study Area prior to the completion of the full RI/FS and baseline risk assessment for the 17-mile LPRSA. This phased approach is consistent with USEPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005a).

The FFS baseline human health risk assessment (HHRA) assesses the cancer risks and non-cancer health hazards associated with exposure to a limited set of contaminants in the FFS Study Area due to the angler/sportsman and other family members consuming self-caught fish and shellfish. The contaminants evaluated are considered to be most bioaccumulative, most persistent in the environment, and most toxic to human beings, to capture the primary risk drivers. Based on the results of Superfund HHRAs conducted for other river sites with bioaccumulative contaminants, such as dioxins and PCBs, consumption of fish and shellfish is anticipated to be associated with the highest cancer risks and non-cancer health hazards compared to ingestion, dermal contact or inhalation of chemicals in surface water or sediment during recreational exposures. Additional discussion of the contaminants and exposure pathways evaluated in the FFS HHRA is provided in Sections 3.3 and 3.4. The full range of exposure pathways and contaminants is being evaluated in the 17-mile Lower Passaic River RI/FS HHRA.

The FFS baseline ecological risk assessment (BERA) assesses the risks to benthic invertebrates, fish (forage and piscivorous), aquatic-feeding birds and piscivorous mammals associated with exposure to a limited set of contaminants in the FFS Study Area due to direct contact with and incidental ingestion of sediments, as well as ingestion of contaminated prey. The contaminants evaluated are bioaccumulative contaminants that were identified in the screening phase as comprising the largest contribution of total risk to ecological receptors. Additional discussion of the contaminants and exposure pathways evaluated in the FFS BERA is provided in Section 4.1. The full range of exposure pathways and contaminants is being evaluated in the 17-mile Lower Passaic River RI/FS BERA.

The HHRA and BERA presented in this document are revised versions of those provided in the *Draft Source Control Early Action Focused Feasibility Study* (Malcolm Pirnie Inc., 2007). The principal difference between the two versions is that this current version uses 2008 (and more recent) analytical data to be consistent with the 17-mile LPRSA RI/FS. The historical analytical data used in the 2007 risk assessments are only used for comparison purposes and trends analyses; they are not included in the risk calculations. A summary of all modifications made to the 2007 HHRA and BERA to be consistent with the 17-mile LPRSA RI/FS risk assessments is provided in Attachment 1.3.

In addition to this brief introduction, Appendix D is presented in the following sections:

- Section 2: **Available Data**. This section describes the data used in the risk assessments and presents the results of the data usability evaluation.
- Section 3: **Human Health Risk Assessment – Baseline Conditions.** This section describes the methodology and results of the HHRA performed as part of the FFS.
- Section 4: **Baseline Ecological Risk Assessment**. This section describes the methodology and results of the BERA performed as part of the FFS.
- Section 5: **Remedial Alternatives Future Risk Assessment**. This section presents the results of the risk assessments conducted under the FFS remedial alternatives.
- Section 6: **Summary and Conclusions**. The section presents summaries and conclusions of the risk assessments.
- Section 7: **Acronyms**.
- Section 8: **References**.

2 AVAILABLE DATA

2.1 Data Compilation for the HHRA

The HHRA considers fish and crab tissue data collected by the Cooperating Parties Group[1] (CPG) for the 17-mile LPRSA RI/FS throughout the FFS Study Area during the late summer/early fall 2009 fish and decapod crustacean tissue sampling event (August and September 2009, with a supplemental effort in October 2009; refer to RI Chapter 2 for more information). Fish samples collected during this sampling event represent exposures within four reaches of the LPRSA (Figure 2-1) and included species from different feeding guilds that are commonly caught and abundant in the FFS Study Area. This allowed for the assessment of a variety of habitats, feeding strategies, and physiological factors that might result in differences in the uptake of contaminants between species. In order to account for the types of fish that may be consumed by recreational anglers/sportsmen, tissue chemistry data from six species (American eel, common carp, smallmouth bass, white catfish, white perch, and white sucker) were used to derive an equal-weighted average concentration to represent chemical concentrations to which someone eating fish would be exposed, similar to the methodology used in the Hudson River Risk Assessment (TAMS Consultants and Gradient Corp., 2000). Tissue samples included in the assessment consisted of both skinless and skin-on fillet samples (USEPA, 2000a).

For crab tissue, the blue crab was selected to assess exposures because it is commonly caught and consumed in the FFS Study Area, as evidenced by Burger (2002). The highest levels of most chemical contaminants are found in the hepatopancreas of the crab (New Jersey Department of Environmental Protection [NJDEP], 2002), commonly known as the tomalley or green gland (the yellowish-green gland under the gills). As noted in published literature, individuals catching and consuming crab may consume the edible white meat (or muscle) from the thoracic cavity, claws, and legs, and some individuals may also consume the hepatopancreas (Belton *et al*., 1985; May and Burger, 1996; NJDEP, 2002). Because the crab is cooked whole (generally boiled) with the hepatopancreas melting into the pan sauce which is also eaten,

[1] The Cooperating Parties Group (CPG) is a group of potentially responsible parties conducting the RI/FS of the 17-mile LPRSA under USEPA oversight.

consumption of only the muscle tissue would still result in exposure to the contaminants initially contained in the hepatopancreas; thus for crab, chemical concentrations at points of exposure were calculated using tissue samples comprising both muscle and hepatopancreas.

Identification of contaminants of potential concern (COPCs) is summarized in Section 3.3. A summary of the tissue chemistry data used in the HHRA is provided in Attachment 1.1. Data used consisted of 39 fish fillet samples (16 American eel, four common carp, one smallmouth bass, six white catfish, 11 white perch, and one white sucker) and 22 crab combined muscle and hepatopancreas samples.

2.2 Data Compilation for the BERA

The BERA evaluated ecological exposures based on site-specific analytical chemistry data for sediment and biota collected throughout the FFS Study Area (Figure 2-2). Sediment samples included surficial (*i.e.*, 0 to 6 inches) data collected in fall 2009 and late summer 2010, as well as samples collected as part of the 2008 low resolution coring program (Appendix A). Biota datasets consisted of the fish and crab tissue data collected during the late summer/early fall 2009 fish and decapod crustacean tissue sampling event described above, as well as mummichog samples collected during summer 2010 (Figure 2-1). Tissue samples included in the BERA consist of either whole body or reconstituted whole body samples (see Attachment 1.1). Reconstituted samples were derived by combining the fractional weight adjusted analytical results for carcass and offal samples.

Identification of contaminants of potential ecological concern (COPECs) is summarized in Section 4.1.1 and detailed in Attachment 2. A summary of the chemistry data used in the BERA is provided in Attachment 1.1. Data used consisted of up to 229 individual sediment samples, several of which were only analyzed for a subset of the analytes. Data used also included up to 36 whole body and reconstituted whole body fish samples (not including mummichog), 15 mummichog whole body samples, nine mummichog egg tissue samples, and 22 reconstituted whole body crab samples.

A subset of the 229 sediment samples was identified to evaluate exposures for receptors that are only expected to come into contact with mudflat sediment. This consisted of 17 sediment samples collected between 2009 and 2011 included in the BERA dataset that were identified as mudflat samples based on their location in the shoal areas of the Passaic River that could potentially be exposed during low tide. The number of mudflat sediment samples is limited, resulting in relatively greater uncertainties in the quantification of this exposure point. Benthic infauna are sedentary and unlikely to experience exposure outside of a small area and exposures were evaluated for both mudflat sediments and average exposures throughout the river. Great blue heron are wading birds that feed on forage fish in mudflat areas, and are likely only to be exposed to mudflat sediments. Mink feed in shallow areas as well, but tend to consume larger predatory fish that are exposed to sediment throughout the area. Incidental sediment ingestion by mink would include sediment entrained in the gut of prey items.

2.3 Data Usability Evaluation

Quality assurance project plans (QAPPs), survey and data reports, and associated metadata information were available electronically for all of the biological tissue and sediment datasets used in the risk assessments.

Biological tissue and surface sediment collections were carried out as scoped in the project QAPPs and associated addendums:

- *Final Oversight Quality Assurance Project Plan for Biological Sampling, Community Surveys, Toxicity and Bioaccumulation Testing* (Malcolm Pirnie, Inc., and Battelle Duxbury Operations, 2009)
- *Quality Assurance Project Plan Fish and Decapod Crustacean Tissue Collection for Chemical Analysis and Fish Community Survey* (Windward Environmental, 2009a)
- *Quality Assurance Project Plan RI Low Resolution Coring/Sediment Sampling (LRC) Quality Assurance Project Plan (QAPP) (*ENSR, 2008*)*
- *The Lower Passaic River Restoration Project Field Sampling Plan Volume 1 (FSP1)* (Malcolm Pirnie, Inc., 2006)

- *Quality Assurance Project Plan Surface Sediment Chemical Analyses and Benthic Invertebrate Toxicity and Bioaccumulation Testing* (Windward Environmental, 2009b)
- *Quality Assurance Project Plan Final Addendum #2, Collection of Surface Sediment Samples Co-located with the Small Forage Fish Tissue Samples During Summer 2010 Benthic Invertebrate Community Survey* (Windward Environmental, 2010a).

<u>Tissue Data</u>

The survey and data reports for the field sampling efforts in late summer/early fall 2009 and late summer 2010 to collect fish and crab tissue for chemical analysis included electronic copies of field forms, field notebook entries, field sampling notes and photos, sample processing photos, protocol modification forms, standard operating procedures (SOPs), catch summaries, and chain-of-custody forms.

- *Fish and Decapod Field Report for the Late Summer/Early Fall 2009 Field Effort, Final* (Windward Environmental, 2010b)
- *Fish Community Survey and Tissue Collection Data Report for the Lower Passaic River Study Area 2010 Field Efforts, Final* (Windward Environmental, 2011a).

<u>Sediment Data</u>

The data reports for the field sampling efforts in 2008, 2009, and 2010 to collect surface sediment for chemical analysis included field forms, field notebook entries, field sampling notes and photos, sample processing photos, modification forms, SOPs, data summaries, and chain-of-custody forms.

- *Lower Resolution Coring Characterization Summary, Lower Passaic River Study Area RI/FS* (AECOM, in prep)
- *2009 and 2010 Sediment Chemistry Data for the Lower Passaic River Study Area* (Windward Environmental, in prep).

<u>Data Validation</u>

Independent data validation of all results was conducted according to the above listed QAPPs, USEPA Region 2 SOPs described in the QAPPs, and USEPA national functional guidelines

(USEPA, 2002a,b; 2005b; 2008). All polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCB) congeners, polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDDs/PCDFs), and organochlorine pesticide data underwent full data validation (USEPA Level 4). For all other chemical groups, at least 20% of the data received full validation and up to 80% received reduced validation (USEPA Level 2). Furthermore, although not all of the datasets received a full data validation, the data were collected under an approved USEPA QAPP. Appropriate quality assurance/quality control (QA/QC) procedures were conducted on these datasets, and the data are deemed to be of sufficient quality to perform these risk assessments.

Using the available information (QAPPs, survey reports, data reports, validation reports), data usability worksheets were prepared as defined in USEPA RAGS Part D Appendix C: Planning Worksheets (USEPA, 2001) for the two tissue datasets (HHRA: 2009 fish and decapod samples[2] and BERA: 2009 and 2010 fish and decapod samples) and the sediment dataset and are provided in Attachment 1.

2.3.1 Method Detection Limits

The data usability evaluation includes assessment of the analyte-specific method detection limit (MDL). Achieved MDLs are a major issue affecting data usability for risk (USEPA, 1992). If the MDL is higher than concentrations known to cause toxicity or adverse effects to human or ecological receptors, the actual contaminant concentration cannot be quantified and risks cannot be evaluated. Because some contaminants cause ecological or human health effects at low levels, the MDL must at least meet or be lower than the effects levels.

For each dataset used in the risk assessments, the lowest available MDLs were compared to the data quality limits (DQLs) documented in the QAPPs (Windward Environmental, 2009a and 2009b) (Attachment 1.2). In addition, for the HHRA, tissue MDLs were compared to more recent USEPA Region 3 fish tissue screening levels[3] because the DQLs documented in the

[2] Refer to Sections 5.1.2 and 6.1.3 for detailed descriptions of the HHRA and BERA exposure media, respectively.
[3] USEPA Region 3 fish tissue screening levels dated May 2013.
(http://www.epa.gov/reg3hwmd/risk/human/pdf/MAY_2013_FISH_THQ1.pdf) were comparable to the May 2008 fish tissue screening levels. Region 3 screening levels assume a default fish consumption rate of 54 g/day and residential exposure

QAPPs were obtained from the May 2008 USEPA Region 3 fish tissue screening levels; for the BERA, tissue and sediment MDLs were compared to toxicological screening thresholds (Attachment 1.2). For sediment, all minimum MDLs were lower than the screening thresholds; however, screening thresholds were exceeded for some tissue chemistry data as summarized in Tables 1 and 2 of Attachment 1.2. Although some MDLs exceeded screening thresholds, all of the tissue chemistry data were acceptable for use in the risk assessments. For the HHRA and the BERA, frequency of detection was not used as a criterion to select COPCs/COPECs.

Tissue Data

As discussed above, minimum MDLs, when available, were compared to human health and ecological tissue DQLs (*i.e.*, screening thresholds) presented in the tissue QAPP (Windward Environmental, 2009a). Analytes with screening benchmarks that were lower than the associated MDLs were flagged and further reviewed for their frequency of detection (Tables 1 and 2 of Attachment 1.2).

For the HHRA dataset comprising fish and crab tissue samples, the MDLs were generally lower than the USEPA Region 3 screening levels for fish tissue ingestion. Chlordane, dieldrin, and dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethane (DDD), and dichlorodiphenyldichloroethylene (DDE) had several nondetected results with MDLs greater than their benchmark value. However, the number of nondetected results that exceeded the DQLs was low compared with the overall number of nondetected results and is anticipated to have a minimal impact on the usability of the pesticide data for the HHRA. A few results for several dioxin/furan (D/F) congeners and PCB 126 and PCB 129 had MDLs above USEPA Region 3 screening levels, but these compounds were not detected in any of the samples collected from the FFS Study Area.

For the BERA, the MDLs were generally lower than the DQLs, except for PCB 126 and PCB 169. About half of the nondetected results for PCB 126 exceeded the DQL, but the average

assumptions. The November 2014 Update to the Regional Screening Level Tables did not include any changes related to the COPCs in the FFS Study Area.

MDL was very similar to the DQL. In the case of PCB 169, only one nondetected value exceeded the DQL.

Sediment Data

Sediment samples included in the dataset for the BERA were collected during three separate field collection events conducted between 2008 and 2010 from river mile (RM) 0.7 to RM 7.37. As discussed above, minimum MDLs, when available, were compared to ecological sediment screening benchmarks presented in the sediment QAPP (Windward Environmental, 2009b). Analytes with sediment benchmarks that were lower than the associated MDLs were flagged and further reviewed for their frequency of detection.

For the 2008 sediment data, samples were analyzed in accordance with the USEPA-approved QAPP and minimum MDLs were lower than ecological screening benchmarks. However, a comparison of split samples analyzed by Axys Analytical Services (AXYS; the laboratory used by USEPA) versus those analyzed by Columbia Analytical Services (CAS; the laboratory used by the CPG) found a systematic bias in PCDD/PCDF results, with CAS results lower than AXYS results. After investigations into disparate laboratory protocols, a contractor from USEPA's Office of Water concluded that CAS laboratory procedures extracted less dioxin from sediment samples than AXYS procedures, and that a correction factor would be appropriate to apply to all CAS dioxin congener results from the 2008 sampling event (CSC and Interface, 2010 and 2011). In 2011, USEPA Region 2 directed that all validated PCDD/PCDF values should be adjusted to address the systematic bias. The adjustments were as follows:

1. No adjustment is provided for CAS data for all results below CAS's quantification limit.
2. For all samples that were split, the CAS results are to be replaced with the results generated by USEPA Region 2's laboratory, AXYS.
3. For all remaining results, the congener-specific adjustment factors developed by CSC are to be applied.

It was agreed that a unique validation qualifier "F" would be assigned to results replaced or adjusted based on Rules 2 and 3 above.

For the 2009 and 2010 sediment data, all of the contaminants of potential ecological concern (COPECs) had high frequencies of detection (>82%). MDLs for dieldrin exceeded sediment benchmarks in some of the studies, but dieldrin overall had a high frequency of detection (*i.e.*, 99 to 100%). The 2009 and 2010 sediment data were considered acceptable for use in the RI/FS process, as qualified. However, MDL exceedances of DQLs occurred for PAHs and organochlorine pesticides. For PAHs and the organochlorine pesticides, the number of cases where MDLs exceed DQLs is limited (*i.e.*, for most chemicals, fewer than 10 samples had nondetected results that were greater than DQLs).

Data Usability Summary

For purposes of conducting the HHRA, the data usability evaluation found that all of the data were collected under USEPA QAPPs, and therefore, the appropriate QA/QC procedures were conducted on the data. Where a systematic bias was found in CPG-collected data (2008 sediment PCDD/PCDF results), a method of correction was developed. In addition, the evaluation identified distinct issues where MDLs were higher than risk-based screening levels for pesticides and D/Fs. Use of surrogate values (*e.g.*, substitution of zero, one-half the detection limit) for nondetect chemicals, including multi-constituent chemicals such as tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalency (TEQ) (D/F) and TCDD TEQ (PCBs) was not performed in this HHRA because it introduces bias tending towards overestimating concentrations; rather, an approach using the Kaplan-Meier (KM) estimator was employed (the KM method is currently a default method used in USEPA's ProUCL software for calculating the 95% upper confidence level (UCL) of the mean for data with one or more censored[4] results) using the ProUCL 4.1 software package (version 4.1.00[5]) developed by USEPA (2010b). The KM estimator is a step function that determines the most likely value for contaminant concentrations below analytical MDLs based on probabilities determined from the observed detected data.

The KM estimator is the most effective approach for estimating concentrations when the frequency of nondetects in a dataset is high (*e.g.*, > 40 to 50%), especially when multiple

[4] A censored result refers to a value of a measurement or observation that is only partially known (*e.g.*, values that are estimated ["J"-qualified] and values less than the MDL [nondetects]).
[5] Subsequent to completion of the risk assessment, USEPA released ProUCL version 5.0.00. KM estimates used in this risk assessment were verified with the newer ProUCL version.

detection limits might be present. When there is a high frequency of nondetects, it is hard to reliably perform goodness of fit tests (to determine data distribution), especially when the datasets are of small sizes (< 10 to 20; USEPA, 2010c, d). Parametric methods (*e.g.*, for normal and lognormal distributions) for estimating values below MDLs often yield unstable estimates of the mean and standard deviation, especially when the number of nondetects exceeds 40 to 50%. In such situations, it is preferable to use nonparametric methods (*e.g*., KM method) to compute UCLs. Nonparametric methods do not require any distributional assumptions about the datasets under investigation. Use of this KM method rather than the substitution method most likely limits an overestimation of the EPC.

Similarly, for the purposes of conducting the BERA, there were several instances where MDLs for dieldrin and several individual PAHs and PCBs exceeded appropriate sediment screening benchmarks. As was the case with the HHRA, surrogate values (*e.g.*, substitution of zero, one-half the detection limit) were not used for nondetect chemicals, because it introduces bias to estimates; rather, an approach using the KM estimator was employed. Use of this KM method rather than the substitution method most likely limits an overestimation of the EPC.

2.4 Data Standardization and Summary Procedures

For this biological and sediment data review, the following chemical classes were examined:

- PCDD (dioxins [D])
- PCDF (furans [F])
- PCB congeners
- Pesticides (chlordane, dieldrin, and DDx compounds only)
- PAHs
- Metals (copper, lead, and mercury only).

In addition, the following TEQ calculations were performed for D/F and coplanar (dioxin-like) PCB congeners:

- TCDD TEQ for D/F: sum of the products of the congener concentration and congener-specific toxic equivalency factors[6] (TEFs) (Table 2-1) for all D/F congeners
- TCDD TEQ for PCB coplanar congeners: sum of the products of the congener concentration and their TEFs (Table 2-1) for 12 coplanar PCB compounds (*i.e.*, the World Health Organization [WHO] congeners)
- Total TCDD TEQ: the sum of the above two results.

[6] A TEF is a measure of the relative potency of a compound to cause a particular toxic or biological effect relative to 2,3,7,8-TCDD. By convention, TCDD is assigned a TEF of 1.0, and the TEFs for other compounds with dioxin-like effects range from 0 to 1. When TEFs are derived based on the relative binding affinity to the aryl hydrocarbon receptor (AhR) or induction of cytochrome P4501A1, it is assumed that these biochemical responses correlate with toxicologically important effects (Van den Berg *et al*., 1998). The consensus TEF values published in 2005 by the WHO and recommended by USEPA (2010a) are used in the risk evaluations along with the ecological TEFs in Van den Berg *et al*., 1998.

3 HUMAN HEALTH RISK ASSESSMENT – BASELINE CONDITIONS

This section describes the methodology and results of the HHRA performed as part of the FFS to determine the magnitude of potential cancer risks and noncancer health hazards to human receptors associated with consumption of fish and crab caught from the FFS Study Area. Baseline conditions denote the absence of remedial action or institutional controls, such as fish advisories, that might alter the behavior of receptors. The HHRA evaluates potential current health risks using site-specific tissue sampling data and potential future health risks based on modeling results. The results of the assessment will be used in accordance with USEPA guidance (1991a) to inform risk management decisions. A separate baseline HHRA is underway to support decision making during the conduct of the comprehensive remedial RI/FS for the entire 17-mile LPRSA.

The HHRA was conducted according to USEPA's RAGS Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989), and other appropriate USEPA guidance, guidelines and policies, including RAGS Part D (USEPA, 2001).

3.1 Environmental Setting

The FFS Study Area is part of the LPRSA, which is the 17-mile, tidal portion of the Passaic River from Dundee Dam (RM17.4) to Newark Bay (RM0). The FFS Study Area is located in a highly developed urban area, with approximately 1.4 million people living in Essex County (west bank) and Hudson County (east bank). Intensive commercial and industrial uses occur near the mouth of the river (RM0) and around portions of Newark Bay, in part to take advantage of the multi-modal transportation infrastructure (rail, air and marine). Near RM4, the Lower Passaic River continues to include commercial uses, but also starts to include more residential and recreational uses. The banks of the FFS Study Area consist of 95% bulkhead and riprap (some with overhanging vegetation) and 5% aquatic vegetation. The mudflats within the FFS Study Area total approximately 101 acres.

The Lower Passaic River has been used as a major means of conveyance for industrial and municipal discharges from the middle of the 19th century to the present. Together, these waste streams have delivered a number of contaminants, including 2,3,7,8-TCDD, PAHs, PCBs, DDT, mercury, lead, and other contaminants, into the river. The river has undergone major physical changes over this period as well. For instance, the Lower Passaic River has an authorized navigation channel (from RM0 to RM15.4), which was constructed at the end of the 19th century, then sporadically maintained through the 1950s above RM2 and through 1983 below RM2. As maintenance dredging declined and stopped, the artificially deep navigation channel filled with sediments. At the same time, industrial activities along the river grew, and industries and municipalities disposed of wastewaters in the river. The coincidence of chemical disposal in the river, along with the filling-in of the navigation channel, created an ideal situation for the accumulation of contaminated sediments in the Lower Passaic River.

The Lower Passaic River's cross-sectional area declines steadily from RM0 to RM17.4, with a pronounced constriction at RM8.3. At that location, a change in sediment texture is also observed. The river bed below RM8.3 is dominated by silt material with pockets of silt and sand mixtures. Above RM8.3, the bed is characterized by coarser sediments with smaller areas of silt, often located outside the channel. About 85% of the silt surface area in the Lower Passaic River is located below RM8.3, and by volume, about 90% of silts in the Lower Passaic River are located below RM8.3. Due to a combination of a wider cross-section and a deeper navigation channel below RM8.3 (16 to 30 feet) than above RM8.3 (10 feet), thicker beds of contaminated sediments accumulated below RM8.3 than above.

The Lower Passaic River is a partially-stratified estuary with a tidally-driven salt wedge that pushes upstream from Newark Bay into the river, under a top layer of fresher water flowing in from the Upper Passaic River over Dundee Dam. Near the upstream limit of the salt wedge is a cloud of suspended sediments called an estuarine turbidity maximum (ETM). During low flow conditions, the salt wedge and ETM reach as far upstream as approximately RM12, while during storm events, they may be pushed out to Newark Bay. Under typical flow conditions, the salt wedge and ETM are usually located between RM2 and RM10, and move back and forth along about 4 miles of the river each tidal cycle (twice a day). The movement of the salt wedge and

ETM causes surface sediments to resuspend and redeposit on each tidal cycle, resulting in longitudinal mixing of the surface sediments, so that, while there is a broad range of concentration values (more than an order of magnitude), there is little or no trend in contaminant of potential concern (COPC) median concentrations with river mile in RM2 through RM12 (RI Chapter 4). In addition, in the river bed below RM8.3 which is dominated by silt material from bank to bank, statistical evaluations of surface sediment data show that there is no trend in contaminant concentrations from navigation channel to shoals. The channel and shoal areas are comparably contaminated (see RI Report, Section 4.1.1).

When maintenance dredging stopped in the 1950s (above RM2) to 1983 (RM0 through RM2), sediment infilling rates in the deep anthropogenic channel were relatively high (approximately 4 in./yr). Since the 2000s, however, the deep channel has filled in and the river has begun to reach a quasi-steady state, with overall patterns of infilling slowing considerably and alternating with some scouring during high flow events. This condition means that the river is not steadily filling with "cleaner" sediments from elsewhere, but rather that legacy[7] sediments are uncovered and resuspended periodically by scouring during high flow events, so that contaminant concentrations in the surface sediments have remained approximately the same in recent years (see Chapter 4 of the RI).

Resuspension of FFS Study Area legacy sediments as a result of tidal activity and scouring during high flow events is the primary ongoing source of chemicals to the water column and surface sediments of the Lower Passaic River. Data and screening-level analyses show that other contributors have relatively smaller impacts (see Section 4.2 of the RI). The other sources evaluated in the RI are the Upper Passaic River, Newark Bay, tributaries (mainly Saddle River, Third River and Second River), combined sewer overflows (CSOs) and stormwater outfalls (SWOs), industrial point sources along the main stem of the river, atmospheric deposition and groundwater.

[7] The term "legacy sediments" is used to refer to contaminated sediments deposited in the river during the period that it was filling in, and that are the legacy of the long history of industrial discharges to the river.

The oldest contaminants found in the sediments are PAH compounds, cadmium, mercury and lead, which probably pre-date the turn of the 20th century. Following these contaminants are, in order of appearance in the river, DDT, 2,3,7,8-TCDD, and PCBs. Other contaminants, such as arsenic, chromium, and copper, are also present in the sediment record. See Section 5.1 of the RI for a description of the environmental fate of these contaminants.

3.2 Conceptual Site Model

An overall project conceptual site model (CSM) is a multidisciplinary tool that serves a critical role in risk assessment, numerical modeling development, project and sample planning, decision making, and ultimately in developing a remedial strategy. The CSM is developed during the first step of the data quality objective (DQO) process (USEPA, 2006) and continues to evolve throughout a project as data are evaluated, DQOs are updated, and risk assessments are refined.

A CSM for the Lower Passaic River (covering the lower 17 miles of the river, from the Dundee Dam to the confluence with Newark Bay) was developed to provide context for the FFS Study Area (see Section 6 of the RI for the FFS Study Area). The river has been divided into three sections based on water salinity measurements and geomorphology. The freshwater section, with salinity values less than 0.5 parts per thousand (‰) extends from the Dundee Dam to RM10. The transitional section represents the portion between the freshwater and brackish sections, where the salt wedge typically advances under high-tide conditions. Here, water conditions can range from slightly brackish (0.5 to 5.0‰) to moderately brackish (5.0 to 18‰). The brackish section has almost always moderately brackish conditions. The FFS Study Area focuses on the lower and brackish transitional sections of the river, from RM0 to RM8.

The conceptual model of potential human exposure to site-related contaminants for the FFS Study Area is shown in Figure 3-1. This CSM depicts contaminant sources; mechanisms by which contaminants have been or may be released to the environment, move from place to place, and from one environmental medium to another; and the locations, media, and routes from which and by which identified human receptors may be exposed to site-related contaminants.

The CSM considers both current and reasonably anticipated future site conditions. The receptors and exposure scenarios associated with future use are not expected to differ significantly from those being evaluated under the current use scenarios. While expected improvements to the river and shoreline will likely increase the number of individuals using the river, the exposure frequency (EF) and duration for some individuals already using the river will not likely increase. While Sections 4 and 5 of the RI contain details regarding the sources and releases of chemicals, source area analysis, and environmental fate and transport mechanisms, the information provided here addresses the potential for human exposures within the FFS Study Area. Further development of the CSM is anticipated as part of the 17-mile LPRSA RI/FS.

3.2.1 Human Exposures

Currently, the banks of the FFS Study Area are extensively developed and surrounded by a mixture of residential, commercial, and industrial activities. From RM0 to RM4 (RM5 for east bank), both banks of the river have a mix of infrastructure (bridges and rail), industrial and commercial facilities, and vacant industrial or commercial land, except for the east bank near the confluence of Newark Bay, which is predominantly open space (Kearny Point). From RM4 to RM5.5, the west bank has narrow bands of park (Riverbank Park and Minish Park) and open space surrounded by commercial and dense urban residential development (Ironbound and other Newark neighborhoods). Further upstream, other than a marina and boat launch at RM7, the west bank from RM5.5 to RM8 is dominated by the elevated Route 21 structure. On the east bank, from RM5 to RM6.5, land use is commercial (hotel, shopping, car wash), with new developments of multi-family condominiums. The east bank from RM6.5 to RM8 then transitions into park land (Kearny Park with a boat launch, Riverbank Park, Rapp's Boat Yard and Marina) surrounded by the suburban residential neighborhoods of Kearny and North Arlington.

Individuals are known to catch fish and crab along the river banks and from docks and bulkheads (May and Burger, 1996; Burger *et al*., 1999; Kirk-Pflugh *et al*., 1999; 2011). In addition, several rowing clubs engage in crew and other boating activities for adults and children, and parks, docks and mudflat areas are used by residents and visitors for recreational purposes. Municipalities along the FFS Study Area have published master plans for the area that consistently call for the expansion and improvement of parks and open space along the river, which, if implemented, will lead to greater access to the river and improved ecological habitat in the future (City of Newark, 2010; City of Newark *et al*., 2004; Clarke Caton Hintz and Ehrenkrantz Eckstut & Kuhn, 1999, 2004; Heyer Gruel & Associates, 2002, 2003).

Impacted environmental media associated with the FFS Study Area include sediment, surface water, and biota. Humans potentially exposed to these media include individuals who occasionally visit the river for recreational purposes and anglers/sportsmen who eat fish/crab caught from the FFS Study Area. In addition, a transient community has occasionally constructed temporary housing along the banks of the river, so that these individuals also potentially may be exposed to contaminants in the environmental media. However, quantitatively evaluating risks and hazards to a transient population is difficult, because there is a lack of information regarding potential exposure patterns for this population, and it is difficult to collect such exposure information. As such, exposure to a transient receptor is not quantitatively evaluated in this HHRA, but is discussed qualitatively in the uncertainty section (Section 3.7). A description of the other potential receptor groups and the ways in which they may come into contact with impacted environmental media are provided below and shown in Figure 3-1.

Angler/Sportsman: The angler/sportsman is defined as an individual catching and consuming a variety of fish and blue crab from the FFS Study Area and surrounding areas. In addition, the possibility that individuals might also catch and consume waterfowl from the river is considered. However, consumption of these other species is not well documented at this time and information on the concentrations of contaminants in the tissues of these organisms is not available from historical data. The collection and consumption of fish and shellfish from the Lower Passaic River have been well documented in published peer-reviewed journals (Belton *et al*., 1985; May and Burger, 1996; NJDEP, 2002; Kirk-Pflugh *et al*., 2011); therefore, it is clear that this exposure pathway is complete for the angler/sportsman. Direct exposures (*i.e.*, dermal contact and incidental ingestion) to sediments and surface water contacted during fishing/crabbing activities are potential pathways relevant to the angler/sportsman. Inhalation exposures may also occur if activities occur in areas where volatile organic compounds (VOCs) are present in sediments or surface water.

Recreational User: Recreational use along the FFS Study Area includes swimming, wading, and sculling. When swimming is feasible, exposure to chemicals in surface water and sediment is likely. Wading includes an individual walking around the mudflat areas, as well as along shallower parts of the river; thus, exposure is primarily to sediment but may include exposure to surface water as well, depending on the location on the river. Scullers, for the most part, are expected to remain in their boats except for the occasional fall into the river, where exposure to surface water and sediment is likely. The sculler can be an adult or an adolescent. Potential exposure pathways include direct contact (ingestion and dermal contact) with sediment and surface water and inhalation exposures if activities occur in mudflat areas or near sediment where VOCs are present. Another potential exposure pathway for the recreational user is ingestion of fish/shellfish. However, quantitative evaluation of this pathway is not necessary as this particular exposure pathway is quantitavely evaluated for the angler and it is expected that the angler's exposure would encompass that of the recreational user.

3.3 Available Data and Identification of Chemicals of Potential Concern

This HHRA was performed using the analytical results of the fish and blue crab tissue samples collected throughout the FFS Study Area during the late summer/early fall 2009 fish and decapod crustacean tissue sampling event as described in Section 2.

Several classes of COPCs were identified in the Pathways Analysis Report (PAR[8]) (Battelle, 2005), including various metals, pesticides, PAHs, D/F, PCBs, and VOCs and semivolatile organic compounds (SVOCs). For human health, a subset of the COPCs identified in the PAR that are considered to be most bioaccumulative, most persistent in the environment, and most toxic to human receptors was used to capture the primary risk drivers and carried through the risk assessment process. In addition, these COPCs represent the contaminants that have triggered states to issue fish and shellfish consumption advisories or bans (USEPA, 2000a; USEPA, 2009; NJDEP, 2013; New York State Department of Health [NYSDOH], 2013). Fish consumption advisories in New Jersey and New York have been issued because concentrations of mercury,

[8] The PAR was prepared to serve as a preliminary planning document in order to evaluate the potential impacts of exposure to contaminants from sediment, water, and biota on humans and wildlife in the lower 17 miles of the Passaic River. An initial chemical screen of historical tissue data was conducted as part of the PAR to identify COPCs.

PCBs, and dioxin are at levels that may be harmful to human health (NJDEP, 2013; NYSDOH, 2013). USEPA (2009) reports that advisories have been issued in the United States for 34 chemical contaminants; however, 97% of these advisories in effect in 2008 involved five bioaccumulative chemicals: mercury, PCBs, chlordane, dioxins, and DDT. The nine human health COPCs identified for this FFS assessment include the following:

- D/F congeners (as TCDD TEQ); referred to as TCDD TEQ (D/F)
- PCB congeners (sum of 12 dioxin-like congeners as TCDD TEQ); referred to as TCDD TEQ (PCBs)
- Total PCBs (sum of nondioxin-like congeners)
- DDE, DDD, and DDT
- Dieldrin
- Total chlordane (sum of alpha and gamma chlordane)
- Mercury (as methylmercury).

Once mercury is released to the environment, it can be converted to a biologically toxic form of methylmercury. Methylmercury is of particular concern because it readily crosses biological membranes and can accumulate and biomagnify up the food chain (Brightbill *et al*., 2004). Most of the mercury consumed in fish or other seafood is the highly absorbable methylmercury form. The Agency for Toxic Substances and Disease Registry (ATSDR, 1999) recognizes that most mercury in fish and shellfish tissue is present as methylmercury. Therefore, it was assumed that the mercury detected in the fish was methylmercury and was assessed in this form in the risk assessment.

It should be noted that the COPCs evaluated in this HHRA are only for the purposes of evaluating the need for an action in the FFS Study Area. The larger set of COPCs identified in the PAR will be assessed as part of the RI/FS for the 17-mile LPRSA.

3.4 Exposure Assessment

The objective of the exposure assessment is to estimate the magnitude, frequency, duration, and routes of current and reasonably anticipated future human exposure to COPCs associated with the FFS Study Area. 3

The exposure assessment is based on the receptor scenarios that define the conditions of exposure to site-related COPCs as depicted on the CSM (Figure 3-1). The exposure assessment identifies both reasonable maximum exposures (RMEs) and central tendency exposures (CTEs) to describe the magnitude and range of exposure that might be incurred by the receptor groups. USEPA (1989) defines the RME as the highest exposure that is reasonably expected to occur at a site. According to USEPA guidance (1989, 1995a, and 2000b), the CTE is intended to reflect central (more typical) estimates of exposure or dose. The objective of providing both the RME and CTE exposure cases is to set boundaries for the risk estimates, although risk decisions are based on the RME consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; USEPA, 1990). Detailed exposure assessment parameters and values, summarized in the rest of this section, are presented in RAGS Part D tables (USEPA, 2001) in Attachment 4.

3.4.1 Potential Receptors and Exposure Pathways

Consumption of fish and shellfish is anticipated to be associated with the highest cancer risks and noncancer health hazards compared to ingestion, dermal contact, or inhalation of chemicals in surface water or sediment based on the results of other Superfund HHRAs conducted for similar river sites and COPCs having the potential to bioaccumulate such as dioxins and PCBs (*e.g.*, Hudson River [TAMS Consultants, Inc., and Gradient Corporation, 2000]; Housatonic River [Weston Solutions, 2005]; Centredale Manor Woonasquatucket River [USEPA Region 1, 2005]). Despite New Jersey’s fish/crab consumption advisories and prohibitions on taking or attempting to take blue crabs in the Newark Bay Complex, NJDEP determined through angler surveys that fishing and crabbing continue to occur in this area (NJDEP, 1995; Kirk-Pflugh *et al.*, 1999, 2011). Therefore, for the purposes of the FFS, the adult angler/sportsman and other immediate family members (*i.e.*, adolescent and child) are the only receptors evaluated for exposure associated with consumption of self-caught fish and blue crab.

Exposures to a recreational user while swimming, wading, or boating will be evaluated in the baseline HHRA conducted as part of the final RI/FS for the 17-mile LPRSA. Because the recreational user and transient resident were not selected for evaluation in this HHRA, impacts these exposures may have had on site-related cancer risk and noncancer health hazards are addressed as uncertainties in Section 3.7.

The angler/sportsman is defined as an adult individual catching and consuming fish and blue crab from the river. The adolescent evaluated in this survey, aged 7 to 18 years, is another possible angling population that may catch fish/crab and consume their catch, or consume fish caught by their angling parent. Studies of angling activities have found that children typically begin fishing at about the age of 10 years (USEPA, 2000c). Many states with licensing programs require children to have licenses beginning at the age of 16 years before they can legally fish (NJDEP, 2011b). Although children under age 15 typically are not required to have fishing licenses, several sources indicate that many children consume sport-caught freshwater fish (Connelly *et al*., 1990; Connelly *et al*., 1992; Wendt, 1986). Young children (1 to 6 years) are assumed to consume fish caught by their angling parent. The collection and consumption of fish and shellfish from the Passaic River have been well documented in a published peer-reviewed creel survey conducted by Belton *et al*. (1985) for NJDEP, as well as in other published literature regarding anglers' perception of risk from contaminated fish (May and Burger, 1996; Burger *et al*., 1999; Kirk-Pflugh *et al*., 1999, 2011); therefore, it is clear that this exposure pathway is complete for the angler/sportsman. Subpopulations of highly exposed or less-exposed anglers have not been explicitly characterized, but instead are assumed to be represented in the overall fish ingestion rates (IRs). It is possible, however, that distinct subpopulations may fish in the FFS Study Area and consume higher amounts of fish but are not explicitly identified in the literature used in this analysis. Subsistence fishing was not evaluated in this HHRA, because there is no evidence to date that any individuals rely solely on their daily catch.

In addition to the routes of exposure mentioned previously, the angler/sportsman may be exposed to COPCs in the FFS Study Area by other potential pathways. One such pathway is exposure from eating waterfowl found along the banks of the FFS Study Area. Waterfowl may contain high concentrations of dioxins and PCBs in their fat and internal organs. Although public health advisories for consumption of these animals have not been issued by NJDEP, two neighboring states, Pennsylvania and New York, have issued consumption advisories for certain game (NYSDOH, 2013; Pennsylvania Department of Environmental Protection [DEP], 2013) associated with the presence of PCBs in their waterways. However, because there are no historical data on chemical concentrations in the tissues of these organisms, consumption of waterfowl is not addressed in this HHRA quantitatively but rather qualitatively as an area of uncertainty in Section 3.7.

Other relevant potential exposure pathways for the angler/sportsman as indicated in the CSM (Figure 3-1) include direct exposures (*i.e.*, dermal contact and incidental ingestion) to sediments and surface water. Because consumption of biota (fish and crab) is anticipated to be a risk driver, it is the only pathway evaluated in this assessment. Exposure to the other media and pathways will be further evaluated in the 17-mile LPRSA RI/FS. Omitting other applicable exposure pathways leads to an underestimate of risk, as discussed in Section 3.7.

3.4.2 Exposure Media

Fish

The predominant fish species of the FFS Study Area were targeted for sample collection during the late summer/early fall 2009 fish community sampling event conducted by the CPG in accordance with the *Quality Assurance Project Plan Fish and Decapod Crustacean Tissue Collection for Chemical Analysis and Fish Community Survey* (Windward Environmental, 2009a). The late summer/early fall 2009 sampling effort also included a fish community survey to describe relative species abundance, community structure, and other indices of the fish population present in the LPRSA, including the FFS Study Area. Results of the tissue collection and fish community survey are reported in the *Fish and Decapod Field Report for the Late Summer/Early Fall 2009 Field Effort* (Windward Environmental, 2010b).

Based on the results of the late summer/early fall 2009 catch, blue crab and American eel were collected in the most abundance throughout the LPRSA, whereas within the fish community, American eel and white perch were the two most abundant species as shown on Figure 3-2 (Windward Environmental, 2010b).

Fish samples collected from the FFS Study Area during the 2009 sampling event included species from different feeding guilds as summarized in Table 3-1. In addition to being commonly caught and abundant in the FFS Study Area, the species listed in Table 3-1 represent distinct ecological groups of fish, which allows for the assessment of a variety of habitats, feeding strategies, and physiological factors that might result in differences in the uptake of contaminants. For instance, bottom-feeding species may bioaccumulate high contaminant concentrations from direct physical contact with contaminated sediment or by consuming epibenthic organisms and benthic invertebrates that live in contaminated sediment. Predator species are good indicators of persistent contaminants such as mercury, which may be biomagnified through several trophic levels of the food web.

In order to account for the distinct ecological groups of fish that may be appreciably consumed by recreational anglers/sportsmen, analytical data from all six species listed in Table 3-1, rather than a single species, were used to derive an equal-weighted concentration to represent the exposure point concentration (EPC) for fish. An equal-weighted concentration was used to represent the EPC for fish because information pertaining to fish species preferences and consumption patterns is not available for this site. Thus, in the absence of site-specific data to support consumption patterns, equal intake of all representative species is assumed.

Average concentrations derived from the 2009 data for each of the six species used to calculate the EPCs have been plotted for dioxins, PCBs, and methylmercury for comparison purposes and are shown on Figures 3-3 and 3-4. Comparisons of average concentrations of TCDD TEQ (D/F) and TCDD TEQ (PCB) (Figure 3-3) and Total PCBs (Figure 3-4) show that in general, average concentrations of these COPCs are highest in the common carp, followed by the white catfish, white perch, American eel and white sucker. Conversely, average concentrations of methylmercury are lowest in the common carp and highest in the white catfish and American eel

(Figure 3-4). Section 3.7 addresses the impact on risks/hazards for those individuals who consume only a specific species.

Crab

For crab tissue, the blue crab is of interest because it is commonly caught and consumed in the FFS Study Area (Burger, 2002). The highest levels of most chemical contaminants are found in the hepatopancreas (NJDEP, 2002), commonly known as the tomalley or green gland (the yellowish-green gland under the gills). The anatomy of the blue crab is depicted on Figure 3-5. Information obtained from published literature reports that individuals catching and consuming crab (*i.e.*, crabbers) may consume the edible white meat (or muscle) from the thoracic cavity, claws, and legs, and that some individuals may also consume the hepatopancreas (Belton *et al*., 1985; May and Burger, 1996; NJDEP, 2002). Belton *et al*. (1985) stated that all of the crab tissue is considered edible food, whereas May and Burger (1996) and NJDEP (2002) report that only a small percentage of individuals purposefully consume the hepatopancreas. May and Burger (1996) reported that most crabbers in the Newark Bay Complex[9] ate only cleaned crabs (hepatopancreas discarded), with fewer than 3% eating the whole crab. NJDEP (2002) reported that 15% of the population it surveyed in the Newark Bay Complex ate the hepatopancreas. Results for additional crab surveys conducted by NJDEP in 2005, 2006, and 2007 within the coastal counties of New Jersey (ORC Macro, 2006; Macro, 2007; 2008) indicated that 23 to 54% of the respondents remove the hepatopancreas before cooking the crabs, 28 to 32% of the respondents remove the hepatopancreas before eating the crab, and up to 2% of the respondents eat the hepatopancreas separately from the crab.

Comparisons of chemical concentrations found in muscle tissue and hepatopancreas samples have been reported in the literature. Belton *et al*. (1985) performed a differential analysis of the muscle and hepatopancreas samples for PCBs and organochlorine pesticides; the analysis indicated that both the PCBs and pesticide concentrations were much higher in the hepatopancreas samples (refer to Table 2C in Belton *et al*., 1985). Although Belton *et al*. (1985) did not specifically report the mean concentrations for the pesticide compounds, they did report mean PCB concentrations of 6,520 μg/kg in the hepatopancreas and 130 μg/kg in muscle tissue.

[9] The Newark Bay Complex includes tidal portions of the Hackensack and Passaic Rivers, the Arthur Kill, the Kill Van Kull, and the Newark Bay and all waters that run into it.

NJDEP (2002) summarized mean dioxin (as 2,3,7,8-TCDD TEQ) concentrations, originally reported in Skinner et al. (1997), as 0.19 µg/kg for the hepatopancreas samples (n = 6) and 0.008 µg/kg for the muscle samples (n = 6). In addition, NJDEP (2002) summarized the mean concentrations of 2,3,7,8-TCDD in hepatopancreas and muscle samples from a field sampling study conducted by Chemical Land Holdings, Inc. (CLH) (2001) as 0.262 µg/kg and 0.018 µg/kg, respectively. Therefore, based on the analytical results for the two sample types, it can be assumed that an individual who consumes only the muscle tissue will be exposed to a smaller amount of the chemical than someone who eats the hepatopancreas as well as the muscle tissue, unless cooking practices (discussed below) are considered.

Exposure to the contaminant depends not only on the specific part of the crab the consumer eats, but also on the method of cooking. NJDEP (2002) reports that even those consumers who do not deliberately eat the hepatopancreas are likely to be exposed to all or part of its content due to its fluid nature and its dispersion in the cooking liquid. Two published peer-reviewed studies, Belton *et al*. (1985) and May and Burger (1996), state that boiling was the preferred method of cooking crabs among the individuals surveyed. Because the crab is cooked whole, consumption of only the muscle tissue would still result in exposure to the contaminants initially contained in the hepatopancreas.

As evidenced in the published literature and addressed in the NJDEP guidance (2013) for consumption of fish and crab, even if the consumer does not eat the hepatopancreas, exposure to the chemical contaminants in the hepatopancreas can still potentially occur if the crab is cooked before the hepatopancreas is removed and if the liquid used to boil the crab is used in juices, sauces, bisques, or soups. Therefore, for the purposes of this risk assessment, exposure to COPCs in the hepatopancreas and muscle is anticipated based on crab cooking practices. Therefore, analytical results for both types of tissue samples were combined and used to determine the EPC for crab consumption, similar to the composite sample approach described in NJDEP (2002). Average concentrations derived from the 2009 data for each of the sample types (*e.g.*, muscle, hepatopancreas, and muscle+hepatopancreas) have been plotted for dioxins, PCBs, and methylmercury for comparison purposes and are shown on Figures 3-6 and 3-7. Comparisons of average concentrations of TCDD TEQ (D/F) and TCDD TEQ (PCB) (Figure 3-

6) and Total PCBs (Figure 3-7) show that concentrations of these COPCs are highest in the hepatopancreas, whereas muscle tissue has very low levels of these COPCs. Conversely, average concentrations of methylmercury are lowest in hepatopancreas (Figure 3-7) and highest in the muscle. The uncertainties associated with an EPC derived using a composite hepatopancreas/muscle approach are addressed in Section 3.7.

3.4.3 Quantification of Exposure

In order to describe the magnitude and range of exposure that might be incurred by the angler/sportsman receptors, both a RME and a CTE were examined. USEPA (1989) defines the RME as the highest exposure that is reasonably expected to occur at a site. According to USEPA guidance (2000a), CTEs are intended to reflect central (more typical) estimates of exposure or dose. The objective of providing both the RME and CTE cases is to set boundaries for the risk estimates, although risk decisions are based on the RME consistent with the NCP (USEPA, 1990).

3.4.3.1 Estimation of Exposure Point Concentrations

In accordance with USEPA guidance (USEPA, 1989), the EPCs for baseline current exposures were calculated using actual tissue data where concentrations are assumed to remain constant throughout a receptor's lifetime and do not consider any attenuation or degradation of the chemical in sediment that may occur over time, whereas the EPCs for baseline future modeled exposures were based upon modeled annual average projections of future concentrations in sediment that consider natural attenuation and degradation over time (modeling detailed in Attachment 7).

The EPCs for baseline current exposures were calculated as the UCL of the arithmetic average using the ProUCL 4.1 software package (version 4.1.00[10]) developed by USEPA (2010b) and following USEPA guidance (2002c; 2010c,d) using fish and crab tissue chemistry data obtained from the late summer/early fall 2009 tissue sampling event. The ProUCL software package was used to determine the underlying distributions and to determine the most applicable EPC for a

[10] Subsequent to completion of the risk assessment, USEPA released ProUCL version 5.0.00. Estimates used in this risk assessment were verified with the newer ProUCL version.

given contaminant based on the characteristics of the data. Depending on the statistical distributions identified by the software application, the program provides a recommended UCL statistic. The ProUCL output files, which contain summaries of the statistics (mean, minimum, maximum values) and assumptions of the data distributions for each of the COPCs/COPECs for human and ecological receptors, are provided in Attachment 3. COPCs for the HHRA also are summarized in the RAGS Part D table format in Attachment 4. A summary of the EPCs for fish and crab is provided in Table 3-2.

Future EPCs for biota were estimated from the modeled sediment concentrations (Attachment 7) using biota uptake factors derived from regression models developed for the FFS Study Area (as detailed in Appendix A, Data Evaluation Report No. 6). Because the EPCs are based upon modeled projections of future concentrations, the typical approach used in Superfund risk assessments of calculating a 95% UCL on a mean concentration may no longer strictly apply because the 95% UCL calculation is based upon the notion that the mean EPC is from a finite set of samples, while with a model an almost unlimited number of model-predicted values can be calculated. As the number of model-projected estimates increases, the model mean and model 95% UCL converge to the same value. Therefore, unlike the current risk assessment which uses 95% UCLs as the EPCs, the EPCs calculated to assess future conditions are based on average concentrations generated directly from a deterministic model. Results of the model indicated that concentrations in sediment will fluctuate over time due to storm-driven resuspension of legacy sediments and/or contributions from outside sources. Therefore, in order to ensure annual average concentrations are not biased low, a sliding scale of annual averages based on the exposure duration ("ED") of the receptor (*e.g.*, 6 years for the child and 24 years for the adult for a total 30-year exposure time period and 12 years for the adolescent) was determined and the maximum annual average concentration based on the receptor-specific ED was selected as the EPC. As such, future modeled EPCs for the adult, adolescent, and child may differ slightly as shown in Table 3-2.

For this risk assessment, the EPCs used in the RME and CTE evaluations are the same. The RMEs and CTEs differ with regard to the receptor-specific exposure variables, which are described further below and are summarized in Attachment 4 (Tables 4-5 through 4-10).

As described in Section 3.4.2, six fish species (American eel, common carp, smallmouth bass, white catfish, white perch, and white sucker) were identified as the fish species that people are most likely to catch and eat from the FFS Study Area. As such, the analytical data for all of these species collected throughout the FFS Study Area in late spring/early fall 2009 were combined for each of the COPCs and used to determine the EPCs to evaluate exposures associated with fish consumption. Tissue samples included in the assessment consisted of both skinless and skin-on fillet samples. The decision to analyze fish species as skin-on or skinless fillets was based on USEPA guidance (USEPA, 2000a, 2000c) and typical consumption practices (Windward Environmental, 2009a). Scaled fish (including perch) were analyzed as skin-on fillets after removing scales. Scaleless fish (including catfish and eel) were analyzed as skinless fillets. Higher concentrations of chlorinated COPCs are associated with skin-on samples, as these COPCs accumulate in the fatty portions of the fish, whereas higher concentrations of mercury are observed in the skinless samples, as mercury tends to concentration in the leaner muscle tissue. To demonstrate the concentration differences among the skin-on and skinless sample types, comparisons of average concentrations of TCDD TEQ and mercury between American eel and white perch fish fillet samples are shown on Figures 3-8 and 3-9, respectively. The effects of uncertainties to derivation of the EPCs are further addressed in Section 3.7.

Blue crab tissue chemistry data, collected during the 2009 late summer/early fall sampling event, were used to determine the EPCs for ingestion of crab. Similar to the concentration differences in the fish samples, higher concentrations of chlorinated COPCs are found in the hepatopancreas rather than the muscle tissue, while higher concentrations of mercury are found in muscle tissue rather than the hepatopancreas as demonstrated on Figure 3-6 for TCDD TEQ and Figure 3-7 for Total PCBs and mercury. The crab EPCs used in this risk assessment were derived by combining all of the sample results represented by the “Muscle + Hepatopancreas” values shown on Figures 3-6 and 3-7. An EPC that has been derived by compositing the sample types therefore may be more representative for those consumers who do not deliberately eat the hepatopancreas but are likely to be exposed to all or part of its content as a result of how the crab is cooked (see Section 3.4.3.3). However, the EPC may be overestimated or underestimated for those individuals specifically eating only the muscle tissue or the hepatopancreas, respectively.

3.4.3.2 Estimation of Chemical Intake

Chemical intake is estimated following USEPA (1989) guidance and other applicable guidance, guidelines, and policies. An intake factor is the amount of a chemical in a quantity of a medium (*e.g.*, fish tissue) taken into the body through an exposure route (*e.g.*, ingestion) and available for absorption. It is expressed in units of milligram (mg) of chemical per kilogram (kg) body weight (BW) per day (mg/kg-day). Intake of a chemical that results in carcinogenic effects is calculated by averaging the dose over a lifetime (70 years × 365 days/year) (USEPA, 2005c). The intake factor for carcinogenic effects is termed the lifetime average daily dose (LADD). Intake of COPCs that produces noncancer health effects is averaged over the period of exposure (*i.e.*, exposure duration [ED] × 365 days/year). The intake factor for EDs equal to or longer than 7 years is termed the chronic average daily dose (ADD) (USEPA, 1989). Intake will be estimated for LADD and ADD ingestion of fish and crab for an adult, adolescent, and child, with appropriate adjustments for IRs and BWs.

The equation used to calculate the LADD/ADD for ingestion of biota (fish and crab) is:

$$\text{LADD/ADD} = \frac{C_t \text{ x IR x EF x FI x} (1 - \text{CL}) \text{ x ED x CF}}{\text{BW x AT}} \qquad (3\text{-}1)$$

where:

C_t = biota tissue concentration (mg/kg)

ED = exposure duration (years)

EF = exposure frequency (days/year)

IR = annualized ingestion rate (g/day)

FI = fraction from contaminated source (unitless)

CL = cooking loss (g/g)

CF = conversion factor (kg/g)

BW = body weight (kg)

AT = averaging time (days) - period over which exposure is averaged (days); over a lifetime for evaluating cancer risks and over the appropriate ED for evaluating noncancer health hazards.

The intake equation requires specific exposure factors, which are described in Section 3.4.3.3.

3.4.3.3 Exposure Factors

Specific exposure parameter values proposed for estimating intake for the RME and CTE for ingestion of fish are presented in RAGS Part D tables (USEPA, 2001) in Attachment 4 (Tables 4-5 through 4-7 for the adult, adolescent, and child receptors, respectively). Similarly, in Attachment 4, Tables 4-8 through 4-10 present the specific exposure parameter values used for estimating intake for the RME and CTE for ingestion of crab for the adult, adolescent, and child receptors, respectively. The exposure factors are consistent with those that were provided in the PAR (Battelle, 2005) and those that will be used in the baseline HHRA for the 17-mile LPRSA (USEPA Region 2, 2012), specifically for an adult and adolescent angler/sportsman and a young child who may consume fish/crabs caught by a parent. The key exposure parameters and the rationale for their selection are described below.

Ingestion Rates of Self-Caught Fish (IR)

The IR is the amount of fish an individual consumes on a daily basis based on averaging the reported consumption rate in 1 year over 365 days. IRs for fish are annualized and are presented in grams eaten per day (g/day). The IR assumes the fish are caught while angling from the FFS Study Area only. It is expected that ingestion of fish from other sources would add to the amount an individual ingested annually.

Fish IRs for the HHRA were developed from a detailed evaluation of LPRSA-pertinent angler and creel surveys and related literature, which was documented in the USEPA Region 2 Technical Memorandum, “Fish and Crab Consumption Rates for the LPRSA Human Health Risk Assessment” (USEPA Region 2, 2012). This analysis provided a weight-of-evidence approach for evaluating consumption for the RME individual. The fish IRs for the Lower Passaic River adult angler were calculated as 34.6 g/day for the RME and 3.85 g/day for the CTE.

IRs for the child and adolescent were based on the assumptions that the intake for the child will be approximately one-third that of the adult and intake for the adolescent will be approximately two-thirds that of the adult (TAMS Consultants, Inc. and Gradient Corporation, 2000). Thus, for the RME, an IR of 11.5 g/day is used for the child receptor and 23.1 g/day is used for the adolescent receptor. For the CTE, an IR of 1.28 g/day is used for the child receptor and 2.57 g/day is used for the adolescent receptor.

Ingestion Rates of Self-Caught Crab (IR)

Crab IRs for the HHRA also were developed from a detailed evaluation of LPRSA-pertinent angler and creel surveys and related literature, as documented in USEPA Region 2 Technical Memorandum, "Fish and Crab Consumption Rates for the LPRSA Human Health Risk Assessment" (USEPA Region 2, 2012). The IR is the amount of crab an individual consumes on a daily basis based on averaging the reported consumption rate in 1 year over 365 days. IRs for crab have been annualized and are presented in g/day. The IR assumes the crabs are caught while angling from the FFS Study Area only. It is expected that ingestion of crab from other sources would add to the amount an individual ingested annually. The crab IRs for the adult angler were calculated as 20.9 g/day for the RME and 3.0 g/day for the CTE.

IRs for the child and adolescent receptors were estimated assuming rates one third and two thirds those of the adult IR, respectively, as was assumed for fish ingestion. Thus, for the RME, an IR of 6.97 g/day is used for the child receptor and 13.9 g/day is used for the adolescent receptor. For the CTE, an IR of 1.0 g/day is used for the child receptor and 2.0 g/day is used for the adolescent receptor.

For purposes of this risk assessment, consumption of crab and fish were assumed to occur in separate populations so that people ate either fish or crab, but not both, because published literature (Burger, 2002) indicated that consumers of both fish and crab make up a smaller percentage than individuals who reported consuming either fish or crab. The uncertainty associated with assuming individuals did not eat both fish and crab is addressed in Section 3.7.

Fraction Ingested from Contaminated Source (FI)

USEPA RAGS Part A (1989) includes a term *fraction ingested* which is defined as "fraction ingested from contaminated source (unitless)". The guidance in the document does not specifically address application of this factor for fish consumption, but rather, describes the application of this factor to adjust for IRs for vegetables or other produce or ingestion of meat, eggs, and dairy products. The evaluation of various risk assessments conducted within USEPA Region 2 indicates the assessments were consistent with the overall guidance from USEPA (1989) on fish ingestion recommendations that states, "Residents near major commercial or recreational fisheries or shell fisheries are likely to ingest larger quantities of locally caught fish and shellfish than inland residents." Further, the fish IR focuses only on the contaminated source; a fraction ingested (FI) term would apply only if other sources of fish were included. Consistent with the recommendations in RAGS Part A (USEPA, 1989), use of an FI less than 1 is not appropriate, because of the following:

- The FFS Study Area has adequate quantity and quality of fish and crabs to support the estimated level of ingestion of fish and crabs for the RME individual, both currently (as found in the fish community survey conducted by the CPG in 2010 [Windward Environmental, 2011a]) and in the future;
- The Lower Passaic River is in a densely populated urban area, with access to the river for fishing and crabbing through parks, boat docks, and publicly-accessible parking lots abutting the river and residences on the river banks. Therefore,
    - anglers have ample opportunities to return to areas where they have successfully caught fish or crab, especially adolescents or lower income families, who have limited means of transportation;
    - workers have the opportunity to fish and/or crab during the work day or on their way to and from work;
    - there are many municipalities along the Lower Passaic River so there is the potential that individuals may move within these municipalities, and yet continue to fish and crab, and consume fish/crabs from the FFS Study Area.
- Many municipalities and counties along the FFS Study Area have published master plans that call for the expansion and improvement of parks and open space along the river that, if implemented, will make the area more amenable to fishing and crabbing (City of Newark, 2010; City of Newark *et al*., 2004; Clarke *et al*., 2004; Clarke *et al*., 1999; Heyer, Gruel & Associates, 2003; Heyer, Gruel & Associates, 2002). As noted in USEPA's Land Use in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedy Selection Process (USEPA,

1995b), comprehensive community master plans are a valuable source of information in determining reasonably anticipated future use for future risk scenarios.

Based on the various lines of evidence, an FI of 1 is applied for the RME and CTE scenarios.

Cooking Loss for Fish

Contaminant losses from cooking may be a function of the cooking method (*i.e*., baking, frying, broiling, etc.), cooking duration, temperature during cooking, preparation techniques (*i.e*., trimmed versus untrimmed, with or without skin), lipid content of the fish, fish species, magnitude of contamination in the raw fish, extent to which lipids separated during cooking are consumed, reporting method, and/or experimental study design. In addition, personal preferences for various preparation and cooking methods and other related habits (such as consuming pan drippings) may result in consumption of contaminants "lost" from the fish upon cooking. Based on these uncertainties and the variability in cooking methods, a 0% cooking loss was assumed for the RME individual.

Summary statistics of the range of percent reductions for the COPCs, as reported by the USEPA (2000c), are summarized in Table 3-3. Note that Table 3-3 summarizes the percent loss values for skin-on, skin-off, and combined (skin-off plus skin-on). Because there were no consistent differences in contaminant losses between cooking methods, the results were grouped only according to contaminant, not by cooking method.

For this particular review of cooking loss, PCBs were not included because numerous studies regarding PCB cooking loss are available in the open literature and evaluations have already been conducted for similar HHRAs. For instance, PCB cooking loss was evaluated in the HHRA for the Hudson River (TAMS Consultants and Gradient Corp., 2000). The 12 studies reviewed in the Hudson River HHRA regarding cooking loss found the rate of cooking loss ranged from 0 to 74% with most PCB losses between 10 and 40%. A factor of 20% was selected as the cooking loss factor for the CTE in the Hudson River HHRA (TAMS Consultants and Gradient Corp., 2000) because the 20% value is the midpoint between 0 and 40%. For the RME in the Hudson River HHRA, 0% cooking loss was assumed for PCBs.

In addition, an analysis of cooking loss of PCBs in fish was conducted more recently by the CPG for the 17-mile LPRSA RI/FS HHRA. This updated evaluation of PCB cooking loss in fish was based on an analysis of 79 studies and found that the previously recommended cooking loss of 20% in the Hudson River HHRA (TAMS Consultants and Gradient Corp., 2000) fell at approximately the 25th percentile of the dataset. Based on the analysis conducted by the CPG, a median cooking loss factor of 30% for Total PCBs was supported. As a result, a median of 30% cooking loss of PCBs in fish is used in the evaluation of cancer risks and noncancer hazards for the CTE individual in this FFS Study Area HHRA. The use of the 30% cooking loss of PCBs in fish for the CTE individual ensures consistency with the 17- mile study area and the literature.

The Exposure Factors Handbook (EFH; USEPA, 2011) provides a recommended default adjustment for cooking and preparation loss. By applying the mean percent weight losses presented in Table 13-69 of the EFH (USEPA, 2011) (e.g., 31.5% for mean net cooking loss for combined fish and shellfish and 10.5% for mean net post-cooking loss), the total cooking loss and preparation adjustment amounts to 39% contaminant concentration reduction, which is similar to the values listed in Table 3-3 under the combined 50th percentile column heading.

In general, for heavy metals, tissue residues are not significantly reduced by processing or cooking methods. Therefore, preparation and cooking loss adjustments should not be applied for metals in most cases (USEPA, 2000c). Mercury, however, may be an exception. Mercury binds strongly to proteins and thus concentrates in the muscle tissue of the fish. It also concentrates in the liver and kidneys, although to a lesser extent (USEPA, 2000c). Several studies on the effects of preparation and cooking on mercury have shown that mercury concentrations are less in raw fish than in cooked fish, although the total amounts of mercury remain the same. The higher concentrations in cooked fish are attributed to the loss of liquid and fat during cooking, which results in a higher concentration. Morgan *et al*. (1997) found that mercury concentrations in pan-fried, baked, and broiled walleye fillets and deep-fried and baked whitefish livers ranged from 1.1 to 1.5 times higher than corresponding raw portions. In lake trout, mercury concentrations were 1.5 to 2.0 times higher in smoked fish than in the raw portions. Burger *et al*. (2003) calculated preparation factors of 1.5 to 1.8 for deep-fried largemouth bass and concluded that based on these two studies, a preparation factor of 2 would be a suitable, protective default for estimating safe consumption levels.

The losses reported generally do not account for degradation of the contaminants. Until there is more information about the toxicity of the byproducts generated during the degradation of PCBs, D/F, organochlorine pesticides, or other chemicals of concern, USEPA recommends that no dose modification be assumed due to degradation alone (USEPA, 2000c).

Table 3-4 summarizes the range of cooking losses from fish for the COPCs that are examined in this risk assessment. As stated previously, a 0% cooking loss was assumed for the RME individual based on the uncertainties and the variability in cooking methods. For CTE, the 50th percentile cooking loss value for combined skin-on/skin-off is used as shown in Table 3-4. It should be noted that the updated literature review conducted by the CPG for the PCB cooking loss as part of the 17-mile LPRSA RI/FS HHRA also found comparable percentages of cooking loss for all of the other COPCs shown in Table 3-4; therefore, the cooking loss percentages used in this FFS Study Area HHRA for all of the COPCs will be consistent with those used in the 17-mile LPRSA RI/FS HHRA for the CTE. For mercury, both the RME and CTE estimates are 0% to be consistent with USEPA (2000c), which states that preparation and cooking loss adjustments should not be applied for metals in most cases. The effects of cooking method on mercury concentrations are addressed further in Section 3.7.

Cooking Loss for Crab

Blue crabs are most often cooked whole by boiling or steaming (Sea Grant Marine Advisory Program, 2006; Kirk-Pflugh *et al*., 2011). Exposure to the contaminant depends not only on the specific part of the crab consumed, but also on the method of cooking. Zabik *et al*. (1992) studied the changes in the distribution of PCBs in blue crab caused by boiling or steaming and found that both cooking procedures reduced PCBs by more than 20% with and without the hepatopancreas intact; however, the cooking water contained 80% of the PCBs lost from the crab. NJDEP (2013) reports that no specific cooking method can be relied on to reduce the chemical contaminant levels in blue crabs. Because the crab is cooked whole, even if the consumer does not eat the hepatopancreas, exposure to the chemical contaminant can still occur if the crab is cooked before the hepatopancreas is removed and if the liquid used to boil the crab is used in juices, sauces, bisques, or soups. It is assumed for this assessment that the cooking liquid is consumed along with the crab meat. Therefore, cooking loss for crabs is assumed to be 0% for the RME for all COPCs. For the CTE, a 20% cooking loss for PCBs, as determined in Zabik *et al*. (1992), has been incorporated for estimating crab ingestion; however, all other COPCs under the CTE assume 0% cooking loss because published literature to support reduction in concentrations are not available.

Exposure Frequency (EF)

The IRs for fish and crabs are annualized and represent daily rates. Therefore, the EF for the fish and crab consumption is assumed to be 365 days per year (USEPA, 1989) for both the RME and CTE scenarios.

Exposure Duration (ED)

For the adult angler/sportsman, exposure is assumed to occur for 6 years as a child and 24 years as an adult, for a total RME ED of 30 years (USEPA, 1989; 1991b). The CTE ED for adult receptors is 9 years, based on the 50th percentile value for years living in the current home (Table 16-108 in USEPA, 2011). These assumptions are based on recommendations by USEPA and represent upper bound and average residential tenure at a single location. For the adolescent angler/sportsman, exposure is assumed to occur for 12 years (from ages 7 through 18 years) for the RME. For the CTE exposures, 6 years and 3 years are assumed for the adolescent and child exposures, respectively.

Connelly *et al*. (1992) found that individuals may travel up to 37 miles to fish. It is possible that individuals may live in one section of the FFS Study Area and move or travel to another portion of the FFS Study Area to fish or crab. Individuals may also move or travel to other portions of the 17-mile stretch and continue to catch fish or crab that bioaccumulate contaminants from the FFS Study Area. As a means to estimate the ED of an angler/sportsman for the Lower Passaic River, the 2000 U.S. Census data for the New Jersey counties surrounding the Lower Passaic River (Essex and Hudson) were used to estimate the number of years local individuals reside along the river. The evaluation quantified (1) how long residents are staying within their county and (2) how long residents stay within the region (*i.e.*, the two-county area).

The distribution of the length of time remaining until an individual moves out of a particular region or county was described by estimating the one-year probability that an individual will move out of the region/county, and then combining these one-year probabilities to calculate the likelihood that an individual will move out of the area over a more extended time period. Table 3-5 displays the estimated one-year probabilities of moving and associated statistics (*i.e.*, the 50th and 95th percentiles of projected residence times within each county and the region). The 95th percentile number of years for an individual to move out of the two-county region is approximately 95 years, and for the individual counties, ranges from approximately 55 years for Hudson County and 60 years for Essex County. Observing that the number of years for an individual to move out of the region is demonstrably higher than that for any individual county suggests that there is nontrivial mobility of the population among counties within the region.

Therefore, individuals may be exposed for longer periods of time than the 30 years identified in this assessment. The use of the 30-year ED may potentially underestimate the cancer risks for this site.

Body Weight (BW)

Age-specific BWs are used in this assessment. For the adult and child receptors, the default weights of 70 kg and 15 kg are used (USEPA, 1989; 1991b). The BW for the adolescent was derived by averaging the mean BW estimates for males and females by year of age from the fourth National Health and Nutrition Examination Survey, as summarized in Table 8-24 of the EFH (USEPA, 2011). The mean BW is 52 kg for the 7- to 18-year-old adolescent.

3.5 Toxicity Assessment

The toxicity assessment determines the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from such exposure. For purposes of this assessment, COPCs are classified into two broad categories:

noncarcinogens and carcinogens. Toxicity studies with laboratory animals or epidemiological studies of human populations provide the data used to develop toxicity criteria.

Carcinogens are agents that induce cancer. Potential carcinogenic effects are expressed as the probability that an individual will develop cancer over a lifetime based on the exposure assumptions used in the risk assessment. The cancer slope factor (CSF) is a plausible upper bound estimate of carcinogenic potency used to calculate cancer risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental probability of an individual developing cancer over a lifetime. CSFs are derived based on an analysis of the animal and/or human data to determine the most appropriate model to use in the extrapolation from animal to humans or direct use of human epidemiological studies (USEPA, 1996, 1999, 2005c). The slope factor is protective and assumes that exposure to any concentration of a carcinogen has the potential to produce an increased risk. The CSFs developed by USEPA are plausible upper-bound estimates, which means that the USEPA is reasonably confident that the actual cancer risk will not exceed the estimated risk calculated using the CSF. Cancer risks from exposure to multiple carcinogens and multiple pathways are assumed to be additive (USEPA, 1989; 2000d).

Noncarcinogenic health effects were evaluated using reference doses (RfDs) developed by USEPA. An RfD is an estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime (USEPA's Integrated Risk Information System [IRIS] definition). RfDs are expressed in milligrams of contaminant per kilogram of BW per day (mg/kg-day). The RfD is a health-based criterion based on the assumption that thresholds exist for noncancer health effects (*e.g.*, liver or kidney damage) over a length of time of exposure (*e.g.*, chronic). Chronic RfDs are specifically developed to be protective against long-term exposure to a contaminant.

A table summarizing the toxicity criteria, target organ, weight-of-evidence classifications, uncertainty factors, and other relevant information for each COPC is provided in Attachment 4, Tables 4-11 and 4-12, for noncancer and cancer toxicity, respectively. Toxicity criteria have been selected according to the USEPA (2003c) Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53, which recommends a hierarchy of human health toxicity values for use in risk assessments at Superfund sites. The hierarchy is as follows: (1) USEPA's IRIS; (2) USEPA's Provisional Peer-Reviewed Toxicity Values (PPRTV) (Office of Research and Development, National Center for Environmental Assessment, Superfund Health Risk Technical Support Center); and (3) other sources of information, such as toxicity values from the California Environmental Protection Agency (CalEPA), the ATSDR's minimal risk levels (MRLs) for noncarcinogenic constituents, and USEPA's Health Effects Assessment Summary Tables (HEAST). Consultation with USEPA's Superfund Technical Support Center is recommended regarding the use of the Tier 3 values for Superfund response decisions when the contaminant appears to be a risk driver for the site.

USEPA released a final *Reanalysis of Key Issues Related to Dioxin Toxicity and Response to NAS Comments* in February 2012 (USEPA, 2012). The document provides hazard identification and dose-response information on 2,3,7,8-TCDD, the most up-to-date analysis of non-cancer health effects from TCDD exposure, and a reference dose (RfD) for non-cancer health assessment. USEPA has not yet completed *Reanalysis, Volume 2*, which will contain the full dioxin cancer assessment. In the absence of Volume 2, a Tier 3 toxicity value was used to evaluate dioxin exposures. A range of toxicity values meeting the Tier 3 criteria include:

- CalEPA Office of Environmental Health Hazard Assessment (OEHHA) value of 130,000 mg/kg-day^{-1} (CalEPA, 2009). The CalEPA (2011) report that describes the derivation of this value indicates that: "The original report on chlorinated dioxins and dibenzofurans (California Department of Health Services, 1986) identified carcinogenicity as the critical effect for defining risk to public health and calculated a potency (slope factor) for TCDD of 1.3 x 10^5 (mg/kg-day)$^{-1}$. This was based on the incidence of liver tumors in male mice in a gavage study (NTP, 1982) and was calculated to be equivalent to a unit risk of 38 (μg/m^3)$^{-1}$ for airborne exposures."
- CalEPA OEHHA value of 7.7 × 10^5 mg/kg-day^{-1} from the 2010 "Public Health Goals of Chemicals in Drinking Water" developed by its Pesticide and Environmental Toxicology Branch (CalEPA, 2010). This CSF is based on the latest National Toxicology Program study in female rats and a new multisite cancer potency factor

calculation, derived using updated methodology, which, according to OEHHA, is considered to represent a more accurate estimate of potential human cancer risk.

- USEPA's Office of Health and Environmental Assessment value of 156,000 mg/kg-day^{-1} based on the "Health Assessment Document for Polychlorinated Dibenzo-p-Dioxins" (USEPA, 1985). The development of the toxicity value was based on the combined incidence of lung, palate, and nasal carcinomas, and liver hyperplastic nodules or carcinomas in female rats in the study by Kociba *et al*. (1978).
- USEPA's HEAST (1997c) value of 150,000 mg/kg-day^{-1} was developed based on the USEPA (1985).

The value of 150,000 mg/kg-day^{-1} was selected to assess the carcinogenic effects from exposure to TCDD TEQ (D/F) in this document to be consistent with earlier USEPA assessments (*e.g.*, Hudson River [TAMS Consultants, Inc., and Gradient Corporation, 2000]; Housatonic River [Weston Solutions, 2005]; Centredale Manor Woonasquatucket River [USEPA Region 1, 2005]). The selection of this value is preferred because of the incidence of all significant tumors combined, rather than based on the incidence of liver tumors alone as is the case with the CalEPA CSF. As discussed above, USEPA released the final *Reanalysis of Key Issues Related to Dioxin Toxicity and Response to NAS Comments*, which included an oral RfD of 7×10^{-10} mg/kg-day for 2,3,7,8-TCDD (USEPA, 2012). This RfD is used here to assess the noncancer effects from exposure to TCDD TEQ (D/F) and is also the oral RfD provided in IRIS.

For Total PCBs (*i.e.*, sum of nondioxin-like PCB congeners), CSFs of 2.0 and 1.0 (mg/kg-day)$^{-1}$ are used to evaluate cancer risks for the upper-bound and central estimate exposures (Attachment 4, Table 4-12). The CSFs are based on the IRIS chemical file (USEPA, 1999), which is based on the 1996 PCB reassessment (USEPA, 1996). Two RfDs are available for Total PCBs, one for Aroclor 1016 and the other for Aroclor 1254. For the noncancer toxicity assessment, the RfD for Aroclor 1254 is used to assess noncancer toxicity since the bioaccumulation of PCBs is more consistent with the more heavily chlorinated Aroclor 1254. Dioxin-like PCBs (TCDD TEQ [PCB]) also have been evaluated for cancer risk based on the HEAST value for 2,3,7,8-TCDD and for noncancer toxicity based on the oral RfD for 2,37,8-TCDD in IRIS.

For TCDD TEQ (D/F) and TCDD TEQ (PCB), the consensus TEF values published in 2005 by the WHO (Van den Berg *et al*., 2006) and recommended by USEPA (2010a) are used to evaluate human health risks posed by these COPCs. Application of the TEFs was discussed in Section 2.4 and a summary of the congener-specific TEFs was provided in Table 2-1.

All other chemicals were evaluated using the toxicity values presented in their respective IRIS chemical files.

3.6 Risk Characterization

Risk characterization involves estimating the magnitude of the potential adverse health effects associated with the COPCs. It also involves making summary judgments about the nature of the human health threat to the defined receptor populations. The risk characterization combines the results of the dose-response (toxicity assessment) and exposure assessment to calculate cancer risks and noncancer health hazards. In accordance with USEPA's guidelines for evaluating the potential toxicity of complex mixtures (USEPA, 1986; 2000d), this assessment assumes that the effects of all constituents are additive through a specific pathway within an exposure scenario.

Risks are estimated as probabilities for COPCs that elicit a carcinogenic response. The excess lifetime cancer risk is the incremental increase in the probability of developing cancer associated with exposures to contaminated media at the site. A risk of 10^{-6} represents the probability that one person in one million exposed to a carcinogen over a lifetime (70 years) will develop cancer. The upper-bound excess lifetime cancer risks derived in this assessment are compared to the risk range of 10^{-4} (one in ten thousand) to 10^{-6} (one in one million) established in the NCP (USEPA, 1990). USEPA's goal of protection for cancer risk is 10^{-6} and risks greater than 10^{-4} typically will require remedial action at a site.

The excess cancer risk is estimated using CSFs where risk is directly related to intake (USEPA, 1989):

$$\text{Risk} = \text{CSF} \times \text{LADD} \quad (3\text{–}6)$$

where:

Risk	=	excess lifetime cancer risk (probability)
CSF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$
LADD	=	lifetime average daily dose (mg/kg-day)

Only LADDs are used in conjunction with CSFs to obtain excess lifetime cancer risk estimates, because slope factors are based on average lifetime exposures. CSFs are derived for specific routes of exposure; because the primary route of exposure to humans is ingestion in this HHRA, only oral toxicity values are applied. Cancer risks from exposure to multiple carcinogens are assumed to be additive (USEPA, 1989). To estimate the total excess cancer risks from all carcinogens, cancer risks from each compound are summed. Excess cancer risks that are less than the acceptable NCP risk range are identified as *de minimis* risk.

The potential for noncarcinogenic health effects is estimated by comparing the ADD of a chemical with the RfD for the specific route of exposure (*e.g.*, oral). The ratio of the intake to reference dose (ADD/RfD) for an individual chemical is the hazard quotient (HQ). When an RfD is available for the chemical, these ratios are calculated for each chemical that elicits a noncarcinogenic health effect. Typically, chemical-specific HQs are summed to calculate pathway hazard index (HI) values. The HI is calculated by summing all HQs for all noncarcinogenic constituents through an exposure pathway:

$$\begin{aligned} HI &= HQ_1 + HQ_2 + \ldots + HQ_j \\ &= (ADD_1/RfD_1) + (ADD_2/RfD_2) + \ldots + (ADD_j/RfD_j) \end{aligned} \qquad (3\text{–}7)$$

where:

HQ_j	=	hazard quotient of the j^{th} chemical
ADD_j	=	average daily dose of the j^{th} chemical
RfD_j	=	reference dose for the j^{th} chemical

USEPA's goal of protection for noncancer health effects is an HI equal to 1. When the HI exceeds 1, there may be a concern for health effects (USEPA, 1989). This approach can result in a situation where HI values exceed 1 even though no chemical-specific HQs exceed 1 (*i.e.*, adverse systemic health effects would be expected to occur only if the receptor was exposed to several contaminants simultaneously). In this case, chemicals are segregated by similar effect on a target organ, and a separate HI value for each effect/target organ is calculated (USEPA, 1989). If any of the separate HI values exceed 1, adverse, noncarcinogenic health effects are possible. It is important to note, however, that an HI exceeding 1 does not predict a specific disease.

3.6.1 Results for Baseline Current Exposure

In accordance with USEPA guidance (USEPA, 1989), these risks were calculated assuming that EPCs would remain at current levels throughout the ED. The cancer risks associated with current conditions are provided in Attachment 4, Tables 4-13 through 4-24 for RME and CTE and are summarized in Tables 3-6 and 3-7 and depicted on Figures 3-10 and 3-11.

Current Reasonable Maximum Exposure

The RME cancer risks are summarized in Table 3-6. The cancer risks represent risks to the adult (24 years) and child (6 years) for a total of 30 years. The calculated total cancer risks for the sportsman/angler[11] are 5×10^{-3} and 2×10^{-3} for ingestion of fish and crab, respectively. The ingestion risks for the adolescent receptor are 2×10^{-3} and 6×10^{-4} for fish and crab, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess risk for ingestion of both fish and crab. Approximate contributions to total risk from fish are 70% from TCDD TEQ (D/F), 11% from TCDD TEQ (PCBs), and 16% from Total PCBs. For ingestion of crab, TCDD TEQ (D/F) comprises 82% of the risk, while TCDD TEQ (PCBs) and Total PCBs contribute 12% and 5%, respectively, to the total risk. As shown on Figure 3-10, RME cancer risks are above the risk range of 10^{-4} to 10^{-6} (USEPA, 1990).

The RME noncancer HIs are summarized in Table 3-7. For ingestion of fish, the total HIs are 126 for the adult, 113 for the adolescent, and 195 for the child. For ingestion of crab, the total HIs are 43 for the adult, 38 for the adolescent, and 67 for the child. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both fish and

[11] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

crab consumption, with individual HQs above 1 for each receptor. The HQ for ingestion of methylmercury in fish is 2 for the adult and adolescent receptors and 3 for the child receptor. The HQ for ingestion of methylmercury in crab is below 1.

Noncancer HIs segregated by effect/target organ also are shown on Table 3-7. For ingestion of fish, the segregated HIs for TCDD TEQ (D/F), PCBs (*i.e.*, TCDD TEQ [PCBs], and Total PCBs), and methylmercury exceed 1 for all of the receptors. For ingestion of crab, the segregrated HIs exceed 1 for only TCDD TEQ (D/F) and PCBs (*i.e.*, TCDD TEQ [PCBs], and Total PCBs) for all recepotrs. Therefore, the USEPA goal of protection of 1 has been exceeded for the fish and crab RME scenarios, as shown on Figure 3-11.

Current Central Tendency Exposure

The CTE cancer risks are summarized in Table 3-6. The calculated total cancer risks for the sportsman/angler[12] for ingestion of fish and crab are both 1×10^{-4}. The ingestion risks for the adolescent receptor are 5×10^{-5} and 4×10^{-5} for fish and crab, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs in fish and crab are the primary contributors to the total cancer risks for both the adult and adolescent receptors. The CTE cancer risks are at the upper end of the risk range (Figure 3-10).

The CTE noncancer HIs are summarized in Table 3-7. For ingestion of fish, the total HIs are 8 for the adult, 8 for the adolescent, and 13 for the child. For ingestion of crab, the total HIs are 6 for the adult, 5 for the adolescent, and 9 for the child. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both fish and crab consumption. Noncancer HIs segregated by effect/target organ also are shown on Table 3-7. The segregated HIs for TCDD TEQ (D/F) and PCBs (*i.e.*, TCDD TEQ [PCBs] + Total PCBs) exceed 1 for each receptor for ingestion of fish. For ingestion of crab, the segregated HIs for TCDD TEQ (D/F) exceed 1 for all receptors, while the segregated HI for PCBs (*i.e.*, TCDD TEQ [PCBs] + Total PCBs) exceed 1 only for the child receptor. Exceedence of the USEPA goal of protection of 1 is indicated for the fish and crab CTE scenarios as shown on Figure 3-11.

3.6.2 Results for Baseline Future Modeled Exposure

These risks were calculated assuming EPCs would change over time as a result of natural recovery processes and degradation over time[12]. Specific details regarding the models used to estimate future concentrations in sediment are provided in Appendices B and C, while the development of modeled EPCs for future conditions is provided in Attachment 7 of this risk assessment. The EPCs derived for the baseline modeled future scenario were selected to represent a maximum average concentration that may be contacted within a 30-year exposure period (*i.e.*, beginning with the year immediately following the completion of the remediation and ending 30 years post remediation), comparable to the manner in which concentrations were assessed in the baseline risk assessment and consistent with USEPA (1989). The cancer risk and noncancer hazard calculations associated with baseline modeled future conditions are provided in Attachment 8 and are summarized on Tables 3-8 and 3-9 and depicted on Figures 3-12 and 3-13.

<u>Future Modeled Reasonable Maximum Exposure</u>

The RME cancer risks are summarized in Table 3-8. The calculated total cancer risks for the adult sportsman/angler[13] are 4×10^{-3} and 2×10^{-3} for ingestion of fish and crab, respectively. The ingestion risks for the adolescent receptor are 1×10^{-3} and 6×10^{-4} for fish and crab, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to a total risk above 1×10^{-3} for both ingestion of fish and ingestion of crab, with individual COPC cancer risks at or above 1×10^{-4} for TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs. Approximate contributions to total risk from fish are 50% from TCDD TEQ (D/F), 37% from TCDD TEQ (PCBs), and 13% from Total PCBs. For ingestion of crab, TCDD TEQ (D/F) comprises 45% of the risk, while TCDD TEQ (PCBs) and Total PCBs contribute 49% and 6%, respectively, to the total risk. As shown on Figure 3-12, RME cancer risks are approximately an order of magnitude above the risk range of 10^{-4} and 10^{-6} (USEPA, 1990).

[12] The baseline future modeled scenario corresponds to the No Action alternative evaluated in Section 5.0 where projections of future concentrations in sediment only considered natural attenuation and degradation over time.

[13] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

The RME HIs are summarized in Table 3-9. For ingestion of fish, the HIs are 90 for the adult, 87 for the adolescent, and 163 for the child. For ingestion of crab, the HIs are 40 for the adult, 39 for the adolescent, and 71 for the child. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both fish and crab consumption, with individual HQs above 1 for each receptor. The fish and crab RME scenarios, as shown in Figure 3-13, are well over one to two orders of magnitude above the USEPA goal of protection of an HI equal to 1. Future concentrations of dieldrin in sediment and biota tissue were not forecast. If one assumes that future dieldrin concentrations will at least be equal to concentrations observed in the historical data for sediment and biota, then estimates of future cancer risks and noncancer hazards are underestimated as a result of excluding dieldrin from the future risk analysis due to model limitations.

Future Modeled Central Tendency Exposure

The CTE cancer risks are summarized in Table 3-8. The calculated total cancer risks for the 30-year ED (*i.e.*, angler/sportsman adult + child receptors) for ingestion of fish and ingestion of crab are both 1×10^{-4}. The ingestion risks for the adolescent receptor are 4×10^{-5} for both fish and crab. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs in fish and crab are the primary contributors to the total cancer risks. As shown on Figure 3-12, CTE cancer risks are within the risk range.

The CTE HIs are summarized in Table 3-9. For ingestion of fish, HIs are 6 for the adult, 6 for the adolescent, and 11 for the child. For ingestion of crab, the HIs are 5 for the adult, 5 for the adolescent, and 9 for the child. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both fish and crab consumption. Exceedence of the USEPA goal of protection of an HI equal to 1 is indicated for the fish and crab CTE scenarios, as shown on Figure 3-13.

3.7 Human Health Uncertainty Analysis

The risk assessment was conducted consistent with USEPA risk assessment guidance, guidelines and policies. The application of these procedures is designed to reduce potential uncertainty and ensure consistency.

The process of evaluating cancer risks and noncancer health hazards involves multiple steps. Inherent in each step of the process are uncertainties that ultimately affect the final calculated cancer risks and noncancer health hazard estimates. Uncertainties may exist in areas including: environmental contaminant concentration data, derivation of toxicity values, and estimation of potential site exposures. In this section, the significant sources of uncertainty in the four risk assessment steps (hazard identification and data collection/evaluation, exposure assessment, toxicity assessment, and risk characterization) are qualitatively discussed, including the strengths, limitations, and uncertainties inherent in key scientific issues and science policy choices. This section accounts for sources of uncertainty in the various components of the risk assessment analysis in order to provide a full understanding of the accuracy and reliability of calculated risks and hazards. An understanding of the strengths and potential uncertainties of the risk assessment provides the risk manager with additional information for consideration in the risk management decision.

3.7.1 Hazard Identification and Data Collection and Evaluation

3.7.1.1 Sampling Methods and Laboratory Analysis

Environmental sampling uncertainties may be introduced through sample collection and preparation methods. Laboratory uncertainties include both random and systematic errors which affect the precision and accuracy of the sample results. Data were collected under USEPA-approved QAPPs and the data quality was validated to reduce the uncertainties involved with laboratory measurement of COPCs in environmental samples. Only valid data were utilized in this risk assessment and thus reduced potential uncertainties.

3.7.1.2 Selection of COPCs

The risk assessment concentrated on the evaluation of COPCs in fish and crabs that were the most bioaccumulative, persistent in the environment, and most toxic to human receptors. As a result, other COPCs found in fish and crabs were not evaluated in the HHRA, resulting in a potential underestimate of risks and hazards. Since the most persistent contaminants were evaluated in the risk assessment for fish and crab consumption, the impact of this uncertainty is most likely limited.

3.7.1.3 Mercury and Methylmercury

Data for total mercury and methylmercury were assumed to be equivalent and treated as if all were methylmercury. Once mercury is released to the environment, it can be converted to a biologically toxic form of methylmercury. Methylmercury is of particular concern because it readily crosses biological membranes and can accumulate and biomagnify up the food chain (Brightbill *et al*., 2004). Most of the mercury consumed in fish or other seafood is the highly absorbable methylmercury form (ATSDR, 1999). USEPA (2000a) recognizes that most mercury in fish and shellfish tissue is present as methylmercury. Studies conducted to assess the correlation between total mercury and methylmercury in fish tissue (Grieb *et al*., 1990; Bloom, 1992; and Kannan *et al*., 1998) reported that contributions of methylmercury to total mercury ranged between 83% and 99%. Because of the relatively high analytical cost for methylmercury, USEPA (2000a) recommends determining total mercury in tissue, then conservatively assuming all of the mercury present is methylmercury. Due to a lack of methylmercury analytical results in the tissue dataset used for this HHRA, results for elemental mercury (the form of mercury for which most of the data were available) were used as a surrogate for methylmercury. Therefore, EPCs derived using mercury data may slightly overestimate the methylmercury concentration and thus, results in a potential slight overestimate of noncancer health hazards.

3.7.2 Exposure Assessment

Several parameters associated with the exposure assessment have associated uncertainties that impact the calculated cancer risks and noncancer health hazards. The HHRA assumes that, while expected improvements to the river and shoreline may increase use of the river, the EF and duration for individuals already using the river will remain the same. The risks and hazards may be underestimated for individuals whose EF and duration increase following river and shoreline improvements. The following sections describe these uncertainties and their impact on the exposure assessment; they are organized based on the selection of exposure pathways and the specific components of the exposure equation used to calculate the dose.

3.7.2.1 Selection of Exposure Pathways

Some uncertainties are inherent in the selection of exposure pathways quantitatively evaluated in the risk assessment. Fish consumption is the most significant source of cancer risk and noncancer health effects due to exposure to contaminants in the FFS Study Area. Anglers also may be exposed to multiple chemicals (*e.g*., dioxins, PCBs, mercury and other contaminants) in sediments and surface water while fishing. Other potential receptors include recreational users who scull, wade, and swim in the river, and transient residents who may live along the river in make-shift shelters and are exposed through direct contact (ingestion and dermal contact) with sediment and surface water, ingestion of fish/other biota, and inhalation exposures if activities occur in mudflat areas or near sediment based on the presence of VOCs. For those individuals engaged in these activities and who also consume fish, the cancer risks and noncancer hazards may be underestimated. Such exposures are not expected to measurably increase the cancer risk or noncancer HIs because the fish ingestion pathway cancer risks and noncancer health hazards have been found to outweigh all other pathways at other sites where both fish ingestion and recreational uses were evaluated.

3.7.2.2 Components of the Exposure Equation

Intake is calculated using the exposure variables that describe the rate, frequency, duration and bodyweight of the exposed individual. Equation 3-1 provides the components evaluated in the calculation. This section describes the uncertainties associated with each of the variables and the impacts of these uncertainties on the calculated risks and hazards.

3.7.2.2.1 Exposure Point Concentrations - Statistical Analyses

EPCs for the COPCs were developed based on USEPA risk assessment guidance (USEPA, 1989, 2002c). The EPC is the UCL on the mean that is designed to be a health-protective estimate of the average site-wide concentration to which an RME receptor may be exposed. The UCLs were calculated from measured data collected from numerous samples distributed across the FFS Study Area. To minimize potential uncertainty in the calculated EPCs, the UCLs were calculated using several statistical methods and the most appropriate value was selected based on factors including the distribution of the raw data (*i.e*., normal, lognormal, etc.). The UCL may underestimate risks and hazards if the mean is greater than the UCL or overestimate risks and hazards if the sample mean is less than the population mean.

The calculation of the EPCs also evaluated nondetect concentrations of COPCs including TCDD TEQ (D/F) and TCDD TEQ (PCBs). To address potential uncertainties associated with detects and nondetects, a KM estimator was employed (the KM method is currently a default method used in USEPA's ProUCL software for calculating the 95% UCL of the mean for data with one or more censored results). Use of this KM method rather than the one-half the detection limit most likely limits an overestimation of the EPC.

3.7.2.2.2 Exposure Point Concentrations in Fish and Crab

Use of an equal-weighted average concentration to represent the EPC for fish ingestion in the baseline current exposures assumes that individuals consume only the six species caught during the late summer/early fall 2009 sampling event (American eel, common carp, smallmouth bass, white catfish, white perch, and white sucker) and that each of these species is equally consumed. The assumption of equal intake of the representative species may under or overestimate risks and hazards for those individuals with specific fish preferences. For example, individuals consuming more common carp than any of the other species may have higher risks and hazards than those calculated because the concentrations of organic COPCs in common carp were always higher than the American eel. Risk estimates for individuals who consume only one of the other fish species with lower concentrations than the common carp (*i.e.*, smallmouth bass, white perch, white sucker) may be overestimated because concentrations in these species are much lower than common carp. The resulting calculated risks and hazards may be overestimated or underestimated, depending on the fish consumption preferences and the ability of the angler to catch a specific species.

EPCs for fish in the baseline current exposures were based on tissue samples including both skinless and skin-on fillet samples, consistent with USEPA guidance. EPCs derived for organic COPCs in fish may be overestimated for those individuals consuming only skinless fillets since fatty tissues concentrate many organic compounds. Conversely, the EPC derived for methylmercury in fish may be underestimated for those individuals consuming only skinless fillets (mercury concentrates in muscle tissue). EPCs for all COPCs may be underestimated for those individuals consuming whole fish. The impacts of these uncertainties are expected to be limited.

Data used to calculate the EPCs for crab in the baseline current exposures incorporated the hepatopancreas that may be ingested while eating the other tissues from the crab. Surveys of anglers around the Newark Bay Complex show that up to 15% of anglers eat the hepatopancreas, including several cultures that specifically consume it as a delicacy. NJDEP (2002) also found that when the crab is cooked whole, even those consumers not deliberately eating the hepatopancreas are likely exposed to all or part of its contents due to its fluid nature and its dispersion in the cooking liquid. Incorporation of this organ results in a potential overestimate of the EPC concentration for chlorinated COPCs among those populations who specifically remove the hepatopancreas before cooking the crab.

The EPC in the baseline current exposures was calculated as an equal-weighted average fish concentration to represent a broad range of fish species that could be caught and consumed in the FFS Study Area. However, this assumes that fish species are equally caught and consumed. Risks/hazards may be overestimated or underestimated for individuals who consume only a single species. For example, risks/hazards associated with PCBs for individuals who consume only white perch would be overestimated because the weighted average concentration of all species combined is much higher than the average concentration measured in white perch only. An equal-weighted averaging of the fish species increased the EPC of PCBs.

3.7.2.2.3 Ingestion Rate

The angler population is defined as those individuals who consume self-caught fish or crab from the FFS Study Area. In accordance with USEPA guidance, risk to these individuals is evaluated assuming the absence of institutional controls, such as fishing/crabbing bans or consumption advisories. The angling population includes anglers who have been fishing for a long period of time, as well as anglers who may have just started fishing. Individuals occasionally consuming fish and crabs caught in the FFS Study Area by a friend or extended family member were not quantitatively evaluated since there is little quantitative information available on such exposures.

Nonetheless, the cancer risks and noncancer health hazards for these individuals are expected to be less than the risks for the angler population as defined, because friends and extended family members of anglers would be expected to have lower fish consumption rates than the angler population evaluated who continue to fish in the FFS Study Area and were evaluated in this risk assessment.

To minimize uncertainty in the calculated risks, exposure assumptions and parameters for these receptors were obtained from published literature sources (*e.g.*, creel surveys) for the Lower Passaic River or surrounding areas. The fish IR is based on the only two published surveys conducted in the New York/New Jersey Harbor estuary with enough information to calculate statistical distributions of IRs. Those surveys use different sampling methods (*i.e*., intercept and licensed angler survey), yet result in comparable consumption rates. The surveys also represent large angling populations from coastal New York and New Jersey watersheds. The fish IR is consistent with rates calculated from other surveys conducted within USEPA Region 2 and nationally.

The IR for crab consumption was based on a 3-month period during which individuals reported catching crab. This rate did not take into consideration the number of meals eaten throughout the remainder of the year when anglers may continue to catch crab or may consume frozen crab caught during the 3-month period. The IR for crab ingestion may be underestimated; therefore, risks may be somewhat underestimated.

The potential exists that the risks may be either underestimated or overestimated, but the analysis conducted by USEPA Region 2 (2012) and consistency with other surveys both regionally and nationally support the conclusion that the selected consumption rates for fish and crab are consistent with an RME.

3.7.2.2.4 Fraction from Source

Angling, crabbing, and consumption of catch within the FFS Study Area were reported by several surveys in this area (May and Burger, 1996; Burger et al., 1999; Kirk-Pflugh et al., 1999, 2011). For this assessment, it is assumed that 100% of the sportfish and crabs caught and consumed are from the FFS Study Area. Given the 8-mile extent of the FFS Study Area and the variety of fish species supported by the FFS Study Area, a recreational angler population may catch all of their fish and crabs from the FFS Study Area (in the absence of fishing restrictions). As such, the uncertainty in the calculated risks may result in either an underestimation or overestimation of risk.

3.7.2.2.5 Angler Exposure Duration

The HHRA used a 30-year default value for ED for the angler, representing an upper bound residential tenure at a single location. The angler was assumed to be a fairly permanent resident in the area. An evaluation was conducted using 2000 U.S. Census data for Essex and Hudson Counties, which quantified (1) how long residents are staying within their county and (2) how long residents stay within the two-county area. The results of this evaluation indicated that the 95th percentile number of years for an individual to move out of the two-county area is about 95 years and for individual counties ranges from 55 to 60 years. Therefore, risks and hazards may be underestimated based on the assumption of a 30-year ED by a factor of 1.5 to 2.

Thirty-year risks were calculated by combining risks for the adult and child receptors. This estimate of risk may be underestimated. As addressed earlier, results of an evaluation of U.S. Census data regarding residential EDs within the seven-county area along the study site suggested that individuals may live longer than 30 years at this location. Therefore, it may be reasonable to assume that risks should be added for the adult (24 years), adolescent (12 years) and child (6 years) to more accurately portray risks to a local resident who lives and fishes in the area. Estimated risks for ingestion of fish and crab would then increase by a factor of 1.4.

3.7.2.2.6 PCB Cooking Losses

As described in Section 3.4.3.3, reported cooking losses vary considerably among the numerous studies reviewed. However, little information is available to quantify personal preferences among anglers for various preparation and cooking methods and other related habits (such as consumption of pan drippings). The assumption that there is no loss of PCBs during cooking or preparation, used in the RME point estimate cancer risk and noncancer health hazard calculations, could overestimate cancer risks and noncancer health hazards on average.

3.7.3 Toxicity Assessment

The assessment did not calculate cancer risks and noncancer health hazards associated with a number of other chemicals but rather concentrated on those chemicals known to be persistent and most toxic to humans and bioaccumulative in fish and crabs as discussed above. This may underestimate cancer risks and noncancer health hazards associated with the other contaminants. While an underestimation of risk is anticipated, the degree of underestimation is expected to be low since the most persistent contaminants in the food chain and most toxic to humans were evaluated.

The toxicity values are designed to be protective of human health, and the potential exists that the risks may be lower (USEPA, 2005c). The toxicity values for dioxins, mercury, and PCBs, the primary chemical risk drivers, were extensively peer-reviewed. The toxicity assessments included human epidemiological studies in addition to animal studies. Following careful review of the data, the most appropriate studies were used to develop toxicity values. The uncertainty around the CSF estimates extends in both directions, *i.e.*, contributing to possible underestimate or overestimate of cancer potency factors. However, the CSFs developed by USEPA represent plausible upper bound estimates, which means that USEPA is reasonably confident that the actual cancer risk will not exceed the estimated risk calculated using the CSF (USEPA, 1986, 1996, 2005c).

The toxicity values used in this risk assessment have been peer reviewed and are the most current values recommended by USEPA in IRIS and other toxicity sources identified in the Toxicity Hierarchy Memo “Human Health Toxicity Values in Superfund Risk Assessments” (OSWER Directive 9285.7-53, USEPA, 2003c). The IRIS files represent Agency consensus views on the toxicity of the chemicals.

3.7.3.1 Dioxin Cancer Slope Factor

At the current time, USEPA is assessing the cancer toxicity of dioxin (*i.e.*, cancer toxicity values for IRIS or PPRTV CSFs are not available). In the absence of an IRIS value, the available Tier 3 sources of toxicity values were evaluated. Following is a list of the available CSFs that meet the Tier 3 criteria outlined in the Toxicity Hierarchy Memo.

- CalEPA Office of Environmental Health Hazard Assessment (OEHHA) value of 130,000 mg/kg-day^{-1} (CalEPA, 2009). The CalEPA (2011) report that describes the derivation of this value indicates that: "The original report on chlorinated dioxins and dibenzofurans (California Department of Health Services, 1986) identified carcinogenicity as the critical effect for defining risk to public health and calculated a potency (slope factor) for TCDD of 1.3 x 10^5 (mg/kg-day)$^{-1}$. This was based on the incidence of liver tumors in male mice in a gavage study (NTP, 1982) and was calculated to be equivalent to a unit risk of 38 (µg/m^3)$^{-1}$ for airborne exposures."
- CalEPA OEHHA value of 7.7 × 10^5 mg/kg-day^{-1} from the 2010 "Public Health Goals of Chemicals in Drinking Water" developed by its Pesticide and Environmental Toxicology Branch (CalEPA, 2010). This CSF is based on the latest National Toxicology Program study in female rats and a new multisite cancer potency factor calculation, derived using updated methodology, which, according to OEHHA, is considered to represent a more accurate estimate of potential human cancer risk.
- USEPA's Office of Health and Environmental Assessment value of 156,000 mg/kg-day^{-1} based on the "Health Assessment Document for Polychlorinated Dibenzo-p-Dioxins" (USEPA, 1985). The development of the toxicity value was based on the combined incidence of lung, palate, and nasal carcinomas, and liver hyperplastic nodules or carcinomas in female rats in the study by Kociba et al. (1978).
- USEPA's HEAST (1997c) value of 150,000 mg/kg-day^{-1}was developed based on the USEPA (1985).

The value of 150,000 mg/kg-day^{-1} was selected to assess the carcinogenic effects from exposure to TCDD TEQ (D/F) in this document to be consistent with earlier USEPA assessments (*e.g.*, Hudson River [TAMS Consultants, Inc., and Gradient Corporation, 2000]; Housatonic River [Weston Solutions, 2005]; Centredale Manor Woonasquatucket River [USEPA Region 1, 2005]). The selection of this value is preferred because of the incidence of all significant tumors combined, rather than based on the incidence of liver tumors alone as is the case with the CalEPA CSF. As discussed above, USEPA released the final *Reanalysis of Key Issues Related* *to Dioxin Toxicity and Response to NAS Comments*, which included an oral RfD of 7×10^{-10} mg/kg-day for 2,3,7,8-TCDD (USEPA, 2012). That RfD is used here to assess the noncancer effects from exposure to TCDD TEQ (D/F) and is also the oral RfD provided in IRIS.

3.7.3.2 Toxic Equivalence Factors for Dioxin-like PCBs

Dioxin and dioxin-like PCBs guidance (USEPA, 2010a) was used in the calculation of cancer risks and noncancer health hazards. The TEF methodology, a component mixture method, used the recommended 2005 WHO consensus TEFs. USEPA recommended these TEFs be used for all effects mediated through aryl hydrocarbon receptor binding by the dioxin-like compounds (DLCs) including cancer and noncancer effects. Potential uncertainties associated with the evaluation of TEFs for dioxins and dioxin-like PCBs are provided in EPA's 2010 document titled "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-like Compounds" (USEPA, 2010a). The document acknowledges the following uncertainties:

> "TEQ uncertainty only pertains to the confidence associated with the estimation of TCDD equivalents in a mixture. There is also uncertainty associated with assessing exposures to environmental mixtures of TCDD and DLCs and with quantitatively linking health effects to the TCDD and DLC exposures."

3.7.3.3 Mercury

The HQ for ingestion of methylmercury in fish is 2 for the adult and adolescent receptors and 3 for the child receptor based on an EPC of 0.36 mg/kg. The oral RfD for mercury is based on human epidemiological studies; therefore, the overall confidence in the RfD for methylmercury is high. Because the HQ for the child receptor is above 1, there may be concern for potential health effects as a result of methylmercury exposure. Thresholds that have been used to establish consumption advisories are 1.0 mg/kg wet weight (ww; used by the Food and Drug Administration [FDA] for restriction of commercial sale of fish) and 0.5 mg/kg (with advisories of no or restricted consumption of fish with higher assessment of total mercury concentrations in fish from rivers, lakes, and reservoirs in New Jersey) (Horwitz *et al*., 2002). In 1994, NJDEP and the Toxics in Biota Committee derived a risk-based criterion for mercury concentrations as low as 0.08 mg/kg as a trigger for state advisories restricting consumption among the most vulnerable segments of the human population (*e.g.*, children and pregnant women) (Horwitz *et al.*, 2002). The uncertainties associated with the exposure assumptions used in the calculation of the noncancer HQ for mercury are similar to the other fish contaminants of concern identified above. The information presented regarding the concentration of mercury in fish used to establish fish advisories for the general and vulnerable portions of the human population (*e.g.*, children and pregnant women) also identifies potential concerns for the ingestion of mercury-contaminated fish at varying concentrations.

3.7.3.4 PCBs

Consistent with the 1996 "PCBs: Cancer Dose Response Assessment and Application to Environmental Mixtures", USEPA evaluated cancer risks from dioxin-like PCBs and non-dioxin-like PCBs. To account for the fact that relative concentrations of dioxin-like congeners may be enhanced in environmental mixtures, particularly in fish due to bioaccumulation of more persistent congeners, the 2005 WHO International Programme on Chemical Safety (IPCS) TEFs (USEPA, 2010a) are used in the risk characterization, along with the CSF of 150,000 for dioxin (USEPA, 1997b), to supplement the evaluation of PCB cancer risks due to fish consumption.

Cancer risks for ingestion of dioxin-like PCBs in fish were calculated similarly to those for PCBs, substituting the dioxin TEQ for the EPC and the dioxin CSF of 150,000 (USEPA, 1997b) for the CSF. The resulting cancer risk estimates are shown in Table 3-6. The RME dioxin-like fish ingestion cancer risk of 6×10^{-4} is approximately equivalent to the RME cancer risk calculated without consideration of the dioxin-like congeners (*i.e.*, 8×10^{-4}). Therefore, an enhancement of dioxin-like PCBs was not found.

3.7.3.5 Life Stages

Exposure to dioxin, dioxin-like compounds, and other bioaccumulative compounds in sensitive subpopulations, such as breast-fed children of mothers who consume contaminated fish, was not evaluated quantitatively. These compounds are lipophilic and concentrate in breast milk. Therefore, risks are more likely to be underestimated for these sensitive populations.

3.7.4 Risk Characterization

Uncertainty in the calculated risks can arise from uncertainty in the way in which risks were calculated or aggregated, as discussed below.

3.7.4.1 Consumption of Biota

Risks were derived assuming that the receptors ate fish or crab, but not both. Although Burger (2002) reported survey results indicating that the majority of people caught either fish or crab, it is likely that some anglers may catch, and eat, both fish and crab. Therefore, risks may be underestimated for individuals who eat both fish and crab. However, for individuals eating both crab and fish at each meal, the respective IRs for both would be expected to decrease (*i.e*., if someone eats both fish and crab during a meal, then the fish IR and the crab IR may be lower than the respective IRs when only fish or only crab is consumed during a meal). Therefore, risks would be overestimated if the same respective consumption rates were assumed for an individual consuming both fish and crab during a meal. As such, the uncertainties in the calculated risks for this site are considered low.

Individuals may be exposed to COPCs from eating game (e.g., turtles, waterfowl) found within the FFS Study Area. Waterfowl may contain high concentrations of dioxins and PCBs in their fat and internal organs. Although public health advisories for consumption of these animals have not been issued by NJDEP, two neighboring states, Pennsylvania and New York, have issued consumption advisories for certain game (NYSDOH, 2011; Pennsylvania Department of Environmental Protection [DEP], 2011) associated with the presence of PCBs in their waterways. However, because there are no historical data on chemical concentrations in the tissues of these organisms, consumption of waterfowl, turtles, and other species is not addressed in this HHRA quantitatively but rather qualitatively as an area of uncertainty. For individuals who consume these animals in addition to fish and crab, risks would be expected to be higher.

3.7.5 Conclusions

The results of the uncertainty analysis indicate that the overall assumptions are representative of the RME individual.

4 BASELINE ECOLOGICAL RISK ASSESSMENT – BASELINE CONDITIONS

The purpose of this BERA is to assess and characterize potential risks to ecological receptors under both baseline and future conditions in the FFS Study Area and to support remedial decision making. This section evaluates baseline risks following USEPA (1998) guidance and is comprised of five subsections including the problem formulation (Section 4.1), exposure assessment (Section 4.2), effects assessment (Section 4.3), risk characterization (Section 4.4) and uncertainty analysis (Section 4.5). An assessment of the potential future risks to ecological receptors under each of the remedial alternatives considered in the FFS is provided in Section 5.0.

Consistent with the specific objective of determining whether site risks attributable to chemical contamination in the FFS Study Area sediments pose an unacceptable risk to the environment potentially warranting remedial consideration, this BERA does not attempt to characterize risks to all chemical stressors nor does it evaluate exposures to all categories of potential receptors. As discussed below in the various subsections of Section 4.1, the evaluation of the COPECs that are anticipated to present the greatest risks to ecological receptors and a focus on the most sensitive categories of ecological receptors is considered adequate to meet the FFS objectives. The BERA for the full 17 miles of the LPRSA, which is currently underway, will supplement this analysis with a full characterization of chemical exposures to all categories of aquatic and aquatic-dependent organisms.

4.1 Problem Formulation

The problem formulation provides the foundation for the BERA whereby the current understanding of the key environmental attributes linking chemical stressors to ecological receptors is evaluated, the objectives of the analysis are defined, hypotheses regarding whether ecological effects are occurring (or could occur in the future) are established, and an approach to analyze and characterize the potential risks is developed (USEPA, 1998). The RI report provides a general understanding of the ecology of the FFS Study Area (Section 3) and the nature and extent of chemical stressors in sediments including potential sources (Section 4), contaminant fate and transport (Section 5), and a CSM (Section 6). The RI and PAR (Battelle, 2005) together provide the basic information necessary to develop this problem formulation approach. An overview of key components necessary to develop the analysis plan for risk characterization is presented in the following subsections, and the reader is referred to the RI and PAR for greater detail on the supporting information.

4.1.1 Identification of Contaminants of Potential Ecological Concern

Several classes of COPECs were identified in the PAR (Battelle, 2005), including various metals, pesticides, PAHs, D/F, PCBs, and VOCs/SVOCs. The screening process used to develop a refined list of COPECs that are evaluated in this BERA is presented in Attachment 2. It is emphasized that the COPECs listed in Table 4-1 were selected for the purposes of evaluating the need for an action within the FFS Study Area while a comprehensive study of ecological risks throughout the 17-mile LPRSA is ongoing. The larger set of COPECs identified in the PAR will be assessed as part of the RI/FS for the 17-mile study area.

For the BERA to support the FFS, sediment and tissue COPECs were identified based on a three-tier screening process that included:

- A bioaccumulation screen, whereby COPECs were retained for further evaluation if they have a tendency to bioaccumulate through the food chain and result in indirect toxicological effects
- An essential nutrient screen, whereby COPECs were eliminated from further evaluation if they are essential dietary nutrients that are not toxic even at very elevated concentrations
- An effects value screen, whereby COPECs were retained for further evaluation if they were determined to be present at levels that could potentially result in direct toxicological effects to benthic invertebrates.

To determine whether contaminants are present at concentrations in sediment that could result in adverse ecological effects, maximum contaminant concentrations were compared with known effects concentrations, called screening benchmarks, to estimate an HQ as shown in Equation 4-1:

$$HQ = \text{Maximum Sediment Concentration/Screening Benchmark} \quad (4\text{-}1)$$

An HQ < 1 indicates that sediment contaminants are not at levels that would pose unacceptable risk to ecological receptors, while an HQ ≥ 1 indicates that sediment contaminants may be present at concentrations that could result in adverse ecological effects.

Nine COPECs were identified as comprising the largest contribution of total risk to ecological receptors and were selected for evaluation in the BERA. These analytes had HQs that exceeded 100 for inorganic compounds and greater than 1,000 for organic compounds (Attachment 2). Ecological COPECs identified for this assessment include:

- Copper
- Lead
- Mercury
- Low molecular weight PAHs (LMW PAHs)
- High molecular weight PAHs (HMW PAHs)
- Total DDx (sum of DDE, DDD, and DDT isomers)
- Dieldrin
- Total PCBs (sum non dioxin-like congeners)
- TCDD TEQ
    - Dioxin/furans (TCDD TEQ [D/F])
    - PCB congeners (TCDD TEQ [PCBs])
    - 2,3,7,8-TCDD.

For the TCDD TEQ, the TEQs for the D/F and PCB congeners were also identified as COPECs separately in order to quantify their relative importance to the total TCDD TEQ risks in the BERA. Ecological risks associated with exposure to 2,3,7,8-TCDD alone were also evaluated for those receptors (*i.e.*, invertebrates) lacking the aryl hydrocarbon (AhR) receptors that are believed to mediate the various toxic effects associated with exposure to compounds that can cause dioxin-like effects.

In summary, the COPECs that were selected for evaluation in this BERA were identified based on their elevated levels, relative to screening ecotoxicological benchmarks, in FFS Study Area sediments as well as their known propensity to accumulate in biological tissue (Battelle, 2005).

4.1.2 Ecological Effects of Contaminants of Potential Ecological Concern

This section presents ecotoxicological profiles for each COPEC and includes relevant ecotoxicological data to support the selection of appropriate toxicological benchmarks (*e.g.*, critical body residues [CBRs] and toxicity reference values [TRVs]) used to quantify risks.

Copper is a reddish metal that occurs naturally in rock, water, soil, and sediment. It is an essential element at low levels for all organisms, including humans and other animals; however, at higher levels, toxic effects can occur. Copper can enter the environment through releases from the mining of copper and other metals and from factories that make or use copper metal or compounds. Copper can also enter the environment through waste dumps, domestic waste water, and combustion of fossil fuels, wood production, fertilizer production, and natural sources such as dust from soils, volcanoes, and forest fires.

Copper strongly adsorbs to organic matter, carbonates, and clay, which reduces its bioavailability. Copper is highly toxic in aquatic environments and causes adverse effects in fish, invertebrates, and amphibians, with all three groups equally sensitive to chronic toxicity (USEPA, 1993a; Horne and Dunson, 1995). Copper bioconcentrates in various organs in both fish and mollusks (Owen, 1981). Toxic effects in birds include reduced growth rates, lowered egg production, and developmental abnormalities (USEPA Region 5, 2006). Although mammals are not as sensitive to copper toxicity as aquatic organisms, toxicity in mammals includes a wide range of animals and effects such as liver cirrhosis, necrosis in kidneys and the brain, gastrointestinal distress, lesions, low blood pressure, and fetal mortality (ATSDR, 2004; Kabata-Pendias and Pendias, 1992; Ware, 1983; Vymazal, 1995).

Lead occurs naturally in the environment; however, most of the elevated levels found throughout the environment come from anthropogenic activities such as mining or factories that make or use lead, lead alloys, or lead compounds. Lead is also released into the air during burning of coal, oil, or waste.

Lead partitions primarily to sediments but becomes more bioavailable under low pH, low hardness, and low organic matter content (among other factors). It can be bioconcentrated from water, but it does not bioaccumulate and tends to decrease with increasing trophic levels in freshwater habitats (Eisler, 1988). Fish exposed to high levels of lead exhibit a wide range of effects, including muscular and neurological degeneration and destruction, growth inhibition, mortality, reproductive problems, and paralysis (Eisler, 1988; USEPA, 1976). Lead also adversely affects invertebrate reproduction.

At elevated levels in plants, lead can cause reduced growth, photosynthesis, mitosis, and water absorption (Eisler, 1988). Lead poisoning in higher organisms primarily affects hematologic and neurologic processes and has been associated with lead shot and organolead compounds, but not with food chain exposure to inorganic lead (other than lead shot, sinkers, or paint) (Eisler, 1988). Birds and mammals suffer effects from lead poisoning such as damage to the nervous system, kidneys, and liver, sterility, growth inhibition, developmental retardation, and detrimental effects in blood (Eisler, 1988; Amdur *et al*., 1991). Lead adversely affects reproduction, liver and thyroid function, as well as the immune system (Eisler, 1988).

Methylmercury is the organic, bioavailable fraction of elemental mercury, which comes from a variety of environmental sources, including mine tailings, gaseous emissions, industrial effluent, and atmospheric deposition. The transformation of inorganic mercury to methylmercury occurs by anaerobic microorganisms in soils and sediment (ATSDR, 1999), as well as in hypoxic bottom waters. When consumed by aquatic organisms such as fish and shellfish, mercury is not purged or easily metabolized and is capable of bioaccumulating and biomagnifying in successive upper-trophic-level organisms that feed on contaminated prey.

Piscivorous mammals and birds that consume sufficient amounts of mercury-contaminated prey show signs of mercury toxicoses, including damage to nervous, excretory, and reproductive systems (Risk Assessment Information System, 1998). Although methylmercury exhibits a range of toxic effects in several target tissues (*e.g*., liver, kidney), its primary effects are on the central nervous system. Methylmercury readily penetrates the blood/brain barrier, producing brain lesions, spinal cord degeneration, and central nervous system dysfunctions (Wolfe *et al*., 1998).

Symptoms of acute methylmercury poisoning in birds include reduced food intake, weight loss, weakness in wings and legs, difficult maneuvering, and inability to coordinate muscle movement (Wolfe *et al*., 1998). Methylmercury is a potent embryo and nervous system stressor in birds with chronic exposures characterized by symptoms that range from embryo lethality (*i.e.*, reduced egg hatchability), reduced clutch size, eggshell thinning, and aberrant juvenile behavior that may include auditory or visual impairment (Wolfe *et al*., 1998; Eisler, 1987a).

Several long-term feeding studies have been conducted using a variety of bird species, including mallards, black ducks, ring-necked pheasants, Japanese quail, chickens, and great egrets; the most relevant studies are summarized in Table 4-2. These laboratory studies are consistent with a field study of the common loon in northwestern Ontario (Barr, 1986), which found that reduction in egg laying and aberrant territorial and nest building behavior occurred when concentrations of methylmercury in the diet exceeded 0.2 to 0.3 µg/g ww. There is reasonable consistency in the levels of methylmercury in the diet associated with the onset of significant reproductive effects in chronically exposed birds. Although Heinz (1974; 1975; 1976a,b; 1979) failed to identify a no observed adverse effects level (NOAEL) value, the study did establish a lowest observed adverse effects level (LOAEL; 0.078 µg methylmercury/g-day). Results indicate that piscivorous birds may be as sensitive to the effects of methylmercury intoxication as are ducks.

Reproductive effects of methylmercury in mammals include developmental alterations that produce behavioral deficits after birth, impaired fertility, and fetal death. Behavioral effects of low doses of methylmercury were noted in swimming ability, operant learning, avoidance, maze learning, and development of reflexes. At higher doses, changes in spontaneous activity, visual function, vocalization, and convulsions may occur (Wolfe *et al.*, 1998). Several long-term feeding studies have been conducted using a variety of mammal species, including the river otter, mink, cat, rat, and laboratory mouse. Table 4-2 also summarizes available long-term laboratory feeding studies for mammals.

PAHs are a group of ubiquitous chemicals that are a major component of petroleum products (*i.e.*, petrogenic) or are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances (*i.e.*, pyrogenic). There are more than 100 different PAHs, which generally occur as complex mixtures. Pyrogenically-derived PAHs mainly enter the environment as releases to air from volcanoes, forest fires, residential wood burning, and exhaust from automobiles and trucks; petrogenically-derived PAHs are typically released as direct spills to surface water, soils, or sediments. PAHs include some compounds that are highly potent carcinogens capable of producing tumors in some organisms at even single doses; other, noncancer-causing effects are not well understood (Eisler, 1987b). Their effects are wide ranging within an organism and they have been found in many types of organisms, including nonhuman mammals, birds, invertebrates, plants, amphibians, fish, and humans. However, their effects are varied, so generalizations cannot be readily made. Effects on benthic invertebrates include inhibited reproduction, delayed emergence, sediment avoidance, and mortality. Fish exposed to PAHs in sediment and surface water have exhibited fin erosion, liver abnormalities, cataracts, and immune system impairments leading to increased susceptibility to disease (Fabacher *et al*., 1991; Weeks and Warinner, 1984; 1986; O'Conner and Huggett, 1988; Payne *et al*., 2003). Early mechanistic models categorized effects of individual PAHs as either being receptor mediated (*e.g.*, AhR) with metabolites forming DNA adducts or generally narcotic in nature; however, recent studies suggest that the toxicology is much more complicated (Barron *et al*., 2004; Incardona *et al*., 2006).

Mammals can absorb PAHs by inhalation, dermal contact, or ingestion (Eisler, 1987b). The oral toxicity of PAHs ranges from very toxic to moderately toxic in rats. In addition to tumor induction, other effects in mammals include adverse effects on reproduction, development, and immunity (ATSDR, 1995).

DDT and its primary metabolites (DDD and DDE) are manufactured organochloride pesticides (collectively referred to as DDx). DDT use in the United States was banned in 1972, but it was still manufactured for export until the mid-1980s. DDT is a broad-spectrum insecticide which was very popular due its effectiveness, long residual persistence, low acute mammalian toxicity, and low cost. DDT has been widely used to control insects on agricultural crops such as peanuts, soybeans, and cotton and has been sprayed to decrease the incidence and spread of diseases such as malaria by controlling mosquitoes.

Upon introduction into the environment, DDT enters soil, water, or air. DDT and its metabolites are strongly adsorbed onto particulates in water and settle into sediments, where they become essentially immobile. DDT is highly toxic to aquatic life, including both invertebrates (crustaceans) and vertebrates (fish, birds). Furthermore, DDT and its analogues accumulate in lipid tissues of fish and other organisms, and subsequently bioconcentrate up the food chain.

The best known effect of DDT toxicity is impairment of nerve impulse conduction. Effects of DDT on the nervous system have been observed in animals and can vary from mildly altered sensations to tremors and convulsions. Death in animals following high exposure to DDT is usually caused by respiratory arrest. In addition to being a neurotoxicant, DDT is capable of inducing marked alterations on reproduction and development, which is attributed to hormone-altering actions of DDT isomers and/or its metabolites (ATSDR, 2002a). Egg-shell thinning in upper-trophic-level birds is believed to have resulted in population crashes in the 1960s and 1970s. Due to the ban on the production and use of DDT in the United States and other parts of the world, exposures of wildlife have been declining since the early 1970s, as evidenced by marked decreases in the levels of DDT compounds in fish, shellfish, aquatic mammals, and birds (ATSDR, 2002a).

The well-publicized decline in wild raptor populations, including the bald eagle, during the 1950s and 1960s was attributed partly to reproductive impairment, particularly eggshell thinning. Egg production, fertility, and hatchability were largely unaffected in numerous studies in a variety of bird species. However, increased embryolethality, decreased egg size, delayed oviposition after mating, and increased testicular effects were observed with some regularity among experimental studies in birds. Several authors speculated that the effects were due to DDT-induced hormonal imbalances, and, in fact, blood hormone levels (estrogen, luteinizing hormone) were altered in three of four studies in birds consuming either DDT or DDE in the diet (ATSDR, 2002a).

The most extensively studied species include the mallard duck (*Anas platyrhynchos*), Japanese quail (*Coturnix coturnix japonica*), domestic fowl, brown pelican (*Pelecanus occidentalis*), and ringed turtle dove (*Streptopelia risoria*). The most commonly reported endpoints were lethality, neurological, and reproductive endpoints. Of particular interest are those effects that were observed consistently across species and in spite of variability in exposure scenarios. The significant health effects most consistently reported were lethality (several taxa), hepatic (liver enzyme induction and liver damage in birds), endocrine (estrogenic effects in several taxa, and reduced thyroid weight and altered thyroid activity in birds), neurological (tremors in several taxa), reproductive (oviposition delay and eggshell thinning in birds), and developmental (reduced chick survival in birds, testicular feminization) (ATSDR, 2002a). Table 4-3 summarizes the effects thresholds derived from various feeding studies with DDT.

USEPA (2000d) summarizes available avian embryo effect data for DDT and related compounds. A study of British golden eagles (*Aquila chrysaetos*) measured mean percent eggshell thinning of up to 7% at an egg concentration of 0.1 µg/g as *p,p'*-DDE (Ratcliffe, 1967).

Dieldrin and *aldrin* are structurally similar, and aldrin readily converts to dieldrin once it enters the environment or is ingested or inhaled by organisms. Dieldrin is an organochloride pesticide, belonging to the cyclodiene group of pesticides, which also includes endrin, endosulfan, and aldrin. Dieldrin is no longer produced or used, but it was once used extensively as an insecticide on crops such as corn and cotton and was also used to control termites. Aldrin is a more effective pesticide than dieldrin and therefore was more extensively used as a soil insecticide (ATSDR, 2002b).

Many species of aquatic invertebrates concentrate dieldrin from very low water concentrations, yielding high concentration factors. The bioconcentration of dieldrin in aquatic organisms is principally from the water rather than by ingestion of food. Aldrin and dieldrin are both highly toxic to aquatic crustaceans and fish. Effects on mammals include liver damage, central nervous system effects, and suppression of the immune system. Dieldrin and aldrin also disrupt the endocrine and reproductive systems (ATSDR, 2002b).

TRVs for dieldrin have been developed by USEPA (2007a) as part of the process of developing ecological soil screening levels (Eco-SSLs; USEPA, 2007a) for mammals and birds for 23 contaminants using a transparent, ecologically relevant, and comprehensive process. A study of eggshell thinning in Peregrine falcons (*Falco peregrinus*) nesting in the Kola peninsula in Russia measured mean percent eggshell thinning of 11.4% at an egg concentration of 0.0591 µg dieldrin/g (Henny *et al*., 1994).

PCBs are mixtures of up to 209 individual chlorinated compounds (known as congeners). While PCBs were manufactured and sold under many names, the most common was the Aroclor series. Because they do not burn easily and are good insulating materials, PCBs were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because there was evidence that PCBs build up in the environment and may cause harmful effects. Once released into the environment, PCBs do not readily degrade and therefore remain for long periods of time, cycling between air, water, and soil. As a consequence, PCBs are found all over the world. The WHO has recognized 12 PCB congeners that are structurally similar to dioxins and have similar toxic effects (Van den Berg *et al*., 1998; 2006). These congeners are listed in Table 4-4.

PCBs are taken up into the bodies of small organisms and fish in water. They are also ingested by other animals that feed on these aquatic animals. PCBs especially accumulate in fish and marine mammals (such as seals and whales), reaching levels that may be many thousands of times higher than in water.

Animals exposed to PCBs show various kinds of health effects, including anemia, acne-like skin conditions, and liver, stomach, and thyroid gland injuries (ATSDR, 2000). Other effects include reductions in the immune system function, behavioral alterations, and impaired reproduction (ATSDR, 2000). Some PCBs can mimic or block the action of hormones from the thyroid and other endocrine glands. Because hormones influence the normal functioning of many organs, some of the effects of PCBs may result from endocrine changes. Inhalation and dermal exposure to PCBs may cause liver, kidney, and skin damage in animals (ATSDR, 2000).

A TEQ approach is employed to normalize the assessment of potential risks associated with wildlife exposure to compounds with dioxin-like toxicological properties (including certain PCB congeners). Consequently, the specific TRVs for PCBs are used to evaluate the nondioxin-like effects attributable to PCB compounds.

A review conducted by USEPA Region 5 (Chapman, 2003) developed avian TRVs for PCBs based on an analysis conducted for the chicken, which is believed to be one of the most sensitive bird species (Table 4-5). Ecotoxicological dose thresholds were developed individually for Aroclors 1242, 1248, and 1254 based on reported dose response data from multiple collated studies for Aroclor exposure and growth or reproductive effects in chickens. Table 4-5 also summarizes mammalian dose thresholds for PCBs that were derived as part of the Chapman (2003) analysis; no mink study for Aroclor 1248 was identified, but the author concluded that this mixture is as toxic as Aroclor 1254 based on *in vitro* bioassay data.

2,3,7,8-TCDD belongs to a class of compounds known as chlorinated dibenzodioxins that are ubiquitous in the environment as a result of various industrial processes (*e.g.,* solid waste incineration; the production, use, and disposal of pesticides and PCBs; the bleaching process for paper manufacturing; and the production and recycling of metals). In the FFS Study Area, 2,3,7,8-TCDD and other dioxin and furan congeners are present largely as the byproducts of the manufacture of Agent Orange and other herbicides. Dioxins are usually generated concurrently with other chemicals known as chlorinated dibenzofurans; both of these chemicals are highly persistent and have been detected in all environmental media (*i.e*., air, water, soil, animal tissue). Although a variety of D/F congeners have been detected in environmental media associated with the FFS Study Area, 2,3,7,8-TCDD, which is believed to be the most toxic congener, typically constitutes a significant majority of both the total dioxin and furan congener concentrations. Table 4-4 presents TEFs for all D/F and PCB congeners evaluated in the BERA.

Laboratory toxicity data show that fish are generally more sensitive to TCDD than plants, aquatic invertebrates, and other aquatic vertebrates (*e.g.,* amphibians) (USEPA, 1993b). The high lipid content in fish makes them highly susceptible to bioaccumulation of TCDD in their tissues, which can be transferred through the food chain to higher-trophic-level organisms such as birds and mammals (including humans). As with mammal studies, it appears that 2,3,7,8-TCDD is the most toxic congener to juvenile and adult fish, with toxic effects noted at concentrations as low as 300 ng/kg (whole body) (van der Weiden *et al.*, 1992). In general, dioxins are of greatest toxicity to fish embryos; adult life stages for fish exhibit lower sensitivity, with the LD_{50} of TCDD in rainbow trout sac fry being 35 times lower than that in juvenile rainbow trout (Walker and Peterson, 1991). Observed 2,3,7,8-TCDD toxicity effects included mortality, edema, hemorrhaging, arrested development, and craniofacial malformations (Walker and Peterson, 1994; Walker *et al.*, 1994; Elonen *et al.*, 1998; Walker *et al.*, 1996). Of the fish examined, trout were the most sensitive to 2,3,7,8-TCDD, having LC_{egg50}[14] concentrations ranging from 69 to 179 pg/g egg (Walker *et al.*, 1994; Walker and Peterson, 1994; Walker *et al.*, 1996). Other relatively sensitive species included fathead minnow, channel catfish, and lake herring, with LC_{egg}50 concentrations of 539, 644, and 902 pg/g egg, respectively (Elonen *et al.,* 1998). Zebrafish (*Danio rerio*) and northern pike (*Esox lucius*) were least sensitive to TCDD, with LC_{50} (embryo mortality) concentrations of 2,610 and 2,460, respectively (Elonen *et al.*, 1998).

Effects of TCDD exposure on early life stages of mammals and birds are similar to the effects on fish; the effects include delayed mortality, a "wasting" syndrome characterized by reduced food intake and reduced BW, reproductive toxicity, histopathological alterations, developmental abnormalities, and immunosuppression (USEPA, 1993b). Several long-term feeding studies have been conducted using a variety of bird species; information on the two most relevant studies with chickens and ring-necked pheasants is summarized in Table 4-6. This table also summarizes the most relevant mammalian chronic feeding studies available for TCDD and Table 4-7 summarizes the available LD_{50}[15] study results for various mammal species. The guinea pig appears to be the most sensitive mammal (USEPA, 1993b), with the mink also known to be

[14] The lethal concentration 50 is the concentration measured in egg tissue that was found to be lethal to 50% of a given test population.
[15] The lethal dose 50 is the dietary dose that was found to be lethal to 50% of the test population.

particularly sensitive to dioxin and PCBs (Aulerich and Ringer, 1977; Aulerich *et al*., 1985; Restum *et al*., 1998; Tillitt *et al*., 1996). Table 4-8 summarizes laboratory and field studies that analyzed TCDD or TCDD TEQ in avian eggs along with ecologically meaningful effects. Similar to fish, the sensitivity of bird species to exposure to TCDD in the embryonic stage is quite variable (Gilbertson *et al*., 1991; USEPA, 1993b, 2003b; Hoffman *et al*., 1996).

4.1.3 Conceptual Site Model

An overall project CSM is a multidisciplinary tool that serves a critical role in risk assessment, numerical modeling development, project and sample planning, decision making, and ultimately in developing a remedial strategy. The CSM is developed during the first step of the DQO process (USEPA, 2006) and continues to evolve throughout a project as historical and recently collected data are evaluated, DQOs are updated, and risk assessments are refined. The ecological CSM is a component of the overall project CSM that details how ecological exposures could occur and guides the risk assessment. Typical risk assessment components of a CSM include the following:

- Potential source of contamination
- Potentially contaminated media and types of contaminants
- Contaminant fate and transport mechanisms and migration pathways
- Potential exposure pathways
- Potential human and ecological receptors.

The CSM for the Lower Passaic River covers the lower 17 miles of the river, from the Dundee Dam to the confluence with Newark Bay (see Section 6 of the RI). The RI provides a thorough understanding of potential sources of contamination, potentially contaminated media and types of contaminants and contaminant fate and transport mechanisms and migration pathways. Further development of the CSM is anticipated as part of the RI/FS process for the 17-mile Lower Passaic River.

The PAR and a subsequent technical memorandum (Battelle, 2005, 2006) provide details regarding chemical stressors and potential sources, the selection of COPECs, potential receptors, and potential exposure pathways. The complete exposure pathways identified in the PAR are:

- Direct contact with contaminated surface water and/or sediment
- Ingestion of contaminated sediment, surface water and biological tissue
- Inhalation of contaminated air.

Surface water quality data were recently collected by the CPG for the 17-mile LPRSA RI/FS; therefore, risks from exposure to contaminated surface water will be evaluated in the 17-mile RI/FS BERA. A determination regarding whether inhalation exposures by ecological receptors needs to be evaluated will also be made during the conduct of the BERA for the 17-mile LPRSA RI/FS. As a result, the focus of this BERA is on sediment-borne contaminants in the FFS Study Area and the incidental ingestion of contaminated sediment and, due to the propensity of most of the COPECs selected to bioaccumulate, biological tissue that has accumulated contaminants through association with those sediments. The current ecological CSM for the FFS Study Area is presented in Figure 4-1.

Many types of ecological receptors are potentially at risk due to direct or indirect exposure to COPECs in the FFS Study Area, including plants (*e.g.*, phytoplankton), benthic invertebrates, fish, and a variety of aquatic-dependent avian and mammalian predator species (Figure 4-1). Table 4-9 summarizes the selected indicator species for each receptor category and the principal exposure pathways of concern evaluated in this BERA.

Risks to benthic invertebrates were evaluated for both the infaunal macroinvertebrate community (invertebrates that live *in* the sediment) and epibenthic invertebrates (invertebrates that live *on* the sediment). Invertebrates that live in the sediment were evaluated through sediment chemistry data. The blue crab (*Callinectes sapidus*), which is abundant throughout the FFS Study Area, was selected to represent the epibenthic invertebrates.

Both demersal (near-bottom) forage and piscivorous fish were evaluated in the BERA. The common mummichog[16] (*Fundulus heteroclitus*) was selected as a conservative surrogate to represent and evaluate risk to demersal forage fish. They are relatively common in the area and provide a forage food base for both piscivorous fish species (*e.g*., striped bass [*Morone saxatilis*], white perch [*M. americana*]) as well as upper-trophic-level wildlife species. A number of fish species were collected as part of the CPG fish sampling program (Windward Environmental, 2011a) including American eel (*Anguilla rostrata*), brown bullhead (*Ameiurus nebulosus*), common carp (*Cyprinus carpio*), smallmouth bass (*Micropterus dolomieu*), white catfish (*Ictalurus catus*), white perch and white sucker (*Catostomus commersonii*). These species are representative of the primary piscivorous and omnivorous life histories characteristic of the Lower Passaic River and in combination (referred to as *generic fish*) were used in the BERA to evaluate exposures and characterize potential risks to the non-forage components of the fish community as well as the potential bioaccumulation hazards to aquatic-dependent piscivorous birds and mammals.

Aquatic-dependent birds and mammals were evaluated in the BERA. The great blue heron (*Ardea herodias*) was selected as a conservative surrogate for the aquatic-dependent bird population, because it is known as a resident bird species that is anticipated to receive substantial exposures to contaminants which can bioaccumulate in aquatic food webs. The American mink (*Neovison vison*) is a possible resident species and was selected as a conservative surrogate for the aquatic-dependent mammals, because it is known to be sensitive to reproductive effects following exposure to compounds such as dioxin, furans and PCBs.

Sediment-probing birds, amphibians, and reptiles were not selected as receptors of concern for this assessment. Although nonpiscivorous bird species may be exposed to elevated exposures to sediment-borne contaminants via the incidental ingestion of sediment during foraging activities, piscivorous species (e.g., great blue heron, herring gull [*Larus argentatus*]) most likely receive higher doses as a result of dietary exposures and can be considered conservative surrogate species in the BERA. The presence of amphibians and reptiles is not well documented in the

[16] In addition to the mummichog, the presence of both the banded killifish (*F. diaphanous*) and striped killifish (*F. majalis*) were documented during the fish community survey conducted in 2010 (Windward Environmental, 2011a).

FFS Study Area and there appears to be little viable habitat to support this ecological group. A subset of ecological receptors within the FFS Study Area, including zooplankton, phytoplankton, and fish species and life stages that are primarily pelagic (water column) foragers, are not benthically-coupled[17] and, hence, are not directly exposed to sediments. The potential exposure and risks to these organisms were not evaluated in the BERA due to the exclusion of the surface water medium from this analysis. A more comprehensive analysis of the entire set of ecological receptors likely to be exposed will be conducted as part of the BERA for the 17-mile LPRSA RI/FS.

4.1.4 Selection of Assessment Endpoints

Assessment endpoints are explicit expressions of the environmental components that are selected for evaluation to ensure that the focus of the analysis is consistent with general management concerns (USEPA, 1998). Based on the identified COPECs along with their expected fate and transport within estuarine environments (particularly their bioaccumulation potential) and the ecotoxicological understanding of the relative sensitivities of receptors of concern (and especially early life stages), the following five assessment endpoints (AEs) were selected for evaluation in the BERA:

- AE(1): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of benthic macroinvertebrate communities that serve as a forage base for fish and wildlife populations
- AE(2): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of demersal, benthinvertivorous fish populations that serve as a forage base for fish and wildlife populations
- AE(3): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of piscivorous, or semi-piscivorous fish populations that serve as a forage base for wildlife populations or sports fishery
- AE(4): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of aquatic-feeding bird populations

[17] Organisms that include in their diet prey associated with benthic or epibenthic (*i.e.*, lying on the sediment surface) habitat, at least in part.

- AE(5): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of piscivorous mammal populations.

These AEs are summarized in Table 4-10; this table also presents testable hypotheses (risk questions) that link COPEC exposures and ecotoxicological data comparisons (as defined by selected measurement endpoints or "measures of effect") to the AEs.

4.1.5 Selected Measures of Effect

Consideration of the magnitude of the benchmark exceedances presented during selection of COPECs (Attachment 2) resulted in a determination that the objectives of this BERA could be met without waiting for the site-specific information currently being collected and evaluated for the BERA for the 17-mile LPRSA RI/FS. As a result, the following three general categories of toxicological data (*i.e.*, measures of effect) were selected to evaluate the AEs and address the risk questions (Table 4-10):

- <u>Sediment benchmarks</u> – used to evaluate direct contact exposures to sediment by benthic macroinvertebrates and fish
- <u>Critical Body Residues</u> – used to estimate the toxicological effects associated with bioaccumulated tissue residues measured or estimated in benthic macroinvertebrates and fish; given the particular sensitivity of early life stages, measures of effect related to exceedance of CBRs by fish and bird embryonic exposures were also selected
- <u>Toxicity Reference Values</u> – used to estimate toxicological effects associated with contaminant exposure experienced by wildlife associated with the incidental sediment ingestion and contaminated prey consumption pathways.

These categories of ecotoxicological benchmark values reflect the primary exposure concerns identified in the CSM related to direct contact with sediment, the migration of sediment-borne COPECs into the estuarine food web, and subsequent internal (*i.e.*, residues) and external (*i.e.*, prey) exposures experienced by higher trophic level organisms.

4.2 Ecological Exposure Assessment

Available data for COPEC concentrations in environmental media (including sediment and biological tissue) are evaluated and summarized in the exposure assessment. The assessment yields an exposure profile that describes the magnitude and distribution of COPECs across different media considering both temporal and spatial aspects. As discussed in the problem formulation, this BERA focused on a subset of chemical stressors that are anticipated to contribute the majority of risks to aquatic receptors within the FFS Study Area.

Chemical properties that contributed to the selection of specific contaminants as COPECs include environmental persistence, bioaccumulation potential and bioavailability. With the possible exception of LMW PAHs, all COPECs are expected to persist in the environment for relatively long periods of time and relative bioaccumulation potential was an explicit criterion used in selecting COPECs. Organochlorine pesticides (including total DDx and dieldrin), total PCBs and D/F are known to bioaccumulate in aquatic environments; this is also true for methylmercury. With the class of PCB and D/F compounds, chemical properties such as the degree of chlorination can affect the bioavailability and toxicity. Copper and lead have a lower tendency to bioaccumulate as do PAHs; although HMW PAHs includes compounds with relatively large octanol-water partition coefficients, they are metabolized in many organisms including fish and wildlife and do not tend to accumulate in tissues. A variety of chemical characteristics (*e.g.*, K_{ow}, Eh) and habitat attributes (*e.g.*, fraction organic matter in sediments, presence of ligands, alkalinity, porewater pH, and salinity) are important in determining the bioavailability of sediment-borne contaminants.

An understanding of the degree of spatial/temporal variability affecting ecological exposures is also critical. As discussed in the RI, physico-chemical gradients that are typical of estuarine environments influence contaminant bioavailability. These gradients tend to vary both spatially throughout the estuary and on various time scales ranging from the daily tide cycle, across seasons and, depending on the magnitude of the monthly tidal effect and degree of freshwater inputs, episodically across years. These patterns intersect with species- and life-stage-specific patterns related to specific habitat and forage (prey) requirements as well as intra- and inter-specific competitive interactions.

Results of previous benthic macroinvertebrate studies (Tierra Solutions, Inc., 2002; Aqua Survey, Inc., 2005; Germano & Associates, Inc., 2005) provide data important in understanding the potential impacts of spatial and temporal variability on the structure of the benthic community. Characterizations of the benthic macroinvertebrate community structure within the estuarine portion of the Lower Passaic River conducted in 2000 (Tierra Solutions, Inc., 2002) and 2005 (Germano & Associates, Inc., 2005), found generally low diversity, abundance and localized spatial heterogeneity that was attributed in part to the relative instability and temporal variability of these sediments. The sediment profile imaging (SPI) study results for the FFS Study Area (Aqua Survey, 2005; Germano & Associates, Inc., 2005) indicate that the benthic macroinvertebrate community is dominated by just one or two taxa (oligochaetes and polychaetes in most cases, with the former representing up to 100% of the numerical counts). The study determined that the apparent successional status of the benthic community was Stage I[18] for all sampling stations with considerable variability in community parameters (such as the number and types of species and organisms per species) throughout the FFS Study Area as well as within individual cross-river transects. The authors concluded that the estuarine benthos in the river exists in a state of flux due to substrate instability and the community is continuously at risk of being buried by newly deposited sediments (Aqua Survey, Inc., 2005; Germano & Associates, 2005).

The depth of the surficial sediment zone that contains the majority of benthos is determined by a variety of interactive biological and physical factors (Rosenberg, 2001; Clarke *et al*., 2001). In estuarine environments, polychaetes, crustaceans (including amphipods) and bivalves utilize the available sediment substrate differently, in part depending on foraging requirements and adaptive behaviors. Physico-chemical properties (including stability, geochemistry and redox conditions) also affect the thickness of the biologically active zone (BAZ). The BAZ is defined as the layer extending from the sediment surface downward to a maximum depth where biological activity

[18] Successional Stage I communities are represented by smaller-bodied, shallow-dwelling, pioneer species that are the first to colonize sediment following physical disturbance (Rosenberg, 2001).

(*e.g.*, burrows or feeding voids) is observed. For the BERA, site-specific empirical evidence was used to establish the vertical extent of current sediment exposures and determine the subset of available data used to estimate the sediment EPCs. Diaz, R., and Arcadis (2008) collected sediment data at 14 locations throughout Newark Bay, including samples from intertidal, subtidal and channel geomorphic units, and estimated the BAZ from measurements of SPI and benthic macroinvertebrate grab samples. The estimated BAZ depths were reported to be relatively consistent across the geomorphic units, with averages ranging from 13.7 cm (subtidal) to 16.4 cm (channel) (*i.e.*, 5.4 to 6.5 inches). The SPI results for Newark Bay and the FFS Study Area demonstrate strong similarities in community structure as well as depth of typical biological activity.

Various researchers have demonstrated that the BAZ depth is often correlated with successional status, with deeper burrowing organisms being associated with more diverse and stable communities typical of later successional stages or found along water depth/hydrological gradients associated with most stable conditions (Pearson and Rosenberg, 1978; Rosenberg, 2001); the benthic fauna identified in the FFS Study Area is characteristic of other shallow estuarine habitats along the U.S. Atlantic coast that are routinely disturbed (Santos and Simon, 1980; Probert, 1984; Zajac and Whitlatch, 1982). These studies are also consistent with a literature summary of bioturbation zone depths (Clarke *et al*., 2001) compiled to assess sediment cap thickness necessary to avoid bioturbation effects, which concluded that the depth of the surficial zone of mixing in coastal silt/clays substrates ranges from 10 to 15 cm (4 to 6 inches) and just 10 cm for sands. Based on this analysis, sediment exposures experienced by ecological receptors were assumed to be limited to 0 to 6 inches below sediment surface and only samples collected within this interval were included in the sediment dataset and evaluated in the BERA (Attachment 1).

4.2.1 Ecological Exposure Areas

The FFS Study Area is characterized by substantial temporal and spatial variability of important physico-chemical factors, such as salinity, temperature, substrate composition and stability. Nonetheless, for the purposes of this BERA, the entire FFS Study Area was considered a single exposure point for a majority of the evaluated receptors. A subset of the aquatic environment that is periodically exposed during low tide (*i.e.*, mudflats or "shoals") was also considered as a second exposure point for the sediment medium because some ecological receptors occur primarily in this habitat. For the purposes of estimating ecological exposures in this BERA, all surficial (*i.e.*, 0 to 6 inches) sediment samples collected throughout the FFS Study Area as part of the RI for the 17-mile Lower Passaic River were used to develop EPCs. In addition, a subset of the sediment data (*i.e.*, 17 sediment samples collected between 2009 and 2011 [Attachment 1]) was selected to evaluate exposures for receptors that are only expected to come into contact with mudflat sediment. The number of available mudflat sediment samples is limited, resulting in relatively greater uncertainties in the quantification of EPCs for this exposure area.

Benthic infauna are sedentary and unlikely to experience exposure outside of a small area; exposures were evaluated for both those typical of mudflat sediments as well as those throughout the FFS Study Area. The great blue heron is a wading bird that feeds on forage fish in mudflat areas, and is likely only exposed to mudflat sediments. The American mink feeds in shallow areas as well, but tend to consume larger predatory fish that are exposed to sediment throughout the FFS Study Area. Because incidental sediment ingestion by mink would include sediment entrained in the gut of prey items as well as mudflat sediment, exposure averages for the entire FFS Study Area are more appropriate. To the extent that herons feed on larger nonforage fish, the use of the sediment EPCs from the entire FFS Study Area to estimate great blue heron exposures associated with the incidental sediment ingestion pathway for the "generic" fish scenario is reasonable.

Although intertidal habitat is fairly limited within the FFS Study Area, it does present a distinctive environment that is utilized by representatives of the different categories of ecological receptors (or in some cases by particular life stages). The mummichog is an example of a species that could be considered a specialist of this type of habitat – utilizing the flooded mudflats during high tide and then retreating farther from the bank or entering tidal tributaries during low tide. A variety of foraging bird species will preferentially forage in intertidal areas. Consequently, exposures to both the entire FFS Study Area as well as the intertidal mudflats were evaluated in the BERA (Table 4-9). The nature and extent section of the RI (Chapter 4) analyzed the spatial distribution of chemicals in surficial sediments and determined that no statistical differences between channel and shoal areas exist for the majority of COPECs[19].

No other stratification of sediment exposures was deemed necessary to meet the objectives of this BERA. As discussed in the RI, extensive tidal mixing results in recently deposited sediments throughout the FFS Study Area having similar concentrations of contaminants (*i.e.*, sediments are well homogenized prior to deposition). Thus, the presence or absence of an interval of high concentration within the sediments at a given location is a function of the depositional history at that location and is generally not controlled by proximity to source. As a result, thick sequences of contaminated sediments will tend to have similar inventories of contaminants regardless of their location in the river. The coring data collected to estimate sediment contaminant inventories exhibit a high degree of local spatial heterogeneity, indicating that localized areas of relatively higher concentrations typically described as “hot spots” do not exist. Instead, “hot” regions of the river typically exist on the scale of a mile or more, nearly bank to bank in lateral extent.

4.2.2 Exposure Point Concentrations

Baseline EPCs evaluated for all media (both abiotic and biotic) were calculated as the 95% UCL of the arithmetic means of the available data[20]. The EPCs used in this assessment are presented in Table 4-1. Section 2 describes the analytical dataset collected by the CPG in 2010 and 2012 as part of the 17-mile LPRSA RI/FS that was used to estimate ecological exposures. Summary statistics for the COPECs in sediment and biological tissue are provided in Attachment 3 and calculated 95% UCLs on the arithmetic mean are summarized in Table 4-1.

As with the HHRA (Section 3), the KM estimator was employed (the KM method is currently a default method used in USEPA’s ProUCL software for calculating the 95% UCL of the mean for data with one or more censored results). Use of this KM method rather than the substitution

[19] The RI evaluation did determine that average concentrations of total DDx, dieldrin and some PAHs were lower (by up to 50%) in RM0 – RM2 shoals compared to channel sediments.

[20] Sedentary infaunal benthos do not integrate sediment exposures as do more mobile receptors such as fish and wildlife and as a result, the exposures (and risks) encountered by this group may not be fully characterized using a single EPC based on the 95% UCL. Attachment 7 includes an assessment of the effects of spatial variability in contaminant concentrations within the FFS Study Area for each receptor group.

method (*e.g.*, substitution of zero, one-half the detection limit or the detection limit for nondetect values) most likely limits an overestimation of the EPC. Also consistent with the HHRA, the following TEQ calculations were performed for D/F and coplanar (dioxin-like) PCB congeners:

- TCDD TEQ for D/F – sum of the products of the congener concentration and congener-specific TEFs[21] (Table 2-1) for all D/F congeners
- TCDD TEQ for PCB coplanar congeners – sum of the products of the congener concentration and their TEFs (Table 2-1) for 12 coplanar PCB compounds (*i.e.*, the WHO congeners)
- Total TCDD TEQ – the sum of the above two results.

To support the various ecological exposure evaluations, TEQ calculations were conducted using TEFs for fish, birds and mammals; the receptor-specific TEQs were used as follows:

- TEQs based on fish TEFs were used to support the residue-based analysis for adult and embryonic fish
- TEQs based on bird TEFs were used to support the residue-based analysis of avian embryos and the dose-based assessment of adult heron
- TEQs based on mammal TEFs were used to support the dose-based analysis of adult mink.

Benthic Invertebrates

EPCs were derived using blue crab tissue data designated as composited whole and all edible tissue fractions as identified in Attachment 1.

Adult Fish

Two sets of fish EPCs (for the mummichog and generic fish categories) were used so that potential trophic level (*i.e.*, piscivorous versus forage) could be considered in the BERA. In addition, inclusion of forage fish which are typically found in shoal rather than a channel environment provides a more realistic estimate of dietary exposures to wading birds such as the heron that was modeled in this assessment. The generic fish category was used in the BERA to

[21] The consensus TEF values published in 2005 by the WHO and recommended by USEPA (2010a) are used in the risk evaluations.

evaluate potential bioaccumulation hazards to the various piscivorous and omnivorous fish species that utilize the Lower Passaic River for at least part of their life cycle as well as aquatic-dependent wildlife that rely on this resource.

The EPCs for mummichog tissue were calculated using composited whole body mummichog tissue samples. For the generic fish category, EPCs were calculated using whole body tissue data for multiple fish species samples including American eel, white perch, white catfish, brown bullhead, common carp, smallmouth bass and white sucker. The dataset includes both whole body and reconstituted whole body results; the latter derived as the sum of mass-adjusted COPEC estimates of fillet and viscera (carcass) fractions. Specific samples used in developing EPCs for COPECs in adult fish tissue are summarized in Attachment 1.

4.2.3 Modeled Tissue Residues

Embryos are known to be particularly sensitive to contaminant exposure including a majority of the selected COPECs. Site-specific egg residue data are not available to evaluate this endpoint so fish and avian egg tissue concentrations were estimated by applying uptake factors to adult fish tissue concentrations to model transfer from either maternal (fish egg analysis) or fish prey (piscivorous bird egg analysis). This evaluation was limited by the availability of appropriate transfer factors and toxicological benchmarks for some COPECs. The toxicological data for egg residues is limited to D/F compounds, PCBs, and a few pesticide compounds. The lack of appropriate fish-to-egg transfer factors for some COPECs results in the potential risks to this life stage being underestimated, as discussed in Section 4.5.

For both fish and avian eggs, the fish tissue EPCs were multiplied by biological magnification factors (BMFs) to estimate the corresponding egg concentrations of either fish or herring gull eggs (depending on the BMF value used) as shown in Equation 4-2:

$$C_{eggnorm} = C_{fishnorm} * BMF \qquad (4\text{-}2)$$

where

$C_{eggnorm}$	=	lipid-normalized egg tissue concentration (µg/g $_{egg\ lipid}$)
$C_{fishnorm}$	=	lipid-normalized fish tissue concentration (µg/g $_{fish\ lipid}$)
BMF	=	biological magnification factor (g $_{fish\ lipid}$/g $_{egg\ lipid}$).

The fish EPCs were lipid normalized using the average lipid content of Lower Passaic River American eel and white perch (*i.e.*, 5.9%) or mummichogs (*i.e.,* 1.9%), depending upon the specific receptor or prey tissue of interest.

Fish Eggs

Fish eggs exhibit great sensitivity to dioxins and coplanar PCBs with LOAEL values as low as 50 ng/kg and the dose lethal to 50% of the test population (lethal dose 50 or LD_{50}) values as low as 58 ng/kg based on subsequent effects on hatched fry. This degree of sensitivity highlights the importance of the transovarial exposure route (USEPA, 1993b). BMFs based on the ratio of lipid-normalized D/F and PCB congeners in lake trout eggs to maternal fish tissue concentrations (Cook *et al*., 2003) was used to estimate COPEC concentrations in FFS Study Area generic fish and mummichog eggs from FFS Study Area fish tissue concentrations using Equation 4-2. The average lipid content in lake trout eggs (8.2%) reported in Cook *et al.* (2003) was used to normalize the fish egg tissue concentrations to calculate the BMFs. The estimated fish egg tissue concentrations from Equation 4-2 (presented in Tables 5-1 [generic fish] and 5-2 [mummichog] in Attachment 5) were compared to embryo-based CBRs (discussed in Section 4.3.2).

Avian Eggs

The embryo is also the avian life stage most sensitive to dioxin-like effects (Gilbertson *et al*., 1991; USEPA, 1993b, 2003b; Hoffman *et al*., 1996) and avian embryo viability was also selected as an AE for this study. Since site-specific embryo tissue residue data are not available for the FFS Study Area, a study analyzing D/F and PCB congeners and various organochlorine pesticide concentrations in herring gull whole body, liver, and egg tissue (Braune and Norstrom, 1989) was used to estimate organochlorine COPEC concentrations in piscivorous bird eggs. Lipid-normalized gull egg/alewife tissue BMFs were derived using results provided in Braune and Norstrom (1989); calculated values are provided in Attachment 5 (Table 5-3). The lipid content in herring gull eggs (7.7%) reported in Braune and Norstrom (1989) was used to normalize the avian egg tissue concentrations to calculate BMFs. The estimated FFS Study Area avian egg tissue concentrations from Equation 4-2 (presented in Table 5-4 in Attachment 5) were compared to embryo-based CBRs.

Parsons (2003) measured chemical residues in cormorants (*Phalacrocorax auritus*) nesting in the greater New York Harbor area, which included sampling locations on Shooter's Island in the southern portion of Newark Bay. The majority of D/F congeners were detected in all cormorant eggs from Shooter's Island collected in 1999. In comparison to the estimated FFS Study Area gull egg tissue concentration for 2,3,7,8-TCDD (0.0023 µg/g, Table 5-4 in Attachment 5) the maximum detected concentration from the Shooter's Island samples (0.000201 µg/g) is approximately an order of magnitude less. Maximum detected concentrations of PCBs 77, 81, and 126, which are among the most toxic to birds, in the Shooter's Island samples were 0.000040, 0.000040, and 0.000070 µg/g, respectively; estimated egg tissue concentrations of PCBs 77, 81, and 126 in eggs of gulls feeding entirely in the Lower Passaic River are 0.0012, 0.00015, and 0.00028 µg/g, respectively (Table 5-4 in Attachment 5). Higher concentrations in the Passaic River samples would be expected and these comparisons suggest that the modeling approach described above is consistent with available empirical data.

4.2.4 Wildlife Dose Model

Exposure models were developed for both the heron and mink receptors to estimate the daily intake rate of each COPEC; each model incorporated natural history information and species characteristics, such as diet composition, IRs, BWs, and foraging ranges. Equation 4-3 is the dose model used to estimate daily exposures by upper-trophic-level wildlife receptors (*i.e.*, great blue heron and mink) to each COPEC:

$$\text{Dose} = \frac{[(C_{sed} \times IR_{sed}) + (C_{food} \times IR_{food})] * EF * SUF}{BW} \quad (4\text{-}3)$$

where

Dose = daily dose resulting from ingestion of sediment and food (mg/kg-day)

C_{sed} = concentration of COPEC in surface sediment (mg/kg)

IR_{sed} = estimate of receptor's daily ingestion rate of surface sediment (kg/day)

C_{food} = concentration of COPEC in food tissue (mg/kg)

IR_{food} = estimate of daily ingestion rate of food tissue (kg/day)

EF = exposure frequency (unitless)

SUF = site use factor (unitless)

BW = body weight (kg)

The dietary exposure parameters for the mink and great blue heron are summarized in Table 4-11. In general, wildlife exposure parameters were obtained from the USEPA "Wildlife Exposure Factors Handbook" (1993a).

Great Blue Heron

Literature values for home range, ED (*i.e*., the number days per year that a typical individual is likely to occur in the general vicinity of the study area) and BW were used to estimate the site use factor (SUF), EF, and BW input parameters, respectively. The SUF was assumed to be 1 based on published data on feeding territory size of a freshwater heron rookery in Oregon (*i.e*., 0.6 hectares [USEPA, 1993a]). Based on data presented in USEPA (1993a) along with review of the Lower Passaic River avian surveys conducted in 2010 (summer and fall) and 2011 (winter and spring) (Windward, 2011b, 2012), the typical heron was assumed to forage at the FFS Study Area for 213 days (*i.e*., EF = 58%) of the year, migrating south in October and returning to New Jersey between February and April. However, the winter/spring avian survey did include documentation of six separate great blue heron sightings (although the timeline and locations of the records suggested that only a single individual may have been involved) in the Lower Passaic River during Winter 2011.

The percentage of different prey in the typical heron diet was presumed to consist of 85% fish and 15% macroinvertebrates with an additional 5% of the daily food IR assumed to consist of surficial sediment incidentally consumed during foraging activities. A regression relationship between the BWs of various wading birds and their daily food IR (Kushlan, 1978) was used to estimate the daily IRs for food and sediment (IR_{food} and IR_{sed}, respectively).

The 95% UCLs on the arithmetic mean COPEC concentrations in environmental media (*i.e.*, sediment, macroinvertebrates and fish) were used to parameterize the C_{sed} and C_{food} concentration terms. C_{food} was estimated as the sum of the two prey fractions multiplied by the respective EPCs for macroinvertebrates and fish. As discussed above, it is possible that some herons remain at the FFS Study Area year-round although most individuals are expected to migrate south for the winter. Thus, both "visitor" and "resident" heron exposure scenarios were evaluated. Finally, two exposure scenarios were evaluated for the great blue heron based on exposure to non-specific fish prey tissue (*i.e.*, "generic") and mummichogs. The incidental sediment ingestion pathway for these two exposure scenarios was quantified using the entire FFS Study Area (termed "entire") and "mudflat" sediment EPCs, respectively. The resulting FFS Study Area dose from Equation 4-3 was compared to TRVs (discussed in Section 4.3.2).

Mink

Similar to the avian exposure model, literature values for home range, ED and BW were used to estimate the SUF, EF, and BW input parameters for the mink receptor, respectively. The SUF term was assumed to be 1 based on published home range data for adult females in a heavily vegetated riverine habitat in Montana (*i.e.*, 8 hectares [Mitchell, 1961]); resident minks were assumed to actively forage throughout the year in the Lower Passaic River (*i.e.*, EF = 1).

The percentage of different prey in the mink diet was assumed to consist of 80% fish and 20% macroinvertebrates with an additional 2% of the daily food IR assumed to consist of surficial sediment incidentally consumed during foraging activities. A regression relationship between the BWs of various mammals and their daily food IR (USEPA, 1993a) was used to estimate the daily IRs for food and sediment (IR_{food} and IR_{sed}, respectively).

The 95% UCLs on the arithmetic mean COPEC concentrations in environmental media (*i.e.*, sediment, macroinvertebrates and fish) were used to parameterize the C_{sed} and C_{food} concentration terms. C_{food} was estimated as the sum of the two prey fractions multiplied by the respective EPCs for macroinvertebrates (blue crab) and fish ("generic"). The resulting FFS Study Area dose from Equation 4-3 was compared to TRVs.

4.3 Ecological Effects Assessment

The ecological effects assessment evaluates available ecotoxicological data, including data sources and data types, and identifies ecological effects concentrations that are media-, receptor- and COPEC-specific. The ecotoxicological data represent a major component of the stressor-response profiles, describing the relationship between ecological stressors and effects.

4.3.1 Effects Data Evaluation

In this section, the sources and types of effects data selected for use in the BERA are described and the rationale for their selection is presented. The effects data (*i.e.*, measurement endpoints) were selected based on relevance to the assessment endpoints described in Section 4.1.4, which are all focused on the population level consequences of COPEC exposure resulting in reduced survival, growth or reproduction of receptors of concern. As discussed previously, site-specific toxicity data[22] were not generally utilized in this BERA and consequently, the effects data were derived from published literature that described the biological responses to COPEC exposure in either the field or laboratory settings.

4.3.2 Stressor-Response Profiles

Stressor-response profiles are used to understand the relationship between stressors and ecological responses (USEPA, 1998) and depend on the objectives of the risk assessment. For each of the three categories of effects data, this BERA relied on identifying two point estimate values for each combination of COPEC (chemical stressor) and receptor. The toxicity summaries presented in Section 4.1 provides general information on the types of ecological effects and relative sensitivities of different receptors.

The lower and upper values were used to establish lower- and upper-bound risk estimates for the effects thresholds. For the sediment benchmarks, percentiles (*e.g.*, 20th/50th and 10th/50th) were selected from compiled toxicity or field community effects data to bound the estimated

[22] The sole exception is the use of oyster reproductive effects data to evaluate the bioaccumulation hazard posed by 2,3,7,8-TCDD to macroinvertebrates, as discussed in Section 4.3.2.

effects concentration relevant to drawing conclusions regarding AE #1. For the other two categories of measurement endpoint results (*i.e*., residue- and dose-based assessments), NOAEL and LOAEL estimates were identified for each medium, COPEC and receptor type evaluated. Details on the identification of lower- and upper-bound point estimates for each of the three categories of measurement endpoints are provided below.

Sediment Benchmarks

The primary source of sediment benchmarks used in the BERA to evaluate direct contact exposures to benthic macroinvertebrates was a USEPA study of marine macroinvertebrate survival in laboratories after exposure to field-collected sediments with a range of contaminant levels from various benthic habitats in coastal North America (USEPA, 2005d). The study used regression models to quantify the relationship between COPEC concentrations in field-collected sediments and the toxicity classification (*i.e*., toxic or not) determined using laboratory toxicity tests with two species of marine amphipod (*Rhepoxynius abronius* and *Ampelisca abdita*). The regression models were derived from a large database of paired sediment chemistry and toxicity (*i.e*., measured survival following 10-day laboratory exposure) data. Chemical concentrations corresponding to a 20% and 50% probability of observing toxicity (termed T20 and T50 models, respectively) were selected to provide lower- and upper-bound sediment benchmarks for the BERA. The study determined that the magnitude of the toxic effect (*i.e*., decreased survival) predicted by the models was strongly correlated with the predicted probability of toxicity. The study provided T20 and T50 values for copper, lead, mercury, dieldrin and Total PCBs for use in the BERA as sediment benchmarks.

For those COPECs lacking T20/T50 logistic regression models, National Oceanic and Atmospheric Administration [NOAA] effects range-low (ER-L) and effects range-median (ER-M) values were used to identify a range of contaminant concentrations over which an adverse toxicological response is increasingly likely to occur. Both values were derived from a database of estuarine and marine toxicity studies reporting various adverse effect endpoints compiled by Long *et al.* (1995). ER-L and ER-M values were selected as lower- and upper-bound sediment benchmarks for LMW PAHs, HMW PAHs and Total DDx. Finally, the U.S. Fish and Wildlife Service (Kubiak *et al*., 2007) developed a sediment benchmark for 2,3,7,8-TCDD based on sediment and suspended solids analytical data collected from the Arthur Kill and oyster effect data presented in Wintermyer and Cooper (2003). Per USEPA (1997) guidance, use of site-specific effects data in the BERA is preferred when available over generic benchmarks. The oyster is an appropriate endpoint species as its occurrence in the FFS Study Area has recently been documented (Windward Environmental, 2010b) and was historically an important resource. The sediment benchmarks used in the analysis are summarized in Table 4-12.

The potential toxicity of sediment associated-PAH compounds to fish receptors has been the subject of considerable scientific study over the last several decades (Douben, 2003; Hylland, 2006; Barron, 2007). Various difficulties are associated with establishing sediment protective concentrations for these compounds for fish receptors, including a range of physicochemical properties (affecting both bioavailability and pharmacokinetics within organisms) and the nature of the adverse effects, for which early life stages are most sensitive (Barron *et al*., 2004). In addition, for some effects, such as tumor development, relatively long periods of time may separate the significant exposure period and the effect (Landahl *et al*., 1990; Myers *et al*., 2003). Moreover, in the majority of fish species, which are capable of rapidly metabolizing PAHs, the etiological agents are degradation products of metabolic pathways rather than the parent compound measured in abiotic media (Leadly *et al*., 1999; Schanke *et al*., 2001; Incardona *et al*., 2006). Some of these daughter compounds are known to form DNA adducts that can result in a range of genotoxic responses in exposed individuals.

Based on work with English sole (*Pleuronectes vetulus*) and supported by work with other fish including winter flounder (*Pseudopleuronectes americanus*), brown bullhead (*Ameirus nebulous*), and mummichogs, total PAH concentrations in sediment of 1 µg/g represent a threshold for adverse effects to estuarine fish species (Horness *et al*., 1998; Johnson *et al*., 2002). Concentrations above this threshold are significantly correlated with measures of reduced embryonic growth and female fish fertility, along with increases in direct damage to the DNA molecule and incidence of liver tumors. This sediment threshold concentration is comparable to the NOAA ER-L values for LMW PAHs and HMW PAHs (0.55 and 1.7 µg/g, respectively).

Critical Body Residues (CBRs)

Modeled FFS Study Area tissue residues described in Section 4.2.3 were compared to CBRs to evaluate whether exposure to FFS Study Area contaminant levels is likely to cause adverse effects. In general, a CBR is a contaminant- and taxon-specific threshold concentration measured in biological tissue above which adverse effects of ecological relevance would be anticipated to occur. This residue-based approach to evaluating risk provides a number of distinct advantages over the exposure-based approach, such as the explicit consideration of contaminant bioavailability and metabolism (McCarty and MacKay, 1993). CBRs are summarized in Table 4-13 and details of their derivation are presented in Table 6-1 (Attachment 6).

Details regarding the selection of CBRs for the COPECs used to estimate residue-based risks to invertebrates and fish, as well as fish and bird embryos are provided in Table 6-1 (Attachment 6); the discussion includes a rationale for application of extrapolation factors where deemed appropriate.

Copper. Absil *et al*. (1996) evaluated survival of sediment-dwelling bivalves (*Macoma balthica*) following a 40 day exposure to dissolved copper. The LOAEL (12 µg copper/g ww tissue) was based on a treatment associated with a mean cumulative mortality of 46% in exposed clams whereas no deaths were observed in the lowest (5 µg copper/g ww tissue) treatment level.

Exposure for 24 hours to 10 parts per million (ppm) copper was acutely toxic (Zyadeh and Abdel-Baky, 2000) to striped mullet (*Mugil cephalus*), and a five-fold acute to chronic (A-C) extrapolation factor was applied because of the short ED. Extrapolation factors are typically applied to effects concentrations in situations where longer exposure to lower concentrations could potentially result in effects or when a low effects concentration has been identified but a no effects concentration has not. The resulting NOAEL and LOAEL CBRs are 0.32 and 1.5 µg copper/g ww tissue.

No CBR was developed for fish and avian early life stages because embryonic exposures could not be reliably estimated for these receptor categories.

Lead. The macroinvertebrate CBRs are based on a 4-week survival study using the freshwater amphipod, *Hyallela azteca* (Borgmann and Norwood, 1999). The selected test endpoint (*i.e.*, LC_{25}) was converted to an equivalent wet weight mass concentration and adjusted using both a two-fold interspecies (IS) and a five-fold A-C EF to account for potentially more sensitive species and length of the study, respectively.

Holcombe *et al*. (1979) exposed brook trout (*Salvelinus fontinalis*) to lead for up to 2 years to a continuous concentration of 119 µg/L and observed third generation embryos with deformed spinal cords that resulted in reduced embryo hatchability. The NOAEL and LOAEL CBRs for embryo tissue are 0.4 and 4 µg lead/g ww tissue based on application of a 10-fold LOAEL-NOAEL (L-N) EF. Assuming that adult and embryonic tissue residues are equivalent, these CBRs were compared to the fish EPCs for generic fish and mummichog to evaluate adult exposures.

Specific EPCs for embryonic fish and bird tissue were not estimated in the BERA, and a CBR for avian embryos was not derived.

Mercury. Following 4-hour exposure to mercury-contaminated phytoplankton, Hook and Fish (2002) measured tissue concentration of copepods (*Acartia tonsa* and *A. hudsonica*); the tissue residues associated with a 50% reduction in the number of eggs produced was selected as the LOAEL. Following conversion to equivalent wet weight mass concentrations, the NOAEL and LOAEL CBRs for invertebrates are 0.048 and 0.095 µg mercury/g ww tissue. No EFs were applied due to the sensitive nature of the endpoint (egg depression) and the presumed sensitivity of zooplankton to mercury.

The fish CBRs for mercury were obtained from a comprehensive review of fish residues associated with adverse survival, growth and reproduction effects (Beckvar *et al*., 2005), which derived no-effect residue and low-effect residue estimates using a variety of ranking and statistical procedures. Residue effect data for adult fish tissue were identified for a total of eight species, primarily freshwater species but including striped mullet and mummichog, exposed to either mercury chloride or methylmercury through either dietary doses or direct water column exposure (Beckvar *et al.*, 2005). The fifth percentile of ranked empirically derived values was selected as the LOAEL CBR (0.26 µg mercury/g ww tissue) and a five-fold L-N EF was applied to estimate the NOAEL (0.052 µg mercury/g ww tissue).

No CBR was developed for fish and avian early life stages because embryonic exposures could not be reliably estimated for these receptor categories.

LMW PAHs. An 8-week chronic toxicity study, based on aqueous exposures, conducted by Emery and Dillon (1996) reported that a tissue residue of 0.78 µg phenanthrene/g ww tissue in the polychaete worm, *Nereis arenaceodentata*, was associated with a 33% decrease in fecundity and 36% decrease in juvenile production. A 10-fold L-N EF was applied to derive an invertebrate NOAEL CBR (0.078 µg phenanthrene/g ww tissue) for invertebrates. Due to the importance of the toxicological effects measured and the chronic study ED, no other EF was applied. It is assumed that phenanthrene is representative of the other component two- and three-ring PAHs present in FFS Study Area surficial sediments.

Fathead minnows were exposed to three aqueous treatment levels, and reproductive endpoints were measured after 6 weeks (Hall and Oris, 1991). A decrease in reproductive output was measured for all treatment levels, and a LOAEL CBR interpolated from a polynomial regression of female carcass residue on aqueous concentration was adjusted using a five-fold IS EF to derive a NOAEL CBR. The regression and application of a L-N EF resulted in LOAEL and NOAEL CBRs of 2.6 and 0.26 µg LMW PAH/g ww tissue, respectively.

No CBR was derived for fish and avian early life stages because embryonic exposures could not be reliably estimated for these receptor categories.

HMW PAHs. Impaired gametogenesis, including deformation of gametes and follicles, was measured in the blue mussel (*Mytilus edulis*) following aqueous exposure for 4 weeks to fluoranthene (Eertman *et al.*, 1995). The tissue residue was converted to a wet weight basis (assuming 80% water content in mussels) and a 10-fold L-N factor applied to obtain the NOAEL and LOAEL CBRs (0.022 and 0.22 µg HMW PAHs/g ww tissue, respectively). Based on the sensitive nature of the endpoint identified in this study, no other EFs were determined to be necessary.

Eggs stripped from adults collected in pristine habitat were exposed to environmentally realistic aqueous exposures of benzo(a)pyrene (BaP) and reproductive endpoints measured in three species of flatfish (Hose *et al*., 1982). The LOAEL CBR was based on estimated BaP concentrations in Pacific sand sole (*Psettichthys melanostichus*) yolk-sac larva from the lowest treatment resulting in reduced egg hatching success. Other than a 10-fold L-N factor to estimate the NOAEL CBR, no other EF was considered necessary due to the sensitive endpoint and life stage. The NOAEL and LOAEL CBRs for fish are 0.21 and 2.1 µg HMW PAHs/g ww tissue. Assuming that adult and larval tissue residues are equivalent, these CBRs were compared to the fish EPCs for generic fish and mummichog to evaluate adult exposures. The BERA also assumed that BaP is representative of the other component four- and greater ring PAHs present in FFS Study Area surficial sediments.

No CBR was necessary for fish and avian early life stages because embryonic exposures could not be reliably estimated for these receptor categories.

Total DDx. Nimmo *et al*. (1970) measured survival in adult pink shrimp (*Penaeus duorum*) exposed to aqueous DDT concentrations for 56 days. The LOAEL CBR (0.13 µg DDT/g ww tissue) is based on the body burden of shrimp that died within 28 days following exposure to 0.14 part per billion (ppb) DDT, whereas the NOAEL CBR (0.06 µg DDT/g ww tissue) was derived from shrimp surviving exposure to the 0.05 ppb DDT treatment level for 56 days. It is assumed that the effects of exposure to DDT are comparable to DDE and DDD to macroinvertebrates.

The fish CBRs for Total DDx were obtained from Beckvar *et al.* (2005) as described above for mercury. The fifth percentile of ranked empirically derived values was selected as the LOAEL CBR (0.39 µg Total DDx/g ww tissue) and a five-fold L-N EF was applied to estimate the NOAEL (0.078 µg Total DDx/g ww tissue).

No fish embryo EPC was derived in the BERA, so CBRs for fish embryos were not necessary. However, avian residue-based exposures were evaluated using a study of eggshell thinning effects in brown pelican (*Pelecanus occidentalis*) (Blus, 1984). The "critical value" or the lowest level of DDE that would result in severely lowered reproductive success and population decline was selected as the LOAEL CBR, and the NOAEL value was based on the range (ND to 1 µg/g, where success was lower than expected). Due to the known sensitivity of this species and early lifestages to DDT, no EF was applied.

Dieldrin. Parrish *et al*. (1973) evaluated survival in adult pink shrimp following a 96-hour aqueous exposure to dieldrin. The LOAEL CBR is based on the treatment associated with 25% mortality in animals, and the NOAEL value is derived from the experimental control in which all animals survived. A five-fold A-C factor was applied because the exposure was only 96 hours resulting in NOAEL and LOAEL CBRs of 0.0016 and 0.008 µg dieldrin/g ww tissue, respectively. No additional extrapolation factor was determined to be warranted, as the pink shrimp appears to be among the most sensitive marine invertebrates to pesticide exposure.

The dieldrin CBRs for fish were derived from a study conducted by Shubat and Curtis (1986) that measured survival in rainbow trout (*Salmo gairdneri*) following a 16-week aqueous exposure that included a clean maintenance diet. The LOAEL CBR (0.04 µg dieldrin/g ww tissue) was based on the lowest treatment where survival was significantly reduced and a two-fold subchronic to chronic factor applied to estimate the NOAEL CBR (0.008 µg dieldrin/g ww tissue). No IS factor was applied due to the known sensitivity of salmonids to organochlorine pesticide compounds.

No fish embryo EPC was derived in the BERA, so CBRs for fish embryos were not necessary. However, avian residue-based exposures were evaluated using a study of eggshell thinning effects in the barn owl (*Tyto alba*) (Mendenhall *et al*., 1983). Owl egg residues of 8.1 µg dieldrin/g ww tissue (LOAEL) were associated with a 5.5% reduction in shell thickness compared to controls (0.2 µg dieldrin/g ww tissue). Due to the sensitive endpoint and receptor, no EF was applied.

Total PCBs. The invertebrate CBRs for total PCBs were derived from a study evaluating effects of dietary exposure to PCBs and reproductive output in the Eastern oyster (*Crassostrea virginica*) (Chu *et al*., 2000; 2003). Following 56 days, PCB exposure in algal food resulted in fewer spawned females. Adult tissue CBRs were estimated by applying the ratio of lipids in adult tissue to eggs to oyster egg threshold concentrations derived from the Chu studies (2000, 2003). The NOAEL and LOAEL CBRs are 0.008 and 0.026 µg total PCBs/g ww tissue and no EFs applied due to the sensitive nature of the endpoint and this species.

For fish, NOAEL and LOAEL CBRs were derived from a behavioral study in Atlantic salmon (*Salmo salar*) smolt (Lerner *et al*., 2007) aqueously exposed as eggs. Smolt derived from yolk-sac larvae exposed in the high concentration treatment group demonstrated a substantial decrease in volitional preference for seawater. The NOAEL and LOAEL CBRs are 0.17 and 0.53 µg total PCBs/g ww tissue, respectively, and no EFs applied due to the sensitive nature of the endpoint and this species.

No fish embryo EPC was derived in the BERA, so CBRs for fish embryos were not necessary. However, results presented in Chapman (2003) were used to derive NOAEL and LOAEL CBRs for avian tissue based on threshold ingestion doses of Aroclor 1248 in chickens. The NOAEL and LOAEL CBRs derived are 0. 7 and 1.3 µg total PCBs/g ww tissue, respectively. No EF was applied because the chicken is known to be sensitive to PCBs.

2,3,7,8-TCDD. The Wintermyer and Cooper (2003) study used to develop the sediment benchmark for 2,3,7,8-TCDD was also used to establish CBRs. This study measured a significant reduction in the number of veligar larvae emerging from fertilized eggs (4 versus 82) and egg fertilization (23.3% versus 53.7%) for eastern oysters deployed at a location in the Arthur Kill (basis for the LOAEL) compared to Sandy Hook (basis for the NOAEL); measured tissue concentrations are 0.15 pg TCDD/g and 1.3 pg TCDD/g tissue (ww basis), respectively.

A behavioral endpoint was selected to establish CBRs for larval mummichog based on topical application of PCB126 to eggs. Treatment effects included a dose-responsive reduction in prey capture ability by four-day old larvae and a concomitant induction of ethoxyresorufin-O-deethylase (EROD) activity (Couillard *et al*., 2011); measured PCB126 concentrations in larval fish were converted to an equivalent TCDD TEQ using WHO fish TEF (*i.e*., 0.005, Van den Berg *et al*., 1998) resulting in NOAEL and LOAEL CBRs equivalent to 0.89 and 1.8 pg TEQ/g tissue, respectively. Given the high stage-specific mortality experienced by larval fish under typical field conditions, the behavioral endpoint measured in this study was assumed to correlate directly with reduced survival and hence be relevant to the established AE.

Estimated fish embryo tissue concentrations were assessed using LCLs and UCLs (7.2 and 86 TEQ/g egg, ww respectively) for the 95% "species protection level" derived from a species sensitivity distribution (SSD) developed from a comprehensive dataset of egg residue effects data (embryological survival endpoint) (Steevens *et al*., 2005). Similarly, USEPA (2003) developed SSDs for avian egg residue effects using both available laboratory and field data. These distributions were used to derive logistic regression models to describe the relationship between TEQs in avian eggs, embryo mortality, and developmental effects (USEPA, 2003b). Estimated NOAEL and LOAEL values that are protective of 95% of species from development effects observed in laboratory tests are 59 and 150 pg TEQ/g egg, respectively; (geometric mean of 94 pg TEQ/g). The mean value is only slightly greater than the geometric mean of available LOAEL values for the species believed to be the most sensitive to embryo-toxicological effects attributable to dioxin exposure; however, based on USEPA's (2003b) analysis there is no sound rationale for eliminating the chicken data (*i.e*., on the grounds that there are no similarly sensitive wildlife analogues). Moreover, there are a number of avian species of special concern that may occur in the FFS Study Area that would warrant this more conservative approach.

Toxicity Reference Values (TRVs)

Chemical- and receptor-specific TRVs are compared to the FFS Study Area ingestion dose estimates to evaluate the potential effects to wildlife associated with exposure to COPECs in the FFS Study Area; the ratio is defined as a HQ (Equation 4-4). In general, an HQ above 1 indicates the potential for unacceptable risk; an HQ below 1 indicates a low potential for unacceptable risk.

$$HQ = dose/TRV \qquad (4\text{-}4)$$

A TRV is defined as a dose level (based on laboratory toxicological investigations) above which a particular ecologically relevant effect may be expected to occur in an organism following chronic dietary exposure and below which it is reasonably expected that such effects will not occur (USEPA, 2005f). TRV derivation may incorporate uncertainty (or extrapolation) factors (Ecological Planning and Toxicology, 1996; Chapman *et al*., 1998) to account for a wide range of limitations, such as interspecies sensitivities. Rather than deriving a single point-estimate associated with specific adverse biological effects, both high and low TRVs[23] are derived for each receptor and each COPEC to reflect the variability of potential risk. The low TRV value is consistent with a chronic NOAEL. It represents a level below which adverse effects are unlikely to occur and is used to identify exposures posing little or no risk. Conversely, the high TRV is an estimator of potential adverse effects, representing a level at which adverse effects are more likely to occur, and is consistent with a chronic LOAEL. Table 4-14 summarizes the TRVs that were identified for the selected COPECs: copper, lead, mercury, LMW PAHs, HMW PAHs, total PCBs, TCDD, Total DDx, and dieldrin; details of their derivation are presented in Table 6-2 (Attachment 6). Two separate wildlife TRVs are developed for each COPEC to characterize risk to the two main categories of wildlife receptors (*i.e*., birds and mammals).

Details regarding the selection of TRVs for the COPECs used to estimate dose-based risks to birds and mammals are provided in Table 6-2 (Attachment 6) including application of uncertainty factors where deemed appropriate.

Copper. TRVs for estimating great blue heron risks associated with dietary exposures to copper were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for avifauna (USEPA, 2007b). Bounded studies are those that identify both a NOAEL and a LOAEL. Kashani *et al*. (1986) measured body weights of juvenile male turkeys (*Melagris gallopavo*) following 8 weeks of exposure to copper in their diet. The LOAEL was based on the lowest exposure treatment resulting in a significant reduction in bodyweight compared to control birds. NOAEL and LOAEL TRVs are 2.3 and 4.7 µg copper/g BW/day, respectively. Due to the conservative approach utilized (*i.e*., lowest of relevant bounded studies), no EF was applied.

[23] The HQs derived using NOAEL and LOAEL values are considered to provide estimates of the lower- and upper-bounds, respectively, to the potential risks.

Mammalian TRVs were also obtained as the lowest relevant bounded study result in the Eco SSL document (USEPA, 2007b). Aulerich *et al*. (1982) exposed juvenile female mink to five levels of copper in their diets for a year and identified treatment (and dose-dependent) effects on the number of viable progeny produced per female. NOAEL and LOAEL TRVs are 3.4 and 6.8 µg copper/g BW/day, respectively. Again, due to the conservative approach utilized (*i.e*., lowest of relevant bounded studies), no EF was applied.

Lead. TRVs for estimating great blue heron risks associated with dietary exposures to lead were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for avifauna (USEPA, 2005f). Edens and Garlich (1983) measured the viable number of progeny produced per unit of body weight for female Japanese quail (*Coturnix japonica*) following 5 weeks of exposure to lead in their diet. The LOAEL was based on the lowest treatment resulting in a significant reduction in bodyweight compared to control birds. NOAEL and LOAEL TRVs are 0.19 and 1.9 µg copper/g BW/day, respectively. Due to the conservative approach utilized (*i.e.*, lowest of relevant bounded studies), no EF was applied.

Mammalian TRVs were also obtained as the lowest relevant bounded study result in the Eco SSL document (USEPA, 2005f). Grant *et al*. (1982) exposed Norway rats to five levels of lead in their drinking water for 62 days and identified treatment effects on the average weight of pups produced. NOAEL and LOAEL TRVs are 0.71 and 7.0 µg lead/g BW/day, respectively. Due to the conservative approach utilized (*i.e*., lowest of relevant bounded studies), no EF was applied.

Methylmercury. USEPA (1995c) derived a LOAEL TRV of 0.5 ppm (as methylmercury) based on adverse reproductive effects in mallards (*Anas platyrhynchos*) documented in the work by Heinz *et al*. (1974, 1975, 1979); this equates to a LOAEL dose of 0.078 µg methylmercury/g BW/day based on the average food IR for treated mallards (0.156 g/g BW/day). The USEPA (1995c) extrapolation factors were considered appropriate and were applied to develop the final NOAEL/LOAEL: a three-fold interspecies extrapolation factor and two-fold L-N factor (due to the fact that the identified LOAEL appeared to be near the threshold for effects).

Work by Wobeser *et al.* (1976a, 1976b) on long-term feeding studies with mink is the basis for the mammalian wildlife TRV for methylmercury. The LOAEL TRV is based on conversion of the lowest concentration where mercury intoxication effects were routinely observed (1.8 ppm total mercury) to daily weight-normalized dietary dose using an assumed female body weight of 1 kg and a daily food IR of 0.15 kg/day. NOAEL and LOAEL TRVs are 0.016 and 0.027 µg methylmercury/g BW/day, respectively. The neurological effects, which are the basis for the suggested threshold, do not relate directly to the typical ecological endpoint types (*i.e.,* mortality, growth, and reproduction); however, intoxicated animals are likely to be less successful at foraging, predator avoidance, and mating, all of which have population-level significance.

LMW PAHs. Schafer *et al*. (1983) demonstrated that various 2- and 3-ring PAHs (including acenaphthene, fluorene, anthracene, and phenanthrene) were acutely toxic (48-h LD_{50}) in red-winged blackbirds (*Agaleius phoenicius*) at concentrations of approximately 100 mg/kg body weight, respectively. Based on professional judgment, 10-fold EF was applied to estimate the NOAEL TRV, along with A-C (five-fold) and IS (three-fold) factors. NOAEL and LOAEL TRVs are 0.67 and 6.7 µg LMW PAHs/g BW/day, respectively.

Mammalian TRVs were also obtained as the lowest relevant bounded study result in the Eco SSL document (USEPA, 2007c). Navarro *et al*. (1991) exposed 8 to 10 week old female Norway rats to four levels of naphthalene in food for 9 days and identified significant body weight effects at the higher concentrations. NOAEL and LOAEL TRVs are 0.50 and 150 µg naphthalene/g–day, respectively. Due to the conservative approach utilized (*i.e*., lowest of relevant bounded studies), no EF was applied.

HMW PAHs. In a laboratory study that exposed pigeons (*Columbia livia*) intramuscularly to BaP (Hough *et al*., 1993), pigeons were injected once weekly, intramuscularly, with BaP (10 mg/kg body weight), and long-term dosing resulted in complete infertility in females. The LOAEL TRV was derived by converting the experimental dosing to a daily dose and applying a three-fold IS factor (0.48 µg BaP/g BW/day); a 10-fold L-A factor was used to estimate the NOAEL (0.048 µg/BaP/g BW/day).

Mammalian TRVs were also obtained as the lowest relevant bounded study result in the Eco SSL document (USEPA, 2007c). Culp *et al*. (1998) exposed juvenile mice (*Mus musculus*) to four levels of BaP in food for 100 weeks and identified significant and dose dependent survival effects at the higher concentrations. NOAEL and LOAEL TRVs are 0.62 and 3.1 µg BaP/g–day, respectively. Due to the conservative approach utilized (*i.e.*, lowest of relevant bounded studies), no EF was applied.

Total DDx. A study of DDT effects in brown pelican conducted by Anderson *et al*. (1975) was selected as the basis for developing the NOAEL and LOAEL TRVs for bird receptors, as the brown pelican is believed to be one of the most sensitive piscivorous bird species to DDT. The LOAEL TRV (0.027 µg DDT/g BW/day/g BW/day) is based on a dosing predicted to result in fledgling rates 30% below that necessary for long-term population stability (USEPA, 1995c); a three-fold L-N factor was applied to derive the NOAEL TRV (0.009 µg DDT/g BW/day).

A long-term reproduction study conducted by Fitzhugh (1948) that evaluated multi-generational toxicity and sensitive endpoints in Sprague-Dawley rats was selected as the basis for establishing mammalian TRVs for this assessment. The NOAEL and LOAEL TRVs are 0.8 and 4.0 µg DDT/g BW/day, respectively, and no EF was used in their derivation.

Dieldrin. NOAEL and LOAEL values selected are the lowest relevant bounded study results presented in the USEPA Eco SSL document for avifauna (USEPA, 2007a). Wiese *et al*. (1968) exposed crowned guinea fowl (*Numida melagris*) to seven levels of dieldrin in the diet of female birds for 21 months and identified significant survival effects. NOAEL and LOAEL TRVs are 0.054 and 0.18 µg dieldrin/g– day, respectively. Due to the conservative approach utilized, no IS or A-C extrapolation factors were deemed necessary.

Harr *et al*. (1970) conducted a 2-year feeding study in which reproductive effects in rats were assessed. NOAEL and LOAEL TRVs are 0.015 and 0.03 µg dieldrin/g BW/day, respectively. Due to the conservative approach utilized, no IS or A-C extrapolation factors were deemed necessary.

Total PCBs. A TEQ approach is employed to normalize the assessment of potential risks associated with wildlife exposure to compounds with dioxin-like toxicological properties (including certain PCB congeners). Consequently, the specific TRVs for PCBs are used to evaluate the nondioxin-like effects attributable to PCB compounds. A review conducted by USEPA Region 5 (Chapman, 2003) developed avian TRVs for PCBs based on an analysis conducted for the chicken, which is believed to be one of the most sensitive bird species (Table 4-5). Ecotoxicological dose thresholds were developed individually for Aroclors 1242, 1248, and 1254 based on reported dose response data from multiple collated studies for Aroclor exposure and growth or reproductive effects in chickens. NOAEL and LOAEL TRVs for total PCBs based on the chicken reproduction data are 0.4 and 0.5 μg Aroclor 1248/g BW/day. No EF was applied due to the known sensitivity of chickens to PCBs.

Table 4-5 also summarizes mammalian dose thresholds for PCBs that were derived as part of the Chapman (2003) analysis. No mink study for Aroclor 1248 was identified, but the author concluded that this mixture is as toxic as Aroclor 1254 based on *in vitro* bioassay data. NOAEL and LOAEL TRVs (0.069 and 0.082 μg total PCBs/g BW/day) were based on data summarized by Chapman (2003) and converted to equivalent daily dose using BW (1 kg) and daily IR (0.137 kg-day) provided in Sample *et al.* (1996). No EF was applied because the mink is considered to be one of the most sensitive mammalian species to dioxin-like effects and the values are based on a chronic endpoint.

TCDD. USEPA (1993b) used studies of pheasant exposures to TCDD conducted by Nosek *et al.* (1992a, b) as the basis for establishing a TCDD TEQ TRV for birds. A 10-fold subchronic-to-chronic extrapolation factor[24] was applied to the pheasant NOAEL/LOAELs because the ED was likely inadequate to achieve steady-state conditions in the laying hens (USEPA, 1993b); moreover, the dose-response function appears to be steep. The NOAEL and LOAEL TRVs for avian receptors (*i.e.*, heron) used in the BERA are 2.8 and 28 pg TCDD/g BW/day, respectively.

[24] This factor is applied to address the uncertainty associated with estimating effects associated with long-term (*i.e.*, chronic" or lifetime) exposure using toxicological studies of shorter exposure periods of intermediate (*i.e.*, falling between single or very short "acute" and lifetime "chronic") durations. The absolute length of a subchronic study will vary depending on the expected lifespan of the test organism – for long-lived mammals, a subchronic duration study would be one that lasted longer than a year but less than the lifetime of the organism.

A five-fold interspecific EF[25] was applied because the pheasant is not among the most sensitive species (Nosek, 1992b; Cohen-Barnhouse, 2010).

The mammalian TRVs for TCDD were derived from a study using mink that were exposed to TCDD in their carp diet for approximately 182 days. The NOAEL and LOAEL mammalian TRVs derived from the study are 0.08 and 2.2 pg TEQ/g BW/day, respectively. No EF was necessary based on the chronic duration of the study and the use of a sensitive receptor.

4.4 Risk Characterization

The risk characterization combines the exposure and effects assessments to derive quantitative estimates of risk for each endpoint. Risks were calculated based on both the low (*e.g.*, smaller percentile from a distribution of effect concentrations or NOAEL-based) and high (*e.g.*, higher percentile from a distribution of effect concentrations or LOAEL-based) estimates of toxicity to provide lower and upper bound estimates of risk, respectively. Individual risk estimates for a given receptor for each chemical were calculated as an HQ, which is the ratio of the EPC to a given toxicological benchmark. For descriptive purposes, the HQs were summed to obtain a total hazard estimate, defined as an HI. HIs were calculated to facilitate a general understanding of the relative differences among different receptors or different remedial alternatives evaluated in Section 5. However, there is relatively high uncertainty associated with the interpretation of these risk estimates (compared to the individual HQs), which obscures the potential for different COPECs to have nonadditive (*i.e.*, synergistic or antagonistic) interactive effects on the evaluated receptors. In drawing conclusions, the BERA predominantly focuses on the results for individual COPECs or chemical classes. The appreciation of order of magnitude or greater differences in HIs are considered of value in understanding the broad findings of the BERA; however, caution is recommended regarding the attendant larger uncertainties associated with their use.

[25] See discussion in risk uncertainties regarding AhR isoform variability and relative species sensitivities to embryonic exposures to dioxin-like compounds.

4.4.1 Benthic Invertebrate Hazard Estimates

Risks to benthic invertebrates were evaluated by comparing sediment EPCs to the lower and upper bound sediment benchmarks developed for marine and estuarine organisms (Table 4-12). For macroinvertebrates, such as blue crab, grass shrimp, and Eastern oyster, residue-based hazard estimates were also derived by comparing measured COPEC concentrations in crab tissue to NOAEL and LOAEL CBRs (Table 4-13).

Sediment Benchmarks

Tables 6-3 and 6-4 (Attachment 6) present the detailed calculations for the sediment benchmark AE for the entire FFS Study Area and mudflat EPCs, respectively. The HQs are summarized in Table 4-15. The entire FFS Study Area and mudflat sediment EPCs for all COPECs exceed the selected sediment benchmarks, and the upper bound HQs for all contaminants except copper and lead exceed 10. Based on the magnitude of exceedance of the sediment benchmarks, 2,3,7,8-TCDD and Total DDx contribute most substantially to the benthic hazard estimates[26]. The lower- and upper-bound HQs for Total DDx based on the sediment EPC for the entire FFS Study Area are 200 and 6, respectively; lower- and upper-bound HQs based on the mudflat EPC are 200 and 7, respectively. The entire FFS Study Area and mudflat sediment EPCs for 2,3,7,8-TCDD exceed the benchmark by factors of 300 and 1,000, respectively (Table 4-15). Figure 6-1 (Attachment 6) presents the lower- and upper-bound HQs for the entire surficial sediment dataset.

The HQs for inorganics, dieldrin, Total PCBs and 2,3,7,8-TCDD are higher in the mudflats compared to the entire sediment dataset, whereas the LMW and HMW PAH HQs are somewhat higher in the entire sediment dataset (Table 4-15). The apparent differences in the HQs for the entire FFS Study Area as compared with the mudflat HQs are likely attributable to the statistical sampling size effects rather than actual differences in risk levels between the two areas. As noted in the geochemical evaluation of the spatial distribution of 2,3,7,8-TCDD and Total PCBs

[26] When interpreting the significance of the risk results, the magnitude of exceedance is considered to provide a measure of the likelihood that adverse effects will occur rather than the magnitude of effects realized in the exposed population. The specific effects anticipated are presumed to be similar in nature to those reported in the studies used to derive the toxicological benchmarks.

in surficial sediments in the FFS Study Area the channel and shoal areas are comparably contaminated, with local variations but no systematic trends with river mile (Section 3.1).

Critical Body Residues

Baseline risks to macroinvertebrates (including benthic invertebrates and large mobile crabs) were also evaluated by comparing measured COPEC concentrations in blue crab tissue to NOAEL and LOAEL CBRs associated with adverse effects to survivorship, growth, and reproduction. Table 6-5 (in Attachment 6) presents the detailed calculations for the CBR AE for blue crab tissue. The HQs are presented in Table 4-15, and Figure 4-2 presents the geometric means of the NOAEL- and LOAEL-based HQs (individual HQs are plotted in Figure 6-1 in Attachment 6).

2,3,7,8-TCDD and total PCBs are the primary contributors to benthic risks based on the residue-based analysis (Table 4-14). Lower and upper-bound HQs (based on NOAEL- and LOAEL benchmarks, respectively) for these COPECs are 400/40 and 40/10, respectively. The HQs for 2,3,7,8-TCDD and total PCBs are of sufficient magnitude to dominate the overall risk.

Both HQs for lead and LMW PAHs are 1 or less, and the NOAEL-based HQs for the remaining COPECs are between 1 and 6. Copper is the only other COPECs for which both NOAEL- and LOAEL-based HQs both exceed or equal 1 indicating that these likely also contribute to the residue-based risks to these receptors. Greatest interpretive uncertainty exists for the remaining COPECs for which the tissue EPCs are bounded by the NOAEL- and LOAEL-based CBR values because the level at which effects would be observed theoretically lies somewhere between the NOAEL, which is exceeded, and LOAEL, which is not.

Although the two approaches used to evaluate invertebrate risk (*i.e.,* sediment benchmark comparison and crab tissue residue analysis) both demonstrate that the COPECs evaluated pose a substantial risk to these receptors, there are some individual differences that are worth noting. With the exception of 2,3,7,8-TCDD and Total PCBs, the HQs based on sediment benchmarks are generally larger than the residue based-values. There are a number of possible reasons for this lack of consistency; in particular, the two approaches evaluate different organisms (small invertebrates living in the sediment versus large mobile crabs) with very different exposures to sediment constituents as well as potentially different sensitivities to the COPECs.

Based on the results presented in this subsection, it is concluded that direct sediment contact and residue-based exposures associated with sediment-borne COPECs are large enough to potentially adversely affect the survival, growth, and/or reproduction of sedentary and motile invertebrate populations (Table 4-15).

4.4.2 Fish Hazard Estimates

Risks evaluated for both piscivorous fish (represented by the "generic" fish) and smaller forage fish (represented by mummichog) receptors are based on estimates of CBRs. As discussed in the previous section for benthic invertebrates, both NOAEL and LOAEL estimates of risk were calculated for the two fish receptor groups based on comparisons of tissue residues with CBRs. The detailed results are presented in Attachment 6 (Tables 6-6 and 6-7, respectively).

Adult Fish

Under baseline conditions, TCDD TEQ (D/F) is the primary contributor to risk to adult fish, including both piscivorous fish (represented by generic fish) and forage fish (represented by mummichogs). The lower- and upper-bound CBR HQs for these two receptor categories are 300/100 and 50/30, respectively (Table 4-16).

Copper and total PCBs are the only other COPECs for which both lower- and upper-bound HQs both exceed or equal 1 indicating that these likely also contribute to the residue-based risks to these receptors.

Fish Embryos

Hazard estimates were also derived by comparing estimated fish egg TCDD TEQ concentrations to appropriate CBRs; Tables 5-2 and 5-3 (in Attachment 5) present the estimated fish embryo concentrations for generic fish and mummichog, respectively. Congener-specific egg concentrations were estimated by multiplying the adult tissue EPC values by egg/adult BMFs derived for lake trout (Cook *et al*., 2003) and by the fish TEFs. The total TEQ (sum of the individual congeners) was compared to the lower and upper confidence levels (LCLs and UCLs) for the 95% "species protection level" estimates of the fish egg SSD (Steevens *et al*., 2005) to estimate the HQs for D/F and PCB congeners; a total TCDD TEQ was also calculated as the sum of the two.

Table 4-17 and Figure 4-4 summarize the residue-based analysis for fish embryos. The estimated LCL and UCL HQs for total TCDD TEQ in generic fish eggs are 30 and 3, respectively. For mummichog, the comparable values are 20 and 2 (Table 4-17). TCDD TEQ (D/F) accounts for nearly 100% of the HQs. These HQs are lower than the equivalent analysis for adult tissue residues, which is somewhat counter-intuitive because embryos are generally considered to be the most sensitive life stage in most taxa. This finding is likely attributable to qualitative differences in the approaches used to quantify risks to these two life stages. The evaluation of fish embryos required that the fish embryo concentrations be estimated (by applying transfer factors to adult tissue concentrations) rather than measured, as in the case of the adult life stage. This additional source of uncertainty likely contributed to the observed differences in risk outcomes.

Based on the results presented in this subsection, it is concluded that residue-based exposures associated with sediment-borne COPECs are large enough to potentially adversely affect the survival, growth, and/or reproduction of local fish populations (Tables 4-16 and 4-17).

4.4.3 Wildlife Hazard Estimates

Wildlife risks were evaluated using both residue- and dose-based analyses; the residue analysis was limited to an assessment of avian embryos.

Gull Embryo Tissue Residues

Table 5-4 (in Attachment 5) presents the calculations that are summarized in Table 4-18 and Figure 4-4. As was done to estimate congener concentrations in fish tissue embryos, chemical and congener-specific gull egg concentrations were estimated by multiplying the generic fish tissue EPC values by adult gull/fish prey BMFs developed by Braune and Norstom (1989) and summarized in Table 5-1 in Attachment 5. A second BMF was applied to model transfer from the maternal gull body tissue to the egg, the appropriate bird TEF values were then applied for dioxin, furan and PCB congeners, and finally the total TEQ was calculated as the sum of all congeners.

Table 4-18 summarizes the results of the piscivorous bird egg residue evaluation using both NOAEL- and LOAEL-based CBR values. HQs for both total PCBs and TCDD TEQ (total) were substantially elevated above 1 and contribute the majority of the estimated risks for this AE. Lower- and upper-bound HQs for these two COPECs are 70/40 and 80/30 for total PCBs and TCDD TEQ, respectively. Birds are relatively sensitive to certain dioxin-like PCB congeners, and the TCDD TEQs attributable to PCBs represent a substantial proportion of the overall TCDD TEQ[27]. The lower- and upper-bound HQs for total DDx are 10 and 2, respectively, indicating that total DDx also contributes to the risks, whereas both HQs for dieldrin are less than 1 (Table 4-18).

Dose-based Assessment

Baseline risks calculated for the mink and the great blue heron are summarized in Table 4-19 and Figure 4-5. Details of the dietary exposure modeling analysis are presented in Attachment 6 (Tables 6-8 through 6-15 [heron, generic fish diet], Tables 6-16 through 6-23 [heron, mummichog diet], and Tables 6-24 through 6-31 [mink]). For the heron, diets including invertebrates (*i.e.*, crab) and either generic fish (site wide exposures) or mummichogs (mudflat exposures) were modeled using measured tissue concentrations. Dietary exposures to generic fish and blue crab were assumed for the mink receptor. For both receptors, the incidental sediment ingestion pathway was also included in deriving the dose estimates. Results for the visitor and resident heron exposure scenarios are discussed separately.

Visitor. Relatively low level risks to the visiting heron receptor based on consumption of generic fish and mummichog diets were identified (Table 4-19). For the generic fish diet scenario, only lower- and upper-bound HQs for total DDx and TCDD TEQ (D/F) both equal or exceed 1. Upper-bound estimates for all other COPECs are less than 1, and exposure risks are uncertain because the dose estimates are bounded by the NOAEL and LOAEL TRVs. The lower- and

[27] PCB congeners contribute between 30 and 40% of the total TCDD TEQ for both the lower- and upper-bound HQs.

upper-bound HQs for LMW PAHs, dieldrin and total PCBs are both less than 1, indicating that these COPECs likely do not contribute substantially to the risks posed by exposure of heron with a generic fish diet to contaminated sediments. The HQs for TCDD TEQ (total), which is based on exposure to all dioxin-like congeners, are the largest with lower- and upper-bound HQs of 20 and 2, respectively.

Results for the mummichog diet scenario are comparable to those for the generic fish diet scenario, with overall hazard estimates generally being slightly lower (Table 4-19). There are low-level risks from exposure to lead and TCDD TEQ (D/F), as the LOAEL-based HQs are equal to 1 and the NOAEL-based HQs range to 10. The lower- and upper-bound HQs for copper, mercury, LMW PAHs, dieldrin, total DDx, and total PCBs are both below 1, and it is unlikely that dietary exposure to these COPECs poses risk to the heron in the scenario of a 100% mummichog diet.

Resident. As anticipated, hazard estimates for those individual birds that over-winter at the FFS Study Area are 50 to 100 percent higher than under the visitor scenario (Table 4-19). For the generic fish diet scenario as is the case for the visiting heron, only lower- and upper-bound HQs for total DDx and TCDD TEQ (D/F) both equal or exceed 1. Upper-bound estimates for all other COPECs are equal to or less than 1 and exposure risks are uncertain because the dose estimates are bounded by the NOAEL and LOAEL TRVs. The lower- and upper-bound HQs for LMW PAHs and dieldrin are both less than 1, indicating that these COPECs likely do not contribute substantially to the risks posed by exposure of the resident heron with a generic fish diet to contaminated sediments. The HQs for TCDD TEQ (total), which is based on exposure to all dioxin-like congeners, are the largest with lower- and upper-bound HQs of 30 and 3, respectively.

Results for the mummichog diet scenario are comparable to those for the generic fish diet scenario, with overall hazard estimates generally being slightly lower (Table 4-19). There are low-level risks from exposure to lead and TCDD TEQ (D/F), as the LOAEL- and NOAEL-based HQs are 2 and 20, respectively. The NOAEL- but not LOAEL-based HQs for both HMW PAHs and total DDx exceed one and the lower- and upper-bound HQs for copper, mercury, LMW

PAHs, dieldrin and total PCBs are both equal to or lower than 1. With the exception of lead and TCDD TEQ, it is unlikely that dietary exposures to the evaluated COPECs pose risk to the heron for this scenario.

Hazard estimates for the mink are considerably higher (Table 4-19). The primary risk contributors for mink are TCDD TEQ (both D/F and PCBs) and total PCBs with lower- and upper-bound HQs for total TCDD TEQ and total PCBs equal to 1,000/30 and 10/9, respectively. With respect to the other COPECs, only the upper-bound HQ for mercury exceeds 1 and it is unlikely that the dietary exposure pathway to other COPECs (including copper, lead, PAHs and pesticides) poses an unacceptable risk to this receptor.

Based on the results presented in this subsection, it is concluded that the likely exposures to sediment-borne COPECs associated with dietary and incidental sediment ingestion exposure pathways are large enough to potentially adversely affect the survival, growth, and/or reproduction of both aquatic-dependent birds and mammal populations (Table 4-19).

4.5 Ecological Uncertainty Analysis

The assessment of ecological risk is based on calculations using sample data collected to represent the nature and extent of contamination at a site, toxicological information on COPECs from laboratory studies, and conservative assumptions regarding the exposure of sensitive ecological receptors. Although a BERA generally uses the most realistic site-specific information available, there is still a degree of uncertainty associated with exposure modeling and HQ calculations. This section presents limitations of the analyses in the FFS Study Area BERA, describes the primary sources of uncertainties, and evaluates whether these uncertainties and limitations may have resulted in an overestimation or underestimation of risk. Uncertainties in the quantification of risk associated with the analysis are identified, and their impacts on risk estimates are discussed below.

The uncertainties associated with the problem formulation (including development of the CSM, receptor identification, and the selection of COPECs), exposure assessment, effects assessment, and overall risk characterizations are presented.

Uncertainties Associated with the Problem Formulation. As with the HHRA, a significant uncertainty associated with the ecological assessment is the decision to focus the analysis on a limited subset of COPECs. As a result, the assessment did not attempt to quantify total site risk, but rather to determine whether existing (baseline) conditions pose a sufficient hazard to warrant consideration of a remedial action. In general, the subset of COPECs selected is expected to contribute most significantly to overall site-related risks. The analysis also did not evaluate all potentially complete exposure pathways (*e.g.*, surface water) or ecological receptor categories (*e.g.,* omnivorous mammals and sediment-probing birds) and overall risks associated with exposure to sediment and surface water may be underestimated. Furthermore, conservative assumptions were employed throughout the problem formulation. Despite the overall conservative approach, the limited focus of the analysis indicates that there is a low to moderate level of uncertainty and that, overall, the risk assessment tended to underestimate ecological hazards associated with environmental exposures.

Uncertainties Associated with the Exposure Assessment. There are uncertainties associated with several parameters in the exposure assessment, including EPCs, potential receptors, and exposure assumptions evaluated in the risk assessment that translate to uncertainty in the calculated risks. Each of these is discussed below.

- Based on USEPA risk assessment guidance, the 95% UCL of the arithmetic mean is used as the EPC because it is a conservative estimate of the average site-wide concentration to which a receptor may be exposed. As discussed for the HHRA, the amount of uncertainty in the calculated risks resulting from uncertainty in the EPCs is considered low. "Hot spots" have not been identified in the FFS Study Area and overall the spatial distribution of COPECs in surficial sediments in the FFS Study Area has no trend with river mile. However, a single exposure point to characterize general sediment exposures throughout the FFS Study Area[28] is not a typical approach in the case of sedentary receptors such as infaunal benthic organisms which may stay on a mudflat. Comparison of sediment benchmarks to the maximum detected concentrations (Attachment 3) of COPECs within the FFS Study Area

[28] Although the mudflat stratum was also evaluated in the BERA, 95%UCLs were also used to develop a single exposure point for this exposure area as well.

results in HIs that are greater by factors ranging from approximately 3 (copper and lead) to 10 (LMW PAHs, total DDx, dieldrin, 2,3,7,8-TCDD). In addition, the evaluation of upper percentile concentrations suggest that the HIs estimated for localized benthic populations could be 6-7 times higher than estimated in the BERA (Attachment 7). Although the conclusions derived in the BERA regarding the likelihood of significant ecological risks for all AEs are robust, this consideration acknowledges the possibility that the risk characterization for sedentary organisms (including benthos as well as localized fish populations) may have been underestimated in some areas; this is obviously less of a concern for wildlife and the majority of fish receptors that integrate exposures through time and space and view the environment in a more coarse fashion (scale).

- The strength of the T20/T50 sediment benchmarks (USEPA, 2005d) used to estimate benthic risks to copper, lead, mercury, dieldrin and Total PCBs derives from the underlying homogeneity of the toxicological database that includes toxicological data for only two epifaunal tube-building amphipods species (*Ampelisca abdita* and *Rhepoxynius abronius*) and are derived using the sample laboratory testing methodology (standard 10-day survival). Consequently, these sediment benchmarks are based on a narrow subset of the benthic/epibenthic soft bottom estuarine community and may not be robust predictors of effects for organisms with different life histories, exposures and/or toxicological sensitivities. Despite this concern, single species toxicity test results and benthic community metrics appear to be reasonably well correlated for most sediment-borne chemical stressors evaluated (Ritter *et al*., 2011). With the exception of individual components (DDD, DDE and DDT) of the total DDx COPEC and LMW PAHs, the Spearman Rank Correlations between sediment chemistry and the logistic regression model predictions for single species toxicity and a measure of impact on benthic community structure are comparable (Ritter *et al*., 2011). This finding supports the use of only chemistry and sediment toxicity lines of evidence to draw conclusions in this BERA although it is acknowledged that the full sediment quality triad (*i.e*., that also incorporates a third measure of effect based on benthic community structure as will done in the 17-mile LPRSA BERA) would provide further confidence in the conclusions drawn.

- Use of a multi-species composite EPC for fish ("generic fish" category) may have affected the BERA in a number of ways. For the residue-based analysis of tissue concentrations, use of analytical data from multiple species to derive the fish tissue EPC likely results in a reduction in the variability of anticipated exposures attributable to a number of different factors (*e.g.*, prey preferences, life history, physiology). In addition, the composite EPC dilutes the significance of heavily contaminated species. On the other hand, use of conservative CBRs that were selected to be protective of the majority of species tends to result in conservative risk estimates. Use of the composite EPCs may have resulted in the wildlife dietary exposures to fish prey being over- or under-estimated depending on prey preferences and the relative availability of different species in the river at any point in time. However, it is likely that the diet of piscivorous wildlife will vary throughout the year as the seasonal abundance of different species and preferred life stages/size classes changes. Therefore, the degree of uncertainty associated with exposure concentrations for the mink is considered low.
- The great blue heron exposure scenario, which assumes a site use fidelity of 100% (SUF = 1), may lead to overestimates of site-related risk because it is assumed that 100% of risk to the population is resulting from site exposures. It is possible that piscivorous birds like the great blue heron may selectively feed in areas with lower concentrations of contaminants during some portion of their time in the area although in this urbanized area, elevated exposures to at least some of the COPECs outside of the FFS Study Area are also possible.
- As a refinement over the initial risk screening (Attachment 2), which assumed great blue herons are present throughout the year at the Lower Passaic River, the BERA adjusted the EF term based on information provided in the wildlife exposure handbook (USEPA, 1993a). For the BERA, it is assumed that the typical heron migrates south for the winter (leaving September and returning the following March/April) and so is exposed only for 58% of the calendar year. However, exposures for herons that overwinter on the Lower Passaic River ("year-long resident" individuals) were also evaluated. Tables 6-32 through 6-39 and Tables 6-40 through 6-47 in Attachment 6 present the risk calculations for resident birds based on

the generic fish and mummichog diet scenarios and results are included in Table 4-19. For both scenarios, year-round exposures are estimated to increase individual site-related HQs by a factor of 67% as compared to migratory individuals because potential off-site exposures are not accounted for. In the case of the generic fish diet scenario, LOAEL-based HQs for Total DDx, TCDD TEQ (D/F), mercury, lead and TCDD TEQ (PCBs) all exceed 1 in the case of resident individuals (Table 6-39 in Attachment 6); only the LOAEL-based HQs for TCDD TEQ (D/F) and lead exceed one in the mummichog diet scenario (Table 6-47 in Attachment 6). As anticipated, the greater exposure results in a greater likelihood that the adverse effects associated with these COPECs would be experienced in exposed individuals. The population level consequences of this increased risk are more difficult to predict as the individuals that choose to overwinter tend to be older birds that may no longer be breeding. However, given that the risk to herons using an EF of 1 or 0.58 results in hazard quotients greater than 1, it is likely that the contaminants in the sediment and prey items consumed by great blue herons may impair the survival, growth or reproduction of great blue heron populations. Without a more detailed understanding of the foraging range and behavior for piscivorous wading birds feeding along the Passaic River, the degree of uncertainty associated with exposure concentrations for these receptors is considered to be moderately high. This area of uncertainty also applies to the residue-based and dose-based assessments (for gull embryos and mammals, respectively), which presumed that COPEC exposures were completely derived from consumption of fish from the FFS Study Area.

- Exposure parameters for wildlife receptors were published values assumed to represent wildlife in the Lower Passaic River. Parameters used included smallest home ranges, smallest average BWs (adult females), and typical sediment and food IRs. Overall, these are conservative assumptions that result in the exposures (and risks) encountered by typical individuals likely being overestimated. However, these assumptions do not consider juvenile receptors that may have higher relative IRs (amount of contaminated prey and sediment per unit BW), and exposures for these more sensitive life stages are likely to have been underestimated.

- Dietary composition assumed for the receptors evaluated was based on species-specific studies. However, dietary composition within a species may vary regionally and between life stages, depending on food availability/accessibility and food preferences. Therefore, there is a degree of uncertainty associated with exposure concentrations that may be associated with differences in dietary composition and may lead to an overestimate or underestimate of risk. Impacts to the exposure rates and HQ calculations are expected to be small.
- One consequence of the need for the fish tissue sampling program to meet multiple objectives was that the size (and age) of the individuals targeted could not be specific to the ecological wildlife modeled. Although larger prey can be speared and brought to shore for dismemberment and consumption, typical fish prey for the great blue heron range in size from 5 to 20 cm (herons foraging in southwestern Lake Erie) and 95% of fish consumed by herons in a Wisconsin population were less than 25 cm (USEPA, 1993a)[29]. Inclusion of larger fish prey in the sample set used to calculate the generic fish EPCs would tend to overestimate exposures to piscivorous birds that feed on forage fish and smaller size categories of other fish because fish body burdens generally increase with size and age (Bache *et al*., 1972; Skinner *et al*., 2010). However, use of larger fish that are reproductively active in the residue-based analysis is appropriate.
- Exposure assessments also assume 100% bioavailability of COPECs at the estimated EPCs. This is likely to have resulted in an overestimate of risks under some exposure scenarios, because a fraction of the total concentrations of COPECs will be bound to sediments and organic carbon and unavailable for uptake. However, for the majority of ecological receptors evaluated, exposures based on measured tissue concentrations were found to be the most significant, and the uncertainties related to sediment bioavailability are not as relevant. Therefore, the impacts to risk estimates are expected to be low.
- The average lipid content in lake trout eggs reported in Cook *et al.* (2003) was used to normalize the fish egg tissue concentrations to calculate the BMFs in the fish embryo analysis. It is not known whether this is an appropriate value for the LPR species;

[29] A 20 to 25 cm white perch from the Hudson River estuary weighs approximately 100 grams (Bath and O'Connor, 1982).

however, egg lipid content is generally higher than adult tissue so it is a reasonable value. Embryo hazard estimates would have been under-estimated to the extent that LPR species egg lipid content is higher than the trout value – the hazard estimates would be twice as high if site-specific values were twice the average trout value, for instance.

The primary aspects of the toxicity assessment that impart uncertainty to the calculated risks include uncertainty in the toxicity data for constituents detected at the site are discussed below.

- *ER-Ls and ER-Ms*: The 10th- and 50th-percentile values from the ranked ascending effects dataset were identified as the ER-L and ER-M values corresponding to concentrations below which adverse effects rarely occur (ER-L) and above which effects frequently occur (ER-M). The percentage of study endpoints indicating adverse effects were calculated for the chemical ranges defined by the ER-Ls and ER-Ms as a measure of benchmark reliability. The incidence of effects was less than 25% when concentrations were below the ER-L value and increased to 40% to 60% for most organics for concentrations within the range defined by the ER-L and ER-M. Above the ER-M, the incidence of adverse effects increased to 80% to 100% for most organics (*e.g.*, 100% of studies above the LMW PAH ER-M and 81.2% of studies above the HMW PAH ER-M were toxic); however, the ER-M for Total DDx was considerably less reliable with only a 53.6% incidence of effects for concentrations exceeding the lower-bound benchmark value (Long *et al*., 1995). The relative degree of confidence in the sediment benchmarks has the greatest impact on interpreting the BERA findings in situations where the hazard estimates are close to unity (*e.g.*, total DDx).
- *CBRs*: Use of the most sensitive species to select CBRs likely resulted in an overestimate of risks for the residue-based analysis. Species such as salmon and trout are not found in the Lower Passaic River, and the risks quantified in the residue-based analysis for the generic fish category were likely conservatively estimated. Use of tissue residue effect data for species such as the domesticated chicken, which is known to be particularly sensitive to PCBs and 2,3,7,8-TCDD, also resulted in conservative risk estimates. Concerns have been raised that the chicken is not an

appropriate surrogate, or model, for avian wildlife toxicology because it is argued that the selective breeding for egg production could have affected overall sensitivities. Recent in vitro work with avian hepatocytes (Herve *et al*., 2010, Farmahin *et al*., 2012; Manning *et al*., 2013) has demonstrated that relative species sensitivity to dioxin-like compounds is related to genotype differences in the aryl hydrocarbon receptor 1 (AhR1) ligand-binding domain. Based on review of AhR1 genotypic variants in 86 avian species, three types (1, 2, and 3) of decreasing sensitivity to dioxin-like compounds have been reported (Farmahin *et al*., 2013). The domestic chicken (along with four other species) is Type 1, the ring-necked pheasant is Type 2 and species such as herring gull, double-crested cormorant and great blue heron (all potential avian receptors) are Type 3. The lack of obvious phylogenetic relationships among the Type 1 birds (chicken, starling, hummingbird and catbird) suggests that taxonomic relatedness is not necessarily a strong predictor of relative sensitivity. However, in the absence of long-term studies of site usage by different species and a concomitant understanding of their relative sensitivities, the use of sensitive species to evaluate risks is appropriate and used at other Superfund Sites (USEPA, 1995c; 2003b).

In several cases, CBR NOAELs were estimated using an assumed 10-fold extrapolation factor, which may have underestimated or overestimated hazards in the assessment. In addition, the literature studies queried in the tissue residue effects databases vary in terms of quality and relevance to the study objectives. Although the conservative procedures employed in the selection of CBRs tended to result in risks being overestimated, suitable tissue residue data for certain COPECs were limited and may not have included relevant sensitive species or life stages.

- *TRVs* are typically based on results of tests performed on test animals under laboratory conditions and extrapolated to wildlife species in their natural habitat; selected values are generally conservatively developed as the lowest LOAEL for well-conducted studies that evaluated ecologically relevant endpoints (survival, growth and reproduction). Results are used to develop TRVs as daily dietary exposures. Because the most conservative values available are typically used, risks are more likely to be overestimated than underestimated. In the case of the mink receptor, well-conducted toxicity test results are available and were used to develop the TRVs. Risks are also likely to be overestimated because researchers attempt to minimize the variability in contaminant exposure when conducting laboratory toxicity studies and often will use more bioavailable forms of chemicals in the prepared diets.

Uncertainties Associated with the Risk Characterization. Finally, uncertainty in the calculated risks can arise from uncertainty in the manner in which risks are calculated or aggregated, as discussed below.

The calculation of HIs that were used in the risk results is only appropriate if it is assumed that exposure to different COPECs affect an organism in an additive manner. While this may be a reasonable assumption for contaminants within a class of compounds (*e.g*., chlorinated pesticides), the HI derived across a number of different contaminant categories will likely have large attendant uncertainty associated with it. Justification for the use of HIs is that it provides a relatively easy way to recognize order of magnitude differences among different scenarios or AEs. Moreover, the conclusions in the BERA are appropriately caveated by this concern, with the recommendation that remedial decision-making be focused on the risk results obtained for individual COPECs.

4.5.1 Conclusions

The results of the uncertainty analysis indicate that the overall assumptions are reasonable and appropriate for characterizing risks to the ecological receptors evaluated.

5 REMEDIAL ALTERNATIVES FUTURE RISK ASSESSMENT

The objective of the risk assessments is to assess the overall protection of human health and the environment under the FFS remedial alternatives, including No Action, to address requirements in NCP Section 300.430(e)(9)(iii). The remedial action objectives and the remedial alternatives identified for the site have been summarized in the text of the FFS. For ease of reference, the alternatives are as follows:

- Alternative 1: No Action
- Alternative 2: Deep Dredging with Backfill
- Alternative 3: Capping with Dredging for Flooding and Navigation
- Alternative 4: Focused Capping with Dredging for Flooding

In order to assess the risk posed by the FFS Study Area sediments after remediation, a mechanistic contaminant fate and transport model and an Empirical Mass Balance Model (EMBM) were developed to predict the concentrations of COPCs and COPECs in FFS Study Area surface sediments and the water column under No Action and three active remedial alternatives. The development, calibration, use and peer reviews of the models are described in Appendices B and C. The future modeled surface sediment concentrations were used in the human health and ecological risk assessments to estimate the future residual risks remaining in the FFS Study Area post-remediation (termed "future modeled risk"). The results of the future modeled risk assessment will be used to assist risk management decisions regarding the potential selection of a remedial action for the sediments of the FFS Study Area. As with the baseline risk assessments provided in Sections 3.0 and 4.0, this future risk assessment is consistent with USEPA guidance, guidelines, and policies and the application of these procedures is designed to reduce potential uncertainty and ensure consistency.

5.1 Future Modeled Human Health Risk Assessment

The future modeled risk assessment evaluated the same COPCs and exposure pathway (ingestion of fish and crab) as were evaluated for the baseline assessment. Consumption of fish and crab is the primary exposure pathway for the FFS Study Area and is the only one evaluated in this future modeled risk assessment. Carcinogenic risks and noncarcinogenic health hazards are estimated only for the RME individual and only for the adult angler/sportsman and child who consumes the adult's catch. For carcinogenic risk, a 30-year exposure period is evaluated, assuming 24 years as an adult and 6 years as a child to depict a scenario resulting in the most health protective calculations of cancer risks. For noncarcinogens, both a child receptor (age 1-6 years) and an adult receptor are evaluated to depict scenarios resulting in the most health-protective noncancer health hazards.

5.1.1 Development of EPCs for Future Modeled Conditions

A summary of the development of tissue EPCs for future conditions is provided in this section and described in more detail in Attachment 7. The tissue EPCs for future exposures were derived using modeled annual average projections of future concentrations in sediment in conjunction with site-specific and chemical-specific sediment-tissue relationships (*e.g.*, sediment-tissue regressions). Derivation of the sediment-tissue relationships is detailed in Appendix A, Data Evaluation Report No. 6.

Contaminant transport models were used to predict surface sediment concentrations for each of the remedial alternatives as average annual concentrations for the COPCs over a 30-year time period to coincide with the total ED of 30 years used in the HHRA. Remedy implementation was assumed to begin in March 2018; however, each of the active remedial alternatives varied with respect to remedy completion. Therefore, the actual 30-year ED time period varied for each active alternative. Table 5-1 summarizes the remedy implementation schedule for each of the alternatives and the beginning and end year for the 30-year ED time period.

Future sediment concentrations for mercury, Total PCBs[30], DDD, DDE, DDT, TCDD TEQ (PCBs) and TCDD TEQ (D/F) were obtained from the Lower Passaic River-Newark Bay Model [LPR-NB Model] (based largely on the model developed for New York/New Jersey Harbor Contaminant Assessment and Reduction Project [HydroQual, 2007]). Not all of the COPCs could be modeled using the LPR-NB Model; therefore, results for chlordane were obtained from

[30] Total PCBs represent the sum of dioxin-like and nondioxin-like congeners.

the EMBM. Concentration projections for dieldrin could not be modeled reliably due to geochemical constructs specific to the available sediment datasets and therefore were not included in the future risk evaluations. Model descriptions are provided in Appendix B for the LPR-NB Model and Appendix C for the EMBM. Figure 5-1 shows the annual average surface sediment concentrations over time predicted by the contaminant transport models for all COPCs under each of the remedial alternatives. Except for chlordane, COPCs exhibit an overall decreasing trend; however, concentrations continue to fluctuate over time due to resuspension of legacy sediments and/or contributions from outside sources. Chlordane concentrations in surface sediment, however, begin to increase over time immediately following completion of the remedial action.

For protection of human health, future EPCs were developed for the COPCs to account for the variable (storm-driven) nature of the surface sediment concentrations over a 30-year time period (as depicted on Figure 5-1) and the ED component of the risk/hazard equation. Therefore, a sliding scale of annual averages based on the ED for each receptor (*e.g.*, 6 years for the child, 12 years for the adolescent, and 24 years for the adult) was determined over the total 30-year ED time period. The maximum annual rolling average for the receptor-specific ED was selected for EPC derivation to ensure the EPC was not biased low because of a downward trend; COPC concentrations are predicted to fluctuate (or increase for chlordane) over time due to the storm-driven resuspension of legacy sediments and/or contributions from outside sources. As such, the maximum annual average over 6-year time periods for the child and 24-year time periods for the adult is used to evaluate exposure for each receptor, respectively.

Table 5-2 presents the 6-year and 24-year rolling annual average concentrations for Total PCBs as an example of how the maximum annual averages were determined based on the sliding ED scale process. For each alternative, 6- and 24-year rolling averages were calculated, depending on the remedy implementation date for that alterative (see Table 5-1) and continuing 30 years post implementation. The yellow highlighted cells in Table 5-2 indicate sediment concentrations during remedy implementation (which were not used to calculate rolling averages), while the orange highlighted cells depict the concentrations within the 30-year ED time period. Maximum rolling average sediment concentrations identified within the 30-year ED time period, denoted as bolded text in Table 5-2, were then selected to calculate the biota tissue EPC. Table 5-3 summarizes the maximum rolling annual average sediment concentrations used to determine future biota tissue EPCs for each of the receptors and remedial alternatives.

Calculation of the future tissue EPCs for fish and blue crab consisted of converting the future sediment EPCs into associated biota EPCs through the use of statistical regression-based relationships between sediment and tissue using site-specific data. The statistical regressions for organic and inorganic COPCs that were determined to best describe the relationship between the analytical chemistry data in tissue residues and sediment are provided in Attachment 7. Table 5-4 summarizes the fish and blue crab future EPCs by remedial alternative.

Additional detail regarding EPC determination for all of the alternatives is provided in Attachment 7.

5.1.2 Future Modeled HHRA Results

The following subsections summarize the cancer risks and noncancer health hazards for each of the active remedial alternatives. Results for Alternative 1, the No Action alternative, were presented in Section 3 as the "baseline future modeled" scenario in Tables 3-8 and 3-9. Detailed risk and hazard calculations for all of the alternatives are provided in Attachment 8.

5.1.2.1 Alternative 2: Deep Dredging with Backfill

The cancer risks for Alternative 2 are summarized in Table 5-5. The calculated total cancer risks for ingestion of fish for the adult sportsman/angler[31] are 5×10^{-4} and 4×10^{-4} for ingestion of crab. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to both the fish and crab total risks above 10^{-4}, with individual cancer risks above 10^{-5}. Individual cancer risks associated with the other COPCs are on the 10^{-6} risk level or lower. Total cancer risks for Alternative 2 are at the upper end of the NCP risk range of 10^{-4} and 10^{-6} (USEPA, 1990). Although USEPA generally uses 1×10^{-4} in making risk management decisions, the upper boundary of the risk range is not a discrete line at 1×10^{-4} (USEPA, 1991a). A specific

[31] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions (USEPA, 1991a).

The noncancer health hazards for Alternative 2 are summarized in Table 5-5. For ingestion of fish, the HI is 10 for the adult and 22 for the child. For ingestion of crab, the HIs for the adult and child receptors are 7 and 15, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both ingestion of fish and crab, with individual HQs above 1. The HQs for the other COPCs are at or less than 1. The fish and crab RME scenarios for both adult and child receptors are approximately an order of magnitude above the USEPA goal of protection of an HI equal to 1.

5.1.2.2 Alternative 3: Capping with Dredging for Flooding and Navigation

The cancer risks for Alternative 3 are summarized in Table 5-6. The calculated total cancer risks for the adult sportsman/angler[32] are 4×10^{-4} and 3×10^{-4} for ingestion of fish and crab, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to both the fish and crab total risks above 10^{-4}, with individual cancer risks above 10^{-5}. Individual cancer risks associated with the other COPCs for ingestion of fish are on the 10^{-6} risk level, while individual cancer risks associated with the other COPCs for ingestion of crab are on the 10^{-7} risk level. Total cancer risks for Alternative 3 are at the upper end of the NCP risk range of 10^{-4} and 10^{-6} (USEPA, 1990).

The noncancer health hazards for Alternative 3 are summarized in Table 5-6. For ingestion of fish, the HIs for the adult and child receptors are 8 and 18, respectively. For ingestion of crab, the HIs for the adult and child are 6 and 13, respectively. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both ingestion of fish and crab, with individual HQs above 1. The HQs for the other COPCs are at or less than 1. The fish and crab RME scenarios for both adult and child receptors are approximately an order of magnitude above the USEPA goal of protection of an HI equal to 1.

[32] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

5.1.2.3 Alternative 4: Focused Capping with Dredging for Flooding

The cancer risks for Alternative 4 are summarized in Table 5-7. The calculated total cancer risk for ingestion of fish for the adult sportsman/angler[33] is 2×10^{-3}. For ingestion of crab, the calculated total cancer risk is 1×10^{-3}. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to both the fish and crab total risks at the 10^{-3} risk level, with individual cancer risks at the 10^{-4} risk level. Individual cancer risks associated with the other COPCs for ingestion of fish are on the 10^{-6} risk level, while individual cancer risks associated with the other COPCs for ingestion of crab are on the 10^{-7} risk level. Total RME cancer risks for Alternative 4 are approximately an order of magnitude above the NCP risk range of 10^{-4} and 10^{-6} (USEPA, 1990).

The noncancer health hazards for Alternative 4 are summarized in Table 5-7. For ingestion of fish, the HI for the adult is 55. For the child receptor, the HI is 97. For ingestion of crab, the HI for the adult is 27, while for the child receptor, the HI is 47. TCDD TEQ (D/F), TCDD TEQ (PCBs), and Total PCBs are the primary contributors to the excess hazard for both ingestion of fish and crab, with individual HQs above 1. Except for mercury under fish ingestion, HQs for the other COPCs are less than 1. The fish and crab RME scenarios for both adult and child receptors are approximately one to two orders of magnitude above the USEPA goal of protection of an HI equal to 1.

5.2 Future Modeled Ecological Risk Assessment

The ecological risk analysis of remedial alternatives generally followed a similar approach used in the future modeled human health assessment, described in Section 5.1. The same set of exposure factors and toxicity benchmarks used to assess current ecological risks (see Section 4.0) were also employed to estimate potential future hazards associated with predicted exposure concentrations for each remedial alternative being considered.

[33] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

Consistent with the assessment of current conditions, three broad ecological receptor categories were evaluated: macroinvertebrates, fish, and aquatic-dependent wildlife. The specific receptors and measures of effect employed were as follows:

- *Macroinvertebrates* (including both benthic and epibenthic organisms) – comparison of predicted sediment EPCs to sediment benchmarks and comparison of predicted biota tissue EPCs to CBRs for the blue crab.
- *Fish* (generic fish and mummichog) – comparison of predicted biota tissue EPCs to CBRs.
- *Aquatic-dependent wildlife* (mink and great blue heron) – comparison of estimated daily dose levels to TRVs. For wildlife, exposure pathways included consumption of contaminated prey and incidental ingestion of sediment. As in the case for the current conditions analysis (Section 4), the mink receptor was assumed to have a primarily fish diet consisting of generic fish, whereas the heron receptor was assumed to have a diet consisting of macroinvertebrates and either generic fish or mummichogs. The future prey tissue concentration of each COPEC was estimated using sediment-tissue concentration relationships (*i.e.*, either regression models or uptake factors as presented in Appendix A) as described in Attachment 7.

Future sediment concentrations for mercury, Total DDx[34], Total PCBs[35], TCDD TEQ (PCBs), TCDD TEQ (D/F) and 2,3,7,8-TCDD were obtained from the LPR-NB Model (HydroQual, 2007). Not all of the COPECs could be modeled using the LPR-NB Model; therefore, results for copper, lead and HMW PAHs were obtained from the EMBM. Model descriptions are provided in Appendix B for the LPR-NB Model and Appendix C for the EMBM. Figure 5-1 includes the annual average surface sediment concentrations over time predicted by the contaminant transport models for Total PCBs, TCDD TEQ (PBCs), TCDD TEQ (D/F) and 2,3,7,8-TCDD under each of the remedial alternatives. Figure 5-2 presents similar plots for Total DDx, copper, lead and HMW PAHs. Similar to other COPECs, where future sediment concentrations were estimated using the LPR-NB model, Total DDx exhibits an overall decreasing trend; however, concentrations continue to fluctuate over time due to resuspension of legacy sediments. In the

[34] Consistent with the derivation of the Total DDx EPCs in Chapter 4, the sediment concentrations for this COPEC were calculated as the sum of the future modeled concentrations of the 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT isomers.
[35] Total PCBs represent the sum of dioxin-like and non-dioxin-like congeners.

case of the COPECs modeled using the EMBM (i.e., copper, lead, and HMW PAHs), concentrations in surface sediment begin to monotonically increase over time immediately following completion of the remedial action.

As discussed in Attachment 7, concentration projections for dieldrin and LMW PAHs could not be modeled reliably due to geochemical constructs specific to the available sediment datasets. As a result, sediment concentration projections were not generated for these two COPECs. It was also not possible to predict future gull egg (or fish embryo) exposures and hazards associated with potential exposures to dioxin-like compounds because individual dioxin, furan, and coplanar PCB congener concentrations were not modeled. Attachment 7 also provides a discussion on selection of the EPCs to estimate future exposures.

Ecological risks were estimated using the future modeled annualized average COPEC concentrations in sediment and biological tissue (crab and fish) for two future time points: immediately following the anticipated completion of the particular remedial action and 30 years thereafter.[36] The hazards are bounded using the lower- and upper-benchmark values. Benthic invertebrate hazard estimates were bounded using the lower- and upper-bound sediment toxicity benchmarks and NOAEL- and LOAEL-based toxicity values (either CBRs for the residue-based analysis or TRVs for the dose-based analysis) were used for all remaining ecological receptors evaluated.

Information supporting the assessment of future ecological risks is included in Attachment 9. Tables 9-1 through 9-8 of Attachment 9 compare future sediment EPCs for each remediation alternative to sediment benchmarks. Tables 9-9 through 9-16, Tables 9-17 through 9-24, and Tables 9-25 through 9-32 (of Attachment 9) compare future tissue EPCs to CBRs for blue crab, generic fish and mummichog tissue, respectively. Finally, results of the wildlife dose modeling calculations (Tables 9-33 through 9-224 in Attachment 9) for the two future time points for each remedial alternative are also provided.

[36] The completion dates for the four remedial scenarios vary between 2019 and 2030: Alternative 1-No Action (2019), Alternative 3-Capping with Dredging for Flooding and Navigation (2023), Alternative 2-Deep Dredging with Backfill (2030), and Alternative 4-Focused Capping with Dredging for Flooding (2020). As a result, the 30 year futurecast risk estimates are 2049, 2053, 2054, and 2050 for Alternatives 1, 3, 2 and 4, respectively.

Future sediment and biota EPCs for Alternative 1 (No Action), Alternative 3 (Capping with Dredging for Flooding and Navigation), Alternative 2 (Deep Dredging with Backfill) and Alternative 4 (Focused Capping with Dredging for Flooding) are summarized in Tables 5-8 through 5-14, respectively. Figures 9-1 through 9-6 of Attachment 9 present the results of the future ecological risk estimates based on sediment benchmarks, crab CBRs, generic fish CBRs, mummichog CBRs, heron dose model, and the mink dose model. Results of the future modeled ERA are discussed in the following sections.

Summaries of future modeled ecological hazards for the receptor/endpoint combinations evaluated are shown in Figures 5-3 and 5-4. In each figure, a horizontal bar (equivalent to a hazard ratio of 1) is provided to allow comparison of the USEPA "point of departure" benchmark with the future modeled results for each remediation alternative.

Typically, an HI equal to the sum of the HQs is only used for an assessment when the contaminants of concern cause effects by the same mechanism and those effects are additive. For this evaluation, HIs are used to simplify risk estimates for comparison to determine whether there are differences in overall risk between alternatives. It is important to note that all risk estimates were rounded to one significant figure for presentation purposes, and in some cases the sum of the presented HQs is greater than the total risk (HI) or that the HQ for one COPEC is equal to the total risk even though other HQs also exceed 1. This is an artifact of the rounding process as the HIs presented were calculated as the sum of the component HQs.

5.2.1 Alternative 1: No Action

Figure 5-3 presents hazard estimates for the four COPECs with the largest geometric mean (of either the lower- and upper-bound sediment benchmarks or the NOAEL- and LOAEL- crab and fish residue analyses); Figure 5-4 presents similar values derived from the dose-based analysis for the heron and mink (both based on the generic fish diet) for the No Action remedial alternative.

Macroinvertebrates

The futurecast hazard estimates for macroinvertebrates based on the sediment benchmark and crab CBR endpoints for Alternative 1 (No Action) are presented in Figures 9-1 and 9-2 (Attachment 9), respectively. For sediment benchmarks, the lower- and upper-based HIs at year 2019 are 300 and 200, respectively, while HIs for year 2048 are 200 and 100 respectively. 2,3,7,8-TCDD accounts for a majority of the lower-based HI in year 2019, with the relative contribution decreasing to approximately 50% by year 2048. The year 2019 lower-based HQs for Total DDx and Total PCBs are also both relatively large (HQ = 60 and 40, respectively), followed by HMW PAHs (HQ = 30) and mercury (HQ = 20). Of the modeled COPECs, only the lower-based HQs for copper and lead are less than 10 (Table 5-8). The lower-based HQs for most COPECs for year 2048 are lower by factors ranging from approximately 20% (lead) to 50% (2,3,7,8-TCDD and mercury). However, the lower-based HQs for HMW PAHs are similar in both assessment years. Although 2,3,7,8-TCDD dominates the risks to benthic macroinvertebrates across the assessment period under the No Action alternative, all modeled COPECs are potential risk contributors. All upper-based HQs are 1 or greater in both assessment years, supporting the conclusion that all modeled COPECs could adversely affect the benthic macroinvertebrate community throughout the period. In likely order of decreasing importance, the sediment COPECs for the direct exposure pathway are 2,3,7,8-TCDD, Total PCBs/Total DDx, HMW PAHs, mercury and copper/lead.

Little change in the overall risk through the 30-year evaluation period is estimated for the blue crab CBR endpoint as well (Figure 9-2, Attachment 9). NOAEL- and LOAEL-based HIs at year 2019 are 400 and 60, respectively, while HIs for year 2048 are 300 and 40, respectively (Table 5-9). In both years, the major contributors to the HIs are 2,3,7,8-TCDD and Total PCBs, with NOAEL-based HQs of approximately 300 and 60[37], respectively, in year 2019 and 200 and 40, respectively, in year 2048. In year 2019, only the NOAEL-HQs for two other COPECs exceed 1, and these range from 2 (mercury) to 5 (copper). LOAEL-based HQs for these COPECs are 1 or greater in year 2019 but only LOAEL-based HQs for 2,3,7,8-TCDD, Total PCBs and copper exceed 1 in year 2048. Across the assessment period, 2,3,7,8-TCDD, Total PCBs, and to a lesser

[37] All risk estimates were rounded to one significant figure for presentation purposes, and in some cases the sum of the presented HQs is greater than the total risk (HI). This is an artifact of the rounding process as the HIs presented were calculated as the sum of the component HQs.

extent, copper account for nearly all the estimated risks to the macroinvertebrate receptor group based on the residue-based analysis.

Fish

The futurecast hazard estimates for fish based on the CBR endpoint for the No Action alternative are presented in Tables 5-10 and 5-11 (generic fish and mummichog, respectively). NOAEL- and LOAEL-based HIs for the generic fish CBR endpoint in year 2019 are 300 and 200, respectively, and 200 and 100 in year 2048 (Table 5-10). For both NOAEL- and LOAEL-based HIs, the major contributor is TCDD TEQ (D/F) with NOAEL-based HQs of 300 and 200, in year 2019 and 200 and 100, in year 2048, respectively. NOAEL-based HQs for other COPECs that are 1 or greater in the two assessment years range from 2 (TCDD TEQ [PCBs] in year 2048) to 20 (copper and Total PCBs in year 2019) (Figure 9-3, Attachment 9). Potential risks posed by several of the COPECs appear to be of little concern, as either both the NOAEL- and LOAEL-based HQs are less than 1 (in the case of lead and HMW PAHs) or only the NOAEL-based HQ exceeds 1 (mercury). Across the assessment period, TCDD TEQ (D/F) accounts for the majority of the total hazard estimate for the generic fish receptor group.

NOAEL- and LOAEL-based HIs for the mummichog CBR endpoint in year 2019 are 50 and 20, respectively, and 40 and 10, respectively, in year 2048 (Table 5-11). The predominant contributors to the HIs are TCDD TEQ (D/F) and copper, with NOAEL-based HQs of 30 and 10, respectively, in year 2019 and 20 and 9 in year 2048. The only other NOAEL-based HQs greater than 1 in the two assessment years are those for lead (HQ = 2 in both years) and Total PCBs (HQ = 3 and 2 in years 2019 and 2048, respectively). With the exception of TCDD TEQ (D/F) and copper, in which the LOAEL-based HQs are 10 and 2, respectively, in both years, the lower bound hazard estimates for this endpoint are less than 1 (Figure 9-4, Attachment 9). Across the assessment period, TCDD TEQ (D/F) and, to a lesser degree, copper account for nearly all the estimated risks to the mummichog receptor group under the No Action alternative.

Wildlife

The futurecast hazard estimates for wildlife based on dose modeling for the No Action alternative are presented in Tables 5-12 and 5-13 (heron assuming generic fish and mummichog diets, respectively) and Table 5-14 (mink). Figures 9-5 and 9-6 (Attachment 9) present the NOAEL- and LOAEL-based hazard ratios for the heron (based on the generic fish diet) and mink receptors, respectively. Assuming a generic fish diet, NOAEL- and LOAEL-based HIs for the heron in year 2019 are 40 and 7, respectively, and 30 and 5, respectively, in year 2048 (Table 5-12). In both assessment years, the major contributor to the total HI is TCDD TEQ (D/F) followed by lead, TCDD TEF (PCBs), HMW PAHs, Total DDx and mercury with NOAEL-based HQs ranging from 2 to 7. However, only the LOAEL-based HQ for TCDD TEQ exceeds 1 in year 2019 (HQ = 2) and all LOAEL-based HQs are 1 or less in year 2048.

Table 5-13 presents a summary of the wildlife dose modeling for the heron with an assumed diet of mummichogs. The results are qualitatively similar to those obtained assuming a generic fish diet, although predicted risks are somewhat lower. NOAEL- and LOAEL-based HIs for the heron in year 2019 are 20 and 3, respectively, and 10 and 2, respectively, in year 2048 (Table 5-13). In both assessment years, the major contributors to the HIs are lead, HMW PAHs, and Total TCDD TEQ (with NOAEL-based HQs for both dioxin/furan and PCB congeners equal to or greater than 1 in both years). NOAEL-based HQs for all other COPECs are less than 1. All LOAEL-based HQs for heron with an assumed mummichog diet under the No Action alternative are also less than 1 for the two assessment periods. Because the actual effects threshold likely lies somewhere between the NOAEL and LOAEL-based values, there is greater uncertainty whether adverse ecological effects would be realized in heron and other similar bird populations under this scenario relative to the generic fish diet scenario[38].

NOAEL- and LOAEL-based HIs for the mink in year 2019 are 1,000 and 50, and 700 and 30 in year 2048 (Table 5-14). Figure 9-7 (Attachment 9) presents the NOAEL- and LOAEL-based hazard quotients for the mink. Total TCDD TEQ HQ accounts for nearly all the estimated total HIs, with the TCDD TEQ (D/F) HQs two to three times greater than TCDD TEQ (PCBs) HQs, depending on the particular comparison. NOAEL-based HQs for Total PCBs and the inorganic COPECs in year 2019 are 1 or greater, ranging from 1 (copper) to 10 (Total PCBs). With the exception of lead, the NOAEL-based HQs are 20 to 40% lower in year 2048. Exposures to

[38] As discussed in Section 4.2, although the mummichog diet is more reasonable than the generic fish diet for herons specifically, this receptor is considered representative of other piscivorous avian species.

HMW PAHs and Total DDx are estimated to pose little risk to aquatic-dependent mammals such as the mink, and based on the magnitude of the LOAEL-based HQ values, the risk from dietary exposure to the inorganic COPECs, with the possible exception of mercury, are minimal. Across the assessment period, the Total TCDD TEQ (including both PCB and D/F congeners) accounts for nearly all the estimated risks to the piscivorous mammal receptor group.

5.2.2 Alternative 2: Deep Dredging with Backfill

Figure 5-3 presents hazard estimates for the four COPECs with the largest geometric mean (of either the lower- and upper-bound sediment benchmarks or the NOAEL- and LOAEL- crab and fish residue analyses); Figure 5-4 presents similar values derived from the dose-based analysis for the heron and mink (both based on the generic fish diet) the Deep Dredging with Backfill Placement remedial alternative.

Macroinvertebrates

The futurecast hazard estimates for macroinvertebrates based on the sediment benchmark and crab CBR endpoints for Alternative 2 (Deep Dredging with Backfill) are presented in Tables 5-8 and 5-9, respectively. For sediment benchmarks, the lower- and upper-based HIs at year 2030 are 10 and 6, respectively, while lower- and upper-bound HIs for year 2059 are 30 and 8, respectively (Table 5-8). 2,3,7,8-TCDD, Total DDx and Total PCBs are the primary contributors to lower-bound HI in year 2030, with HQs ranging from 2 to 5 and upper-bound HQs ranging from 0.1 to 5; the HQs for all other COPECs are 1 or less. In year 2059, HMW PAHs contribute most to the total HI, although values for copper, lead, Total DDx and 2,3,7,8-TCDD exceed 1, as well, with lower-bound HQs ranging from 2 (copper) to 20 (HMW PAHs). By 2059, modeled tissue concentrations of copper, lead and HMW PAHs are predicted to increase by approximately 20-fold over conditions immediately following completion of remedial construction activities[39].

[39] Future sediment concentrations for these COPECs were estimated using the EMBM (Appendix C), which determined that external loadings are relatively important (*i.e.*, compared to 2,3,7,8-TCDD) in their respective mass balance equations. As a result, the sediment concentration trajectories for the active remedial alternatives are predicted to trend upwards following completion of the remedial construction phase as solids from the Upper Passaic River deposit on the river bottom.

Estimated HIs for the blue crab CBR endpoint do not change much through the 30-year evaluation period for Alternative 2. NOAEL- and LOAEL-based HIs are 20 and 4, respectively, at both years 2030 and 2059 (Table 5-9). In both years, the largest contributors to the HIs are 2,3,7,8-TCDD and Total PCBs, with NOAEL-based HQs equal to 10 and 6, respectively, in year 2030 and 8 and 6, respectively, in year 2059. As noted above in the evaluation of the sediment benchmark endpoint, concentrations of copper, lead and HMW PAHs are predicted to increase throughout the assessment period under Alternative 2, although the NOAEL-based HQs for these COPECs do not exceed 1 in year 2059. With the exception of the LOAEL-based HQs for 2,3,7,8-TCDD and Total PCBs in year 2030 and for Total PCBs in year 2059 (all three HQs = 2), all LOAEL-based HQs are less than 1 in both assessment years. As a result, there is relatively large uncertainty with regard to whether post-construction conditions will pose a bioaccumulation hazard to macroinvertebrates.

Fish

The futurecast hazard estimates for fish based on the CBR endpoints for Alternative 2 are presented in Tables 5-10 and 5-11 (generic fish and mummichog, respectively). NOAEL- and LOAEL-based HIs for the generic fish CBR in year 2030 are 20 and 7, respectively, and 20 and 6 in year 2059 (Table 5-10). While TCDD TEQ (D/F) is the primary contributor to the HI in year 2030 (NOAEL-based HQ = 10), copper is estimated to also be a contributor by year 2059 (NOAEL-based HQ = 6). With the exception of TCDD TEQ (D/F), all LOAEL-based HQs are 1 or less, and no other COPEC appears to pose a bioaccumulation hazard to fish throughout the assessment period.

Similar conclusions are drawn from the residue-based analysis for mummichog tissue under Alternative 2. NOAEL- and LOAEL-based HIs for the mummichog CBR endpoint are 4 and 2 , respectively, in year 2030 and 8 and 2, respectively, in 2059 (Table 5-11). The NOAEL-based HQs for TCDD TEQ (D/F) in years 2030 and 2059 (HQs = 3 and 2, respectively) and for copper (HQ = 4) in 2054 are the only values that are equal to or greater than 1. The analysis suggests that copper may pose a slight bioaccumulation hazard to fish as sediment condition track back to baseline conditions, as the LOAEL-based HQ is just under 1 (HQ = 0.8).

Wildlife

The estimated futurecast hazard estimates for wildlife based on dose modeling for the full dredging alternative are presented in Tables 7-10 and 7-11 (heron assuming generic fish and mummichog diets, respectively) and Table 7-12 (mink). Assuming a generic fish diet, NOAEL- and LOAEL-based HIs for the heron in year 2030 are 4 and 1, respectively, and 9 and 2, respectively, in year 2059 (Table 7-10). The year 2059 HIs are higher than those immediately following the completion of dredging activities due to the increased lead and HMW PAH concentrations predicted in the heron diet. Only the NOAEL-based HQs for lead and HMW PAHs (HQs both equal to 3) exceed 1 (in year 2059), suggesting that conditions pose a low bioaccumulation hazard to heron under this remedial alternative.

Table 5-13 presents a summary of the wildlife dose modeling for the heron with an assumed diet of mummichogs. The results are qualitatively similar to those obtained assuming a generic fish diet, although predicted risks are somewhat lower. NOAEL- and LOAEL-based HIs for the heron in year 2030 are 1 and 0.2, respectively, and 7 and 0.8, respectively, in year 2059 (Table 5-13). As with the exposure scenario assuming a generic fish diet, the year 2059 HIs are higher than those immediately following the completion of dredging activities due to the increased lead and HMW PAH concentrations predicted in the heron diet. The lead and HMW PAHs NOAEL-based HQs in year 2059 are both 2 (also as estimated for the generic fish diet scenario).

NOAEL- and LOAEL-based HIs for the mink in both years 2030 and 2059 are 50 and 3, respectively (Table 5-14). Total TCDD TEQ HQ accounts for nearly all the estimated HIs, with the TCDD TEQ (D/F) HQ substantially larger than the TCDD TEQ (PCBs) HQ in year 2030 (HQs are 40 and 7, respectively) and the TCDD TEQ (D/F) HQ decreasing by 50% by year 2059 (HQ = 20) while the TCDD TEQ (PCBs) increases slightly (HQ = 10). HQs for all other COPECs are 1 or less for both assessment periods, as are the LOAEL-based HQs for TCDD TEQ (PCBs) and TCDD TEQ (D/F) parameters.

5.2.3 Alternative 3: Capping with Dredging for Flooding and Navigation

Figure 5-3 presents hazard estimates for the four COPECs with the largest geometric mean (of either the lower- and upper-bound sediment benchmarks or the NOAEL- and LOAEL- crab and fish residue analyses); Figure 5-4 presents similar values derived from the dose-based analysis for the heron and mink (both based on the generic fish diet) the Capping with Dredging for Flooding and Navigation remedial alternative.

Macroinvertebrates

The futurecast hazard estimates for macroinvertebrates based on the sediment benchmark and crab CBR endpoints for Alternative 3 (Capping with Dredging for Flooding and Navigation) are presented in Tables 5-8 and 5-9, respectively. For sediment benchmarks, the lower- and upper-based HIs at year 2019 are 20 and 8, respectively, while HIs for year 2052 are 30 and 7, respectively (Table 5-8). Only the NOAEL-based HQs for 2,3,7,8-TCDD, Total DDx and Total PCBs exceed 1 in 2023 (HQs range from 3 to 7). The remaining lower-based HQs are equal to 1 (HMW PAHs and mercury) or less (copper and lead). In year 2052, the lower-based HQ for HMW PAHs contributes most to the total HI. The lower-based HQs for copper, lead and HMW PAHs are all predicted to have increased by a factor of approximately 20 (HQs = 2, 3 and 20, respectively), whereas the HQs for the other COPECs are smaller in 2052, with values for ranging from 0.6 (mercury) to 3 (Total DDx) (Table 5-8). Only the upper-based HQs for 2,3,7,8-TCDD (both years) and HMW PAHs (year 2052 only) exceed 1.

The overall risk estimates for the blue crab CBR endpoint are predicted to remain similar through the 30-year evaluation period. NOAEL- and LOAEL-based HIs for year 2023 are 30 and 5, respectively, whereas the HIs for year 2052 are 10 and 3, respectively (Table 5-9). In both years, 2,3,7,8-TCDD is the major contributor to the HI values, with NOAEL-based HQs of 20 and 6 in years 2023 and 2052, respectively, and LOAEL-based HQs of 2 and 0.7, respectively. In addition, the NOAEL-based HQs for Total PCBs are 9 and 5 in years 2023 and 2052, respectively, and LOAEL-based HQs are 3 and 2, respectively. The NOAEL- and LOAEL-based HQs for all other COPECs are 1 or less in both years, and these appear to pose little threat to omnivorous macroinvertebrates as represented by the blue crab.

Fish

The futurecast hazard estimates for fish based on the CBR endpoints for Alternative 3 are presented in Tables 5-10 and 5-11 (generic fish and mummichog, respectively). NOAEL- and

LOAEL-based HIs for the generic fish CBR endpoint in year 2023 are 20 and 9, respectively, and 20 and 5 in year 2052 (Table 5-10). While TCDD TEQ (D/F) is the primary contributor to the NOAEL- and LOAEL-based HIs in year 2023, the copper HQ also contributes substantially to the NOAEL-based HI in year 2052. In both years, the NOAEL-based HQs for TCDD TEQ (D/F), Total DDx and mercury exceed 1 but only the LOAEL-based HQ for TCDD TEQ (D/F) is greater than 1 (HQs = 8 and 3 in 2023 and 2052, respectively).

NOAEL- and LOAEL-based HIs for the mummichog CBR endpoint are 4 and 2, respectively, in year 2023 and 7 and 2, respectively, in year 2052 (Table 5-11). Similar to the generic fish evaluation, the NOAEL-based HQ for TCDD TEQ (D/F) is the primary contributor to the year 2023 HI with copper also assuming importance in 2052. Based on the magnitude of the largest NOAEL-based HQs (*i.e.*, 3 for TCDD TEQ [D/F] in year 2023 and 4 for copper in year 2052) and the finding that only the LOAEL-based HQ for TCDD TEQ (D/F) (HQ = 2) exceeds 1, it is uncertain whether any adverse effects would be realized in forage fish populations under this remedial alternative.

<u>Wildlife</u>

The futurecast hazard estimates for wildlife based on dose modeling for Alternative 3 are presented in Tables 5-12 and 5-13 (heron assuming generic fish and mummichog diets, respectively) and Table 5-14 (mink). Assuming a generic fish diet, NOAEL- and LOAEL-based HIs for the heron in year 2023 are 4 and 1, respectively, and 9 and 2, respectively, in year 2052 (Table 5-12). Conditions in 2023 are estimated to pose a low risk of harm to the heron under this scenario, with the largest NOAEL-based HQ (Total DDx) equal to 2. In 2052, the primary contributors to the HIs are lead, HMW PAHs and Total DDx, with NOAEL-based HQs ranging from 2 to 3. All other NOAEL- and all LOAEL-based HQs (in both years 2023 and 2052) are less than 1. Overall the risk of harm to the heron, assuming a generic fish diet, appears to be low under Alternative 3.

Table 5-13 presents a summary of the wildlife dose modeling for the heron with an assumed diet of mummichogs. The results are similar to those obtained assuming a generic fish diet. NOAEL- and LOAEL-based HIs for the heron in year 2023 are 1 and 0.3, respectively, and 7 and 0.8, respectively, in year 2052 (Table 5-13). As discussed above for the generic fish diet, dietary exposure to the COPECs is unlikely to pose a substantial risk of harm to the heron following completion of the remedial construction phase. Over the 30-year assessment period, exposure doses to lead and HMW PAHs are predicted to increase by more than 10-fold and exceed NOAEL-based TRVs by a factor of 3; however, NOAEL- and LOAEL-based HQs for all other COPECs are estimated to be less than 1.

NOAEL- and LOAEL-based HIs for the mink in year 2023 are 60 and 4, respectively, and 30 and 2 in year 2052 (Table 5-14). The Total TCDD TEQ is the largest contributor to the HIs, with D/F congeners (predominately 2,3,7,8-TCDD) of greatest importance throughout the assessment period. With the exception of the NOAEL-based HQ for mercury in year 2023, estimated HQs for all COPECs are 1 or less in both assessment years (Table 5-14). Across the assessment period, Total TCDD TEQ (including both PCB and D/F congeners) accounts for nearly all the estimated risks to the wildlife mammal receptor group.

5.2.4 Alternative 4: Focused Capping with Dredging for Flooding

Figure 5-3 present hazard estimates for the four COPECs with the largest geometric mean (of either the lower- and upper-bound sediment benchmarks or the NOAEL- and LOAEL- crab and fish residue analyses); Figure 5-4 presents similar values derived from the dose-based analysis for the heron and mink (both based on the generic fish diet) the Focused Capping with Dredging for Flooding remedial alternative.

Macroinvertebrates

The futurecast hazard estimates for macroinvertebrates based on the sediment benchmark and crab CBR endpoints for Alternative 4 (Focused Capping with Dredging for Flooding) are presented in Tables 5-8 and 5-9, respectively. For sediment benchmarks, the lower- and upper-based HIs at year 2020 are 200 and 100, respectively, while HIs for year 2049 are 100 and 70, respectively (Table 5-8). 2,3,7,8-TCDD accounts for a majority of the lower- and upper-based HIs in year 2020, with the relative contribution decreasing somewhat by year 2049. The year 2020 lower-based HQs for Total DDx and Total PCBs are also both relatively large (NOAEL-based HQs = 40 and 30, respectively), followed by HMW PAHs and mercury (NOAEL-based

HQs = 10). Of the modeled COPECs, only the lower-based HQs for copper, lead and DDx are equal to or less than 1 in 2020 (Table 5-8). The lower-based HQs for most COPECs for year 2049 are somewhat decreased compared to the start of the 30-year assessment period; however, the HMW PAH HQ is twice as large. Although 2,3,7,8-TCDD dominates the risks to benthic macroinvertebrates across the assessment period under Alternative 4, all modeled COPECs are potential risk contributors. All upper-based HQs are greater than 1 except for the value for Total DDx in 2049 (HQ = 0.9) in both assessment years, supporting the conclusion that all modeled COPECs could adversely affect the benthic macroinvertebrate community throughout the assessment period. In likely order of decreasing importance, the sediment COPECs for the direct exposure pathway are 2,3,7,8-TCDD, Total DDx/Total PCBs, HMW PAHs, mercury and copper/lead. (Table 5-8).

Table 5-9 presents a summary of the blue crab CBR endpoint for Alternative 4. Estimated NOAEL- and LOAEL-based HIs at year 2020 are 200 and 40, respectively, and HIs for year 2049 are 200 and 30, respectively. In both years, the major contributors to the HIs are 2,3,7,8-TCDD and, to a lesser extent, Total PCBs. Otherwise, only the NOAEL-HQs for copper and mercury exceed 1 (HQs ranging from 2 to 3). 2,3,7,8-TCDD and Total PCBs account for nearly all the estimated residue-based risks to the macroinvertebrate receptor group and are the only COPECs with LOAEL-based HQs that exceed 1.

Fish

The futurecast hazard estimates for fish based on the CBR endpoints for Alternative 4 are presented in Tables 5-10 and 5-11 (generic fish and mummichog, respectively). NOAEL- and LOAEL-based HIs for the generic fish CBR endpoint in year 2020 are 200 and 90, respectively, and 100 and 70 in year 2049 (Table 5-10). For both assessment years, the major contributor to the HIs is TCDD TEQ (D/F) with NOAEL-based HQs of 200 and 100, respectively, in years 2020 and 2049. NOAEL-based HQs for other COPECs that exceed 1 in the two assessments include copper, mercury, and Total DDx, and the NOAEL-based HQ for TCDD TEQ (PCBs) exceeds 1 in 2020. Potential risks posed by lead and HMW PAHs appear to be of little concern, as both the NOAEL- and LOAEL-based HQs are less than 1. Across the assessment period, TCDD TEQ (D/F), copper and Total PCBs account for nearly all of the estimated risks to the generic fish receptor group under this remedial alternative.

NOAEL- and LOAEL-based HIs for the mummichog CBR endpoint are 30 and 10, respectively, in both years 2020 and 2049 (Table 5-11). In both years, the major contributors to the HIs are TCDD TEQ (D/F) and copper, with NOAEL-based HQs of 20 and 6, respectively, in year 2020 and 10 and 7, respectively, in year 2049. Only the LOAEL-based HQs for TCDD TEQ (D/F) exceed 1 (HQs = 9 and 7 for years 2020 and 2049, respectively). With the exception of the NOAEL-based HQ for Total PCBs in year 2020 (HQ = 2), all other HQs are 1 or less. Across the assessment period, TCDD TEQ (D/F) and copper account for nearly all the estimated risks to the mummichog receptor group under Alternative 4.

Wildlife

The futurecast hazard estimates for wildlife based on dose modeling for Alternative 4 are presented in Tables 5-12 and 5-13 (heron assuming generic fish and mummichog diets, respectively) and Table 5-14 (mink). Assuming a generic fish diet, NOAEL- and LOAEL-based HIs for the heron in year 2020 are 20 and 5, respectively, and 20 and 4 in year 2049, respectively (Table 5-12). In both assessment years, the following COPECs contribute roughly equally to the HI values: TCDD TEQ (D/F), TCDD TEQ (PCBs) lead, Total DDx, HMW PAHs and mercury. HQs at the beginning and end of the 30-year assessment period are comparable and all LOAEL-based HQs in both years are 1 or less.

Table 5-13 presents a summary of the wildlife dose modeling for the heron with an assumed diet of mummichogs from foraging in mudflat areas. The results are similar to those obtained assuming a generic fish diet, although predicted risks are somewhat lower. NOAEL- and LOAEL-based HIs for the heron in both years 2020 and 2059 are 10 and 2, respectively, (Table 5-13). In both assessment years, lead, HMW PAHs and TCDD TEQ are the primary contributors to the HIs with NOAEL-based HQs ranging from 2 to 4, in both years. NOAEL- and LOAEL-based HQs for all other COPECs are 1 or less; all LOAEL-based HQs in the focused capping alternative for the two assessment periods are less than 1.

NOAEL- and LOAEL-based HIs for the mink in year 2020 are 600 and 30, respectively, decreasing to 400 and 20 at year 2049 (Table 5-14). Total TCDD TEQ HQ accounts for nearly all of the HI values, with the relative contribution of D/F congeners being much greater than the PCB congeners (*e.g.*, NOAEL-based HQs for year 2020 for D/F and PCB congeners are 500 and 70, respectively). NOAEL-based HQs for Total PCBs and mercury in both years exceed 1, ranging from 4 (mercury) to 8 (Total PCBs), and values are slightly lower in year 2049. Exposures to copper, HMW PAHs and Total DDx are estimated to pose little risk to aquatic-dependent mammals such as the mink, and based on the NOAEL- and LOAEL-based HQs all being less than 1. Across the assessment period, Total TCDD TEQ (including both PCB and D/F congeners) account for a substantial majority of the estimated risks to the wildlife mammal receptor group under Alternative 4.

5.3 Future Risk Assessment Uncertainties

Uncertainties associated with the estimates of future modeled risks and hazards are identified in this section. As stated previously for the baseline risk assessments, the process of evaluating risks and hazards involves multiple steps and inherent in each step of the process are uncertainties that ultimately affect the final calculated risk and hazard estimates. As such, the significant sources of uncertainties discussed in detail in Sections 3.0 and 4.0 for the baseline HHRA and BERA, respectively, also apply to the estimated risks and hazards for the future modeled risk assessments and will not be restated here. The major difference between the baseline risk assessments and the future modeled risk assessments is that measured sediment and tissue concentrations were used to estimate baseline exposures, while future exposures were based on concentrations estimated from contaminant fate and transport models and regression models. Therefore, there are two additional significant sources of variability and uncertainty[40] associated only with the future modeled risk assessments that are identified here. These additional uncertainties include those associated with (1) modeled sediment concentrations and (2) estimated biota tissue concentrations. Both sources of uncertainty, and the likely impacts of

[40] Although different and possibly requiring separate treatments in the analysis, the distinction between uncertainty (*i.e.*, ignorance about a poorly characterized phenomenon, which may be reducible given further study; extrinsic property) and variability (*i.e.*, diversity in a well characterized population that is not generally reducible through further study; intrinsic property) can be overdrawn from a risk management perspective (Morgan, 1998) and a bright line distinction is not attempted here.

these uncertainties on the calculated risks, are summarized in the following subsections, while more detailed analyses of these uncertainties are included in Attachment 7.

5.3.1 Modeled Sediment Concentrations

In order to perform risk assessments for the remedial alternatives, COPC and COPEC concentrations in the sediments were forecast using two models. Two separate model-based examinations of contaminant transport were conducted. The LPR-NB Model used a mechanistic modeling approach, incorporating sediment transport and organic carbon modeling as inputs to a contaminant fate and transport model for the COPCs and COPECs on an individual basis. The EMBM used an empirical approach to simultaneously examine the particle-borne loads of a broad suite of COPCs and COPECs and other compounds and thereby establish the magnitude of each COPC/COPEC load from each of the major sources to the estuary. Appendices B and C discuss the analysis, assumptions, and model-specific uncertainties associated with forecasting sediment exposures in the Lower Passaic River out to 2059 for the LPR-NB and EMBM models, respectively.

Results from the LPR-NB Model were selected over the EMBM for use in the future HHRA and BERA based on peer review recommendations (described in Appendix B); however, several COPC/COPECs were only modeled from the EMBM, in which case these results were used in the future risk assessments. For the HHRA, future modeled concentrations for all COPCs except chlordane were obtained from the LPR-NB Model (note that chlordane is not a risk driver for human health). For the BERA, future modeled concentrations for all COPECs except chlordane, copper, lead, and HMW PAHs were obtained from the LPR-NB Model. A comparison of modeled sediment concentrations for those constituents included in both models was conducted and is provided in Table 5-15. The results of this comparison showed that concentrations estimated with the LPR-NB Model are lower than those from the EMBM, especially for Total PCBs. Therefore, concentrations of the COPC/COPECs in sediment may be over- or underestimated depending on which model results are used. As such, the risks and hazards presented for human and ecological receptors may be over- or underestimated depending on which model results were used.

In addition, future concentrations of dieldrin and LMW PAHs in sediment could not be forecast with either model due to geochemical constructs specific to the available sediment datasets. Therefore, these two constituents were not evaluated in the future risk assessments and future estimates of risk/hazard are underestimated for both human and ecological receptors.

As would be true of any model, there is some uncertainty associated with forecasting future sediment concentrations. For the LPR-NB, uncertainties were accounted for by lower and upper bound scale factors developed following methodology in Connolly and Tonelli (1985) (Appendix B). Attachment 7 provides the chemical-specific lower and upper bounds on the forecast sediment concentrations for each of the COPCs/COPECs, while the likely impact of these uncertainties on the calculated human and ecological risks are provided in Sections 5.3.1.1 and 5.3.1.2, respectively.

5.3.1.1 Impacts on Human Health Risk

To show the variability of the forecast concentrations on total risk/hazard estimates for human health, upper and lower bounds on cancer risk and noncancer health hazard were calculated for all of the COPCs for the sportsman/angler[41] for consumption of both fish and crab. The tissue EPCs for future exposures were derived using site-specific and chemical-specific sediment-tissue relationships (*e.g.*, sediment-tissue regressions) as described previously in Section 5. Figure 5-5 shows the upper and lower bounds on the future modeled total cancer risks and noncancer health hazards.

Dieldrin was not evaluated in the future risk assessment and, therefore, estimates of future cancer risks and noncancer health hazards are underestimated for the HHRA. Note that dieldrin was not a risk driver for human health; that is, risk due to the presence of dieldrin was within the risk range. If it is assumed that future dieldrin concentrations will at least be equal to concentrations observed in the historical data for fish and crab, then future total cancer risks for each of the remediation alternatives have been underestimated by as much as the value for the current dieldrin risk associated with fish and crab ingestion. The current estimates of risk are 9×10^{-5}

[41] Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and the child (based on 6-year exposure).

and 2×10^{-5} for fish and crab ingestion, respectively (values obtained by adding risk for adult and child as presented in the baseline risk assessment, Tables 4-13 and 4-15 of Attachment 4). Similarly, future noncancer HIs for fish and crab ingestion have been underestimated by as much as the current HQs for dieldrin for fish and crab ingestion (HQs ranged from 0.1 to 0.4 for fish and crab ingestion, for adult and child receptors as obtained from the baseline risk assessment, Tables 4-16 and 4-18 of Attachment 4).

5.3.1.2 Impacts on Ecological Risk

Future exposure estimates to fish and gull embryos were not derived because individual dioxin, furan, and PCB congener concentrations were not modeled with the LPR-NB Model. Although future modeled risks estimates were not derived for these life stages, the BERA determined that risks for adult organisms were comparable to those assessed for early life stages under current conditions. It is anticipated that the evaluation of adult exposures would continue to be suitable surrogates for early life stage effects in the future.

Future modeled hazard estimates for the heron assumed that the typical individual is not a year-long resident within the FFS Study Area. An exposure frequency (EF) of 0.58 was used (*i.e.*, visitor heron scenario) in the exposure dose models to account for the time that individuals is not present but rather at a presumably uncontaminated site. As determined in Section 4, it is expected that future resident omnivorous piscivores would have site-related exposures/risks approximately double the estimated values presented in Tables 5-10 and 5-11 (generic fish and mummichog diets, respectively). Due to the borderline nature of the modeled future risk estimates for this receptor, it is predicted that there would be reduced uncertainty regarding the likelihood of adverse effects in this receptor category for resident populations.

The lack of future modeled concentrations for LMW PAHs and dieldrin resulted in overall risks being somewhat under-estimated. However, the hazard estimates associated with these were relatively low compared to other COPECs for which future concentrations were projected. Under current conditions, residue-based hazard estimates for LMW PAHs and dieldrin in generic fish and mummichog tissue represent only 1 to 2% of the total HIs (Table 4-16) and relative hazards for wildlife are even lower (Table 4-19). Two other factors that also contribute to the future modeled ERA under-estimating risks include the evaluation of a subset of potential chemical stressors and the lack of evaluation of the surface water exposure pathway; these also affect interpretation of the BERA conclusions (Section 4), as well.

Attachment 7 presents an assessment of the impact of sediment modeling uncertainties on the future modeled ERA. Consideration of uncertainty associated with the forecast COPEC sediment concentrations has minimal impact on the overall conclusions of the predictive risk analysis. Borderline situations, where total HI or HQs for individual COPECs are close to 1, are most likely to be affected. An example is the future modeled risk assessment for herons, particularly Alternatives 2 and 3, discussed above. Uncertainty related to the sediment concentration forecasts, along with uncertainty about the specific effective dose (as bounded by the NOAEL and LOAELs TRVs), daily site fidelity and annual EF (resident versus visiting individuals) combine to make a definitive determination about the realization of population-level impacts challenging in this instance. The likelihood that residual exposures to FFS Study Area sediments will continue to adversely affect aquatic organisms is more compelling for other receptors such as mink, sediment benthos and fish. Of course these uncertainties apply across all remedial alternatives evaluated and do not affect relative performance evaluations.

The potential effects of spatial and temporal variability are also evaluated in Attachment 7 (Section 7.2). The fifth and 95th percentiles of the LPR-NB model (and EMBM in the case of copper, lead and HMW PAHs) forecast sediment concentrations were used to evaluate the potential impacts of spatial heterogeneity on the risk analysis, particularly for more sedentary organisms such as benthic macroinvertebrates. This analysis concludes that the estimates hazard estimates could be up to six- to seven-fold higher in portions of the FFS Study Area where elevated COPEC concentrations reside. This concern would apply, for instance, regarding exposures in RM0-2, which is highly depositional due to a combination of hydrodynamic and physic-chemical factors.

5.3.2 Estimated Biota Tissue Concentrations

Another source of uncertainty is associated with estimating the EPC concentrations in fish and shellfish tissue. Tissue concentrations were estimated based on the results of regression analyses conducted to develop site-specific sediment-tissue relationships for the FFS Study Area (as described in Attachment 7 and detailed in Appendix A, Data Evaluation Report No. 6). In most cases, it was determined that the functional relationship between COPC and COPEC concentrations in sediment and biological tissue could best be described using regression models. However, biota sediment accumulation factors were calculated to estimate Total non-dioxin-like PCBs concentrations in white perch and American eel, and bioaccumulation factors were calculated to estimate copper concentrations in white perch, American eel and mummichog based on concentrations of these COPECs in sediment. The development of site-specific sediment-tissue relationships is preferable to the use of generic literature values. Literature values may under-or overestimate the extent of biological uptake because site conditions that affect contaminant bioavailability and uptake potential are not considered or cannot be easily measured.

Because the fish consumption pathway is typically associated with the majority of risk to both human and wildlife receptors and is the basis for the tissue exposures evaluated in the ecological residue-based analysis, the uncertainties associated with these values may have an impact on the outcome of both the ecological and the human health assessments.

Uncertainties associated with predicting tissue residues based on sediment COPEC concentrations are discussed in Appendix A (Data Evaluation Report No. 6). The evaluation presented in Attachment 7 included consideration of the regression model correlation coefficients and in the case of the BSAF for Total PCBs (white perch and American eel) and the BAF for copper (white perch, American eel and mummichog), standard errors of the uptake factor. This analysis concludes that this source of uncertainty is unlikely to impact the general conclusions of the future modeled risk assessments; of particular interest is the relatively strong correlation coefficients for 2,3,7,8-TCDD, which is one of the primary risk contributors across the receptors evaluated. In addition, the site derived sediment-tissue relationships are comparable to available uptake data for other similar urbanized estuaries (Appendix 1).

6 SUMMARY AND CONCLUSIONS

The HHRA and BERA were conducted as part of the FFS to evaluate the need for, and feasibility of, implementing an action to control the sediments of the FFS Study Area. Separate baseline human health and ecological risk assessments are being prepared to support decision-making during the conduct of the comprehensive RI/FS for the entire 17-mile LPRSA, which is currently underway. The overall process for assessing risks to support USEPA's evaluation of remedial alternatives to address the sediments in the FFS Study Area consisted of: (1) estimating baseline risks; and (2) estimating risks associated with modeled future sediment contaminant concentrations following implementation of each remedial alternative being considered based on the results of contaminant fate and transport models.

Results of both the HHRA and the ERA support the conclusion that current conditions within the FFS Study Area pose significant risks to human and ecological receptors.

6.1 Human Health Risk Assessment Summary

6.1.1 Baseline Human Health Risk Assessment

Potential risk to human health is evaluated for consumption of fish and crab. For purposes of establishing baseline[42] risks and evaluating modeled future risks, cancer risks and noncancer health hazards were estimated for an adult and a child receptor. The ED for the combined adult/child of 30 years is used to represent the most conservative standard receptor for evaluation of carcinogens. The child, age 1-6 years, is assumed to represent the most conservative standard receptor for noncarcinogens. Cancer risks and noncancer health hazards were evaluated for RME and CTE to describe the magnitude and range of exposure that might be incurred by the receptor groups. The objective of providing both the RME and CTE exposure cases is to bound the risk estimates, although decisions are based on the RME consistent with the NCP (USEPA, 1985). The cancer risks derived in the HHRA are compared to the NCP risk range of 10^{-4} (one in ten thousand) to 10^{-6} (one in a million) and noncancer threshold of one (USEPA, 1990). The

[42] For the purposes of this HHRA, baseline conditions denote the absence of remedial action.

cancer risks and noncancer hazards associated with baseline current and future modeled conditions are summarized in Table 6-1.

The HHRA determined that under baseline conditions the cancer risks to individuals based on the RME are greater than the risk range established in the NCP of 10^{-4} (one in ten thousand) to 10^{-6} (one in one million) and that noncancer health hazards are higher than USEPA's goal of protection of an HI equal to 1. The majority of the cancer risk is associated with dioxin (approximately 70% for fish and 80% for crab). Most of the remaining cancer risk is from PCBs for both fish and crab consumption. Similarly, dioxin and PCBs combined contribute approximately 98% of the excess hazard, while the remaining excess hazard is associated with methylmercury for all receptors for ingestion of both fish and crab. There are uncertainties associated with the results of this risk assessment that may contribute to over- or underestimates of cancer risk and non-cancer health hazards that should be considered when making risk management decisions for this site. However, given that there were exposure pathways (*e.g.*, boating, wading) and COPCs not evaluated, risks may be underestimated, so that the conclusion that the sediments of FFS Study Area pose unacceptable risks to human health is robust.

6.1.2 Future Modeled Human Health Risk Assessment

The process of evaluating remedial alternatives for human health used the same risk assessment methodology, including potential exposure scenarios and assumptions that were evaluated in the baseline risk assessment described in Section 3.0.

To evaluate future modeled human health risk, carcinogenic risks and noncarcinogenic health hazards were estimated only for the RME individual and only for the adult angler/sportsman and child consuming the adult's catch. For carcinogenic risk, a 30-year exposure period was evaluated, assuming 24 years as an adult and 6 years as a child, to depict a scenario resulting in the most health protective calculations of cancer risks. For noncarcinogens, both a child receptor and an adult were evaluated to depict scenarios resulting in the most health protective noncancer health hazards.

Future chemical concentrations in fish and crab were derived using modeled annual average projections of future concentrations in sediment in conjunction with site-specific and chemical-specific sediment-tissue relationships (*e.g.*, sediment-tissue regressions).

Table 6-2 summarizes the estimated total future modeled cancer risks and noncancer health hazards for each active remedial alternative. Note that risk results for Alternative 1, the No Action alternative, corresponds to the risk results for the baseline future modeled alternative provided in Table 6-1. The impacts of remedial Alternative 1 and Alternative 4 are not apparent because total cancer risks for these two alternatives (Tables 6-1 and 6-2) are outside the NCP risk range of 10^{-4} to 10^{-6} and noncancer HIs are estimated to be considerably higher than USEPA's goal of protection of an HI equal to 1. However, impacts of remediation associated with Alternative 2 and Alternative 3 demonstrate that cancer risks are closer to achieving risks within the NCP risk range of 10^{-4} to 10^{-6} and noncancer HIs are estimated to be closer to USEPA's goal of protection of an HI equal to 1.

6.2 Ecological Risk Assessment Summary

6.2.1 Current Ecological Risk Assessment

The BERA conducted to support the FFS evaluated risks to sediment-associated organisms from direct contact exposures with contaminated sediment, as well as bioaccumulation hazards to aquatic organisms that forage in the FFS Study Area and the wildlife that consume them. Receptors of interest included sediment-dwelling and epibenthic macroinvertebrates, pelagic and demersal fish, and piscivorous wildlife (mink and great blue heron).

A chemical screening process was used to select nine COPECs for consideration including copper, lead, mercury, LMW PAHs, HMW PAHs, dieldrin, total DDx, total PCBs, and TCDD TEQs (including contributions from D/F and coplanar PCB congeners). Reasonable, but conservative exposure assumptions were used to estimate EPCs and model dietary exposures. For each assessment endpoint, lower- and upper-bound toxicity benchmarks (*e.g.*, T20/T50 and NOAA ER-L/ER-M sediment benchmarks and NOAEL/LOAEL CBRs and TRVs for tissue residues and wildlife dose, respectively) were used to quantify uncertainty in the risk estimates.

Consistent with the Ecological Risk Assessment Guidance (USEPA, 1997), conservative assumptions employed in the initial risk screening and COPEC selection process (presented in Attachment 2) were relaxed to obtain more reasonable risk conclusions. Examples include preference for T20/T50 sediment benchmarks over other compiled values with lower confidence, evaluation of "visitor" bird exposure scenarios and use of 95% UCLs rather than maximum concentrations to develop EPCs.

Table 6-3 summarizes the HIs calculated for the receptors evaluated under current conditions in the FFS Study Area. Individual HQs for each COPEC and receptor are presented in Attachment 6. Typically, HIs are only calculated to characterize ecological risks when all COPECs cause effects by the same mechanism or mode of action and when those effects are additive. Although that is not the case for all COPECs evaluated for this BERA, HIs were calculated to simplify the characterization of risks and evaluation of estimated changes in risk as a result of the different remedial alternatives. Generally, an HI greater than 1 indicates a potential for adverse effects. Results from the assessment of baseline risks strongly support the conclusion that ecological receptors residing and foraging in the FFS Study Area are being adversely impacted as a result of exposures to COPECs.

Pesticides and 2,3,7,8-TCDD present the greatest direct exposure hazards to benthic macroinvertebrates, although there are risks to this receptor group from direct exposure to all of the COPECs evaluated. Residue-based hazards to macroinvertebrates were evaluated by comparing measured blue crab tissue concentrations to CBRs for aquatic invertebrates. This analysis indicated that 2,3,7,8-TCDD and total PCBs posed the greatest bioaccumulation hazard to macroinvertebrates, although tissue concentrations of all COPECs except lead exceed at least one residue-based benchmark. TCDD TEQ (D/F), copper and total PCBs present a substantial bioaccumulation hazard to fish (including mummichogs) in the FFS Study Area. Risks to piscivorous bird populations are relatively low compared with other receptors in the area, with the greatest hazards posed by exposure to TCDD TEQ (including both D/F and PCBs). TCDD TEQ (D/F) is the primary risk contributor to piscivorous mammals in the FFS Study Area, and risk estimates are over an order of magnitude greater than those for birds.

6.2.2 Future Ecological Risk Assessment

The process of evaluating remedial alternatives to address ecological concerns employed the same risk assessment methodology, including the same potential exposure scenarios and toxicological data, used in the assessment of baseline conditions (presented in Section 4.0). The future modeled risk assessment also examines the receptors, exposure pathways, and chemicals most likely associated with the greatest contribution to overall risks. Results of the assessment of future modeled ecological risks for invertebrates, fish and wildlife are summarized in Figures 6-1 through 6-3, respectively.

In general, eight sets of future EPCs were developed for each COPEC, corresponding to each of the remediation alternatives at two time periods (*i.e.*, at the beginning and end of the 30-year evaluation period).

The following general conclusions are made regarding ecological risk reduction based on future risk projections:

- Elevated risks to the benthos are predicted to continue for most COPECs and across all remedial alternatives (Tables 5-6 and 5-7, Figure 6-1). Both Alternative 3 (Capping with Dredging for Flooding and Navigation) and Alternative 2 (Deep Dredging with Backfill) are predicted to reduce risks to benthic macroinvertebrates by well over an order of magnitude for both the invertebrate direct contact and tissue residue assessment endpoints.
- Residue-based risks to forage fish and dose-based risks to birds are predicted to be marginal by the end of the 30-year assessment period for Alternatives 2 and 3 (Tables 5-9 through 5-11). For both of these, the majority of LOAEL-based HQs (and often the overall HI as well) are less than 1; these risk estimates are in the grey area where actual risks may or may not be realized because the exact effect threshold concentration is uncertain but likely lies somewhere between the NOAEL and LOAEL values.
- In all instances, Alternatives 3 and 2 are predicted to result in the greatest reduction in ecological risks across the range of receptors evaluated in the assessment. Furthermore, these active remedies are predicted to result in substantive ecological

improvements and achieve preliminary remediation goals for at least one of the primary risk drivers in a substantially shorter period of time than Alternatives 1 and 4.

The results of the assessment of future conditions associated with each of the remedial alternatives at the end of the assessment period are summarized in Table 6-4, which presents geometric means of the lower- and upper HIs for each combination of receptor and alternative evaluated. Across the different receptors, HIs for Alternatives 1 and A4 are between 5-10 fold greater than similar values for Alternatives 2 and 3. Geometric mean HIs for Alternative 1 range from 10 to 200, with the heron dose modeling endpoint at the low end of the range and benthos, generic fish residue and mink dose modeling endpoints at the upper end. Geometric mean HIs for Alternative 4 are similar although the upper end of the range is 100. With consideration to the various uncertainties in this risk analysis, there is little doubt that the majority of environmental endpoints evaluated would still be adversely impacted at the end of the assessment period for these two alternatives. Geometric mean HIs for Alternatives 2 and 3 range from 4 to 20 and 4 to 10, respectively (Table 6-4). These results suggest that although at least some of the endpoint receptors could still be impacted 30 years post-implementation, ecosystem recovery would be far advanced compared to the other two alternatives.

7 ACRONYMS

A-C	acute to chronic
ADD	average daily dose
AE	assessment endpoint
AhR	aryl hydrocarbon hydroxylase receptor
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
AXYS	Axys Analytical Services
BaP	benzo(a)pyrene
BAZ	biologically active zone
BERA	baseline ecological risk assessment
BMF	biological magnification factor
bss	below sediment surface
BW	body weight
CalEPA	California Environmental Protection Agency
CAS	Columbia Analytical Services
CBR	critical body residue
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CLH	Chemical Land Holdings, Inc.
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CPG	Cooperating Parties Group
CSF	cancer slope factor
CSM	conceptual site model
CSO	combined sewer overflow
Ct	biota tissue concentration
CTE	Central tendency exposure
DDD	dichlorodiphenyldichloroethane

DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDx	sum of DDD, DDE, and DDT
DEP	Department of Environmental Protection
D/F	dioxin/furan
DLC	dioxin-like compound
DQL	data quality limit
DQO	data quality objective
Eco-SSL	Ecological Soil Screening Level
ED	exposure duration
EF	exposure frequency
EFH	Exposure Factors Handbook
EMBM	Empirical Mass Balance Model
EPC	exposure point concentration
ER-L	effects range-low
ER-M	effects range-median
EROD	7-ethoxyresorufin-O-deethylase
ETM	estuarine turbidity maximum
FDA	Food and Drug Administration
FFS	Focused Feasibility Study
FI	fraction ingested from contaminated sources
FS	Feasibility Study
FSP	Field Sampling Plan
g	gram
g/day	grams per day
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HMW PAH	high molecular weight PAH
HQ	hazard quotient
I	intake rate

I_A	adjusted intake rate
in./yr	inches per year
IPCS	International Programme on Chemical Safety
IR	ingestion rate
IRIS	Integrated Risk Information System
IS	interspecies
kg	kilogram
KM	Kaplan Meier
L_1	cooking loss
L_2	post-cooking loss
LADD	lifetime average daily dose
LCL	lower confidence level
LMW PAH	low molecular weight PAH
L-N	LOAEL-NOAEL
LOAEL	lowest observed-adverse-effects level
LPR-NB	Lower Passaic River-Newark Bay Model
LPRSA	Lower Passaic River Study Area
µg/g	micrograms per gram (equivalent to parts per million)
µg/kg	micrograms per kilogram
MDL	method detection limit
mg	milligram
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram of body weight per day
MRL	minimal risk level
NA	not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	not determined
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed-adverse-effects level
NYSDOH	New York State Department of Health

OEHHA	Office of Environmental Health Hazard Assessment
OSWER	Office of Solid Waste and Emergency Response (USEPA)
‰	parts per thousand
PAH	polycyclic aromatic hydrocarbon
PAR	Pathways Analysis Report
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran
ppb	part per billion
ppm	part per million
PPRTV	provisional peer-reviewed toxicity value
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose
RI	Remedial Investigation
RM	river mile
RME	reasonable maximum exposure
SOP	standard operating procedure
SPI	sediment profile imaging
SSD	species sensitivity distribution
SUF	site use factor
SVOC	semivolatile organic compound
SWO	stormwater outfall
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	toxic equivalency
TRV	toxicity reference value
UCL	upper confidence level
USEPA	United States Environmental Protection Agency

VOC	volatile organic compound
WHO	World Health Organization
ww	wet weight

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Tables

Table 2-1 TEQ Factors for Dioxin/Furans and Dioxin-like PCB Congeners

Congener	TEF		
	Mammal[(a)]	Fish[(a)]	Bird[(a)]
Dioxins/Furans			
2,3,7,8- TCDD	1	1	1
1,2,3,7,8-PeCDD	1	1	1
1,2,3,4,7,8-HxCDD	0.1	0.5	0.05
1,2,3,6,7,8-HxCDD	0.1	0.01	0.01
1,2,3,7,8,9-HxCDD	0.1	0.01	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.001	0.001
OCDD	0.0003	0.0001	0.0001
2,3,7,8-TCDF	0.1	0.05	1
1,2,3,7,8-PeCDF	0.03	0.05	0.1
2,3,4,7,8-PeCDF	0.3	0.5	1
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.01
OCDF	0.0003	0.0001	0.0001
PCB Congeners			
3,3',4,4'-Tetrachlorobiphenyl (77)	0.0001	0.0001	0.05
3,4,4',5-Tetrachlorobiphenyl (81)	0.0003	0.0005	0.1
3,3',4,4',5-Pentachlorobiphenyl (126)	0.1	0.005	0.1
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	0.03	0.00005	0.001
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.00003	0.000005	0.0001
2,3,4,4',5-Pentachlorobiphenyl (114)	0.00003	0.000005	0.0001
2,3',4,4',5-Pentachlorobiphenyl (118)	0.00003	0.000005	0.00001
2',3,4,4',5-Pentachlorobiphenyl (123)	0.00003	0.000005	0.00001
2,3,3',4,4',5-Hexachlorobiphenyl (156)	0.00003	0.000005	0.0001
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	0.00003	0.000005	0.0001
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	0.00003	0.000005	0.00001
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	0.00003	0.000005	0.00001

(a) Mammalian TEF values published in 2005 by the World Health Organization (Van den Berg *et al*., 2006) and recommended by USEPA (2010a); TEFs for bird and fish species presented in Van den Berg *et al*., 1998.

Table 3-1 Fish Feeding Guilds and Preferences

Guild[a]	Feeding Preferences	Species Collected	Ecological Habitat
Invertivore/omnivore	insects, small fish, mollusks, crustaceans/anything available	white catfish	demersal - bottom feeder
		white perch	pelagic - predator
		white sucker	demersal - bottom feeder
		common carp	demersal - bottom feeder
Piscivore	other fish	smallmouth bass	pelagic - predator
Piscivore/invertivore	other fish/ insects, small fish, mollusks, crustaceans	American eel	demersal - bottom feeder

(a) Fish feeding guilds and preferences were obtained from the QAPP for the late summer/early fall 2009 sampling event (Windward Environmental, 2009a).

Table 3-2 Exposure Point Concentrations for the Human Health Risk Assessment

COPC	EPC[(a)] (mg/kg)							
	Current Baseline		Future Modeled Baseline					
	Fish[(b)]	Crab[(c)]	Fish[(e)]			Crab[(e)]		
	Adult, Adolescent and Child	Adult, Adolescent and Child	Adult	Adolescent	Child	Adult	Adolescent	Child
Chlordane	0.062	0.0057	0.042	0.042	0.042	0.0042	0.0042	0.0042
Dieldrin	0.025	0.0084	NA[f]	NA[f]	NA[f]	NA[f]	NA[f]	NA[f]
Mercury	0.36	0.17	0.29	0.31	0.32	0.092	0.097	0.10
TCDD TEQ (D/F)	0.00010	0.000075	0.000053	0.000054	0.000060	0.000039	0.000042	0.000043
TCDD TEQ (PCB)	0.000016	0.000011	0.000038	0.000042	0.000045	0.000043	0.000046	0.000048
Total PCBs[(d)]	1.7	0.37	0.98	1.1	1.2	0.37	0.39	0.42
DDD	0.069	0.022	0.10	0.11	0.11	0.018	0.019	0.020
DDE	0.13	0.057	0.11	0.11	0.12	0.021	0.022	0.023
DDT	0.0046	0.0034	0.098	0.10	0.11	0.016	0.018	0.019

(a) EPCs are 95% UCL on the arithmetic mean for the current baseline exposures. Samples included in the 95% UCL calculations are listed in Attachment 1.1. 95% UCLs calculated using USEPA ProUCL 4.1 software (version 4.1.00); ProUCL output files that contain assumptions on the distribution of the data are included in Attachment 3.

(b) In order to account for the distinct ecological groups of fish that may be appreciably consumed by recreational anglers/sportsmen, analytical data from six species, rather than a single species, were used to derive an equal-weighted average concentration to represent the EPC for fish (see Section 3.4.2 for details).

(c) EPC derived from samples consisting of muscle and hepatopancreas tissues for the HHRA.

(d) Total PCBs represent the sum of nondioxin-like PCB congeners.

(e) EPCs are based on modeled projections of future sediment concentrations using biota uptake factors as discussed in Attachment 7. A 30-year exposure period is evaluated, assuming 24 years as an adult and 6 years as a child to depict a scenario resulting in the most health protective calculations of cancer risks. In order to ensure annual average concentrations are not biased low (concentrations fluctuate over time due to resuspension of legacy sediments and/or contributions from outside sources), a sliding scale of annual averages based on the ED for each receptor (*e.g.*, 6 years for the child, 24 years for the adult, and 12 years for the adolescent) was determined for a total 30-year exposure time period. Thus, a maximum rolling annual average based on the receptor-specific ED was selected as the EPC.

(f) Dieldrin could not be forecast due to geochemical constructs specific to the available sediment datasets and therefore could not be included in the future risk evaluation.

D/F = dioxin/furan
mg/kg = milligram per kilogram

Table 3-3 Summary Statistics for Contaminant Percent Loss[a] from Fish Due to Cooking

	Skin Off					Skin On					Combined[c]				
Contaminant[b]	Minimum	Average	50th Percentile	90th Percentile	Maximum	Minimum	Average	50th Percentile	90th Percentile	Maximum	Minimum	Average	50th Percentile	90th Percentile	Maximum
DDD	4	30	19	61	88	10	37	36	54	54	4	31	30	58	88
DDE	7	30	27	52	75	7	39	39	49	59	7	32	35	52	75
DDT	0	38	30	69	141	4	33	29	58	60	0	37	30	64	141
Chlordane	1	29	30	51	83	3	38	38	52	63	1	32	33	51	83
Dieldrin	4	29	25	52	88	3	36	38	58	93	3	32	30	55	93
TCDD	54	56	56	57	57	37	51	44	69	80	37	53	49	69	80

Source: USEPA, 2000c

(a) Percent losses are derived by combining all cooking methods.

(b) Contaminants have all been grouped under one heading. For example, alpha chlordane and gamma chlordane have been combined and results summarized as “chlordane”.

(c) Combined includes both skin-on and skin-off results.

Table 3-4 Range of Cooking Losses from Fish[a]

COPC	Exposure Scenario	
	RME (%)	CTE (%)
DDD	0	30[b]
DDE	0	35[b]
DDT	0	30[b]
Chlordane	0	33[b]
Dieldrin	0	30[b]
Dioxins	0	49[b]
PCBs	0	30
Mercury[c]	0	0

RME – reasonable maximum exposure
CTE – central tendency exposure
(a) Refer to Table 3-4, "combined column".
(b) The USEPA EFH (2011) provides a recommended default adjustment for cooking and preparation loss. The values given in the EFH for fish/shellfish are 31.5% for mean net cooking loss and 10.5% for mean net post cooking loss.
(c) Preparation and cooking loss adjustments should not be applied for metals in most cases (USEPA, 2000c).

Table 3-5 Distribution of Time Remaining Until an Individual Moves Out

County	Population Tracked[a]	Probability of Moving in 5-Year Span	Probability of Moving in 1-Year Span	50th Percentile (Years)	95th Percentile (Years)
Essex	750,904	0.1841	0.0496	14.6	59.9
Hudson	561,984	0.2004	0.0544	13.4	54.6
Region (Essex and Hudson Counties combined)	1,312,888	0.1199	0.0314	22.7	94.8

(a) By county: non-movers + movers within the county + total movers out of the county; by region: non-movers + movers within the county + movers within the region + movers outside the region.

Table 3-6 Summary of Baseline Current Cancer Risk for Ingestion of Fish and Crab

Fish Cancer Risk - RME						Fish Cancer Risk - CTE				
COPC	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[a]	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[a]
TCDD TEQ (D/F)	3.E-03	1.E-03	1.E-03	4.E-03	70%	5.E-05	3.E-05	3.E-05	8.E-05	70%
TCDD TEQ (PCBs)	4.E-04	2.E-04	2.E-04	6.E-04	11%	1.E-05	7.E-06	6.E-06	2.E-05	17%
Total PCBs	6.E-04	3.E-04	2.E-04	8.E-04	16%	8.E-06	5.E-06	4.E-06	1.E-05	10%
4,4'-DDD	3.E-06	1.E-06	1.E-06	4.E-06	0.08%	8.E-08	5.E-08	4.E-08	1.E-07	0.1%
4,4'-DDE	7.E-06	3.E-06	3.E-06	1.E-05	0.21%	2.E-07	1.E-07	1.E-07	3.E-07	0.3%
4,4'-DDT	3.E-07	1.E-07	1.E-07	4.E-07	0.01%	8.E-09	5.E-09	4.E-09	1.E-08	0.01%
Total Chlordane	4.E-06	2.E-06	1.E-06	5.E-06	0.10%	1.E-07	6.E-08	5.E-08	2.E-07	0.1%
Dieldrin	7.E-05	3.E-05	3.E-05	9.E-05	2%	2.E-06	1.E-06	1.E-06	3.E-06	3%
Methylmercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Total	4.E-03	2.E-03	1.E-03	5.E-03	--	8.E-05	5.E-05	4.E-05	1.E-04	--
Crab Cancer Risk - RME						Crab Cancer Risk - CTE				
COPC	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[a]	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[a]
TCDD TEQ (D/F)	1.E-03	5.E-04	4.E-04	2.E-03	82%	6.E-05	4.E-05	3.E-05	9.E-05	86%
TCDD TEQ (PCBs)	2.E-04	8.E-05	7.E-05	2.E-04	12%	7.E-06	4.E-06	4.E-06	1.E-05	10%
Total PCBs	8.E-05	3.E-05	3.E-05	1.E-04	5%	2.E-06	1.E-06	8.E-07	2.E-06	2%
4,4'-DDD	5.E-07	2.E-07	2.E-07	8.E-07	0.04%	3.E-08	2.E-08	2.E-08	4.E-08	0.04%
4,4'-DDE	2.E-06	9.E-07	8.E-07	3.E-06	0.14%	1.E-07	6.E-08	6.E-08	2.E-07	0.1%
4,4'-DDT	1.E-07	5.E-08	5.E-08	2.E-07	0.01%	6.E-09	4.E-09	3.E-09	1.E-08	0.01%
Total Chlordane	2.E-07	9.E-08	8.E-08	3.E-07	0.01%	1.E-08	7.E-09	6.E-09	2.E-08	0.02%
Dieldrin	1.E-05	6.E-06	5.E-06	2.E-05	1%	7.E-07	4.E-07	4.E-07	1.E-06	1.0%
Methylmercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total	1.E-03	6.E-04	5.E-04	2.E-03	--	7.E-05	4.E-05	4.E-05	1.E-04	--

Scientific notation such as 5.E-03 is equivalent to 5×10^{-3}.
CTE – central tendency exposure
RME – reasonable maximum exposure
ND – not determined
(a) Percent contribution to total risk is based on the summed risk of the adult and child receptors.

Table 3-7 Summary of Baseline Current Noncancer Health Hazards for Ingestion of Fish and Crab

Effect/ Target Organ	COPC	Fish Noncancer Health Hazard - RME				Fish Noncancer Health Hazard - CTE			
		Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]
Dermal, Developmental, Immunological, Reproductive	TCDD TEQ (D/F)	71	63	110	56%	4	4	6	49%
Immune system, eye	TCDD TEQ (PCBs)	11	10	18	9%	0.9	0.8	1	8%
	Total PCBs	42	38	65	33%	3	3	5	40%
NA	4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND
NA	4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND
Liver	4,4'-DDT	0.004	0.004	0.007	0.004%	0.0003	0.0003	0.001	0.004%
	Total Chlordane	0.06	0.06	0.1	0.05%	0.0046	0.0041	0.01	0.1%
	Dieldrin	0.2	0.2	0.4	0.2%	0.02	0.02	0.03	0.2%
Central nervous system	Methylmercury	2	2	3	1%	0.2	0.2	0.3	2%
	Total HI	126	113	195	--	8	8	13	--
Effect/Target Organ	COPC	Crab Noncancer Health Hazard - RME				Crab Noncancer Health Hazard - CTE			
		Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]
Dermal, Developmental, Immunological, Reproductive	TCDD TEQ (D/F)	32	29	50	75%	5	4	7	79%
Immune system, eye	TCDD TEQ (PCBs)	5	4	7	11%	0.5	0.5	1	9%
	Total PCBs	6	5	9	13%	0.6	0.6	1.0	11%
NA	4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND
NA	4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND
Liver	4,4'-DDT	0.002	0.002	0.003	0.005%	0.0003	0.0003	0.0005	0.005%
	Total Chlordane	0.003	0.003	0.005	0.01%	0.0005	0.0004	0.001	0.01%
	Dieldrin	0.05	0.04	0.1	0.1%	0.01	0.01	0.01	0.1%
Central nervous system	Methylmercury	0.5	0.5	0.8	1%	0.07	0.07	0.1	1%
	Total HI	43	38	67	--	6	5	9	--

CTE – central tendency exposure
HI – hazard index
RME – reasonable maximum exposure
NA – not applicable
ND – not determined
(a) Percent contribution is provided for the child receptor.

Table 3-8 Summary of Baseline Future Modeled Cancer Risk for Ingestion of Fish and Crab

	Fish Cancer Risk - RME					Fish Cancer Risk - CTE				
COPC	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[(a)]	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[(a)]
TCDD TEQ (D/F)	1.E-03	6.E-04	6.E-04	2.E-03	50%	3.E-05	2.E-05	2.E-05	5.E-05	42%
TCDD TEQ (PCBs)	1.E-03	5.E-04	4.E-04	1.E-03	37%	3.E-05	2.E-05	2.E-05	5.E-05	42%
Total PCBs	3.E-04	2.E-04	2.E-04	5.E-04	13%	1.E-05	6.E-06	6.E-06	2.E-05	15%
4,4'-DDD	4.E-06	2.E-06	2.E-06	6.E-06	0.1%	1.E-07	7.E-08	7.E-08	2.E-07	0.2%
4,4'-DDE	6.E-06	3.E-06	3.E-06	9.E-06	0.2%	2.E-07	1.E-07	9.E-08	3.E-07	0.2%
4,4'-DDT	6.E-06	3.E-06	2.E-06	8.E-06	0.2%	2.E-07	1.E-07	9.E-08	3.E-07	0.2%
Total Chlordane	2.E-06	1.E-06	1.E-06	3.E-06	0.1%	7.E-08	4.E-08	4.E-08	1.E-07	0.1%
Methyl mercury	ND	ND	ND	ND		ND	ND	ND	ND	
Total	3.E-03	1.E-03	1.E-03	4.E-03		7.E-05	4.E-05	4.E-05	1.E-04	
	Crab Cancer Risk - RME					Crab Cancer Risk - CTE				
COPC	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[(a)]	Adult	Adolescent	Child	Adult + Child	Percent Contribution to Total Risk[(a)]
TCDD TEQ (D/F)	6.E-04	3.E-04	3.E-04	9.E-04	45%	3.E-05	2.E-05	2.E-05	5.E-05	50%
TCDD TEQ (PCBs)	7.E-04	3.E-04	3.E-04	9.E-04	49%	3.E-05	2.E-05	2.E-05	4.E-05	44%
Total PCBs	7.E-05	4.E-05	3.E-05	1.E-04	6%	3.E-06	2.E-06	2.E-06	5.E-06	5%
4,4'-DDD	4.E-07	2.E-07	2.E-07	6.E-07	0.03%	2.E-08	1.E-08	1.E-08	4.E-08	0.04%
4,4'-DDE	7.E-07	3.E-07	3.E-07	1.E-06	0.1%	4.E-08	3.E-08	2.E-08	6.E-08	0.1%
4,4'-DDT	6.E-07	3.E-07	3.E-07	8.E-07	0.04%	3.E-08	2.E-08	2.E-08	5.E-08	0.05%
Total Chlordane	1.E-07	7.E-08	6.E-08	2.E-07	0.01%	8.E-09	5.E-09	4.E-09	1.E-08	0.01%
Methyl mercury	ND	ND	ND	ND		ND	ND	ND	ND	
Total	1.E-03	6.E-04	6.E-04	2.E-03		6.E-05	4.E-05	4.E-05	1.E-04	

Note: Scientific notation such as 1.E-03 is equivalent to 1×10^{-3}.
CTE – central tendency exposure
RME – reasonable maximum exposure
ND – not determined
(a) Percent contribution to total risk is based on the summed risk of the adult and child receptors.

Table 3-9 Summary of Baseline Future Modeled Noncancer Health Hazards for Ingestion of Fish and Crab

	Fish Noncancer Health Hazard - RME				Fish Noncancer Health Hazard - CTE			
	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]
TCDD TEQ (D/F)	38	34	65	40%	2	2	4	33%
TCDD TEQ (PCBs)	27	27	50	30%	2	2	4	34%
Total PCBs	24	24	45	28%	2	2	4	31%
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	0.1	0.09	0.2	0.1%	0.008	0.007	0.01	0.1%
Total Chlordane	0.04	0.04	0.06	0.04%	0.003	0.003	0.005	0.04%
Methylmercury	1	1	2	2%	0.2	0.2	0.3	2%
Total HI	90	87	163		6	6	11	
	Crab Noncancer Health Hazard - RME				Crab Noncancer Health Hazard - CTE			
	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]	Adult	Adolescent	Child	Percent Contribution to Total Hazard[a]
TCDD TEQ (D/F)	17	16	29	41%	2	2	4	46%
TCDD TEQ (PCBs)	18	17	32	45%	2	2	4	41%
Total PCBs	5	5	10	14%	0.6	0.6	1	12%
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	0.01	0.01	0.02	0.02%	0.001	0.001	0.003	0.03%
Total Chlordane	0.002	0.002	0.004	0.01%	0.0004	0.0003	0.0006	0.01%
Methylmercury	0.3	0.3	0.5	1%	0.04	0.04	0.07	1%
Total HI	40	39	71		5	5	9	

CTE – central tendency exposure
HI – hazard index
RME – reasonable maximum exposure
ND – not determined
(a) Percent contribution is provided for the child receptor.

Table 4-1 Exposure Point Concentrations (EPCs) Used in the BERA

COPEC		EPCs[a]				
		Sediment		Tissue		
		Entire	Mudflat	Mummichog[b]	Eco Crab[c]	Eco Fish[d]
Copper		170	220	3.1	24	12
Lead		240	320	2.2	0.37	0.5
Mercury		2.6	5.8	0.065	0.15	0.24
Methylmercury		0.0044	0.0065	0.057	0.13	0.23
LMW PAHs		24	6.4	0.093	0.11	0.23
HMW PAHs		45	31	0.19	0.12	0.13
Total DDx		0.26	0.31	0.063	0.071	0.32
Dieldrin		0.015	0.044	0.0084	0.0073	0.038
Total PCBs[e]		2.0	6.6	0.62	0.36	3.0
2,3,7,8-TCDD		0.0011	0.0045	0.000044	0.000058	0.00024
TCDD TEQ (D/F)	Mammal	0.0012	0.0046	0.000046	0.000063	0.00025
	Bird	0.0012	0.0047	0.000048	0.000073	0.00026
	Fish	0.0012	0.0046	0.000046	0.000063	0.00025
TCDD TEQ (PCB)	Mammal	0.000028	0.0001	0.0000082	0.0000090	0.000033
	Bird	0.00044	0.0013	0.000047	0.000096	0.00017
	Fish	0.0000023	0.0000067	0.00000063	0.00000080	0.0000026

(a) All units in mg/kg (parts per million). EPCs are 95% UCLs on the arithmetic means of COPEC concentrations in sediment and tissue samples. Samples included are listed in Attachment 1.1. 95% UCLs were calculated using USEPA ProUCL 4.1 software (version 4.1.00); ProUCL output files that contain assumptions on the distribution of the data are included in Attachment 3. In those situations where ProUCL recommended more than one 95% UCL statistic, the first value was selected.

(b) EPCs derived using composited whole body mummichog tissue samples as identified in Attachment 1.

(c) EPC derived using tissue data designated as composited whole and all edible tissue fractions as identified in Attachment 1.

(d) EPC derived using whole body tissue data for fish samples. EPCs were derived based on analytical tissue chemistry data for multiple fish species samples including American eel, white perch, white catfish, brown bullhead, common carp, smallmouth bass and white sucker. Data include both whole body and reconstituted whole body results; the latter derived as the sum of mass-adjusted estimates of fillet and visceral (carcass) fractions.

(e) Total PCBs represent the sum of nondioxin-like PCB congeners.

Table 4-2 Summary of Wildlife Chronic Feeding Studies with Methylmercury

Species	NOAEL (µg/g-d)	LOAEL (µg/g-d)	Effect	Reference
Birds				
Chicken (*Gallus domesticus*)	-	1.1	Growth inhibition	Fimreite, 1970
Ring-necked pheasant (*Phasianus colchicus*)	-	0.18	Reduced survival, reduced egg production	Fimreite, 1971
Mallard (*Anas platyrhynchos*)	-	0.078	Reduced number viable eggs, reduced duckling growth, reduced chick survival to day 7	Heinz, 1974, 1975, 1976a, 1976b, 1979
Great egret (*Ardea albus*)	-	0.5 µg/g (food)	Behavioral effects including reduced inclination to forage	Bouton *et al.*, 1999
Black duck (*Anas rubripes*)	-	3 µg/g (food)	Reduced clutch size, egg production, hatchability and duckling survival	Finley and Stendell, 1978
Coturnix (Japanese) quail (*Coturnix japonica*)	8 µg/g food	32 µg/g food	Enzyme induction (AChE, LDH)	Hill and Soares, 1984
Mammals				
Mink (*Neovison vison*)	0.055	0.18	Anorexia, ataxia; nerve tissue lesions	Wobeser *et al*., 1976a, 1976b
River otter (*Lutra canadensis*)	-	2 µg/g[(a)]	Anorexia and ataxia	O'Connor and Nielsen, 1981
Cat (*Felis domesticus*)	0.020	0.046	Ataxia, loss of balance, motor incoordination	Charbonneau *et al.*, 1974; 1976
Rat (*Rattus norvegicus*)	0.032	0.16	Reproduction	Verschuuren *et al.*, 1976
Mouse (*Mus musculus*)	0.15	0.73	Sensory neuropathy, cerebral and cerebellar neuronal necrosis	Hirano *et al.*, 1986

(a) Concentration in diet (ww basis).

Table 4-3 Summary of Chronic Feeding Studies with DDT

Species	NOAEL (µg/g-d)	LOAEL (µg/g-d)	Effect	Reference
Birds				
Brown pelican (*Pelecanus occidentalis*)	0.003	0.03	Reproductive	Anderson *et al.*, 1975
Mallard duck (*Anas platyrhynchos*)	-	1.5	Reproductive	USEPA, 1995c
Pelican (*Pelecanus occidentalis*)	0.009	-	Reproductive	USEPA, 1995c
Mammals				
Rat (Sprague Dawley)	0.8	4	Reproductive	Fitzhugh, 1948

Table 4-4 TEQ Factors for Dioxin/Furans and Dioxin-like PCB Congeners

Congener	TEF		
	Mammal[a]	Fish[b]	Bird[b]
Dioxins/Furans			
2,3,7,8- TCDD	1	1	1
1,2,3,7,8-PeCDD	1	1	1
1,2,3,4,7,8-HxCDD	0.1	0.5	0.05
1,2,3,6,7,8-HxCDD	0.1	0.01	0.01
1,2,3,7,8,9-HxCDD	0.1	0.01	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.001	0.001
OCDD	0.0003	0.0001	0.0001
2,3,7,8-TCDF	0.1	0.05	1
1,2,3,7,8-PeCDF	0.03	0.05	0.1
2,3,4,7,8-PeCDF	0.3	0.5	1
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.01
OCDF	0.0003	0.0001	0.0001
PCB Congeners			
3,3',4,4'-Tetrachlorobiphenyl (77)	0.0001	0.0001	0.05
3,4,4',5-Tetrachlorobiphenyl (81)	0.0003	0.0005	0.1
3,3',4,4',5-Pentachlorobiphenyl (126)	0.1	0.005	0.1
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	0.03	0.00005	0.001
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.00003	0.000005	0.0001
2,3,4,4',5-Pentachlorobiphenyl (114)	0.00003	0.000005	0.0001
2,3',4,4',5-Pentachlorobiphenyl (118)	0.00003	0.000005	0.00001
2',3,4,4',5-Pentachlorobiphenyl (123)	0.00003	0.000005	0.00001
2,3,3',4,4',5-Hexachlorobiphenyl (156)	0.00003	0.000005	0.0001
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	0.00003	0.000005	0.0001
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	0.00003	0.000005	0.00001
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	0.00003	0.000005	0.00001

(a) TEF values published in 2005 by the World Health Organization (Van den Berg *et al*., 2006) and recommended by USEPA (2010a).

(b) Van den Berg *et al*., 1998

Table 4-5 Summary of Wildlife Effect Thresholds for PCB Mixtures

Aroclor Mixture	No Effect[a] (µg/g-d)	Low Effect[a] (µg/g-d)	Effect	Reference
Birds				
Aroclor 1242[b]	0.1	0.4	Chick hatchability	Chapman, 2003
Aroclor 1248	0.4	0.5	Chick hatchability	Chapman, 2003
Aroclor 1254	0.6	1.2	Chick hatchability	Chapman, 2003
Mammals				
Aroclor 1242[c]	0.208	0.224	Decrease in live kit production	Chapman, 2003
Aroclor 1254[c]	0.080	0.096	Decrease in number of live kits per mated female; kit birth weight	Chapman, 2003

(a) These values are interpreted as the interpolated dose resulting in a 10% or 25% decrease in endpoint response relative to the control group for the NOAEL and LOAEL, respectively; see Chapman (2003).
(b) Chapman (2003) reports two dose-response patterns in the chicken studies for Aroclor 1242; this may be due to the difference in the batch tested, organisms, feed characteristics, or experimental design. Selected values are derived from the more sensitive response data.
(c) Data converted from diet-based TRV to dose assuming that a female mink consumes 0.16 g/g BW-day (average farm-raised individuals in Michigan [Bleavins and Aulerich, 1981]).

Table 4-6 Summary of Chronic Feeding Studies with TCDD/TCDF

Species	NOAEL (µg/g-d)	LOAEL (µg/g-d)	Effect	Reference
Birds				
Ring-necked pheasant (*Phasianus colchicus*)	1.4×10^{-6}[a]	1.4×10^{-5}[a]	Significant reduction in egg production; 100% embryotoxicity	Nosek *et al.*, 1992a, 1992b
Chicken (*Gallus domesticus*)	0.1×10^{-5}[b]	0.1×10^{-4}[b]	Survival of newly hatched chicks to 21 days	McKinney *et al.*, 1976
Mammals				
Rat (Sprague Dawley)	0.1×10^{-5}	0.1×10^{-4}	Decreases in fertility in F_1 and F_2 generations	Murray *et al.*, 1979
Mink (*Neovison vison*)	0.8×10^{-7}	2.2×10^{-6}	Reduced kit body weights (3 weeks) and reduced survival (3 and 6 weeks)	Tillitt *et al.*, 1996

(a) Reported doses were based on exposures via interperitoneal injection and converted to an ingestion dose (USEPA, 1993b).
(b) Based on dietary exposures to tetrachlorodibenzofuran (TCDF).

Table 4-7 Summary of Estimated Mammalian LD_{50} Benchmarks for TCDD TEQs

Species	LD_{50} (µg/g)	Reference
Guinea pig (*Cavia porcellus*)	0.0006 – 0.002	As cited in USEPA, 1993b
Mink (*Neovison vison*)	0.0042	Hochstein *et al.*, 1988
Rat (*Rattus norvegicus*)	0.022 – 0.045	As cited in USEPA, 1993b
Rabbit (*Oryctolagus cuniculus*)	0.115	As cited in USEPA, 1993b
Mouse (*Mus musculus*)	0.114 – 0.284	As cited in USEPA, 1993b
Hamster (various species)	1.157 – 5.0	As cited in USEPA, 1993b

Table 4-8 Summary of Avian Egg TCDD Residues Associated with Adverse Effects[a]

Species	NOAEL (µg/g)	LOAEL (µg/g)	Effect	Reference[b]
Laboratory Studies				
Chicken (*Gallus domesticus*)	0.000066	0.00008	Embryo mortality; reduced hatchling weight	Henshel *et al*., 1997; Powell *et al*., 1996a,b; Brunstrom, 1988, 1989, 1990; Brunstrom *et al*., 1990; Zhao *et al*., 1997; Lipsitz *et al*., 1997; Brunstrom and Andersson, 1988; Brunstrom and Lund, 1988
American kestrel (*Falco sparverius*)	0.00023	0.0034	Teratata, chick edema	Hoffman *et al*., 1998
Ring-necked pheasant (*Phasianus colchicus*)	0.00071	0.0079	Embryo mortality	Nosek *et al*., 1992a,b; Brunstrom and Reutergardh, 1986
Double-crested cormorant (*Phalcrocorax auritus*)	0.0037	0.0011	Embryo mortality	Powell *et al*., 1997a,b; Powell *et al*., 1998
Turkey (*Meleagris gallopavo*)	0.010	0.010	Embryo mortality	Brunstrom and Lund, 1988
Mallard (*Anas platyrhynchos*)	0.035	-	Embryo mortality	Brunstrom and Reutergardh, 1986; Brunstrom, 1988
Greylag goose (*Anser anser*)	0.050	-	Embryo mortality	Brunstrom, 1988
Bucephala clangula	0.050	-	Embryo mortality	Brunstrom and Reutergardh, 1986
Black-headed gull (*Larus ridibundus*)	0.050	-	Embryo mortality	Brunstrom and Reutergardh, 1986;
Herring gull (*Larus argentatus*)	0.050	-	Embryo mortality	Brunstrom, 1988
Common tern (*Sterna hirundo*)	-	0.0044	Embryo mortality	Hoffman *et al*., 1998
Field Studies				
Wood duck (*Aix sponsa*)	0.000005	0.00002	Reproduction	White and Seginak, 1994
Great blue heron (*Ardea herodias*)	0.000013	0.0001	Terata, reduced fledging, and brain asymmetries	Hart *et al*., 1991; Henshel *et al*., 1995
Osprey (*Pandion haliaetus*)	0.00014	-	Reduced hatching/fledging	Woodford *et al*., 1998
Forster's tern (*Sterna forsteri*)	0.00035	-	Reduced hatching/fledging	Kubiak *et al*., 1989; Harris *et al*., 1993
Double-crested cormorant (*Phalcrocorax auritus*)	-	0.00035	Terata	Yamashita *et al*., 1993
Caspian tern (*Sterna caspia*)	0.0014	0.0014	Wasting syndrome, terata	Yamashita *et al*., 1993, Ludwig *et al*., 1993; Ewins *et al*., 1994

(a) Data on avian toxicity associated with compounds with dioxin-like effects as presented in USEPA (2003a); values are TEQs and, in the case of multiple studies, are based on geometric means.
(b) As cited in USEPA (2003a).

Table 4-9 Ecological Receptors, Indicator Species, Exposure Pathways and Exposure Points Evaluated

Receptor Category	Indicator Species	Exposure Pathways	Exposure Points Evaluated	
			Entire	Mudflats
Benthic Macroinvertebrates	Various infaunal species	Incidental ingestion and dermal contact with sediment/ Ingestion of contaminated prey tissue	√	√
	Various epibenthic species (including blue crab)		√	√
Fish (generic)[a]	White perch, American eel, white catfish, brown bullhead, common carp, smallmouth bass, white sucker and Atlantic tomcod		√	-
Fish (forage)	Mummichog		-	√
Aquatic-dependent Birds	Great blue heron		√	√
	Herring gull (embryos)		√	-
Aquatic-dependent Mammals	Mink		√	-

(a) The generic fish category was evaluated using the species collected during the 2009 through 2011 fish sampling program and the indicator species presented include those that were collected during those sampling efforts. The white perch and American eel are the indicator species for the generic fish category for the future risk assessment (see Section 5.2) because analytical tissue chemistry data for these species were the basis for the development of site-specific uptake factors applied to modeled predicted sediment concentrations to estimate future fish (and crab) tissue concentrations.

Table 4-10 Ecological Receptors, Assessment Endpoints, Testable Hypotheses and Measurement Endpoints

Receptor Category	Assessment Endpoint	Testable Hypotheses	Measurement Endpoints
Benthic Macroinvertebrates	Survival, growth and reproduction of benthic and epibenthic invertebrates	Are COPEC concentrations measured in surficial sediment and macroinvertebrate tissue at levels that might adversely affect the survival, growth, and/or reproduction of invertebrates?	1. Comparison of sediment screening benchmarks to sediment EPCs 2. Comparison of invertebrate CBRs to crab tissue EPCs
Fish (general)	Survival, growth and reproduction of generic fish	Are COPEC concentrations in adult (measured) or egg (estimated) fish tissue at levels that might adversely affect the survival, growth, and/or reproduction of generic fish populations?	1. Comparison of fish CBRs to fish tissue EPCs 2. Comparison of fish egg CBRs to estimated fish egg tissue EPCs
Fish (forage)	Survival, growth and reproduction of forage fish	Are COPEC concentrations in adult (measured) or egg (estimated) forage fish tissue at levels that might adversely affect the survival, growth, and/or reproduction of forage fish populations?	1. Comparison of fish CBRs to mummichog tissue EPCs 2. Comparison of fish egg CBRs to estimated mummichog egg tissue EPCs
Aquatic-dependent Birds	Survival, growth and reproduction of birds	Are modeled COPEC concentrations in adult bird diet or egg tissue at levels that might adversely affect the survival, growth, and/or reproduction of aquatic-dependent birds?	1. Comparison of modeled daily dose estimates to avian TRVs 2. Comparison of avian egg CBRs to estimated herring gull egg tissue EPCs
Aquatic-dependent Mammals	Survival, growth and reproduction of mammals	Are modeled COPEC concentrations in adult mammal diet at levels that might adversely affect the survival, growth, and/or reproduction of aquatic-dependent mammals?	1. Comparison of modeled daily dose estimates to mammalian TRVs

Table 4-11 Dietary Exposure Parameters for the Heron and Mink Wildlife Receptors

Exposure Parameter	Abbreviation	Unit	Value	Source
Heron				
Body weight	BW	kg	2.2	USEPA, 1993a
Daily ingestion rate of sediment[(a)]	IR_{sed}	$kg\text{-}day^{-1}$	0.019	assumption
Daily ingestion rate of fish and crabs[(b,c)]	IR_{fish}	$kg\text{-}day^{-1}$	0.39	Kushlan, 1978
Exposure Frequency[(d)]	EF	unitless	0.58[d]	USEPA, 1993a
Site Use Factor (max of 1)	SUF	unitless	1	assumption
Mink				
Body weight	BW	kg	0.6	Mitchell, 1961
Daily ingestion rate of sediment[(a)]	IR_{sed}	$kg\text{-}day^{-1}$	0.003	assumption
Daily ingestion rate of fish and crabs[(b,e)]	IR_{fish}	$kg\text{-}day^{-1}$	0.17	USEPA, 1993a
Exposure Frequency	EF	unitless	1	USEPA, 1993a
Site Use Factor (max of 1)	SUF	unitless	1	assumption

(a) The amount of sediment in the diet was estimated as 5% and 2% of the daily IR for the heron and mink receptors, respectively.
(b) The heron is assumed to consume 85% fish and 15% crab in the diet and the mink assumed to consume 80% fish and 20% crab.
(c) Calculated using the regression equation for wading birds: $\log (IR_{food})$ (g/day) = 0.966 * log (BW) - 0.64 (g).
(d) The risk analysis assumes that most herons foraging in the Lower Passaic River are spring-early fall residents only; however, risks were also calculated assuming that individuals are exposure year-round (see Section 4.5).
(e) Calculated using the regression equation for mammals: IR_{food} (g/day) = 0.235 * $BW^{0.822}$ (g).

Table 4-12 Sediment Benchmark Values

COPEC	Units	Sediment Benchmark			
		Lower Bound		Upper Bound	
Copper	µg/g	32	(b)	94	(b)
Lead	µg/g	30	(b)	94	(b)
Mercury[(a)]	µg/g	0.14	(b)	0.48	(b)
LMW PAHs	µg/g	0.55	(c)	3.2	(c)
HMW PAHs	µg/g	1.7	(c)	9.6	(c)
Dieldrin	µg/g	0.00083	(b)	0.0029	(b)
Total DDx	µg/g	0.0016	(c)	0.046	(c)
Total PCBs	µg/g	0.035	(b)	0.37	(b)
2,3,7,8-TCDD	µg/g	0.0000032	(d)	-	

(a) Benchmarks based on total mercury exposure.
(b) Logistic model point estimates for T20 and T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively) estimates based on laboratory toxicity testing using two species of marine amphipod (USEPA, 2005d).
(c) Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).
(d) Value for 2,3,7,8-TCDD derived by U.S. Fish and Wildlife Service (Kubiak *et al*., 2007) using sediment chemistry for Arthur Kill and oyster effect data presented in Wintermyer and Cooper (2003).

Table 4-13 Summary of Critical Body Residue Threshold Values for Various Ecological Receptors

COPEC	CBR[a] NOAEL	CBR[a] LOAEL	Species	Endpoint	Reference
Macroinvertebrates					
Copper	5	12	*Macoma balthica*	survival	Absil *et al*., 1996
Lead	0.52	2.6	*Hyalella azteca*	survival	Borgmann and Norwood, 1999
Mercury	0.048	0.095	*Acartia tonsa and A. hudsonica*	reproduction	Hook and Fisher, 2002
LMW PAHs	0.078	0.78	*Nereis arenaceodentata*	reproduction	Emery and Dillon, 1996
HMW PAHs	0.022	0.22	*Mytilus edulis*	reproduction	Eertman *et al*., 1995
Total PCBs	0.0080	0.026	*Crassostrea virginica*	reproduction	Chu *et al*., 2000; Chu *et al*., 2003
Dieldrin	0.0016	0.0080	*Penaeus duorarum*	survival	Parrish *et al*., 1973
Total DDx	0.060	0.13	*Penaeus duorarum*	survival	Nimmo *et al*., 1970
2,3,7,8-TCDD	1.5E-07	1.3E-06	*Crassostrea virginica*	reproduction	Wintermyer and Cooper, 2003
Fish					
Copper	0.32	1.5	*Mugil cephalus*	survival	Zyadah and Abdel-Baky, 2000
Lead	0.40	4.0	*Salvelinus fontinalis*	reproductive (reduced egg hatchability)	Holcombe *et al*., 1976
Mercury	0.052	0.26	various species	growth, reproduction, survival, behavior	Beckvar *et al*., 2005
LMW PAHs	0.26	2.6	*Pimephales promelas*	reproduction (decreased # eggs laid)	Hall and Oris, 1991
HMW PAHs	0.21	2.1	*Psettichthys melanostichus*	survival (reduced egg hatching success)	Hose *et al*., 1982
Total PCBs	0.17	0.53	*Salmo salar*	behavior (smolt seawater preference	Lerner *et al*., 2007
Dieldrin	0.0080	0.040	*Salmo gairdneri*	survival	Shubat and Curtis, 1986
Total DDx	0.078	0.39	various species	growth, reproduction, survival, behavior	Beckvar *et al*., 2005
2,3,7,8-TCDD	8.9E-07	1.8E-06	*Fundulus heteroclitus*	behavior (prey capture ability), growth	Couillard *et al*., 2011
Fish Embryos					
2,3,7,8-TCDD	7.2E-06	8.6E-05	various species	survival	Steevens et al., 2005
Avian Embryos					
Dieldrin	0.20	8.1	*Tyto alba*	reproduction	Mendenhall *et al*., 1983
Total DDx	0.50	3.7	*Pelecanus occidentalis*	reproduction (eggshell thinning)	Blus, 1984
2,3,7,8-TCDD	5.9E-05	1.5E-04	various species	reproduction	USEPA, 2003bb

(a) CBRs; units µg/g ww basis. Further details of the derivation of the CBR values are provided in Table 6-1 in Attachment 6.
(b) Benchmarks based on total mercury exposure.

Table 4-14 Summary of Toxicity Reference Values for Avian and Mammalian Wildlife Receptors

COPEC	TRV[a] NOAEL	TRV[a] LOAEL	Species	Endpoint	Reference
Birds					
Copper	2.3	4.7	*Melagris gallopavo*	growth	Kashani *et al.*, 1986
Lead	0.19	1.9	*Coturnix japonica*	reproduction	Edens and Garlich, 1983
Mercury[b]	0.013	0.026	*Anas platyrhynchos*	reproduction	Heinz, 1974, 1976, 1979
LMW PAHs	0.67	6.7	*Agaleius phoenicius*	survival	Schafer *et al.*, 1983
HMW PAHs	0.048	0.48	*Columba livia*	reproduction	Hough *et al.*, 1993
Dieldrin	0.054	0.18	*Numida meleagris*	survival	Wiese *et al.*, 1969
Total DDx	0.0090	0.027	*Pelecanus occidentalis*	reproduction	Anderson *et al.*, 1975
Total PCBs	0.40	0.50	*Gallus gallus domesticus*	reproduction	Chapman, 2003
2,3,7,8-TCDD	2.8E-06	2.8E-05	*Phasianus colchicus*	mortality, growth, reproduction	Nosek *et al.*, 1992a, 1992b
Mammals					
Copper	3.4	6.8	*Neovison vison*	reproduction	Aulerich *et al.*, 1982
Lead	0.71	7.0	*Rattus norvegicus*	reproduction	Grant *et al.*, 1980
Mercury[(b)]	0.016	0.027	*Neovison vison*	growth, reproduction	Wobeser *et al.*, 1976a,b as derived in USEPA, 1995c
LMW PAHs	50	150	*Rattus norvegicus*	growth	Navarro *et al.*, 1991
HMW PAHs	0.62	3.1	*Mus musculus*	growth	Culp *et al.*, 2000
Dieldrin	0.015	0.030	*Rattus norvegicus*	reproduction	Harr *et al.*, 1970
Total DDx	0.80	4.0	*Rattus norvegicus*	reproduction	Fitzhugh, 1948
Total PCBs	0.069	0.082	*Neovison vison*	reproduction	Chapman, 2003
2,3,7,8-TCDD	8.0E-08	2.2E-06	*Neovison vison*	reproduction	Tillitt *et al.*, 1996

(a) Units are µg COPEC/g BW-day (dry weight basis). Further details of the derivation of the values are provided in Table 6-2 in Attachment 6.
(b) Benchmarks based on methylmercury exposure.

Table 4-15 Summary of Baseline Ecological Hazard Estimates for Benthic Macroinvertebrates

COPEC	Sediment Benchmarks[a]				Critical Body Residues[b]	
	Entire		Mudflat			
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	NOAEL	LOAEL
	Inorganics/Metals					
Copper	5	2	7	2	5	2
Lead	8	3	10	3	0.7	0.1
Mercury	20	5	40	10	3	2
	Semivolatile Organic Compounds (PAHs)					
LMW PAHs	40	8	10	2	1	0.1
HMW PAHs	30	5	20	3	6	0.6
	Pesticides					
Dieldrin	20	5	50	20	5	0.9
Total DDx	200	6	200	7	1	0.5
	PCBs					
Total PCBs	60	6	200	20	40	10
	Dioxin-like Compounds					
2,3,7,8-TCDD	300	300	1,000	1,000	400	40
Total HI	700	300	2,000	1,000	500	60

(a) HQs estimated by comparing EPCs for the entire and mudflat surficial sediment datasets to sediment benchmarks (Table 4-12).
(b) HQs estimated by comparing EPCs for blue crab tissue data to invertebrate CBRs as presented in Table 4-13.

Table 4-16 Summary of Baseline Residue Based Hazard Estimates for Adult Fish

COPEC	Generic Fish[a]		Mummichog[a]	
	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics/Metals				
Copper	40	8	10	2
Lead	1	0.1	6	0.6
Mercury	5	0.9	1	0.3
Semivolatile Organic Compounds (PAHs)				
LMW PAHs	0.9	0.09	0.4	0.04
HMW PAHs	0.6	0.06	0.9	0.09
Pesticides				
Dieldrin	5	0.9	1	0.2
Total DDx	4	0.8	0.8	0.2
PCBs (Aroclors)				
Total PCBs	20	6	4	1
Dioxin-like Compounds				
TCDD TEQ (D/F)	300	100	50	30
TCDD TEQ (PCBs)	3	1	0.7	0.3
TCDD TEQ (Total)	300	100	50	30
Total HI	400	200	80	30

(a) HQs estimated by comparing EPCs for the generic fish and mummichog tissue to CBR values presented in Table 4-13.

Table 4-17 Summary of Residue-based Analysis for Estimated Fish Embryo Tissue

COPEC	Generic Fish		Mummichog	
	LCL	UCL	LCL	UCL
TCDD TEQ (D/F)	30	3	20	2
TCDD TEQ (PCBs)	0.3	0.03	0.2	0.02
Total TCDD TEQ	30	3	20	2

LCL/UCL – Lower and upper confidence levels for the 95% "species protection level" estimates of the fish egg SSDs from Steevens *et al.* (2005).

Table 4-18 Summary of Residue-based Analysis for Estimated Avian Embryo Tissue

COPEC	NOAEL	LOAEL
Dieldrin	0.7	0.02
Total DDx	10	2
Total PCBs	70	40
TCDD TEQ (D/F)	40	20
TCDD TEQ (PCBs)	30	10
Total TCDD TEQ	80	30
Total HI	200	70

Table 4-19 Summary of Baseline Ecological Hazard Estimates for Wildlife Receptors

COPEC	Heron (visitor)[b]				Heron (resident)[b]				Mink[b,d]	
	Generic fish diet)[c]		Mummichog diet)[c]		Generic fish diet)[c]		Mummichog diet)[c]			
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics/Metals										
Copper	1	0.5	0.8	0.4	2	0.8	1	0.6	2	0.8
Lead	7	0.7	10	1	10	1	20	2	2	0.2
Mercury	2	0.8	0.5	0.3	3	1	1	0.5	4	2
Semivolatile Organics Compounds (PAHs)										
LMW PAHs	0.2	0.02	0.06	0.006	0.4	0.04	0.1	0.01	0.004	0.001
HMW PAHs	5	0.5	4	0.4	9	0.9	6	0.6	0.5	0.1
Pesticides										
Dieldrin	0.06	0.02	0.02	0.006	0.1	0.03	0.03	0.01	0.6	0.3
Total DDx	3	1	0.9	0.3	6	2	2	0.5	0.1	0.02
PCBs (Aroclors)										
Total PCBs	0.7	0.6	0.2	0.2	1	1	0.4	0.3	10	9
Dioxin-like Compounds										
TCDD TEQ (D/F)	10	1	10	1	20	2	20	2	900	30
TCDD TEQ (PCBs)	7	0.7	4	0.4	10	1	8	0.8	100	4
TCDD TEQ (Total)	20	2	10	1	30	3	30	3	1000	30
Total HI[e]	40	6	30	4	60	10	60	8	1000	40

(a) HQs estimated by comparing EPCs for exposure pathway-specific dose estimates to avian TRVs (presented in Table 6-2, Attachment 6). Pathways modeled include incidental sediment ingestion and consumption of contaminated invertebrate (crab EPCs) and fish (generic fish EPCs) prey. HQs based on NOAEL- and LOAEL-based TRVs are presented in Attachment 6 (Tables 6-14 and 6-15, respectively). The generic fish diet scenario assumes exposure to the entire sediment exposure area. The ED throughout the year was assumed to fall between late Spring and early Fall (*i.e.*, Exposure Frequency = 263/365 day or 58%). The potential exposure by year-round resident individuals was also modeled and the results are discussed in the Uncertainty Section.

(b) For the mummichog diet scenario, HQs were estimated as in "a" above with the exception that the mudflat exposure area and mummichog fish EPCs were used instead of the entire sediment exposure area and generic fish EPCs. HQs based on NOAEL-and LOAEL-based TRVs are presented in Attachment 6 (Tables 6-22 and 6-23, respectively).

(c) HQs estimated by comparing EPCs for exposure pathway-specific dose estimates to mammalian TRVs (presented in Table 6-2, Attachment 6). Pathways modeled include incidental sediment ingestion and consumption of contaminated invertebrate (crab EPCs) and fish (generic fish EPCs) prey. HQs based on NOAEL- and LOAEL-based TRVs are presented in Attachment 6 (Tables 6-30 and 6-31, respectively). The mink was assumed to be a year-round resident in the Lower Passaic River.

(d) The Total HI is the sum of HQs for individual COPECs but ignoring the specific TEQ D/F and PCB HQ terms (shaded) to avoid double counting.

Table 5-1 Remedy Implementation Schedule

Alternative	Description	Remedy Implementation	30-Year Time Period
1	No Action	Mar-2018	2019 - 2048
2	Deep Dredging with Backfill	1-Mar-2018 through 30-Jul-2029	2030 - 2059
3	Capping with Dredging for Flooding and Navigation	1-Mar-2018 through 1-Dec-2022	2023 - 2052
4	Focused Capping with Dredging for Flooding	1-Mar-2018 through 20-May-2019	2020 - 2049

Table 5-2 Example Calculation of Six-Year and 24-Year Rolling Annual Average Concentrations for Total PCBs

COPC	6-Year Annual Rolling Averages		Alt 1: No Action	Alt 3: Capping with Dredging for Flooding and Navigation[(a)]	Alt 2: Deep Dredging with Backfill[(b)]	Alt 4: Focused Capping with Dredging for Flooding[(c)]
Total PCBs	2019	2024	**1290**	749	954	830
Total PCBs	2020	2025	1232	535	835	**771**
Total PCBs	2021	2026	1187	344	736	733
Total PCBs	2022	2027	1152	189	653	704
Total PCBs	2023	2028	1130	**107**	570	685
Total PCBs	2024	2029	1109	105	473	669
Total PCBs	2025	2030	1090	94	370	661
Total PCBs	2026	2031	1067	80	270	650
Total PCBs	2027	2032	1047	70	185	644
Total PCBs	2028	2033	1031	61	118	641
Total PCBs	2029	2034	1012	53	77	637
Total PCBs	2030	2035	995	48	72	637
Total PCBs	2031	2036	976	48	72	626
Total PCBs	2032	2037	955	48	71	613
Total PCBs	2033	2038	931	47	68	599
Total PCBs	2034	2039	917	52	84	592
Total PCBs	2035	2040	913	59	107	589
Total PCBs	2036	2041	912	62	116	585
Total PCBs	2037	2042	911	66	121	582
Total PCBs	2038	2043	918	69	**123**	583
Total PCBs	2039	2044	923	71	**123**	582
Total PCBs	2040	2045	923	64	100	585
Total PCBs	2041	2046	913	56	73	584
Total PCBs	2042	2047	908	52	64	586
Total PCBs	2043	2048	905	48	61	590
Total PCBs	2044	2049	899	44	60	592
Total PCBs	2045	2050	892	42	61	597
Total PCBs	2046	2051	879	42	65	591
Total PCBs	2047	2052	865	42	65	581
Total PCBs	2048	2053	847	42	63	572
Total PCBs	2049	2054	835	46	72	567
Total PCBs	2050	2055	832	51	85	567
Total PCBs	2051	2056	833	54	90	565
Total PCBs	2052	2057	834	57	92	563
Total PCBs	2053	2058	842	59	93	564
Total PCBs	2054	2059	849	61	92	563

24-Year Annual Rolling Averages		Alt 1: No Action	Alt 3: Capping with Dredging for Flooding and Navigation[(a)]	Alt 2: Deep Dredging with Backfill[(b)]	Alt 4: Focused Capping with Dredging for Flooding[(c)]
2019	2042	**1067**	240	379	675
2020	2043	1043	183	325	**654**
2021	2044	1022	133	278	640
2022	2045	1005	92	239	630
2023	2046	992	**69**	207	624
2024	2047	981	67	181	620
2025	2048	971	64	156	615
2026	2049	960	60	131	610
2027	2050	948	57	109	606
2028	2051	937	55	92	602
2029	2052	926	53	81	598
2030	2053	915	51	79	595
2031	2054	907	52	81	591
2032	2055	901	53	**85**	589
2033	2056	895	54	**85**	586
2034	2057	888	54	**85**	583
2035	2058	883	54	**85**	580
2036	2059	879	54	84	577

(a) Remedy Implementation Mar-2018 through Dec-2022; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

(b) Remedy Implementation Mar-2018 through Jul-2029; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

(c) Remedy Implementation Mar-2018 through May-2019; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

Notes:

Orange-highlighted cells indicate the 30-year expoure duration time period for the remedial alternative.

Bolded number indicates the maximum annual rolling averge.

units are ug/kg

Table 5-3 Summary of Future Modeled Rolling Annual Average Sediment Concentrations Used to Calculate Biota Tissue EPCs

COPC	Alternative 1 (µg/kg)			Alternative 2 (µg/kg)		
	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average
9 TCDD TEQ (D/F)[(a)]	0.444	0.432	0.392	0.055	0.034	0.027
TCDD TEQ (PCBs)	0.049	0.046	0.042	0.007	0.007	0.006
Total PCBs	1290	1190	1067	123	97	85
DDD	26.7	24.0	21.2	2.4	2.2	1.9
DDE	32.9	31.1	28.3	4.4	3.6	3.3
DDT	24.0	21.7	19.4	3.5	3.4	3.0
Methylmercury[(b)]	1922	1708	1450	191	183	156
Chlordane	25	25	25	16	15	12
COPC	**Alternative 3 (µg/kg)**			**Alternative 4 (µg/kg)**		
	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average
10 TCDD TEQ (D/F)[(a)]	0.041	0.027	0.024	0.225	0.213	0.203
TCDD TEQ (PCBs)	0.006	0.005	0.005	0.033	0.031	0.029
Total PCBs	107	80	69	771	711	654
DDD	2.1	1.7	1.5	15.8	14.2	12.8
DDE	3.8	2.9	2.6	20.0	18.6	17.2
DDT	2.7	2.3	2.2	16.9	15.1	13.7
Methylmercury[(b)]	227	177	143	1278	1134	996
Chlordane	16	15	12	21	20	19

(a) Note that the regression model derived for TCDD TEQ (D/F) was based on analytical tissue data for 2,3,7,8-TCDD due to a lack of congener-specific analytical results in the historical tissue dataset. Therefore, a decision was made to use the modeled sediment results for 2,3,7,8-TCDD, rather than the combined TCDD TEQ (D/F) modeled data under the assumption that data for elemental mercury and methylmercury are assumed to be equivalent.

(b) Note that the regression model derived for mercury was based on analytical tissue data for elemental mercury due to a lack of methylmercury analytical results in the historical tissue dataset. Therefore, a decision was made to use the modeled sediment results for elemental mercury under the assumption that data for elemental mercury and methylmercury are assumed to be equivalent.

Table 5-4 Summary of Future Human Health Biota Exposure Point Concentrations

Alternative	COPC	Fish (mg/kg)			Blue Crab (mg/kg)		
		Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average
Alternative 1: No Action	TCDD TEQ (D/F)	0.000060	0.000054	0.000053	0.000044	0.000042	0.000039
	TCDD TEQ (PCBs)	0.000045	0.000042	0.000038	0.000048	0.000045	0.000043
	Total PCBs	1.2	1.1	0.98	0.41	0.39	0.37
	4,4'-DDD	0.11	0.10	0.10	0.020	0.019	0.017
	4,4'-DDE	0.12	0.11	0.11	0.023	0.022	0.021
	4,4'-DDT	0.10	0.10	0.098	0.019	0.018	0.016
	Total Chlordane	0.042	0.042	0.042	0.0042	0.0042	0.0042
	Methyl mercury	0.32	0.31	0.29	0.10	0.097	0.092
Alternative 2: Deep Dredging with Backfill	TCDD TEQ (D/F)	0.0000088	0.0000056	0.0000046	0.0000061	0.0000039	0.0000031
	TCDD TEQ (PCBs)	0.0000061	0.0000060	0.0000055	0.000013	0.000012	0.000012
	Total PCBs	0.11	0.089	0.079	0.087	0.074	0.068
	4,4'-DDD	0.050	0.048	0.046	0.0041	0.0039	0.0035
	4,4'-DDE	0.060	0.057	0.055	0.0062	0.0054	0.0051
	4,4'-DDT	0.056	0.056	0.053	0.0053	0.0052	0.0048
	Total Chlordane	0.035	0.034	0.032	0.0039	0.0039	0.0038
	Methyl mercury	0.14	0.13	0.13	0.043	0.042	0.040
Alternative 3: Capping with Dredging for Flooding and Navigation	TCDD TEQ (D/F)	0.0000067	0.0000046	0.0000041	0.0000047	0.0000032	0.0000028
	TCDD TEQ (PCBs)	0.0000051	0.0000044	0.0000043	0.000011	0.000010	0.0000099
	Total PCBs	0.098	0.074	0.063	0.079	0.066	0.059
	4,4'-DDD	0.048	0.044	0.043	0.0038	0.0033	0.0030
	4,4'-DDE	0.058	0.053	0.051	0.0056	0.0047	0.0044
	4,4'-DDT	0.052	0.049	0.048	0.0045	0.0040	0.0039
	Total Chlordane	0.035	0.034	0.032	0.0039	0.0039	0.0038
	Methyl mercury	0.14	0.13	0.12	0.046	0.042	0.038
Alternative 4: Focused Capping with Dredging for Flooding	TCDD TEQ (D/F)	0.000032	0.000030	0.000029	0.000023	0.000022	0.000021
	TCDD TEQ (PCBs)	0.000030	0.000028	0.000027	0.000036	0.000035	0.000033
	Total PCBs	0.71	0.65	0.60	0.29	0.28	0.26
	4,4'-DDD	0.091	0.088	0.085	0.014	0.013	0.012
	4,4'-DDE	0.099	0.096	0.094	0.017	0.016	0.015
	4,4'-DDT	0.093	0.090	0.087	0.015	0.014	0.013
	Total Chlordane	0.039	0.039	0.038	0.0041	0.0041	0.0040
	Methyl mercury	0.28	0.13	0.25	0.087	0.042	0.080

Table 5-5 Summary of Risks/Hazards for Alternative 2 (Deep Dredging with Backfill)

Fish	30-Year Exposure Duration[(a)]				
	Adult		Child		Adult + Child[(b)]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	1.E-04	3	9.E-05	10	2.E-04
TCDD TEQ (PCBs)	1.E-04	4	6.E-05	7	2.E-04
Total PCBs	3.E-05	2	1.E-05	4	4.E-05
4,4'-DDD	2.E-06	ND	8.E-07	ND	3.E-06
4,4'-DDE	3.E-06	ND	1.E-06	ND	5.E-06
4,4'-DDT	3.E-06	0.05	1.E-06	0.09	4.E-06
Total Chlordane	2.E-06	0.03	8.E-07	0.05	3.E-06
Methylmercury	ND	0.6	ND	1	ND
Total	3.E-04	10	2.E-04	22	5.E-04
Crab	30-Year Exposure Duration[(a)]				
	Adult		Child		Adult + Child[(b)]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	5.E-05	1	4.E-05	4	8.E-05
TCDD TEQ (PCBs)	2.E-04	5	8.E-05	8	3.E-04
Total PCBs	1.E-05	1	7.E-06	2	2.E-05
4,4'-DDD	9.E-08	ND	4.E-08	ND	1.E-07
4,4'-DDE	2.E-07	ND	8.E-08	ND	3.E-07
4,4'-DDT	2.E-07	0.003	7.E-08	0.005	2.E-07
Total Chlordane	1.E-07	0.002	5.E-08	0.004	2.E-07
Methylmercury	ND	0.1	ND	0.2	ND
Total	2.E-04	7	1.E-04	15	4.E-04

Scientific notation such as 1.E-03 is equivalent to 1×10^{-3}.

Future concentrations for dieldrin were not forecast due to geochemical constructs inherent in the model; therefore, future risks were not estimated for this COPC.

ND – not determined because toxicity values are not available for this exposure route.

(a) For protection of human health, future EPCs considered the ED component of the risk/hazard equation. The EPC derived for this time period was selected to represent a maximum concentration that may be contacted within a 30-year exposure period (*i.e.*, beginning with the year immediately following the completion of the remediation and ending 30 years post remediation), comparable to the manner in which concentrations were assessed in the baseline risk assessment and consistent with USEPA (1989).

(b) Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and a child (based on 6-year exposure).

Table 5-6 Summary of Risks/Hazards for Alternative 3 (Capping with Dredging for Flooding and Navigation)

Fish	30-Year Exposure Duration[a]				
	Adult		Child		Adult + Child[b]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	1.E-04	3	7.E-05	7	2.E-04
TCDD TEQ (PCBs)	1.E-04	3	5.E-05	6	2.E-04
Total PCBs	2.E-05	2	1.E-05	4	3.E-05
4,4'-DDD	2.E-06	ND	8.E-07	ND	2.E-06
4,4'-DDE	3.E-06	ND	1.E-06	ND	4.E-06
4,4'-DDT	3.E-06	0.05	1.E-06	0.08	4.E-06
Total Chlordane	2.E-06	0.03	8.E-07	0.05	3.E-06
Methylmercury	ND	0.6	ND	1	ND
Total	2.E-04	8	1.E-04	18	4.E-04
Crab	30-Year Exposure Duration[a]				
	Adult		Child		Adult + Child[b]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	4.E-05	1	3.E-05	3	7.E-05
TCDD TEQ (PCBs)	2.E-04	4	7.E-05	7	2.E-04
Total PCBs	1.E-05	1	6.E-06	2	2.E-05
4,4'-DDD	7.E-08	ND	4.E-08	ND	1.E-07
4,4'-DDE	2.E-07	ND	8.E-08	ND	2.E-07
4,4'-DDT	1.E-07	0.002	6.E-08	0.004	2.E-07
Total Chlordane	1.E-07	0.002	5.E-08	0.004	2.E-07
Methylmercury	ND	0.1	ND	0.1	ND
Total	2.E-04	6	1.E-04	13	3.E-04

Scientific notation such as 1.E-03 is equivalent to 1×10^{-3}.

Future concentrations for dieldrin were not forecast due to geochemical constructs inherent in the model; therefore, future risks were not estimated for this COPC.

ND – not determined because toxicity values are not available for this exposure route.

(a) For protection of human health, future EPCs considered the ED component of the risk/hazard equation. Therefore, the EPC derived for this time period was selected to represent a maximum concentration that may be contacted within a 30-year exposure period (*i.e.*, beginning with the year immediately following the completion of the remediation and ending 30 years post remediation), comparable to the manner in which concentrations were assessed in the baseline risk assessment and consistent with USEPA (1989).

(b) Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and a child (based on 6-year exposure).

Table 5-7 Summary of Risks/Hazards for Alternative 4 (Focused Capping with Dredging for Flooding)

Fish	30-Year Exposure Duration[a]				
	Adult		Child		Adult + Child[b]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	7.E-04	20	3.E-04	35	1.E-03
TCDD TEQ (PCBs)	7.E-04	19	3.E-04	33	1.E-03
Total PCBs	2.E-04	15	9.E-05	27	3.E-04
4,4'-DDD	3.E-06	ND	1.E-06	ND	5.E-06
4,4'-DDE	5.E-06	ND	2.E-06	ND	8.E-06
4,4'-DDT	5.E-06	0.09	2.E-06	0.1	7.E-06
Total Chlordane	2.E-06	0.04	9.E-07	0.06	3.E-06
Methylmercury	ND	1	ND	2	ND
Total	2.E-03	55	7.E-04	97	2.E-03
Crab	30-Year Exposure Duration[a]				
	Adult		Child		Adult + Child[b]
COPC	Cancer Risk	Noncancer Health Hazard	Cancer Risk	Noncancer Health Hazard	Cancer Risk
TCDD TEQ (D/F)	3.E-04	9	1.E-04	15	5.E-04
TCDD TEQ (PCBs)	5.E-04	14	2.E-04	24	7.E-04
Total PCBs	5.E-05	4	2.E-05	7	8.E-05
4,4'-DDD	3.E-07	ND	1.E-07	ND	4.E-07
4,4'-DDE	5.E-07	ND	2.E-07	ND	8.E-07
4,4'-DDT	5.E-07	0.008	2.E-07	0.01	7.E-07
Total Chlordane	1.E-07	0.002	6.E-08	0.004	2.E-07
Methylmercury	ND	0.2	ND	0.4	ND
Total	9.E-04	27	4.E-04	47	1.E-03

Scientific notation such as 1.E-03 is equivalent to 1×10^{-3}.

Future concentrations for dieldrin were not forecast due to geochemical constructs inherent in the model; therefore, future risks were not estimated for this COPC.

ND – not determined because toxicity values are not available for this exposure route.

(a) For protection of human health, future EPCs considered the ED component of the risk/hazard equation. Therefore, the EPC derived for this time period was selected to represent a maximum concentration that may be contacted within a 30-year exposure period (*i.e.*, beginning with the year immediately following the completion of the remediation and ending 30 years post remediation), comparable to the manner in which concentrations were assessed in the baseline risk assessment and consistent with USEPA (1989).

(b) Estimated for a 30-year ED by summing the risks for the adult (based on 24-year exposure) and a child (based on 6-year exposure).

Table 5-8 Summary of Hazard Estimates for Benthic Macroinvertebrates – Sediment Benchmarks

COPEC	Sediment Benchmarks Hazard Quotients - Benthic Invertebrates															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Copper	5	2	4	1	0.1	0.05	2	0.7	0.1	0.05	2	0.6	3	1	3	1
Lead	8	3	7	2	0.2	0.07	3	1	0.2	0.07	3	1	5	1	5	2
Mercury	20	5	8	2	1	0.4	0.6	0.2	0.9	0.3	0.7	0.2	10	3	6	2
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	30	4	30	4	1	0.2	20	3	1	0.2	20	3	10	2	20	4
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	60	2	40	1	5	0.2	3	0.1	4	0.1	4	0.1	40	1	20	0.9
Total PCBs	40	4	30	2	3	0.2	1	0.1	2	0.2	1	0.1	30	2	20	2
2,3,7,8-TCDD	200	200	100	100	7	7	2	2	5	5	3	3	80	80	60	60
Total	**300**	**200**	**200**	**100**	**20**	**8**	**30**	**7**	**10**	**6**	**30**	**8**	**200**	**100**	**100**	**70**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

Table 5-9 Summary of Hazard Estimates for Blue Crab – Critical Body Residues

COPEC	CBR - Benthic Invertebrate Tissue															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Copper	**5**	**2**	**4**	**2**	0.06	0.02	1	0.6	0.05	0.02	1	0.6	**2**	1	**3**	1
Lead	0.4	0.08	0.3	0.06	0.03	0.01	0.2	0.04	0.03	0.005	0.2	0.04	0.3	0.05	0.3	0.05
Mercury	**2**	1	**2**	0.9	0.9	0.5	0.6	0.3	0.7	0.4	0.7	0.3	**2**	1	**2**	0.8
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	0.9	0.09	0.9	0.09	0.1	0.01	0.7	0.07	0.1	0.01	0.7	0.07	0.6	0.06	0.8	0.08
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	0.8	0.4	0.6	0.3	0.1	0.07	0.1	0.05	0.1	0.06	0.1	0.06	0.6	0.3	0.4	0.2
Total PCBs	**60**	**20**	**40**	**10**	**9**	**3**	**5**	**2**	**6**	**2**	**6**	**2**	**40**	**10**	**30**	**9**
2,3,7,8-TCDD	**300**	**40**	**200**	**30**	**20**	**2**	**6**	0.7	**10**	**2**	**8**	0.9	**200**	**20**	**100**	**10**
Total HI	**400**	**60**	**300**	**40**	**30**	**5**	**10**	**3**	**20**	**4**	**20**	**4**	**200**	**40**	**200**	**30**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

Table 5-10 Summary of Hazard Estimates for Generic Fish Tissue – Critical Body Residues

COPEC	CBR - Generic Fish Tissue															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL
Copper	**20**	**3**	**10**	**3**	0.4	0.1	**6**	1	0.4	0.09	**6**	1	**9**	**2**	**10**	**2**
Lead	0.9	0.09	0.7	0.07	0.06	0.006	0.4	0.04	0.06	0.006	0.4	0.04	0.6	0.06	0.6	0.06
Mercury	**4**	0.9	**3**	0.6	**2**	0.3	1	0.2	1	0.3	1	0.3	**4**	0.7	**3**	0.6
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	0.4	0.04	0.4	0.04	0.02	0.002	0.3	0.03	0.02	0.002	0.3	0.03	0.2	0.02	0.3	0.03
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	**6**	1	**5**	1	**3**	0.5	**2**	0.5	**2**	0.5	**2**	0.5	**5**	1	**5**	0.9
Total PCBs	**20**	**7**	**10**	**4**	1	0.4	0.6	0.2	0.8	0.3	0.8	0.2	**10**	**4**	**9**	**3**
TCDD TEQ (PCBs)	**3**	1	**2**	0.8	0.3	0.2	0.2	0.1	0.2	0.09	0.2	0.1	**2**	0.9	1	0.6
TCDD TEQ (D/F)	**300**	**100**	**200**	**100**	**20**	**8**	**6**	**3**	**10**	**6**	**8**	**4**	**200**	**80**	**100**	**60**
Total TCDD TEQ	**300**	**100**	**200**	**100**	**20**	**8**	**6**	**3**	**10**	**6**	**8**	**4**	**200**	**80**	**100**	**60**
Total HI	**300**	**200**	**200**	**100**	**20**	**9**	**20**	**5**	**20**	**7**	**20**	**6**	**200**	**90**	**100**	**70**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

(c) The sum of the 2,3,7,8-TCDD toxic equivalences contributed by PCB and dioxin/furan congeners; value not included in the total HI.

Table 5-11 Summary of Hazard Estimates for Mummichog Tissue – Critical Body Residues

COPEC	CBR - Mummichog Tissue															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL
Copper	**10**	**2**	**9**	**2**	0.3	0.06	**4**	0.8	0.3	0.06	**4**	0.8	**6**	1	**7**	1
Lead	**2**	0.2	**2**	0.2	0.1	0.01	1	0.1	0.1	0.01	0.9	0.09	1	0.1	1	0.1
Mercury	0.8	0.2	0.6	0.1	0.3	0.07	0.2	0.05	0.3	0.06	0.3	0.05	0.7	0.1	0.6	0.1
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	0.3	0.03	0.3	0.03	0.05	0.005	0.2	0.02	0.05	0.005	0.2	0.02	0.2	0.02	0.3	0.03
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	0.5	0.09	0.4	0.08	0.2	0.04	0.2	0.03	0.2	0.03	0.2	0.03	0.4	0.08	0.3	0.07
Total PCBs	**3**	0.9	**2**	0.6	0.2	0.07	0.1	0.03	0.1	0.04	0.1	0.04	**2**	0.6	1	0.4
TCDD TEQ (PCBs)	0.8	0.4	0.6	0.3	0.1	0.07	0.1	0.05	0.1	0.05	0.1	0.06	0.6	0.3	0.4	0.2
TCDD TEQ (D/F)	**30**	**10**	**20**	**10**	**3**	**2**	**2**	0.8	**3**	1	**2**	0.9	**20**	**9**	**10**	**7**
Total TCDD TEQ	**30**	**10**	**20**	**10**	**3**	**2**	**2**	0.8	**3**	1	**2**	1	**20**	**9**	**20**	**7**
Total HI	**50**	**20**	**40**	**10**	**4**	2	**7**	**2**	**4**	2	**8**	**2**	**30**	**10**	**30**	**10**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

(c) The sum of the 2,3,7,8-TCDD Toxic Equivalences contributed by PCB and dioxin/furan congeners; value not included in the total HI.

Table 5-12 Summary of Hazard Estimates for Heron – Ingestion of Generic Fish and Sediment

COPEC	Exposure Model - Heron (generic fish diet)															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL
Copper	0.7	0.3	0.6	0.3	0.02	0.009	0.3	0.1	0.02	0.008	0.3	0.1	0.4	0.2	0.4	0.2
Lead	**7**	0.7	**6**	0.6	0.2	0.02	**3**	0.3	0.2	0.02	**3**	0.3	**4**	0.4	**4**	0.4
Mercury	**3**	1	**2**	0.8	0.7	0.4	0.5	0.2	0.6	0.3	0.5	0.3	**2**	1	1	0.7
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	**5**	0.5	**5**	0.5	0.2	0.02	**3**	0.3	0.2	0.02	**3**	0.3	**3**	0.3	**4**	0.4
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	**5**	**2**	**4**	1	**2**	1	**2**	0.6	**2**	0.6	**2**	0.6	**4**	1	**3**	1
Total PCBs	0.9	0.7	0.5	0.4	0.1	0.04	0.02	0.02	0.03	0.03	0.03	0.02	0.5	0.4	0.3	0.3
TCDD TEQ (PCBs)	**7**	0.7	**4**	0.4	0.5	0.05	0.3	0.03	0.3	0.03	0.3	0.03	**4**	0.4	**3**	0.3
TCDD TEQ (D/F)	**10**	1	**7**	0.7	0.5	0.05	0.2	0.02	0.4	0.04	0.3	0.03	**6**	0.6	**4**	0.4
Total TCDD TEQ	**20**	**2**	**10**	1	1	0.1	0.5	0.05	0.8	0.08	0.6	0.06	**10**	1	**7**	0.7
Total HI	**40**	**7**	**30**	**5**	**4**	1	**9**	2	**4**	1	**9**	2	**20**	**5**	**20**	**4**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

(c) The sum of the 2,3,7,8-TCDD toxic equivalences contributed by PCB and dioxin/furan congeners; value not included in the total HI.

Table 5-13 Summary of Hazard Quotients for Heron – Ingestion of Mummichog and Sediment

COPEC	Exposure Model - Heron (mummichog diet)															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL
Copper	0.6	0.3	0.5	0.3	0.02	0.008	0.2	0.1	0.02	0.007	0.2	0.1	0.3	0.2	0.4	0.2
Lead	**7**	0.7	**6**	0.6	0.2	0.02	**3**	0.3	0.2	0.02	**3**	0.3	**4**	0.4	**4**	0.4
Mercury	1	0.7	0.7	0.4	0.3	0.1	0.2	0.08	0.2	0.09	0.2	0.08	1	0.5	0.6	0.3
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	**5**	0.5	**5**	0.5	0.2	0.02	**3**	0.3	0.2	0.02	**3**	0.3	**3**	0.3	**4**	0.4
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	0.5	0.2	0.4	0.1	0.2	0.05	0.1	0.04	0.1	0.05	0.1	0.05	0.4	0.1	0.3	0.1
Total PCBs	0.1	0.1	0.09	0.07	0.01	0.009	0.006	0.005	0.008	0.006	0.007	0.006	0.09	0.07	0.06	0.05
TCDD TEQ (PCBs)	**2**	0.2	1	0.1	0.2	0.02	0.09	0.009	0.1	0.01	0.1	0.01	1	0.1	0.7	0.07
TCDD TEQ (D/F)	**2**	0.2	**2**	0.2	0.2	0.02	0.07	0.007	0.1	0.01	0.09	0.009	1	0.1	1	0.1
Total TCDD TEQ	**4**	0.4	**3**	0.3	0.3	0.03	0.2	0.02	0.2	0.02	0.2	0.02	**2**	0.2	**2**	0.2
Total HI	**20**	**3**	**10**	**2**	1	0.3	**7**	0.8	1	0.2	**7**	0.8	**10**	**2**	**10**	**2**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

(c) The sum of the 2,3,7,8-TCDD toxic equivalences contributed by PCB and dioxin/furan congeners; value not included in the total HI.

Table 5-14 Summary of Hazard Quotients for Mink – Ingestion of Generic Fish and Sediment

COPEC	Exposure Model- Mink[a]															
	No Action				Capping with Dredging for Flooding and Navigation				Deep Dredging with Backfill Placement				Focused Capping with Dredging for Flooding			
	Year - 2019		Year = 2048		Year - 2023		Year = 2052		Year - 2030		Year = 2059		Year - 2020		Year = 2049	
	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL	NO AEL	LO AEL
Copper	1	0.5	0.9	0.4	0.02	0.01	0.4	0.2	0.02	0.01	0.4	0.2	0.6	0.3	0.7	0.3
Lead	**2**	0.2	**2**	0.2	0.07	0.007	0.9	0.09	0.07	0.007	0.8	0.08	1	0.1	1	0.1
Mercury	**5**	**3**	**3**	**2**	**2**	1	1	0.7	1	0.8	1	0.7	**4**	**2**	**3**	**2**
LMW PAHs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HMW PAHs	0.4	0.09	0.4	0.09	0.02	0.004	0.3	0.06	0.02	0.004	0.3	0.06	0.3	0.05	0.4	0.08
Dieldrin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total DDx	0.1	0.03	0.1	0.02	0.06	0.01	0.05	0.01	0.06	0.01	0.06	0.01	0.1	0.03	0.1	0.02
Total PCBs	**10**	**10**	**8**	**7**	0.9	0.7	0.4	0.3	0.5	0.5	0.5	0.4	**8**	**7**	**5**	**5**
TCDD TEQ (PCBs)	**100**	**3**	**60**	**2**	**10**	0.4	**9**	0.3	**7**	0.3	**10**	0.4	**70**	**2**	**50**	**2**
TCDD TEQ (D/F)	**900**	**30**	**600**	**20**	**50**	**2**	**20**	0.7	**40**	1	**20**	0.9	**500**	**20**	**300**	**10**
Total TCDD TEQ	**1000**	**30**	**700**	**20**	**60**	**2**	**30**	1	**40**	**2**	**30**	1	**500**	**20**	**400**	**10**
Total HI	**1000**	**50**	**700**	**30**	**60**	4	**30**	2	**50**	**3**	**40**	**3**	**600**	**30**	**400**	**20**

(a) HQ calculations presented in Attachment 9.

(b) Futurecast sediment concentrations for LMW PAHs and dieldrin are not available.

Table 5-15 Predicted Annual Average Sediment Concentrations for the COPCS/COPECs

2,3,7,8-TCDD (µg/kg)				
Alternative	Model	Lower Uncertainty Bound[(a)]	Average[(b)]	Upper Uncertainty Bound[(a)]
Alt 2: Deep Dredging with Backfill	EMBM	NA	0.046	NA
	LPR-NB	0.0062	0.0096	0.013
Alt 3: Capping with Dredging for Flooding and Navigation	EMBM	NA	0.053	NA
	LPR-NB	0.0085	0.013	0.018
Alt 4: Focused Capping with Dredging for Flooding	EMBM	NA	0.14	NA
	LPR-NB	0.11	0.17	0.23
Total PCBs (µg/kg)				
Alternative	Model	Lower Uncertainty Bound[(a)]	Average[(b)]	Upper Uncertainty Bound[(a)]
Alt 2: Deep Dredging with Backfill	EMBM	NA	382	NA
	LPR-NB	37	51	65
Alt 3: Capping with Dredging for Flooding and Navigation	EMBM	NA	424	NA
	LPR-NB	35	48	61
Alt 4: Focused Capping with Dredging for Flooding	EMBM	NA	673	NA
	LPR-NB	394	540	686

NA – not available

(a) The lower and upper bounds were estimated by subtracting and adding, respectively, the median relative error terms to the annualized average concentrations for contaminant/year combinations of interest. These uncertainty factors are only available for the LPR-NB Model and quantification of the uncertainties associated with the COPECs that relied on the EMBM projections was not conducted. Refer to Attachment 7 for additional information regarding uncertainty of the modeled sediment concentrations.

(b) Concentrations are provided for year 2059 for comparison purposes.

Table 6-1 Summary of Baseline risks Associated with Fish and Crab Consumption

Baseline Current Results			
Fish Consumption			
RME		CTE	
Cancer Risk[a]	Hazard Index[b]	Cancer Risk[a]	Hazard Index[b]
5×10^{-3}	195	1×10^{-4}	13
Crab Consumption			
RME		CTE	
Cancer Risk[a]	Hazard Index[b]	Cancer Risk[a]	Hazard Index[b]
2×10^{-3}	67	1×10^{-4}	9
Baseline Future Modeled Results[c]			
Fish Consumption			
RME		CTE	
Cancer Risk[a]	Hazard Index[b]	Cancer Risk[a]	Hazard Index[b]
4×10^{-3}	163	1×10^{-4}	11
Crab Consumption			
RME		CTE	
Cancer Risk[a]	Hazard Index[b]	Cancer Risk[a]	Hazard Index[b]
2×10^{-3}	71	1×10^{-4}	9

(a) Results based on the combined adult/child receptor (6 years as a child and 24 years as an adult).
(b) Results based on the child receptor.
(c) The baseline future modeled results corresponds to Alternative 1, No Action alternative, where projections of future concentrations in sediment only considered natural attenuation and degradation over time.

Table 6-2 Summary of Estimated Future Modeled Risks for Each Remediation Alternative

	Remediation Scenario[a]	Cancer Risk[b]	Hazard Index[c]
Fish	Alternative 2: Deep Dredging with Backfill	5×10^{-4}	22
	Alternative 3: Capping with Dredging for Flooding and Navigation	4×10^{-4}	18
	Alternative 4: Focused Capping with Dredging for Flooding	2×10^{-3}	97
Crab	Remediation Scenario[a]	Cancer Risk[b]	Hazard Index[c]
	Alternative 2: Deep Dredging with Backfill	4×10^{-4}	15
	Alternative 3: Capping with Dredging for Flooding and Navigation	3×10^{-4}	13
	Alternative 4: Focused Capping with Dredging for Flooding	1×10^{-3}	47

(a) The remediation alternatives represent future modeled exposures. Alternative 1, the No Action alternative, corresponds to the baseline future modeled alternative (see Table 6-1).

(b) Results based on the combined adult/child receptor (6 years as a child and 24 years as an adult).

(c) Results based on the child receptor.

Table 6-3 Summary of Baseline Ecological Risk Assessment Hazard Estimates[(a)]

Receptor Category	Exposure Point or Species	Measure of Effect	Hazard Estimate[(b)]	
			Lower	Upper
Macroinvertebrate	Entire	Sediment benchmarks	700	400
	Mudflat		2,300	1,000
	Blue crab	Critical Body Residues	500	60
Fish	Generic fish		400	200
	Generic fish embryo		30	3
	Mummichog		80	30
	Mummichog Embryo		20	2
Bird	Herring gull		200	70
	Heron - generic fish diet (visitor)	Ingestion dose model	40	6
	Heron - mummichog diet (visitor)		30	4
	Heron - generic fish diet (resident		60	10
	Heron - mummichog diet (resident)		60	8
Mammal	Mink		1,000	40

(a) Derivation of risk estimates provided in Attachment 6 and as summarized in Tables 4-15 (invertebrates), Table 4-16 (fish), Table 4-17 (fish embryo), Table 4-18 (bird embryo) and Table 4-19 (wildlife).

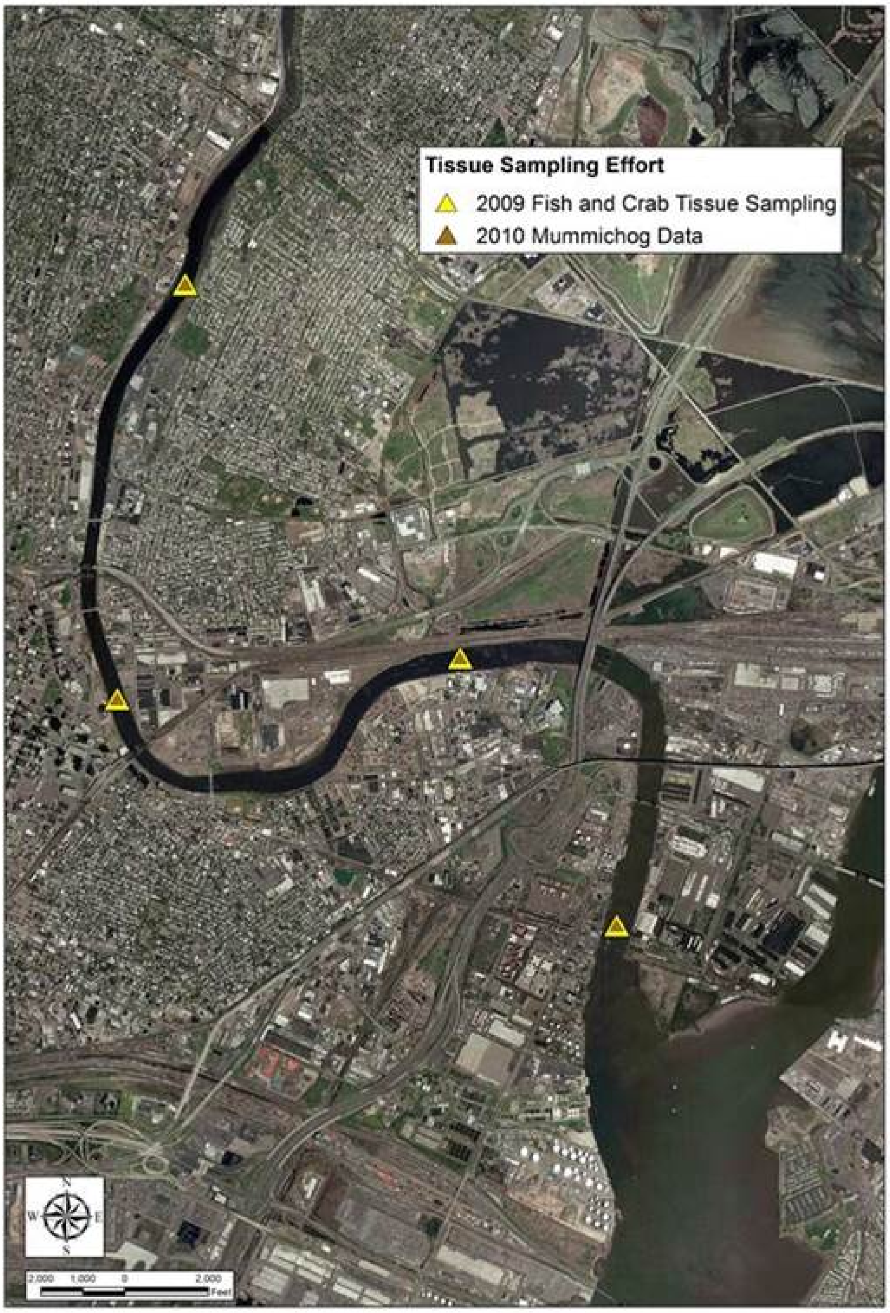
(b) Hazard estimates are HIs based on lower- and upper-bound sediment benchmarks and NOAEL- and LOAEL-based CBRs and TRVs.

Table 6-4 Summary of Future Modeled Ecological Risks[(a)] for Remedial Alternatives

Endpoint Receptors	Alternative 1: No Action	Alternative 2: Deep Dredging with Backfill Placement	Alternative 3: Capping with Dredging for Flooding and Navigation	Alternative 4: Focused Capping with Dredging for Flooding
Benthos	200	20	20	100
Crab CBR	100	10	10	100
Generic Fish CBR	200	10	10	100
Mummichog CBR	20	4	4	20
Heron Diet (generic fish)	10	4	4	10
Mink Diet (generic fish)	200	10	10	100

(a) Geometric mean of the lower- and upper-bound HIs for each assessment endpoint/alternative.

Figures

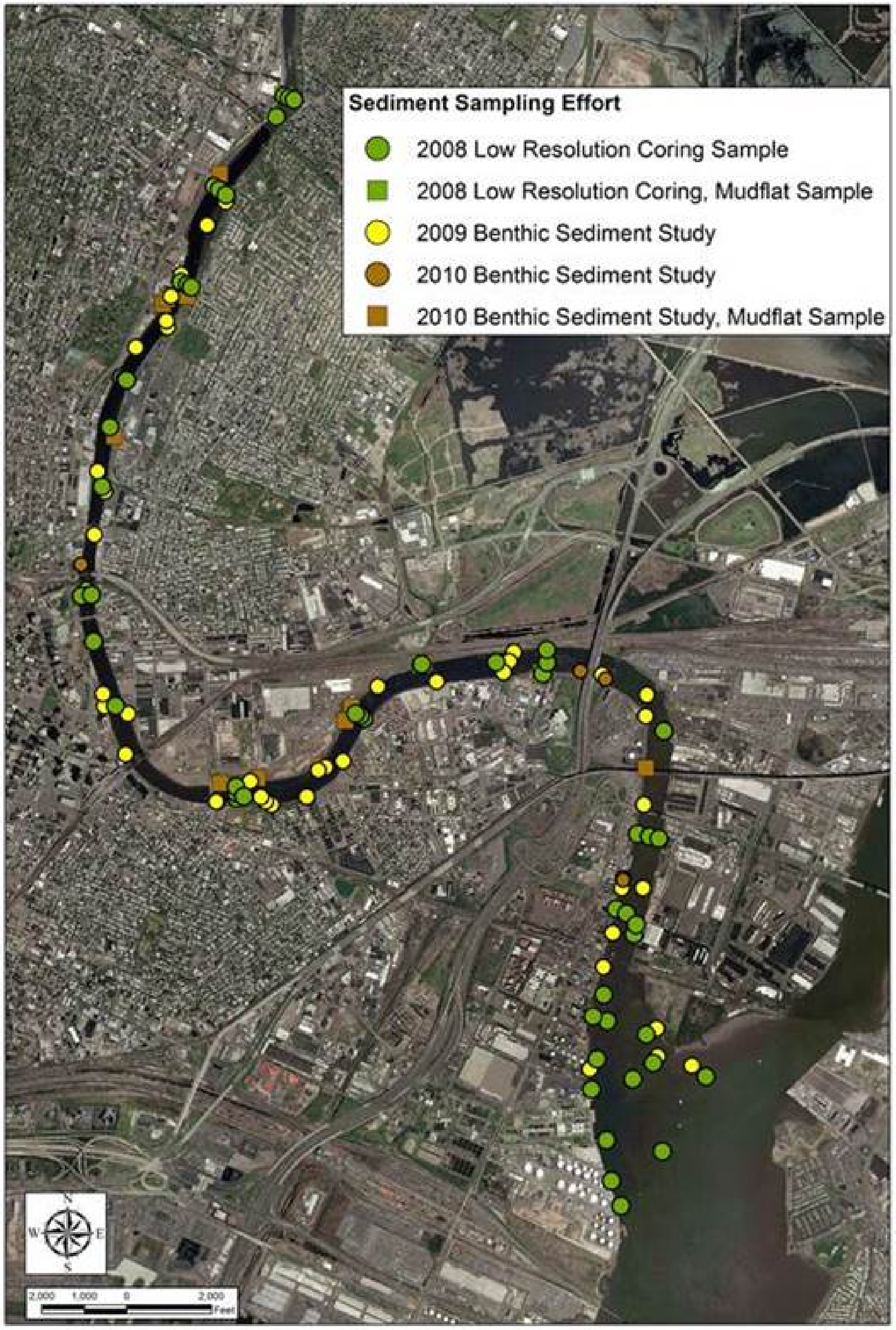


FFS Study Area Tissue Sampling Location

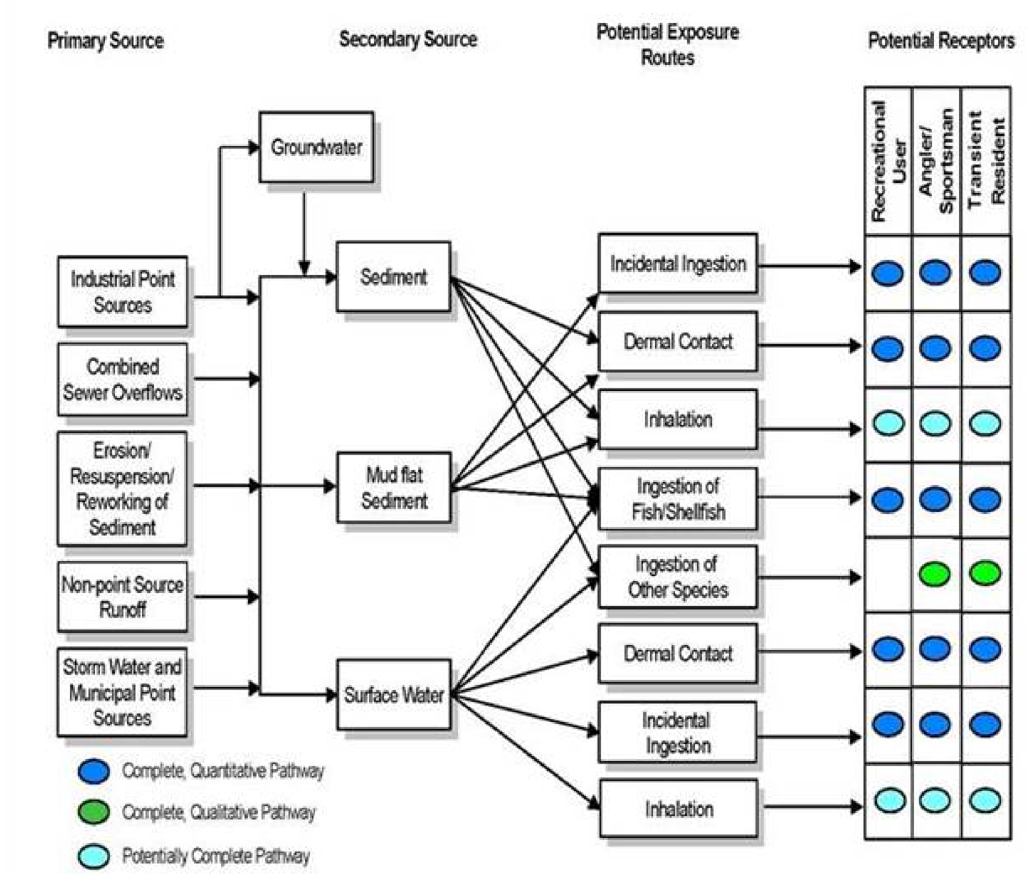
Lower Eight Miles of the Lower Passaic River

Figure 2-1

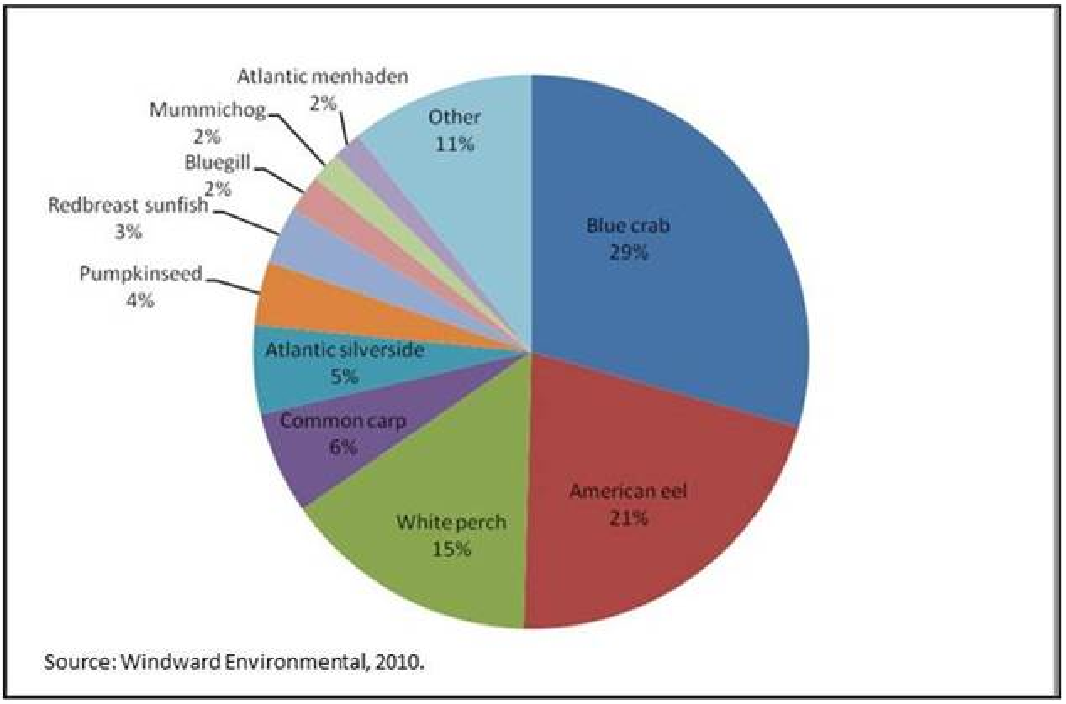
2014



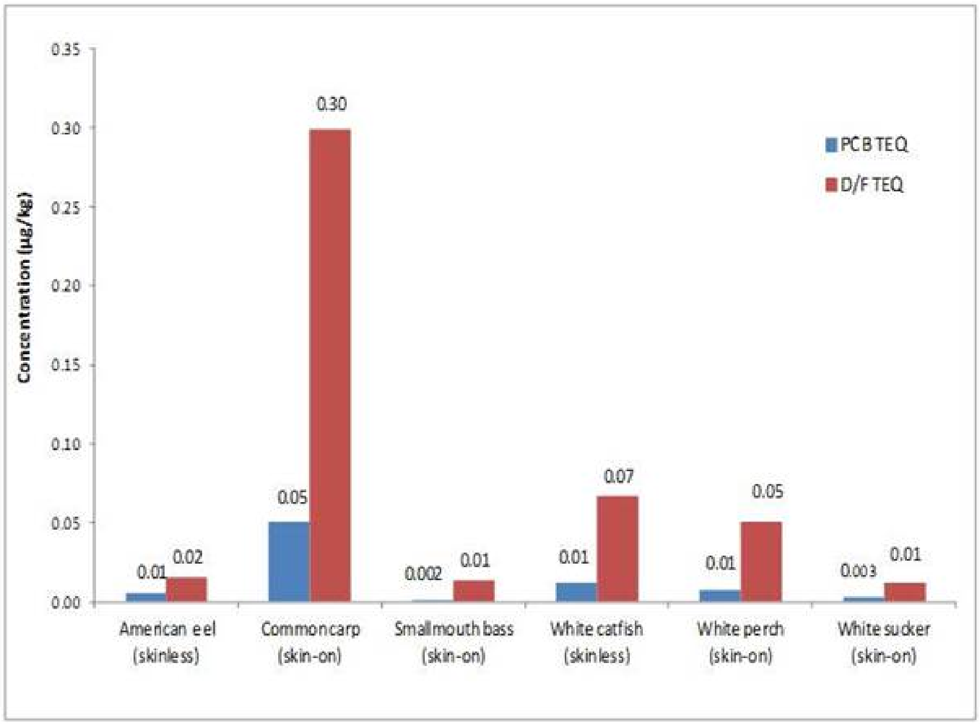
FFS Study Area Sediment Sampling Locations	Figure 2-2
Lower Eight Miles of the Lower Passaic River	2014



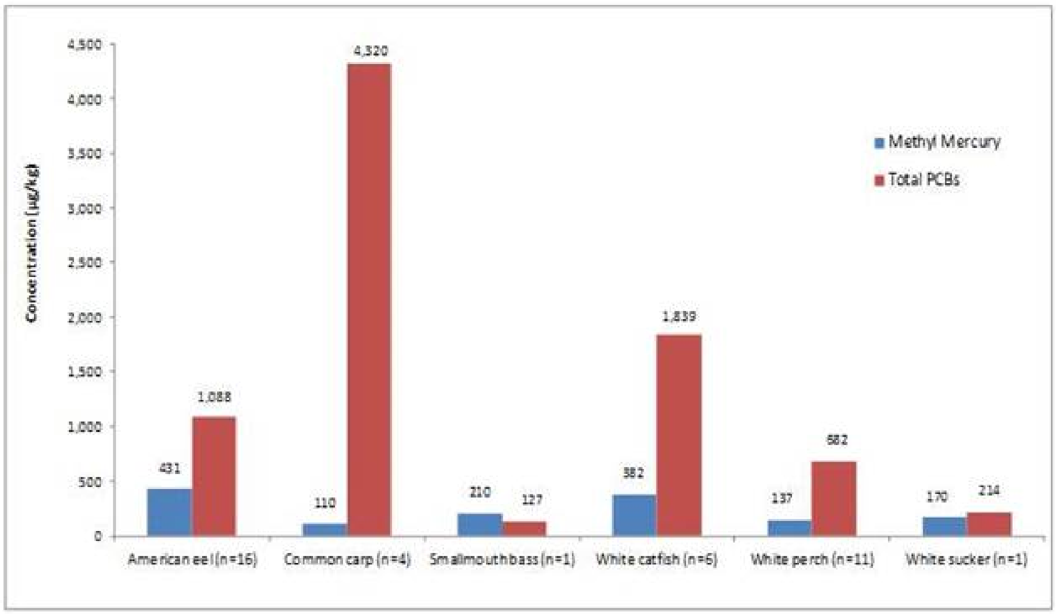
Conceptual Model of Potential Human Exposure to Site-Related Contaminants for the FFS Study Area *Lower Eight Miles of the Lower Passaic River*	Figure 3-1
	2014



Relative Abundance of Blue Crab and Fish Species Collected in Late Summer/Early Fall 2009 (percent of total number of individuals collected) *Lower Eight Miles of the Lower Passaic River*	Figure 3-2 2014



Comparison of Average TCDD TEQ Concentrations in Fish Species	Figure 3-3
Lower Eight Miles of the Lower Passaic River	2014

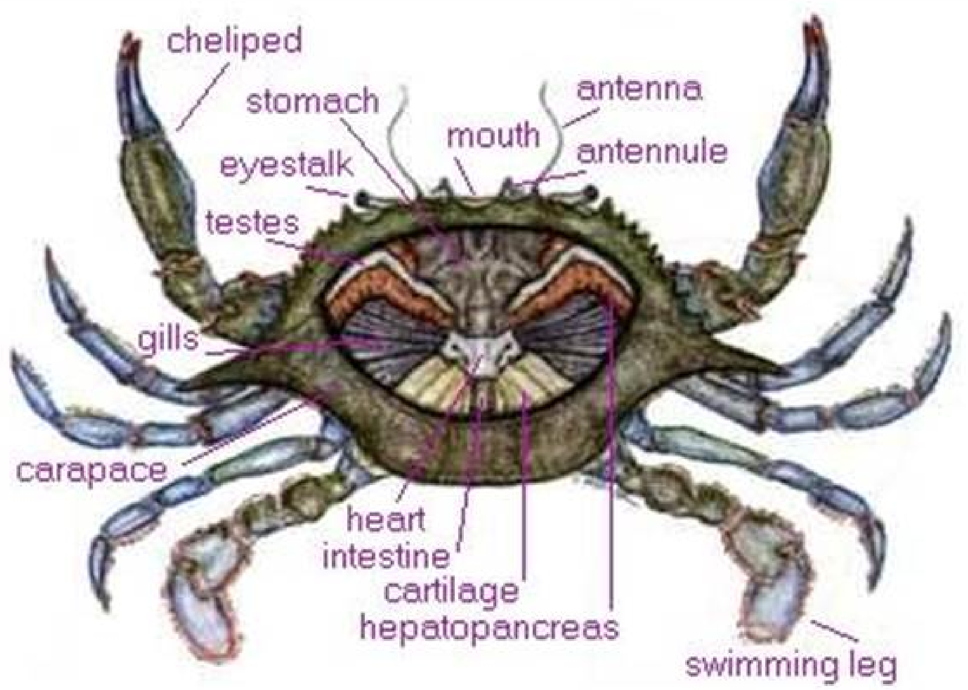


Comparison of Average Methylmercury and Total PCB Concentrations in Fish Species

Lower Eight Miles of the Lower Passaic River

Figure 3-4

2014



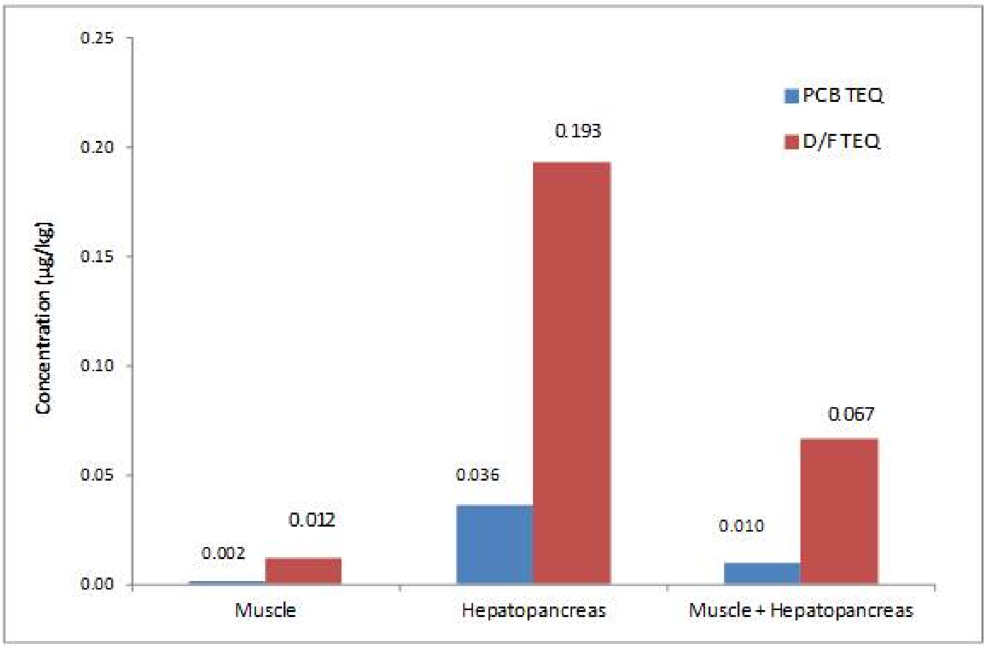
Source: Virginia Institute of Marine Science (http://www.marine-ed.org/bridge/bluecrabworkshop2.pdf)

Anatomy of a Blue Crab

Lower Eight Miles of the Lower Passaic River

Figure 3-5

2014

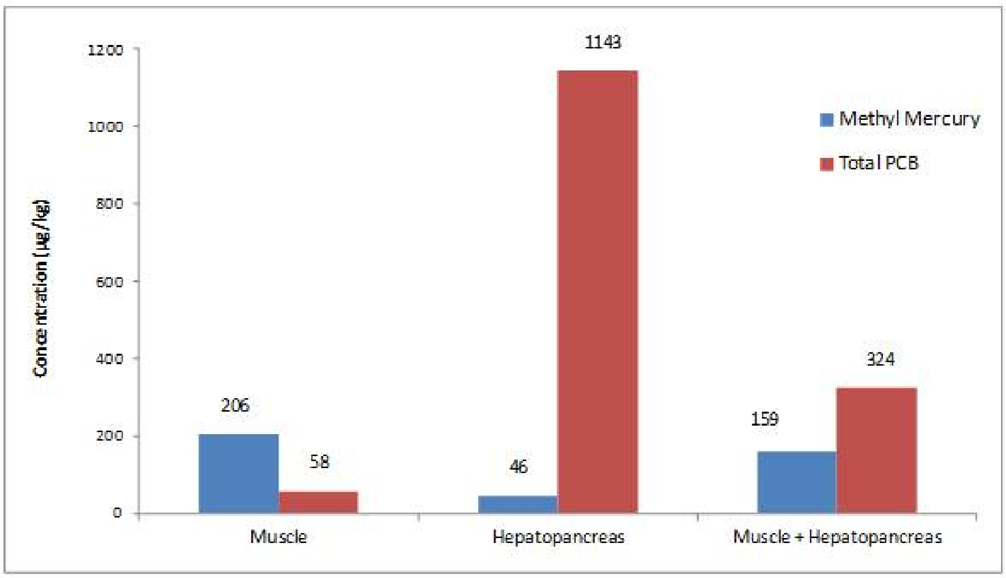


Comparison of Average TCDD TEQ Concentrations in Crab Sample Types

Lower Eight Miles of the Lower Passaic River

Figure 3-6

2014

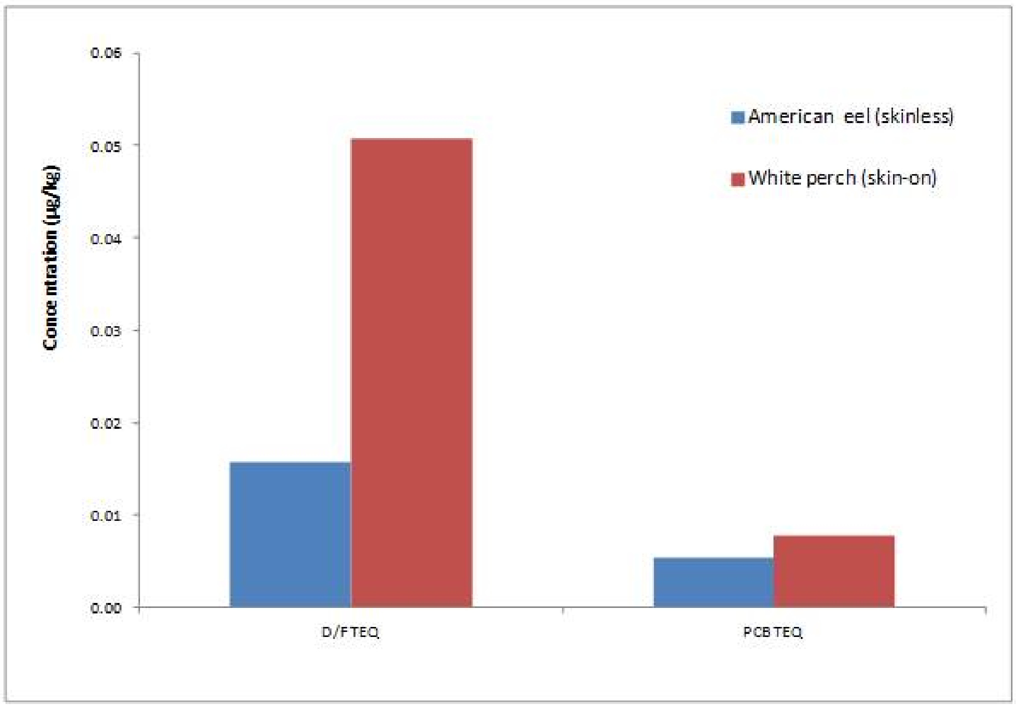


Comparison of Average Methylmercury and Total PCB Concentrations in Crab Sample Types

Lower Eight Miles of the Lower Passaic River

Figure 3-7

2014

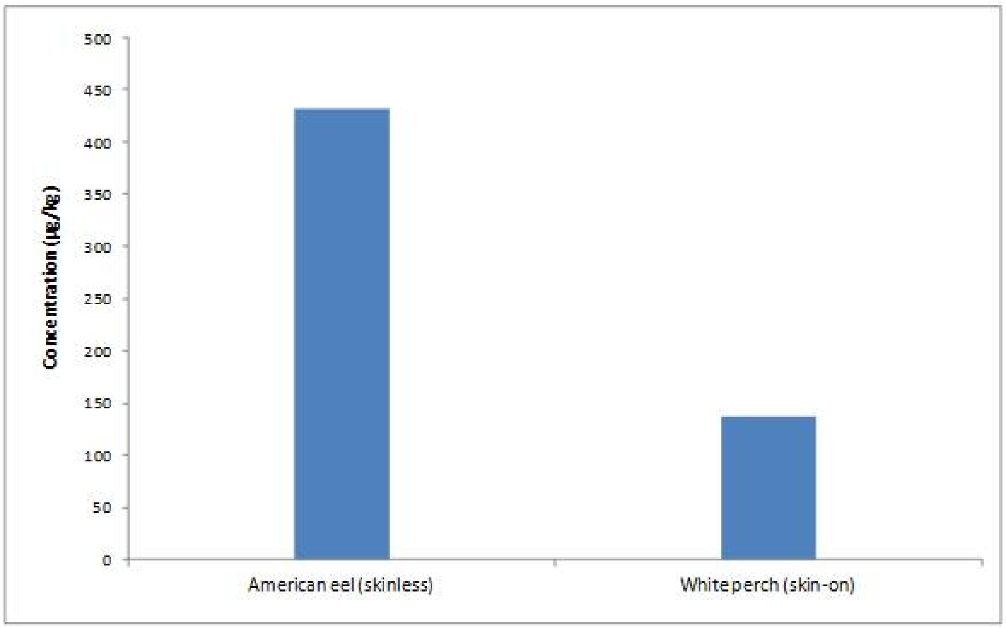


Comparison of Average TCDD TEQ Concentrations – Fish Species and Fillet Type

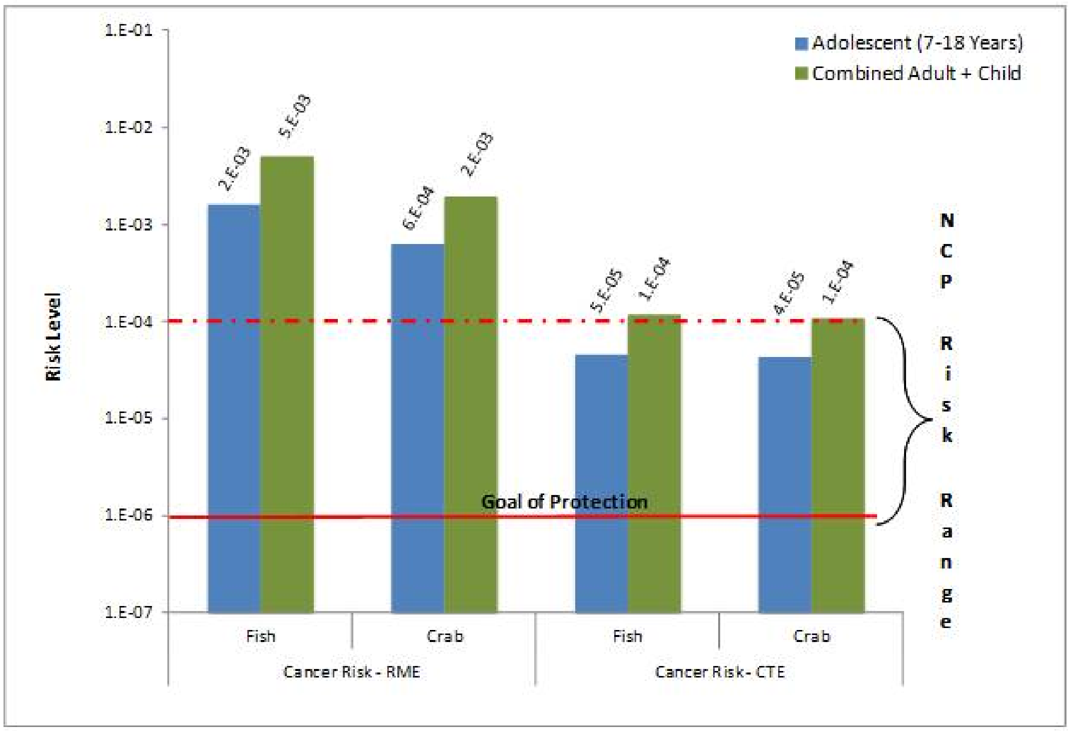
Lower Eight Miles of the Lower Passaic River

Figure 3-8

2014



Comparison of Average Methylmercury Concentrations – Fish Species and Fillet Type *Lower Eight Miles of the Lower Passaic River*	Figure 3-9 2014

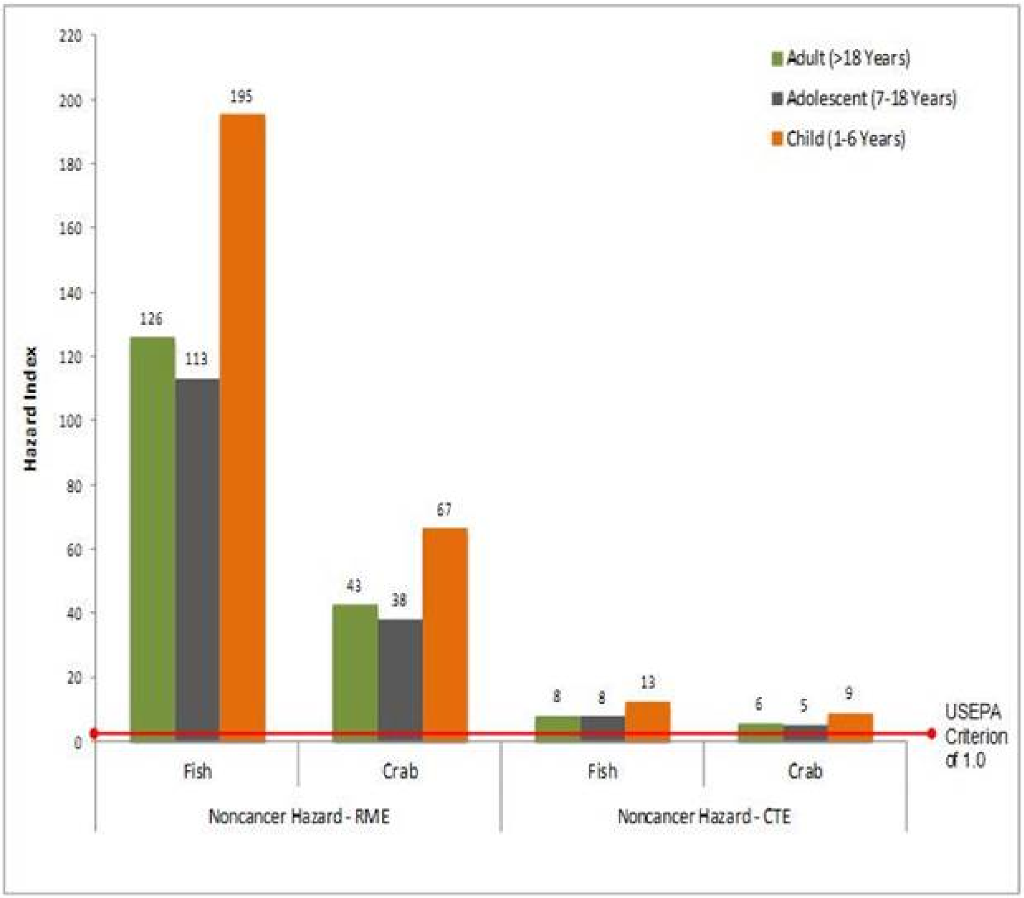


Baseline Current Cancer Risks for RME and CTE

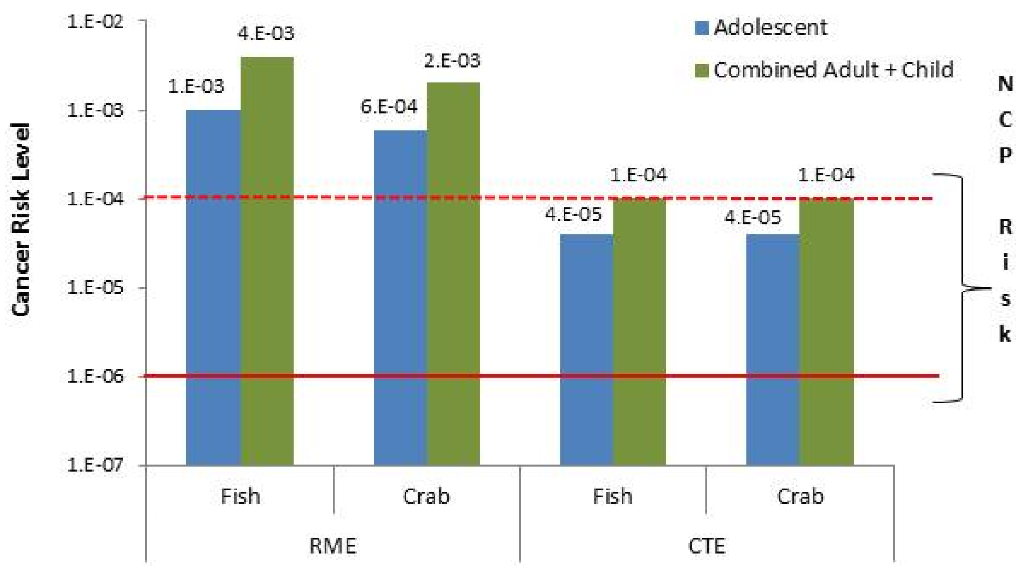
Lower Eight Miles of the Lower Passaic River

Figure 3-10

2014



Baseline Current Noncancer Health Hazards for RME and CTE	Figure 3-11
Lower Eight Miles of the Lower Passaic River	2014

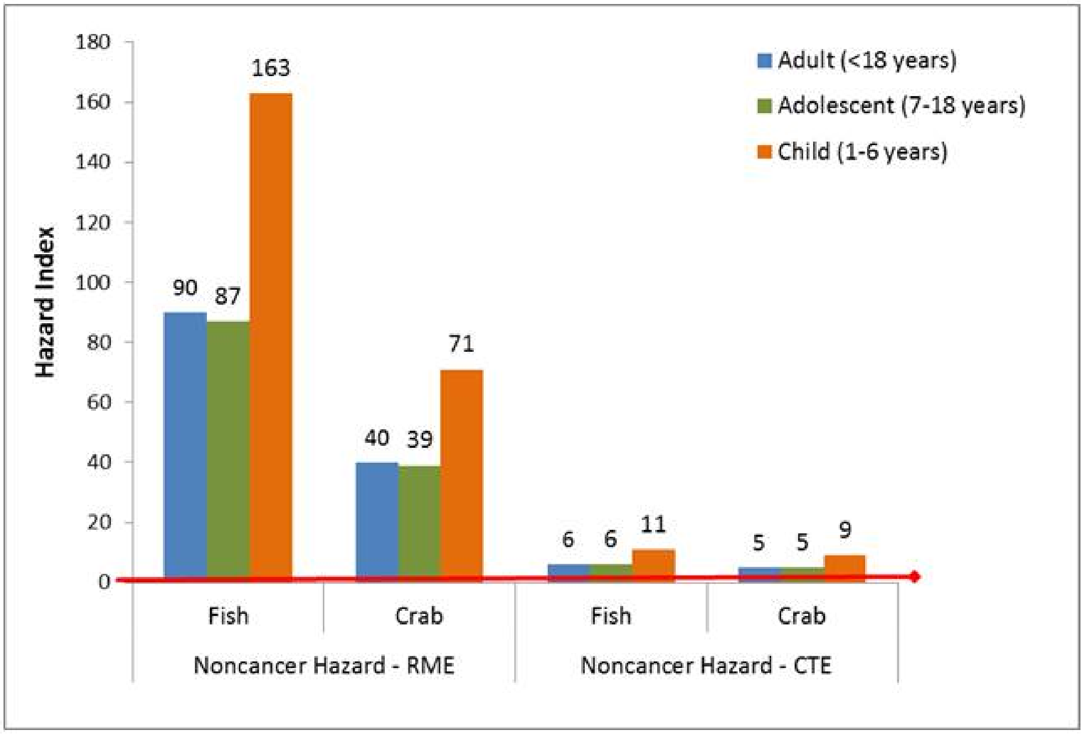


Baseline Future Modeled Cancer Risks for RME and CTE

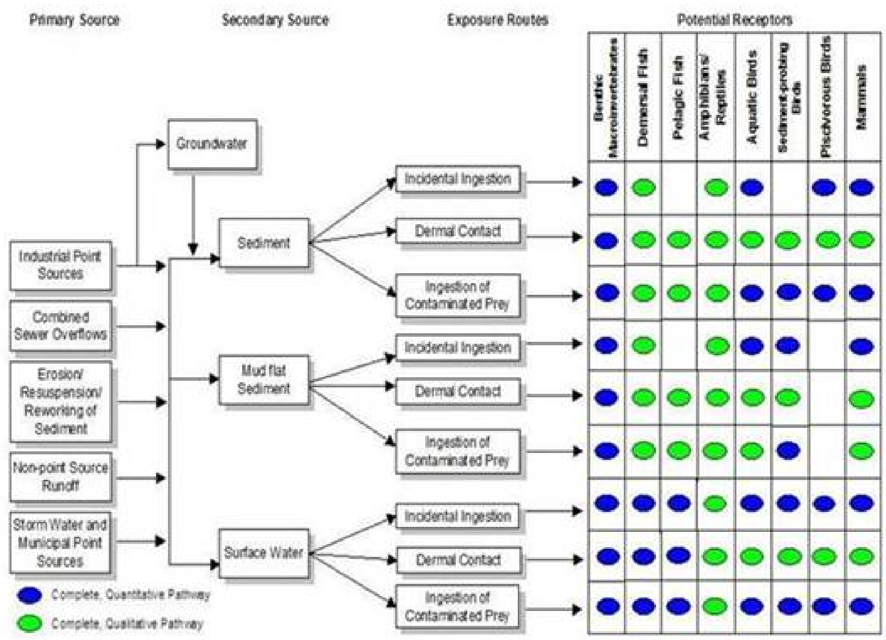
Lower Eight Miles of the Lower Passaic River

Figure 3-12

2014



Baseline Future Modeled ~~Future~~ Noncancer Health Hazards for RME and CTE *Lower Eight Miles of the Lower Passaic River*	Figure 3-13 2014

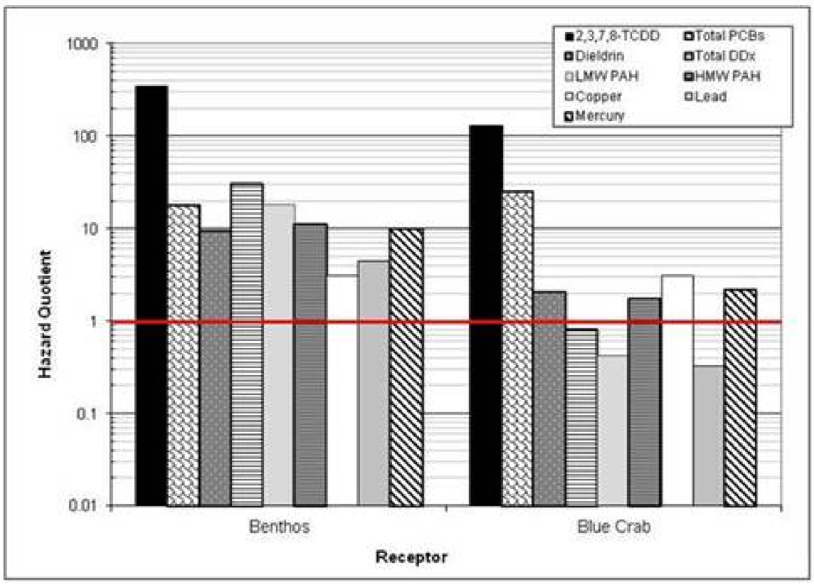


Ecological Conceptual Site Model

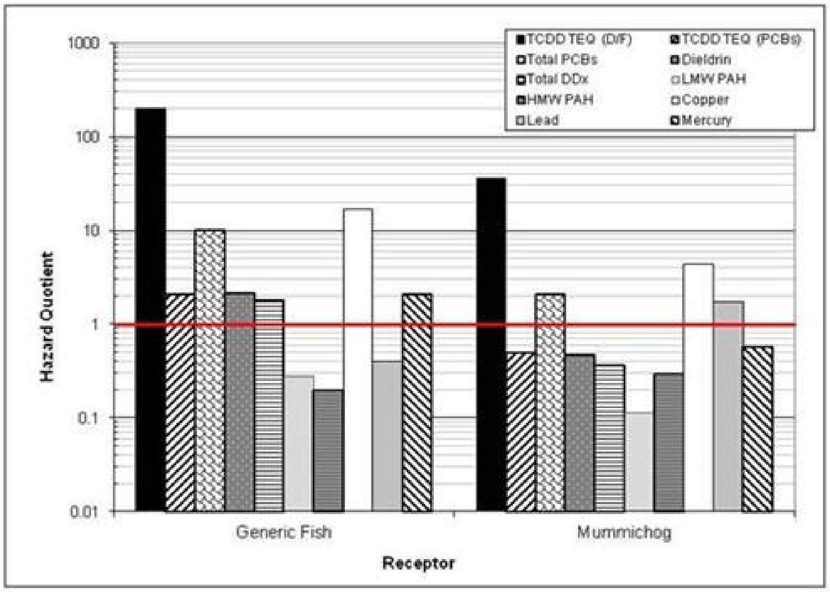
Lower Eight Miles of the Lower Passaic River

Figure 4-1

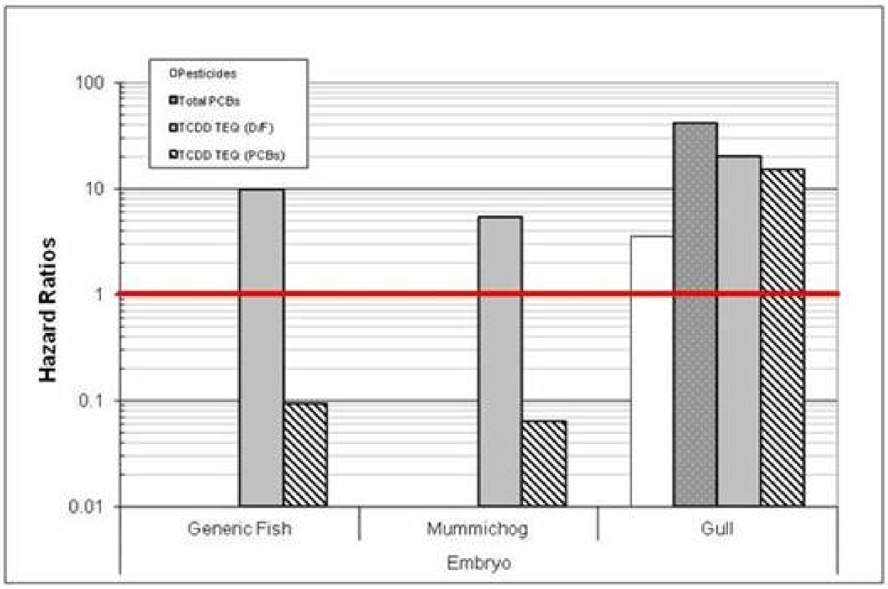
2014



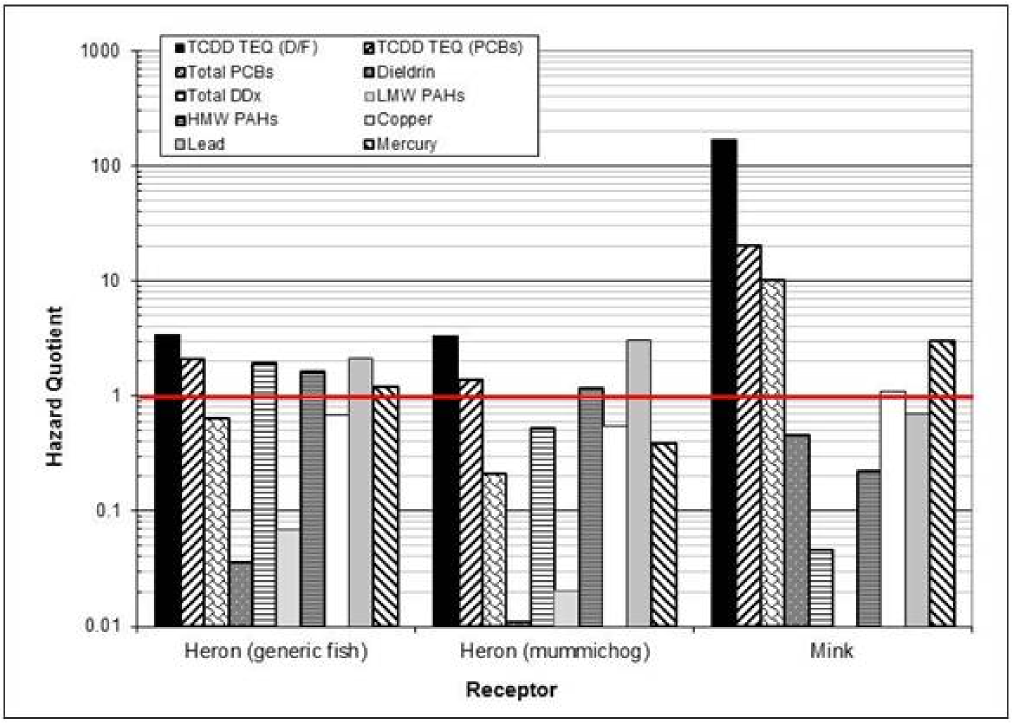
Summary of Sediment Benchmark HQs and Blue Crab Geometric Mean CBR HQs for Baseline Conditions *Lower Eight Miles of the Lower Passaic River*	Figure 4-2
	2014



Summary of Generic Fish Geometric Mean CBR HQs for Baseline Conditions *Lower Eight Miles of the Lower Passaic River*	Figure 4-3
	2014



Summary of Geometric Mean CBR Hazard Quotients for Fish and Avian Embryo Tissue Under Baseline Conditions *Lower Eight Miles of the Lower Passaic River*	Figure 4-4 2014

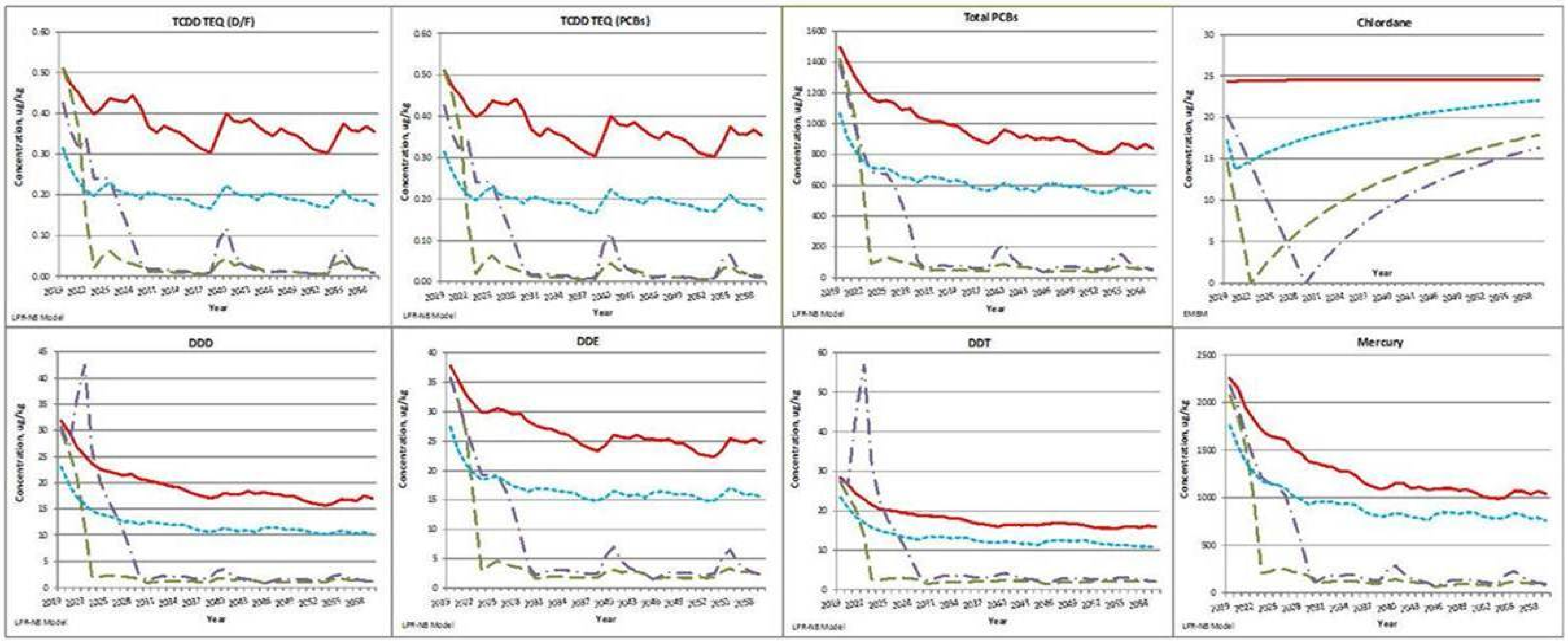


Summary of Wildlife Exposure Dose Modeling Geometric Mean HQs for Baseline Conditions

Lower Eight Miles of the Lower Passaic River

Figure 4-5

2014



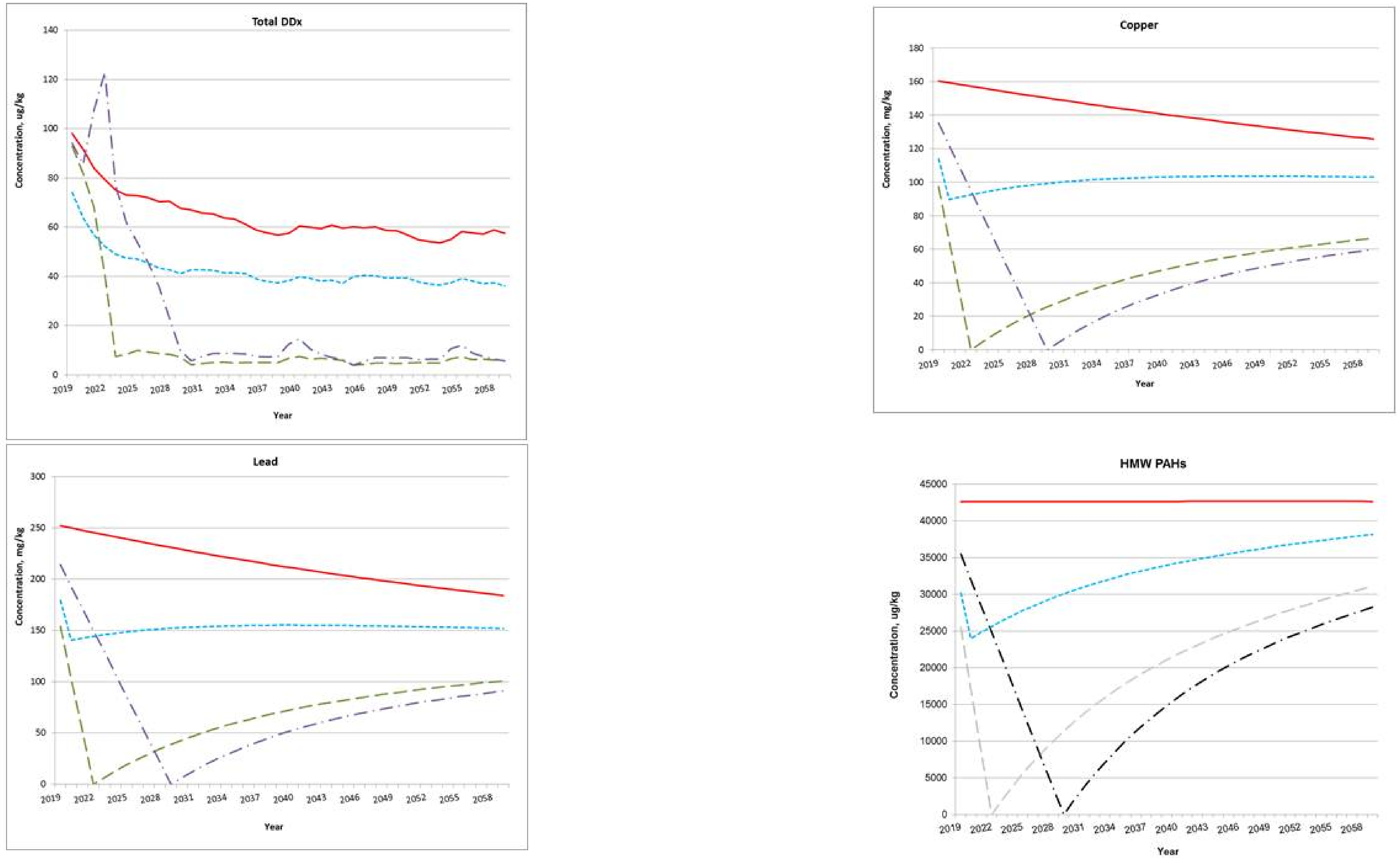
Annual average sediment concentrations predicted by the LPR-NB Model for all COPCs except chlordane. The EMBM was used to predict future sediment concentrations for chlordane.

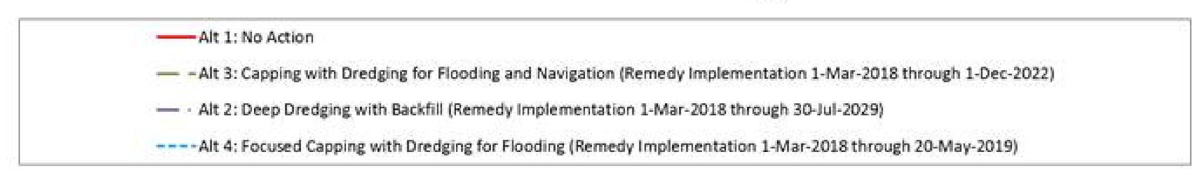
Annual Average Sediment Concentrations Predicted by the Contaminant Transport and Empirical Mass Balance Models

Lower Eight Miles of the Lower Passaic River

Figure 5-1

2014





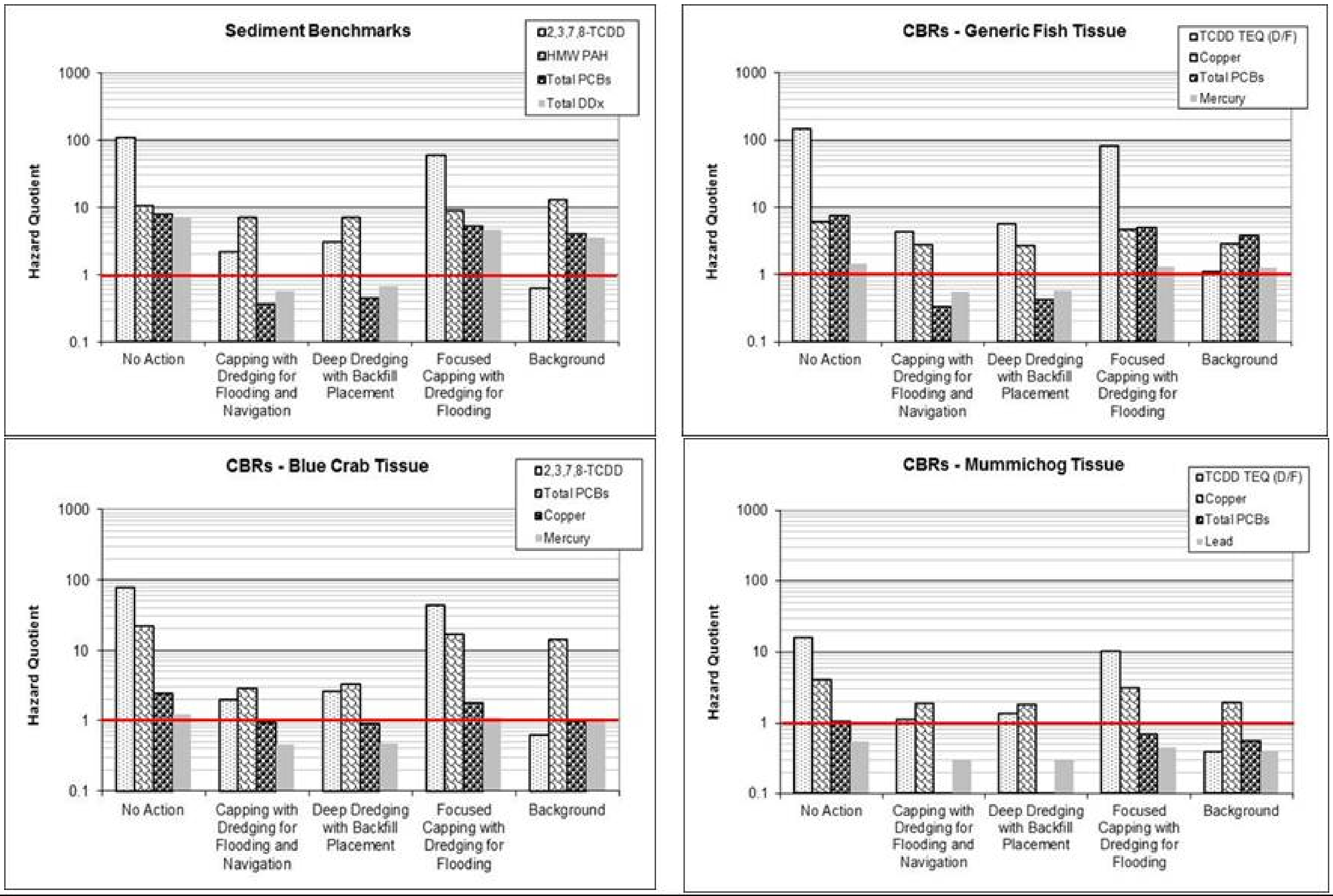
Annual average sediment concentrations predicted by the LPR-NB Model for Total DDx (the only modeled COPEC not included in Figure 5-1). The EMBM was used to predict future sediment concentrations for copper, lead and HMW PAHs.

Annual Average Sediment Concentrations Predicted by the Contaminant Transport and Empirical Mass Balance Models (Select COPECs)

Lower Eight Miles of the Lower Passaic River

Figure 5-2

2014

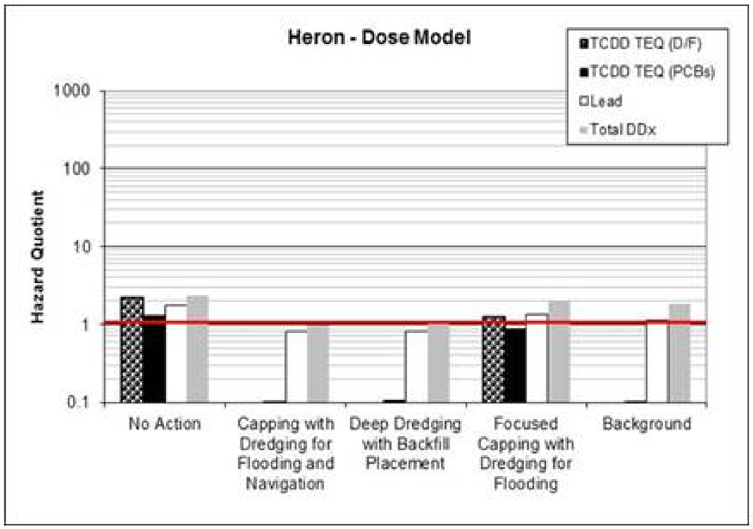


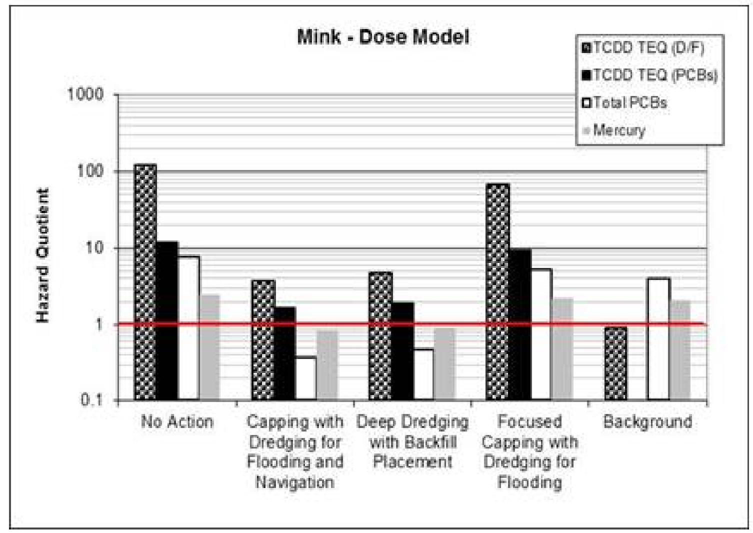
Macroinvertebrates and Fish Hazard Estimates for Top Four COPECs for Remedial Alternatives/Background Conditions

Lower Eight Miles of the Lower Passaic River

Figure 5-3

2014



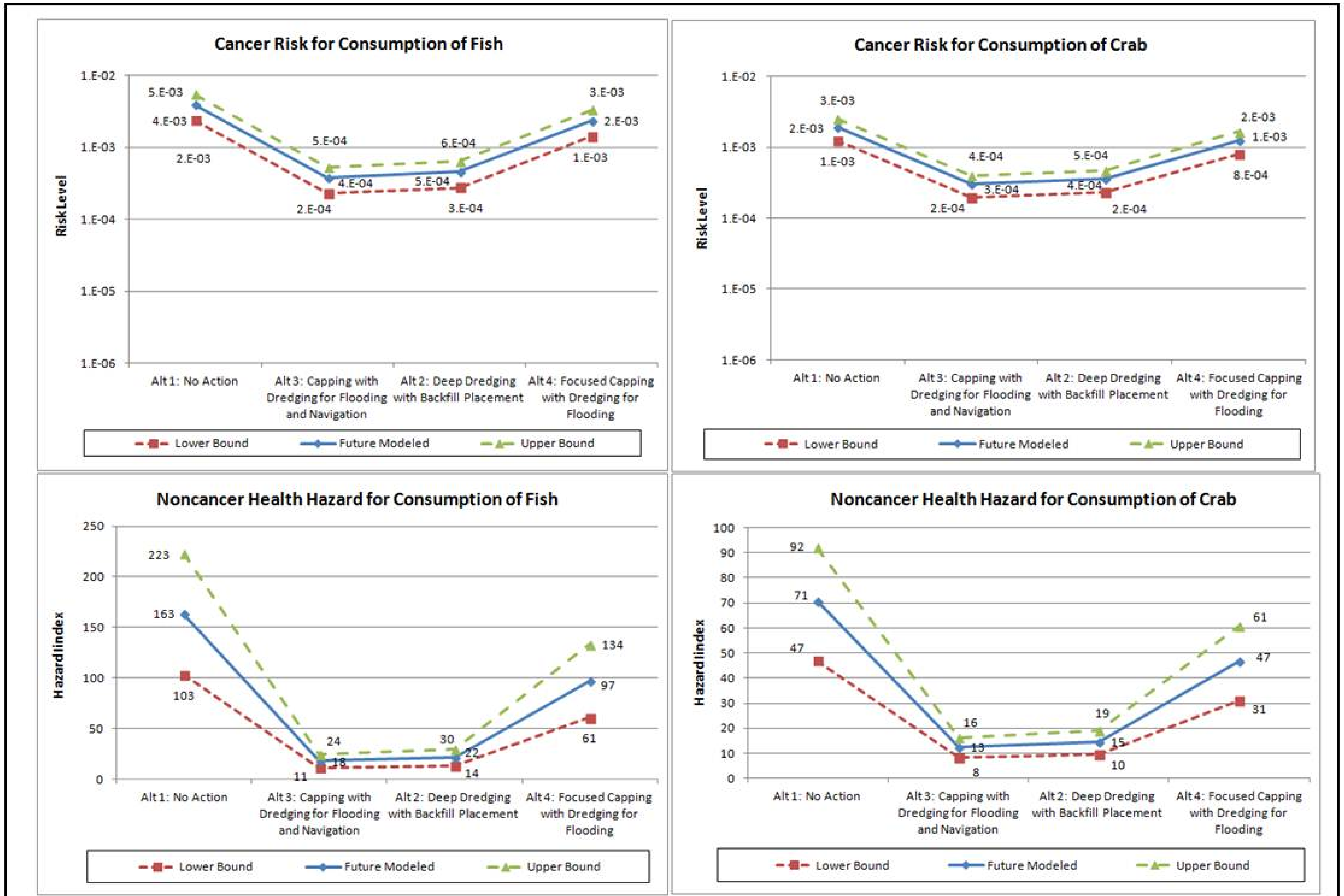


Wildlife Geometric Mean Hazard Estimates for Top Four Risk Drivers for Remedial Alternatives and Background Conditions

Lower Eight Miles of the Lower Passaic River

Figure 5-4

2014

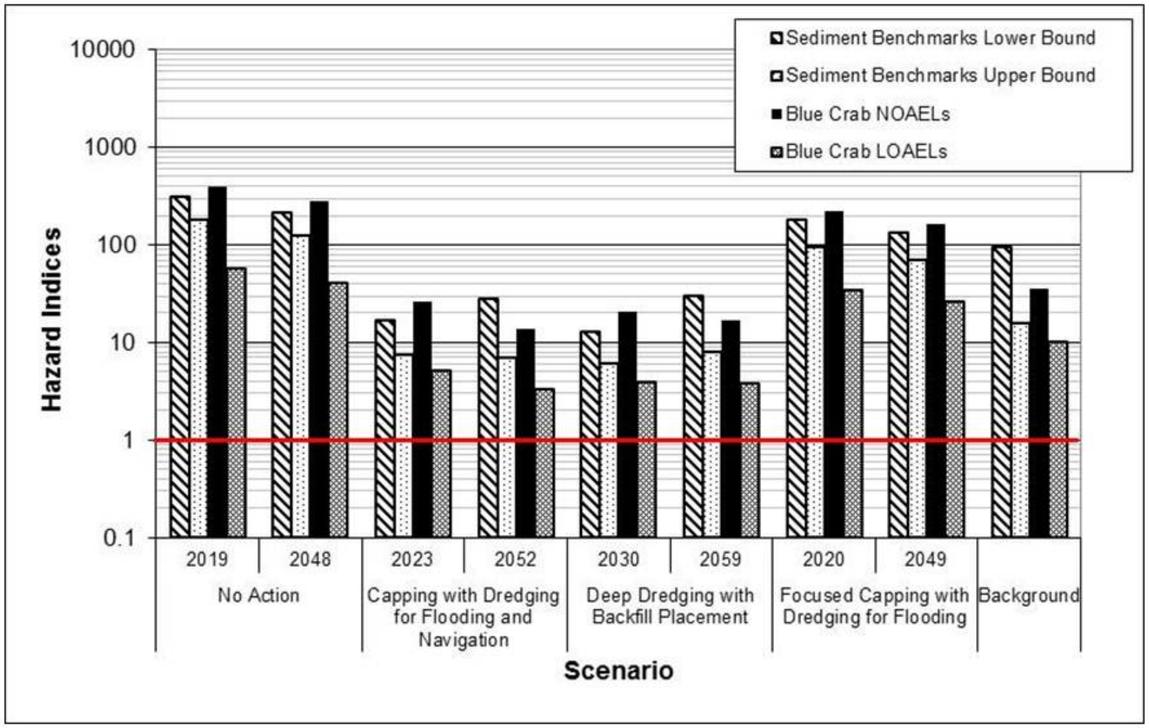


Upper and Lower Bounds on the Future Modeled Cancer Risks and Noncancer Health Hazards

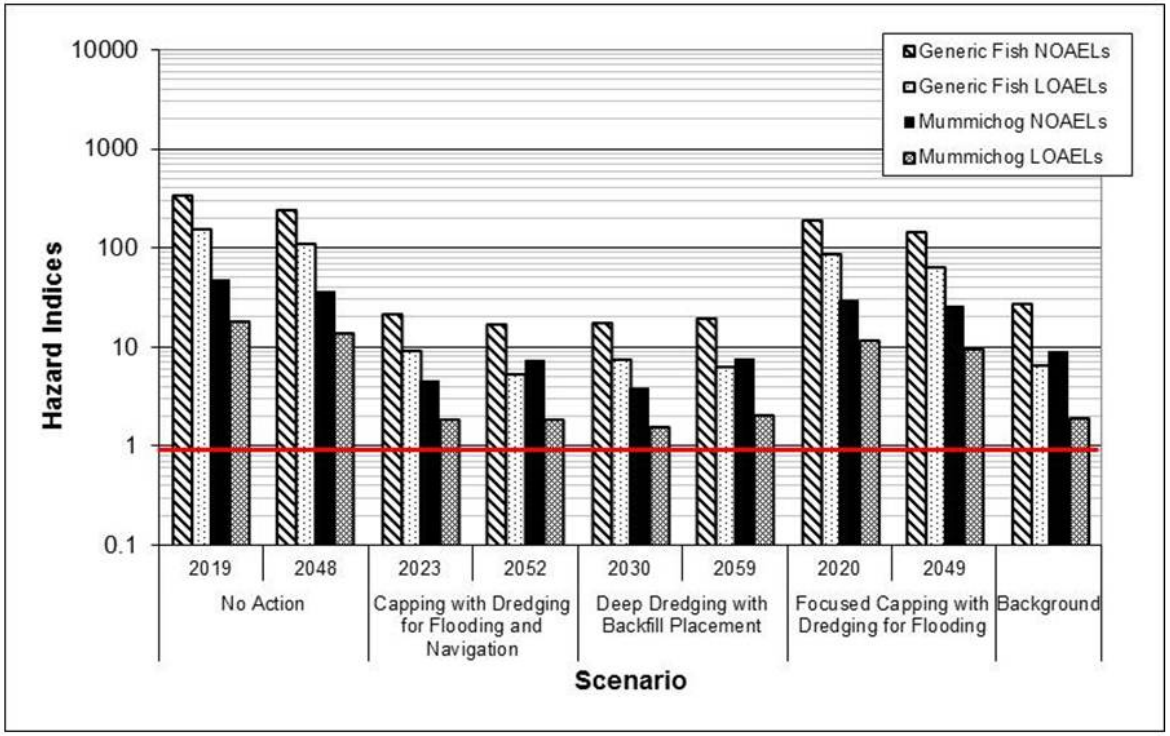
Lower Eight Miles of the Lower Passaic River

Figure 5-5

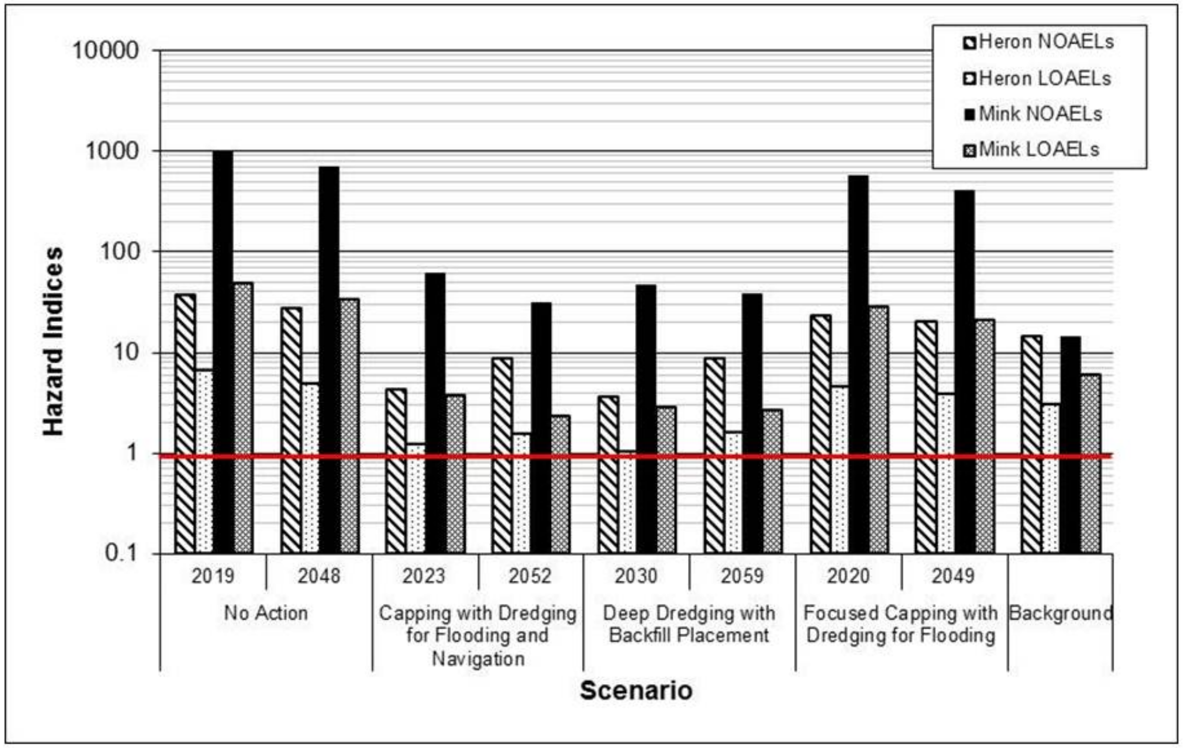
2014



Comparison of Future Modeled Lower- and Upper-Bound Hazard Estimates for Macroinvertebrates *Lower Eight Miles of the Lower Passaic River*	Figure 6-1 2014



Comparison of Future Modeled Lower- and Upper-Bound Hazard Estimates for Fish	Figure 6-2
Lower Eight Miles of the Lower Passaic River	2014



Comparison of Modeled Future Lower- and Upper-Bound Hazard Estimates for Wildlife

Lower Eight Miles of the Lower Passaic River

Figure 6-3

2014

ATTACHMENT 1

1.1 - SUPPORTING DATA

SURVEY_ID	Mudflat Sampling Locations [a]	SAMPLE_ID	RIVER_MILE	X_COORD	Y_COORD	DEPTH_TOP	DEPTH_BOTTOM	DEPTH_UNIT	DATETIME_ PLACED	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	Dieldrin	Total 4,4-DDx	Total Chlordane	HMW PAH	LMW PAH	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	TOC
08A - 2008 LPRS - Low Res Coring Samples		08A-0001-C1AS	0	597301.82	682661.59	0	0.5	ft	20-Nov-08	1	1	1				1	1			1		
		08A-0001-C2AS	0	597297.44	682660.01	0	0.5	ft	20-Nov-08				1	1	1	1	1	1	1			1
		08A-0001-G2AS	0	597303.97	682665.47	0	0.5	ft	20-Nov-08												1	
		08A-0002-C1AS	0	598285.74	683952.08	0	0.5	ft	11-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0002-C2AS	0	598285.36	683946.64	0	0.5	ft	11-Nov-08									1	1			1
		08A-0003-C1AS	0.22	599309.86	685714.27	0	0.5	ft	11-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0003-C2AS	0.22	599311.54	685708.56	0	0.5	ft	11-Nov-08							1	1	1	1			1
		08A-0004-C1AS	0	597077.03	683256.55	0	0.5	ft	25-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0004-C2AS	0	597076.59	683253.43	0	0.5	ft	25-Nov-08							1	1	1	1			1
		08A-0005-C1AS	0.15	596970.16	684208.91	0	0.5	ft	12-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0005-C2AS	0.16	596966.05	684209.27	0	0.5	ft	12-Nov-08									1	1			1
		08A-0006-C1AS	0.35	597587.97	685648.83	0	0.5	ft	18-Nov-08	1	1					1	1			1		
		08A-0006-C2AS	0.35	597584.9	685650.94	0	0.5	ft	18-Nov-08			1	1	1	1	1	1	1	1			1
		08A-0007-C1AS	0.41	598062.5	686026.6	0	0.5	ft	19-Nov-08							1	1	1	1			1
		08A-0007-C2AS	0.41	598063.84	686023.11	0	0.5	ft	19-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0007-G2AS	0.41	598068.02	686023.61	0	0.5	ft	19-Nov-08												1	
		08A-0008-C1AS	0.37	596615.12	685405.69	0	0.5	ft	24-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0008-C2AS	0.37	596612.41	685404.94	0	0.5	ft	24-Nov-08									1	1			1
		08A-0009-C1AS	0.47	596735.05	686124.36	0	0.5	ft	10-Nov-08									1	1			1
		08A-0009-C3AS	0.46	596740.46	686118.62	0	0.5	ft	10-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0010-C1AS	0.63	596986.96	687012.6	0	0.5	ft	08-Dec-08									1	1			1
		08A-0010-C2AS	0.63	596984.46	687016.48	0	0.5	ft	08-Dec-08	1	1	1	1	1	1	1	1			1		
		08A-0011-C1AS	0.54	597908.31	686695.92	0	0.5	ft	13-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0011-C2AS	0.54	597908.76	686700.8	0	0.5	ft	13-Nov-08									1	1			1
		08A-0012-C1AS	0.66	596648.85	687126.15	0	0.5	ft	04-Dec-08	1	1	1	1	1	1	1	1			1		
		08A-0012-C2AS	0.66	596645.29	687124.22	0	0.5	ft	04-Dec-08									1	1			1
		08A-0013-C1AS	0.74	596899.11	687639.06	0	0.5	ft	17-Nov-08							1	1	1	1			1
		08A-0013-C2AS	0.74	596896.21	687635.58	0	0.5	ft	17-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0014-C1AS	1.03	597607.05	689071.73	0	0.5	ft	03-Dec-08	1	1	1	1	1	1	1	1			1		
		08A-0014-C2AS	1.03	597611.16	689068.72	0	0.5	ft	03-Dec-08									1	1			1
		08A-0015-C1AS	1.11	597193.58	689657.27	0	0.5	ft	12-Nov-08									1	1			1
		08A-0015-C2AS	1.11	597193.45	689658.21	0	0.5	ft	12-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0016-C1AS	1.11	597439.98	689556.13	0	0.5	ft	01-Dec-08	1	1	1	1	1	1	1	1			1		
		08A-0016-C2AS	1.11	597439.8	689550.09	0	0.5	ft	01-Dec-08									1	1			1
		08A-0017-C1AS	1.07	597668.78	689293.07	0	0.5	ft	02-Dec-08	1	1					1	1					
		08A-0017-C2AS	1.07	597666.49	689294.8	0	0.5	ft	02-Dec-08							1	1			1		
		08A-0017-C3AS	1.07	597663.79	689291.14	0	0.5	ft	02-Dec-08			1	1	1	1			1	1			1
		08A-0018-C1AS	1.47	597700.68	691425.57	0	0.5	ft	10-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0018-C2AS	1.47	597701.12	691423.67	0	0.5	ft	10-Nov-08									1	1			1
		08A-0019-C1AS	1.47	597975.04	691369.53	0	0.5	ft	24-Sep-08									1	1			1
		08A-0019-C3AS	1.47	597977.34	691367.74	0	0.5	ft	24-Sep-08	1	1	1	1	1	1	1	1			1		
		08A-0020-C2AS	1.47	598203.64	691321.5	0	0.5	ft	04-Nov-08	1	1	1				1	1			1		
		08A-0020-C3AS	1.47	598202.03	691321.44	0	0.5	ft	04-Nov-08				1	1	1	1	1	1				1
		08A-0021-C1AS	1.94	598323.52	693855.06	0	0.5	ft	06-Nov-08	1	1	1	1	1	1	1	1			1		

SURVEY_ID	Mudflat Sampling Locations [a]	SAMPLE_ID	RIVER_MILE	X_COORD	Y_COORD	DEPTH_TOP	DEPTH_BOTTOM	DEPTH_UNIT	DATETIME_ PLACED	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	Dieldrin	Total 4,4-DDx	Total Chlordane	HMW PAH	LMW PAH	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	TOC
08A - 2008 LPRS - Low Res Coring Samples (continued)		08A-0021-C2AS	1.94	598323.5	693856.58	0	0.5	ft	06-Nov-08							1	1	1	1			1
		08A-0021-G4AS	1.94	598320.01	693854.71	0	0.5	ft	06-Nov-08												1	
	√	08A-0022-C1AS	2.64	595458.74	695201.33	0	0.5	ft	03-Nov-08	1	1	1	1	1	1	1	1			1		
	√	08A-0022-C2AS	2.64	595459.64	695200.21	0	0.5	ft	03-Nov-08									1	1			1
		08A-0023-C1AS	2.62	595561.92	695458.83	0	0.5	ft	05-Nov-08									1	1			1
		08A-0023-C2AS	2.62	595567.32	695458.53	0	0.5	ft	05-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0024-C1AS	2.62	595560.39	695766.62	0	0.5	ft	30-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0024-C2AS	2.62	595557.65	695764.89	0	0.5	ft	30-Oct-08									1	1			1
		08A-0025-C1AS	2.85	594361.07	695470.17	0	0.5	ft	03-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0025-C3AS	2.85	594358.12	695468.89	0	0.5	ft	03-Nov-08									1	1			1
	√	08A-0026-C1AS	3.17	592600.84	695422.3	0	0.5	ft	28-Oct-08	1	1	1	1	1	1	1	1			1		
	√	08A-0026-C2AS	3.17	592602.2	695427.12	0	0.5	ft	28-Oct-08									1	1			1
	√	08A-0026-G2AS	3.17	592607.92	695424.39	0	0.5	ft	29-Oct-08												1	
		08A-0027-C1AS	3.52	591239.45	694158.03	0	0.5	ft	29-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0027-C2AS	3.52	591241.73	694154.72	0	0.5	ft	29-Oct-08									1	1			1
		08A-0028-C1AS	3.53	591150.5	694214.58	0	0.5	ft	05-Nov-08							1	1	1	1			1
		08A-0028-C2AS	3.53	591148.05	694214.63	0	0.5	ft	05-Nov-08	1	1	1	1	1	1	1	1			1		
		08A-0029-C1AS	3.53	591048.5	694266.4	0	0.5	ft	29-Oct-08	1	1					1	1					
		08A-0029-C2AS	3.53	591051.06	694264.88	0	0.5	ft	29-Oct-08			1	1	1	1	1	1			1		
		08A-0029-C3AS	3.53	591046.27	694263.02	0	0.5	ft	29-Oct-08									1	1			1
		08A-0030-C1AS	4.25	588236.97	692271.5	0	0.5	ft	27-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0030-C2AS	4.25	588237.8	692266.83	0	0.5	ft	27-Oct-08									1	1			1
		08A-0031-C1AS	--	588232.98	692388.54	0	0.5	ft	23-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0031-C2AS	--	588233.55	692391.07	0	0.5	ft	23-Oct-08							1	1	1	1			1
		08A-0032-C1AS	--	588226.44	692539.02	0	0.5	ft	23-Oct-08									1	1			1
		08A-0032-C2AS	--	588222.28	692540.62	0	0.5	ft	23-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0033-C1AS	--	585378.15	694445.6	0	0.5	ft	22-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0033-C2AS	--	585377.39	694443.53	0	0.5	ft	22-Oct-08									1	1			1
		08A-0034-C1AS	--	584863.43	695962.95	0	0.5	ft	22-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0034-C3AS	--	584861.13	695957.84	0	0.5	ft	22-Oct-08									1	1			1
		08A-0034-G2AS	--	584859.34	695958.3	0	0.5	ft	22-Oct-08												1	
		08A-0035-C5AS	5.51	584726.66	697054.4	0	0.5	ft	23-Sep-08	1	1	1	1	1	1	1	1			1		
		08A-0035-C6AS	5.51	584727.2	697057.44	0	0.5	ft	23-Sep-08									1	1			1
		08A-0036-C1AS	5.51	584571.97	697027.29	0	0.5	ft	21-Oct-08									1	1			1
		08A-0036-C2AS	5.51	584570.02	697031.74	0	0.5	ft	21-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0037-C1AS	5.51	584810.07	697059.41	0	0.5	ft	20-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0037-C2AS	5.51	584806.08	697059.25	0	0.5	ft	20-Oct-08									1	1			1
		08A-0038-C1AS	6	585065.99	699603.68	0	0.5	ft	21-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0038-C2AS	6	585066.8	699604.71	0	0.5	ft	21-Oct-08									1	1			1
		08A-0039-C1AS	6.27	585242.16	701012.99	0	0.5	ft	20-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0039-C2AS	6.27	585243.56	701011.1	0	0.5	ft	20-Oct-08									1	1			1
		08A-0040-C1AS	6.49	585513.96	702183.89	0	0.5	ft	24-Sep-08	1	1	1	1	1	1	1	1			1		
		08A-0040-C3AS	6.49	585520.1	702179.84	0	0.5	ft	24-Sep-08									1	1			1
		08A-0041-C1AS	6.49	585602.36	702138.22	0	0.5	ft	22-Sep-08	1	1	1	1	1	1	1	1			1		
		08A-0041-C2AS	6.49	585598.81	702136.58	0	0.5	ft	22-Sep-08									1	1			1
		08A-0042-C1AS	6.5	585642.78	702117.08	0	0.5	ft	22-Sep-08									1	1			1
		08A-0042-C2AS	6.5	585641.32	702120.41	0	0.5	ft	22-Sep-08	1	1	1	1	1	1	1	1			1		
		08A-0043-C2AS	7	586923.6	704432.89	0	0.5	ft	19-Aug-08	1	1	1	1	1	1	1	1			1		
		08A-0043-C4AS	7	586927.42	704435.39	0	0.5	ft	19-Aug-08							1	1	1	1			1
		08A-0044-C1AS	7	587069.14	704368.86	0	0.5	ft	19-Aug-08	1	1	1	1	1	1	1	1			1		
		08A-0044-C3AS	7	587069.81	704364.87	0	0.5	ft	19-Aug-08									1	1			1

SURVEY_ID	Mudflat Sampling Locations [a]	SAMPLE_ID	RIVER_MILE	X_COORD	Y_COORD	DEPTH_TOP	DEPTH_BOTTOM	DEPTH_UNIT	DATETIME_ PLACED	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	Dieldrin	Total 4,4-DDx	Total Chlordane	HMW PAH	LMW PAH	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	TOC
08A - 2008 LPRS - Low Res Coring Samples (continued)	√	08A-0045-C1AS	7	587160.6	704312.07	0	0.5	ft	20-Aug-08									1	1			1
	√	08A-0045-C2AS	7	587158.38	704314.44	0	0.5	ft	20-Aug-08	1	1	1	1	1	1	1	1			1		
	√	08A-0045-G2AS	7	587165.09	704312.51	0	0.5	ft	20-Aug-08												1	
		08A-0046-C2AS	7.45	587705.85	706683.04	0	0.5	ft	20-Aug-08	1	1	1	1	1	1	1	1	1	1	1		1
		08A-0047-C1AS	7.45	587833.66	706607.08	0	0.5	ft	30-Jul-08	1	1	1	1	1	1	1	1			1		
		08A-0047-C4AS	7.45	587826.66	706604.64	0	0.5	ft	30-Jul-08							1	1	1	1			1
	√	08A-0048-C2AS	7.44	587985.28	706484.99	0	0.5	ft	31-Jul-08	1	1	1	1	1	1	1	1			1		
	√	08A-0048-C3AS	7.44	587982.93	706482.4	0	0.5	ft	31-Jul-08									1	1			1
		08A-0049-C1AS	7.86	589179.08	708328.47	0	0.5	ft	06-Aug-08	1	1	1	1	1	1	1	1	1	1	1		1
	√	08A-0050-C1AS	7.97	589359.01	708814.87	0	0.5	ft	03-Sep-08	1	1	1	1	1	1	1	1			1		
	√	08A-0050-C2AS	7.97	589357.88	708818.48	0	0.5	ft	03-Sep-08									1	1			1
		08A-0051-C1AS	7.97	589473.28	708764.3	0	0.5	ft	26-Aug-08	1	1	1	1	1	1	1	1			1		
		08A-0051-C2AS	7.97	589471.53	708765.64	0	0.5	ft	26-Aug-08							1	1	1	1			1
		08A-0052-C2AS	7.97	589597.65	708728.08	0	0.5	ft	26-Aug-08	1	1	1	1	1	1	1	1			1		
		08A-0052-C3AS	7.97	589593.07	708727.66	0	0.5	ft	26-Aug-08							1	1	1	1			1
		08A-0115-C1AS	4.21	588401.15	692313.9	0	0.5	ft	27-Oct-08	1	1	1	1	1	1	1	1			1		
		08A-0115-C2AS	4.21	588406.98	692314.85	0	0.5	ft	27-Oct-08									1	1			1
		Study Total								53	53	53	53	53	53	69	69	53	52	53	6	53
2009 Benthic Sediment Study		LPRH05A	4.08	-74.1502	40.733	0	0.2	ft	12-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRH05B	4.35	-74.1548	40.7332	0	0.5	ft	11-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRH07B	6.81	-74.1589	40.7639	0	0.4	ft	12-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01A	0	-74.1214	40.7086	0	0.5	ft	12-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01B	0.46	-74.1232	40.7158	0	0.5	ft	12-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01C	0.29	-74.1145	40.716	0	0.5	ft	09-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01D	0.42	-74.1174	40.7166	0	0.5	ft	12-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01E	0.56	-74.1175	40.7184	0	0.5	ft	09-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01F	0.63	-74.1217	40.7189	0	0.5	ft	13-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT01G	0.86	-74.122	40.7224	0	0.5	ft	13-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02A	1.01	-74.1212	40.7246	0	0.5	ft	13-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02B	1.24	-74.1186	40.7275	0	0.5	ft	13-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02C	1.25	-74.1203	40.7281	0	0.5	ft	09-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02D	1.21	-74.1204	40.7275	0	0.5	ft	10-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02E	1.47	-74.1181	40.7308	0	0.5	ft	14-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT02F	1.6	-74.1185	40.7329	0	0.5	ft	14-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03A	2.03	-74.1183	40.7386	0	0.5	ft	14-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03B	2.13	-74.1182	40.74	0	0.5	ft	15-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03C	2.37	-74.122	40.7413	0	0.5	ft	10-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03D	2.77	-74.1295	40.7428	0	0.5	ft	15-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03E	2.8	-74.1299	40.7422	0	0.5	ft	15-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	

SURVEY_ID	Mudflat Sampling Locations [a]	SAMPLE_ID	RIVER_MILE	X_COORD	Y_COORD	DEPTH_TOP	DEPTH_BOTTOM	DEPTH_UNIT	DATETIME_ PLACED	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	Dieldrin	Total 4,4-DDx	Total Chlordane	HMW PAH	LMW PAH	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	TOC
2009 Benthic Sediment Study (continued)		LPRT03F	2.83	-74.1304	40.7415	0	0.5	ft	11-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT03G	3.13	-74.1361	40.7409	0	0.5	ft	12-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04A	3.39	-74.1411	40.7406	0	0.5	ft	16-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04B	3.54	-74.143	40.7389	0	0.5	ft	16-Oct-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04C	3.74	-74.1441	40.7358	0	0.5	ft	11-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04D	3.82	-74.1456	40.7354	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04E	3.85	-74.1462	40.7352	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT04F	3.95	-74.1472	40.7335	0	0.5	ft	11-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05A	4.12	-74.1507	40.7332	0	0.5	ft	11-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05B	4.14	-74.1511	40.7335	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05C	4.19	-74.152	40.7345	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05D	4.35	-74.1549	40.7332	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05E	4.8	-74.1626	40.7363	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT05F	4.96	-74.1624	40.7389	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06A	5.02	-74.1644	40.7394	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06B	5.08	-74.1645	40.7402	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06C	5.52	-74.1655	40.7466	0	0.5	ft	09-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06D	5.54	-74.1659	40.7469	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06E	5.79	-74.1652	40.7505	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT06F	5.99	-74.1643	40.7533	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT07A	6.07	-74.1649	40.7546	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT07B	6.51	-74.1628	40.7606	0	0.5	ft	06-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT07C	6.65	-74.1616	40.7626	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT07D	6.83	-74.159	40.7643	0	0.5	ft	03-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT07E	6.94	-74.1586	40.7659	0	0.5	ft	03-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT08A	7.05	-74.1577	40.7673	0	0.5	ft	03-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT08B	7.33	-74.1555	40.7705	0	0.5	ft	04-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT08C	7.43	-74.1539	40.772	0	0.5	ft	03-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT08D	7.47	-74.1545	40.7728	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRT08E	7.88	-74.1495	40.7775	0	0.5	ft	05-Nov-09	1	1	1	1	1	1	1	1	1	1	1	1	
		Study Total								51	51	51	51	51	51	51	51	51	51	51	51	0
2010 CPG Benthic Sediment Sampling		LPRC02A	1.25	597359	690336	0	0.5	ft	10-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC02B	1.77	597899	692976	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRC03A	2.34	596945	695077	0	0.5	ft	10-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRC03B	2.47	596346	695265	0	0.5	ft	10-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC04A	3.16	592670	695454	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC04B	3.52	590951	694422	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC04C	3.58	590806	694090	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC04D	3.83	590184	693034	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC05A	4.16	588734	692738	0	0.5	ft	12-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC05B	4.32	587856	692620	0	0.5	ft	11-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
		LPRC06A	5.66	584567	697782	0	0.5	ft	12-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC07A	6.24	585349	700795	0	0.5	ft	12-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC07B	6.88	586506	703905	0	0.5	ft	12-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC07C	6.97	587075	704094	0	0.5	ft	16-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC07D	6.91	586608	704034	0	0.5	ft	12-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
	√	LPRC08A	7.52	587843	706977	0	0.5	ft	13-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	
		Study Total								16	16	16	16	16	16	16	16	16	16	16	16	0
		Total of All Studies								120	120	120	120	120	120	136	136	120	119	120	73	53

Footnote

a. Sample IDs for intertidal (i.e., "mudflat") sampling locations are indicated with checkmarks.. Analytical data for these samples were used to calculate mudflat Exposure Point Concentrations (EPCs).

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	atetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
2009 Fish & Crab Tissue Sampling	LPR1-ARFT-COMP01	1	-74.1204	40.7243	American eel	Fillet (skinless)	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1		1	1	1	HH
	LPR1-ARFT-COMP02	1	-74.1204	40.7243	American eel	Fillet (skinless)	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1		1	1	1	HH
	LPR1-ARFT-IND085	1	-74.1204	40.7243	American eel	Fillet (skinless)	TA	05-Sep-09	1	1	1	1	1	1	1	1	1	1		1	1	1	HH
	LPR2-ARFT-COMP04	3	-74.1338	40.7419	American eel	Fillet (skinless)	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1		1	1	1	HH
	LPR3-ARFT-COMP05	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ARFT-COMP06	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ARFT-COMP20	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ARFT-IND005	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ARFT-IND010	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ARFT-IND014	5	-74.1634	40.7393	American eel	Fillet (skinless)	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-COMP07	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	19-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-COMP08	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	20-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-IND022	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-IND026	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-IND034	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	19-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ARFT-IND044	7	-74.1574	40.7665	American eel	Fillet (skinless)	TA	20-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - American Eel HHRA Samples								16	16	16	16	16	16	16	16	16	16	12	16	16	16	HH
	LPR1-ARCT-IND085	1	-74.1204	40.7243	American eel	Reconstituted Whole	TA	05-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-ARCT-COMP04	3	-74.1338	40.7419	American eel	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR1-ARWB-COMP03	1	-74.1204	40.7243	American eel	Whole body	TA	03-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-ARWB-IND001	5	-74.1634	40.7393	American eel	Whole body	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR3-ARWB-IND009	5	-74.1634	40.7393	American eel	Whole body	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR3-ARWB-IND012	5	-74.1634	40.7393	American eel	Whole body	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR4-ARWB-IND024	7	-74.1574	40.7665	American eel	Whole body	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR4-ARWB-IND025	7	-74.1574	40.7665	American eel	Whole body	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1		1	1	1	ECO
	LPR4-ARWB-IND043	7	-74.1574	40.7665	American eel	Whole body	TA	20-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-ARWB-IND060	7	-74.1574	40.7665	American eel	Whole body	TA	22-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - American Eel ERA Samples								10	10	10	10	10	10	10	10	10	10	4	10	10	10	ECO
	LPR1-CSMH-COMP01	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP02	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP03	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP04	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	Datetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
2009 Fish & Crab Tissue Sampling (continued)	LPR1-CSMH-COMP06	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP07	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP11	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-CSMH-COMP13	1	-74.1204	40.7243	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP14	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP15	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP17	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP18	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	03-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP19	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR2-CSMH-COMP20	3	-74.1338	40.7419	Blue crab	Muscle/hepatopancreas	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-CSMH-COMP24	5	-74.1634	40.7393	Blue crab	Muscle/hepatopancreas	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-CSMH-COMP26	5	-74.1634	40.7393	Blue crab	Muscle/hepatopancreas	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-CSMH-COMP27	5	-74.1634	40.7393	Blue crab	Muscle/hepatopancreas	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-CSMH-COMP28	5	-74.1634	40.7393	Blue crab	Muscle/hepatopancreas	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CSMH-COMP30	7	-74.1574	40.7665	Blue crab	Muscle/hepatopancreas	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CSMH-COMP31	7	-74.1574	40.7665	Blue crab	Muscle/hepatopancreas	TA	20-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CSMH-COMP32	7	-74.1574	40.7665	Blue crab	Muscle/hepatopancreas	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CSMH-COMP33	7	-74.1574	40.7665	Blue crab	Muscle/hepatopancreas	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - Blue Crab HHRA Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	HH
	LPR1-CSCT-COMP01	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP02	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP03	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP04	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP06	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP07	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP11	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-CSCT-COMP13	1	-74.1204	40.7243	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP14	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP15	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP17	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP18	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	03-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP19	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-CSCT-COMP20	3	-74.1338	40.7419	Blue crab	Reconstituted Whole	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-CSCT-COMP24	5	-74.1634	40.7393	Blue crab	Reconstituted Whole	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-CSCT-COMP26	5	-74.1634	40.7393	Blue crab	Reconstituted Whole	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-CSCT-COMP27	5	-74.1634	40.7393	Blue crab	Reconstituted Whole	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-CSCT-COMP28	5	-74.1634	40.7393	Blue crab	Reconstituted Whole	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	Datetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
2009 Fish & Crab Tissue Sampling (continued)	LPR4-CSCT-COMP30	7	-74.1574	40.7665	Blue crab	Reconstituted Whole	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-CSCT-COMP31	7	-74.1574	40.7665	Blue crab	Reconstituted Whole	TA	20-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-CSCT-COMP32	7	-74.1574	40.7665	Blue crab	Reconstituted Whole	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-CSCT-COMP33	7	-74.1574	40.7665	Blue crab	Reconstituted Whole	TA	18-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - Blue Crab ERA Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	ECO
	LPR3-ANWB-IND001	5	-74.1634	40.7393	Brown bullhead	Whole body	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-ANWB-IND007	7	-74.1574	40.7665	Brown bullhead	Whole body	TA	16-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - Brown Bullhead ERA Samples								2	2	2	2	2	2	2	2	2	2	2	2	2	2	ECO
	LPR3-CCFT-IND001	5	-74.1634	40.7393	Common carp	Fillet (with skin)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-CCFT-IND004	5	-74.1634	40.7393	Common carp	Fillet (with skin)	TA	15-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CCFT-IND155	7	-74.1574	40.7665	Common carp	Fillet (with skin)	TA	17-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-CCFT-IND156	7	-74.1574	40.7665	Common carp	Fillet (with skin)	TA	17-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - Common Carp HHRA Samples								4	4	4	4	4	4	4	4	4	4	4	4	4	4	HH
	LPR3-CCWB-IND002	5	-74.1634	40.7393	Common carp	Whole body	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-CCWB-IND005	5	-74.1634	40.7393	Common carp	Whole body	TA	15-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-CCWB-IND175	7	-74.1574	40.7665	Common carp	Whole body	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-CCWB-IND186	7	-74.1574	40.7665	Common carp	Whole body	TA	19-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - Common Carp ERA Samples								4	4	4	4	4	4	4	4	4	4	4	4	4	4	ECO
	LPR2-FHET-COMP01	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP02	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP03	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP04	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP05	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP06	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP07	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP08	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	LPR2-FHET-COMP10	3	-74.1338	40.7419	Mummichog	Egg tissue	TA	25-May-10														1	ECO
	Survey Total - Mummichog Egg Tissue ERA Samples								0	0	0	0	0	0	0	0	0	0	0	0	0	9	ECO
	LPR4-MDFT-COMP01	7	-74.1574	40.7665	Smallmouth bass	Fillet (with skin)	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - Smallmouth Bass HHRA Samples								1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-MDCT-COMP01	7			Smallmouth bass	Reconstituted Whole	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	Datetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
2009 Fish & Crab Tissue Sampling (continued)	Survey Total - Smallmouth Bass ERA Samples								1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-ACFT-IND018	3	-74.1338	40.7419	White catfish	Fillet (skinless)	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ACFT-IND001	5	-74.1634	40.7393	White catfish	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ACFT-IND002	5	-74.1634	40.7393	White catfish	Fillet (skinless)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ACFT-IND003	5	-74.1634	40.7393	White catfish	Fillet (skinless)	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-ACFT-IND005	5	-74.1634	40.7393	White catfish	Fillet (skinless)	TA	14-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-ACFT-IND023	7	-74.1574	40.7665	White catfish	Fillet (skinless)	TA	17-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - White Catfish HHRA Samples								6	6	6	6	6	6	6	6	6	6	6	6	6	6	HH
	LPR2-ACCT-IND018	3	-74.1338	40.7419	White catfish	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-ACCT-IND001	5	-74.1634	40.7393	White catfish	Reconstituted Whole	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-ACCT-IND002	5	-74.1634	40.7393	White catfish	Reconstituted Whole	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-ACCT-IND003	5	-74.1634	40.7393	White catfish	Reconstituted Whole	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-ACCT-IND005	5	-74.1634	40.7393	White catfish	Reconstituted Whole	TA	14-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-ACCT-IND023	7	-74.1574	40.7665	White catfish	Reconstituted Whole	TA	17-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - White Catfish ERA Samples								6	6	6	6	6	6	6	6	6	6	6	6	6	6	ECO
	LPR1-MAFT-COMP01	1	-74.1204	40.7243	White perch	Fillet (with skin)	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR1-MAFT-IND145	1	-74.1204	40.7243	White perch	Fillet (with skin)	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP02	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP03	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP04	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	12-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP05	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP07	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP08	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR3-MAFT-COMP13	5	-74.1634	40.7393	White perch	Fillet (with skin)	TA	14-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-MAFT-COMP16	7	-74.1574	40.7665	White perch	Fillet (with skin)	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-MAFT-COMP17	7	-74.1574	40.7665	White perch	Fillet (with skin)	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	atetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
	Survey Total - White Perch HHRA Samples								11	11	11	11	11	11	11	11	11	11	11	11	11	11	HH
	LPR1-MACT-IND145	1	-74.1204	40.7243	White perch	Reconstituted Whole	TA	02-Sep-09	1	1	1	1	1	1	1	1	1	1	0	1	1	1	ECO
	LPR1-MAWB-IND138	1	-74.1204	40.7243	White perch	Whole body	TA	01-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-MAWB-IND158	3	-74.1338	40.7419	White perch	Whole body	TA	04-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP06	5	-74.1634	40.7393	White perch	Whole body	TA	11-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP09	5	-74.1634	40.7393	White perch	Whole body	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP10	5	-74.1634	40.7393	White perch	Whole body	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP11	5	-74.1634	40.7393	White perch	Whole body	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP12	5	-74.1634	40.7393	White perch	Whole body	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-MAWB-COMP30	5	-74.1634	40.7393	White perch	Whole body	TA	13-Aug-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-MAWB-COMP14	7	-74.1574	40.7665	White perch	Whole body	TA	15-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-MAWB-COMP15	7	-74.1574	40.7665	White perch	Whole body	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - White Perch ERA Samples								11	11	11	11	11	11	11	11	11	11	10	11	11	11	ECO
	LPR4-WSFT-IND023	7	-74.1574	40.7665	White sucker	Fillet (with skin)	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	Survey Total - White Sucker HHRA Samples								1	1	1	1	1	1	1	1	1	1	1	1	1	1	HH
	LPR4-WSCT-IND023	7			White sucker	Reconstituted Whole	TA	18-Sep-09	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
2009 Fish & Crab Tissue Sampling (continued)	Survey Total - White Sucker ERA Samples								1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - Fish HHRA Samples								39	39	39	39	39	39	39	39	39	39	35	39	39	39	HH
	Survey Total - Fish ERA Samples								35	35	35	35	35	35	35	35	35	35	28	35	35	35	ECO
	Survey Total - Blue Crab HHRA Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	HH
	Survey Total - Blue Crab ERA Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	ECO

Survey_ID	Sample_ID	River_Mile	X_Coord	Y_Coord	Species_Code	Tissue_Type	Matrix	Datetime_Place	CONG	Dioxins/Furans	Total Dioxin Like PCB	Total Aroclor	LMW PAH	HMW PAH	Dieldrin	Total 4,4-DDx	Total Chlordane	Metals Copper	Metals Lead	Metals Mercury	Methyl mercury	LIPIDS	Risk Assessment Exposure Point
2010 CPG Fish & Crab Tissue Sampling	LPR1-FHWB-COMP01	1	597327	688986	Mummichog	Whole Body	TA	23-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR1-FHWB-COMP02	1	597327	688986	Mummichog	Whole Body	TA	23-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP03	3	593588	695378	Mummichog	Whole Body	TA	25-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP04	3	593588	695378	Mummichog	Whole Body	TA	25-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP05	3	593588	695378	Mummichog	Whole Body	TA	26-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP06	3	593588	695378	Mummichog	Whole Body	TA	25-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP07	3	593588	695378	Mummichog	Whole Body	TA	25-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR2-FHWB-COMP08	3	593588	695378	Mummichog	Whole Body	TA	23-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-FHWB-COMP09	5	585393	694402	Mummichog	Whole Body	TA	23-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-FHWB-COMP10	5	585393	694402	Mummichog	Whole Body	TA	25-Jun-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR3-FHWB-COMP11	5	585393	694402	Mummichog	Whole Body	TA	09-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-FHWB-COMP12	7	587020	704315	Mummichog	Whole Body	TA	26-Jul-10	1	1	1	0	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-FHWB-COMP13	7	587020	704315	Mummichog	Whole Body	TA	26-Jul-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-FHWB-COMP14	7	587020	704315	Mummichog	Whole Body	TA	09-Aug-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	LPR4-FHWB-COMP15	7	587020	704315	Mummichog	Whole Body	TA	26-Jul-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Survey Total - Mummichog ERA Samples								15	15	15	14	15	15	15	15	15	15	15	15	15	15	ECO
	LPR4-MAWB-COMP33	7	587020	704315	White Perch	Whole Body	TA	26-Jul-10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Survey Total - White Perch ERA Samples								1	1	1	1	1	1	1	1	1	1	1	1	1	1	ECO
	Total Fish HHRA Samples								39	39	39	39	39	39	39	39	39	39	35	39	39	39	HH
	Total ERA Fish Samples								36	36	36	36	36	36	36	36	36	36	29	36	36	36	ECO
	Total ERA Mummichog Samples								15	15	15	14	15	15	15	15	15	15	15	15	15	15	
	Total HHRA Blue Crab Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	HH
	Total ERA Blue Crab Samples								22	22	22	22	22	22	22	22	22	22	22	22	22	22	ECO

ATTACHMENT 1.2

DATA USABILITY EVALUATION WORKSHEETS

<u>DATA USABILITY WORKSHEET</u>

Study: ***2008 CPG Low Resolution Coring Program***
Medium: ***Sediment***
Source: ENSR, AECOM, Windward. 2008. Lower Passaic River Restoration Project. Quality Assurance Project Plan: RI low resolution coring/sediment sampling. Revision 4. Prepared for Cooperating Parties Group. ENSR AECOM, Newark, NJ.

AECOM, in prep. Lower Resolution Coring Characterization Summary Lower Passaic River Study Area RI/FS. July.

Activity	Comment
FIELD SAMPLING	
Discuss sampling problems and field conditions that affect data usability.	None. Sampling activities were conducted from July 30 to December 16, 2008, and were performed in accordance with the LRC QAPP.
Are samples representative of receptor exposure for this medium (e.g. sample depth, grab vs composite, filtered vs unfiltered, low flow, etc.)?	Yes. Sediment collected from cores; top section of cores (0 to 0.5 ft) used for risk assessment purposes.
Assess the effect of field QC results on data usability.	Field staff were required to be familiar with the SOPs that applied to their specific tasks and to demonstrate proficiency in each of those tasks under the supervision of a qualified staff member. Following SOPs leads to better quality data.
Summarize the effect of field sampling issues on the risk assessment, if applicable.	Not applicable.
ANALYTICAL TECHNIQUES	
Were the analytical methods appropriate for quantitative risk assessment?	Yes. Samples were analyzed using the methods presented in footnotes below.
Were detection limits adequate for risk assessment?	Yes. All minimum MDLs were lower than the ecological screening benchmarks.
Summarize the effect of analytical technique issues on the risk assessment, if applicable.	There are no analytical technique issues that should affect the risk assessment.
DATA QUALITY OBJECTIVES	
Precision - How were duplicates handled?	Overall, the precision objectives stated in LRC QAPP Worksheet #28 and Appendix C-2 (ENSR 2008a) were achieved. Approximately 2 percent of the reportable data points generated were qualified for reasons related to either field or laboratory precision, but these data points are considered valid and acceptable for use. Approximately 0.01 percent of the reportable sediment data points were rejected based on Region 2 data validation criteria for either field or laboratory precision. Duplicates were compared to the site results for comparison purposes. If the results were relatively similar, only the site results were included in the RA.
Accuracy - How were split samples handled?	Overall, the accuracy objectives stated in LRC QAPP Worksheet #28 and Appendix C-2 (ENSR 2008a) were achieved; less than 0.2 percent of all reportable sediment results were rejected on the

Activity	Comment
	basis of accuracy measurements. Split samples were collected and used for comparison purposes only. Split samples were not included in the risk assessment dataset.
Representativeness - Indicate any problems associated with data representativeness (e.g., trip blank or rinsate blank contamination, chain of custody problems, etc.).	Laboratory qualifiers (J) indicate low-level blank contamination for some organics.
Completeness - Indicate any problems associated with data completeness (e.g., incorrect sample analysis, incomplete sample records, problems with field procedures, etc.).	No problems noted.
Comparability - Indicate any problems associated with data comparability.	On January 25, 2011, Region 2 directed that all validated dioxin/furan (PCDD/PCDF) data generated by the CPG as part of the EPA-approved LRC QAPP should be adjusted to address what was characterized in reports prepared by an EPA Office of Water consultant (CSC Environmental Solutions March 2010 and January 2011) as a "disparity" or "systematic bias" between the split samples analyzed by the CPG's laboratory (Columbia Analytical Services [CAS]) and Region 2's laboratory (Axys Analytical Services [AXYS]). In its March 2010 and January 2011 reports, CSC Environmental Solutions recommended a set of rules to adjust the CPG's PCDD/PCDF results as follows: 1. No adjustment is provided for CAS data for all results below CAS's Quantification Limit. 2. For all samples which were split by MPI, the CAS results are to be replaced with the results generated by Region 2's laboratory, AXYS. 3. For all remaining results, the congener-specific adjustment factors developed by CSC Environmental Solutions are to be applied. It was agreed that a unique validation qualifier "F" was assigned to results replaced or adjusted based on rules 2 and 3.
Were the DQOs specified in the QAPP satisfied?	Yes
Summarize the effect of DQO issues on the risk assessment, if applicable.	No problems noted.
DATA VALIDATION AND INTERPRETATION	
What are the data validation requirements?	The laboratory results for the LRC program were subjected to formal data validation as described in the LRC QAPP (ENSR 2008a). In general, the USEPA Region 2 validation SOPs were used as the basis for validation. If a Region 2 SOP was not available for a specific method, an SOP for a

Activity	Comment
	similar method was adopted for guidance.
What method or guidance was used to validate the data?	The validation consisted of two steps: verification of adherence to program specifications (QAPP, analytical methods, contractual documents), and an evaluation of the quality of the data in terms of precision, accuracy, representativeness, comparability, and completeness. These elements, referred to as data quality indicators (DQIs), were assessed by comparing the sample results generated during the LRC program to pre-established standards or criteria documented in the QAPP.
Was the data validation method consistent with guidance? Discuss any discrepancies.	Data validation was consistent with guidance.
Were all data qualifiers defined? Discuss those which were not.	Data qualifiers were applied based on the criteria in the LRC QAPP (ENSR 2008a) and method-specific Region 2 validation SOPs where available. Professional judgment was used where other guidance was absent.
Which qualifiers represent useable data?	B, BJ, C, D, EMPC, J, JB, JN, N, U, UJ.
Which qualifiers represent unusable data?	Major deviations from established criteria resulted in the associated data being qualified with an "R" to indicate that the data were rejected and considered invalid for use in decision-making.
How are tentatively identified compounds (TICs) handled?	Samples were qualified with a N, JN. TICs were not quantitatively evaluated in the risk assessment.
Summarize the effect of data validation and interpretation issues on the risk assessment, if applicable.	The systematic difference between PCDD/PCDF concentrations determined by CAS and those determined by AXYS indicates that a systematic correction of results determined by CAS may be warranted. As a whole, the issues surrounding application of the correction factor appear to be outweighed by the decrease in bias achieved by applying this factor. This is especially true for 2,3,7,8-TCDD, the analyte with the largest systematic difference observed in the split samples. Risks may be over- or underestimated depending on which PCDD/PCDF results are used.
Additional notes.	None.

Notes:
Analytical methods as follows:

Analyte Group	Method	Laboratory
PCB Aroclors	SW8082	Test America
PCB homologs and congeners	EPA 1668A	Test America
Dioxins/furans	EPA 1613B	Columbia Analytical Services
Organochlorine Pesticides	EPA 8081A/ WS-ID-0014	Test America
Organochlorine Pesticides (HRGC/HRMS)	Based on EPA Methods 1613B, 1668, 8081A and NYSDEC HRMS-2	Test America
PAHs and alkyl PAHs	Method KNOX-ID-0016,	Test America

	HRGC/LRMS-SIM	
Semivolatiles	EPA 8270C	Test America
Volatiles	EPA 8260B	Test America
TPH	NJ Method OQA-QAM-025-10/91, 8015B	Test America
Herbicides	EPA 8151	Test America
Butyltins	EPA 8000B, NOAA 130 (modified),	Columbia Analytical Services
Metals	EPA 6020/6010	Columbia Analytical Services
Mercury	EPA 1631	Brooks Rand LLC
AVS/SEM	EPA Methods 821R91100, 6010C/6020	Columbia Analytical Services
Ammonia	EPA 350.1	Columbia Analytical Services
Cyanide	EPA 9010C/9014	Columbia Analytical Services
Total Phosphorus	EPA 365.3	Columbia Analytical Services
TKN	ASTM D3590-89-02	Columbia Analytical Services
TOC	Lloyd Kahn Method	Columbia Analytical Services
Total Sulfides	SW846 9030 modified	Columbia Analytical Services
Radionuclides	DOE EML HASL-300/USEPA 900	GEL Laboratories
Atterberg Limits	ASTM D4318	Columbia Analytical Services
Specific Gravity	ASTM D854	Columbia Analytical Services
Grain Size	ASTM D422 or D4464	Columbia Analytical Services
Moisture	ASTM D2974-07A	Columbia Analytical Services
Fecal and Total Coliforms	Standard Methods 9222D, Modified	Analytical Services, Inc.
Giardia	EPA Method 1623, Modified	Analytical Services, Inc.

DATA USABILITY WORKSHEET

Study: ***Passaic River Ecological Sampling Program (Late Summer/Early Fall 2009)***
Medium: ***Sediment***
Source: ***Windward Environmental LLC. 2011. 2009 and 2010 Sediment Chemistry Data for The Lower Passaic River Study Area. September 2.***

Windward Environmental LLC. 2009. Lower Passaic River Restoration Project Quality Assurance Project Plan: Surface Sediment Chemical Analysis and Benthic Invertebrate Toxicity and Bioaccumulation Testing.

Windward Environmental LLC. 2011. Fall 2009 Benthic Invertebrate Community Survey And Benthic Field Data Collection For The Lower Passaic River Study Area. June 17.

Activity	Comment
FIELD SAMPLING	
Discuss sampling problems and field conditions that affect data usability.	Reviewed Field Report and Appendix E: Protocol Modification Forms. Modifications did not appear to affect the data quality objectives or data usability.
Are samples representative of receptor exposure for this medium (e.g. sample depth, grab vs composite, filtered vs unfiltered, low flow, etc.)?	Yes. Grab samples collected top 6 inches of surface sediment for chemical analysis, toxicity testing, and bioaccumulation testing.
Assess the effect of field QC results on data usability.	Field duplicates and MS/MD/MSD samples were collected in the field and analyzed simultaneously with other field samples. No issues were reported in the validation report.
Summarize the effect of field sampling issues on the risk assessment, if applicable.	Field sampling issues/modifications did not affect the risk assessment.
ANALYTICAL TECHNIQUES	
Were the analytical methods appropriate for quantitative risk assessment?	Yes. Samples were analyzed using the methods and protocols described in the QAPP that were specifically selected because of the risk assessment objective.
Were detection limits adequate for risk assessment?	Table 1 of the *2009 and 2010 Sediment Chemistry Data Repor*t (Windward, 2011) presents a summary of the chemicals for which sediment laboratory reporting limits (RLs) exceed the DQLs provided in the Benthic QAPP (Windward 2009). As noted in Worksheet No. 15 of the Benthic QAPP, exceedances of DQLs were expected for a number of chemicals. However, RL exceedances of DQLs were not expected for 6 polycyclic aromatic hydrocarbons (PAHs), 3 semivolatile organic compounds (SVOCs), 9 polychlorinated biphenyl Aroclor mixtures, 14 organochlorine pesticides, 1 herbicide, and 3 volatile organic compounds (VOCs) (Table 1). SVOCs were infrequently or never detected, and detection limits

Activity	Comment
	of these chemicals were frequently greater than DQLs. Aroclors 1242, 1254, and 1260 were also infrequently or never detected, and detection limits of these chemicals were frequently greater than DQLs primarily because of dilutions required to quantify the detected Aroclors. For PAHs, organochlorine pesticides, and herbicides, the number of cases where RLs exceed DLs is limited (i.e., for most chemicals, fewer than 10 samples had non-detected results that were greater than DQLs). Four VOCs with no or limited detected concentrations (i.e., 1,2,4-trichlorobenzene, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, and bromomethane) had RL values that frequently exceeded the associated DQLs. Although some detection limits exceeded DQLs, the majority of the data were acceptable for use in the risk assessment.
Summarize the effect of analytical technique issues on the risk assessment, if applicable.	Not applicable
DATA QUALITY OBJECTIVES	
Precision - How were duplicates handled?	Field duplicate samples were collected at a rate of one per 20 samples, and consisted of a thoroughly homogenized sample collected from one location that was split between two sets of containers and labeled as representing two separate sampling locations. RPDs were calculated for duplicates where appropriate. No issues were reported in the validation report. Duplicates were compared to the site results for comparison purposes. If the results were relatively similar, only the site results were included in the RA.
Accuracy - How were split samples handled?	Grab sampler was used to collect sediment and then homogenized sediment was split into the appropriate sample containers for analysis. LCS, equipment blanks, MS, and certified or standard reference material were used to assess accuracy. No issues were reported in the validation report.
Representativeness - Indicate any problems associated with data representativeness (e.g., trip blank or rinsate blank contamination, chain of custody problems, etc.).	Review of data report confirmed that samples were collected and analyzed as planned and according to required SOPs. Rinsate blanks/trip blanks were collected and analyzed according to the QAPP. No issues were reported in the validation report.
Completeness - Indicate any problems associated with data completeness (e.g., incorrect sample analysis, incomplete sample records, problems with field procedures, etc.).	Completeness for the analytical program was calculated as the number of data points that are accepted as usable based on the validation process divided by the total number of data points for each analysis. Completeness was reported for each

Activity	Comment
	analytical category, and an overall value was reported. The analytical completeness goal was ≥ 90%. Completeness for the field program was calculated as the number of samples successfully collected (101) compared to the total number proposed in the QAPP (102). The completeness goal for the field sampling program (≥ 95%) was achieved. The "Benthic Community Survey and Field Data Collection Report" as well as the "2009 and 2010 Sediment Chemistry Data Report" (Windward, 2010 and 2011, respectively) lists the objectives of the field survey and describes protocol modifications to the plan. None of these modifications appears to have any impact to the data usability.
Comparability - Indicate any problems associated with data comparability.	The sampling and analytical procedures used in this program were selected to ensure that the resulting data were comparable to data from similar programs conducted previously or that will be conducted in the future. Any modifications or deviations from stated procedures that might impact data comparability will be addressed in the project final report.
Were the DQOs specified in the QAPP satisfied?	Yes. The objectives of the fall 2009 benthic field effort were met with regard to the collection of benthic invertebrate community samples throughout the LPRSA.
Summarize the effect of DQO issues on the risk assessment, if applicable.	None
DATA VALIDATION AND INTERPRETATION	
What are the data validation requirements?	USEPA Region 2
What method or guidance was used to validate the data?	USEPA Region 2
Was the data validation method consistent with guidance? Discuss any discrepancies.	Data validation was performed under USEPA Level IV guidelines following the QAPP and 2007 USEPA Region 2 MEDD format, which included all qualified and rejected data (including the reported, numerical value for rejected data). No issues were reported in the validation report.
Were all data qualifiers defined? Discuss those which were not.	Yes, data qualifiers used in the validation reports were listed in the introduction of the validation reports.
Which qualifiers represent useable data?	D, U, J, J-, J+, L, N, NJ, U, UJ
Which qualifiers represent unusable data?	R, F
How are tentatively identified compounds (TICs) handled?	Samples were qualified with a "N" or "NJ". TICs were not quantitatively evaluated in the risk assessment.

Activity	Comment
Summarize the effect of data validation and interpretation issues on the risk assessment, if applicable.	Unusable data qualified with an "R" or "F" were not used in the risk assessment. All other data, both qualified and unqualified, were used in the risk assessment.
Additional notes.	None

Notes:
Analytical methods as follows:

Analyte Group	Method	Laboratory
PCB Aroclors	USEPA SW-846 8082	Alpha Analytical, Mansfield, MA
PCB Congeners	USEPA1668A	Analytical Perspectives, Wilmington, NC
Dioxin/furans	USEPA 1613B	Analytical Perspectives, Wilmington, NC
Alpha and Gamma Chlordane	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
Dieldrin	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
p,p'-DDD, DDE, DDT	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
Copper	ICP/MS, USEPA SW-846 6020	CAS, Kelso WA
Lead	ICP/MS, USEPA SW-846 6020	CAS, Kelso WA
Total Mercury	USEPA 1631	Brooks Rand Labs, Seattle, WA
Methyl mercury	USEPA 1630	Brooks Rand Labs, Seattle, WA
PAHs Alkylated PAHs	CARB 429 Modified USEPA SW-846 8270D	Maxxam Analytics, Mississauga, ON Alpha Analytical, Mansfield, MA

DATA USABILITY WORKSHEET

Study: ***Passaic River Ecological Sampling Program (Late Summer/Early Fall 2009, Winter 2010, Late Spring/Early Summer 2010)***
Medium: ***Biological Tissue***
Source:

Windward Environmental LLC. 2010. Lower Passaic River Restoration Project. Fish and Decapod Field Report for the Late Summer/Early Fall 2009 Field Effort, Final.

Windward Environmental LLC. 2011. Fish Community Survey and Tissue Collection Data Report for the Lower Passaic River Study Area 2010 Field Efforts, Final. July 20, 2011.

Activity	Comment
FIELD SAMPLING	
Discuss sampling problems and field conditions that affect data usability.	Reviewed Field Report and Appendix E: Protocol Modification Forms. Modifications did not affect the data quality objectives or data usability. Deviations from protocols presented in the Fish/Decapod QAPP (Windward 2009), Fish/Decapod QAPP Addendum No. 3 (Windward 2010g) and Addendum No.4 (Windward 2010d) were not necessary during the 2010 field effort. All procedures were followed as stated in the original study design.
Are samples representative of receptor exposure for this medium (e.g. sample depth, grab vs composite, filtered vs unfiltered, low flow, etc.)?	Yes. Tissue type collected and analyzed included blue crab, white perch, American eel, Atlantic menhaden, mummichog, darter/killifish, Atlantic silverside, bluegill, spottail shiner, redbreast sunfish, and pumpkinseed.
Assess the effect of field QC results on data usability.	Duplicates and/or MS/MSD samples were collected in the field, per the approved QAPP, and analyzed simultaneously with other field samples. No issues were noted in the field survey reports from 2009 or 2010.
Summarize the effect of field sampling issues on the risk assessment, if applicable.	Field sampling issues/modifications did not affect the risk assessment.
ANALYTICAL TECHNIQUES	
Were the analytical methods appropriate for quantitative risk assessment?	Yes. Samples were analyzed using the methods and protocols described in the QAPP that were specifically selected because of the risk assessment objective.
Were detection limits adequate for risk assessment?	A summary of the type and number of parameters that had reporting detection limits (RDLs) exceeding the data quality limits (DQLs) documented in the QAPP is shown in Table 1 for human health risk assessment fish and decapod samples (2009) and Table 2 for ecological risk assessment fish and decapod samples (2009 and 2010).

Activity	Comment
Summarize the effect of analytical technique issues on the risk assessment, if applicable.	Not applicable
DATA QUALITY OBJECTIVES	
Precision - How were duplicates handled?	No field duplicate samples of biological tissue were collected but analytical duplicates and MS/MD/MSD samples were analyzed.
Accuracy - How were split samples handled?	According to the QAPP, after homogenization, sample masses were reviewed, and samples were selected for USEPA splits and matrix-specific QC samples (MD, MS, and MSD). Matrix-specific QC samples were analyzed at a rate of approximately one sample per 20 per matrix type (unless the analytical method required more) as sample mass permitted.
Representativeness - Indicate any problems associated with data representativeness (e.g., trip blank or rinsate blank contamination, chain of custody problems, etc.).	As stated in the QAPP, trip blanks were not collected because they are not applicable to solid samples. Rinsate blanks were created from the tissue homogenization equipment.
Completeness - Indicate any problems associated with data completeness (e.g., incorrect sample analysis, incomplete sample records, problems with field procedures, etc.).	Completeness for the analytical program was calculated as the number of data points that are accepted as usable based on the validation process divided by the total number of data points for each analysis. Completeness was reported for each analytical category, and an overall value was reported. The analytical completeness goal was $\geq$ 90%. Completeness for the field program was calculated as the number of samples successfully collected compared to the total number proposed in this QAPP. The completeness goal for the field sampling program was $\geq$ 95%. The “Fish and Decapod Field Report for the Late Summer/Early Fall 2009 Field Effort” and the ”Fish Community Survey and Tissue Collection Data Report for the Lower Passaic River Study Area 2010 Field Efforts” document that all proposed samples were collected so the completeness objective was met.
Comparability - Indicate any problems associated with data comparability.	The sampling and analytical procedures used in this program were selected to ensure that the resulting data were comparable to data from similar programs conducted previously or that will be conducted in the future. Any modifications or deviations from stated procedures that might impact data comparability will be addressed in the project final report.
Were the DQOs specified in the QAPP satisfied?	Yes. Tissue samples were collected and submitted for chemical analysis. The sampling objective of collection of decapods tissue (2009) and fish tissue

Activity	Comment
	(2010) for the risk assessments was met in each sampling event (initial event in 2009 and fulfillment of data gaps in 2010).
Summarize the effect of DQO issues on the risk assessment, if applicable.	None
DATA VALIDATION AND INTERPRETATION	
What are the data validation requirements?	USEPA Region 2
What method or guidance was used to validate the data?	USEPA Region 2
Was the data validation method consistent with guidance? Discuss any discrepancies.	Data validation was performed under USEPA Level IV guidelines following the QAPP and 2007 USEPA Region 2 MEDD format, which included all qualified and rejected data (including the reported, numerical value for rejected data). No issues were reported in the validation report.
Were all data qualifiers defined? Discuss those which were not.	Yes, data qualifiers used in the validation reports were listed in the introduction of the validation reports.
Which qualifiers represent useable data?	D, U, J, J-, J+, L, N, NJ, U, UJ
Which qualifiers represent unusable data?	R, F
How are tentatively identified compounds (TICs) handled?	Samples were qualified with a "N" or "NJ". TICs were not quantitatively evaluated in the risk assessment.
Summarize the effect of data validation and interpretation issues on the risk assessment, if applicable.	Unusable data qualified with an "R" or "F" were not used in the risk assessment. All other data were used in the risk assessment.
Additional notes.	Congener – Method E1668B 12,808 of 21,582 data points had no flags 8,426 had J, U, UJ flags 348 had EMPC-J flags (estimated maximum possible concentration) Metals – Method E1630 (methyl mercury) 84 of 99 had no flags 15 had U or J flags Dioxin – Method 1613B 603 of 2475 had no flags 1419 had U, J, UJ 453 had EMPC-J Pesticides – Method 1699 modified 354 of 891 had no flags 537 had U, J, UJ PAHs – CARB method 62 of 2376 had no flags 2314 had U, J, UJ

Notes:

Analytical methods as follows:

Analyte Group	Method	Laboratory
PCB Congeners	USEPA 1668A	Analytical Perspectives, Wilmington, NC
Dioxin/furans	USEPA 1613B	Analytical Perspectives, Wilmington, NC
Alpha and Gamma Chlordane	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
Dieldrin	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
p,p'-DDD, DDE, DDT	USEPA 1699 Modified (NYSDEC HRMS-2)	Maxxam Analytics, Mississauga, ON
Methyl mercury	USEPA 1630	Brooks Rand Labs, Seattle, WA
PAHs	CARB 429 Modified	Maxxam Analytics, Mississauga, ON

Table 1. Comparison of Nondetect Samples to Fish Tissue DQLs for Human Health Risk Assessment

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
CONG	2051-60-7	PCB 1	2-Chlorobiphenyl	1.58	0	20	E1668B	0.0021	0.0048	0.00326
CONG	2051-61-8	PCB 2	Chlorobiphenyl; 3-	1.58	0	47	E1668B	0.00065	0.0054	0.003059
CONG	2051-62-9	PCB 3	Chlorobiphenyl; 4-	1.58	0	44	E1668B	0.0011	0.0066	0.003757
CONG	13029-08-8	PCB 4	Dichlorobiphenyl; 2,2'-	1.58	0	3	E1668B	0.015	0.042	0.031333
CONG	16605-91-7	PCB 5	Dichlorobiphenyl; 2,3-	1.58	0	44	E1668B	0.0044	0.034	0.016532
CONG	25569-80-6	PCB 6	Dichlorobiphenyl; 2,3'-	1.58	0	6	E1668B	0.02	0.032	0.023833
CONG	33284-50-3	PCB 7	Dichlorobiphenyl; 2,4-	1.58	0	40	E1668B	0.0072	0.032	0.016268
CONG	34883-39-1	PCB 9	Dichlorobiphenyl; 2,5-	1.58	0	32	E1668B	0.0077	0.032	0.018234
CONG	33146-45-1	PCB 10	Dichlorobiphenyl; 2,6-	1.58	0	29	E1668B	0.007	0.03	0.014448
CONG	2050-67-1	PCB 11	Dichlorobiphenyl; 3,3'-	1.58	0	17	E1668B	0.0018	0.015	0.006118
CONG	2974-92-7	PCB 12	Dichlorobiphenyl; 3,4-	1.58	0	13	E1668B	0.0055	0.036	0.021115
CONG	2974-90-5	PCB 13	Dichlorobiphenyl; 3,4'-	1.58	0	13	E1668B	0.0055	0.036	0.021115
CONG	34883-41-5	PCB 14	Dichlorobiphenyl; 3,5-	1.58	0	61	E1668B	0.003	0.034	0.014275
CONG	2050-68-2	PCB 15	4,4'-Dichlorobiphenyl	1.58	0	1	E1668B	0.0034	0.0034	0.0034
CONG	38444-78-9	PCB 16	Trichlorobiphenyl; 2,2',3-	1.58	0	1	E1668B	0.008	0.008	0.008
CONG	38444-73-4	PCB 19	Trichlorobiphenyl; 2,2',6-	1.58	0	5	E1668B	0.0069	0.0097	0.00876
CONG	55702-46-0	PCB 21	Trichlorobiphenyl; 2,3,4-	1.58	0	4	E1668B	0.0037	0.01	0.006775
CONG	55720-44-0	PCB 23	Trichlorobiphenyl; 2,3,5-	1.58	0	46	E1668B	0.0031	0.022	0.010959
CONG	55702-45-9	PCB 24	Trichlorobiphenyl; 2,3,6-	1.58	0	27	E1668B	0.0018	0.0068	0.004296
CONG	55712-37-3	PCB 25	Trichlorobiphenyl; 2,3',4-	1.58	0	1	E1668B	0.0028	0.0028	0.0028
CONG	38444-76-7	PCB 27	Trichlorobiphenyl; 2,3',6-	1.58	0	1	E1668B	0.0053	0.0053	0.0053
CONG	16606-02-3	PCB 31	Trichlorobiphenyl; 2,4',5-	1.58	0	1	E1668B	0.0028	0.0028	0.0028
CONG	38444-86-9	PCB 33	Trichlorobiphenyl; 2,3',4'-	1.58	0	4	E1668B	0.0037	0.01	0.006775
CONG	37680-68-5	PCB 34	Trichlorobiphenyl; 2,3',5'-	1.58	0	9	E1668B	0.0032	0.019	0.010911
CONG	37680-69-6	PCB 35	Trichlorobiphenyl; 3,3',4-	1.58	0	57	E1668B	0.0019	0.029	0.010814
CONG	38444-87-0	PCB 36	Trichlorobiphenyl; 3,3',5-	1.58	0	61	E1668B	0.0016	0.025	0.009107
CONG	38444-90-5	PCB 37	Trichlorobiphenyl; 3,4,4'-	1.58	0	21	E1668B	0.0038	0.04	0.012814
CONG	53555-66-1	PCB 38	Trichlorobiphenyl; 3,4,5-	1.58	0	45	E1668B	0.0019	0.021	0.010938
CONG	38444-88-1	PCB 39	Trichlorobiphenyl; 3,4',5-	1.58	0	40	E1668B	0.0019	0.029	0.0106

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
CONG	52663-59-9	PCB 41	Tetrachlorobiphenyl; 2,2',3,4-	1.58	0	38	E1668B	0.0023	0.015	0.0086
CONG	70362-46-8	PCB 43	Tetrachlorobiphenyl; 2,2',3,5-	1.58	0	10	E1668B	0.0048	0.02	0.01196
CONG	70362-45-7	PCB 45	Tetrachlorobiphenyl; 2,2',3,6-	1.58	0	21	E1668B	0.0045	0.013	0.008195
CONG	41464-47-5	PCB 46	Tetrachlorobiphenyl; 2,2',3,6'-	1.58	0	13	E1668B	0.0053	0.016	0.0101
CONG	70362-47-9	PCB 48	Tetrachlorobiphenyl; 2,2',4,5-	1.58	0	1	E1668B	0.01	0.01	0.01
CONG	15968-05-5	PCB 54	Tetrachlorobiphenyl; 2,2',6,6'-	1.58	0	17	E1668B	0.0029	0.0077	0.004953
CONG	74338-24-2	PCB 55	Tetrachlorobiphenyl; 2,3,3',4-	1.58	0	47	E1668B	0.0039	0.05	0.01413
CONG	70424-67-8	PCB 57	Tetrachlorobiphenyl; 2,3,3',5-	1.58	0	27	E1668B	0.0072	0.025	0.014489
CONG	41464-49-7	PCB 58	Tetrachlorobiphenyl; 2,3,3',5'-	1.58	0	26	E1668B	0.0037	0.021	0.012958
CONG	33284-53-6	PCB 61	2,3,4,5- Tetrachlorobiphenyl	1.58	0	3	E1668B	0.0059	0.014	0.009967
CONG	73575-53-8	PCB 67	Tetrachlorobiphenyl; 2,3',4,5-	1.58	0	21	E1668B	0.0035	0.016	0.009186
CONG	32598-11-1	PCB 70	Tetrachlorobiphenyl; 2,3',4',5-	1.58	0	3	E1668B	0.0059	0.014	0.009967
CONG	41464-42-0	PCB 72	Tetrachlorobiphenyl; 2,3',5,5'-	1.58	0	1	E1668B	0.011	0.011	0.011
CONG	74338-23-1	PCB 73	Tetrachlorobiphenyl; 2,3',5',6-	1.58	0	14	E1668B	0.0016	0.011	0.006736
CONG	32690-93-0	PCB 74	Tetrachlorobiphenyl; 2,4,4',5-	1.58	0	3	E1668B	0.0059	0.014	0.009967
CONG	70362-48-0	PCB 76	Tetrachlorobiphenyl; 2,3',4',5'-	1.58	0	3	E1668B	0.0059	0.014	0.009967
CONG	70362-49-1	PCB 78	Tetrachlorobiphenyl; 3,3',4,5-	1.58	0	61	E1668B	0.0041	0.056	0.013264

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
CONG	41464-48-6	PCB 79	Tetrachlorobiphenyl; 3,3',4,5'-	1.58	0	1	E1668B	0.011	0.011	0.011
CONG	33284-52-5	PCB 80	Tetrachlorobiphenyl; 3,3',5,5'-	1.58	0	61	E1668B	0.0039	0.053	0.012856
CONG	52663-62-4	PCB 82	PCB-82	1.58	0	9	E1668B	0.014	0.035	0.022333
CONG	60145-20-2	PCB 83	Pentachlorobiphenyl; 2,2',3,3',5-	1.58	0	26	E1668B	0.003	0.05	0.023615
CONG	52663-60-2	PCB 84	Pentachlorobiphenyl; 2,2',3,3',6-	1.58	0	1	E1668B	0.013	0.013	0.013
CONG	55215-17-3	PCB 88	Pentachlorobiphenyl; 2,2',3,4,6-	1.58	0	60	E1668B	0.0036	0.13	0.019128
CONG	73575-57-2	PCB 89	Pentachlorobiphenyl; 2,2',3,4,6'-	1.58	0	36	E1668B	0.0045	0.048	0.019747
CONG	73575-55-0	PCB 94	Pentachlorobiphenyl; 2,2',3,5,6'-	1.58	0	5	E1668B	0.013	0.027	0.0168
CONG	73575-54-9	PCB 96	Pentachlorobiphenyl; 2,2',3,6,6'-	1.58	0	22	E1668B	0.0037	0.011	0.006609
CONG	60233-25-2	PCB 98	Pentachlorobiphenyl; 2,2',3,4',6'-	1.58	0	55	E1668B	0.0031	0.12	0.017787
CONG	68194-06-9	PCB 102	Pentachlorobiphenyl; 2,2',4,5,6'-	1.58	0	3	E1668B	0.0063	0.021	0.013767
CONG	60145-21-3	PCB 103	Pentachlorobiphenyl; 2,2',4,5',6-	1.58	0	10	E1668B	0.0089	0.02	0.01332
CONG	56558-16-8	PCB 104	Pentachlorobiphenyl; 2,2',4,6,6'-	1.58	0	32	E1668B	0.0019	0.012	0.005922
CONG	70424-69-0	PCB 106	Pentachlorobiphenyl; 2,3,3',4,5-	1.58	0	61	E1668B	0.0019	0.081	0.012052
CONG	70362-41-3	PCB 108	Pentachlorobiphenyl; 2,3,3',4,5'-	1.58	0	7	E1668B	0.0019	0.018	0.010614
CONG	39635-32-0	PCB 111	Pentachlorobiphenyl; 2,3,3',5,5'-	1.58	0	8	E1668B	0.0054	0.026	0.01295
CONG	74472-36-9	PCB 112	Pentachlorobiphenyl; 2,3,3',5,6-	1.58	0	59	E1668B	0.0018	0.079	0.011822

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
CONG	74472-38-1	PCB 115	Pentachlorobiphenyl; 2,3,4,4',6-	1.58	0	33	E1668B	0.0016	0.083	0.008212
CONG	68194-11-6	PCB 117	Pentachlorobiphenyl; 2,3,4',5,6-	1.58	0	4	E1668B	0.0095	0.021	0.014875
CONG	56558-18-0	PCB 121	Pentachlorobiphenyl; 2,3',4,5',6-	1.58	0	2	E1668B	0.0064	0.01	0.0082
CONG	76842-07-4	PCB 122	Pentachlorobiphenyl; 2,3,3',4',5'-	1.58	0	29	E1668B	0.0052	0.038	0.019648
CONG	70424-70-3	PCB 124	Pentachlorobiphenyl; 2,3',4',5,5'-	1.58	0	7	E1668B	0.0019	0.018	0.010614
CONG	39635-33-1	PCB 127	Pentachlorobiphenyl; 3,3',4,5,5'-	1.58	0	60	E1668B	0.0021	0.086	0.013467
CONG	61798-70-7	PCB 131	Hexachlorobiphenyl; 2,2',3,3',4,6-	1.58	0	11	E1668B	0.004	0.012	0.008282
CONG	38380-05-1	PCB 132	Hexachlorobiphenyl; 2,2',3,3',4,6'-	1.58	0	2	E1668B	0.0095	0.011	0.01025
CONG	52704-70-8	PCB 134	Hexachlorobiphenyl; 2,2',3,3',5,6-	1.58	0	14	E1668B	0.0059	0.014	0.009414
CONG	38411-22-2	PCB 136	Hexachlorobiphenyl; 2,2',3,3',6,6'-	1.58	0	2	E1668B	0.0057	0.0075	0.0066
CONG	41411-61-4	PCB 142	Hexachlorobiphenyl; 2,2',3,4,5,6-	1.58	0	58	E1668B	0.0016	0.015	0.007293
CONG	68194-15-0	PCB 143	Hexachlorobiphenyl; 2,2',3,4,5,6'-	1.58	0	55	E1668B	0.0016	0.013	0.006902
CONG	74472-40-5	PCB 145	Hexachlorobiphenyl; 2,2',3,4,6,6'-	1.58	0	56	E1668B	0.0012	0.013	0.005102
CONG	68194-08-1	PCB 150	Hexachlorobiphenyl; 2,2',3,4',6,6'-	1.58	0	36	E1668B	0.0014	0.013	0.005953
CONG	68194-09-2	PCB 152	Hexachlorobiphenyl; 2,2',3,5,6,6'-	1.58	0	35	E1668B	0.0012	0.01	0.004903
CONG	39635-35-3	PCB 159	Hexachlorobiphenyl; 2,3,3',4,5,5'-	1.58	0	37	E1668B	0.0033	0.03	0.014681
CONG	41411-62-5	PCB 160	Hexachlorobiphenyl; 2,3,3',4,5,6-	1.58	0	60	E1668B	0.0012	0.01	0.00531

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
CONG	74472-43-8	PCB 161	Hexachlorobiphenyl; 2,3,3',4,5',6-	1.58	0	59	E1668B	0.0011	0.0099	0.004817
CONG	39635-34-2	PCB 162	Hexachlorobiphenyl; 2,3,3',4',5,5'-	1.58	0	3	E1668B	0.008	0.025	0.016333
CONG	74472-45-0	PCB 164	Hexachlorobiphenyl; 2,3,3',4',5',6-	1.58	0	1	E1668B	0.0067	0.0067	0.0067
CONG	74472-46-1	PCB 165	Hexachlorobiphenyl; 2,3,3',5,5',6-	1.58	0	14	E1668B	0.0023	0.01	0.006279
CONG	40186-70-7	PCB 175	Heptachlorobiphenyl; 2,2',3,3',4,5',6-	1.58	0	2	E1668B	0.045	0.063	0.054
CONG	52663-65-7	PCB 176	Heptachlorobiphenyl; 2,2',3,3',4,6,6'-	1.58	0	1	E1668B	0.012	0.012	0.012
CONG	52663-64-6	PCB 179	Heptachlorobiphenyl; 2,2',3,3',5,6,6'-	1.58	0	1	E1668B	0.01	0.01	0.01
CONG	74472-47-2	PCB 181	Heptachlorobiphenyl; 2,2',3,4,4',5,6-	1.58	0	2	E1668B	0.017	0.029	0.023
CONG	60145-23-5	PCB 182	Heptachlorobiphenyl; 2,2',3,4,4',5,6'-	1.58	0	4	E1668B	0.011	0.055	0.03025
CONG	74472-48-3	PCB 184	Heptachlorobiphenyl; 2,2',3,4,4',6,6'-	1.58	0	1	E1668B	0.0063	0.0063	0.0063
CONG	52712-05-7	PCB 185	Heptachlorobiphenyl; 2,2',3,4,5,5',6-	1.58	0	40	E1668B	0.0033	0.07	0.017863
CONG	74472-49-4	PCB 186	Heptachlorobiphenyl; 2,2',3,4,5,6,6'-	1.58	0	61	E1668B	0.0012	0.01	0.0044
CONG	74472-51-8	PCB 192	Heptachlorobiphenyl; 2,3,3',4,5,5',6-	1.58	0	61	E1668B	0.0019	0.051	0.012085
CONG	52663-73-7	PCB 200	Octachlorobiphenyl; 2,2',3,3',4,5,6,6'-	1.58	0	18	E1668B	0.0021	0.011	0.007094
CONG	74472-52-9	PCB 204	Octachlorobiphenyl; 2,2',3,4,4',5,6,6'-	1.58	0	42	E1668B	0.0013	0.014	0.005638
CONG	74472-53-0	PCB 205	Octachlorobiphenyl; 2,3,3',4,4',5,5',6-	1.58	0	4	E1668B	0.0097	0.012	0.01035

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
Total Chlordane (alpha and gamma)	5103-71-9	cis-Chlordane	ALPHA-CHLORDANE	9.01	0	1	USEPA 1699 MOD	4.1	4.1	4.1
Total Chlordane (alpha and gamma)	12789-03-6	trans-Chlordane	GAMMA-CHLORDANE	9.01	3	9	USEPA 1699 MOD	0.15	18	6.705556
Dieldrin	60-57-1	Dieldrin	DIELDRIN	0.197	1	1	USEPA 1699 MOD	20	20	20
Total DDx	3424-82-6	2,4'-DDE	O,P'-DDE	9.28	1	29	USEPA 1699 MOD	0.22	12	2.704828
Total DDx	53-19-0	2,4'-DDD	O,P'-DDD	13.1	0	23	USEPA 1699 MOD	0.13	7.7	2.726522
Total DDx	72-54-8	4,4'-DDD	P,P'-DDD	13.1	8	9	USEPA 1699 MOD	11	87	27.44444
Total DDx	789-02-6	2,4'-DDT	O,P'-DDT	9.28	4	54	USEPA 1699 MOD	0.13	120	4.901296
Total DDx	50-29-3	4,4'-DDT	P,P'-DDT	9.28	4	22	USEPA 1699 MOD	0.5	19	4.998636
Dioxins/ Furans	35822-46-9	1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8-HEPTACHLORODIBENZO-P-DIOXIN	0.00243	0	13	E1613	0.00036	0.0013	0.000732
Dioxins/ Furans	67562-39-4	1,2,3,4,6,7,8-HpCDF	1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN	0.00243	0	6	E1613	0.00016	0.00035	0.000257
Dioxins/ Furans	39227-28-6	1,2,3,4,7,8-HxCDD	1,2,3,4,7,8-HEXACHLORODIBENZO-P-DIOXIN	0.000243	46	52	E1613	0.00017	0.0012	0.000526
Dioxins/ Furans	70648-26-9	1,2,3,4,7,8-HxCDF	1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	0.000243	0	3	E1613	0.00014	0.00023	0.000187

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
Dioxins/ Furans	55673-89-7	1,2,3,4,7,8, 9-HpCDF	1,2,3,4,7,8,9- HEPTACHLORODIBENZ OFURAN	0.00243	0	61	E1613	0.00016	0.00099	0.000451
Dioxins/ Furans	57653-85-7	1,2,3,6,7,8- HxCDD	1,2,3,6,7,8- HEXACHLORODIBENZ O-P-DIOXIN	0.000243	19	20	E1613	0.00024	0.0013	0.000599
Dioxins/ Furans	57117-44-9	1,2,3,6,7,8- HxCDF	1,2,3,6,7,8- HEXACHLORODIBENZ OFURAN	0.000243	7	11	E1613	0.00014	0.00056	0.000306
Dioxins/ Furans	19408-74-3	1,2,3,7,8,9- HxCDD	1,2,3,7,8,9- HEXACHLORODIBENZ O-P-DIOXIN	0.000243	47	47	E1613	0.00028	0.0014	0.000626
Dioxins/ Furans	72918-21-9	1,2,3,7,8,9- HxCDF	1,2,3,7,8,9- HEXACHLORODIBENZ OFURAN	0.000243	45	61	E1613	0.00013	0.0011	0.000401
Dioxins/ Furans	40321-76-4	1,2,3,7,8- PeCDD	1,2,3,7,8- PENTACHLORODIBENZ O-P-DIOXIN	0.0000243	22	22	E1613	0.00023	0.0009	0.000537
Dioxins/ Furans	57117-41-6	1,2,3,7,8- PeCDF	1,2,3,7,8- PENTACHLORODIBENZ OFURAN	0.000809	0	24	E1613	0.0001	0.00071	0.000277
Dioxins/ Furans	60851-34-5	2,3,4,6,7,8- HxCDF	2,3,4,6,7,8- HEXACHLORODIBENZ OFURAN	0.000243	21	38	E1613	0.0001	0.0006	0.000302
Dioxins/ Furans	57117-31-4	2,3,4,7,8- PeCDF	2,3,4,7,8- PENTACHLORODIBENZ OFURAN	0.0000809	7	7	E1613	0.00018	0.00044	0.000281
Dioxins/ Furans	51207-31-9	2,3,7,8- TCDF	2,3,7,8- TETRACHLORODIBENZ OFURAN	0.000243	9	19	E1613	0.00012	0.00056	0.000258

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
Dioxins/ Furans	3268-87-9	OCDD	OCTACHLORODIBENZO-P-DIOXIN	0.0809	0	42	E1613	0.00039	0.0026	0.00112
Dioxins/ Furans	39001-02-0	OCDF	OCTACHLORODIBENZOFURAN	0.0809	0	51	E1613	0.00033	0.0019	0.000847
Total Dioxin Like PCB (12)	32598-13-3	PCB 77	Tetrachlorobiphenyl; 3,3',4,4'-	0.243	0	4	E1668B	0.0075	0.023	0.016375
Total Dioxin Like PCB (12)	70362-50-4	PCB 81	Tetrachlorobiphenyl; 3,4,4',5-	0.0809	0	16	E1668B	0.0047	0.02	0.011469
Total Dioxin Like PCB (12)	57465-28-8	PCB 126	Pentachlorobiphenyl; 3,3',4,4',5-	0.000243	12	12	E1668B	0.0058	0.023	0.01465
Total Dioxin Like PCB (12)	32774-16-6	PCB 169	Hexachlorobiphenyl; 3,3',4,4',5,5'-	0.000809	61	61	E1668B	0.0051	0.076	0.024321

Table 2. Comparison of Nondetect Samples to Fish Tissue DQLs for Ecological Risk Assessment

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
LMW PAH	90-12-0	1-Methylnaphthalene	1-METHYLNAPHTHALENE	-	0	22	CARB429 MOD	1.8	6.8	2.86
LMW PAH	2245-38-7	2,3,5-Trimethylnaphthalene	1,6,7-TRIMETHYL-NAPTHALENE	-	0	49	CARB429 MOD	0.088	7.4	1.73
LMW PAH	581-42-0	2,6-Dimethylnaphthalene	2,6-DIMETHYL-NAPTHALENE	-	0	23	CARB429 MOD	0.82	6.5	1.96
LMW PAH	91-57-6	2-Methylnaphthalene	2-METHYLNAPHTHALENE	337000	0	25	CARB429 MOD	1.8	6.6	2.79
LMW PAH	208-96-8	Acenaphthylene	ACENAPHTHYLENE	240	0	20	CARB429 MOD	1.1	9.4	3.18
LMW PAH	120-12-7	Anthracene	ANTHRACENE	240	0	15	CARB429 MOD	0.88	2.3	1.49
LMW PAH	86-73-7	Fluorene	FLUORENE	240	0	25	CARB429 MOD	1.1	3.9	2.27
LMW PAH	91-20-3	Naphthalene	NAPHTHALENE	240	0	55	CARB429 MOD	1.5	7.1	3.73
LMW PAH	85-01-8	Phenanthrene	PHENANTHRENE	240	0	7	CARB429 MOD	0.4	2.1	1.07
HMW PAH	56-55-3	Benzo[a]anthracene	BENZO(A)ANTHRACENE	240	0	11	CARB429 MOD	0.83	3.3	2.00
HMW PAH	50-32-8	Benzo[a]pyrene	BENZO(A)PYRENE	240	0	19	CARB429 MOD	0.58	2.6	1.31
HMW PAH	192-97-2	Benzo[e]pyrene	BENZO[E]PYRENE	-	0	12	CARB429 MOD	0.37	2.2	1.09
HMW PAH	191-24-2	Benzo[g,h,i]perylene	BENZO(G,H,I)PERYLENE	240	0	45	CARB429 MOD	0.28	3.8	1.60
HMW PAH	207-08-9	Benzo[k]fluoranthene	BENZO(K)FLUORANTHENE	240	0	15	CARB429 MOD	0.24	1.6	0.71
HMW PAH	218-01-9	Chrysene	CHRYSENE	240	0	7	CARB429 MOD	0.81	3.4	1.84
HMW PAH	53-70-3	Dibenzo[a,h]anthracene	DIBENZ(A,H)ANTHRACENE	240	0	57	CARB429 MOD	0.23	5.9	2.40
HMW PAH	132-65-0	Dibenzothiophene	DIBENZOTHIOPHENE (SYNFUEL)	293000	0	7	CARB429 MOD	0.0097	0.12	0.04
HMW PAH	206-44-0	Fluoranthene	FLUORANTHENE	240	0	2	CARB429 MOD	0.87	1.6	1.24

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
HMW PAH	193-39-5	Indeno-[1,2,3c,d]pyrene	INDENO(1,2,3-C,D)PYRENE	240	0	44	CARB429 MOD	0.31	5.3	1.65
HMW PAH	198-55-0	Perylene	PERYLENE	-	0	48	CARB429 MOD	0.4	2.5	1.15
HMW PAH	129-00-0	Pyrene	PYRENE	240	0	2	CARB429 MOD	0.6	1.3	0.95
Dieldrin	60-57-1	Dieldrin	DIELDRIN	57	0	1	USEPA 1699 MOD	20	20	20
Total DDx	53-19-0	2,4'-DDD	O,P'-DDD	154	0	19	USEPA 1699 MOD	0.13	13	2.92
Total DDx	3424-82-6	2,4'-DDE	O,P'-DDE	55	0	24	USEPA 1699 MOD	0.22	14	2.39
Total DDx	789-02-6	2,4'-DDT	O,P'-DDT	26	1	50	USEPA 1699 MOD	0.13	200	5.78
Total DDx	72-54-8	4,4'-DDD	P,P'-DDD	154	0	5	USEPA 1699 MOD	11	140	59.8
Total DDx	50-29-3	4,4'-DDT	P,P'-DDT	26	0	15	USEPA 1699 MOD	0.75	17	4.10
Dioxins/ Furans	40321-76-4	1,2,3,7,8-PeCDD	1,2,3,7,8-PENTACHLORODIBENZO-P-DIOXIN	0.00275	0	21	E1613	0.00019	0.0009	0.000389
Dioxins/ Furans	39227-28-6	1,2,3,4,7,8-HxCDD	1,2,3,4,7,8-HEXACHLORODIBENZO-P-DIOXIN	0.0275	0	37	E1613	0.00019	0.0012	0.000518
Dioxins/ Furans	57653-85-7	1,2,3,6,7,8-HxCDD	1,2,3,6,7,8-HEXACHLORODIBENZO-P-DIOXIN	0.0275	0	21	E1613	0.00023	0.0013	0.000539
Dioxins/ Furans	19408-74-3	1,2,3,7,8,9-HxCDD	1,2,3,7,8,9-HEXACHLORODIBENZO-P-DIOXIN	0.0275	0	40	E1613	0.00008	0.0014	0.000553

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
Dioxins/ Furans	35822-46-9	1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8-HEPTACHLORODIBENZO-P-DIOXIN	0.275	0	3	E1613	0.00055	0.0011	0.00079
Dioxins/ Furans	3268-87-9	OCDD	OCTACHLORODIBENZO-P-DIOXIN	9.16	0	17	E1613	0.00063	0.002	0.00108
Dioxins/ Furans	51207-31-9	2,3,7,8-TCDF	2,3,7,8-TETRACHLORODIBENZOFURAN	0.012	0	7	E1613	0.00016	0.00024	0.000206
Dioxins/ Furans	57117-41-6	1,2,3,7,8-PeCDF	1,2,3,7,8-PENTACHLORODIBENZOFURAN	0.092	0	20	E1613	0.00011	0.00028	0.000208
Dioxins/ Furans	57117-31-4	2,3,4,7,8-PeCDF	2,3,4,7,8-PENTACHLORODIBENZOFURAN	0.0092	0	3	E1613	0.00016	0.0002	0.00018
Dioxins/ Furans	70648-26-9	1,2,3,4,7,8-HxCDF	1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	0.0275	0	1	E1613	0.0002	0.0002	0.0002
Dioxins/ Furans	57117-44-9	1,2,3,6,7,8-HxCDF	1,2,3,6,7,8-HEXACHLORODIBENZOFURAN	0.0275	0	10	E1613	0.00014	0.00023	0.00018
Dioxins/ Furans	72918-21-9	1,2,3,7,8,9-HxCDF	1,2,3,7,8,9-HEXACHLORODIBENZOFURAN	0.0275	0	60	E1613	0.000076	0.0011	0.000361
Dioxins/ Furans	60851-34-5	2,3,4,6,7,8-HxCDF	2,3,4,6,7,8-HEXACHLORODIBENZOFURAN	0.0275	0	24	E1613	0.00015	0.00058	0.000298
Dioxins/ Furans	55673-89-7	1,2,3,4,7,8,9-HpCDF	1,2,3,4,7,8,9-HEPTACHLORODIBENZOFURAN	0.275	0	59	E1613	0.000077	0.00099	0.000388
Dioxins/ Furans	39001-02-0	OCDF	OCTACHLORODIBENZOFURAN	9.2	0	32	E1613	0.00038	0.0019	0.000828
Total Dioxin Like PCB (12)	32598-13-3	PCB 077	Tetrachlorobiphenyl; 3,3',4,4'-	0.24	0	5	E1668B	0.011	0.052	0.029
Total Dioxin Like PCB (12)	70362-50-4	PCB 081	Tetrachlorobiphenyl; 3,4,4',5-	0.12	0	6	E1668B	0.01	0.048	0.024

Group Name	Parameter Code	Analyte	Description	DQL (ppb)	Number of Nondetects that Exceed DQL	Count of Nondetect Samples	Analysis Method	MIN of MDL (ppb)	MAX of MDL (ppb)	AVG of MDL (ppb)
Total Dioxin Like PCB (12)	57465-28-8	PCB 126	Pentachlorobiphenyl; 3,3',4,4',5-	0.027	5	8	E1668B	0.013	0.048	0.029
Total Dioxin Like PCB (12)	32774-16-6	PCB 169	Hexachlorobiphenyl; 3,3',4,4',5,5'-	0.092	1	60	E1668B	0.0041	0.17	0.027

ATTACHMENT 1.3

SUMMARIES OF MODIFICATIONS MADE TO THE 2007 HHRA AND ERA TO BE CONSISTENT WITH THE 17-MILE LPRSA RI/FS RISK ASSESSMENTS

A draft Focused Feasibility Study (FFS), including a human health risk assessment (HHRA) and ecological risk assessment (ERA), was made publicly available in 2007. Since then, additional work has been done to further develop the FFS and all of its appendices. The revised HHRA and ERA are presented in the main text (termed "Appendix D of the FFS"). For those who may have reviewed the 2007 FFS HHRA and ERA, this attachment highlights changes that were made to produce this revised version. The same chemicals of potential concern (COPCs) evaluated in the 2007 Focused Feasibility Study (FFS) human health risk assessment (HHRA) were evaluated in the 2013 FFS HHRA.

Human Health Risk Assessment (HHRA)

A summary of the modifications made to 2013 HHRA are provided in Table 1-1. Modifications having the greatest impact to estimates of cancer risk and noncancer hazard involve tissue sample type, calculation of total polychlorinated biphenyls (PCBs), and ingestion rates (IRs) as discussed below:

- **Tissue Sample Type.** For the 2007 Focused Feasibility Study (FFS) HHRA, all of the historical tissue chemistry data for white perch and American eel collected throughout the FFS Study Area were combined and used to determine the exposure point concentrations (EPCs) to evaluate exposures associated with consumption of fish. Although it was unknown at the time the 2007 HHRA was completed, it was later discovered that the historical tissue samples used to calculate EPCs in the 2007 HHRA consisted of skinless fillet samples, skin-on whole organism samples that excluded the head and viscera (designated as W-H/V samples), and whole organisms. To be consistent with the 17-mile Lower Passaic River Study Area (LPRSA) remedial investigation/feasibility study (RI/FS) HHRA, the 2013 HHRA fish tissue dataset is comprised of only skinless and skin-on fillet tissue samples collected during the late summer/early fall 2009 sampling event conducted as part of the 17-mile LPRSA RI/FS in accordance with the USEPA-approved Quality Assurance Project Plan (QAPP) (Windward Environmental, 2009). As such, EPCs calculated in this 2013 HHRA are based only on fillet data. Using only fillet tissue samples in this 2013 HHRA, compared to using fillet plus W-H/V and whole organism samples as used in the 2007 HHRA results in lower EPCs for the organic contaminants of potential concern (COPCs), because the fatty tissues comprising the W-H/V and whole organism samples would contain higher concentrations of these COPCs than the fillet samples (i.e., these organic COPCs tend to bioaccumulate more in fatty tissues than in muscle fillets). Figure 1-1 demonstrates (using dioxin/furans as toxic equivalencies [D/F TEQ]) that the 2013 HHRA EPCs were lower than the 2007 HHRA EPCs, not because concentrations of COPCs in fish are declining over time, but because of the use of fillet data, which tend to have lower COPC concentrations than W-H/V samples. As shown on Figure 1-1, concentrations associated with the historical W-H/V and whole tissue samples are much higher than the historical fillet data (which contributed to a higher upper confidence limit [UCL] in the 2007 HHRA), while the historical and more recent fillet data are similar in concentrations and have comparable UCLs.
- **Calculation of Total PCBs.** Calculation of total PCBs in the 2007 HHRA involved summing Aroclors (*i.e.*, Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260) because PCB congener data were not available in the historical data, and using one-half the reported detection limit (DL) for those Aroclors indicated as nondetect. Based on a review of the historical data, it was determined that the Aroclor analysis method used resulted in high DLs (*i.e.*, poor sensitivity). Therefore, use of one-half the DL resulted in a potential overestimation of the total PCB concentration. Data obtained from the late summer/early fall 2009 sampling event conducted as part of the 17-mile RI/FS included analyses of up to 209 PCB congeners. Therefore, total PCB concentrations in this 2013 HHRA were calculated as the sum of PCB congeners and not the sum of Aroclors. Use of surrogate values (e.g.,

substitution of zero, one-half the detection limit) for nondetect chemicals was not performed in this 2013 HHRA because it introduces bias tending towards overestimating concentrations; rather, an approach using the Kaplan-Meier (KM) estimator was employed (the KM method is currently a default method used in USEPA's ProUCL software for calculating the 95% upper confidence limit (UCL) of the mean for data with one or more censored results). The KM estimator is a step function that determines the most likely value for contaminant concentrations below analytical MDLs based on probabilities determined from the observed detected data.

- **Ingestion Rates.** For consumption of fish, IRs in the 2007 HHRA were based on data collected for recreational freshwater anglers provided in the *Exposure Factors Handbook* (EFH) (USEPA, 1997). For the adult angler/sportsman, 25 g/day (*i.e.*, 40 half-pound meals/year), which is the 95th percentile, was used for the reasonable maximum exposure (RME), whereas the recommended mean of 8 g/day (*i.e.*, 13 half-pound meals/year), was used for the central tendency exposure (CTE). IRs for this 2013 HHRA were changed to be consistent with the IRs that will be used in the 17-mile LPRSA RI/FS HHRA, namely 34.6 g/day for the RME adult angler and 3.85 g/day for the CTE. For crab, the RME and CTE IRs were calculated as 20.9 g/day and 3.0 g/day, respectively. These IRs were developed by USEPA Region 2 (2012) to be consistent with the 2011 EFH recommendation to include site-specific ingestion rates; data from a survey of fish ingestion within the Newark Bay Complex, which is the area of concern for this analysis; and information obtained from peer-reviewed, published consumption surveys from areas with geography, population groups and climatic conditions similar to those of the Lower Passaic River. In the 2013 HHRA, as in the 2007 HHRA, IRs for the adolescent and child were based on the assumptions that the intake for the adolescent will be approximately two-thirds that of the adult and the intake for the child will be approximately one-third that of the adult, similar to how ingestion rates for these two receptors were determined in the Hudson River Risk Assessment (TAMS Consultants, Inc. and Gradient Corporation, 2000).

Ecological Risk Assessment (ERA)

Modifications made to the ecological risk assessment (ERA) are summarized in Table 1-2 and include tissue chemistry data sets, fish species, quantification of EPCs, sediment benchmarks, heron exposure frequency and selection of toxicological benchmarks. Of these, the selection of benchmarks, which were combined with exposure estimates to quantify ecological risks, had the greatest impact on the results. Further details are discussed in the Baseline Ecological Risk Assessment (BERA) (*i.e.,* Section 4 of this Risk Assessment report) and summarized as follows:

- **Sediment Benchmarks.** The 2007 ERA used a single set of sediment benchmarks (primarily Effects Range-Low values derived to support the National Oceanic and Atmospheric Administration Status and Trends Program) to evaluate the likelihood of adverse effects to macroinvertebrates from contaminated sediment exposure. For the 2013 BERA, lower-bound benchmarks were included and a hierarchical approach to selecting sediment benchmarks was employed. Due to the relative low reliability of the effects range-low/effects range-median (ER-L/ER-M) values for some chemicals of potential ecological concern (COPECs) (*e.g.*, Total DDx and dieldrin), logistic regression model results derived from a marine macroinvertebrate laboratory toxicity dataset (USEPA, 2005) was the primary source of sediment benchmarks used in the BERA to evaluate direct contact exposures to benthic macroinvertebrates. Regression models were developed for copper, lead, mercury, dieldrin and Total PCBs, whereas ER-Ls (along with the inclusion of ER-Ms) were retained as the selected benchmarks for low molecular weight (LMW) polycyclic aromatic hydrocarbons (PAHs), high molecular weight (HMW) PAHs and Total DDx. The relatively low reliability of the Total DDx ER-M value was discussed in the uncertainty section of the 2013 BERA.

- **Mercury Form Refinement**. In the 2007 ERA, the EPC for the mercury COPEC was based on the total mercury tissue chemistry dataset regardless of the basis for quantifying mercury exposure used in developing the selected ecotoxicological benchmarks. The basis of the various mercury benchmarks were reviewed in the 2013 BERA and the mercury EPCs used to model wildlife exposures were derived as the 95 percent UCL concentration on the methylmercury datasets for each relevant exposure medium (including sediment and crab and fish tissue). Total mercury results were used in developing EPCs for comparison to sediment and critical body residue (CBR) benchmarks consistent with the 2007 assessment.
- **Toxicological Benchmarks**. In the 2007 ERA, CBR values used in the residue-based analysis of tissue were derived from a United States Army Corps of Engineers (USACE) database and values for some COPECs were very low. In this 2013 BERA, a more rigorous evaluation of the literature was conducted, including consideration and selection, in some cases, of toxicological endpoints that were not strictly based on survival, growth or reproductive effects. However, the final set of CBRs and toxicity reference values (TRVs) that derived from a consensus-based review process with Partner Agencies was determined to be more relevant to the objectives of the BERA than the 2007 benchmark set. The 2013 revisions to the ecotoxicological benchmark set resulted in values that were lower in some cases and considerably higher in others and resulted in some changes in the relative importance of different COPECs to the predicted ecological risks assessed.

Figures 1-2 and 1-3 show the spatial distribution of the sampling stations for the tissue and sediment data sets. The 2013 HHRA and BERA use 2009 and 2010 data, while the 2007 HHRA and ERA used the pre-2007 datasets to calculate EPCs.

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TAMS Consultants and Gradient Corporation, 2000. Phase 2 Report Further Site Characterization and Analysis Volume 2F- Revised Human Health Risk Assessment, Hudson River PCBs Reassessment RI/FS. November.

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United States Environmental Protection Agency (USEPA), 2012. Ecological Soil Screening Levels; available at http://www.epa.gov/ecotox/ecossl/.

United States Environmental Protection Agency (USEPA), Region 2, 2012. Technical Memorandum, "Fish and Crab Consumption Rates for the LPRSA Human Health Risk Assessment". February.

Windward Environmental, 2009. Quality Assurance Project Plan Fish and Decapod Crustacean Tissue Collection for Chemical Analysis and Fish Community Survey. Final. August 6.

Table 1-1. Summary of Modifications to the Human Health Risk Assessment

Issue	2007 HHRA	2013 HHRA
Tissue Chemistry Data	Tissue data collected between 1993 and 2004: ➢ New York State Department of Environmental Conservation (NYSDEC) 1993 ➢ Passaic 1995 Biological Sampling Program ➢ Passaic 1999 Late Summer/Early Fall Ecological Sampling Program ➢ Passaic 2000 Spring Ecological Sampling Program ➢ Passaic 2001 RI Supplemental Ecological Sampling Program Biota Sampling Program ➢ CARP Datasets 2000-2004 (Harbor Crustacean Collection and Harbor Fish Collection)	Tissue data collected in the late summer/early fall 2009 as part of the 17-mile LPRSA RI/FS in accordance with the USEPA-approved Quality Assurance Project Plan (QAPP) (Windward Environmental, 2009). Only the CPG 2009 tissue data contained fish species/tissue samples applicable to the HHRA. Tissue samples collected in 2010 by the CPG consisted of whole body mummichog and white perch, which are not used in the HHRA (only fillet samples for white perch are used in the HHRA).
Fish Species	American eel and white perch	American eel, common carp, smallmouth bass, white catfish, white perch, and white sucker
Tissue Sample Type	For fish, skin-on and skinless fillet samples, whole body minus the head and viscera samples, and whole organism samples. For crab, individual hepatopancreas, muscle, and all edible tissue samples.	For fish, skin-on and skinless fillet samples. For crab, combined muscle/hepatopancreas samples.
Chemical of Potential Concern	Total PCBs were derived by summing Aroclors 1221, 1232, 1016, 1242, 1248, 1254, and 1260 and using ½ the detection limit in the summation for those Aroclors not detected. Calculation of sums for totals for other multi-constituent chemicals (*e.g.*, dioxins/furan, dioxin-like PCB) involved simple substitution of ½ the detection limit for left-censored (*i.e.*, nondetect) data.	Total PCBs are derived by summing individual nondioxin-like congeners and the Kaplan-Meier (KM) product limit estimator. Calculation of sums for totals for other multi-constituent chemicals involved the KM product limit estimator.
Exposure Point Concentrations	Calculated with an earlier version of USEPA's ProUCL that could not account for left censored data (*i.e.*, had to assume ½ the detection limit for nondetects).	Calculated using USEPA's most current version of ProUCL that utilizes the detection limit of nondetects and takes into account frequency of nondetects to determine most appropriate method to calculate upper confidence limits (KM Estimator).
Ingestion Rates	Fish ingestion rates (g/day): Adult - RME = 25; CTE = 8 Adolescent - RME = 17; CTE = 5 Child - RME = 8; CTE = 3 Crab ingestion rates: Adult - RME = 23; CTE = 16 Adolescent - RME = 15; CTE = 11 Child - RME = 8; CTE = 5	Fish ingestion rates (g/day): Adult - RME = 34.6; CTE = 3.85 Adolescent - RME = 23.1; CTE = 2.57 Child - RME = 11.5; CTE = 1.28 Crab ingestion rates: Adult - RME = 20.9; CTE = 3.0 Adolescent - RME = 13.9 ; CTE = 2.0 Child - RME = 6.97; CTE = 1.0
Exposure Duration (ED)	Adolescent (10-18 years): RME = 9 years; CTE = 6 years	Adolescent (7-18 years): RME = 12 years; CTE = 6 years
Body Weight (BW)	Adolescent (10-18 years) = 54.5 kg	Adolescent (7-18 years) = 52 kg

CPG- Cooperative Parties Group
CTE – central tendency exposure
HHRA – human health risk assessment
kg - kilogram
RME – reasonable maximum exposure

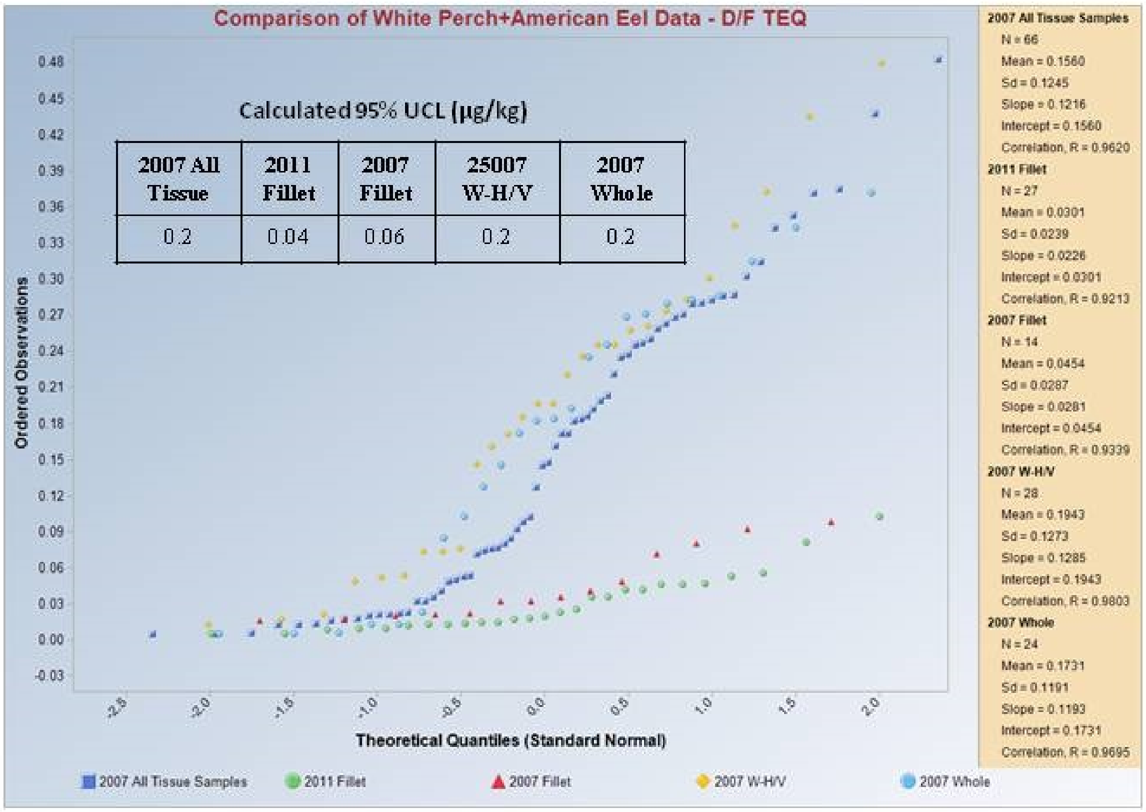
Table 1-2. Summary of Modifications to the Ecological Risk Assessment

Issue	2007 ERA	2013 BERA
Tissue Chemistry Data	Tissue data collected between 1993 and 2004: ➢ NYSDEC 1993 ➢ Passaic 1995 Biological Sampling Program ➢ Passaic 1999 Late Summer/Early Fall Ecological Sampling Program ➢ Passaic 2000 Spring Ecological Sampling Program ➢ Passaic 2001 RI Supplemental Ecological Sampling Program Biota Sampling Program ➢ CARP Datasets 2000-2004 (Harbor Crustacean Collection and Harbor Fish Collection)	Tissue data collected in 2009 and 2010 as part of the 17-mile LPRSA RI/FS in accordance with the USEPA-approved Quality Assurance Project Plan (QAPP) (Windward Environmental, 2009). CPG 2009 and 2010 tissue data contained fish species/tissue samples applicable to the BERA.
Fish Species	American eel and white perch	American eel, common carp, smallmouth bass, white catfish, white perch, white sucker and mummichog.
Chemical of Potential Ecological Concern	Total PCBs were derived by summing Aroclors 1221, 1232, 1016, 1242, 1248, 1254, and 1260 and using ½ the detection limit in the summation for those Aroclors not detected. Calculation of sums for totals for other multi-constituent chemicals (*e.g.*, dioxins/furan, dioxin-like PCB) involved simple substitution of ½ the detection limit for left-censored (*i.e.*, nondetect) data.	Total PCBs are derived by summing individual nondioxin-like congeners and the KM product limit estimator. Calculation of sums for totals for other multi-constituent chemicals involved the KM product limit estimator.
Exposure Point Concentrations	Calculated with an earlier version of USEPA's ProUCL that could not account for left censored data (*i.e.*, had to assume ½ the detection limit for nondetects).	Calculated using USEPA's most current version of ProUCL that utilizes the detection limit of nondetects and takes into account frequency of nondetects to determine most appropriate method to calculate UCLs (KM Estimator).
Sediment Benchmarks	Sediment benchmarks were selected as the lower of the NOAA Effect Range – Low (ER-L) and comparable NJDEP sediment screening benchmarks	Following evaluation of low level of confidence associated with some of the ER-L values, particularly dieldrin, and the lack of bounding risk estimates for the sediment benchmark endpoint, the sediment benchmark selection process was substantially revised to address both of these issues.
Heron Exposure Frequency	To provide a more realistic exposure estimate compared to the initial screening analysis, exposure duration information from USEPA (1993) was used to estimate a yearly exposure frequency (58%) for typical adult birds rather than the year-round residency assumed in the screening.	The uncertainty analysis was revised to discuss the impact of these different exposure frequency assumptions on the risk estimates and exposure modeling was conducted using both sets of assumptions.
Report Organization	Consistent with the study objectives, a hybrid approach was employed to characterize ecological risks in the 2007 report, which included aspects of both SLERAs and BERAs.	The 2013 report has been reorganized to follow BERA format more closely to improve clarity. All relevant information has been aggregated in Section 4 of the 2013 risk assessment report and analysis now laid out as problem formulation, analysis phase and risk characterization components.

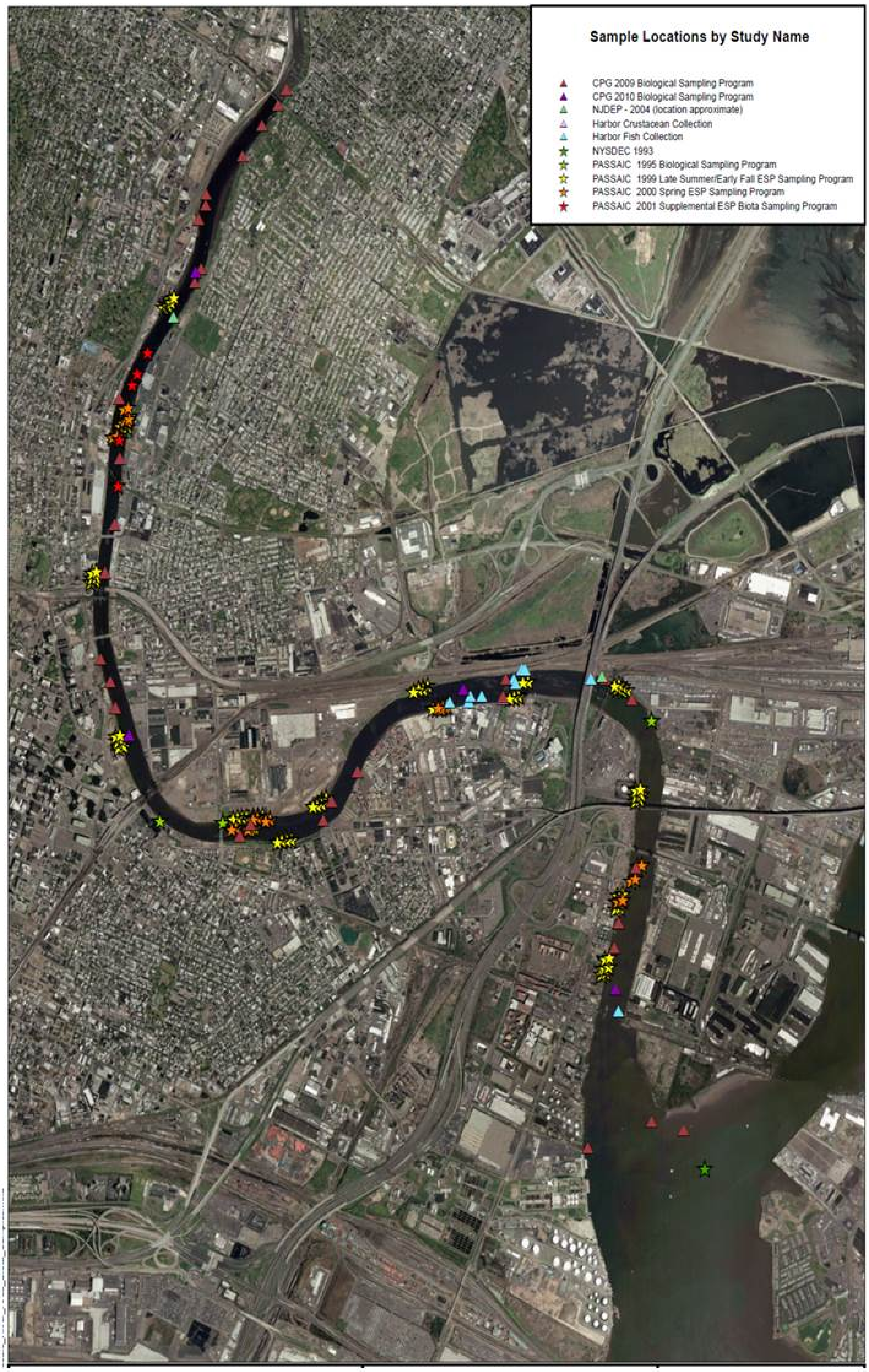
Table 1-2. Summary of Modifications to the Ecological Risk Assessment (Continued)

Issue	2007 ERA	2013 BERA
Mercury Form Refinement	While tissue chemistry data for both total mercury and methylmercury were available for some environmental media, all ecological exposures were quantified using total mercury tissue chemistry results.	The basis of the various mercury benchmarks were reviewed in the 2013 BERA and the mercury EPCs used to model wildlife exposures were derived as the 95 percent UCL concentration on the methylmercury datasets for each relevant exposure medium (including sediment and crab and fish tissue). Total mercury results were used in developing EPCs for comparison to sediment and CBR benchmarks consistent with the 2007 assessment.
Toxicological Benchmarks	CBRs were obtained from queries of the Army Corps of Engineers Environmental Residue Effects Database (ERED) and supplemented with other literature as necessary. Generally, the lowest threshold values were selected as benchmarks to quantify residue-based risks for invertebrates and fish tissue. For fish tissue, two sets of thresholds were established (generic fish and mummichog). Toxicity reference values (TRVs) were obtained from standard compilations (including Sample et al., 1996 and USEPA, 2012 EcoSSL documents for individual COPECs).	Following a review of uncertainties associated with the 2007 CBR data sets, CBR values were established for COPECs based on a literature review and recommendations received on the 2007 document. Although the established TRVs were also reviewed during development of the 2013 BERA, the values were generally consistent with those used previously unless a better study (more appropriate to the Lower Passaic River environment or the study was determined to be more reliable for the established assessment endpoints [AEs]).

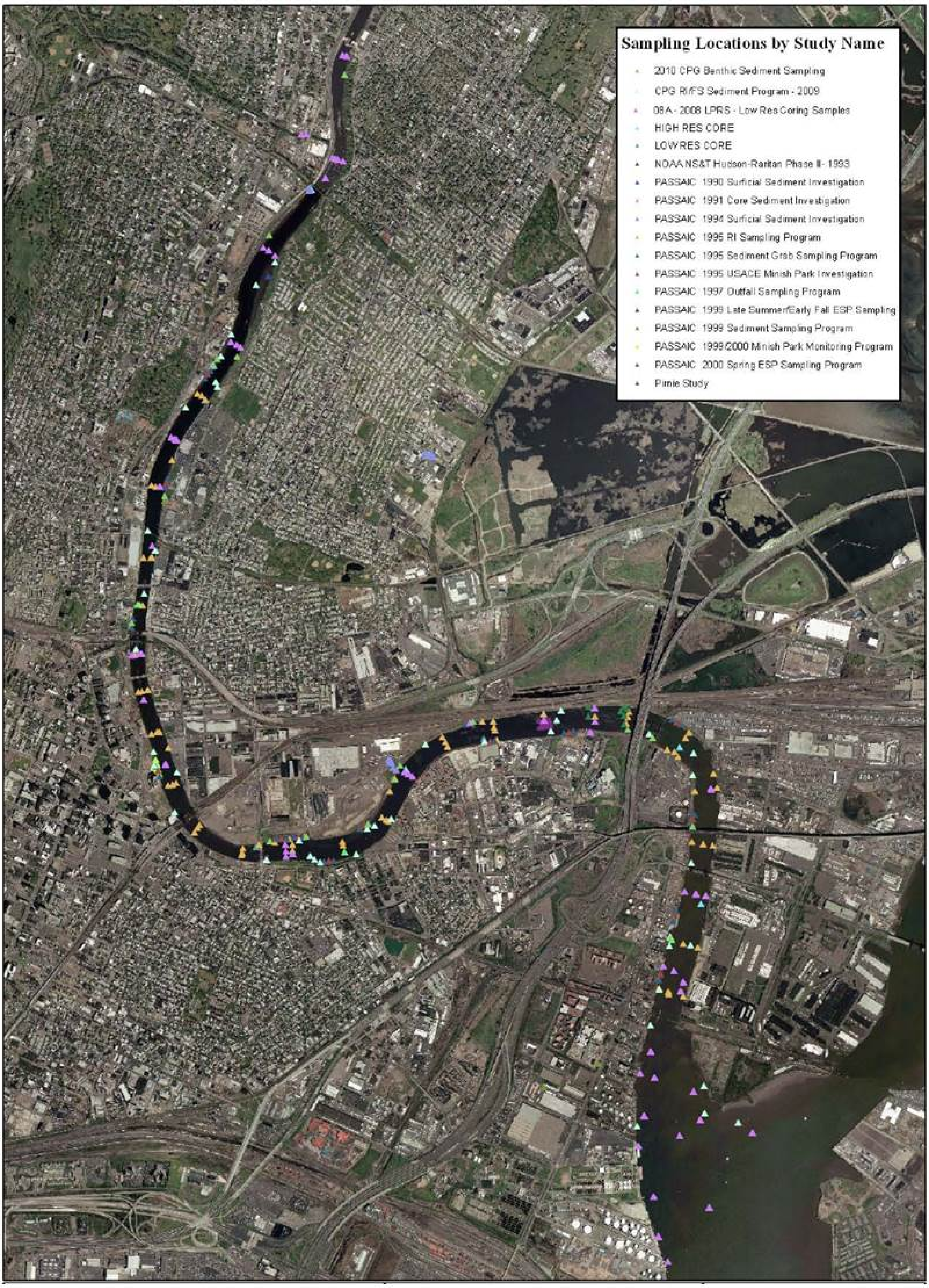
BERA- baseline ecological risk assessment
CBR – critical body residue
COPEC – chemical of potential ecological concern
CPG- Cooperative Parties Group
EPC – exposure point concentration
ERA – ecological risk assessment
ER-L – effects range-low
NJDEP – New Jersey Department of Environmental Protection
SLERA – screening level ecological risk assessment
UCL – upper confidence limit



	Effect of Sample Tissue Concentration on EPCs for TCDD TEQ (D/F)	Figure 1-1
	Lower Eight Miles of the Lower Passaic River	August 2012



Biota Sample Locations by Study	Figure 1-2
Lower Eight Miles of the Lower Passaic River	2014



Sediment Sample Locations by Study	Figure 1-3
Lower Eight Miles of the Lower Passaic River	2014

ATTACHMENT 2

SCREENING PROCESS FOR CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECS)

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Technical Memorandum

Technical Approach to Identify Contaminants of Potential Ecological Concern (COPECs) to Support the Focused Feasibility Study – Ecological Risk Assessment Lower Passaic River Restoration Project February 21, 2007

This technical memorandum presents the process used to identify Contaminants of Potential Ecological Concern (COPECs) to support the Focused Feasibility Study (FFS) for the Lower Passaic River Restoration Project (LPRRP). The FFS evaluates alternative remedial actions within three target areas for the lower seven miles of the Lower Passaic River. This memorandum identifies those chemicals whose sediment concentrations exceed sediment benchmarks and presents hazard quotients (HQs) to categorize the magnitude of benchmark exceedances. These hazard estimates were developed to provide risk managers a better understanding of which chemicals are likely to pose the greatest ecological concern in the Lower Passaic River. In turn, this will provide a basis for selecting a final set of COPECs for assessment in the FFS.

This analysis is not a screening-level ecological risk assessment (SLERA) but provides the information necessary to develop an early final action prior to the completion of a baseline ecological risk assessment and a full Remedial Investigation/Feasibility Study (RI/FS).

COMPILATION OF AVAILABLE DATA

Surface sediment data from the lower seven miles of the Lower Passaic River, obtained from www.ourPassaic.org, were utilized in this evaluation. Only surface (0-2.3 ft) sediment data collected from 1994 to the present were used. Table 1 provides a list of the specific sampling programs that were utilized for this task and associated QA/QC procedures, if available. The sampling locations are depicted in Figure 1. The full dataset used in this evaluation is provided in Attachment A.

Sediment data for the various studies were loaded into a Microsoft Access database and the data were compiled into one table and loaded into an Oracle database. All queries and summations use the detection limit where qualifiers are reported as “U”. Data where the result was reported as 0 and qualified as “ND” were not included in the calculations.

Data queries were performed in the Oracle database for each parameter group of interest. The individual analytical results were summed in Oracle for the following chemicals: Total DDTs (sum of dichlorodiphenyldichloroethylene, dichlorodiphenyldichloroethane, and dichlorodiphenyltrichloroethane isomers); hexachlorocyclohexane (BHC, sum of alpha, beta and gamma isomers); total endosulfan (sum of endosulfan sulfate and alpha and beta isomers); chlordane (sum of alpha and gamma isomers); endrin (sum of endrin aldehyde and endrin ketone); and total polychlorinated biphenyls (PCBs, sum of Aroclors). In addition, low molecular weight (LMW) PAHs (*i.e.*, 2- and 3-ring compounds), high molecular weight (MHW) PAHs (*i.e.*, greater than 3-ring compounds), and total PAHs were summed.

The data set includes analytical results for dioxin and furan congeners as well as data for individual PCB congeners, Only 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), considered the most toxic of this class of compounds was evaluated in this analysis. It should be understood that TCDD is considered to be a surrogate for the class of compounds that can produce “dioxin-like” effects (i.e., dioxins, furans, and coplanar PCBs) and that the potential ecological effects associated with exposure to these compounds will be evaluated using a toxic equivalency (TEQ) approach (Tillitt, 1999) in the baseline risk assessments.

Table 1. Summary of Data Used for the COPEC Selection Process

Name of Study in Database	Depth (ft)	Number of Samples	River Mile Range	QA/QC Procedures[a]
PASSAIC 1994 Surficial Sediment Investigation	0.5	30	3.5-6.9	Quantitative QA/QC[b]
PASSAIC 1995 USACE Minish Park Investigation	0.5	2	3.9-5.4	Not Specified
PASSAIC 1995 Sediment Grab Sampling Program	0.5	7	2.5-2.7	USEPA Region 2 Validation; full validation
PASSAIC 1995 RI Sampling Program	0.5	194	1.0-6.7	USEPA Region 2 Validation; full validation
PASSAIC 1997 Outfall Sampling Program	0.5	3	1.2-5.7	Quantitative QA/QC[b]
PASSAIC 1999 Sediment Sampling Program	1.0	3	0.7-6.2	Quantitative QA/QC[b]
PASSAIC 1999 Late Summer/Early Fall ESP Sampling Program	0.5	48	1.0-6.9	USEPA Region 2 Validation
PASSAIC 1999/2000 Minish Park Monitoring Program	0.5	2	5.0-5.1	Quantitative QA/QC[b]
PASSAIC 2000 Spring ESP Sampling Program	0.5	17	1.0-6.8	USEPA Region 2 Validation
Dredge Pilot Coring Program 2004 – Earth Tech	1.0	15	2.8-2.9	Third Party Full and Partial Data Validation[c]
Low-Res Sediment Coring- Pirnie Study	2.297	21	2.9-6.7	USEPA Region 2 Validation
High Res Core Sampling- Pirnie Study	0.984	79	1.4-7.8	USEPA Region 2 Validation

a. QA/QC procedures from PREmis datasets as described by TSI (2004).

b. Quantitative QA/QC includes the analysis of field and laboratory duplicates, rinsate blanks, matrix spike/matrix spike duplicates, and other quantitative measures of precision and accuracy but without specification of implementing USEPA Region 2 data validation procedures.

c. Data validation activities were performed by Severn-Trent Laboratories (STL) in accordance with the USEPA Method, the Laboratories Standard Operating Procedure (SOP) and the Malcolm Pirnie, Inc. Statement of Work (SOW).

RI = Remedial Investigation
ESP = Ecological Sampling Program

Figure 1. Sampling Locations along the Lower Seven Miles of the Passaic River

IDENTIFICATION OF PRELIMINARY CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECS)

To support the FFS, sediment COPECs were identified based on a review of historical data that were collected by various agencies including USEPA, USACE, and NOAA NS&T, as well as Tierra Solutions Inc. (TSI), and which are currently stored in an online database at www.ourPassaic.org. Preliminary COPECs were identified using a three-tier screening process that included the following factors:

1. Bioaccumulation screen (indirect toxicological effects to wildlife through the food chain);
2. Essential nutrient screen; and,
3. Effects value screen (direct toxicological effects to benthic invertebrates).

The screening process is described below and is depicted graphically in Figure 2. The sediment screening values used in the analysis are presented in Table 2.

Maximum chemical concentrations were used in the screening evaluation. As noted previously, the reported detection limit was used to represent values reported as nondetect ("U" qualified data). In some instances, values based on detection limits represent the maximum available value for an individual chemical. The detection frequency was considered in the analysis insofar that chemicals that were not reported as detected in any sample are not proposed for further consideration in the FFS.

Bioaccumulation Screen

Any detected bioaccumulative compound, as recognized by USEPA (2000), was evaluated for both direct and indirect toxicological effects. Potential risks to higher trophic level organisms were assessed using Protective Concentration Levels (PCL), which are sediment concentrations derived using conservative exposure assumptions to be protective of bioaccumulative hazards to higher trophic level receptors (Table 2). Maximum concentrations of bioaccumulative compounds were compared to PCLs and available screening values so that the potential toxicity to both wildlife and benthic invertebrates could be considered. Those compounds that exceeded either their PCL or their screening value (*e.g.,* NOAA ER-Ls) were retained as preliminary COPECs. In many cases, wildlife PCLs are lower than marine/estuarine sediment benchmarks because sediment benchmarks are protective of benthic invertebrates without consideration of bioaccumulation, while PCLs are protective of bioaccumulative hazards to higher trophic level receptors.

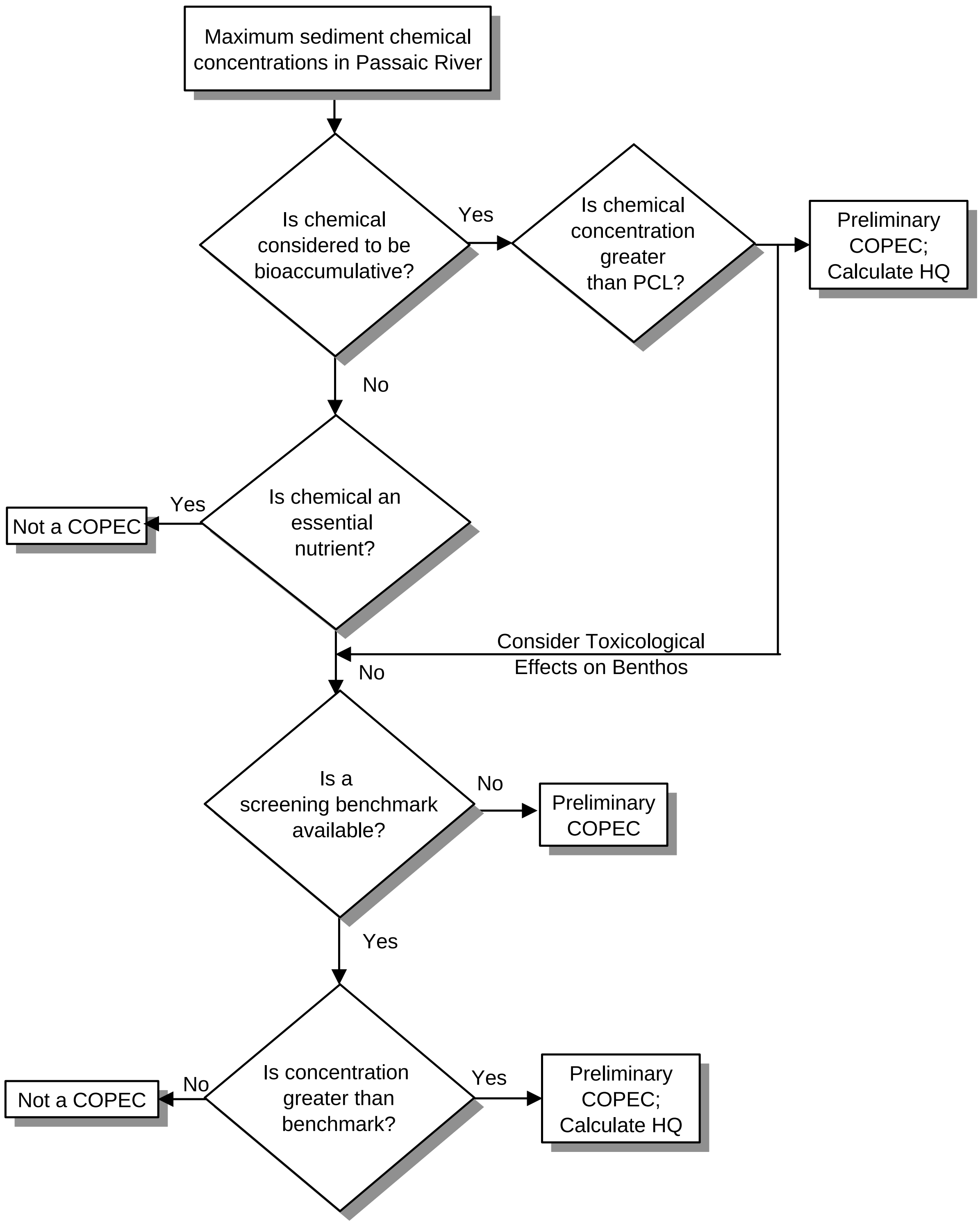

Figure 2. Sediment Preliminary COPEC Decision Diagram to Support the Focused Feasibility Study for the Lower Passaic River Restoration Project

Table 2. Summary of Screening Values Used in the Assessment

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
Inorganics								
7429-90-5	ng/g	Aluminum	-	-	-	N	-	
7664-41-7	ng/g	Ammonia	-	-	-	N	-	
7440-36-0	ng/g	Antimony	-	-	-	N	-	
7440-38-2	ng/g	Arsenic	8,200	8,200	8,200	Y	173,228	NOAA ER-L
7440-39-3	ng/g	Barium	-	-	-	N	-	
7440-41-7	ng/g	Beryllium	-	-	-	N	-	
7440-43-9	ng/g	Cadmium	1,200	1,200	1,200	Y	2,971	NOAA ER-L
7440-70-2	ng/g	Calcium	-	-	-	N	-	
7440-47-3	ng/g	Chromium	81,000	81,000	81,000	Y	41,409	Wildlife PCL
7440-48-4	ng/g	Cobalt	-	-	-	N	-	
7440-50-8	ng/g	Copper	34,000	34,000	34,000	Y	13,318	Wildlife PCL
57-12-5	ng/g	Cyanide	-	-	-	N	-	
7439-89-6	ng/g	Iron	-	-	-	N	-	
7439-92-1	ng/g	Lead	46,700	47,000	46,700	Y	10,606	Wildlife PCL
7439-95-4	ng/g	Magnesium	-	-	-	N	-	
7439-96-5	ng/g	Manganese	-	-	-	N	-	
7439-97-6	ng/g	Mercury	150	150	150	Y	37	Wildlife PCL
7440-02-0	ng/g	Nickel	20,900	21,000	20,900	Y	21,551	NOAA ER-L
7440-09-7	ng/g	Potassium	-	-	-	N	-	
7782-49-2	ng/g	Selenium	-	-	-	Y	925	Wildlife PCL
7440-22-4	ng/g	Silver	1,000	1,000	1,000	Y	1,298,747	NOAA ER-L
7440-21-3	ng/g	Silicon	-	-	-	N	-	
7440-23-5	ng/g	Sodium	-	-	-	N	-	
7440-28-0	ng/g	Thallium	-	-	-	N	-	
7440-31-5	ng/g	Tin	-	-	-	N	-	
7440-32-6	ng/g	Titanium	-	-	-	N	-	
7440-62-2	ng/g	Vanadium	-	-	-	N	-	
7440-66-6	ng/g	Zinc	150,000	150,000	150,000	Y	46,688	Wildlife PCL
Volatile Organic Compounds (VOCs)								
630-20-6	ng/g	1,1,1,2-Tetrachloroethane	-	-		N	-	
71-55-6	ng/g	1,1,1-Trichloroethane	-	-		N	-	
79-34-5	ng/g	1,1,2,2-Tetrachloroethane	-	-		N	-	
76-13-1	ng/g	1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	N	-	

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
79-00-5	ng/g	1,1,2-Trichloroethane	-	-	-	N	-	
75-34-3	ng/g	1,1-Dichloroethane	-	-	-	N	-	
75-35-4	ng/g	1,1-Dichloroethene	-	-	-	N	-	
563-58-6	ng/g	1,1-Dichloropropene	-	-	-	N	-	
96-18-4	ng/g	1,2,3-Trichloropropane	-	-	-	N	-	
96-12-8	ng/g	1,2-Dibromo-3-chloropropane	-	-	-	N	-	
106-93-4	ng/g	1,2-Dibromoethane	-	-	-	N	-	
107-06-2	ng/g	1,2-Dichloroethane	-	-	-	N	-	
540-59-0	ng/g	1,2-Dichloroethylene	-	-	-	N	-	
540-59-0	ng/g	1,2-Dichloroethylene	-	-	-	N	-	
78-87-5	ng/g	1,2-Dichloropropane	-	-	-	N	-	
142-28-9	ng/g	1,3-Dichloropropane	-	-	-	N	-	
594-20-7	ng/g	2,2-Dichloropropane	-	-	-	N	-	
591-78-6	ng/g	2-Hexanone	-	-	-	N	-	
59-50-7	ng/g	4-Chloro-3-methylphenol	-	-	-	N	-	
106-43-4	ng/g	4-Chlorotoluene	-	-	-	N	-	
108-10-1	ng/g	4-Methy-2-pentanone	-	-	-	N	-	
67-64-1	ng/g	Acetone	-	-	-	N	-	
98-86-2	ng/g	Acetophenone	-	-	-	N	-	
107-02-8	ng/g	Acrolein	-	-	-	N	-	
107-13-1	ng/g	Acrylonitrile	-	-	-	N	-	
71-43-2	ng/g	Benzene	-	340	340	N	-	NJ Benchmark
74-97-5	ng/g	Bromochloromethane	-	-	-	N	-	
75-25-2	ng/g	Bromoform	-	-	-	N	-	
75-15-0	ng/g	Carbon disulfide	-	-	-	N	-	
56-23-5	ng/g	Carbon Tetrachloride	-	-	-	N	-	
108-90-7	ng/g	Chlorobenzene	-	-	-	N	-	
124-48-1	ng/g	Chlorodibromomethane	-	-	-	N	-	
75-00-3	ng/g	Chloroethane	-	-	-	N	-	
67-66-3	ng/g	Chloroform	-	-	-	N	-	
156-59-2	ng/g	cis-1,2-Dichloroethylene	-	-	-	N	-	
1006-10-15	ng/g	cis-1,3-Dichloropropene	-	-	-	N	-	
110-82-7	ng/g	cyclohexane	-	-	-	N	-	
75-27-4	ng/g	Dichlorobromomethane	-	-	-	N	-	
75-71-8	ng/g	Dichlorodifluoromethane	-	-	-	N	-	

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
100-41-4	ng/g	Ethylbenzene	-	1400	1400	N	-	NJ Benchmark
98-82-8	ng/g	Isopropylbenzene	-	-	-	N	-	
M&PXYLENE	ng/g	m&p-Xylene	-	120	120	N	-	NJ Benchmark
79-20-9	ng/g	methyl acetate	-	-	-	N	-	
74-83-9	ng/g	Methyl bromide	-	-	-	N	-	
74-87-3	ng/g	Methyl Chloride	-	-	-	N	-	
108-87-2	ng/g	Methyl Cyclohexane	-	-	-	N	-	
78-93-3	ng/g	Methyl Ethyl Ketone	-	-	-	N	-	
74-95-3	ng/g	Methylene Bromide	-	-	-	N	-	
75-09-2	ng/g	Methylene Chloride	-	-	-	N	-	
1634-04-4	ng/g	Methyl-t-Butyl Ether	-	-	-	N	-	
104-51-8	ng/g	n-Butylbenzene	-	-	-	N	-	
103-65-1	ng/g	n-Propylbenzene	-	-	-	N	-	
95-47-6	ng/g	O-Xylene	-	120	120	N	-	NJ Benchmark
99-87-6	ng/g	p-Isopropyltoluene	-	-	-	N	-	
100-42-5	ng/g	Styrene	-	-	-	N	-	
127-18-4	ng/g	Tetrachloroethylene	-	450	450	N	-	NJ Benchmark
108-88-3	ng/g	Toluene	-	2500	2500	N	-	NJ Benchmark
BTEX	ng/g	Total BTEX	-	-	-	N	-	
1330-20-7	ng/g	Total Xylenes	-	120	120	N	-	NJ Benchmark
156-60-5	ng/g	trans-1,2-Dichloroethylene	-	-	-	N	-	
10061-02-6	ng/g	Trans-1,3-dichloropropene	-	-	-	N	-	
79-01-6	ng/g	Trichloroethylene	-	1,600	1,600	N	-	NJ Benchmark
75-69-4	ng/g	Trichlorofluoromethane	-	-	-	N	-	
75-01-4	ng/g	Vinyl Chloride	-	-	-	N	-	
Semi-Volatile Organic Compounds (Non-PAHs)								
108-60-1	ng/g	1-Chloropropane	-	-	-	N	-	
95-50-1	ng/g	1,2-Dichlorobenzene	-	-	-	Y	2,746,538	Wildlife PCL
541-73-1	ng/g	1,3-Dichlorobenzene	-	-	-	Y	560,635	Wildlife PCL
106-46-7	ng/g	1,4-Dichlorobenzene	-	-	-	Y	560,635	Wildlife PCL
123-91-1	ng/g	1,4-Dioxane	-	-	-	N	-	
87-61-6	ng/g	1,2,3-Trichlorobenzene	-	-	-	Y	3,845,153	Wildlife PCL
120-82-1	ng/g	1,2,4-Trichlorobenzene	-	-	-	Y	3,845,153	Wildlife PCL
95-63-6	ng/g	1,2,4-Trimethylbenzene	-	-	-	N	-	
108-67-8	ng/g	1,3,5-Trimethylbenzene	-	-	-	N	-	
95-94-3	ng/g	1,2,4,5-Tetrachlorobenzene	-	-	-	Y	13,238	Wildlife PCL

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
95-95-4	ng/g	2,4,5-Trichlorophenol	-	-	-	N	-	
88-06-2	ng/g	2,4,6-Trichlorophenol	-	-	-	N	-	
120-83-2	ng/g	2,4-Dichlorophenol	-	-	-	N	-	
105-67-9	ng/g	2,4-Dimethylphenol	-	-	-	N	-	
51-28-5	ng/g	2,4-Dinitrophenol	-	-	-	N	-	
121-14-2	ng/g	2,4-Dinitrotoluene	-	-	-	N	-	
28804-88-8	ng/g	2,6/2,7-Dimethylnaphthalene	-	-	-	N	-	
606-20-2	ng/g	2,6-Dinitrotoluene	-	-	-	N	-	
91-58-7	ng/g	2-Chloronaphthalene	-	-	-	N	-	
95-57-8	ng/g	2-Chlorophenol	-	-	-	N	-	
95-48-7	ng/g	2-Methylphenol	-	-	-	N	-	
88-74-4	ng/g	2-Nitroanaline	-	-	-	N	-	
88-75-5	ng/g	2-Nitrophenol	-	-	-	N	-	
91-94-1	ng/g	3,3'-Dichlorobenzidine	-	-	-	N	-	
99-09-2	ng/g	3-Nitroaniline	-	-	-	N	-	
101-55-3	ng/g	4-Bromophenyl Phenyl Ether	-	-	-	Y	5,850,214	Wildlife PCL
106-47-8	ng/g	4-Chloroaniline	-	-	-	N	-	
7005-72-3	ng/g	4-Chlorophenyl Phenyl Ether	-	-	-	Y	73,676,722	Wildlife PCL
106-44-5	ng/g	4-Methylphenol	-	-	-	N	-	
100-01-6	ng/g	4-Nitroaniline	-	-	-	N	-	
100-02-7	ng/g	4-Nitrophenol	-	-	-	N	-	
534-52-1	ng/g	4,6-Dinitro-2-Methylphenol	-	-	-	N	-	
95-15-8	ng/g	Benzo(b)thiophene	-		-	N	-	
92-87-5	ng/g	Benzidine	-		-	N	-	
65-85-0	ng/g	Benzoic Acid	-		-	N	-	
100-51-6	ng/g	Benzyl Alcohol	-	-	-	N	-	
111-91-1	ng/g	Bis(2-Chloroethoxy)methane	-	-	-	N	-	
111-44-4	ng/g	Bis(2-Chloroethyl)ether	-	-	-	N	-	
117-81-7	ng/g	Bis(2-Ethylhexyl)phthalate	-	-	-	N	-	
108-86-1	ng/g	Bromobenzene	-	-	-	N	-	
85-68-7	ng/g	Butyl Benzyl Phthalate	-	-	-	N	-	
86-74-8	ng/g	Carbazole	-	-	-	N	-	
1861-32-1	ng/g	Dacthal	-	-	-	N	-	

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
132-64-9	ng/g	Dibenzofuran	-	-	-	N	-	
132-65-0	ng/g	Dibenzothiophene	-	-	-	N	-	
1002-53-5	ng/g	Dibutyltin	-	-	-	N	-	
84-66-2	ng/g	Diethyl Phthalate	-	-	-	N	-	
131-11-3	ng/g	Dimethylphthalate	-	-	-	N	-	
84-74-2	ng/g	Di-n-butyl Phthalate	-	-	-	N	-	
117-84-0	ng/g	Di-n-Octyl Phthalate	-	-	-	N	-	
87-68-3	ng/g	Hexachlorobutadiene	-	-	-	Y	117,004	Wildlife PCL
77-47-4	ng/g	Hexachlorocyclopentadiene	-	-	-	Y	-	
67-72-1	ng/g	Hexachloroethane	-	-	-	Y	-	
78-59-1	ng/g	Isophorone	-	-	-	N	-	
78763-54-9	ng/g	Monobutyltin	-	-	-	N	-	
98-95-3	ng/g	Nitrobenzene	-	-	-	N	-	
621-64-7	ng/g	N-nitrosodipropylamine	-	-	-	N	-	
86-30-6	ng/g	N-Nitroso-diI-phenylamine	-	-	-	N	-	
87-86-5	ng/g	Pentachlorophenol	-	-	-	Y	415,862	Wildlife PCL
108-95-2	ng/g	Phenol	-	-	-	N	-	
1461-25-2	ng/g	Tetrabutyltin	-	-	-	N	-	
56573-85-4	ng/g	Tributyltin	25	-	25	Y	3,583	NOAA ER-L
Semi-Volatile Organic Compounds (PAHs)								
90-12-0	ng/g	1-Methylnaphthalene	-	-	-	N	-	
832-69-9	ng/g	1-Methylphenanthrene	-	-	-	N	-	
91-57-6	ng/g	2-Methylnaphthalene	70	70	70	N	-	NOAA ER-L
2245-38-7	ng/g	2,3,5-Trimethylnaphthalene	-	-	-	N	-	
581-42-0	ng/g	2,6-Dimethylnaphthalene	-	-	-	N	-	
83-32-9	ng/g	Acenaphthene	16	16	16	Y	-	NOAA ER-L
208-96-8	ng/g	Acenaphthylene	44	44	44	Y	-	NOAA ER-L
120-12-7	ng/g	Anthracene	85.3	85	85	Y	-	NJ Benchmark
56-55-3	ng/g	Benzo[a]anthracene	261	261	261	Y	-	NOAA ER-L
50-32-8	ng/g	Benzo[a]pyrene	430	430	430	Y	-	NOAA ER-L
205-99-2	ng/g	Benzo[b]fluoranthene	-	-	-	Y	-	
192-97-2	ng/g	Benzo[e]pyrene	-	-	-	N	-	
191-24-2	ng/g	Benzo[g,h,i]perylene	-	-	-	Y	-	
92-52-4	ng/g	Biphenyl	-	-	-	Y	-	
207-08-9	ng/g	Benzo[k]fluoranthene	-	-	-	Y	-	
218-01-9	ng/g	Chrysene	384	384	384	Y	-	NOAA ER-L

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
53-70-3	ng/g	Dibenz[a,h]anthracene	63.4	63	63	Y	-	NJ Benchmark
206-44-0	ng/g	Fluoranthene	600	600	600	Y	-	NOAA ER-L
86-73-7	ng/g	Fluorene	19	19	19	Y	-	NOAA ER-L
193-39-5	ng/g	Indeno[1,2,3-c,d]-pyrene	-	-	-	Y	-	
91-20-3	ng/g	Naphthalene	160	160	160	N	-	NOAA ER-L
198-55-0	ng/g	Perylene	-	-	-	N	-	
85-01-8	ng/g	Phenanthrene	240	240	240	Y	-	NOAA ER-L
129-00-0	ng/g	Pyrene	665	665	665	Y	-	NOAA ER-L
SUM_HIGH_PAH	ng/g	Low Molecular Weight PAHs	552	552		N	-	NOAA ER-L
SUM_LOW_PAH	ng/g	High Molecular Weight PAHs	1,700	1,700		N	-	NOAA ER-L
SUM_PAH	ng/g	Total PAHs	4,022	4,000	4,000	N	-	NJ Benchmark
PCB Aroclors								
12674-11-2	ng/g	Aroclor 1016	-	-	-	Y	365	Wildlife PCL
11104-28-2	ng/g	Aroclor 1221	-	-	-	Y	365	Wildlife PCL
11141-16-5	ng/g	Aroclor 1232	-	-	-	Y	365	Wildlife PCL
53469-21-9	ng/g	Aroclor 1242	-	-	-	Y	365	Wildlife PCL
12672-29-6	ng/g	Aroclor 1248	-	-	-	Y	365	Wildlife PCL
11097-69-1	ng/g	Aroclor 1254	-	-	-	Y	365	Wildlife PCL
11096-82-5	ng/g	Aroclor 1260	-	-	-	Y	365	Wildlife PCL
37324-23-5	ng/g	Aroclor-1262	-	-	-	Y	365	Wildlife PCL
SUM_PCB	ng/g	Total PCBs	22.7	23	22.7	Y	365	NOAA ER-L
Pesticides/Herbicides								
93-76-5	ng/g	2,4,5-T	-	-	-	N	-	
93-72-1	ng/g	2,4,5-TP	-	-	-	N	-	
94-75-7	ng/g	2,4-D	-	-	-	N	-	
94-82-6	ng/g	2,4-DB	-	-	-	N	-	
53-19-0	ng/g	2,4-DDD	2	-	2	Y	830	NOAA ER-L
3424-82-6	ng/g	2,4-DDE	2.2	-	2.2	Y	19	NOAA ER-L
789-02-6	ng/g	2,4-DDT	1	-	1	Y	139	NOAA ER-L
72-54-8	ng/g	4,4'-DDD	2	-	2	Y	830	NOAA ER-L
72-55-9	ng/g	4,4'-DDE	2.2	2.2	2.2	Y	19	NOAA ER-L
50-29-3	ng/g	4,4'-DDT	1	-	1	Y	139	NOAA ER-L
SUM_TDDT	ng/g	Total DDTs, sum of 6 isomers	1.58	1.6	1.58	Y	19	NOAA ER-L
309-00-2	ng/g	Aldrin	-	-	-	Y	463	Wildlife PCL
319-84-6	ng/g	BHC-alpha	-	-	-	Y	1,247	Wildlife PCL

CASRN	Units	Chemical	Marine/ Estuarine Values		Lowest Aquatic Benchmark	USEPA List of Bioaccumulators[c]	Wildlife-Based PCL[d]	Basis
			NOAA ER-L[a]	NJDEP[b]				
319-85-7	ng/g	BHC-beta	-	-	-	Y	1,247	Wildlife PCL
58-89-9	ng/g	BHC-gamma (Lindane)	-	-	-	Y	1,247	Wildlife PCL
319-86-8	ng/g	BHC, delta	-	-	-	Y	1,247	Wildlife PCL
SUM_BHC	ng/g	SUM_BHC	-	-	-	Y	1,247	Wildlife PCL
5103-71-9	ng/g	Chlordane, alpha (cis)	-	-	-	Y	2,006	Wildlife PCL
5103-74-2	ng/g	Chlordane, gamma (trans)	-	-	-	Y	2,006	Wildlife PCL
SUM_CHLORDANE	ng/g	Total Chlordane	-	-	-	Y	2,006	Wildlife PCL
60-57-1	ng/g	Dieldrin	0.02	-	0.02	Y	271	NOAA ER-L
1031-07-8	ng/g	Endosulfan Sulfate	-	-	-	Y	4,875	Wildlife PCL
959-98-8	ng/g	Endosulfan, alpha	-	-	-	Y	4,875	Wildlife PCL
33213-65-9	ng/g	Endosulfan, beta	-	-	-	Y	4,875	Wildlife PCL
SUM_ENDOSULFAN	ng/g	Total Endosulfan	-	-	-	Y	4,875	Wildlife PCL
7421-93-4	ng/g	Endrin Aldehyde	-	-	-	Y	35	Wildlife PCL
53494-70-5	ng/g	Endrin Ketone	-	-	-	Y	35	Wildlife PCL
SUM_ENDRIN	ng/g	Total Endrin	-	-	-	Y	35	Wildlife PCL
1024-57-3	ng/g	Heptachlor Epoxide	-	-	-	Y	9,663	Wildlife PCL
76-44-8	ng/g	Total Heptachlor	-	-	-	Y	-	
118-74-1	ng/g	Hexachlorobenzene	-	-	-	Y	92,898	Wildlife PCL
72-43-5	ng/g	Methoxychlor	-	-	-	Y	114,909	Wildlife PCL
2385-85-5	ng/g	Mirex	-	-	-	Y	-	
5103-73-1	ng/g	Total Nonachlor	-	-	-	N	-	
8001-35-2	ng/g	Toxaphene	-	-	-	Y	1,398	Wildlife PCL
Dioxins/Furans								
1746-01-6	ng/g	2,3,7,8-TCDD	0.0032	-	0.0032	Y	0.0025	Wildlife PCL

- no value available
a. ER-L = Effects Range-Low from Long and Morgan, 1991 and Long *et al.*, 1995; except where noted.
b NJDEP Guidance For Sediment Quality Evaluations, November 1998. References Long *et al.*, 1995.
c. From USEPA 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. USEPA-823-R-00-001.
d. Protective Concentration Levels (PCLs) derived as discussed in the text; see Attachments B and C.

Protective Concentration Levels (PCLs)

Wildlife-protective sediment concentrations for bioaccumulating compounds were calculated to provide a sediment benchmark based on exposures to higher trophic level organisms. Equation 1 was used to estimate PCLs for piscivorous wildlife receptors in the LPRRP study area. The otter (*Lutra canadensis*) and belted kingfisher (*Ceryle alcyon*) were selected as the model receptors due to their relatively large dietary exposures to sediment-associated chemicals that can bioaccumulate in biological tissue.

$$PCL_{sed} = \frac{THQ * TRV * BW}{\left(BAF_{fish} * IR_{fish} * P_{fish} * SFF\right)} \qquad \text{Equation 1}$$

where:

PCL_{sed}	=	Protective Concentration Level for sediment protective of bioaccumulation hazards associated with the fish consumption pathway (μg COPEC/g sediment).
THQ	=	Target Hazard Quotient for the COPEC based on tissue residue effects (dimensionless); a THQ of 1 was used.
TRV	=	Toxicity Reference Value. Receptor-specific literature-based toxicity threshold value. NOAEL and LOAEL-based TRV values are presented in Attachment B. The MATC-based TRV is the geometric mean of the NOAEL- and LOAEL-based values.
BW	=	Receptor body weights (Kg) are summarized in Attachment B.
BAF_{fish}	=	Bioaccumulation Factor between sediment and fish prey consumed by the receptor (g sediment [dry weight]/ g fish [wet weight])
IR_{fish}	=	Daily fish ingestion rate (Kg fish consumed per day).
P_{fish}	=	Percentage of fish in the diet
SFF	=	Site Foraging Frequency (unitless); fraction of time receptor is assumed to forage at the site.

Table 3. Summary of Exposure Parameters Used to Develop the PCLs

Parameter	Value	Units	Reference
PCL_{sed}	Calculated using Equation 1	μg COPEC/g sediment	
THQ	1	unitless	
TRV	Chemical specific	μg COPEC/g-day	See Attachment B and Attachment C
BW	7.4 (otter)	Kg	USEPA, 1993a
	0.136 (kingfisher)		USEPA, 1993a; Brooks and Davis, 1987
BAF_{fish}	Chemical specific		See Attachment B and Attachment C
IR_{fish}	0.4 (otter)	Kg/day	USEPA, 1993a
	0.068 (kingfisher)		USEPA, 1993a; Alexander, 1977
P_{fish}	100	%	Assumption
SFF	1	unitless	Assumption

Chemical-specific TRVs and BAFs are presented in Attachments B and C, and the calculated PCLs for both receptors are provided in Table 2. For each chemical, the lower of the two PCL values was identified as the wildlife PCL and used in the screening evaluation. Note that there are relatively few TRVs for avian receptors and, consequently, for some COPECs, the wildlife value is based solely on the mammalian PCL.

Rather than derive PCLs for TCDD using the above approach, sediment concentrations protective of piscivorous mammals (2.5 picograms/gram [pg/g] or parts per trillion) and birds (21 pg/g) derived by USEPA (1993b) were used. The lower of these values was selected as the wildlife PCL value.

<u>Essential Nutrients</u>

Inorganic constituents considered to be "essential nutrients", which are not likely to be toxic at anticipated environmental levels, were excluded from consideration in this analysis. These analytes include calcium, magnesium, potassium, and sodium.

<u>Effects Values</u>

The maximum concentrations of all constituents that were detected, including those considered bioaccumulative, and not considered essential nutrients, were screened against a hierarchy of effects-based sediment screening values. Screening values for sediments were obtained from sediment quality guidelines developed for marine and estuarine waters for NOAA by Long *et al.*, 1995; the Effects Range Low (ER-L). The ER-L values represent the low end of a range of levels at which adverse effects were observed in compiled studies and represent values at which toxicity may begin to be observed in sensitive species (Long *et al.*, 1995). Therefore, concentrations below the ER-L are considered to be within the "no effects range." The ER-L values used in the selection of COPECs are listed in Table 2. Additional sediment quality values for New Jersey Department of Environmental Protection are also used (NJDEP, 1998) in this evaluation. These screening levels were developed specifically for sediment evaluations for use in the ecological risk assessment process. Although the NJDEP sediment guidelines are also based primarily on the Long *et al*., 1995 study, several VOC benchmarks are also provided that were derived using an equilibrium partitioning approach (NJDEP, 1998).

A NOAA ER-L is not available for TCDD; therefore a site-specific screening benchmark (3.1 pg/g) as presented by Wintermyer and Cooper (2003), was derived by the U.S. Fish and Wildlife Service (USFWS) using Arthur Kill sediment and oyster tissue chemistry and ecological effects.

Chemicals for which no effects-based sediment screening value was readily available were retained as preliminary COPECs. These are further addressed in a refinement step. In addition, as part of future risk assessment activities, a literature review will be conducted to identify appropriate screening values for chemicals currently lacking screening values.

Preliminary Sediment COPEC Selection

<u>Inorganic Constituents</u>

Surface sediments were analyzed for 26 inorganic constituents and these were all detected in at least one of the samples. A total of ten inorganic constituents are included on the USEPA list of bioaccumulative compounds (USEPA, 2000) and were compared to appropriate PCLs and sediment effects benchmarks where available. Four essential nutrients (calcium, magnesium, potassium, and sodium) were detected but eliminated from consideration as COPECs.

Sediment screening values were not available for 12 inorganic analytes (Table 4) detected in surface sediment samples. Excluding the essential nutrients, the remaining 12 analytes were retained as preliminary COPECs. Analytes that do not have sediment screening values will be discussed further in the refinement step. Hazard quotients were calculated for each of the analytes retained as preliminary COPECs and range from 8 for selenium to 290 for mercury (Attachment A).

Volatile Organic Compounds (VOCs)

Surface sediment samples were analyzed for a total of 61 VOCs and 21 VOCs were detected at least once among the samples evaluated. Sediment screening levels are available for a total of eight compounds. Only toluene slightly exceeded its screening value (HQ= 1.1) and was retained as a preliminary COPEC. Relevant screening values are not available for 53 VOCs that were retained as preliminary COPECs (Attachment A). Of these, 40 were reported as non-detects; however, in the absence of a screening level, the appropriateness of the detection level could not be fully evaluated. These compounds will be discussed further in the refinement step.

No VOC is included on the USEPA list of bioaccumulative compounds (USEPA, 2000).

Semivolatile Organic Compounds (SVOCs), Excluding PAHs

A total of 56 SVOCs were analyzed in surface sediment and 31 SVOCs were detected. Of the 31 compounds detected, only tributyltin exceeded the available screening level and was retained as a preliminary COPEC. In addition, the detection limit for hexachlorobutadiene was above the screening level and was therefore retained as a preliminary COPEC.

Forty-five additional SVOCs (Table 4) were identified as preliminary COPECs because they lack available sediment screening benchmarks. It should be noted that 26 of these compounds were also reported as non-detected, however, in the absence of a screening level, the appropriateness of the detection level could not be evaluated.

Polycyclic Aromatic Hydrocarbons (PAHs)

A total of 28 individual PAHs were detected in surface sediment samples. Sediment screening values are available for 16 PAHs, including total PAHs, total LMW PAHs, and total HMW PAHs. Nineteen constituents or summed totals were detected at maximum concentrations greater than the available sediment screening value and were retained as preliminary COPECs. No sediment screening value is available for six of the PAHs; therefore these constituents were also retained as preliminary COPECs.

Nineteen individual PAHs or summed totals are considered to be bioaccumulative compounds (USEPA, 2000). Nine were detected at maximum concentrations that exceed their respective PCL sediment screening values and were selected as preliminary COPECs.

Polychlorinated Biphenyls (PCBs)

Total PCBs (sum of Aroclor mixtures) and eight Aroclor mixtures were analyzed in Passaic River sediment samples. All PCBs are considered to be bioaccumulative compounds and were consequently evaluated by comparing maximum concentrations to the conservative wildlife-based PCLs. Four Aroclor mixtures were reported as non-detected (Table 4). The maximum concentrations of Total PCBs and

Aroclor mixtures 1242, 1248, 1254, and 1260 exceed their respective sediment screening values and were retained as preliminary COPECs.

Pesticides/Herbicides

Passaic River sediments were analyzed for 32 individual pesticides and herbicides, and total chlordane, total endosulfan, total endrin, total BHC, and total DDT (sum of six DDT isomers). Screening levels were not available for six of these compounds, including the four herbicides. Fourteen additional individual compounds and summed totals exceeded screening values and were retained as preliminary COPECs.

Dioxins/Furans

For dioxins, 2,3,7,8-TCDD was selected as an indicator for screening PCDDs, PCDFs, and coplanar PCBs for the purpose of this assessment. 2,3,7,8-TCDD was detected in almost all the samples (detection frequency of 99.6%). Dioxin/furan compounds are considered to be bioaccumulative compounds (USEPA, 2000). The maximum concentration substantially exceeds the PCL screening value (HQ=7,800) and TCDD was retained as a preliminary COPEC.

REFINEMENT AND IDENTIFICATION OF COPECS

A conservative screening evaluation was used to develop a list of preliminary COPECs. These compounds were screened based on their maximum concentration and using conservative screening values such as the NOAA ER-Ls. Further refinement of this list of COPECs was conducted to identify those chemicals that provide the best basis for making sediment management decisions in the FFS. Although a category of preliminary COPECs was identified based on the unavailability of sediment screening benchmarks, these are not considered to be likely risk drivers that would provide the primary rationale for a possible early action at the LPRRP site. This is supported by the following arguments:

- Protective screening benchmarks were established for all detected sediment constituents considered to pose a bioaccumulation hazard to wildlife; as a result these risk uncertainties are limited to macroinvertebrate receptors. While lower trophic levels provide important ecosystem functions such as providing a prey base and in cycling nutrients, they are generally not considered to have the same societal relevance as do fish and wildlife species.

- The lack of readily available benchmarks suggests that in at least some cases the particular constituent is not typically bioavailable and/or toxic at environmental concentrations.

- It is unlikely that the potential ecological hazards attributable to constituents that lack screening benchmarks would be of a comparable magnitude to those definitively identified as a result of this screening process. Given the advancements in scientific understanding of ecotoxicological principles made during the last four decades, it is reasonable to conclude that a list of COPCs that include some of the most toxic components of all major chemical classes should provide an adequate basis for proceeding to characterize substantive environmental risks and to facilitate decision making.

Table 4 provides a summary of preliminary COPECs that were identified as non-detect and/or lack of available screening values. It is recommended that these compounds not be considered further in the FFS due to the uncertainty associated with these values.

Table 4. Preliminary COPECs Reported as Non-Detect or Lacking Established Sediment Screening Values

Chemical	Units	Maximum Concentration[a]	Qualifier[b]	Number Samples	Detection Frequency	Non Detect[c]	No Benchmark[d]
Inorganics							
Aluminum	ng/g	2.4E+07	M	320	100%		√
Ammonia	ng/g	2.9E+06		77	97%		√
Antimony	ng/g	3.8E+04		301	38%		√
Barium	ng/g	1.3E+06		315	99%		√
Beryllium	ng/g	3.1E+03		318	69%		√
Calcium	ng/g	3.7E+07	M	320	100%		√
Cobalt	ng/g	4.1E+04		318	93%		√
Cyanide	ng/g	2.7E+05		220	16%		√
Iron	ng/g	4.8E+07		320	100%		√
Magnesium	ng/g	9.8E+06	M	320	100%		√
Manganese	ng/g	8.6E+05	M	315	100%		√
Potassium	ng/g	5.9E+06	NJH	277	99%		√
Sodium	ng/g	1.4E+07	M	320	100%		√
Thallium	ng/g	4.9E+03	M	304	50%		√
Titanium	ng/g	7.4E+05	N*JL	134	100%		√
Vanadium	ng/g	9.9E+04	M	318	100%		√
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	ng/g	3.1E+00	U	1	0%	√	√
1,1,1-Trichloroethane	ng/g	6.6E+01	U	162	0%	√	√
1,1,2,2-Tetrachloroethane	ng/g	6.6E+01	U	162	0%	√	√
1,1,2-trichloro-1,2,2-trifluoroethane	ng/g	6.6E+01	U	25	0%	√	√
1,1,2-Trichloroethane	ng/g	6.6E+01	U	162	0%	√	√
1,1-Dichloroethane	ng/g	6.6E+01	U	162	0%	√	√
1,1-Dichloroethane	ng/g	6.6E+01	U	162	0%	√	√
1,1-Dichloroethene	ng/g	6.6E+01	U	162	0%	√	√
1,1-Dichloropropene	ng/g	3.3E+00	U	1	0%	√	√
1,2,3-Trichloropropane	ng/g	5.6E+00	U	1	0%	√	√
1,2-Dibromo-3-chloropropane	ng/g	6.6E+01	U	26	0%	√	√
1,2-Dibromoethane	ng/g	6.6E+01	U	26	0%	√	√
1,2-Dichloroethylene	ng/g	3.8E+01	U, UJL	136	2%		√
1,2-Dichloropropane	ng/g	6.6E+01	U	162	0%	√	√
1,3-Dichloropropane	ng/g	5.6E+00	U	1	0%	√	√
2,2-Dichloropropane	ng/g	1.1E+01	U	1	0%	√	√
2-Hexanone	ng/g	6.6E+01	U	161	0%	√	√
4-Chloro-3-Methylphenol	ng/g	1.2E+04	UM	219	0%	√	√
4-Chlorotoluene	ng/g	2.5E+00	U	1	0%	√	√
4-Methyl-2-Pentanone	ng/g	6.6E+01	U	161	0%	√	√
Acetone	ng/g	4.3E+02	M	161	64%		√
Acetophenone	ng/g	4.2E+02	U	10	20%		√
Bromochloromethane	ng/g	4.6E+00	U	1	0%	√	√
Bromoform	ng/g	6.6E+01	U	162	0%	√	√
Carbon Disulfide	ng/g	6.6E+01	U	161	1%		√
Carbon Tetrachloride	ng/g	6.6E+01	U	162	0%	√	√
Chlorobenzene	ng/g	1.4E+03		162	15%		√
Chlorodibromomethane	ng/g	6.6E+01	U	162	0%	√	√
Chloroethane	ng/g	6.6E+01	U	162	0%	√	√
Chloroform	ng/g	6.6E+01	U	162	0%	√	√
Cis-1,2-Dichloroethylene	ng/g	6.6E+01	U	26	0%	√	√

Chemical	Units	Maximum Concentration[a]	Qualifier[b]	Number Samples	Detection Frequency	Non Detect[c]	No Benchmark[d]
cis-1,3-Dichloropropene	ng/g	6.6E+01	U	162	0%	√	√
Cyclohexane	ng/g	6.6E+01	U	25	0%	√	√
Dichlorobromomethane	ng/g	6.6E+01	U	162	0%	√	√
Dichlorodifluoromethane	ng/g	6.6E+01	U	26	0%	√	√
Isopropylbenzene	ng/g	6.6E+01	U	26	12%		√
Methyl acetate	ng/g	6.6E+01	U	25	0%	√	√
Methyl Bromide	ng/g	6.6E+01	U	162	1%		√
Methyl Chloride	ng/g	6.6E+01	U	162	7%		√
Methyl cyclohexane	ng/g	6.6E+01	U	25	4%		√
Methyl Ethyl Ketone	ng/g	8.3E+01	JL	161	18%		√
Methylene Bromide	ng/g	6.2E+00	U	1	0%	√	√
Methylene Chloride	ng/g	6.6E+01	U	162	6%		√
Methyl-t-Butyl Ether	ng/g	6.6E+01	U	25	0%	√	√
n-Butylbenzene	ng/g	8.7E+00		1	100%		√
n-Propylbenzene	ng/g	7.7E+00		1	100%		√
p-Isopropyltoluene	ng/g	3.7E+00		1	100%		√
Styrene	ng/g	6.6E+01	U	162	0%	√	√
Tetrachloroethylene	ng/g	6.6E+01	U	162	0%	√	
Total BTEX	ng/g	2.8E+03		22	100%		√
Total xylenes	ng/g	6.6E+01	U	15	0%	√	
Trans-1,2-Dichloroethylene	ng/g	6.6E+01	U	26	0%	√	√
Trans-1,3-dichloropropene	ng/g	6.6E+01	U	162	0%	√	√
Trichlorofluoromethane	ng/g	6.6E+01	U	26	0%	√	√
Vinyl Chloride	ng/g	6.6E+01	U	162	0%	√	√
Semi-Volatile Organic Compounds (Non PAHs)							
1,2,3-Trichlorobenzene	ng/g	5.0E+00	U	1	0%	√	
1,2,4,5-Tetrachlorobenzene	ng/g	4.2E+02	U	10	0%	√	
1,2,4-Trimethylbenzene	ng/g	7.1E+00		1	100%		√
1,3,5-Trimethylbenzene	ng/g	1.9E+01		1	100%		√
1,4-Dioxane	ng/g	4.0E+02	U	10	10%		√
1-Chloropropane	ng/g	1.2E+04	UM	219	0%	√	√
2,4,5-Trichlorophenol	ng/g	1.2E+04	U, UM	219	2%		√
2,4,6-Trichlorophenol	ng/g	1.2E+04	UM	219	0%		√
2,4-Dichlorophenol	ng/g	1.2E+04	UM	219	4%		√
2,4-Dimethylphenol	ng/g	1.2E+04	UM	219	0%	√	√
2,4-Dinitrophenol	ng/g	7.1E+04	UM	219	0%	√	√
2,4-Dinitrotoluene	ng/g	1.2E+04	UM	219	0%	√	√
2,6-Dinitrotoluene	ng/g	1.2E+04	UM	219	0%	√	√
2-Chloronaphthalene	ng/g	1.2E+04	UM	219	0%	√	√
2-Chlorophenol	ng/g	1.2E+04	UM	219	0%		√
2-Methylphenol	ng/g	1.2E+04	UM	219	0%		√
2-Nitroanaline	ng/g	1.2E+04	U, UM	219	0%	√	√
2-Nitrophenol	ng/g	1.2E+04	UM	219	0%	√	√
3,3'-Dichlorobenzidine	ng/g	2.4E+04	UM	218	0%		√
3-Nitroaniline	ng/g	1.2E+04	UJ, UM	218	0%	√	√
4,6-Dinitro-2-Methylphenol	ng/g	3.0E+04	UM	219	0%	√	√
4-Bromophenyl Phenyl Ether	ng/g	1.2E+04	UM	219	0%	√	
4-Chloroaniline	ng/g	1.2E+04	UM	219	3%		√
4-Chlorophenyl Phenyl Ether	ng/g	1.2E+04	UM	219	0%	√	
4-Methylphenol	ng/g	1.2E+04	UM	219	2%		√
4-Nitroaniline	ng/g	1.2E+04	U, UM	219	0%	√	√
4-Nitrophenol	ng/g	3.0E+04	UM	219	0%		√
Bis(2-Chloroethoxy)methane	ng/g	1.2E+04	UM	219	0%	√	√
Bis(2-Chloroethyl)ether	ng/g	1.2E+04	UM	219	0%	√	√

Chemical	Units	Maximum Concentration[a]	Qualifier[b]	Number Samples	Detection Frequency	Non Detect[c]	No Benchmark[d]
Bis(2-Ethylhexyl)phthalate	ng/g	2.3E+07	DM	220	97%		√
Bromobenzene	ng/g	3.3E+00	U	1	0%	√	√
Butyl Benzyl Phthalate	ng/g	3.6E+05	J	219	45%		√
Carbazole	ng/g	1.2E+04	UM	219	34%		√
Dibenzofuran	ng/g	7.0E+04		219	22%		√
Dibenzothiophene	ng/g	1.4E+03		103	97%		√
Dibutyltin	ng/g	2.1E+02	M	74	99%		√
Diethyl Phthalate	ng/g	4.5E+04		219	1%		√
Dimethylphthalate	ng/g	1.2E+04	UM	219	1%		√
Di-n-butyl Phthalate	ng/g	1.2E+04	UM	219	15%		√
Di-n-Octyl Phthalate	ng/g	1.2E+04	UM	219	47%		√
Hexachlorobutadiene	ng/g	1.2E+04	UM	220	0%	√	
Hexachlorocyclopentadiene	ng/g	2.4E+04	UM	219	0%	√	√
Hexachloroethane	ng/g	1.2E+04	UM	219	0%	√	√
Isophorone	ng/g	1.2E+04	UM	219	0%	√	√
Monobutyltin	ng/g	2.8E+01	JL	74	57%		√
Nitrobenzene	ng/g	1.2E+04	UM	219	0%	√	√
N-Nitroso-di-phenylamine	ng/g	1.2E+04	UM	219	9%		√
N-nitrosodipropylamine	ng/g	1.2E+04	UJ	219	0%	√	√
Pentachlorophenol	ng/g	3.0E+04	UM	219	0%	√	
Phenol	ng/g	1.2E+04	UM	219	1%		√
Tetrabutyltin	ng/g	1.6E+00	M	74	15%		√
Semi-Volatile Organic Compounds (PAHs)							
1-Methylnaphthalene	ng/g	9.1E+02	M	84	89%		√
1-Methylphenanthrene	ng/g	3.0E+03		103	98%		√
2,3,5-Trimethylnaphthalene	ng/g	2.1E+03		103	92%		√
2,6-Dimethylnaphthalene	ng/g	1.8E+03		103	93%		√
Benzo[b/j]fluoranthene	ng/g	8.4E+03		19	100%		√
Benzo[b]fluoranthene	ng/g	1.0E+05		294	96%		√
Benzo[e]pyrene	ng/g	8.3E+03	NJ	103	100%		√
Benzo[g,h,i]perylene	ng/g	6.3E+04		313	82%		√
Benzo[k]fluoranthene	ng/g	6.3E+04		313	95%		√
Biphenyl	ng/g	4.2E+02	U	84	88%		√
Indeno[1,2,3-c,d]-pyrene	ng/g	5.7E+04		312	83%		√
Perylene	ng/g	2.6E+03		103	99%		√
PCB Aroclors							
Aroclor 1016	ng/g	9.7E+02	UJ	229	0%	√	
Aroclor 1221	ng/g	1.4E+03	UM	229	0%	√	
Aroclor 1232	ng/g	9.7E+02	UJ	229	0%	√	
Aroclor-1262	ng/g	8.2E+00	U	10	0%	√	
Pesticide/Herbicides							
2,4,5-T	ng/g	4.1E+02	U	167	0%	√	√
2,4,5-TP	ng/g	4.1E+02	U	177	6%		√
2,4-D	ng/g	1.0E+03	U	166	0%	√	√
2,4-DB	ng/g	6.9E+02	UM	166	11%		√
Toxaphene	ng/g	3.4E+03	UM	231	0%	√	

Notes:
a. Obtained from query of PREmis database; units in ng/g (ppb).
b. Data qualifiers from PREmis database; metadata not available.
c. Symbol indicates that the chemical parameter was not detected in the evaluated dataset.
d. Symbol indicates that no benchmark was identified for the particular chemical parameter.

As previously stated, future risk assessment activities will include a literature review to identify appropriate screening values for chemicals currently lacking screening values as well as a data usability assessment. Although not considered as part of the FFS, these compounds will be evaluated further in the baseline risk assessment activities.

The refinement step also considers the magnitude of exceedances. The magnitude of exceedances was assessed using a hazard quotient methodology. Table 5 provides a summary of the magnitude HQ of exceedances. The magnitudes of exceedances were categorized in relationship to the chemical-specific HQ. Exceedances were categorized in a range from 1 to 1,000 times the HQ and are summarized in Table 5.

Table 5. Summary of FFS COPECs and Magnitude of Hazard Quotient Exceedances

Chemical[a]	Units	Maximum Concentration	Qualifier[b]	Number Samples	Detection Frequency	Sediment Benchmarks		Hazard Quotient		Hazard Quotient Exceedance Category[c]					
						Aquatic	Wildlife	Aquatic	Wildlife	1	10	50	100	500	1000
Inorganics															
Arsenic	ng/g	1.08E+05		309	98%	8.2E+03	1.7E+05	1.3E+01	6.2E-01	√	√				
Cadmium	ng/g	2.53E+04		321	98%	1.2E+03	3.0E+03	2.1E+01	8.5E+00	√	√				
Chromium	ng/g	6.70E+05		318	100%	8.1E+04	4.1E+04	8.3E+00	1.6E+01	√	√				
Copper	ng/g	2.47E+06		321	100%	3.4E+04	1.3E+04	7.3E+01	1.9E+02	√	√	√	√		
Lead	ng/g	1.55E+06		316	100%	4.7E+04	1.1E+04	3.3E+01	1.5E+02	√	√	√	√		
Mercury	ng/g	1.07E+04	M	260	97%	1.5E+02	3.7E+01	7.1E+01	2.9E+02	√	√	√	√		
Nickel	ng/g	3.69E+05		303	100%	2.1E+04	2.2E+04	1.8E+01	1.7E+01	√	√				
Selenium	ng/g	7.40E+03	U	245	44%		9.2E+02		8.0E+00	√					
Silver	ng/g	3.95E+04		245	88%	1.0E+03	1.3E+06	4.0E+01	3.0E-02	√	√				
Zinc	ng/g	1.62E+06		313	100%	1.5E+05	4.7E+04	1.1E+01	3.5E+01	√	√				
Volatile Organic Compounds															
Toluene	ng/g	2.80E+03	DJL	162	10%	2.5E+03	-	1.1E+00		√					
Semi-Volatile Organic Compounds (Non-PAHs)															
Tributyltin	ng/g	6.90E+02	IM	74	93%	2.5E+01	3.6E+03	2.8E+01	1.9E-01	√	√				
Semi-Volatile Organic Compounds (PAHs)															
2-Methylnaphthalene	ng/g	2.40E+04	M	312	49%	7.0E+01	-	3.4E+02		√	√	√	√		
Acenaphthene	ng/g	4.20E+05		312	58%	1.6E+01	-	2.6E+04		√	√	√	√	√	√
Acenaphthylene	ng/g	1.20E+04	UM	312	62%	4.4E+01	-	2.7E+02		√	√	√	√		
Anthracene	ng/g	2.30E+05	D	312	78%	8.5E+01	-	2.7E+03		√	√	√	√	√	√
Benzo[a]anthracene	ng/g	1.50E+05		313	95%	2.6E+02	-	5.7E+02		√	√	√	√	√	
Benzo[a]pyrene	ng/g	1.30E+05		313	97%	4.3E+02	-	3.0E+02		√	√	√	√		
Chrysene	ng/g	1.50E+05		313	99%	3.8E+02	-	3.9E+02		√	√	√	√		
Dibenz[a,h]anthracene	ng/g	2.50E+04		312	70%	6.3E+01	-	4.0E+02		√	√	√	√		
Fluoranthene	ng/g	3.20E+05	D	313	99%	6.0E+02	-	5.3E+02		√	√	√	√	√	
Fluorene	ng/g	1.40E+05		312	59%	1.9E+01	-	7.4E+03		√	√	√	√	√	√
Naphthalene	ng/g	4.00E+04	D	313	51%	1.6E+02	-	2.5E+02		√	√	√	√		
Phenanthrene	ng/g	5.70E+05	D	313	91%	2.4E+02	-	2.4E+03		√	√	√	√	√	√
Pyrene	ng/g	3.40E+05	D	313	99%	6.7E+02	-	5.1E+02		√	√	√	√	√	
SUM_HIGH_PAH	ng/g	1.40E+06		239	0%	5.5E+02	-	2.5E+03		√	√	√	√	√	√
SUM_LOW_PAH	ng/g	1.41E+06		240	0%	1.7E+03	-	8.3E+02		√	√	√	√	√	
SUM_PAH	ng/g	2.81E+06		240	0%	4.0E+03	-	7.0E+02		√	√	√	√	√	
PCB Aroclors															
Aroclor 1242	ng/g	1.72E+04	D	229	1%		3.7E+02		4.7E+01	√	√				
Aroclor 1248	ng/g	7.45E+03	DM	235	72%		3.7E+02		2.0E+01	√	√				
Aroclor 1254	ng/g	5.80E+03		231	65%		3.7E+02		1.6E+01	√	√				
Aroclor 1260	ng/g	2.16E+03	DM	228	38%		3.7E+02		5.9E+00	√					
SUM_PCB AROCLORS	ng/g	1.75E+04		236	0%	2.3E+01	3.7E+02	7.7E+02	4.8E+01	√	√	√	√	√	
Pesticide/Herbicides															
2,4-DDD	ng/g	6.87E+02	T	22	95%	2.0E+00	8.3E+02	3.4E+02	8.3E-01	√	√	√	√		
2,4-DDE	ng/g	3.03E+02		22	100%	2.2E+00	1.9E+01	1.4E+02	1.6E+01	√	√	√	√		
2,4-DDT	ng/g	1.45E+02	T	22	95%	1.0E+00	1.4E+02	1.5E+02	1.0E+00	√	√	√	√		
4,4'-DDD	ng/g	5.98E+03	DM	236	91%	2.0E+00	8.3E+02	3.0E+03	7.2E+00	√	√	√	√	√	√
4,4'-DDE	ng/g	1.01E+03		237	91%	2.2E+00	1.9E+01	4.6E+02	5.3E+01	√	√	√	√		
4,4'-DDT	ng/g	2.47E+03	DM	234	75%	1.0E+00	1.4E+02	2.5E+03	1.8E+01	√	√	√	√	√	√
SUM_TDDT	ng/g	5.99E+03		248	0%	1.6E+00	1.9E+01	3.8E+03	3.1E+02	√	√	√	√	√	√
Aldrin	ng/g	6.60E+02		236	7%		4.6E+02		1.4E+00	√					
BHC-beta	ng/g	2.00E+03		227	3%		1.2E+03		1.6E+00	√					
SUM_BHC	ng/g	2.01E+03		233	0%		1.2E+03		1.6E+00	√					
Dieldrin	ng/g	1.41E+02	PDJ	236	46%	2.0E-02	2.7E+02	7.1E+03	5.2E-01	√	√	√	√	√	√

Table 5. Summary of FFS COPECs and Magnitude of Hazard Quotient Exceedances (continued)

Chemical[a]	Units	Maximum Concentration	Qualifier[b]	Number Samples	Detection Frequency	Sediment Benchmarks		Hazard Quotient		Hazard Quotient Exceedance Category[e]					
						Aquatic	Wildlife	Aquatic	Wildlife	1	10	50	100	500	1000
Endrin aldehyde	ng/g	6.70E+01		227	7%		3.5E+01		1.9E+00	√					
Endrin ketone	ng/g	2.36E+03	D	229	27%		3.5E+01		6.7E+01	√	√	√			
SUM_ENDRIN	ng/g	2.37E+03		233	0%		3.5E+01		6.7E+01	√	√	√			
Dioxin/Furans															
2,3,7,8-TCDD	ng/g	1.94E+01	BD	230	100%	3.2E-03	2.5E-03	6.1E+03	7.8E+03	√	√	√	√	√	√

Notes:
a. Detected chemicals with maximum concentration exceeding the selected sediment benchmark; units in ng/g (ppb).
b. Data qualifiers from PREmis database; metadata not available.
c. Derivation of sediment benchmarks described in the text.
d. Sediment benchmarks were selected as the lowest of the NOAA Effects Range-Low, the NJDEP sediment screening guidelines, and the estimated wildlife PCL values.
e. Checks indicate that the Hazard Quotient exceeds the indicated HQ exceedance category.

Inorganic Constituents

No sediment screening values were available for 16 inorganic analytes (including the four essential nutrients); it is recommended that these not be retained as COPECs for the FFS. Hazard quotients for the remaining 10 inorganic analytes exceed 1 (Table 5) and are retained for further consideration as COPECs. The highest magnitude of exceedances were associated with copper (HQ=190), lead (HQ = 150, and mercury (HQ = 290).

Volatile Organic Compounds (VOCs)

Sediment screening values were only available for eight VOC compounds. The majority of VOCs were reported as non-detect and lack sediment screening benchmarks (Table 4). Because VOCs have a propensity for rapid dispersion and degradation in environmental media (*e.g.*, surface water, sediment, surface soil, and biota), it is unlikely that these compounds are risk drivers for ecological receptors. Only the HQ for toluene (i.e., 1.1) exceeds 1 and only slightly (Table 5).

Semivolatile Organic Compounds (SVOCs) Excluding PAHs

A total of 31 SVOCs were detected but only the maximum concentration of tributyltin exceeds the screening value (HQ=28) (Table 5). The remaining compounds were either reported as non-detect and/or lacked an available screening value.

Polycyclic Aromatic Hydrocarbons (PAHs)

Thirteen individual PAH compounds, HMW PAHs, LMW PAHs, and total PAHs are recommended for further consideration as potential COPECs (Table 5). The magnitude of exceedances for these compounds range from 250 (naphthalene) to 26,000 (acenaphthene).

Polychlorinated Biphenyls (PCBs)

Maximum concentrations of four Aroclor mixtures and total PCB exceed the established screening levels (Table 5). The highest HQs are associated with total PCBs (HQ=770) and Aroclor 1242 (HQ=47).

Pesticides/Herbicides

Fourteen pesticide compounds or their summed totals were retained for further consideration as COPECs. The maximum concentrations of total DDTs (HQ=3,800), 4,4'DDD (HQ=3,000) and dieldrin (HQ= 7,100) exceed the screening values by the greatest degree (Table 5).

Dioxins/Furans

As stated previously, 2,3,7,8-TCDD was selected as an indicator for screening individual PCDDs, PCDFs, and coplanar PCBs for the purpose of this assessment. 2,3,7,8-TCDD was retained for further consideration as a COPEC with an HQ of 7,800 based on the maximum detected concentration (Table 5).

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Attachment A
Analytical Data Summary Used in Ecological Screening

Lower Passaic River Restoration Project
Focused Feasibility Study

CASRN	Chemical	Units	Database Query Results[a] Min Value	Qualifier[b]	Max Value	Qualifier[b]	Min MDL[c]	Max MDL	Number of Samples	Number of Detected Results	NOAA ER-L[d]	NJDEP Benchmark[e]	USEPA[f] List Bioaccumulators	Wildlife Based PCL[g]	Hazard Quotient[h] Aquatic	Wildlife	Basis[i]
Inorganics																	
7429-90-5	Aluminum	ng/g	36.7		23,700,000.	M	20,000.	20,000.	320.	320.	-	-	N				
7664-41-7	Ammonia	ng/g	81,000.	G	2,880,000.		190,000.	830,000.	77.	75.			N				
7440-36-0	Antimony	ng/g	0.0017	GJL	38,000.		0.003	21,900.	301.	114.	-		N				
7440-38-2	Arsenic	ng/g	0.0085		108,000.		1,000.	12,300.	309.	303.	8200	8200	Y	1.7E+05	1.3E+01	6.2E-01	NOAA ER-L
7440-39-3	Barium	ng/g	0.191		1,280,000.		10,000.	41,400.	315.	312.	-	-	N				
7440-41-7	Beryllium	ng/g	0.0134	G	3,100.		260.	1,800.	318.	218.	-	-	N				
7440-43-9	Cadmium	ng/g	0.00576	G	25,300.		550.	1,000.	321.	316.	1200	1200	Y	3.0E+03	2.1E+01	8.5E+00	NOAA ER-L
7440-70-2	Calcium	ng/g	58.8		36,500,000.	M	500,000.	549,000.	320.	319.	-	-	N				
7440-47-3	Chromium	ng/g	0.331		670,000.		2,000.	2,000.	318.	318.	81000	81000	Y	4.1E+04	8.3E+00	1.6E+01	Wildlife PCL
7440-48-4	Cobalt	ng/g	0.0192	GJ	41,100.		1,000.	18,300.	318.	296.	-	-	N				
7440-50-8	Copper	ng/g	0.0123		2,470,000.		2,000.	2,000.	321.	321.	34000	34000	Y	1.3E+04	7.3E+01	1.9E+02	Wildlife PCL
57-12-5	Cyanide	ng/g	170.	NUJL	269,000.		170.	2,500.	220.	35.	-	-	N				
7439-89-6	Iron	ng/g	47.1		47,500,000.		10,000.	10,000.	320.	320.	-	-	N				
7439-92-1	Lead	ng/g	0.3		1,550,000.		1,000.	1,000.	316.	316.	46700	47000	Y	1.1E+04	3.3E+01	1.5E+02	Wildlife PCL
7439-95-4	Magnesium	ng/g	51.2		9,820,000.	M	500,000.	500,000.	320.	320.	-	-	N				
7439-96-5	Manganese	ng/g	1.29		861,000.	M	1,000.	1,000.	315.	315.	-	-	N				
7439-97-6	Mercury	ng/g	0.00005		10,700.	M	0.00017	120.	260.	251.	150	150	Y	3.7E+01	7.1E+01	2.9E+02	Wildlife PCL
7440-02-0	Nickel	ng/g	0.068	J	369,000.		1,000.	1,000.	303.	303.	20900	21000	Y	2.2E+04	1.8E+01	1.7E+01	NOAA ER-L
7440-09-7	Potassium	ng/g	6.11		5,860,000.	NJH	500,000.	1,110,000.	277.	274.	-		N				
7782-49-2	Selenium	ng/g	0.0039		7,400.	U	0.0046	7,400.	245.	107.	-	-	Y	9.2E+02		8.0E+00	Wildlife PCL
7440-22-4	Silver	ng/g	0.0019		39,500.		0.0068	3,700.	245.	215.	1000	1000	Y	1.3E+06	4.0E-01	3.0E-02	NOAA ER-L
7440-23-5	Sodium	ng/g	28.6	J	13,900,000.	M	500,000.	563,000.	320.	319.	-		N				
7440-28-0	Thallium	ng/g	0.0017	G	4,900.	M	0.0044	3,200.	304.	152.	-	-	N				
7440-32-6	Titanium	ng/g	141,000.	NJH	735,000.	N*JL	100,000.	100,000.	134.	134.	-	-	N				
7440-62-2	Vanadium	ng/g	0.079		98,800.	M	1,000.	1,000.	318.	318.	-	-	N				
7440-66-6	Zinc	ng/g	1.27		1,620,000.		2,000.	2,000.	313.	313.	150000	150000	Y	4.7E+04	1.1E+01	3.5E+01	Wildlife PCL
Volatile Organic Compounds																	
630-20-6	1,1,1,2-Tetrachloroethane	ng/g	3.1	U	3.1	U	3.1	3.1	1.	0.			N				
71-55-6	1,1,1-Trichloroethane	ng/g	5.	U	66.	U	5.	66.	162.	0.	-	-	N				
79-34-5	1,1,2,2-Tetrachloroethane	ng/g	10.	U	66.	U	10.	66.	162.	0.	-	-	N				
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethan	ng/g	11.	U	66.	U	11.	66.	25.	0.			N				
79-00-5	1,1,2-Trichloroethane	ng/g	7.7	U	66.	U	7.7	66.	162.	0.	-		N				
107-06-2	1,2-Dichloroethane	ng/g	6.4	U	66.	U	6.4	66.	162.	0.	-		N				
75-34-3	1,1-Dichloroethane	ng/g	2.9	U	66.	U	2.9	66.	162.	0.			N				
75-35-4	1,1-Dichloroethene	ng/g	3.5	U	66.	U	3.5	66.	162.	0.	-	-	N				
563-58-6	1,1-Dichloropropene	ng/g	3.3	U	3.3	U	3.3	3.3	1.	0.			N				
96-18-4	1,2,3-Trichloropropane	ng/g	5.6	U	5.6	U	5.6	5.6	1.	0.			N				
96-12-8	1,2-Dibromo-3-chloropropane	ng/g	7.3	U	66.	U	7.3	66.	26.	0.			N				
106-93-4	1,2-Dibromoethane	ng/g	7.7	U	66.	U	7.7	66.	26.	0.			N				
540-59-0	1,2-Dichloroethylene	ng/g	7.		38.	U, UJL	12.	38.	136.	3.	-	-	N				
78-87-5	1,2-Dichloropropane	ng/g	3.7	U	66.	U	3.7	66.	162.	0.	-	-	N				
142-28-9	1,3-Dichloropropane	ng/g	5.6	U	5.6	U	5.6	5.6	1.	0.			N				
594-20-7	2,2-Dichloropropane	ng/g	11.	U	11.	U	11.	11.	1.	0.			N				
591-78-6	2-Hexanone	ng/g	12.	U	66.	U	12.	66.	161.	0.	-	-	N				
59-50-7	4-Chloro-3-Methylphenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	0.			N				
106-43-4	4-Chlorotoluene	ng/g	2.5	U	2.5	U	2.5	2.5	1.	0.			N				
108-10-1	4-Methyl-2-Pentanone	ng/g	12.	U	66.	U	12.	66.	161.	0.			N				
67-64-1	Acetone	ng/g	8.		430.	M	12.	240.	161.	103.	-	-	N				
98-86-2	Acetophenone	ng/g	82.	J	420.	U	290.	420.	10.	2.			N				
71-43-2	Benzene	ng/g	7.	J	300.	M	8.	91.	162.	8.	-	340 1	N		8.8E-01		NJ Benchmark
74-97-5	Bromochloromethane	ng/g	4.6	U	4.6	U	4.6	4.6	1.	0.			N				
75-25-2	Bromoform	ng/g	6.8	U	66.	U	6.8	66.	162.	0.	-	-	N				
75-15-0	Carbon Disulfide	ng/g	6.	J	66.	U	6.	66.	161.	2.			N				
56-23-5	Carbon Tetrachloride	ng/g	4.6	U	66.	U	4.6	66.	162.	0.	-	-	N				
108-90-7	Chlorobenzene	ng/g	2.9	U	1,400.		2.9	66.	162.	25.	-	-	N				

CASRN	Chemical	Units	Database Query Results[a]: Min Value	Qualifier[b]	Max Value	Qualifier[b]	Min MDL[c]	Max MDL	Number of Samples	Number of Detected Results	NOAA ER-L[d]	NJDEP Benchmark[e]		USEPA[f] List Bioaccumulators	Wildlife Based PCL[g]	Hazard Quotient[h]: Aquatic	Wildlife	Basis[i]
124-48-1	Chlorodibromomethane	ng/g	4.8	U	66.	U	4.8	66.	162.	0.	-	-		N				
75-00-3	Chloroethane	ng/g	4.1	U	66.	U	4.1	66.	162.	0.	-	-		N				
67-66-3	Chloroform	ng/g	3.3	U	66.	U	3.3	66.	162.	0.	-	-		N				
156-59-2	Cis-1,2-Dichloroethylene	ng/g	3.3	U	66.	U	3.3	66.	26.	0.				N				
1006-10-15	cis-1,3-Dichloropropene	ng/g	5.2	U	66.	U	5.2	66.	162.	0.	-	-		N				
110-82-7	Cyclohexane	ng/g	11.	U	66.	U	11.	66.	25.	0.				N				
75-27-4	Dichlorobromomethane	ng/g	4.1	U	66.	U	4.1	66.	162.	0.	-	-		N				
75-71-8	Dichlorodifluoromethane	ng/g	11.	U	66.	U	11.	66.	26.	0.	-			N				
100-41-4	Ethylbenzene	ng/g	4.	J	240.	JL	4.	66.	162.	7.	-	1400	1	N		1.7E-01		NJ Benchmark
98-82-8	Isopropylbenzene	ng/g	2.	J	66.	U	2.	66.	26.	3.				N				
M&PXYLENE	m&p-Xylene	ng/g	38.		38.				1.	1.		120	1	N		3.2E-01		NJ Benchmark
79-20-9	Methyl acetate	ng/g	11.	U	66.	U	11.	66.	25.	0.				N				
74-83-9	Methyl Bromide	ng/g	5.6	U	66.	U	5.6	66.	162.	1.				N				
74-87-3	Methyl Chloride	ng/g	3.		66.	U	4.4	66.	162.	11.	-	-		N				
108-87-2	Methyl cyclohexane	ng/g	10.	J	66.	U	10.	66.	25.	1.				N				
78-93-3	Methyl Ethyl Ketone	ng/g	9.		83.	JL	12.	70.	161.	29.	-	-		N				
74-95-3	Methylene Bromide	ng/g	6.2	U	6.2	U	6.2	6.2	1.	0.	-	-		N				
75-09-2	Methylene Chloride	ng/g	7.7		66.	U	5.	66.	162.	10.	-	-		N				
1634-04-4	Methyl-t-Butyl Ether	ng/g	11.	U	66.	U	11.	66.	25.	0.				N				
104-51-8	n-Butylbenzene	ng/g	8.7		8.7				1.	1.				N				
103-65-1	n-Propylbenzene	ng/g	7.7		7.7				1.	1.				N				
95-47-6	O-Xylene	ng/g	13.	U	23.		13.	23.	11.	3.		120	1	N		1.9E-01		NJ Benchmark
99-87-6	p-Isopropyltoluene	ng/g	3.7		3.7				1.	1.				N				
100-42-5	Styrene	ng/g	2.9	U	66.	U	2.9	66.	162.	0.	-	-		N				
127-18-4	Tetrachloroethylene	ng/g	3.1	U	66.	U	3.1	66.	162.	0.	-	450	1	N		1.5E-01		NJ Benchmark
108-88-3	Toluene	ng/g	3.		2,800.	DJL	12.	72.	162.	17.		2500	1	N		1.1E+00		NJ Benchmark
BTEX	Total BTEX	ng/g	5.		2,800.				22.	22.	-	-		N				
1330-20-7	total xylenes	ng/g	40.	U	66.	U	40.	66.	15.	0.	-	120	1	N		5.5E-01		NJ Benchmark
156-60-5	Trans-1,2-Dichloroethylene	ng/g	3.7	U	66.	U	3.7	66.	26.	0.				N				
10061-02-6	Trans-1,3-dichloropropene	ng/g	7.5	U	66.	U	7.5	66.	162.	0.	-	-		N				
79-01-6	Trichloroethylene	ng/g	4.6	U	66.	U	3.	66.	162.	1.	-	1600	1	N		4.1E-02		NJ Benchmark
75-69-4	Trichlorofluoromethane	ng/g	2.3	U	66.	U	2.3	66.	26.	0.	-			N				
75-01-4	Vinyl Chloride	ng/g	2.9	U	66.	U	2.9	66.	162.	0.	-	-		N				
Semi-Volatile Organic Compounds (Non PAHs)																		
87-61-6	1,2,3-Trichlorobenzene	ng/g	5.	U	5.	U	5.	5.	1.	0.				N	3.8E+06		1.3E-06	Wildlife PCL
95-94-3	1,2,4,5-Tetrachlorobenzene	ng/g	290.	U	420.	U	290.	420.	10.	0.				N	1.3E+04		3.2E-02	Wildlife PCL
120-82-1	1,2,4-Trichlorobenzene	ng/g	3.9	U	12,000.	UM	3.	12,000.	235.	11.	-	-		Y	3.8E+06		3.1E-03	Wildlife PCL
95-63-6	1,2,4-Trimethylbenzene	ng/g	7.1		7.1				1.	1.				N				
95-50-1	1,2-Dichlorobenzene	ng/g	11.	U	12,000.	UM	11.	12,000.	235.	2.	-	-		Y	2.7E+06		4.4E-03	Wildlife PCL
108-67-8	1,3,5-Trimethylbenzene	ng/g	19.		19.				1.	1.				N				
541-73-1	1,3-Dichlorobenzene	ng/g	11.	U	12,000.	UM	11.	12,000.	235.	2.	-	-		Y	5.6E+05		2.1E-02	Wildlife PCL
106-46-7	1,4-Dichlorobenzene	ng/g	11.	U	12,000.	UM	11.	12,000.	235.	50.				N	5.6E+05		2.1E-02	Wildlife PCL
123-91-1	1,4-Dioxane	ng/g	24.	J	400.	U	24.	400.	10.	1.				N				
108-60-1	1-Chloropropane	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-		N				
95-95-4	2,4,5-Trichlorophenol	ng/g	290.	U	12,000.	U, UM	290.	12,000.	219.	5.	-	-		N				
88-06-2	2,4,6-Trichlorophenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	1.	-	-		N				
120-83-2	2,4-Dichlorophenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	9.	-	-		N				
105-67-9	2,4-Dimethylphenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	0.	-	-		N				
51-28-5	2,4-Dinitrophenol	ng/g	290.	U	71,000.	UM	290.	71,000.	219.	0.	-	-		N				
121-14-2	2,4-Dinitrotoluene	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-		N				
606-20-2	2,6-Dinitrotoluene	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-		N				
91-58-7	2-Chloronaphthalene	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-		N				
95-57-8	2-Chlorophenol	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	1.	-	-		N				
95-48-7	2-Methylphenol	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	1.	-	-		N				
88-74-4	2-Nitroanaline	ng/g	290.	U	12,000.	U, UM	290.	12,000.	219.	0.	-	-		N				
88-75-5	2-Nitrophenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	0.	-	-		N				
91-94-1	3,3'-Dichlorobenzidine	ng/g	93.		24,000.	UM	290.	24,000.	218.	1.	-	-		N				
99-09-2	3-Nitroaniline	ng/g	290.	U	12,000.	UJ, UM	290.	12,000.	218.	0.	-	-		N				
534-52-1	4,6-Dinitro-2-Methylphenol	ng/g	290.	U	30,000.	UM	290.	30,000.	219.	0.	-	-		N				
101-55-3	4-Bromophenyl Phenyl Ether	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-		Y	5.9E+06		2.1E-03	Wildlife PCL

CASRN	Chemical	Units	Database Query Results[a] Min Value	Qualifier[b]	Max Value	Qualifier[b]	Min MDL[c]	Max MDL	Number of Samples	Number of Detected Results	NOAA ER-L[d]	NJDEP Benchmark[e]	USEPA[f] List Bioaccumulators	Wildlife Based PCL[g]	Hazard Quotient[h] Aquatic	Wildlife	Basis[i]
106-47-8	4-Chloroaniline	ng/g	78.	J	12,000.	UM	290.	12,000.	219.	6.	-	-	N				
7005-72-3	4-Chlorophenyl Phenyl Ether	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-	Y	7.4E+07		1.6E-04	Wildlife PCL
106-44-5	4-Methylphenol	ng/g	130.	G	12,000.	UM	290.	12,000.	219.	5.	-	-	N				
100-01-6	4-Nitroaniline	ng/g	290.	U	12,000.	U, UM	290.	12,000.	219.	0.	-	-	N				
100-02-7	4-Nitrophenol	ng/g	200.	J	30,000.	UM	290.	30,000.	219.	1.	-	-	N				
111-91-1	Bis(2-Chloroethoxy)methane	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	0.	-	-	N				
111-44-4	Bis(2-Chloroethyl)ether	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-	N				
117-81-7	Bis(2-Ethylhexyl)phthalate	ng/g	410.	U	23,000,000.	DM	290.	28,000.	220.	214.	-	-	N				
108-86-1	Bromobenzene	ng/g	3.3	U	3.3	U	3.3	3.3	1.	0.			N				
85-68-7	Butyl Benzyl Phthalate	ng/g	89.		360,000.	J	230.	12,000.	219.	99.	-	-	N				
86-74-8	Carbazole	ng/g	91.	J	12,000.	UM	160.	12,000.	219.	74.	-	-	N				
132-64-9	Dibenzofuran	ng/g	81.	GM	70,000.		160.	12,000.	219.	49.	-	-	N				
132-65-0	Dibenzothiophene	ng/g	6.4	U	1,390.		0.468	93.7	103.	100.	-	-	N				
1002-53-5	Dibutyltin	ng/g	1.	UJ	212.	M	1.	1.	74.	73.	-	-	N				
84-66-2	Diethyl Phthalate	ng/g	290.	U	45,000.		290.	12,000.	219.	2.	-	-	N				
131-11-3	Dimethylphthalate	ng/g	270.		12,000.	UM	290.	12,000.	219.	3.	-	-	N				
84-74-2	Di-n-butyl Phthalate	ng/g	60.	J	12,000.	UM	290.	12,000.	219.	32.	-	-	N				
117-84-0	Di-n-Octyl Phthalate	ng/g	92.	J	12,000.	UM	290.	12,000.	219.	104.	-	-	N				
87-68-3	Hexachlorobutadiene	ng/g	3.7	U	12,000.	UM	3.7	12,000.	220.	0.	-	-	Y	1.2E+05		1.0E-01	Wildlife PCL
77-47-4	Hexachlorocyclopentadiene	ng/g	290.	U	24,000.	UM	290.	24,000.	219.	0.	-	-	Y	0.0E+00			
67-72-1	Hexachloroethane	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-	Y	0.0E+00			
78-59-1	Isophorone	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-	N				
78763-54-9	Monobutyltin	ng/g	0.233	GJ	28.1	JL	1.	1.	74.	42.	-	-	N				
98-95-3	Nitrobenzene	ng/g	160.	U	12,000.	UM	160.	12,000.	219.	0.	-	-	N				
86-30-6	N-Nitroso-di-phenylamine	ng/g	65.	G	12,000.	UM	160.	12,000.	219.	20.			N				
621-64-7	N-nitrosodipropylamine	ng/g	160.	U	12,000.	UJ	160.	12,000.	219.	0.	-	-	N				
87-86-5	Pentachlorophenol	ng/g	290.	U	30,000.	UM	290.	30,000.	219.	0.	-	-	Y	4.2E+05		7.2E-02	Wildlife PCL
108-95-2	Phenol	ng/g	290.	U	12,000.	UM	290.	12,000.	219.	3.	-	-	N				
1461-25-2	Tetrabutyltin	ng/g	0.508	GM	1.57	M	1.	1.	74.	11.	-	-	N				
56573-85-4	Tributyltin	ng/g	5.81	UM	690.	IM	5.81	10.3	74.	69.	25	-	Y	3.6E+03	2.8E+01	1.9E-01	NOAA ER-L
Semi-Volatile Organic Compounds (PAHs)[j]																	
90-12-0	1-Methylnaphthalene	ng/g	109.		911.	M	154.	420.	84.	75.	-	-	N				
832-69-9	1-Methylphenanthrene	ng/g	90.7	M	2,960.		0.331	420.	103.	101.	-	-	N				
2245-38-7	2,3,5-Trimethylnaphthalene	ng/g	36.4	NJ	2,130.		1.78	420.	103.	95.	-	-	N				
581-42-0	2,6-Dimethylnaphthalene	ng/g	78.	J	1,830.		1.1	420.	103.	96.	-	-	N				
91-57-6	2-Methylnaphthalene	ng/g	62.	G	24,000.	M	1.06	12,000.	312.	153.	70	70	N		3.4E+02		NOAA ER-L
83-32-9	Acenaphthene	ng/g	62.	J	420,000.		0.597	12,000.	312.	182.	16	16	Y		2.6E+04		NOAA ER-L
208-96-8	Acenaphthylene	ng/g	79.	J	12,000.	UM	0.448	12,000.	312.	192.	44	44	Y		2.7E+02		NOAA ER-L
120-12-7	Anthracene	ng/g	87.		230,000.	D	1.81	12,000.	312.	244.	85.3	85	Y		2.7E+03		NJ Benchmark
56-55-3	Benzo[a]anthracene	ng/g	160.	J	150,000.		1.16	1,200.	313.	297.	261	261	Y		5.7E+02		NOAA ER-L
50-32-8	Benzo[a]pyrene	ng/g	150.	J	130,000.		2.91	1,200.	313.	305.	430	430	Y		3.0E+02		NOAA ER-L
205-99-2	Benzo[b]fluoranthene	ng/g	190.	J	100,000.		290.	1,200.	294.	283.	-	-	Y				
192-97-2	Benzo[e]pyrene	ng/g	110.	J	8,300.	NJ	2.79	420.	103.	103.	-	-	N				
191-24-2	Benzo[g,h,i]perylene	ng/g	100.	J	63,000.		4.66	3,800.	313.	258.	-	-	Y				
207-08-9	Benzo[k]fluoranthene	ng/g	160.	U	63,000.		2.13	3,800.	313.	296.	-	-	Y				
205-82-3	Benzo[b/j]fluoranthene	ng/g	3,040.		8,350.		2.13	22.7	19.	19.			N				
92-52-4	Biphenyl	ng/g	73.4		420.	U	290.	420.	84.	74.			Y				
218-01-9	Chrysene	ng/g	170.	J	150,000.		2.37	1,200.	313.	309.	384	384	Y		3.9E+02		NOAA ER-L
53-70-3	Dibenz[a,h]anthracene	ng/g	82.	J	25,000.		2.98	12,000.	312.	218.	63.4	63	Y		4.0E+02		NJ Benchmark
206-44-0	Fluoranthene	ng/g	320.	J	320,000.	D	1.28	1,200.	313.	310.	600	600	Y		5.3E+02		NOAA ER-L
86-73-7	Fluorene	ng/g	64.		140,000.		0.616	12,000.	312.	185.	19	19	Y		7.4E+03		NOAA ER-L
193-39-5	Indeno[1,2,3-c,d]-pyrene	ng/g	95.	J	57,000.		5.3	3,800.	312.	259.	-	-	Y				
91-20-3	Naphthalene	ng/g	7.1		40,000.	D	1.88	12,000.	313.	159.	160	160	N		2.5E+02		NOAA ER-L
198-55-0	Perylene	ng/g	190.	J	2,630.		2.67	420.	103.	102.	-	-	N				
85-01-8	Phenanthrene	ng/g	140.	J	570,000.	D	1.57	3,800.	313.	284.	240	240	Y		2.4E+03		NOAA ER-L
129-00-0	Pyrene	ng/g	360.		340,000.	D	1.22	1,200.	313.	310.	665	665	Y		5.1E+02		NOAA ER-L
SUM_HIGH_PAH	SUM_HIGH_PAH	ng/g	2,645.		1,398,000.				239.		552	552	Y		2.5E+03		NOAA ER-L
SUM_LOW_PAH	SUM_LOW_PAH	ng/g	7.1		1,413,300.				240.		1700	1700	Y		8.3E+02		NOAA ER-L
SUM_PAH	SUM_PAH	ng/g	7.1		2,811,300.				240.		4022	4000	Y		7.0E+02		NJ Benchmark
PCB Aroclors																	

Attachment A
Analytical Data Summary Used in Ecological Screening

Lower Passaic River Restoration Project
Focused Feasibility Study

CASRN	Chemical	Units	Database Query Results[a] Min Value	Qualifier[b]	Max Value	Qualifier[b]	Min MDL[c]	Max MDL	Number of Samples	Number of Detected Results	NOAA ER-L[d]		NJDEP Benchmark[e]	USEPA[f] List Bioaccumulators	Wildlife Based PCL[g]	Hazard Quotient[h] Aquatic	Wildlife	Basis[i]
12674-11-2	Aroclor 1016	ng/g	5.7	U	970.	UJ	5.7	970.	229.	0.	-		-	Y	3.7E+02		2.7E+00	Wildlife PCL
11104-28-2	Aroclor 1221	ng/g	5.7	U	1,350.	UM	5.7	1,350.	229.	0.	-		-	Y	3.7E+02		3.7E+00	Wildlife PCL
11141-16-5	Aroclor 1232	ng/g	5.7	U	970.	UJ	5.7	970.	229.	0.	-		-	Y	3.7E+02		2.7E+00	Wildlife PCL
53469-21-9	Aroclor 1242	ng/g	5.7	U	17,200.	D	5.7	970.	229.	3.	-		-	Y	3.7E+02		4.7E+01	Wildlife PCL
12672-29-6	Aroclor 1248	ng/g	5.7	U	7,450.	DM	5.7	2,890.	235.	169.	-		-	Y	3.7E+02		2.0E+01	Wildlife PCL
11097-69-1	Aroclor 1254	ng/g	38.5	U	5,800.		5.7	2,070.	231.	151.	-		-	Y	3.7E+02		1.6E+01	Wildlife PCL
11096-82-5	Aroclor 1260	ng/g	5.7	U	2,160.	DM	5.7	970.	228.	87.	-		-	Y	3.7E+02		5.9E+00	Wildlife PCL
37324-23-5	Aroclor-1262	ng/g	5.7	U	8.2	U	5.7	8.2	10.	0.			-	N	3.7E+02		2.2E-02	Wildlife PCL
SUM_PCB	SUM_PCB AROCLORS	ng/g	73.2		17,506.5				236.		22.7		23	N	3.7E+02	7.7E+02	4.8E+01	NOAA ER-L
Pesticides/Herbicides																		
93-76-5	2,4,5-T	ng/g	38.	U	410.	U	5.	410.	167.	0.	-		-	N				
93-72-1	2,4,5-TP	ng/g	1.9	GPNJ	410.	U	5.	410.	177.	10.	-		-	N				
94-75-7	2,4-D	ng/g	240.	U	1,000.	U	50.	1,000.	166.	0.	-		-	N				
94-82-6	2,4-DB	ng/g	18.	GPJ	685.	UM	54.3	685.	166.	18.	-		-	N				
53-19-0	2,4-DDD	ng/g	16.7	T	687.	T	1.61	26.1	22.	21.	2	1	-	Y	8.3E+02	3.4E+02	8.3E-01	NOAA ER-L
3424-82-6	2,4-DDE	ng/g	11.8	K	303.		0.956	32.3	22.	22.	2.2	1	-	Y	1.9E+01	1.4E+02	1.6E+01	NOAA ER-L
789-02-6	2,4-DDT	ng/g	5.91	UT	145.	T	2.73	36.7	22.	21.	1	1	-	Y	1.4E+02	1.5E+02	1.0E+00	NOAA ER-L
72-54-8	4,4'-DDD	ng/g	4.07	U	5,980.	DM	2.26	66.5	236.	215.	2		-	Y	8.3E+02	3.0E+03	7.2E+00	NOAA ER-L
72-55-9	4,4'-DDE	ng/g	4.07	U	1,010.		1.26	66.5	237.	215.	2.2		2.2	Y	1.9E+01	4.6E+02	5.3E+01	NOAA ER-L
50-29-3	4,4'-DDT	ng/g	3.85	U	2,470.	DM	2.73	79.2	234.	175.	1		-	Y	1.4E+02	2.5E+03	1.8E+01	NOAA ER-L
SUM_TDDT	SUM_TDDT	ng/g	10.54		5,989				248.		1.58		1.6	N	1.9E+01	3.8E+03	3.1E+02	NOAA ER-L
309-00-2	Aldrin	ng/g	0.619	U	660.		0.576	34.3	236.	17.	-		-	Y	4.6E+02		1.4E+00	Wildlife PCL
319-86-8	BHC, delta	ng/g	0.211	QJB	74.		0.159	37.	231.	11.			-	N	1.2E+03		5.9E-02	Wildlife PCL
319-84-6	BHC-alpha	ng/g	0.34	U	34.3	UM	0.205	34.3	233.	8.	-		-	Y	1.2E+03		2.8E-02	Wildlife PCL
319-85-7	BHC-beta	ng/g	0.776	U	2,000.		0.776	41.9	227.	6.	-		-	Y	1.2E+03		1.6E+00	Wildlife PCL
58-89-9	BHC-gamma (Lindane)	ng/g	0.542	UD	34.3	UM	0.529	34.3	232.	10.	-		-	Y	1.2E+03		2.8E-02	Wildlife PCL
SUM_BHC	SUM_BHC	ng/g	1.132		2,012				233.				-	N	1.2E+03		1.6E+00	Wildlife PCL
5103-71-9	Chlordane,alpha (cis)	ng/g	2.06	U	330.		0.0967	233.	221.	120.			-	N	2.0E+03		1.6E-01	Wildlife PCL
5103-74-2	Chlordane,gamma (trans)	ng/g	2.09	U	125.	PDNJ	0.0815	48.2	212.	120.			-	N	2.0E+03		6.2E-02	Wildlife PCL
SUM_CHLORDANE	SUM_CHLORDANE	ng/g	3.19		335				231.				-	N	2.0E+03		1.7E-01	Wildlife PCL
60-57-1	Dieldrin	ng/g	1.38	DJ	141.	PDJ	0.163	93.5	236.	109.	0.02		-	Y	2.7E+02	7.1E+03	5.2E-01	NOAA ER-L
1031-07-8	Endosulfan sulfate	ng/g	0.422	UD	71.	UM	0.33	71.	224.	8.			-	N	4.9E+03		1.5E-02	Wildlife PCL
959-98-8	Endosulfan, alpha	ng/g	0.18	U	94.	U	0.18	94.	231.	1.			-	N	4.9E+03		1.9E-02	Wildlife PCL
33213-65-9	Endosulfan, beta	ng/g	0.341	UD	177.	PDJ	0.341	38.	234.	108.			-	N	4.9E+03		3.6E-02	Wildlife PCL
SUM_ENDOSULFAN	SUM_ENDOSULFAN	ng/g	1.331		244.8				240.				-	N	4.9E+03		5.0E-02	Wildlife PCL
7421-93-4	Endrin aldehyde	ng/g	0.501	U	67.		0.442	66.5	227.	15.			-	N	3.5E+01		1.9E+00	Wildlife PCL
53494-70-5	Endrin ketone	ng/g	0.248	QJ	2,360.	D	0.106	93.5	229.	62.			-	N	3.5E+01		6.7E+01	Wildlife PCL
SUM_ENDRIN	SUM_ENDRIN	ng/g	0.947		2,366				233.				-	N	3.5E+01		6.7E+01	Wildlife PCL
1024-57-3	Heptachlor epoxide	ng/g	0.421	UD	87.		0.315	58.	231.	18.	-		-	Y	9.7E+03		9.0E-03	Wildlife PCL
118-74-1	Hexachlorobenzene	ng/g	91.	GM	12,000.	UM	160.	12,000.	219.	2.	-		-	Y	9.3E+04		1.3E-01	Wildlife PCL
72-43-5	Methoxychlor	ng/g	1.63	QJ	7,900.		0.26	343.	231.	21.	-		-	Y	1.1E+05		6.9E-02	Wildlife PCL
8001-35-2	Toxaphene	ng/g	45.3	U	3,430.	UM	45.3	3,430.	231.	0.	-		-	Y	1.4E+03		2.5E+00	Wildlife PCL
Dioxins/Furans																		
1746-01-6	2,3,7,8-TCDD		0.	DJ	19.4	BD	0.00011	0.0044	230.	229.	3.2E-03	2	-	Y	2.5E-03	6.1E+03	7.8E+03	Wildlife PCL

Notes
a. Data obtained from a query of the PREmis database completed on 10 January 2007.
b. Data qualifiers as provided in PREmis.
c. Method Detection Limits (MDLs) as provided in PREmis.
d. ER-L = Effects Range-Low from Long and Morgan, 1991 and Long *et al.* , 1995; except where noted.
1. Based on value for the para position isomer.
2. Derived by USFWS using sediment chemistry for the Arthur Kill and oyster effect data presented in Wintermyer and Cooper, 2003.
e. Sediment benchmarks from NJDEP, 1998. Guidance for Sediment Quality Evaluations.
1. NJ Volatile Organic Sediment Screening Guidelines derived from MacDonald et al., 1992.
f. From USEPA 2000b. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment; USEPA 823-R-00-001.
g. Derivation of Wildlife PCLs discussed in the text and summarized in Attachment B.
h. Hazard Quotient is the ratio of the maximum concentration to either the aquatic- or wildlife-based screening benchmark.
i Basis for the lowest benchmark value is indicated.
j. Although a number of PAHs are identified as bioaccumulating compounds, no wildlife PCLs were derived for this class of COPEC because they are generally metabolized quickly in the tissues of higher organisms including aquatic wildife prey.

Attachment B
Derviation of Protective Concentrations (PCLs) for Wildlife

Lower Passaic River Restoration Project
Focused Feasibility Study

CASRN	Chemical Name	Units	TRV[a]		BAF[b]	PCL$_{sed}$[c]		
			Mammal	Bird		Mammal	Bird	Wildlife
Inorganics								
7440-38-2	Arsenic	ug/g	1.2E+00	1.1E+01	1.3E-01	1.8E+02	1.7E+02	1.7E+02
7440-43-9	Cadmium	ug/g	4.0E-01	9.1E-01	6.1E-01	1.2E+01	3.0E+00	3.0E+00
7440-47-3	Chromium	ug/g	6.6E+00	2.2E+00	1.1E-01	1.1E+03	4.1E+01	4.1E+01
7440-50-8	Copper	ug/g	4.1E+01	1.1E+01	1.6E+00	4.6E+02	1.3E+01	1.3E+01
7439-92-1	Lead	ug/g	1.6E+01	3.5E-01	6.6E-02	4.4E+03	1.1E+01	1.1E+01
7439-97-6	Mercury	ug/g	7.2E-02	2.0E-02	1.1E+00	1.2E+00	3.7E-02	3.7E-02
7440-02-0	Nickel	ug/g	2.1E+00	8.8E+00	8.2E-01	4.6E+01	2.2E+01	2.2E+01
7782-49-2	Selenium	ug/g	2.5E-01	4.6E-01	1.0E+00	4.6E+00	9.2E-01	9.2E-01
7440-22-4	Silver	ug/g	7.0E+01		1.0E+00	1.3E+03		1.3E+03
7440-66-6	Zinc	ug/g	6.3E+01	5.4E+01	2.3E+00	5.0E+02	4.7E+01	4.7E+01
SVOCs (Non PAHs)								
101-55-3	4-Bromophenyl Phenyl Ether	ug/g	3.2E+02	-	1.0E+00	5.9E+03		5.9E+03
7005-72-3	4-Chlorophenyl Phenyl Ether	ug/g	3.2E+02	-	7.9E-02	7.4E+04		7.4E+04
87-68-3	Hexachlorobutadiene	ug/g	6.3E+00		1.0E+00	1.2E+02		1.2E+02
77-47-4	Hexachlorocyclopentadiene	ug/g	-	-	-			0.0E+00
67-72-1	Hexachloroethane	ug/g	-	-	1.0E+00			0.0E+00
87-86-5	Pentachlorophenol	ug/g	7.6E-01	2.4E+01	3.4E-02	4.2E+02	1.4E+03	4.2E+02
56573-85-4	Tributyltin	ug/g	1.9E+00	-	1.0E+01	3.6E+00		3.6E+00
95-50-1	1,2-Dichlorobenzene	ug/g	1.5E+02	-	1.0E+00	2.7E+03		2.7E+03
541-73-1	1,3-Dichlorobenzene	ug/g	3.0E+01	-	1.0E+00	5.6E+02		5.6E+02
120-82-1	1,2,4-Trichlorobenzene	ug/g	2.1E+02	-	1.0E+00	3.8E+03		3.8E+03
106-46-7	1,4-Dichlorobenzene	ug/g	3.0E+01	-	1.0E+00	5.6E+02		5.6E+02
87-61-6	1,2,3-Trichlorobenzene (Historical)	ug/g	2.1E+02	-	1.0E+00	3.8E+03		3.8E+03
120-82-1	1,2,4-Trichlorobenzene	ug/g	2.1E+02	-	1.0E+00	3.8E+03		3.8E+03
95-94-3	1,2,4,5-Tetrachlorobenzene	ug/g	7.2E-01	-	1.0E+00	1.3E+01		1.3E+01
PCB Aroclors								
12674-11-2	Aroclor 1016	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
11104-28-2	Aroclor 1221	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
11141-16-5	Aroclor 1232	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
53469-21-9	Aroclor 1242	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
12672-29-6	Aroclor 1248	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
11097-69-1	Aroclor 1254	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
11096-82-5	Aroclor 1260	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
37324-23-5	Aroclor-1262	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
SUM_PCB	SUM_PCB AROCLORS	ug/g	6.8E-01	3.4E-01	1.9E+00	6.8E+00	3.7E-01	3.7E-01
Pesticides								
53-19-0	2,4-DDD	ug/g	3.6E+00	1.2E-01	2.8E-01	2.4E+02	8.3E-01	8.3E-01
3424-82-6	2,4-DDE	ug/g	3.6E+00	7.3E-02	7.7E+00	8.6E+00	1.9E-02	1.9E-02
789-02-6	2,4-DDT	ug/g	3.6E+00	1.2E-01	1.7E+00	4.0E+01	1.4E-01	1.4E-01
72-54-8	4,4'-DDD	ug/g	3.6E+00	1.2E-01	2.8E-01	2.4E+02	8.3E-01	8.3E-01
72-55-9	4,4'-DDE	ug/g	3.6E+00	7.3E-02	7.7E+00	8.6E+00	1.9E-02	1.9E-02
50-29-3	4,4'-DDT	ug/g	3.6E+00	1.2E-01	1.7E+00	4.0E+01	1.4E-01	1.4E-01
SUM_TDDT	SUM_TDDT	ug/g	3.6E+00	7.3E-02	7.7E+00	8.6E+00	1.9E-02	1.9E-02
309-00-2	Aldrin	ug/g	3.2E-01	4.2E-01	1.8E+00	3.3E+00	4.6E-01	4.6E-01
319-84-6	BHC-alpha	ug/g	4.3E-01	1.1E+00	1.8E+00	4.5E+00	1.2E+00	1.2E+00
319-85-7	BHC-beta	ug/g	4.3E-01	1.1E+00	1.8E+00	4.5E+00	1.2E+00	1.2E+00
58-89-9	BHC-gamma (Lindane)	ug/g	4.3E-01	1.1E+00	1.8E+00	4.5E+00	1.2E+00	1.2E+00
319-86-8	BHC, delta	ug/g	4.3E-01	1.1E+00	1.8E+00	4.5E+00	1.2E+00	1.2E+00
SUM_BHC	SUM_BHC	ug/g	4.3E-01	1.1E+00	1.8E+00	4.5E+00	1.2E+00	1.2E+00
5103-71-9	Chlordane,alpha (cis)	ug/g	6.5E+00	4.8E+00	4.8E+00	2.5E+01	2.0E+00	2.0E+00
5103-74-2	Chlordane,gamma (trans)	ug/g	6.5E+00	4.8E+00	4.8E+00	2.5E+01	2.0E+00	2.0E+00
57-74-9	Total Chlordane	ug/g	6.5E+00	4.8E+00	4.8E+00	2.5E+01	2.0E+00	2.0E+00

Attachment B
Derviation of Protective Concentrations (PCLs) for Wildlife

Lower Passaic River Restoration Project
Focused Feasibility Study

CASRN	Chemical Name	Units	TRV[a]		BAF[b]	PCL_{sed}[c]		
			Mammal	Bird		Mammal	Bird	Wildlife
Inorganics								
SUM_CHLORDANE	SUM_CHLORDANE	ug/g	6.5E+00	4.8E+00	4.8E+00	2.5E+01	2.0E+00	2.0E+00
60-57-1	Dieldrin	ug/g	6.3E-02	2.4E-01	1.8E+00	6.5E-01	2.7E-01	2.7E-01
1031-07-8	Endosulfan sulfate	ug/g	4.7E-01	3.2E+01	1.8E+00	4.9E+00	3.5E+01	4.9E+00
959-98-8	Endosulfan, alpha	ug/g	4.7E-01	3.2E+01	1.8E+00	4.9E+00	3.5E+01	4.9E+00
33213-65-9	Endosulfan, beta	ug/g	4.7E-01	3.2E+01	1.8E+00	4.9E+00	3.5E+01	4.9E+00
115-29-7	Total Endosulfan	ug/g	4.7E-01	3.2E+01	1.8E+00	4.9E+00	3.5E+01	4.9E+00
SUM_ENDOSULFAN	SUM_ENDOSULFAN	ug/g	4.7E-01	3.2E+01	1.8E+00	4.9E+00	3.5E+01	4.9E+00
7421-93-4	Endrin aldehyde	ug/g	2.9E-01	3.2E-02	1.8E+00	3.0E+00	3.5E-02	3.5E-02
53494-70-5	Endrin ketone	ug/g	2.9E-01	3.2E-02	1.8E+00	3.0E+00	3.5E-02	3.5E-02
72-20-8	Total Endrin	ug/g	2.9E-01	3.2E-02	1.8E+00	3.0E+00	3.5E-02	3.5E-02
SUM_ENDRIN	SUM_ENDRIN	ug/g	2.9E-01	3.2E-02	1.8E+00	3.0E+00	3.5E-02	3.5E-02
1024-57-3	Heptachlor epoxide	ug/g	9.4E-01	1.3E+02	1.8E+00	9.7E+00	1.5E+02	9.7E+00
76-44-8	Total Heptachlor	ug/g	9.4E-01	2.1E+00	1.8E+00	9.7E+00	2.4E+00	2.4E+00
SUM_HEPTACHLOR	SUM_HEPTACHLOR	ug/g	9.4E-01	2.1E+00	1.8E+00	9.7E+00	2.4E+00	2.4E+00
118-74-1	Hexachlorobenzene	ug/g		4.2E+00	9.0E-02		9.3E+01	9.3E+01
72-43-5	Methoxychlor	ug/g	1.1E+01	2.5E+02	1.8E+00	1.1E+02	2.8E+02	1.1E+02
2385-85-5	Mirex	ug/g	1.1E+00	1.0E+01	1.3E+00	1.6E+01	1.6E+01	1.6E+01
8001-35-2	Toxaphene	ug/g	2.5E+01	1.3E+00	1.8E+00	2.6E+02	1.4E+00	1.4E+00
Dioxin/Furan Congeners								
1746-01-6	2,3,7,8-TCDD[d]	ug/g	-	-	2.5E-02	2.5E-06	2.1E-05	2.5E-06

a. TRVs presented in Attachment C.

b. Aquatic BAFs presented in Attachment C.

c. Wildife PCLs calculated using the following equation and parameters provided in Table 3.

$$PCL_{sed} = \frac{THQ * TRV * BW}{\left(BAF_{fish} * IR_{fish} * P_{fish} * SFF\right)}$$

d. Wildlife PCLs for 2,3,7,8-TCDD as presented in Table 5-1 (USEPA, 1993) "Low Risk" sediment concentrations for mammalian and avian receptors.

Attachment C
Supporting Data for PCL Derivation

Lower Passaic River Restoration Project
Focused Feasibility Study

CASRN	Chemical Name	Units	TRVs[a] Mammals TRV_{low}	Mammals TRV_{high}	Mammals Source		Birds TRV_{low}	Birds TRV_{high}	Birds Source		MATCs[b] Mammal	MATCs[b] Bird	BAFs[c]		
Inorganics															
7440-38-2	Arsenic	ug/g-d	0.32	4.7	DTSC, 2002		5.5	22	DTSC, 2002		1.2E+00	1.1E+01	0.127	1	1998, Bechtel Jacobs Company, LLC
7440-43-9	Cadmium	ug/g-d	0.06	2.64	DTSC, 2002		0.08	10.4	DTSC, 2002		4.0E-01	9.1E-01	0.614	1	1998, Bechtel Jacobs Company, LLC
7440-47-3	Chromium	ug/g-d	3.28	13.4	ORNL, 1996		1	5	ORNL, 1996		6.6E+00	2.2E+00	0.108	1	1998, Bechtel Jacobs Company, LLC
7440-50-8	Copper	ug/g-d	2.67	632	DTSC, 2002		2.3	52.3	DTSC, 2002		4.1E+01	1.1E+01	1.647	1	1998, Bechtel Jacobs Company, LLC
7439-92-1	Lead	ug/g-d	1	241	DTSC, 2002		0.014	8.75	DTSC, 2002		1.6E+01	3.5E-01	0.066	1	1998, Bechtel Jacobs Company, LLC
7439-97-6	Mercury	ug/g-d	0.032	0.16	ORNL, 1996		0.0064	0.064	ORNL, 1996		7.2E-02	2.0E-02	1.081	1	1998, Bechtel Jacobs Company, LLC
7440-02-0	Nickel	ug/g-d	0.133	31.6	DTSC, 2002		1.38	56.3	DTSC, 2002		2.1E+00	8.8E+00	0.818	1	1998, Bechtel Jacobs Company, LLC
7782-49-2	Selenium	ug/g-d	0.05	1.21	DTSC, 2002		0.23	0.93	DTSC, 2002		2.5E-01	4.6E-01	1		Assumption
7440-22-4	Silver	ug/g-d	22.2	222	ATSDR, 1990; Matuk et al., 1981		-	-	-		7.0E+01		1		Assumption
7440-66-6	Zinc	ug/g-d	9.6	411	DTSC, 2002		17.2	172	DTSC, 2002		6.3E+01	5.4E+01	2.33	1	1998, Bechtel Jacobs Company, LLC
SVOCs (Non-PAHs)															
95-50-1	1,2-Dichlorobenzene	ug/g-d	86	257	ATSDR, 1998; NTP, 1985		-	-	-		1.5E+02	-	1		National Quality Sediment Survey
541-73-1	1,3-Dichlorobenzene	ug/g-d	21	43	ATSDR, 1998; NTP, 1987		-	-	-		3.0E+01	-	1		National Quality Sediment Survey
106-46-7	1,4-Dichlorobenzene	ug/g-d	21.4	42.9	ATSDR, 1998; NTP, 1987		-	-	-		3.0E+01	-	1		National Quality Sediment Survey
120-82-1	1,2,4-Trichlorobenzene	ug/g-d	120	360	IRIS, 2002; Kitchin and Ebron, 1980		-	-	-		2.1E+02	-	1		National Quality Sediment Survey
87-61-6	1,2,3-Trichlorobenzene (Historical)	ug/g-d	120	360	IRIS, 2002; Kitchin and Ebron, 1980		-	-	-		2.1E+02	-	1		National Quality Sediment Survey
120-82-1	1,2,4-Trichlorobenzene	ug/g-d	120	360	IRIS, 2002; Kitchin and Ebron, 1980		-	-	-		2.1E+02	-	1		National Quality Sediment Survey
95-94-3	1,2,4,5-Tetrachlorobenzene	ug/g-d	0.32	1.6	ATSDR, 2000; Arnold et al., 1985		-	-	-		7.2E-01	-	1		National Quality Sediment Survey
123-91-1	1,4-DIOXANE	ug/g-d	0.5	1	ORNL, 1996		-	-	-		7.1E-01	-	1		Assumption
101-55-3	4-Bromophenyl Phenyl Ether	ug/g-d	100	1000	INCHEM 1994; Francis, 1989		-	-	-		3.2E+02	-	1		National Quality Sediment Survey
7005-72-3	4-Chlorophenyl Phenyl Ether	ug/g-d	100	1000	INCHEM 1994; Francis, 1989		-	-	-		3.2E+02	-	0.079		National Quality Sediment Survey
87-68-3	Hexachlorobutadiene	ug/g-d	2	20	IRIS, 2002; Kociba, 1977a		-	-	-		6.3E+00		1		National Quality Sediment Survey
77-47-4	Hexachlorocyclopentadiene	ug/g-d	-	-	-		-	-	-		-	-	-		
67-72-1	Hexachloroethane	ug/g-d	-	-	-		-	-	-		-	-	1		National Quality Sediment Survey
87-86-5	Pentachlorophenol	ug/g-d	0.24	2.4	ORNL, 1996		7.6	76	Hudson et al., 1984		7.6E-01	2.4E+01	0.034		National Quality Sediment Survey
56573-85-4	Tributyltin	ug/g-d	0.25	15	DTSC, 2002		-	-	-		1.9E+00	-	10		Meador, 2000
PCB Aroclors															
12674-11-2	Aroclor 1016	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
11104-28-2	Aroclor 1221	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
11141-16-5	Aroclor 1232	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
53469-21-9	Aroclor 1242	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
12672-29-6	Aroclor 1248	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
11097-69-1	Aroclor 1254	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
11096-82-5	Aroclor 1260	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
37324-23-5	Aroclor-1262	ug/g-d	0.36	1.28	DTSC, 2002	2	0.09	1.27	DTSC, 2002	2	6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
SUM_PCB	SUM_PCB AROCLORS	ug/g-d	0.36	1.28	DTSC, 2002		0.09	1.27	DTSC, 2002		6.8E-01	3.4E-01	1.85		National Quality Sediment Survey
Pesticides															
53-19-0	2,4-DDD	ug/g-d	0.8	16	DTSC, 2002	3	0.009	1.5	DTSC, 2002	3	3.6E+00	1.2E-01	0.28	1	National Quality Sediment Survey
3424-82-6	2,4-DDE	ug/g-d	0.8	16	DTSC, 2002	3	0.009	0.6	DTSC, 2002		3.6E+00	7.3E-02	7.7	1	National Quality Sediment Survey
789-02-6	2,4-DDT	ug/g-d	0.8	16	DTSC, 2002	3	0.009	1.5	DTSC, 2002		3.6E+00	1.2E-01	1.67	1	National Quality Sediment Survey
72-54-8	4,4'-DDD	ug/g-d	0.8	16	DTSC, 2002		0.009	1.5	DTSC, 2002	3	3.6E+00	1.2E-01	0.28		National Quality Sediment Survey
72-55-9	4,4'-DDE	ug/g-d	0.8	16	DTSC, 2002	3	0.009	0.6	DTSC, 2002		3.6E+00	7.3E-02	7.7		National Quality Sediment Survey
50-29-3	4,4'-DDT	ug/g-d	0.8	16	DTSC, 2002	3	0.009	1.5	DTSC, 2002		3.6E+00	1.2E-01	1.67		National Quality Sediment Survey
SUM_TDDT	SUM_TDDT	ug/g-d	0.8	16	DTSC, 2002		0.009	0.6	DTSC, 2002		3.6E+00	7.3E-02	7.7		National Quality Sediment Survey
309-00-2	Aldrin	ug/g-d	0.1	1	DTSC, 2002		0.13	1.3	Hudson et al., 1970		3.2E-01	4.2E-01	1.8		National Quality Sediment Survey
319-84-6	BHC-alpha	ug/g-d	0.05	3.75	DTSC, 2002	4	0.56	2.25	ORNL, 1996	4	4.3E-01	1.1E+00	1.8		National Quality Sediment Survey
319-85-7	BHC-beta	ug/g-d	0.05	3.75	DTSC, 2002	4	0.56	2.25	ORNL, 1996	4	4.3E-01	1.1E+00	1.8		National Quality Sediment Survey
58-89-9	BHC-gamma (Lindane)	ug/g-d	0.05	3.75	DTSC, 2002		0.56	2.25	ORNL, 1996		4.3E-01	1.1E+00	1.8		National Quality Sediment Survey
319-86-8	BHC, delta	ug/g-d	0.05	3.75	DTSC, 2002		0.56	2.25	ORNL, 1996		4.3E-01	1.1E+00	1.8		National Quality Sediment Survey
SUM_BHC	SUM_BHC	ug/g-d	0.05	3.75	DTSC, 2002		0.56	2.25	ORNL, 1996		4.3E-01	1.1E+00	1.8		National Quality Sediment Survey

Attachment C
Supporting Data for PCL Derivation

Lower Passaic River Restoration Project
Focused Feasibility Study

			TRVs[a]								MATCs[b]				
			Mammals				Birds								
CASRN	Chemical Name	Units	TRV_{low}	TRV_{high}	Source		TRV_{low}	TRV_{high}	Source		Mammal	Bird	BAFs[c]		
5103-71-9	Chlordane,alpha (cis)	ug/g-d	4.6	9.2	ORNL, 1996		2.14	10.7	ORNL, 1996		6.5E+00	4.8E+00	4.77		National Quality Sediment Survey
5103-74-2	Chlordane,gamma (trans)	ug/g-d	4.6	9.2	ORNL, 1996		2.14	10.7	ORNL, 1996		6.5E+00	4.8E+00	4.77		National Quality Sediment Survey
57-74-9	Total Chlordane	ug/g-d	4.6	9.2	ORNL, 1996		2.14	10.7	ORNL, 1996		6.5E+00	4.8E+00	4.77		National Quality Sediment Survey
SUM_CHLORDANE	SUM_CHLORDANE	ug/g-d	4.6	9.2	ORNL, 1996		2.14	10.7	ORNL, 1996		6.5E+00	4.8E+00	4.77		National Quality Sediment Survey
60-57-1	Dieldrin	ug/g-d	0.02	0.2	ORNL, 1996		0.077	0.77	ORNL, 1996	5	6.3E-02	2.4E-01	1.8		National Quality Sediment Survey
1031-07-8	Endosulfan sulfate	ug/g-d	0.15	1.5	ORNL, 1996		10	100	ORNL, 1996		4.7E-01	3.2E+01	1.8		National Quality Sediment Survey
959-98-8	Endosulfan, alpha	ug/g-d	0.15	1.5	ORNL, 1996		10	100	ORNL, 1996		4.7E-01	3.2E+01	1.8		National Quality Sediment Survey
33213-65-9	Endosulfan, beta	ug/g-d	0.15	1.5	ORNL, 1996		10	100	ORNL, 1996		4.7E-01	3.2E+01	1.8		National Quality Sediment Survey
115-29-7	Total Endosulfan	ug/g-d	0.15	1.5	ORNL, 1996	5	10	100	ORNL, 1996	5	4.7E-01	3.2E+01	1.8		National Quality Sediment Survey
SUM_ENDOSULFAN	SUM_ENDOSULFAN	ug/g-d	0.15	1.5	ORNL, 1996	5	10	100	ORNL, 1996	5	4.7E-01	3.2E+01	1.8		National Quality Sediment Survey
7421-93-4	Endrin aldehyde	ug/g-d	0.092	0.92	ORNL, 1996		0.01	0.1	ORNL, 1996		2.9E-01	3.2E-02	1.8		National Quality Sediment Survey
53494-70-5	Endrin ketone	ug/g-d	0.092	0.92	ORNL, 1996		0.01	0.1	ORNL, 1996		2.9E-01	3.2E-02	1.8		National Quality Sediment Survey
72-20-8	Total Endrin	ug/g-d	0.092	0.92	ORNL, 1996		0.01	0.1	ORNL, 1996		2.9E-01	3.2E-02	1.8		National Quality Sediment Survey
SUM_ENDRIN	SUM_ENDRIN	ug/g-d	0.092	0.92	ORNL, 1996		0.01	0.1	ORNL, 1996		2.9E-01	3.2E-02	1.8		National Quality Sediment Survey
1024-57-3	Heptachlor epoxide	ug/g-d	0.13	6.8	DTSC, 2002		41.6	416	Hudson et al., 1984		9.4E-01	1.3E+02	1.8		National Quality Sediment Survey
76-44-8	Total Heptachlor	ug/g-d	0.13	6.8	DTSC, 2002		0.7	6.7	Hill et al., 1975		9.4E-01	2.1E+00	1.8		National Quality Sediment Survey
SUM_HEPTACHLOR	SUM_HEPTACHLOR	ug/g-d	0.13	6.8	DTSC, 2002		0.7	6.7	Hill et al., 1975		9.4E-01	2.1E+00	1.8		National Quality Sediment Survey
118-74-1	Hexachlorobenzene	ug/g-d	-	-	-		1.3	13.2	Hill et al., 1975			4.2E+00	0.09		National Quality Sediment Survey
72-43-5	Methoxychlor	ug/g-d	2.5	50	DTSC, 2002		80	800	Hudson et al., 1970		1.1E+01	2.5E+02	1.8		National Quality Sediment Survey
2385-85-5	Mirex	ug/g-d	0.7	1.8	IRIS, 2007		3.3	33.0	Hill et al., 1975		1.1E+00	1.0E+01	1.31		National Quality Sediment Survey
8001-35-2	Toxaphene	ug/g-d	8	80	ORNL, 1996	5	0.398	3.98	Hudson et al., 1970		2.5E+01	1.3E+00	1.8		National Quality Sediment Survey
Dioxin/Furan Congeners															
1746-01-6	2,3,7,8-TCDD[d]	ug/g-d											0.025		National Quality Sediment Survey

Notes

a. Toxicity Reference Values (TRV) - based on dietary doses below which adverse ecological effects are not anticipated ($TRVl_{ow}$) or above which are anticipate (TRV_{high}). The TRV_{low} and TRV_{high} terminology is used in the DTSC, 2002 compilation; comparable values from other reference sources are the No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL).

1. LD50 study result converted to a TRV using the following assumptions:

Parameter	Value	Units	Reference
mouse body weight	0.03	kg	USEPA, 1988a, from ORNL, 1996
mouse ingestion rate	0.0055	kg/day	Calculated using allometric equation from EPA 1988a.
LD_{50}	8.5	mg/kg	NTPChemIDPLus
Equivalent dose	0.0016	ug/g-day	
LD50 - Acute NOAEL	0.2	unitless	
Acute/Chronic	0.1	unitless	
TRV_{low}	3.1E-05	ug/g-day	

2. Based on value for Total PCBs (Aroclors).
3. Based on value for DDT
4. Based on value for gamma-BHC (Lindane).
5. LOAEL estimated using a 10 fold extrapolation factor

b. Maximum Allowable Toxicant Concentration (MATC) - geometric mean of the $TRVl_{ow}$ and TRV_{high}.

1. Value for corresponding para-isomer.

c. Bioaccumulation Factors (BAFs) - literature--derived ratio between aquatic biological tissue and sediment (wet weight/dry weight basis).

1. Values were taken from Table 2, median, non-dep for each analyte.

d. TRVs not calculated for 2,3,7,8-TCDD, instead protective sediment concentrations available in USEPA (1993) used in the screening process.

DTSC, 2002 reference available at http://www.dtsc.ca.gov/AssessingRisk/upload/Eco_Btag-mammal-bird-TRV-table.pdf

*Bechtel Jacobs Company LLC.1998. Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. Used median literature values for non-depurated literature values (Table 2)

ATTACHMENT 3

PROUCL OUTPUT WORKSHEETS: RECOMMENDED EXPOSURE POINT CONCENTRATIONS

ProUCL OUTPUT FOR FISH/CRAB – BASELINE CURRENT HHRA

	A	B	C	D	E	F	G	H	I	J	K	L
1				General UCL Statistics for Full Data Sets								
2		User Selected Options										
3			From File	C:\Documents and Settings\rodgersp\My Documents\PROJECTS\Passaic River\FFS\Risk Assessment\2011 Ris								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	HH Fish DF TEQ											
10												
11						General Statistics						
12					Number of Valid Observations	39					Number of Distinct Observations	38
13												
14			Raw Statistics						Log-transformed Statistics			
15					Minimum	0.00487					Minimum of Log Data	-5.325
16					Maximum	0.576					Maximum of Log Data	-0.551
17					Mean	0.0624					Mean of log Data	-3.449
18					Median	0.0332					SD of log Data	1.075
19					SD	0.104						
20					Std. Error of Mean	0.0167						
21					Coefficient of Variation	1.669						
22					Skewness	3.745						
23												
24						Relevant UCL Statistics						
25			Normal Distribution Test						Lognormal Distribution Test			
26					Shapiro Wilk Test Statistic	0.532					Shapiro Wilk Test Statistic	0.959
27					Shapiro Wilk Critical Value	0.939					Shapiro Wilk Critical Value	0.939
28			Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level			
29												
30			Assuming Normal Distribution						Assuming Lognormal Distribution			
31					95% Student's-t UCL	0.0905					95% H-UCL	0.0874
32			95% UCLs (Adjusted for Skewness)								95% Chebyshev (MVUE) UCL	0.105
33					95% Adjusted-CLT UCL (Chen-1995)	0.1					97.5% Chebyshev (MVUE) UCL	0.126
34					95% Modified-t UCL (Johnson-1978)	0.0921					99% Chebyshev (MVUE) UCL	0.168
35												
36			Gamma Distribution Test						Data Distribution			
37					k star (bias corrected)	0.82			Data appear Lognormal at 5% Significance Level			
38					Theta Star	0.076						
39					MLE of Mean	0.0624						
40					MLE of Standard Deviation	0.0689						
41					nu star	63.98						
42					Approximate Chi Square Value (.05)	46.58			Nonparametric Statistics			
43					Adjusted Level of Significance	0.0437					95% CLT UCL	0.0898
44					Adjusted Chi Square Value	46					95% Jackknife UCL	0.0905
45											95% Standard Bootstrap UCL	0.09
46					Anderson-Darling Test Statistic	1.88					95% Bootstrap-t UCL	0.118
47					Anderson-Darling 5% Critical Value	0.784					95% Hall's Bootstrap UCL	0.171

	A–E	F	G–K	L
48	Kolmogorov-Smirnov Test Statistic	0.195	95% Percentile Bootstrap UCL	0.0891
49	Kolmogorov-Smirnov 5% Critical Value	0.146	95% BCA Bootstrap UCL	0.101
50	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.135
51			97.5% Chebyshev(Mean, Sd) UCL	0.166
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.228
53	95% Approximate Gamma UCL	0.0857		
54	95% Adjusted Gamma UCL	0.0868		
55				
56	**Potential UCL to Use**		Use 95% H-UCL	0.0874
57	**Per recommendation from the Battelle Statistician, the 95% BCA Bootstrap UCL is used in place of the 95% U-UCL**		95% BCA Bootstrap UCL	0.101
58	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
59	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
60	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
61	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
62				
63	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
64	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
65	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
66				
67				
68	**HH Fish PCB TEQ**			
69				
70	**General Statistics**			
71	Number of Valid Observations	39	Number of Distinct Observations	39
72				
73	**Raw Statistics**		**Log-transformed Statistics**	
74	Minimum	0.00137	Minimum of Log Data	-6.59
75	Maximum	0.0697	Maximum of Log Data	-2.663
76	Mean	0.0116	Mean of log Data	-4.941
77	Median	0.00616	SD of log Data	0.913
78	SD	0.0149		
79	Std. Error of Mean	0.00238		
80	Coefficient of Variation	1.286		
81	Skewness	2.644		
82				
83	**Relevant UCL Statistics**			
84	**Normal Distribution Test**		**Lognormal Distribution Test**	
85	Shapiro Wilk Test Statistic	0.617	Shapiro Wilk Test Statistic	0.94
86	Shapiro Wilk Critical Value	0.939	Shapiro Wilk Critical Value	0.939
87	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
88				
89	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
90	95% Student's-t UCL	0.0156	95% H-UCL	0.0152
91	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0184
92	95% Adjusted-CLT UCL (Chen-1995)	0.0165	97.5% Chebyshev (MVUE) UCL	0.0218
93	95% Modified-t UCL (Johnson-1978)	0.0157	99% Chebyshev (MVUE) UCL	0.0284

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.105	**Data appear Lognormal at 5% Significance Level**	
Theta Star	0.0105		
MLE of Mean	0.0116		
MLE of Standard Deviation	0.011		
nu star	86.21		
Approximate Chi Square Value (.05)	65.81	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0437	95% CLT UCL	0.0155
Adjusted Chi Square Value	65.1	95% Jackknife UCL	0.0156
		95% Standard Bootstrap UCL	0.0153
Anderson-Darling Test Statistic	2.296	95% Bootstrap-t UCL	0.0176
Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	0.0168
Kolmogorov-Smirnov Test Statistic	0.235	95% Percentile Bootstrap UCL	0.0157
Kolmogorov-Smirnov 5% Critical Value	0.145	95% BCA Bootstrap UCL	0.0163
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0219
		97.5% Chebyshev(Mean, Sd) UCL	0.0264
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0352
95% Approximate Gamma UCL	0.0151		
95% Adjusted Gamma UCL	0.0153		
Potential UCL to Use		Use 95% H-UCL	0.0152
Per recommendation from the Battelle Statistician, the 95% BCA Bootstrap UCL is used in place of the 95% U-UCL		95% BCA Bootstrap UCL	0.0163

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

HH Fish PCB non-Dioxin

General Statistics

Number of Valid Observations	39	Number of Distinct Observations	39
Raw Statistics		**Log-transformed Statistics**	
Minimum	127	Minimum of Log Data	4.844
Maximum	5600	Maximum of Log Data	8.631
Mean	1228	Mean of log Data	6.734
Median	734.2	SD of log Data	0.844
SD	1287		
Std. Error of Mean	206.1		
Coefficient of Variation	1.049		
Skewness	2.109		

	A–E	F	G–K	L
141				
142	**Relevant UCL Statistics**			
143	**Normal Distribution Test**		**Lognormal Distribution Test**	
144	Shapiro Wilk Test Statistic	0.693	Shapiro Wilk Test Statistic	0.958
145	Shapiro Wilk Critical Value	0.939	Shapiro Wilk Critical Value	0.939
146	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
147				
148	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
149	95% Student's-t UCL	1575	95% H-UCL	1628
150	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1969
151	95% Adjusted-CLT UCL (Chen-1995)	1641	97.5% Chebyshev (MVUE) UCL	2309
152	95% Modified-t UCL (Johnson-1978)	1587	99% Chebyshev (MVUE) UCL	2975
153				
154	**Gamma Distribution Test**		**Data Distribution**	
155	k star (bias corrected)	1.367	**Data appear Lognormal at 5% Significance Level**	
156	Theta Star	898		
157	MLE of Mean	1228		
158	MLE of Standard Deviation	1050		
159	nu star	106.6		
160	Approximate Chi Square Value (.05)	83.8	**Nonparametric Statistics**	
161	Adjusted Level of Significance	0.0437	95% CLT UCL	1567
162	Adjusted Chi Square Value	83.01	95% Jackknife UCL	1575
163			95% Standard Bootstrap UCL	1560
164	Anderson-Darling Test Statistic	1.688	95% Bootstrap-t UCL	1724
165	Anderson-Darling 5% Critical Value	0.767	95% Hall's Bootstrap UCL	1607
166	Kolmogorov-Smirnov Test Statistic	0.179	95% Percentile Bootstrap UCL	1565
167	Kolmogorov-Smirnov 5% Critical Value	0.144	95% BCA Bootstrap UCL	1658
168	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	2126
169			97.5% Chebyshev(Mean, Sd) UCL	2515
170	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	3279
171	95% Approximate Gamma UCL	1562		
172	95% Adjusted Gamma UCL	1577		
173				
174	**Potential UCL to Use**		Use 95% H-UCL	1628
175	**Per recommendation from the Battelle Statistician, the 95% BCA Bootstrap UCL is used in place of the 95% U-UCL**		95% BCA Bootstrap UCL	1658
176	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
177	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
178	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
179	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
180				
181	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
182	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
183	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
184				
185				
186	**HH Crab DF TEQ**			

	A-E	F	G-K	L
187				
188	**General Statistics**			
189	Number of Valid Observations	22	Number of Distinct Observations	22
190				
191	**Raw Statistics**		**Log-transformed Statistics**	
192	Minimum	0.0257	Minimum of Log Data	-3.662
193	Maximum	0.115	Maximum of Log Data	-2.161
194	Mean	0.0665	Mean of log Data	-2.768
195	Median	0.0638	SD of log Data	0.362
196	SD	0.0222		
197	Std. Error of Mean	0.00474		
198	Coefficient of Variation	0.334		
199	Skewness	0.354		
200				
201	**Relevant UCL Statistics**			
202	**Normal Distribution Test**		**Lognormal Distribution Test**	
203	Shapiro Wilk Test Statistic	0.964	Shapiro Wilk Test Statistic	0.948
204	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
205	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
206				
207	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
208	95% Student's-t UCL	0.0747	95% H-UCL	0.0778
209	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0897
210	95% Adjusted-CLT UCL (Chen-1995)	0.0747	97.5% Chebyshev (MVUE) UCL	0.0997
211	95% Modified-t UCL (Johnson-1978)	0.0748	99% Chebyshev (MVUE) UCL	0.119
212				
213	**Gamma Distribution Test**		**Data Distribution**	
214	k star (bias corrected)	7.6	**Data appear Normal at 5% Significance Level**	
215	Theta Star	0.00876		
216	MLE of Mean	0.0665		
217	MLE of Standard Deviation	0.0241		
218	nu star	334.4		
219	Approximate Chi Square Value (.05)	293	**Nonparametric Statistics**	
220	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0743
221	Adjusted Chi Square Value	290.1	95% Jackknife UCL	0.0747
222			95% Standard Bootstrap UCL	0.0742
223	Anderson-Darling Test Statistic	0.417	95% Bootstrap-t UCL	0.0752
224	Anderson-Darling 5% Critical Value	0.744	95% Hall's Bootstrap UCL	0.0753
225	Kolmogorov-Smirnov Test Statistic	0.146	95% Percentile Bootstrap UCL	0.0742
226	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0749
227	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0872
228			97.5% Chebyshev(Mean, Sd) UCL	0.0962
229	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.114
230	95% Approximate Gamma UCL	0.0759		
231	95% Adjusted Gamma UCL	0.0767		
232				
233	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0747

	A	B	C	D	E	F	G	H	I	J	K	L
234												
235	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
236	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
237	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.											
238												
239												
240	HH Crab PCB TEQ											
241												
242	General Statistics											
243	Number of Valid Observations					22	Number of Distinct Observations					20
244												
245	Raw Statistics						Log-transformed Statistics					
246	Minimum					0.0008013	Minimum of Log Data					-7.129
247	Maximum					0.0173	Maximum of Log Data					-4.059
248	Mean					0.00986	Mean of log Data					-4.756
249	Median					0.0104	SD of log Data					0.674
250	SD					0.00375						
251	Std. Error of Mean					0.0007994						
252	Coefficient of Variation					0.38						
253	Skewness					-0.594						
254												
255	Relevant UCL Statistics											
256	Normal Distribution Test						Lognormal Distribution Test					
257	Shapiro Wilk Test Statistic					0.939	Shapiro Wilk Test Statistic					0.678
258	Shapiro Wilk Critical Value					0.911	Shapiro Wilk Critical Value					0.911
259	Data appear Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
260												
261	Assuming Normal Distribution						Assuming Lognormal Distribution					
262	95% Student's-t UCL					0.0112	95% H-UCL					0.0149
263	95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL					0.0178
264	95% Adjusted-CLT UCL (Chen-1995)					0.0111	97.5% Chebyshev (MVUE) UCL					0.0209
265	95% Modified-t UCL (Johnson-1978)					0.0112	99% Chebyshev (MVUE) UCL					0.0269
266												
267	Gamma Distribution Test						Data Distribution					
268	k star (bias corrected)					3.319	Data appear Normal at 5% Significance Level					
269	Theta Star					0.00297						
270	MLE of Mean					0.00986						
271	MLE of Standard Deviation					0.00541						
272	nu star					146.1						
273	Approximate Chi Square Value (.05)					119.1	Nonparametric Statistics					
274	Adjusted Level of Significance					0.0386	95% CLT UCL					0.0112
275	Adjusted Chi Square Value					117.3	95% Jackknife UCL					0.0112
276							95% Standard Bootstrap UCL					0.0111
277	Anderson-Darling Test Statistic					1.713	95% Bootstrap-t UCL					0.0111
278	Anderson-Darling 5% Critical Value					0.747	95% Hall's Bootstrap UCL					0.0111
279	Kolmogorov-Smirnov Test Statistic					0.246	95% Percentile Bootstrap UCL					0.0111
280	Kolmogorov-Smirnov 5% Critical Value					0.186	95% BCA Bootstrap UCL					0.011

	A-E	F	G-K	L
281	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0133
282			97.5% Chebyshev(Mean, Sd) UCL	0.0149
283	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0178
284	95% Approximate Gamma UCL	0.0121		
285	95% Adjusted Gamma UCL	0.0123		
286				
287	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0112
288				
289	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
290	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
291	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
292				
293	**Note: For highly negative-skewed data, confidence limits**			
294	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
295	**reliable. Chen's and Johnson's methods provide**			
296	**adjustments for positvely skewed data sets.**			
297				
298				
299	**HH Crab PCB non-Dioxin**			
300				
301	**General Statistics**			
302	Number of Valid Observations	22	Number of Distinct Observations	22
303				
304	**Raw Statistics**		**Log-transformed Statistics**	
305	Minimum	114.5	Minimum of Log Data	4.741
306	Maximum	689	Maximum of Log Data	6.535
307	Mean	324.2	Mean of log Data	5.705
308	Median	294.2	SD of log Data	0.405
309	SD	132		
310	Std. Error of Mean	28.14		
311	Coefficient of Variation	0.407		
312	Skewness	1.077		
313				
314	**Relevant UCL Statistics**			
315	**Normal Distribution Test**		**Lognormal Distribution Test**	
316	Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Test Statistic	0.976
317	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
318	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
319				
320	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
321	95% Student's-t UCL	372.6	95% H-UCL	386.1
322	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	450
323	95% Adjusted-CLT UCL (Chen-1995)	377.4	97.5% Chebyshev (MVUE) UCL	504.2
324	95% Modified-t UCL (Johnson-1978)	373.7	99% Chebyshev (MVUE) UCL	610.8
325				
326	**Gamma Distribution Test**		**Data Distribution**	
327	k star (bias corrected)	5.819	**Data appear Normal at 5% Significance Level**	

	A	B	C	D	E	F	G	H	I	J	K	L
328					Theta Star	55.71						
329					MLE of Mean	324.2						
330					MLE of Standard Deviation	134.4						
331					nu star	256.1						
332					Approximate Chi Square Value (.05)	220			**Nonparametric Statistics**			
333					Adjusted Level of Significance	0.0386					95% CLT UCL	370.5
334					Adjusted Chi Square Value	217.5					95% Jackknife UCL	372.6
335											95% Standard Bootstrap UCL	370.1
336					Anderson-Darling Test Statistic	0.345					95% Bootstrap-t UCL	383.6
337					Anderson-Darling 5% Critical Value	0.745					95% Hall's Bootstrap UCL	389.3
338					Kolmogorov-Smirnov Test Statistic	0.155					95% Percentile Bootstrap UCL	370.5
339					Kolmogorov-Smirnov 5% Critical Value	0.186					95% BCA Bootstrap UCL	374.1
340	**Data appear Gamma Distributed at 5% Significance Level**										95% Chebyshev(Mean, Sd) UCL	446.9
341											97.5% Chebyshev(Mean, Sd) UCL	500
342	**Assuming Gamma Distribution**										99% Chebyshev(Mean, Sd) UCL	604.2
343					95% Approximate Gamma UCL	377.3						
344					95% Adjusted Gamma UCL	381.7						
345												
346	**Potential UCL to Use**										Use 95% Student's-t UCL	372.6
347												
348	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
349	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
350	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
351												

	A	B	C	D	E	F	G	H	I	J	K	L
1				**General UCL Statistics for Data Sets with Non-Detects**								
2			**User Selected Options**									
3			From File	C:\Documents and Settings\rodgersp\My Documents\PROJECTS\Passaic River\FFS\Risk Assessment\2011 Ris								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	**Methyl Hg**											
10												
11						**General Statistics**						
12					Number of Valid Observations	39					Number of Distinct Observations	28
13												
14			**Raw Statistics**						**Log-transformed Statistics**			
15					Minimum	70					Minimum of Log Data	4.248
16					Maximum	830					Maximum of Log Data	6.721
17					Mean	295.3					Mean of log Data	5.467
18					Median	230					SD of log Data	0.696
19					SD	191.3						
20					Std. Error of Mean	30.64						
21					Coefficient of Variation	0.648						
22					Skewness	0.82						
23												
24						**Relevant UCL Statistics**						
25			**Normal Distribution Test**						**Lognormal Distribution Test**			
26					Shapiro Wilk Test Statistic	0.907					Shapiro Wilk Test Statistic	0.939
27					Shapiro Wilk Critical Value	0.939					Shapiro Wilk Critical Value	0.939
28			**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**			
29												
30			**Assuming Normal Distribution**						**Assuming Lognormal Distribution**			
31					95% Student's-t UCL	346.9					95% H-UCL	381.7
32			**95% UCLs (Adjusted for Skewness)**								95% Chebyshev (MVUE) UCL	457.7
33					95% Adjusted-CLT UCL (Chen-1995)	349.9					97.5% Chebyshev (MVUE) UCL	526.2
34					95% Modified-t UCL (Johnson-1978)	347.6					99% Chebyshev (MVUE) UCL	660.8
35												
36			**Gamma Distribution Test**						**Data Distribution**			
37					k star (bias corrected)	2.246			**Data appear Gamma Distributed at 5% Significance Level**			
38					Theta Star	131.5						
39					MLE of Mean	295.3						
40					MLE of Standard Deviation	197						
41					nu star	175.2						
42					Approximate Chi Square Value (.05)	145.6			**Nonparametric Statistics**			
43					Adjusted Level of Significance	0.0437					95% CLT UCL	345.6
44					Adjusted Chi Square Value	144.5					95% Jackknife UCL	346.9
45											95% Standard Bootstrap UCL	346.1
46					Anderson-Darling Test Statistic	0.693					95% Bootstrap-t UCL	353.5
47					Anderson-Darling 5% Critical Value	0.757					95% Hall's Bootstrap UCL	352.9

	A B C D E	F	G H I J K	L
48	Kolmogorov-Smirnov Test Statistic	0.122	95% Percentile Bootstrap UCL	346.9
49	Kolmogorov-Smirnov 5% Critical Value	0.143	95% BCA Bootstrap UCL	346.6
50	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	428.8
51			97.5% Chebyshev(Mean, Sd) UCL	486.6
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	600.1
53	95% Approximate Gamma UCL	355.3		
54	95% Adjusted Gamma UCL	357.9		
55				
56	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	355.3
57				
58	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
59	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
60	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
61				
62				
63	DDT			
64				
65	**General Statistics**			
66	Number of Valid Data	39	Number of Detected Data	23
67	Number of Distinct Detected Data	17	Number of Non-Detect Data	16
68			Percent Non-Detects	41.03%
69				
70	**Raw Statistics**		**Log-transformed Statistics**	
71	Minimum Detected	0.62	Minimum Detected	-0.478
72	Maximum Detected	14	Maximum Detected	2.639
73	Mean of Detected	4.627	Mean of Detected	1.242
74	SD of Detected	3.755	SD of Detected	0.788
75	Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
76	Maximum Non-Detect	19	Maximum Non-Detect	2.944
77				
78	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	39
79	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
80	Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
81				
82	**UCL Statistics**			
83	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
84	Shapiro Wilk Test Statistic	0.809	Shapiro Wilk Test Statistic	0.967
85	5% Shapiro Wilk Critical Value	0.914	5% Shapiro Wilk Critical Value	0.914
86	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
87				
88	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
89	DL/2 Substitution Method		DL/2 Substitution Method	
90	Mean	3.94	Mean	0.98
91	SD	3.445	SD	0.965
92	95% DL/2 (t) UCL	4.87	95% H-Stat (DL/2) UCL	6.145
93				
94	Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	

	A	B	C	D	E	F	G	H	I	J	K	L
95	**MLE method failed to converge properly**										Mean in Log Scale	0.855
96											SD in Log Scale	0.825
97											Mean in Original Scale	3.343
98											SD in Original Scale	3.278
99											95% t UCL	4.228
100											95% Percentile Bootstrap UCL	4.235
101											95% BCA Bootstrap UCL	4.355
102											95% H-UCL	4.447
103												
104	**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**					
105					k star (bias corrected)	1.661	**Data appear Gamma Distributed at 5% Significance Level**					
106					Theta Star	2.785						
107					nu star	76.42						
108												
109					A-D Test Statistic	0.566	**Nonparametric Statistics**					
110					5% A-D Critical Value	0.756					Kaplan-Meier (KM) Method	
111					K-S Test Statistic	0.756					Mean	3.478
112					5% K-S Critical Value	0.184					SD	3.365
113	**Data appear Gamma Distributed at 5% Significance Level**										SE of Mean	0.582
114											95% KM (t) UCL	4.459
115	**Assuming Gamma Distribution**										95% KM (z) UCL	4.435
116					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	4.378
117					Minimum	0.000001					95% KM (bootstrap t) UCL	4.684
118					Maximum	14					95% KM (BCA) UCL	4.688
119					Mean	3.289					95% KM (Percentile Bootstrap) UCL	4.501
120					Median	2.511					95% KM (Chebyshev) UCL	6.013
121					SD	3.394					97.5% KM (Chebyshev) UCL	7.11
122					k star	0.307					99% KM (Chebyshev) UCL	9.265
123					Theta star	10.73						
124					Nu star	23.91	**Potential UCLs to Use**					
125					AppChi2	13.78					95% KM (t) UCL	4.459
126					95% Gamma Approximate UCL	5.706						
127					95% Adjusted Gamma UCL	5.835						
128	**Note: DL/2 is not a recommended method.**											
129												
130	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
131	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
132	**For additional insight, the user may want to consult a statistician.**											
133												
134												
135	DDD											
136												
137	**General Statistics**											
138					Number of Valid Data	39					Number of Detected Data	32
139					Number of Distinct Detected Data	27					Number of Non-Detect Data	7
140											Percent Non-Detects	17.95%
141												

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	5	Minimum Detected	1.609
Maximum Detected	320	Maximum Detected	5.768
Mean of Detected	58.38	Mean of Detected	3.63
SD of Detected	65.37	SD of Detected	0.943
Minimum Non-Detect	15	Minimum Non-Detect	2.708
Maximum Non-Detect	87	Maximum Non-Detect	4.466
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	33
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	6
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	84.62%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.697	Shapiro Wilk Test Statistic	0.986
5% Shapiro Wilk Critical Value	0.93	5% Shapiro Wilk Critical Value	0.93
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	50.73	Mean	3.438
SD	61.53	SD	0.98
95% DL/2 (t) UCL	67.34	95% H-Stat (DL/2) UCL	73.39
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	3.451
		SD in Log Scale	0.946
		Mean in Original Scale	50.54
		SD in Original Scale	61.48
		95% t UCL	67.13
		95% Percentile Bootstrap UCL	67.48
		95% BCA Bootstrap UCL	71.95
		95% H-UCL	70.66
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.186	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	49.21		
nu star	75.92		
A-D Test Statistic	0.575	**Nonparametric Statistics**	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	50.7
5% K-S Critical Value	0.159	SD	60.73
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	9.903
		95% KM (t) UCL	67.4
Assuming Gamma Distribution		95% KM (z) UCL	66.99
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	67.35

	A	B	C	D	E	F	G	H	I	J	K	L
189					Minimum	0.000001					95% KM (bootstrap t) UCL	78.44
190					Maximum	320					95% KM (BCA) UCL	68.64
191					Mean	49.52					95% KM (Percentile Bootstrap) UCL	69.28
192					Median	37					95% KM (Chebyshev) UCL	93.87
193					SD	62.33					97.5% KM (Chebyshev) UCL	112.5
194					k star	0.314					99% KM (Chebyshev) UCL	149.2
195					Theta star	157.5						
196					Nu star	24.52	**Potential UCLs to Use**					
197					AppChi2	14.24					95% KM (BCA) UCL	68.64
198					95% Gamma Approximate UCL	85.24						
199					95% Adjusted Gamma UCL	87.14						
200	**Note: DL/2 is not a recommended method.**											
201												
202	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
203	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
204	**For additional insight, the user may want to consult a statistician.**											
205												
206												
207	DDE											
208												
209	**General Statistics**											
210					Number of Valid Observations	39					Number of Distinct Observations	30
211												
212	**Raw Statistics**						**Log-transformed Statistics**					
213					Minimum	12					Minimum of Log Data	2.485
214					Maximum	420					Maximum of Log Data	6.04
215					Mean	98.64					Mean of log Data	4.231
216					Median	73					SD of log Data	0.877
217					SD	88.76						
218					Std. Error of Mean	14.21						
219					Coefficient of Variation	0.9						
220					Skewness	1.81						
221												
222	**Relevant UCL Statistics**											
223	**Normal Distribution Test**						**Lognormal Distribution Test**					
224					Shapiro Wilk Test Statistic	0.816					Shapiro Wilk Test Statistic	0.963
225					Shapiro Wilk Critical Value	0.939					Shapiro Wilk Critical Value	0.939
226	**Data not Normal at 5% Significance Level**						**Data appear Lognormal at 5% Significance Level**					
227												
228	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
229					95% Student's-t UCL	122.6					95% H-UCL	139.4
230	**95% UCLs (Adjusted for Skewness)**										95% Chebyshev (MVUE) UCL	168.7
231					95% Adjusted-CLT UCL (Chen-1995)	126.4					97.5% Chebyshev (MVUE) UCL	198.6
232					95% Modified-t UCL (Johnson-1978)	123.3					99% Chebyshev (MVUE) UCL	257.3
233												
234	**Gamma Distribution Test**						**Data Distribution**					
235					k star (bias corrected)	1.43	**Data Follow Appr. Gamma Distribution at 5% Significance Level**					

	A–E	F	G–K	L
236	Theta Star	68.98		
237	MLE of Mean	98.64		
238	MLE of Standard Deviation	82.49		
239	nu star	111.5		
240	Approximate Chi Square Value (.05)	88.16	**Nonparametric Statistics**	
241	Adjusted Level of Significance	0.0437	95% CLT UCL	122
242	Adjusted Chi Square Value	87.34	95% Jackknife UCL	122.6
243			95% Standard Bootstrap UCL	121.7
244	Anderson-Darling Test Statistic	0.624	95% Bootstrap-t UCL	129.9
245	Anderson-Darling 5% Critical Value	0.766	95% Hall's Bootstrap UCL	131.4
246	Kolmogorov-Smirnov Test Statistic	0.149	95% Percentile Bootstrap UCL	122.5
247	Kolmogorov-Smirnov 5% Critical Value	0.144	95% BCA Bootstrap UCL	127.5
248	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	160.6
249			97.5% Chebyshev(Mean, Sd) UCL	187.4
250	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	240.1
251	95% Approximate Gamma UCL	124.8		
252	95% Adjusted Gamma UCL	126		
253				
254	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	124.8
255				
256	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
257	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
258	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
259				
260				
261	**Dieldrin**			
262				
263	**General Statistics**			
264	Number of Valid Observations	39	Number of Distinct Observations	33
265				
266	**Raw Statistics**		**Log-transformed Statistics**	
267	Minimum	1.7	Minimum of Log Data	0.531
268	Maximum	100	Maximum of Log Data	4.605
269	Mean	19.19	Mean of log Data	2.565
270	Median	14	SD of log Data	0.918
271	SD	19.14		
272	Std. Error of Mean	3.066		
273	Coefficient of Variation	0.997		
274	Skewness	2.475		
275				
276	**Relevant UCL Statistics**			
277	**Normal Distribution Test**		**Lognormal Distribution Test**	
278	Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.986
279	Shapiro Wilk Critical Value	0.939	Shapiro Wilk Critical Value	0.939
280	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
281				
282	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	

	A	B	C	D	E	F	G	H	I	J	K	L
283					95% Student's-t UCL	24.36					95% H-UCL	27.92
284	95% UCLs (Adjusted for Skewness)										95% Chebyshev (MVUE) UCL	33.78
285					95% Adjusted-CLT UCL (Chen-1995)	25.54					97.5% Chebyshev (MVUE) UCL	39.96
286					95% Modified-t UCL (Johnson-1978)	24.57					99% Chebyshev (MVUE) UCL	52.09
287												
288	Gamma Distribution Test						Data Distribution					
289					k star (bias corrected)	1.333	Data appear Gamma Distributed at 5% Significance Level					
290					Theta Star	14.4						
291					MLE of Mean	19.19						
292					MLE of Standard Deviation	16.63						
293					nu star	104						
294					Approximate Chi Square Value (.05)	81.43	Nonparametric Statistics					
295					Adjusted Level of Significance	0.0437					95% CLT UCL	24.24
296					Adjusted Chi Square Value	80.64					95% Jackknife UCL	24.36
297											95% Standard Bootstrap UCL	24.2
298					Anderson-Darling Test Statistic	0.392					95% Bootstrap-t UCL	26.82
299					Anderson-Darling 5% Critical Value	0.768					95% Hall's Bootstrap UCL	29.02
300					Kolmogorov-Smirnov Test Statistic	0.11					95% Percentile Bootstrap UCL	24.72
301					Kolmogorov-Smirnov 5% Critical Value	0.144					95% BCA Bootstrap UCL	26.01
302	Data appear Gamma Distributed at 5% Significance Level										95% Chebyshev(Mean, Sd) UCL	32.56
303											97.5% Chebyshev(Mean, Sd) UCL	38.34
304	Assuming Gamma Distribution										99% Chebyshev(Mean, Sd) UCL	49.7
305					95% Approximate Gamma UCL	24.51						
306					95% Adjusted Gamma UCL	24.74						
307												
308	Potential UCL to Use										Use 95% Approximate Gamma UCL	24.51
309												
310	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
311	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
312	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.											
313												

	General UCL Statistics for Data Sets with Non-Detects	
User Selected Options		
From File	C:\Documents and Settings\rodgersp\My Documents\PROJECTS\Passaic River\FFS\Risk Assessment\2011 Ris	
Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations	2000	

Methyl Mercury

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	89	Minimum of Log Data	4.489
Maximum	230	Maximum of Log Data	5.438
Mean	159.1	Mean of log Data	5.036
Median	160	SD of log Data	0.274
SD	40.21		
Std. Error of Mean	8.572		
Coefficient of Variation	0.253		
Skewness	-0.222		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	173.8	95% H-UCL	178
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	200.4
95% Adjusted-CLT UCL (Chen-1995)	172.8	97.5% Chebyshev (MVUE) UCL	218.2
95% Modified-t UCL (Johnson-1978)	173.8	99% Chebyshev (MVUE) UCL	253
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	12.96	**Data appear Normal at 5% Significance Level**	
Theta Star	12.27		
MLE of Mean	159.1		
MLE of Standard Deviation	44.18		
nu star	570.4		
Approximate Chi Square Value (.05)	516	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	173.2
Adjusted Chi Square Value	512.2	95% Jackknife UCL	173.8
		95% Standard Bootstrap UCL	172.9
Anderson-Darling Test Statistic	0.532	95% Bootstrap-t UCL	173.9
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	172.5

	A–F	F	G–K	L
48	Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL	172.7
49	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	173
50	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	196.5
51			97.5% Chebyshev(Mean, Sd) UCL	212.6
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	244.4
53	95% Approximate Gamma UCL	175.9		
54	95% Adjusted Gamma UCL	177.2		
55				
56	**Potential UCL to Use**		Use 95% Student's-t UCL	173.8
57				
58	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
59	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
60	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
61				
62	**Note: For highly negative-skewed data, confidence limits**			
63	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
64	**reliable. Chen's and Johnson's methods provide**			
65	**adjustments for positvely skewed data sets.**			
66				
67				
68	**P,P'-DDT**			
69				
70	**General Statistics**			
71	Number of Valid Data	22	Number of Detected Data	16
72	Number of Distinct Detected Data	13	Number of Non-Detect Data	6
73			Percent Non-Detects	27.27%
74				
75	**Raw Statistics**		**Log-transformed Statistics**	
76	Minimum Detected	0.25	Minimum Detected	-1.386
77	Maximum Detected	12	Maximum Detected	2.485
78	Mean of Detected	2.919	Mean of Detected	0.631
79	SD of Detected	3.114	SD of Detected	0.992
80	Minimum Non-Detect	1.1	Minimum Non-Detect	0.0953
81	Maximum Non-Detect	5.6	Maximum Non-Detect	1.723
82				
83	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	20
84	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
85	Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.91%
86				
87	**UCL Statistics**			
88	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
89	Shapiro Wilk Test Statistic	0.731	Shapiro Wilk Test Statistic	0.974
90	5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
91	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
92				
93	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
94	DL/2 Substitution Method		DL/2 Substitution Method	

	A	B	C	D	E	F	G	H	I	J	K	L
95					Mean	2.475					Mean	0.482
96					SD	2.767					SD	0.926
97					95% DL/2 (t) UCL	3.49					95% H-Stat (DL/2) UCL	4.11
98												
99					Maximum Likelihood Estimate(MLE) Method	N/A					Log ROS Method	
100	**MLE method failed to converge properly**										Mean in Log Scale	0.407
101											SD in Log Scale	0.938
102											Mean in Original Scale	2.363
103											SD in Original Scale	2.796
104											95% t UCL	3.388
105											95% Percentile Bootstrap UCL	3.429
106											95% BCA Bootstrap UCL	3.747
107											95% H-UCL	3.892
108												
109	**Gamma Distribution Test with Detected Values Only**						**Data Distribution Test with Detected Values Only**					
110					k star (bias corrected)	1.08	**Data appear Gamma Distributed at 5% Significance Level**					
111					Theta Star	2.703						
112					nu star	34.56						
113												
114					A-D Test Statistic	0.46	**Nonparametric Statistics**					
115					5% A-D Critical Value	0.759					Kaplan-Meier (KM) Method	
116					K-S Test Statistic	0.759					Mean	2.403
117					5% K-S Critical Value	0.22					SD	2.738
118	**Data appear Gamma Distributed at 5% Significance Level**										SE of Mean	0.609
119											95% KM (t) UCL	3.452
120	**Assuming Gamma Distribution**										95% KM (z) UCL	3.406
121					Gamma ROS Statistics using Extrapolated Data						95% KM (jackknife) UCL	3.445
122					Minimum	0.000001					95% KM (bootstrap t) UCL	4.58
123					Maximum	12					95% KM (BCA) UCL	3.443
124					Mean	2.354					95% KM (Percentile Bootstrap) UCL	3.385
125					Median	1.873					95% KM (Chebyshev) UCL	5.06
126					SD	2.831					97.5% KM (Chebyshev) UCL	6.209
127					k star	0.373					99% KM (Chebyshev) UCL	8.467
128					Theta star	6.316						
129					Nu star	16.4	**Potential UCLs to Use**					
130					AppChi2	8.243					95% KM (Percentile Bootstrap) UCL	3.385
131					95% Gamma Approximate UCL	4.682						
132					95% Adjusted Gamma UCL	4.94						
133	**Note: DL/2 is not a recommended method.**											
134												
135	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
136	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
137	**For additional insight, the user may want to consult a statistician.**											
138												
139												
140	**P,P'-DDD**											
141												

	A–E	F	G–K	L
142	**General Statistics**			
143	Number of Valid Data	22	Number of Detected Data	20
144	Number of Distinct Detected Data	11	Number of Non-Detect Data	2
145			Percent Non-Detects	9.09%
146				
147	**Raw Statistics**		**Log-transformed Statistics**	
148	Minimum Detected	11	Minimum Detected	2.398
149	Maximum Detected	36	Maximum Detected	3.584
150	Mean of Detected	20.65	Mean of Detected	2.987
151	SD of Detected	6.226	SD of Detected	0.294
152	Minimum Non-Detect	11	Minimum Non-Detect	2.398
153	Maximum Non-Detect	15	Maximum Non-Detect	2.708
154				
155	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	4
156	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	18
157	Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	18.18%
158				
159	**UCL Statistics**			
160	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
161	Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Test Statistic	0.923
162	5% Shapiro Wilk Critical Value	0.905	5% Shapiro Wilk Critical Value	0.905
163	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
164				
165	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
166	DL/2 Substitution Method		DL/2 Substitution Method	
167	Mean	19.36	Mean	2.884
168	SD	7.246	SD	0.436
169	95% DL/2 (t) UCL	22.02	95% H-Stat (DL/2) UCL	23.67
170				
171	Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
172	Mean	19.81	Mean in Log Scale	2.931
173	SD	6.5	SD in Log Scale	0.334
174	95% MLE (t) UCL	22.2	Mean in Original Scale	19.75
175	95% MLE (Tiku) UCL	22.22	SD in Original Scale	6.604
176			95% t UCL	22.18
177			95% Percentile Bootstrap UCL	22.12
178			95% BCA Bootstrap UCL	22.15
179			95% H UCL	22.7
180				
181	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
182	k star (bias corrected)	10.52	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
183	Theta Star	1.963		
184	nu star	420.9		
185				
186	A-D Test Statistic	0.749	**Nonparametric Statistics**	
187	5% A-D Critical Value	0.742	Kaplan-Meier (KM) Method	
188	K-S Test Statistic	0.742	Mean	19.77

189	5% K-S Critical Value	0.194	SD	6.417
190	**Data follow Appr. Gamma Distribution at 5% Significance Level**		SE of Mean	1.404
191			95% KM (t) UCL	22.19
192	**Assuming Gamma Distribution**		95% KM (z) UCL	22.08
193	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	22.18
194	Minimum	1.979	95% KM (bootstrap t) UCL	22.67
195	Maximum	36	95% KM (BCA) UCL	22.27
196	Mean	19.23	95% KM (Percentile Bootstrap) UCL	22.23
197	Median	19	95% KM (Chebyshev) UCL	25.89
198	SD	7.558	97.5% KM (Chebyshev) UCL	28.54
199	k star	3.909	99% KM (Chebyshev) UCL	33.74
200	Theta star	4.919		
201	Nu star	172	**Potential UCLs to Use**	
202	AppChi2	142.7	95% KM (BCA) UCL	22.27
203	95% Gamma Approximate UCL	23.18		
204	95% Adjusted Gamma UCL	23.51		
205	**Note: DL/2 is not a recommended method.**			
206				
207	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
208	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**			
209	**For additional insight, the user may want to consult a statistician.**			
210				
211				
212	**P,P'-DDE**			
213				
214	**General Statistics**			
215	Number of Valid Observations	22	Number of Distinct Observations	19
216				
217	**Raw Statistics**		**Log-transformed Statistics**	
218	Minimum	21	Minimum of Log Data	3.045
219	Maximum	77	Maximum of Log Data	4.344
220	Mean	52.41	Mean of log Data	3.923
221	Median	49.5	SD of log Data	0.29
222	SD	13.45		
223	Std. Error of Mean	2.868		
224	Coefficient of Variation	0.257		
225	Skewness	-0.212		
226				
227	**Relevant UCL Statistics**			
228	**Normal Distribution Test**		**Lognormal Distribution Test**	
229	Shapiro Wilk Test Statistic	0.971	Shapiro Wilk Test Statistic	0.912
230	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
231	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
232				
233	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
234	95% Student's-t UCL	57.34	95% H-UCL	59.18
235	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	66.97

	A	B	C	D	E	F	G	H	I	J	K	L
236	95% Adjusted-CLT UCL (Chen-1995)					56.99	97.5% Chebyshev (MVUE) UCL					73.18
237	95% Modified-t UCL (Johnson-1978)					57.32	99% Chebyshev (MVUE) UCL					85.39
238												
239	**Gamma Distribution Test**						**Data Distribution**					
240	k star (bias corrected)					12.04	**Data appear Normal at 5% Significance Level**					
241	Theta Star					4.354						
242	MLE of Mean					52.41						
243	MLE of Standard Deviation					15.11						
244	nu star					529.7						
245	Approximate Chi Square Value (.05)					477.3	**Nonparametric Statistics**					
246	Adjusted Level of Significance					0.0386	95% CLT UCL					57.13
247	Adjusted Chi Square Value					473.6	95% Jackknife UCL					57.34
248							95% Standard Bootstrap UCL					57.02
249	Anderson-Darling Test Statistic					0.382	95% Bootstrap-t UCL					57.29
250	Anderson-Darling 5% Critical Value					0.742	95% Hall's Bootstrap UCL					56.88
251	Kolmogorov-Smirnov Test Statistic					0.123	95% Percentile Bootstrap UCL					57.05
252	Kolmogorov-Smirnov 5% Critical Value					0.185	95% BCA Bootstrap UCL					56.82
253	**Data appear Gamma Distributed at 5% Significance Level**						95% Chebyshev(Mean, Sd) UCL					64.91
254							97.5% Chebyshev(Mean, Sd) UCL					70.32
255	**Assuming Gamma Distribution**						99% Chebyshev(Mean, Sd) UCL					80.94
256	95% Approximate Gamma UCL					58.16						
257	95% Adjusted Gamma UCL					58.61						
258												
259	**Potential UCL to Use**						Use 95% Student's-t UCL					57.34
260												
261	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
262	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
263	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
264												
265	**Note: For highly negative-skewed data, confidence limits**											
266	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
267	**reliable. Chen's and Johnson's methods provide**											
268	**adjustments for positvely skewed data sets.**											
269												
270												
271	GAMMA-CHLORDANE											
272												
273	**General Statistics**											
274	Number of Valid Data					22	Number of Detected Data					18
275	Number of Distinct Detected Data					14	Number of Non-Detect Data					4
276							Percent Non-Detects					18.18%
277												
278	**Raw Statistics**						**Log-transformed Statistics**					
279	Minimum Detected					0.18	Minimum Detected					-1.715
280	Maximum Detected					1.4	Maximum Detected					0.336
281	Mean of Detected					0.637	Mean of Detected					-0.576
282	SD of Detected					0.322	SD of Detected					0.531

	A–E	F	G–K	L
283	Minimum Non-Detect	0.15	Minimum Non-Detect	-1.897
284	Maximum Non-Detect	1.3	Maximum Non-Detect	0.262
285				
286	Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	21
287	For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	1
288	Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	95.45%
289				
290	**UCL Statistics**			
291	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
292	Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Test Statistic	0.977
293	5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
294	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
295				
296	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
297	DL/2 Substitution Method		DL/2 Substitution Method	
298	Mean	0.577	Mean	-0.735
299	SD	0.331	SD	0.68
300	95% DL/2 (t) UCL	0.698	95% H-Stat (DL/2) UCL	0.835
301				
302	Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
303	**MLE method failed to converge properly**		Mean in Log Scale	-0.694
304			SD in Log Scale	0.57
305			Mean in Original Scale	0.579
306			SD in Original Scale	0.32
307			95% t UCL	0.696
308			95% Percentile Bootstrap UCL	0.691
309			95% BCA Bootstrap UCL	0.711
310			95% H-UCL	0.76
311				
312	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
313	k star (bias corrected)	3.499	**Data appear Normal at 5% Significance Level**	
314	Theta Star	0.182		
315	nu star	126		
316				
317	A-D Test Statistic	0.181	**Nonparametric Statistics**	
318	5% A-D Critical Value	0.743	Kaplan-Meier (KM) Method	
319	K-S Test Statistic	0.743	Mean	0.583
320	5% K-S Critical Value	0.205	SD	0.318
321	**Data appear Gamma Distributed at 5% Significance Level**		SE of Mean	0.0714
322			95% KM (t) UCL	0.706
323	**Assuming Gamma Distribution**		95% KM (z) UCL	0.7
324	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.703
325	Minimum	0.000001	95% KM (bootstrap t) UCL	0.724
326	Maximum	1.4	95% KM (BCA) UCL	0.706
327	Mean	0.573	95% KM (Percentile Bootstrap) UCL	0.7
328	Median	0.57	95% KM (Chebyshev) UCL	0.894
329	SD	0.335	97.5% KM (Chebyshev) UCL	1.029

k star	0.77	99% KM (Chebyshev) UCL	1.293
Theta star	0.745		
Nu star	33.87	**Potential UCLs to Use**	
AppChi2	21.56	95% KM (t) UCL	0.706
95% Gamma Approximate UCL	0.901	95% KM (Percentile Bootstrap) UCL	0.7
95% Adjusted Gamma UCL	0.932		

Note: DL/2 is not a recommended method.

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

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

ALPHA-CHLORDANE

General Statistics

Number of Valid Data	22	Number of Detected Data	21
Number of Distinct Detected Data	15	Number of Non-Detect Data	1
		Percent Non-Detects	4.55%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1.5	Minimum Detected	0.405
Maximum Detected	8.1	Maximum Detected	2.092
Mean of Detected	4.462	Mean of Detected	1.392
SD of Detected	1.984	SD of Detected	0.484
Minimum Non-Detect	4.1	Minimum Non-Detect	1.411
Maximum Non-Detect	4.1	Maximum Non-Detect	1.411

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Test Statistic	0.958
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.352	Mean	1.361
SD	2.003	SD	0.494
95% DL/2 (t) UCL	5.087	95% H-Stat (DL/2) UCL	5.461
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	4.161	Mean in Log Scale	1.375
SD	2.268	SD in Log Scale	0.479
95% MLE (t) UCL	4.993	Mean in Original Scale	4.385
95% MLE (Tiku) UCL	5.185	SD in Original Scale	1.969
		95% t UCL	5.108

	A–E	F	G–K	L
377			95% Percentile Bootstrap UCL	5.067
378			95% BCA Bootstrap UCL	5.118
379			95% H UCL	5.455
380				
381	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
382	k star (bias corrected)	4.293	**Data appear Normal at 5% Significance Level**	
383	Theta Star	1.039		
384	nu star	180.3		
385				
386	A-D Test Statistic	0.249	**Nonparametric Statistics**	
387	5% A-D Critical Value	0.745	Kaplan-Meier (KM) Method	
388	K-S Test Statistic	0.745	Mean	4.385
389	5% K-S Critical Value	0.19	SD	1.931
390	**Data appear Gamma Distributed at 5% Significance Level**		SE of Mean	0.423
391			95% KM (t) UCL	5.113
392	**Assuming Gamma Distribution**		95% KM (z) UCL	5.081
393	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	5.113
394	Minimum	1.5	95% KM (bootstrap t) UCL	5.155
395	Maximum	8.1	95% KM (BCA) UCL	5.073
396	Mean	4.4	95% KM (Percentile Bootstrap) UCL	5.091
397	Median	4.3	95% KM (Chebyshev) UCL	6.23
398	SD	1.957	97.5% KM (Chebyshev) UCL	7.029
399	k star	4.412	99% KM (Chebyshev) UCL	8.598
400	Theta star	0.997		
401	Nu star	194.1	**Potential UCLs to Use**	
402	AppChi2	162.9	95% KM (t) UCL	5.113
403	95% Gamma Approximate UCL	5.244	95% KM (Percentile Bootstrap) UCL	5.091
404	95% Adjusted Gamma UCL	5.314		
405	**Note: DL/2 is not a recommended method.**			
406				
407	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
408	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**			
409	**For additional insight, the user may want to consult a statistician.**			
410				
411				
412	DIELDRIN			
413				
414	**General Statistics**			
415	Number of Valid Data	22	Number of Detected Data	21
416	Number of Distinct Detected Data	19	Number of Non-Detect Data	1
417			Percent Non-Detects	4.55%
418				
419	**Raw Statistics**		**Log-transformed Statistics**	
420	Minimum Detected	2	Minimum Detected	0.693
421	Maximum Detected	13	Maximum Detected	2.565
422	Mean of Detected	7.448	Mean of Detected	1.937
423	SD of Detected	2.63	SD of Detected	0.416

	A–E	F	G–K	L
424	Minimum Non-Detect	20	Minimum Non-Detect	2.996
425	Maximum Non-Detect	20	Maximum Non-Detect	2.996
426				
427				
428	**UCL Statistics**			
429	**Normal Distribution Test with Detected Values Only**		**Lognormal Distribution Test with Detected Values Only**	
430	Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Test Statistic	0.904
431	5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
432	**Data appear Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
433				
434	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
435	DL/2 Substitution Method		DL/2 Substitution Method	
436	Mean	7.564	Mean	1.953
437	SD	2.624	SD	0.414
438	95% DL/2 (t) UCL	8.526	95% H-Stat (DL/2) UCL	9.136
439				
440	Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
441	**MLE method failed to converge properly**		Mean in Log Scale	1.937
442			SD in Log Scale	0.406
443			Mean in Original Scale	7.424
444			SD in Original Scale	2.569
445			95% t UCL	8.367
446			95% Percentile Bootstrap UCL	8.33
447			95% BCA Bootstrap UCL	8.345
448			95% H-UCL	8.926
449				
450	**Gamma Distribution Test with Detected Values Only**		**Data Distribution Test with Detected Values Only**	
451	k star (bias corrected)	6.186	**Data appear Normal at 5% Significance Level**	
452	Theta Star	1.204		
453	nu star	259.8		
454				
455	A-D Test Statistic	0.383	**Nonparametric Statistics**	
456	5% A-D Critical Value	0.744	Kaplan-Meier (KM) Method	
457	K-S Test Statistic	0.744	Mean	7.448
458	5% K-S Critical Value	0.19	SD	2.567
459	**Data appear Gamma Distributed at 5% Significance Level**		SE of Mean	0.574
460			95% KM (t) UCL	8.435
461	**Assuming Gamma Distribution**		95% KM (z) UCL	8.392
462	Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	8.436
463	Minimum	2	95% KM (bootstrap t) UCL	8.499
464	Maximum	13	95% KM (BCA) UCL	8.43
465	Mean	7.471	95% KM (Percentile Bootstrap) UCL	8.367
466	Median	7.25	95% KM (Chebyshev) UCL	9.949
467	SD	2.569	97.5% KM (Chebyshev) UCL	11.03
468	k star	6.511	99% KM (Chebyshev) UCL	13.16
469	Theta star	1.147		
470	Nu star	286.5	**Potential UCLs to Use**	

	A	B	C	D	E	F	G	H	I	J	K	L
471					AppChi2	248.3					95% KM (t) UCL	8.435
472					95% Gamma Approximate UCL	8.621					95% KM (Percentile Bootstrap) UCL	8.367
473					95% Adjusted Gamma UCL	8.714						
474	**Note: DL/2 is not a recommended method.**											
475												
476	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
477	**These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).**											
478	**For additional insight, the user may want to consult a statistician.**											
479												

	A–C	D–F	G–K	L
1		**General UCL Statistics for Full Data Sets**		
2	**User Selected Options**			
3	From File	WorkSheet.wst		
4	Full Precision	OFF		
5	Confidence Coefficient	95%		
6	Number of Bootstrap Operations	2000		
7				
8				
9	**Chlordane Fish**			
10				
11		**General Statistics**		
12	Number of Valid Observations	39	Number of Distinct Observations	36
13				
14	**Raw Statistics**		**Log-transformed Statistics**	
15	Minimum	3.9	Minimum of Log Data	1.361
16	Maximum	280	Maximum of Log Data	5.635
17	Mean	44.43	Mean of log Data	3.456
18	Median	27.5	SD of log Data	0.787
19	SD	48.89		
20	Std. Error of Mean	7.829		
21	Coefficient of Variation	1.1		
22	Skewness	3.42		
23				
24		**Relevant UCL Statistics**		
25	**Normal Distribution Test**		**Lognormal Distribution Test**	
26	Shapiro Wilk Test Statistic	0.63	Shapiro Wilk Test Statistic	0.972
27	Shapiro Wilk Critical Value	0.939	Shapiro Wilk Critical Value	0.939
28	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
29				
30	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
31	95% Student's-t UCL	57.63	95% H-UCL	57.02
32	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	68.84
33	95% Adjusted-CLT UCL (Chen-1995)	61.89	97.5% Chebyshev (MVUE) UCL	80.12
34	95% Modified-t UCL (Johnson-1978)	58.35	99% Chebyshev (MVUE) UCL	102.3
35				
36	**Gamma Distribution Test**		**Data Distribution**	
37	k star (bias corrected)	1.517	**Data appear Lognormal at 5% Significance Level**	
38	Theta Star	29.28		
39	MLE of Mean	44.43		
40	MLE of Standard Deviation	36.07		
41	nu star	118.4		
42	Approximate Chi Square Value (.05)	94.24	**Nonparametric Statistics**	
43	Adjusted Level of Significance	0.0437	95% CLT UCL	57.31
44	Adjusted Chi Square Value	93.39	95% Jackknife UCL	57.63
45			95% Standard Bootstrap UCL	57.19
46	Anderson-Darling Test Statistic	1.354	95% Bootstrap-t UCL	67.82
47	Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	113.6

	A	B	C	D	E	F	G	H	I	J	K	L
48	Kolmogorov-Smirnov Test Statistic					0.16	95% Percentile Bootstrap UCL					58.5
49	Kolmogorov-Smirnov 5% Critical Value					0.144	95% BCA Bootstrap UCL					62.44
50	**Data not Gamma Distributed at 5% Significance Level**						95% Chebyshev(Mean, Sd) UCL					78.56
51							97.5% Chebyshev(Mean, Sd) UCL					93.32
52	**Assuming Gamma Distribution**						99% Chebyshev(Mean, Sd) UCL					122.3
53	95% Approximate Gamma UCL					55.8						
54	95% Adjusted Gamma UCL					56.31						
55												
56	**Potential UCL to Use**						Use 95% H-UCL					57.02
57	**Per recommendation from the Battelle Statistician, the 95% BCA Bootstrap UCL is used in place of the 95% U-UCL**						95% BCA Bootstrap UCL					62.44
58	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
59	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
60	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
61	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											
62												
63	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
64	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
65	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
66												

	A	B	C	D	E	F	G	H	I	J	K	L
1				**General UCL Statistics for Full Data Sets**								
2			**User Selected Options**									
3			From File	WorkSheet_a.wst								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	**Chlordane Crab**											
10												
11							**General Statistics**					
12					Number of Valid Observations	22					Number of Distinct Observations	21
13												
14			**Raw Statistics**						**Log-transformed Statistics**			
15					Minimum	1.68					Minimum of Log Data	0.519
16					Maximum	9.4					Maximum of Log Data	2.241
17					Mean	4.929					Mean of log Data	1.487
18					Median	4.87					SD of log Data	0.495
19					SD	2.222						
20					Std. Error of Mean	0.474						
21					Coefficient of Variation	0.451						
22					Skewness	0.332						
23												
24							**Relevant UCL Statistics**					
25			**Normal Distribution Test**						**Lognormal Distribution Test**			
26					Shapiro Wilk Test Statistic	0.96					Shapiro Wilk Test Statistic	0.958
27					Shapiro Wilk Critical Value	0.911					Shapiro Wilk Critical Value	0.911
28			**Data appear Normal at 5% Significance Level**						**Data appear Lognormal at 5% Significance Level**			
29												
30			**Assuming Normal Distribution**						**Assuming Lognormal Distribution**			
31					95% Student's-t UCL	5.745					95% H-UCL	6.201
32			**95% UCLs (Adjusted for Skewness)**								95% Chebyshev (MVUE) UCL	7.343
33					95% Adjusted-CLT UCL (Chen-1995)	5.744					97.5% Chebyshev (MVUE) UCL	8.37
34					95% Modified-t UCL (Johnson-1978)	5.75					99% Chebyshev (MVUE) UCL	10.39
35												
36			**Gamma Distribution Test**						**Data Distribution**			
37					k star (bias corrected)	4.144			**Data appear Normal at 5% Significance Level**			
38					Theta Star	1.189						
39					MLE of Mean	4.929						
40					MLE of Standard Deviation	2.421						
41					nu star	182.3						
42					Approximate Chi Square Value (.05)	152.1			**Nonparametric Statistics**			
43					Adjusted Level of Significance	0.0386					95% CLT UCL	5.709
44					Adjusted Chi Square Value	150					95% Jackknife UCL	5.745
45											95% Standard Bootstrap UCL	5.696
46					Anderson-Darling Test Statistic	0.266					95% Bootstrap-t UCL	5.802
47					Anderson-Darling 5% Critical Value	0.746					95% Hall's Bootstrap UCL	5.757

	A	B	C	D	E	F	G	H	I	J	K	L
48	Kolmogorov-Smirnov Test Statistic					0.106	95% Percentile Bootstrap UCL					5.709
49	Kolmogorov-Smirnov 5% Critical Value					0.186	95% BCA Bootstrap UCL					5.726
50	**Data appear Gamma Distributed at 5% Significance Level**						95% Chebyshev(Mean, Sd) UCL					6.995
51							97.5% Chebyshev(Mean, Sd) UCL					7.888
52	**Assuming Gamma Distribution**						99% Chebyshev(Mean, Sd) UCL					9.644
53	95% Approximate Gamma UCL					5.909						
54	95% Adjusted Gamma UCL					5.99						
55												
56	**Potential UCL to Use**						Use 95% Student's-t UCL					5.745
57												
58	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
59	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
60	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
61												

ProUCL OUTPUT FOR SEDIMENT, FISH, CRAB – BASELINE ERA

	A–C	D–F	G–L
1		General UCL Statistics for Full Data Sets	
2	User Selected Options		
3	From File	WorkSheet.wst	
4	Full Precision	OFF	
5	Confidence Coefficient	95%	
6	Number of Bootstrap Operations	2000	
7			
8	Biota_Mummichog_COPPER		
9			

	Label	Value	Label	Value
10	General Statistics			
11	Number of Valid Observations	15	Number of Distinct Observations	11
12				
13	Raw Statistics		Log-transformed Statistics	
14	Minimum	2000	Minimum of Log Data	7.601
15	Maximum	4300	Maximum of Log Data	8.366
16	Mean	2767	Mean of log Data	7.9
17	Median	2700	SD of log Data	0.229
18	SD	654.3		
19	Std. Error of Mean	168.9		
20	Coefficient of Variation	0.236		
21	Skewness	0.789		
22				
23	Relevant UCL Statistics			
24	Normal Distribution Test		Lognormal Distribution Test	
25	Shapiro Wilk Test Statistic	0.927	Shapiro Wilk Test Statistic	0.945
26	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
27	Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
28				
29	Assuming Normal Distribution		Assuming Lognormal Distribution	
30	95% Student's-t UCL	3064	95% H-UCL	3099
31	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3484
32	95% Adjusted-CLT UCL (Chen-1995)	3081	97.5% Chebyshev (MVUE) UCL	3795
33	95% Modified-t UCL (Johnson-1978)	3070	99% Chebyshev (MVUE) UCL	4406
34				
35	Gamma Distribution Test		Data Distribution	
36	k star (bias corrected)	16.21	Data appear Normal at 5% Significance Level	
37	Theta Star	170.7		
38	MLE of Mean	2767		
39	MLE of Standard Deviation	687.2		
40	nu star	486.3		
41	Approximate Chi Square Value (.05)	436.1	Nonparametric Statistics	
42	Adjusted Level of Significance	0.0324	95% CLT UCL	3045
43	Adjusted Chi Square Value	430.3	95% Jackknife UCL	3064
44			95% Standard Bootstrap UCL	3036
45	Anderson-Darling Test Statistic	0.309	95% Bootstrap-t UCL	3101
46	Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	3146
47	Kolmogorov-Smirnov Test Statistic	0.133	95% Percentile Bootstrap UCL	3040
48	Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	3067
49	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3503
50			97.5% Chebyshev(Mean, Sd) UCL	3822
51	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	4448
52	95% Approximate Gamma UCL	3085		
53	95% Adjusted Gamma UCL	3127		
54				
55	Potential UCL to Use		Use 95% Student's-t UCL	3064
56				

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Mummichog_LEAD

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	380	Minimum of Log Data	5.94
Maximum	3900	Maximum of Log Data	8.269
Mean	1057	Mean of log Data	6.652
Median	530	SD of log Data	0.75
SD	1024		
Std. Error of Mean	264.4		
Coefficient of Variation	0.969		
Skewness	1.95		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.694	Shapiro Wilk Test Statistic	0.82
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1523	95% H-UCL	1649
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1899
95% Adjusted-CLT UCL (Chen-1995)	1635	97.5% Chebyshev (MVUE) UCL	2287
95% Modified-t UCL (Johnson-1978)	1545	99% Chebyshev (MVUE) UCL	3049
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.446	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	731.2		
MLE of Mean	1057		
MLE of Standard Deviation	879.3		
nu star	43.38		
Approximate Chi Square Value (.05)	29.28	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	1492
Adjusted Chi Square Value	27.85	95% Jackknife UCL	1523
		95% Standard Bootstrap UCL	1486
Anderson-Darling Test Statistic	1.461	95% Bootstrap-t UCL	1922
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	1739
Kolmogorov-Smirnov Test Statistic	0.27	95% Percentile Bootstrap UCL	1509
Kolmogorov-Smirnov 5% Critical Value	0.225	95% BCA Bootstrap UCL	1633
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2210
		97.5% Chebyshev(Mean, Sd) UCL	2709
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3688
95% Approximate Gamma UCL	1567		
95% Adjusted Gamma UCL	1647		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	2210

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Biota_Mummichog_MERCURY

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	10
Raw Statistics		**Log-transformed Statistics**	
Minimum	36	Minimum of Log Data	3.584
Maximum	71	Maximum of Log Data	4.263
Mean	59.73	Mean of log Data	4.067
Median	65	SD of log Data	0.228
SD	12.12		
Std. Error of Mean	3.13		
Coefficient of Variation	0.203		
Skewness	-0.92		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Test Statistic	0.813
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	65.25	95% H-UCL	67
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	75.29
95% Adjusted-CLT UCL (Chen-1995)	64.09	97.5% Chebyshev (MVUE) UCL	81.97
95% Modified-t UCL (Johnson-1978)	65.12	99% Chebyshev (MVUE) UCL	95.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	18.03	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	3.313		
MLE of Mean	59.73		
MLE of Standard Deviation	14.07		
nu star	540.9		
Approximate Chi Square Value (.05)	487.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	64.88
Adjusted Chi Square Value	481.7	95% Jackknife UCL	65.25
		95% Standard Bootstrap UCL	64.59
Anderson-Darling Test Statistic	1.134	95% Bootstrap-t UCL	64.63
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	64.13
Kolmogorov-Smirnov Test Statistic	0.265	95% Percentile Bootstrap UCL	64.73
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	63.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	73.38
		97.5% Chebyshev(Mean, Sd) UCL	79.28
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	90.87
95% Approximate Gamma UCL	66.21		
95% Adjusted Gamma UCL	67.06		
Potential UCL to Use		Use 95% Student's-t UCL	65.25
		or 95% Modified-t UCL	65.12

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	A	B	C	D	E	F	G	H	I	J	K	L
169												
170	Note: For highly negative-skewed data, confidence limits											
171	(e.g., Chen, Johnson, Lognormal, and Gamma) may not be											
172	reliable. Chen's and Johnson's methods provide											
173	adjustments for positvely skewed data sets.											
174												
175												
176	Biota_Mummichog_Methyl Mercury											
177												
178	General Statistics											
179	Number of Valid Observations					15	Number of Distinct Observations					13
180												
181	Raw Statistics						Log-transformed Statistics					
182	Minimum					19	Minimum of Log Data					2.944
183	Maximum					69	Maximum of Log Data					4.234
184	Mean					48.93	Mean of log Data					3.801
185	Median					60	SD of log Data					0.47
186	SD					18.6						
187	Std. Error of Mean					4.802						
188	Coefficient of Variation					0.38						
189	Skewness					-0.636						
190												
191	Relevant UCL Statistics											
192	Normal Distribution Test						Lognormal Distribution Test					
193	Shapiro Wilk Test Statistic					0.825	Shapiro Wilk Test Statistic					0.796
194	Shapiro Wilk Critical Value					0.881	Shapiro Wilk Critical Value					0.881
195	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
196												
197	Assuming Normal Distribution						Assuming Lognormal Distribution					
198	95% Student's-t UCL					57.39	95% H-UCL					64.51
199	95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL					76.46
200	95% Adjusted-CLT UCL (Chen-1995)					55.99	97.5% Chebyshev (MVUE) UCL					88.1
201	95% Modified-t UCL (Johnson-1978)					57.26	99% Chebyshev (MVUE) UCL					111
202												
203	Gamma Distribution Test						Data Distribution					
204	k star (bias corrected)					4.645	Data do not follow a Discernable Distribution (0.05)					
205	Theta Star					10.53						
206	MLE of Mean					48.93						
207	MLE of Standard Deviation					22.7						
208	nu star					139.3						
209	Approximate Chi Square Value (.05)					113.1	Nonparametric Statistics					
210	Adjusted Level of Significance					0.0324	95% CLT UCL					56.83
211	Adjusted Chi Square Value					110.2	95% Jackknife UCL					57.39
212							95% Standard Bootstrap UCL					56.53
213	Anderson-Darling Test Statistic					1.351	95% Bootstrap-t UCL					56
214	Anderson-Darling 5% Critical Value					0.738	95% Hall's Bootstrap UCL					55.98
215	Kolmogorov-Smirnov Test Statistic					0.311	95% Percentile Bootstrap UCL					56.6
216	Kolmogorov-Smirnov 5% Critical Value					0.222	95% BCA Bootstrap UCL					56.2
217	Data not Gamma Distributed at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL					69.87
218							97.5% Chebyshev(Mean, Sd) UCL					78.92
219	Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL					96.72
220	95% Approximate Gamma UCL					60.3						
221	95% Adjusted Gamma UCL					61.9						
222												
223	Potential UCL to Use						Use 95% Student's-t UCL					57.39
224							or 95% Modified-t UCL					57.26

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Biota_Mummichog_ LMW PAHs

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	43.51	Minimum of Log Data	3.773
Maximum	177.1	Maximum of Log Data	5.177
Mean	75.81	Mean of log Data	4.245
Median	59.77	SD of log Data	0.403
SD	35.65		
Std. Error of Mean	9.205		
Coefficient of Variation	0.47		
Skewness	1.795		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	92.02	95% H-UCL	93.55
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	110
95% Adjusted-CLT UCL (Chen-1995)	95.51	97.5% Chebyshev (MVUE) UCL	125.1
95% Modified-t UCL (Johnson-1978)	92.73	99% Chebyshev (MVUE) UCL	154.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	5.008	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	15.14		
MLE of Mean	75.81		
MLE of Standard Deviation	33.88		
nu star	150.2		
Approximate Chi Square Value (.05)	122.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	90.95
Adjusted Chi Square Value	119.9	95% Jackknife UCL	92.02
		95% Standard Bootstrap UCL	90.36
Anderson-Darling Test Statistic	0.521	95% Bootstrap-t UCL	98.05
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	113.4
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	91.61
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	95.87
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	115.9
		97.5% Chebyshev(Mean, Sd) UCL	133.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	167.4
95% Approximate Gamma UCL	92.67		
95% Adjusted Gamma UCL	95.02		

	A–E	F	G–K	L
281	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	92.67
282				
283	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
284	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
285	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
286				
287				
288	**Biota_Mummichog_HMW PAHs**			
289				
290			**General Statistics**	
291	Number of Valid Observations	15	Number of Distinct Observations	15
292				
293	**Raw Statistics**		**Log-transformed Statistics**	
294	Minimum	34.6	Minimum of Log Data	3.544
295	Maximum	504	Maximum of Log Data	6.223
296	Mean	120.2	Mean of log Data	4.463
297	Median	76.8	SD of log Data	0.766
298	SD	124.4		
299	Std. Error of Mean	32.11		
300	Coefficient of Variation	1.034		
301	Skewness	2.434		
302				
303			**Relevant UCL Statistics**	
304	**Normal Distribution Test**		**Lognormal Distribution Test**	
305	Shapiro Wilk Test Statistic	0.672	Shapiro Wilk Test Statistic	0.897
306	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
307	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
308				
309	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
310	95% Student's-t UCL	176.8	95% H-UCL	190
311	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	217.6
312	95% Adjusted-CLT UCL (Chen-1995)	194.6	97.5% Chebyshev (MVUE) UCL	262.7
313	95% Modified-t UCL (Johnson-1978)	180.2	99% Chebyshev (MVUE) UCL	351.1
314				
315	**Gamma Distribution Test**		**Data Distribution**	
316	k star (bias corrected)	1.388	**Data appear Lognormal at 5% Significance Level**	
317	Theta Star	86.66		
318	MLE of Mean	120.2		
319	MLE of Standard Deviation	102.1		
320	nu star	41.63		
321	Approximate Chi Square Value (.05)	27.84	**Nonparametric Statistics**	
322	Adjusted Level of Significance	0.0324	95% CLT UCL	173.1
323	Adjusted Chi Square Value	26.46	95% Jackknife UCL	176.8
324			95% Standard Bootstrap UCL	171
325	Anderson-Darling Test Statistic	1.035	95% Bootstrap-t UCL	234.1
326	Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	362.8
327	Kolmogorov-Smirnov Test Statistic	0.305	95% Percentile Bootstrap UCL	176
328	Kolmogorov-Smirnov 5% Critical Value	0.225	95% BCA Bootstrap UCL	189.5
329	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	260.2
330			97.5% Chebyshev(Mean, Sd) UCL	320.8
331	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	439.8
332	95% Approximate Gamma UCL	179.8		
333	95% Adjusted Gamma UCL	189.2		
334				
335	**Potential UCL to Use**		Use 95% H-UCL	190
336				

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

General UCL Statistics for Full Data Sets

User Selected Options	
From File	ProUCL additional input.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Biota_Mummichog_Dieldrin

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	13
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.5	Minimum of Log Data	1.253
Maximum	13	Maximum of Log Data	2.565
Mean	6.693	Mean of log Data	1.798
Median	5.4	SD of log Data	0.462
SD	3.23		
Std. Error of Mean	0.834		
Coefficient of Variation	0.483		
Skewness	0.774		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.855	Shapiro Wilk Test Statistic	0.895
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8.162	95% H-UCL	8.635
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.23
95% Adjusted-CLT UCL (Chen-1995)	8.243	97.5% Chebyshev (MVUE) UCL	11.77
95% Modified-t UCL (Johnson-1978)	8.19	99% Chebyshev (MVUE) UCL	14.79
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.067	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	1.646		
MLE of Mean	6.693		
MLE of Standard Deviation	3.319		
nu star	122		
Approximate Chi Square Value (.05)	97.51	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	8.065
Adjusted Chi Square Value	94.82	95% Jackknife UCL	8.162
		95% Standard Bootstrap UCL	7.986
Anderson-Darling Test Statistic	0.743	95% Bootstrap-t UCL	8.418
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL	8.053
Kolmogorov-Smirnov Test Statistic	0.208	95% Percentile Bootstrap UCL	8.087

	A–E	F	G–K	L
393	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	8.06
394	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	10.33
395			97.5% Chebyshev(Mean, Sd) UCL	11.9
396	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	14.99
397	95% Approximate Gamma UCL	8.376		
398	95% Adjusted Gamma UCL	8.614		
399				
400	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	8.376
401				
402	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
403	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
404	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
405				
406	**Biota_Mummichog_ Total DDx**			
407				
408	**General Statistics**			
409	Number of Valid Observations	15	Number of Distinct Observations	15
410				
411	**Raw Statistics**		**Log-transformed Statistics**	
412	Minimum	25.35	Minimum of Log Data	3.233
413	Maximum	96.8	Maximum of Log Data	4.573
414	Mean	53.57	Mean of log Data	3.912
415	Median	44.7	SD of log Data	0.385
416	SD	20.78		
417	Std. Error of Mean	5.365		
418	Coefficient of Variation	0.388		
419	Skewness	0.694		
420				
421	**Relevant UCL Statistics**			
422	**Normal Distribution Test**		**Lognormal Distribution Test**	
423	Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Test Statistic	0.975
424	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
425	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
426				
427	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
428	95% Student's-t UCL	63.02	95% H-UCL	65.82
429	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	77.18
430	95% Adjusted-CLT UCL (Chen-1995)	63.42	97.5% Chebyshev (MVUE) UCL	87.4
431	95% Modified-t UCL (Johnson-1978)	63.18	99% Chebyshev (MVUE) UCL	107.5
432				
433	**Gamma Distribution Test**		**Data Distribution**	
434	k star (bias corrected)	5.978	**Data appear Normal at 5% Significance Level**	
435	Theta Star	8.96		
436	MLE of Mean	53.57		
437	MLE of Standard Deviation	21.91		
438	nu star	179.4		
439	Approximate Chi Square Value (.05)	149.4	**Nonparametric Statistics**	
440	Adjusted Level of Significance	0.0324	95% CLT UCL	62.39
441	Adjusted Chi Square Value	146	95% Jackknife UCL	63.02
442			95% Standard Bootstrap UCL	62.2
443	Anderson-Darling Test Statistic	0.272	95% Bootstrap-t UCL	64.1
444	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	63.65
445	Kolmogorov-Smirnov Test Statistic	0.172	95% Percentile Bootstrap UCL	62.2
446	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	63.12
447	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	76.95
448			97.5% Chebyshev(Mean, Sd) UCL	87.07

	A–E	F	G–K	L
449	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	106.9
450	95% Approximate Gamma UCL	64.32		
451	95% Adjusted Gamma UCL	65.8		
452				
453	**Potential UCL to Use**		Use 95% Student's-t UCL	63.02
454				
455	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
456	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
457	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
458				
459	**Biota_Mummichog_ Total PCB**			
460				
461	**General Statistics**			
462	Number of Valid Observations	15	Number of Distinct Observations	15
463				
464	**Raw Statistics**		**Log-transformed Statistics**	
465	Minimum	235.8	Minimum of Log Data	5.463
466	Maximum	932.6	Maximum of Log Data	6.838
467	Mean	513	Mean of log Data	6.155
468	Median	431.5	SD of log Data	0.424
469	SD	224.5		
470	Std. Error of Mean	57.97		
471	Coefficient of Variation	0.438		
472	Skewness	0.769		
473				
474	**Relevant UCL Statistics**			
475	**Normal Distribution Test**		**Lognormal Distribution Test**	
476	Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.946
477	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
478	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
479				
480	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
481	95% Student's-t UCL	615.1	95% H-UCL	645.7
482	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	761.7
483	95% Adjusted-CLT UCL (Chen-1995)	620.6	97.5% Chebyshev (MVUE) UCL	869.8
484	95% Modified-t UCL (Johnson-1978)	617	99% Chebyshev (MVUE) UCL	1082
485				
486	**Gamma Distribution Test**		**Data Distribution**	
487	k star (bias corrected)	4.862	**Data appear Normal at 5% Significance Level**	
488	Theta Star	105.5		
489	MLE of Mean	513		
490	MLE of Standard Deviation	232.6		
491	nu star	145.9		
492	Approximate Chi Square Value (.05)	119	**Nonparametric Statistics**	
493	Adjusted Level of Significance	0.0324	95% CLT UCL	608.3
494	Adjusted Chi Square Value	116	95% Jackknife UCL	615.1
495			95% Standard Bootstrap UCL	602.8
496	Anderson-Darling Test Statistic	0.494	95% Bootstrap-t UCL	626.2
497	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	608.5
498	Kolmogorov-Smirnov Test Statistic	0.181	95% Percentile Bootstrap UCL	608.4
499	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	611.5
500	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	765.7
501			97.5% Chebyshev(Mean, Sd) UCL	875
502	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	1090
503	95% Approximate Gamma UCL	629		
504	95% Adjusted Gamma UCL	645.2		

	A-F		G-L	
505				
506	Potential UCL to Use		Use 95% Student's-t UCL	615.1
507				
508	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
509	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
510	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
511				
512	Biota_Mummichog_TCDD TEQ(PCBs) - mammal TEFs			
513				
514	General Statistics			
515	Number of Valid Observations	15	Number of Distinct Observations	15
516				
517	Raw Statistics		Log-transformed Statistics	
518	Minimum	0.00363	Minimum of Log Data	-5.619
519	Maximum	0.0117	Maximum of Log Data	-4.452
520	Mean	0.00705	Mean of log Data	-5.009
521	Median	0.00646	SD of log Data	0.342
522	SD	0.00247		
523	Std. Error of Mean	0.0006365		
524	Coefficient of Variation	0.35		
525	Skewness	0.732		
526				
527	Relevant UCL Statistics			
528	Normal Distribution Test		Lognormal Distribution Test	
529	Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.96
530	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
531	Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
532				
533	Assuming Normal Distribution		Assuming Lognormal Distribution	
534	95% Student's-t UCL	0.00817	95% H-UCL	0.00843
535	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0098
536	95% Adjusted-CLT UCL (Chen-1995)	0.00823	97.5% Chebyshev (MVUE) UCL	0.011
537	95% Modified-t UCL (Johnson-1978)	0.00819	99% Chebyshev (MVUE) UCL	0.0133
538				
539	Gamma Distribution Test		Data Distribution	
540	k star (bias corrected)	7.456	Data appear Normal at 5% Significance Level	
541	Theta Star	0.0009459		
542	MLE of Mean	0.00705		
543	MLE of Standard Deviation	0.00258		
544	nu star	223.7		
545	Approximate Chi Square Value (.05)	190.1	Nonparametric Statistics	
546	Adjusted Level of Significance	0.0324	95% CLT UCL	0.0081
547	Adjusted Chi Square Value	186.3	95% Jackknife UCL	0.00817
548			95% Standard Bootstrap UCL	0.00808
549	Anderson-Darling Test Statistic	0.367	95% Bootstrap-t UCL	0.00836
550	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.00813
551	Kolmogorov-Smirnov Test Statistic	0.166	95% Percentile Bootstrap UCL	0.00808
552	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.00812
553	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.00983
554			97.5% Chebyshev(Mean, Sd) UCL	0.011
555	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0134
556	95% Approximate Gamma UCL	0.0083		
557	95% Adjusted Gamma UCL	0.00847		
558				
559	Potential UCL to Use		Use 95% Student's-t UCL	0.00817
560				

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Mummichog_TCDD TEQ(PCBs) - bird TEFs

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0173	Minimum of Log Data	-4.059
Maximum	0.0734	Maximum of Log Data	-2.612
Mean	0.0392	Mean of log Data	-3.322
Median	0.0316	SD of log Data	0.42
SD	0.0168		
Std. Error of Mean	0.00434		
Coefficient of Variation	0.429		
Skewness	0.738		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0468	95% H-UCL	0.0493
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0581
95% Adjusted-CLT UCL (Chen-1995)	0.0472	97.5% Chebyshev (MVUE) UCL	0.0663
95% Modified-t UCL (Johnson-1978)	0.047	99% Chebyshev (MVUE) UCL	0.0823
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.996	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00785		
MLE of Mean	0.0392		
MLE of Standard Deviation	0.0175		
nu star	149.9		
Approximate Chi Square Value (.05)	122.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.0463
Adjusted Chi Square Value	119.5	95% Jackknife UCL	0.0468
		95% Standard Bootstrap UCL	0.0462
Anderson-Darling Test Statistic	0.663	95% Bootstrap-t UCL	0.0486
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.0468
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL	0.0462
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.0468
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0581
		97.5% Chebyshev(Mean, Sd) UCL	0.0663
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0824
95% Approximate Gamma UCL	0.0479		
95% Adjusted Gamma UCL	0.0492		
Potential UCL to Use		Use 95% Student's-t UCL	0.0468

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Biota_Mummichog_TCDD TEQ(PCBs) - fish TEFs

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0002679	Minimum of Log Data	-8.225
Maximum	0.0008961	Maximum of Log Data	-7.017
Mean	0.0005418	Mean of log Data	-7.577
Median	0.0004796	SD of log Data	0.347
SD	0.0001911		
Std. Error of Mean	4.934E-05		
Coefficient of Variation	0.353		
Skewness	0.683		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.918	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0006287	95% H-UCL	0.0006501
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0007565
95% Adjusted-CLT UCL (Chen-1995)	0.0006323	97.5% Chebyshev (MVUE) UCL	0.0008495
95% Modified-t UCL (Johnson-1978)	0.0006302	99% Chebyshev (MVUE) UCL	0.00103
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.258	**Data appear Normal at 5% Significance Level**	
Theta Star	7.466E-05		
MLE of Mean	0.0005418		
MLE of Standard Deviation	0.0002011		
nu star	217.7		
Approximate Chi Square Value (.05)	184.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.000623
Adjusted Chi Square Value	180.8	95% Jackknife UCL	0.0006287
		95% Standard Bootstrap UCL	0.00062
Anderson-Darling Test Statistic	0.359	95% Bootstrap-t UCL	0.0006481
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.000631
Kolmogorov-Smirnov Test Statistic	0.142	95% Percentile Bootstrap UCL	0.0006219
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.0006305
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0007569
		97.5% Chebyshev(Mean, Sd) UCL	0.00085
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.00103
95% Approximate Gamma UCL	0.0006391		
95% Adjusted Gamma UCL	0.0006524		
Potential UCL to Use		Use 95% Student's-t UCL	0.0006287

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Row				
673				
674	**Biota_Mummichog_TCDD TEQ(D/F) - mammal TEFs**			
675				
676	**General Statistics**			
677	Number of Valid Observations	15	Number of Distinct Observations	14
678				
679	**Raw Statistics**		**Log-transformed Statistics**	
680	Minimum	0.0114	Minimum of Log Data	-4.476
681	Maximum	0.0801	Maximum of Log Data	-2.525
682	Mean	0.0348	Mean of log Data	-3.509
683	Median	0.0255	SD of log Data	0.561
684	SD	0.0204		
685	Std. Error of Mean	0.00527		
686	Coefficient of Variation	0.587		
687	Skewness	1.044		
688				
689	**Relevant UCL Statistics**			
690	**Normal Distribution Test**		**Lognormal Distribution Test**	
691	Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.952
692	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
693	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
694				
695	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
696	95% Student's-t UCL	0.044	95% H-UCL	0.0482
697	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0573
698	95% Adjusted-CLT UCL (Chen-1995)	0.0449	97.5% Chebyshev (MVUE) UCL	0.0671
699	95% Modified-t UCL (Johnson-1978)	0.0443	99% Chebyshev (MVUE) UCL	0.0863
700				
701	**Gamma Distribution Test**		**Data Distribution**	
702	k star (bias corrected)	2.845	**Data appear Gamma Distributed at 5% Significance Level**	
703	Theta Star	0.0122		
704	MLE of Mean	0.0348		
705	MLE of Standard Deviation	0.0206		
706	nu star	85.34		
707	Approximate Chi Square Value (.05)	65.05	**Nonparametric Statistics**	
708	Adjusted Level of Significance	0.0324	95% CLT UCL	0.0434
709	Adjusted Chi Square Value	62.87	95% Jackknife UCL	0.044
710			95% Standard Bootstrap UCL	0.043
711	Anderson-Darling Test Statistic	0.567	95% Bootstrap-t UCL	0.0471
712	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0444
713	Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.0433
714	Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.044
715	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0577
716			97.5% Chebyshev(Mean, Sd) UCL	0.0676
717	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0871
718	95% Approximate Gamma UCL	0.0456		
719	95% Adjusted Gamma UCL	0.0472		
720				
721	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.0456
722				
723	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
724	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
725	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
726				
727				
728	**Biota_Mummichog_TCDD TEQ(D/F) - bird TEFs**			

Row	A–E	F	G–K	L
729				
730	**General Statistics**			
731	Number of Valid Observations	15	Number of Distinct Observations	15
732				
733	**Raw Statistics**		**Log-transformed Statistics**	
734	Minimum	0.0123	Minimum of Log Data	-4.395
735	Maximum	0.084	Maximum of Log Data	-2.477
736	Mean	0.0365	Mean of log Data	-3.457
737	Median	0.027	SD of log Data	0.555
738	SD	0.0213		
739	Std. Error of Mean	0.00549		
740	Coefficient of Variation	0.582		
741	Skewness	1.053		
742				
743	**Relevant UCL Statistics**			
744	**Normal Distribution Test**		**Lognormal Distribution Test**	
745	Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.951
746	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
747	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
748				
749	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
750	95% Student's-t UCL	0.0462	95% H-UCL	0.0504
751	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0598
752	95% Adjusted-CLT UCL (Chen-1995)	0.0471	97.5% Chebyshev (MVUE) UCL	0.07
753	95% Modified-t UCL (Johnson-1978)	0.0464	99% Chebyshev (MVUE) UCL	0.09
754				
755	**Gamma Distribution Test**		**Data Distribution**	
756	k star (bias corrected)	2.897	**Data appear Gamma Distributed at 5% Significance Level**	
757	Theta Star	0.0126		
758	MLE of Mean	0.0365		
759	MLE of Standard Deviation	0.0214		
760	nu star	86.92		
761	Approximate Chi Square Value (.05)	66.43	**Nonparametric Statistics**	
762	Adjusted Level of Significance	0.0324	95% CLT UCL	0.0455
763	Adjusted Chi Square Value	64.23	95% Jackknife UCL	0.0462
764			95% Standard Bootstrap UCL	0.0452
765	Anderson-Darling Test Statistic	0.567	95% Bootstrap-t UCL	0.0488
766	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0464
767	Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	0.0459
768	Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.0462
769	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0604
770			97.5% Chebyshev(Mean, Sd) UCL	0.0708
771	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0911
772	95% Approximate Gamma UCL	0.0477		
773	95% Adjusted Gamma UCL	0.0494		
774				
775	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.0477
776				
777	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
778	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
779	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
780				
781				
782	**Biota_Mummichog_TCDD TEQ(PCBs) - fish TEFs**			
783				
784	**General Statistics**			

Number of Valid Observations	15	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0115	Minimum of Log Data	-4.469
Maximum	0.0806	Maximum of Log Data	-2.519
Mean	0.0349	Mean of log Data	-3.504
Median	0.0257	SD of log Data	0.561
SD	0.0205		
Std. Error of Mean	0.00529		
Coefficient of Variation	0.587		
Skewness	1.05		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0442	95% H-UCL	0.0484
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0575
95% Adjusted-CLT UCL (Chen-1995)	0.0451	97.5% Chebyshev (MVUE) UCL	0.0673
95% Modified-t UCL (Johnson-1978)	0.0445	99% Chebyshev (MVUE) UCL	0.0867
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.848	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0123		
MLE of Mean	0.0349		
MLE of Standard Deviation	0.0207		
nu star	85.45		
Approximate Chi Square Value (.05)	65.14	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.0436
Adjusted Chi Square Value	62.96	95% Jackknife UCL	0.0442
		95% Standard Bootstrap UCL	0.043
Anderson-Darling Test Statistic	0.56	95% Bootstrap-t UCL	0.0465
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0443
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.0438
Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.044
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.058
		97.5% Chebyshev(Mean, Sd) UCL	0.0679
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0875
95% Approximate Gamma UCL	0.0458		
95% Adjusted Gamma UCL	0.0474		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0458
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
Biota_Mummichog_Lipids			
General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	8

	A–E	F	G–K	L
841				
842	**Raw Statistics**		**Log-transformed Statistics**	
843	Minimum	1.4	Minimum of Log Data	0.336
844	Maximum	3.1	Maximum of Log Data	1.131
845	Mean	1.9	Mean of log Data	0.614
846	Median	1.8	SD of log Data	0.241
847	SD	0.488		
848	Std. Error of Mean	0.126		
849	Coefficient of Variation	0.257		
850	Skewness	1.078		
851				
852				
853	**Relevant UCL Statistics**			
854	**Normal Distribution Test**		**Lognormal Distribution Test**	
855	Shapiro Wilk Test Statistic	0.877	Shapiro Wilk Test Statistic	0.913
856	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
857	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
858				
859	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
860	95% Student's-t UCL	2.122	95% H-UCL	2.141
861	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	2.417
862	95% Adjusted-CLT UCL (Chen-1995)	2.145	97.5% Chebyshev (MVUE) UCL	2.641
863	95% Modified-t UCL (Johnson-1978)	2.128	99% Chebyshev (MVUE) UCL	3.082
864				
865	**Gamma Distribution Test**		**Data Distribution**	
866	k star (bias corrected)	14.35	**Data appear Gamma Distributed at 5% Significance Level**	
867	Theta Star	0.132		
868	MLE of Mean	1.9		
869	MLE of Standard Deviation	0.501		
870	nu star	430.6		
871	Approximate Chi Square Value (.05)	383.5	**Nonparametric Statistics**	
872	Adjusted Level of Significance	0.0324	95% CLT UCL	2.107
873	Adjusted Chi Square Value	378.1	95% Jackknife UCL	2.122
874			95% Standard Bootstrap UCL	2.104
875	Anderson-Darling Test Statistic	0.562	95% Bootstrap-t UCL	2.191
876	Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	2.174
877	Kolmogorov-Smirnov Test Statistic	0.159	95% Percentile Bootstrap UCL	2.107
878	Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	2.14
879	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	2.45
880			97.5% Chebyshev(Mean, Sd) UCL	2.688
881	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	3.155
882	95% Approximate Gamma UCL	2.133		
883	95% Adjusted Gamma UCL	2.164		
884				
885	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	2.133
886				
887	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
888	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
889	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General UCL Statistics for Full Data Sets									
2		User Selected Options											
3		From File		WorkSheet.wst									
4		Full Precision		OFF									
5		Confidence Coefficient		95%									
6		Number of Bootstrap Operations		2000									
7													
8	Biota_Crab_Copper												
9													
10						General Statistics							
11				Number of Valid Observations		22					Number of Distinct Observations	22	
12													
13			Raw Statistics						Log-transformed Statistics				
14					Minimum	16209					Minimum of Log Data	9.693	
15					Maximum	30605					Maximum of Log Data	10.33	
16					Mean	22494					Mean of log Data	10.01	
17					Median	22271					SD of log Data	0.18	
18					SD	4110							
19					Std. Error of Mean	876.3							
20					Coefficient of Variation	0.183							
21					Skewness	0.458							
22													
23						Relevant UCL Statistics							
24			Normal Distribution Test						Lognormal Distribution Test				
25					Shapiro Wilk Test Statistic	0.947					Shapiro Wilk Test Statistic	0.963	
26					Shapiro Wilk Critical Value	0.911					Shapiro Wilk Critical Value	0.911	
27			Data appear Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level				
28													
29			Assuming Normal Distribution						Assuming Lognormal Distribution				
30					95% Student's-t UCL	24002					95% H-UCL	24126	
31			95% UCLs (Adjusted for Skewness)								95% Chebyshev (MVUE) UCL	26282	
32					95% Adjusted-CLT UCL (Chen-1995)	24026					97.5% Chebyshev (MVUE) UCL	27922	
33					95% Modified-t UCL (Johnson-1978)	24016					99% Chebyshev (MVUE) UCL	31144	
34													
35			Gamma Distribution Test						Data Distribution				
36					k star (bias corrected)	27.79			Data appear Normal at 5% Significance Level				
37					Theta Star	809.6							
38					MLE of Mean	22494							
39					MLE of Standard Deviation	4267							
40					nu star	1223							
41					Approximate Chi Square Value (.05)	1142			Nonparametric Statistics				
42					Adjusted Level of Significance	0.0386					95% CLT UCL	23935	
43					Adjusted Chi Square Value	1137					95% Jackknife UCL	24002	
44											95% Standard Bootstrap UCL	23925	
45					Anderson-Darling Test Statistic	0.385					95% Bootstrap-t UCL	24131	
46					Anderson-Darling 5% Critical Value	0.741					95% Hall's Bootstrap UCL	24002	
47					Kolmogorov-Smirnov Test Statistic	0.145					95% Percentile Bootstrap UCL	23927	
48					Kolmogorov-Smirnov 5% Critical Value	0.185					95% BCA Bootstrap UCL	23982	
49			Data appear Gamma Distributed at 5% Significance Level								95% Chebyshev(Mean, Sd) UCL	26313	
50											97.5% Chebyshev(Mean, Sd) UCL	27966	
51			Assuming Gamma Distribution								99% Chebyshev(Mean, Sd) UCL	31213	
52					95% Approximate Gamma UCL	24072							
53					95% Adjusted Gamma UCL	24195							
54													
55			Potential UCL to Use								Use 95% Student's-t UCL	24002	
56													

Row	A–E	F	G–K	L	M
57	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.				
58	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)				
59	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.				
60					
61					
62	Biota_Crab_Lead				
63					
64	**General Statistics**				
65	Number of Valid Observations	22	Number of Distinct Observations	22	
66					
67	**Raw Statistics**		**Log-transformed Statistics**		
68	Minimum	201.4	Minimum of Log Data	5.305	
69	Maximum	656.2	Maximum of Log Data	6.486	
70	Mean	327.3	Mean of log Data	5.747	
71	Median	302	SD of log Data	0.293	
72	SD	108.2			
73	Std. Error of Mean	23.07			
74	Coefficient of Variation	0.331			
75	Skewness	1.593			
76					
77	**Relevant UCL Statistics**				
78	**Normal Distribution Test**		**Lognormal Distribution Test**		
79	Shapiro Wilk Test Statistic	0.862	Shapiro Wilk Test Statistic	0.952	
80	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911	
81	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**		
82					
83	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**		
84	95% Student's-t UCL	367	95% H-UCL	367.7	
85	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	416.4	
86	95% Adjusted-CLT UCL (Chen-1995)	373.6	97.5% Chebyshev (MVUE) UCL	455.4	
87	95% Modified-t UCL (Johnson-1978)	368.3	99% Chebyshev (MVUE) UCL	532	
88					
89	**Gamma Distribution Test**		**Data Distribution**		
90	k star (bias corrected)	9.984	**Data appear Gamma Distributed at 5% Significance Level**		
91	Theta Star	32.78			
92	MLE of Mean	327.3			
93	MLE of Standard Deviation	103.6			
94	nu star	439.3			
95	Approximate Chi Square Value (.05)	391.7	**Nonparametric Statistics**		
96	Adjusted Level of Significance	0.0386	95% CLT UCL	365.2	
97	Adjusted Chi Square Value	388.4	95% Jackknife UCL	367	
98			95% Standard Bootstrap UCL	365	
99	Anderson-Darling Test Statistic	0.508	95% Bootstrap-t UCL	379.8	
100	Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	389.5	
101	Kolmogorov-Smirnov Test Statistic	0.148	95% Percentile Bootstrap UCL	363.4	
102	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	370.7	
103	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	427.9	
104			97.5% Chebyshev(Mean, Sd) UCL	471.4	
105	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	556.8	
106	95% Approximate Gamma UCL	367.1			
107	95% Adjusted Gamma UCL	370.2			
108					
109	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	367.1	
110					
111	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.				
112	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)				

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

Biota_Crab_Mercury

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	86.1	Minimum of Log Data	4.456
Maximum	190.2	Maximum of Log Data	5.248
Mean	136.5	Mean of log Data	4.892
Median	135.9	SD of log Data	0.23
SD	29.99		
Std. Error of Mean	6.395		
Coefficient of Variation	0.22		
Skewness	-0.0754		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.969	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	147.5	95% H-UCL	149.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	166.1
95% Adjusted-CLT UCL (Chen-1995)	146.9	97.5% Chebyshev (MVUE) UCL	178.9
95% Modified-t UCL (Johnson-1978)	147.5	99% Chebyshev (MVUE) UCL	204
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	17.81	**Data appear Normal at 5% Significance Level**	
Theta Star	7.662		
MLE of Mean	136.5		
MLE of Standard Deviation	32.34		
nu star	783.8		
Approximate Chi Square Value (.05)	719.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	147
Adjusted Chi Square Value	715.3	95% Jackknife UCL	147.5
		95% Standard Bootstrap UCL	146.6
Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL	147.4
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL	147.3
Kolmogorov-Smirnov Test Statistic	0.114	95% Percentile Bootstrap UCL	147
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	146.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	164.4
		97.5% Chebyshev(Mean, Sd) UCL	176.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	200.1
95% Approximate Gamma UCL	148.6		
95% Adjusted Gamma UCL	149.6		
Potential UCL to Use		Use 95% Student's-t UCL	147.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Biota_Crab_Methyl Mercury

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	65.14	Minimum of Log Data	4.177
Maximum	170.6	Maximum of Log Data	5.14
Mean	115.1	Mean of log Data	4.714
Median	117.8	SD of log Data	0.265
SD	28.44		
Std. Error of Mean	6.064		
Coefficient of Variation	0.247		
Skewness	-0.117		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	125.5	95% H-UCL	128.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	144
95% Adjusted-CLT UCL (Chen-1995)	124.9	97.5% Chebyshev (MVUE) UCL	156.5
95% Modified-t UCL (Johnson-1978)	125.5	99% Chebyshev (MVUE) UCL	180.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.73	**Data appear Normal at 5% Significance Level**	
Theta Star	8.381		
MLE of Mean	115.1		
MLE of Standard Deviation	31.06		
nu star	604.3		
Approximate Chi Square Value (.05)	548.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	125.1
Adjusted Chi Square Value	544.3	95% Jackknife UCL	125.5
		95% Standard Bootstrap UCL	124.9
Anderson-Darling Test Statistic	0.304	95% Bootstrap-t UCL	126.1
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	125.2
Kolmogorov-Smirnov Test Statistic	0.109	95% Percentile Bootstrap UCL	124.9
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	125.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	141.5
		97.5% Chebyshev(Mean, Sd) UCL	153
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	175.4
95% Approximate Gamma UCL	126.9		
95% Adjusted Gamma UCL	127.8		
Potential UCL to Use		Use 95% Student's-t UCL	125.5

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Biota_Crab_LMW PAHs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	19.73	Minimum of Log Data	2.982
Maximum	292.3	Maximum of Log Data	5.678
Mean	80.04	Mean of log Data	4.145
Median	54.11	SD of log Data	0.655
SD	69.74		
Std. Error of Mean	14.87		
Coefficient of Variation	0.871		
Skewness	2.373		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.674	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	105.6	95% H-UCL	106.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	127.3
95% Adjusted-CLT UCL (Chen-1995)	112.5	97.5% Chebyshev (MVUE) UCL	148.9
95% Modified-t UCL (Johnson-1978)	106.9	99% Chebyshev (MVUE) UCL	191.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.98	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	40.43		
MLE of Mean	80.04		
MLE of Standard Deviation	56.89		
nu star	87.1		
Approximate Chi Square Value (.05)	66.59	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	104.5
Adjusted Chi Square Value	65.25	95% Jackknife UCL	105.6
		95% Standard Bootstrap UCL	104.2
Anderson-Darling Test Statistic	1.044	95% Bootstrap-t UCL	141.3
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	239.2
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL	104.8
Kolmogorov-Smirnov 5% Critical Value	0.188	95% BCA Bootstrap UCL	113.8
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	144.8
		97.5% Chebyshev(Mean, Sd) UCL	172.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	228
95% Approximate Gamma UCL	104.7		
95% Adjusted Gamma UCL	106.8		

	A	B	C	D	E	F	G	H	I	J	K	L	M
281					Potential UCL to Use						Use 95% Approximate Gamma UCL	104.7	
282													
283	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
284	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)												
285	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.												
286													
287													
288	Biota_Crab_ HMW PAHs												
289													
290							General Statistics						
291					Number of Valid Observations	22					Number of Distinct Observations	22	
292													
293					Raw Statistics						Log-transformed Statistics		
294					Minimum	20.52					Minimum of Log Data	3.021	
295					Maximum	354.8					Maximum of Log Data	5.872	
296					Mean	89.21					Mean of log Data	4.238	
297					Median	56.84					SD of log Data	0.688	
298					SD	77.77							
299					Std. Error of Mean	16.58							
300					Coefficient of Variation	0.872							
301					Skewness	2.332							
302													
303							Relevant UCL Statistics						
304					Normal Distribution Test						Lognormal Distribution Test		
305					Shapiro Wilk Test Statistic	0.72					Shapiro Wilk Test Statistic	0.943	
306					Shapiro Wilk Critical Value	0.911					Shapiro Wilk Critical Value	0.911	
307					Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level		
308													
309					Assuming Normal Distribution						Assuming Lognormal Distribution		
310					95% Student's-t UCL	117.7					95% H-UCL	122	
311					95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL	145.9	
312					95% Adjusted-CLT UCL (Chen-1995)	125.3					97.5% Chebyshev (MVUE) UCL	171.5	
313					95% Modified-t UCL (Johnson-1978)	119.1					99% Chebyshev (MVUE) UCL	221.9	
314													
315					Gamma Distribution Test						Data Distribution		
316					k star (bias corrected)	1.87					Data appear Lognormal at 5% Significance Level		
317					Theta Star	47.71							
318					MLE of Mean	89.21							
319					MLE of Standard Deviation	65.24							
320					nu star	82.28							
321					Approximate Chi Square Value (.05)	62.37					Nonparametric Statistics		
322					Adjusted Level of Significance	0.0386					95% CLT UCL	116.5	
323					Adjusted Chi Square Value	61.08					95% Jackknife UCL	117.7	
324											95% Standard Bootstrap UCL	116.1	
325					Anderson-Darling Test Statistic	1.015					95% Bootstrap-t UCL	141.7	
326					Anderson-Darling 5% Critical Value	0.755					95% Hall's Bootstrap UCL	226.5	
327					Kolmogorov-Smirnov Test Statistic	0.214					95% Percentile Bootstrap UCL	119.8	
328					Kolmogorov-Smirnov 5% Critical Value	0.188					95% BCA Bootstrap UCL	125.3	
329					Data not Gamma Distributed at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL	161.5	
330											97.5% Chebyshev(Mean, Sd) UCL	192.8	
331					Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL	254.2	
332					95% Approximate Gamma UCL	117.7							
333					95% Adjusted Gamma UCL	120.2							
334													
335					Potential UCL to Use						Use 95% H-UCL	122	
336													

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Biota_Crab_Dieldrin

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.431	Minimum of Log Data	0.888
Maximum	14.49	Maximum of Log Data	2.673
Mean	6.328	Mean of log Data	1.776
Median	5.967	SD of log Data	0.38
SD	2.547		
Std. Error of Mean	0.543		
Coefficient of Variation	0.403		
Skewness	1.555		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.978
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.263	95% H-UCL	7.425
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.606
95% Adjusted-CLT UCL (Chen-1995)	7.414	97.5% Chebyshev (MVUE) UCL	9.593
95% Modified-t UCL (Johnson-1978)	7.293	99% Chebyshev (MVUE) UCL	11.53
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.395	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.99		
MLE of Mean	6.328		
MLE of Standard Deviation	2.503		
nu star	281.4		
Approximate Chi Square Value (.05)	243.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	7.222
Adjusted Chi Square Value	240.9	95% Jackknife UCL	7.263
		95% Standard Bootstrap UCL	7.213
Anderson-Darling Test Statistic	0.3	95% Bootstrap-t UCL	7.535
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	7.916
Kolmogorov-Smirnov Test Statistic	0.116	95% Percentile Bootstrap UCL	7.247
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	7.365
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.696
		97.5% Chebyshev(Mean, Sd) UCL	9.72
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11.73
95% Approximate Gamma UCL	7.312		
95% Adjusted Gamma UCL	7.392		

Potential UCL to Use		Use 95% Approximate Gamma UCL	7.312

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_Total DDx

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	30.17	Minimum of Log Data	3.407
Maximum	104.4	Maximum of Log Data	4.649
Mean	65.35	Mean of log Data	4.148
Median	64.85	SD of log Data	0.263
SD	16.31		
Std. Error of Mean	3.478		
Coefficient of Variation	0.25		
Skewness	0.315		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	71.33	95% H-UCL	72.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	81.66
95% Adjusted-CLT UCL (Chen-1995)	71.32	97.5% Chebyshev (MVUE) UCL	88.67
95% Modified-t UCL (Johnson-1978)	71.37	99% Chebyshev (MVUE) UCL	102.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.89	**Data appear Normal at 5% Significance Level**	
Theta Star	4.705		
MLE of Mean	65.35		
MLE of Standard Deviation	17.54		
nu star	611		
Approximate Chi Square Value (.05)	554.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	71.07
Adjusted Chi Square Value	550.7	95% Jackknife UCL	71.33
		95% Standard Bootstrap UCL	70.89
Anderson-Darling Test Statistic	0.26	95% Bootstrap-t UCL	71.41
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	71.93
Kolmogorov-Smirnov Test Statistic	0.0968	95% Percentile Bootstrap UCL	70.75
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	71.37
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	80.5
		97.5% Chebyshev(Mean, Sd) UCL	87.06
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	99.95
95% Approximate Gamma UCL	71.98		
95% Adjusted Gamma UCL	72.51		

	A-F		G-L	
449	Potential UCL to Use		Use 95% Student's-t UCL	71.33
450				
451	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
452	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
453	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
454				
455				
456	Biota_Crab_Total PCB			
457				
458	General Statistics			
459	Number of Valid Observations	22	Number of Distinct Observations	22
460				
461	Raw Statistics		Log-transformed Statistics	
462	Minimum	154	Minimum of Log Data	5.037
463	Maximum	576.9	Maximum of Log Data	6.358
464	Mean	320.5	Mean of log Data	5.722
465	Median	291.5	SD of log Data	0.317
466	SD	103.8		
467	Std. Error of Mean	22.12		
468	Coefficient of Variation	0.324		
469	Skewness	0.841		
470				
471	Relevant UCL Statistics			
472	Normal Distribution Test		Lognormal Distribution Test	
473	Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Test Statistic	0.979
474	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
475	Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
476				
477	Assuming Normal Distribution		Assuming Lognormal Distribution	
478	95% Student's-t UCL	358.6	95% H-UCL	365.2
479	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	416.5
480	95% Adjusted-CLT UCL (Chen-1995)	361.1	97.5% Chebyshev (MVUE) UCL	458.1
481	95% Modified-t UCL (Johnson-1978)	359.2	99% Chebyshev (MVUE) UCL	539.8
482				
483	Gamma Distribution Test		Data Distribution	
484	k star (bias corrected)	9.142	Data appear Normal at 5% Significance Level	
485	Theta Star	35.06		
486	MLE of Mean	320.5		
487	MLE of Standard Deviation	106		
488	nu star	402.2		
489	Approximate Chi Square Value (.05)	356.8	Nonparametric Statistics	
490	Adjusted Level of Significance	0.0386	95% CLT UCL	356.9
491	Adjusted Chi Square Value	353.6	95% Jackknife UCL	358.6
492			95% Standard Bootstrap UCL	356.9
493	Anderson-Darling Test Statistic	0.351	95% Bootstrap-t UCL	362.4
494	Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	362.7
495	Kolmogorov-Smirnov Test Statistic	0.123	95% Percentile Bootstrap UCL	357.6
496	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	360.2
497	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	416.9
498			97.5% Chebyshev(Mean, Sd) UCL	458.6
499	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	540.6
500	95% Approximate Gamma UCL	361.4		
501	95% Adjusted Gamma UCL	364.6		
502				
503	Potential UCL to Use		Use 95% Student's-t UCL	358.6
504				

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_TCDD TEQ(PCBs) - mammal TEFs

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00175	Minimum of Log Data	-6.349
Maximum	0.012	Maximum of Log Data	-4.424
Mean	0.00813	Mean of log Data	-4.881
Median	0.0084	SD of log Data	0.436
SD	0.00247		
Std. Error of Mean	0.0005262		
Coefficient of Variation	0.303		
Skewness	-0.886		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk Test Statistic	0.745
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.00904	95% H-UCL	0.01
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0118
95% Adjusted-CLT UCL (Chen-1995)	0.00889	97.5% Chebyshev (MVUE) UCL	0.0133
95% Modified-t UCL (Johnson-1978)	0.00902	99% Chebyshev (MVUE) UCL	0.0162
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.438	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00126		
MLE of Mean	0.00813		
MLE of Standard Deviation	0.0032		
nu star	283.3		
Approximate Chi Square Value (.05)	245.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.009
Adjusted Chi Square Value	242.6	95% Jackknife UCL	0.00904
		95% Standard Bootstrap UCL	0.00898
Anderson-Darling Test Statistic	1.331	95% Bootstrap-t UCL	0.00892
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	0.0089
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.00898
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	0.00887
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0104
		97.5% Chebyshev(Mean, Sd) UCL	0.0114
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0134
95% Approximate Gamma UCL	0.00939		
95% Adjusted Gamma UCL	0.00949		
Potential UCL to Use		Use 95% Student's-t UCL	0.00904

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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561	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
562				
563	Note: For highly negative-skewed data, confidence limits			
564	(e.g., Chen, Johnson, Lognormal, and Gamma) may not be			
565	reliable. Chen's and Johnson's methods provide			
566	adjustments for positvely skewed data sets.			
567				
568				
569	**Biota_Crab_TCDD TEQ(PCBs) - bird TEFs**			
570				
571	**General Statistics**			
572	Number of Valid Observations	22	Number of Distinct Observations	21
573				
574	**Raw Statistics**		**Log-transformed Statistics**	
575	Minimum	0.0505	Minimum of Log Data	-2.986
576	Maximum	0.111	Maximum of Log Data	-2.197
577	Mean	0.0903	Mean of log Data	-2.419
578	Median	0.0908	SD of log Data	0.179
579	SD	0.0142		
580	Std. Error of Mean	0.00303		
581	Coefficient of Variation	0.158		
582	Skewness	-1.135		
583				
584	**Relevant UCL Statistics**			
585	**Normal Distribution Test**		**Lognormal Distribution Test**	
586	Shapiro Wilk Test Statistic	0.917	Shapiro Wilk Test Statistic	0.845
587	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
588	**Data appear Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
589				
590	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
591	95% Student's-t UCL	0.0955	95% H-UCL	0.0969
592	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.106
593	95% Adjusted-CLT UCL (Chen-1995)	0.0945	97.5% Chebyshev (MVUE) UCL	0.112
594	95% Modified-t UCL (Johnson-1978)	0.0954	99% Chebyshev (MVUE) UCL	0.125
595				
596	**Gamma Distribution Test**		**Data Distribution**	
597	k star (bias corrected)	31	**Data appear Normal at 5% Significance Level**	
598	Theta Star	0.00291		
599	MLE of Mean	0.0903		
600	MLE of Standard Deviation	0.0162		
601	nu star	1364		
602	Approximate Chi Square Value (.05)	1279	**Nonparametric Statistics**	
603	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0953
604	Adjusted Chi Square Value	1273	95% Jackknife UCL	0.0955
605			95% Standard Bootstrap UCL	0.095
606	Anderson-Darling Test Statistic	0.886	95% Bootstrap-t UCL	0.0949
607	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0949
608	Kolmogorov-Smirnov Test Statistic	0.214	95% Percentile Bootstrap UCL	0.0947
609	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0945
610	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.103
611			97.5% Chebyshev(Mean, Sd) UCL	0.109
612	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.12
613	95% Approximate Gamma UCL	0.0962		
614	95% Adjusted Gamma UCL	0.0967		
615				
616	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0955

	A–E	F	G–K	L	M
617					
618	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.				
619	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)				
620	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.				
621					
622	Note: For highly negative-skewed data, confidence limits				
623	(e.g., Chen, Johnson, Lognormal, and Gamma) may not be				
624	reliable. Chen's and Johnson's methods provide				
625	adjustments for positvely skewed data sets.				
626					
627					
628	**Biota_Crab_TCDD TEQ(PCBs) - fish TEFs**				
629					
630	**General Statistics**				
631	Number of Valid Observations	22	Number of Distinct Observations	22	
632					
633	**Raw Statistics**		**Log-transformed Statistics**		
634	Minimum	0.0003164	Minimum of Log Data	-8.058	
635	Maximum	0.00106	Maximum of Log Data	-6.85	
636	Mean	0.0007351	Mean of log Data	-7.247	
637	Median	0.0007421	SD of log Data	0.272	
638	SD	0.0001727			
639	Std. Error of Mean	3.681E-05			
640	Coefficient of Variation	0.235			
641	Skewness	-0.445			
642					
643	**Relevant UCL Statistics**				
644	**Normal Distribution Test**		**Lognormal Distribution Test**		
645	Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Test Statistic	0.887	
646	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911	
647	**Data appear Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**		
648					
649	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**		
650	95% Student's-t UCL	0.0007984	95% H-UCL	0.0008232	
651	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0009262	
652	95% Adjusted-CLT UCL (Chen-1995)	0.0007919	97.5% Chebyshev (MVUE) UCL	0.00101	
653	95% Modified-t UCL (Johnson-1978)	0.0007979	99% Chebyshev (MVUE) UCL	0.00117	
654					
655	**Gamma Distribution Test**		**Data Distribution**		
656	k star (bias corrected)	13.89	**Data appear Normal at 5% Significance Level**		
657	Theta Star	5.292E-05			
658	MLE of Mean	0.0007351			
659	MLE of Standard Deviation	0.0001972			
660	nu star	611.2			
661	Approximate Chi Square Value (.05)	554.8	**Nonparametric Statistics**		
662	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0007957	
663	Adjusted Chi Square Value	550.8	95% Jackknife UCL	0.0007984	
664			95% Standard Bootstrap UCL	0.0007933	
665	Anderson-Darling Test Statistic	0.589	95% Bootstrap-t UCL	0.000797	
666	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0007945	
667	Kolmogorov-Smirnov Test Statistic	0.15	95% Percentile Bootstrap UCL	0.0007948	
668	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0007926	
669	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0008956	
670			97.5% Chebyshev(Mean, Sd) UCL	0.000965	
671	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0011	
672	95% Approximate Gamma UCL	0.0008098			

	A–E	F	G–K	L	M
673	95% Adjusted Gamma UCL	0.0008156			
674					
675	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0007984	
676					
677	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**				
678	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**				
679	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**				
680					
681	**Note: For highly negative-skewed data, confidence limits**				
682	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**				
683	**reliable. Chen's and Johnson's methods provide**				
684	**adjustments for positvely skewed data sets.**				
685					
686					
687	**Biota_Crab_TCDD TEQ(D/F) - mammal TEFs**				
688					
689	**General Statistics**				
690	Number of Valid Observations	22	Number of Distinct Observations	20	
691					
692	**Raw Statistics**		**Log-transformed Statistics**		
693	Minimum	0.026	Minimum of Log Data	-3.649	
694	Maximum	0.0898	Maximum of Log Data	-2.411	
695	Mean	0.0566	Mean of log Data	-2.914	
696	Median	0.0569	SD of log Data	0.307	
697	SD	0.016			
698	Std. Error of Mean	0.00341			
699	Coefficient of Variation	0.283			
700	Skewness	0.0702			
701					
702	**Relevant UCL Statistics**				
703	**Normal Distribution Test**		**Lognormal Distribution Test**		
704	Shapiro Wilk Test Statistic	0.982	Shapiro Wilk Test Statistic	0.952	
705	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911	
706	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**		
707					
708	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**		
709	95% Student's-t UCL	0.0625	95% H-UCL	0.0644	
710	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0732	
711	95% Adjusted-CLT UCL (Chen-1995)	0.0623	97.5% Chebyshev (MVUE) UCL	0.0803	
712	95% Modified-t UCL (Johnson-1978)	0.0625	99% Chebyshev (MVUE) UCL	0.0943	
713					
714	**Gamma Distribution Test**		**Data Distribution**		
715	k star (bias corrected)	10.44	**Data appear Normal at 5% Significance Level**		
716	Theta Star	0.00542			
717	MLE of Mean	0.0566			
718	MLE of Standard Deviation	0.0175			
719	nu star	459.4			
720	Approximate Chi Square Value (.05)	410.7	**Nonparametric Statistics**		
721	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0622	
722	Adjusted Chi Square Value	407.3	95% Jackknife UCL	0.0625	
723			95% Standard Bootstrap UCL	0.0622	
724	Anderson-Darling Test Statistic	0.278	95% Bootstrap-t UCL	0.0626	
725	Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	0.0626	
726	Kolmogorov-Smirnov Test Statistic	0.101	95% Percentile Bootstrap UCL	0.0623	
727	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0622	
728	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0715	

	A–E	F	G–K	L
729			97.5% Chebyshev(Mean, Sd) UCL	0.0779
730	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0905
731	95% Approximate Gamma UCL	0.0633		
732	95% Adjusted Gamma UCL	0.0639		
733				
734	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0625
735				
736	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
737	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
738	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
739				
740				
741	**Biota_Crab_TCDD TEQ(D/F) - bird TEFs**			
742				
743	**General Statistics**			
744	Number of Valid Observations	22	Number of Distinct Observations	21
745				
746	**Raw Statistics**		**Log-transformed Statistics**	
747	Minimum	0.0308	Minimum of Log Data	-3.481
748	Maximum	0.0981	Maximum of Log Data	-2.322
749	Mean	0.067	Mean of log Data	-2.734
750	Median	0.0681	SD of log Data	0.265
751	SD	0.0158		
752	Std. Error of Mean	0.00336		
753	Coefficient of Variation	0.235		
754	Skewness	-0.351		
755				
756	**Relevant UCL Statistics**			
757	**Normal Distribution Test**		**Lognormal Distribution Test**	
758	Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.919
759	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
760	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
761				
762	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
763	95% Student's-t UCL	0.0727	95% H-UCL	0.0747
764	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0839
765	95% Adjusted-CLT UCL (Chen-1995)	0.0722	97.5% Chebyshev (MVUE) UCL	0.0911
766	95% Modified-t UCL (Johnson-1978)	0.0727	99% Chebyshev (MVUE) UCL	0.105
767				
768	**Gamma Distribution Test**		**Data Distribution**	
769	k star (bias corrected)	14.28	**Data appear Normal at 5% Significance Level**	
770	Theta Star	0.00469		
771	MLE of Mean	0.067		
772	MLE of Standard Deviation	0.0177		
773	nu star	628.4		
774	Approximate Chi Square Value (.05)	571.2	**Nonparametric Statistics**	
775	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0725
776	Adjusted Chi Square Value	567.1	95% Jackknife UCL	0.0727
777			95% Standard Bootstrap UCL	0.0724
778	Anderson-Darling Test Statistic	0.433	95% Bootstrap-t UCL	0.0724
779	Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	0.0727
780	Kolmogorov-Smirnov Test Statistic	0.147	95% Percentile Bootstrap UCL	0.0723
781	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0718
782	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0816
783			97.5% Chebyshev(Mean, Sd) UCL	0.0879
784	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.1

95% Approximate Gamma UCL	0.0737		
95% Adjusted Gamma UCL	0.0742		
Potential UCL to Use		Use 95% Student's-t UCL	0.0727

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Biota_Crab_TCDD TEQ(D/F) - fish TEFs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	21
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0262	Minimum of Log Data	-3.643
Maximum	0.0903	Maximum of Log Data	-2.405
Mean	0.0572	Mean of log Data	-2.902
Median	0.0575	SD of log Data	0.304
SD	0.0159		
Std. Error of Mean	0.0034		
Coefficient of Variation	0.279		
Skewness	0.0374		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.983	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0631	95% H-UCL	0.065
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0738
95% Adjusted-CLT UCL (Chen-1995)	0.0628	97.5% Chebyshev (MVUE) UCL	0.0809
95% Modified-t UCL (Johnson-1978)	0.0631	99% Chebyshev (MVUE) UCL	0.0949
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	10.67	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00536		
MLE of Mean	0.0572		
MLE of Standard Deviation	0.0175		
nu star	469.7		
Approximate Chi Square Value (.05)	420.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.0628
Adjusted Chi Square Value	417	95% Jackknife UCL	0.0631
		95% Standard Bootstrap UCL	0.0626
Anderson-Darling Test Statistic	0.288	95% Bootstrap-t UCL	0.0633
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	0.063
Kolmogorov-Smirnov Test Statistic	0.1	95% Percentile Bootstrap UCL	0.0625
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0625

	A	B	C	D	E	F	G	H	I	J	K	L	M
841	Data appear Gamma Distributed at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL					0.072	
842							97.5% Chebyshev(Mean, Sd) UCL					0.0784	
843	Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL					0.091	
844	95% Approximate Gamma UCL					0.0639							
845	95% Adjusted Gamma UCL					0.0644							
846													
847	Potential UCL to Use						Use 95% Student's-t UCL					0.0631	
848													
849	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
850	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)												
851	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.												
852													

	Label	Value	Label	Value
1		General UCL Statistics for Full Data Sets		
2	**User Selected Options**			
3	From File	WorkSheet.wst		
4	Full Precision	OFF		
5	Confidence Coefficient	95%		
6	Number of Bootstrap Operations	2000		
7				
8				
9	Biota_Fish_COPPER			
10				
11	**General Statistics**			
12	Number of Valid Observations	36	Number of Distinct Observations	34
13				
14	**Raw Statistics**		**Log-transformed Statistics**	
15	Minimum	404.7	Minimum of Log Data	6.003
16	Maximum	50900	Maximum of Log Data	10.84
17	Mean	4632	Mean of log Data	7.412
18	Median	855	SD of log Data	1.281
19	SD	9585		
20	Std. Error of Mean	1597		
21	Coefficient of Variation	2.069		
22	Skewness	3.86		
23				
24	**Relevant UCL Statistics**			
25	**Normal Distribution Test**		**Lognormal Distribution Test**	
26	Shapiro Wilk Test Statistic	0.48	Shapiro Wilk Test Statistic	0.815
27	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
28	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
29				
30	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
31	95% Student's-t UCL	7331	95% H-UCL	6773
32	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	7760
33	95% Adjusted-CLT UCL (Chen-1995)	8358	97.5% Chebyshev (MVUE) UCL	9554
34	95% Modified-t UCL (Johnson-1978)	7503	99% Chebyshev (MVUE) UCL	13078
35				
36	**Gamma Distribution Test**		**Data Distribution**	
37	k star (bias corrected)	0.569	**Data do not follow a Discernable Distribution (0.05)**	
38	Theta Star	8145		
39	MLE of Mean	4632		
40	MLE of Standard Deviation	6143		
41	nu star	40.95		
42	Approximate Chi Square Value (.05)	27.28	**Nonparametric Statistics**	
43	Adjusted Level of Significance	0.0428	95% CLT UCL	7260
44	Adjusted Chi Square Value	26.78	95% Jackknife UCL	7331
45			95% Standard Bootstrap UCL	7241
46	Anderson-Darling Test Statistic	3.875	95% Bootstrap-t UCL	11010
47	Anderson-Darling 5% Critical Value	0.803	95% Hall's Bootstrap UCL	18623
48	Kolmogorov-Smirnov Test Statistic	0.321	95% Percentile Bootstrap UCL	7577
49	Kolmogorov-Smirnov 5% Critical Value	0.154	95% BCA Bootstrap UCL	8440
50	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	11596
51			97.5% Chebyshev(Mean, Sd) UCL	14609
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	20527
53	95% Approximate Gamma UCL	6952		
54	95% Adjusted Gamma UCL	7084		
55				
56	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	11596

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_LEAD

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	25
Raw Statistics		**Log-transformed Statistics**	
Minimum	51.85	Minimum of Log Data	3.948
Maximum	2170	Maximum of Log Data	7.683
Mean	410.6	Mean of log Data	5.797
Median	310	SD of log Data	0.648
SD	373.3		
Std. Error of Mean	69.32		
Coefficient of Variation	0.909		
Skewness	3.956		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.582	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	528.6	95% H-UCL	524
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	628.9
95% Adjusted-CLT UCL (Chen-1995)	579.1	97.5% Chebyshev (MVUE) UCL	726.8
95% Modified-t UCL (Johnson-1978)	537.1	99% Chebyshev (MVUE) UCL	919
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.191	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	187.4		
MLE of Mean	410.6		
MLE of Standard Deviation	277.4		
nu star	127.1		
Approximate Chi Square Value (.05)	102	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0407	95% CLT UCL	524.7
Adjusted Chi Square Value	100.7	95% Jackknife UCL	528.6
		95% Standard Bootstrap UCL	522
Anderson-Darling Test Statistic	0.976	95% Bootstrap-t UCL	658.7
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	1011
Kolmogorov-Smirnov Test Statistic	0.149	95% Percentile Bootstrap UCL	537.6
Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	599.9
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	712.8
		97.5% Chebyshev(Mean, Sd) UCL	843.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1100
95% Approximate Gamma UCL	511.4		
95% Adjusted Gamma UCL	518.2		
		Use 95% Approximate Gamma UCL	511.4

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_MERCURY

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	31
Raw Statistics		**Log-transformed Statistics**	
Minimum	46	Minimum of Log Data	3.829
Maximum	630.9	Maximum of Log Data	6.447
Mean	194.8	Mean of log Data	5.031
Median	160	SD of log Data	0.726
SD	137.7		
Std. Error of Mean	22.96		
Coefficient of Variation	0.707		
Skewness	1.333		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.88	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	233.6	95% H-UCL	257.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	311
95% Adjusted-CLT UCL (Chen-1995)	238	97.5% Chebyshev (MVUE) UCL	360.2
95% Modified-t UCL (Johnson-1978)	234.5	99% Chebyshev (MVUE) UCL	456.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.056	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	94.77		
MLE of Mean	194.8		
MLE of Standard Deviation	135.9		
nu star	148		
Approximate Chi Square Value (.05)	120.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	232.6
Adjusted Chi Square Value	119.8	95% Jackknife UCL	233.6
		95% Standard Bootstrap UCL	231.8
Anderson-Darling Test Statistic	0.31	95% Bootstrap-t UCL	244.9
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	239.7
Kolmogorov-Smirnov Test Statistic	0.0775	95% Percentile Bootstrap UCL	234.1
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	234.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	294.9
		97.5% Chebyshev(Mean, Sd) UCL	338.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	423.3
95% Approximate Gamma UCL	238.5		
95% Adjusted Gamma UCL	240.7		
Potential UCL to Use		Use 95% Approximate Gamma UCL	238.5

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

Biota_Fish_Methyl Mercury

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	33
Raw Statistics		**Log-transformed Statistics**	
Minimum	39	Minimum of Log Data	3.664
Maximum	534.8	Maximum of Log Data	6.282
Mean	184.2	Mean of log Data	4.956
Median	145.4	SD of log Data	0.764
SD	129.4		
Std. Error of Mean	21.56		
Coefficient of Variation	0.702		
Skewness	0.973		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	220.6	95% H-UCL	250.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	303.2
95% Adjusted-CLT UCL (Chen-1995)	223.4	97.5% Chebyshev (MVUE) UCL	352.9
95% Modified-t UCL (Johnson-1978)	221.2	99% Chebyshev (MVUE) UCL	450.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.922	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	95.83		
MLE of Mean	184.2		
MLE of Standard Deviation	132.9		
nu star	138.4		
Approximate Chi Square Value (.05)	112.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	219.6
Adjusted Chi Square Value	111.1	95% Jackknife UCL	220.6
		95% Standard Bootstrap UCL	218
Anderson-Darling Test Statistic	0.373	95% Bootstrap-t UCL	225.7
Anderson-Darling 5% Critical Value	0.759	95% Hall's Bootstrap UCL	221.8
Kolmogorov-Smirnov Test Statistic	0.09	95% Percentile Bootstrap UCL	220.5
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	224.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	278.2
		97.5% Chebyshev(Mean, Sd) UCL	318.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	398.7
95% Approximate Gamma UCL	227.2		
95% Adjusted Gamma UCL	229.3		
Potential UCL to Use		Use 95% Approximate Gamma UCL	227.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_ LMW PAHs

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	35
Raw Statistics		**Log-transformed Statistics**	
Minimum	42.46	Minimum of Log Data	3.749
Maximum	368.9	Maximum of Log Data	5.911
Mean	199.1	Mean of log Data	5.137
Median	206.4	SD of log Data	0.615
SD	99.15		
Std. Error of Mean	16.53		
Coefficient of Variation	0.498		
Skewness	0.057		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk Test Statistic	0.91
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	227	95% H-UCL	253.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	301.9
95% Adjusted-CLT UCL (Chen-1995)	226.4	97.5% Chebyshev (MVUE) UCL	344.1
95% Modified-t UCL (Johnson-1978)	227	99% Chebyshev (MVUE) UCL	427.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.084	**Data appear Normal at 5% Significance Level**	
Theta Star	64.55		
MLE of Mean	199.1		
MLE of Standard Deviation	113.4		
nu star	222		
Approximate Chi Square Value (.05)	188.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	226.2
Adjusted Chi Square Value	187.1	95% Jackknife UCL	227
		95% Standard Bootstrap UCL	225.5
Anderson-Darling Test Statistic	0.717	95% Bootstrap-t UCL	227.4
Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	226
Kolmogorov-Smirnov Test Statistic	0.144	95% Percentile Bootstrap UCL	225
Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	228.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	271.1
		97.5% Chebyshev(Mean, Sd) UCL	302.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	363.5
95% Approximate Gamma UCL	234.4		
95% Adjusted Gamma UCL	236.2		
Potential UCL to Use		Use 95% Student's-t UCL	227

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_ HMW PAHs

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	36

Raw Statistics		**Log-transformed Statistics**	
Minimum	7.45	Minimum of Log Data	2.008
Maximum	453	Maximum of Log Data	6.116
Mean	101.8	Mean of log Data	4.308
Median	83.7	SD of log Data	0.824
SD	91.83		
Std. Error of Mean	15.31		
Coefficient of Variation	0.902		
Skewness	2.339		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.98
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	127.7	95% H-UCL	141.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	171.9
95% Adjusted-CLT UCL (Chen-1995)	133.4	97.5% Chebyshev (MVUE) UCL	201.6
95% Modified-t UCL (Johnson-1978)	128.7	99% Chebyshev (MVUE) UCL	260.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.609	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	63.26		
MLE of Mean	101.8		
MLE of Standard Deviation	80.25		
nu star	115.9		
Approximate Chi Square Value (.05)	92.02	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	127
Adjusted Chi Square Value	91.05	95% Jackknife UCL	127.7
		95% Standard Bootstrap UCL	126.5
Anderson-Darling Test Statistic	0.507	95% Bootstrap-t UCL	140
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	145.5
Kolmogorov-Smirnov Test Statistic	0.129	95% Percentile Bootstrap UCL	127.9
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	132.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	168.5
		97.5% Chebyshev(Mean, Sd) UCL	197.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	254.1
95% Approximate Gamma UCL	128.2		
95% Adjusted Gamma UCL	129.5		
Potential UCL to Use		Use 95% Approximate Gamma UCL	128.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_Dieldrin

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	33
Raw Statistics		**Log-transformed Statistics**	

Row	A–E	F	G–K	L
337	Minimum	7.178	Minimum of Log Data	1.971
338	Maximum	88	Maximum of Log Data	4.477
339	Mean	32.18	Mean of log Data	3.309
340	Median	30.11	SD of log Data	0.596
341	SD	18.42		
342	Std. Error of Mean	3.069		
343	Coefficient of Variation	0.572		
344	Skewness	1.09		
345				
346	**Relevant UCL Statistics**			
347	**Normal Distribution Test**		**Lognormal Distribution Test**	
348	Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Test Statistic	0.977
349	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
350	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
351				
352	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
353	95% Student's-t UCL	37.36	95% H-UCL	39.93
354	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	47.49
355	95% Adjusted-CLT UCL (Chen-1995)	37.82	97.5% Chebyshev (MVUE) UCL	53.98
356	95% Modified-t UCL (Johnson-1978)	37.46	99% Chebyshev (MVUE) UCL	66.72
357				
358	**Gamma Distribution Test**		**Data Distribution**	
359	k star (bias corrected)	2.995	**Data appear Gamma Distributed at 5% Significance Level**	
360	Theta Star	10.74		
361	MLE of Mean	32.18		
362	MLE of Standard Deviation	18.59		
363	nu star	215.6		
364	Approximate Chi Square Value (.05)	182.6	**Nonparametric Statistics**	
365	Adjusted Level of Significance	0.0428	95% CLT UCL	37.23
366	Adjusted Chi Square Value	181.3	95% Jackknife UCL	37.36
367			95% Standard Bootstrap UCL	37.27
368	Anderson-Darling Test Statistic	0.21	95% Bootstrap-t UCL	38.13
369	Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	38.09
370	Kolmogorov-Smirnov Test Statistic	0.0973	95% Percentile Bootstrap UCL	37.3
371	Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	37.35
372	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	45.56
373			97.5% Chebyshev(Mean, Sd) UCL	51.34
374	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	62.72
375	95% Approximate Gamma UCL	37.99		
376	95% Adjusted Gamma UCL	38.28		
377				
378	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	37.99
379				
380	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
381	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
382	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
383	**Biota_Fish_Total DDx**			
384				
385	**General Statistics**			
386	Number of Valid Observations	36	Number of Distinct Observations	35
387				
388	**Raw Statistics**		**Log-transformed Statistics**	
389	Minimum	131.5	Minimum of Log Data	4.879
390	Maximum	923	Maximum of Log Data	6.828
391	Mean	276.4	Mean of log Data	5.513
392	Median	233.8	SD of log Data	0.451

	A–E	F	G–K	L
393	SD	150.8		
394	Std. Error of Mean	25.13		
395	Coefficient of Variation	0.546		
396	Skewness	2.4		
397				
398	**Relevant UCL Statistics**			
399	**Normal Distribution Test**		**Lognormal Distribution Test**	
400	Shapiro Wilk Test Statistic	0.785	Shapiro Wilk Test Statistic	0.944
401	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
402	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
403				
404	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
405	95% Student's-t UCL	318.9	95% H-UCL	316.8
406	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	367
407	95% Adjusted-CLT UCL (Chen-1995)	328.5	97.5% Chebyshev (MVUE) UCL	407.3
408	95% Modified-t UCL (Johnson-1978)	320.6	99% Chebyshev (MVUE) UCL	486.5
409				
410	**Gamma Distribution Test**		**Data Distribution**	
411	k star (bias corrected)	4.39	**Data appear Gamma Distributed at 5% Significance Level**	
412	Theta Star	62.97		
413	MLE of Mean	276.4		
414	MLE of Standard Deviation	131.9		
415	nu star	316.1		
416	Approximate Chi Square Value (.05)	275.9	**Nonparametric Statistics**	
417	Adjusted Level of Significance	0.0428	95% CLT UCL	317.8
418	Adjusted Chi Square Value	274.2	95% Jackknife UCL	318.9
419			95% Standard Bootstrap UCL	317.7
420	Anderson-Darling Test Statistic	0.704	95% Bootstrap-t UCL	333.8
421	Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	366
422	Kolmogorov-Smirnov Test Statistic	0.125	95% Percentile Bootstrap UCL	319.8
423	Kolmogorov-Smirnov 5% Critical Value	0.147	95% BCA Bootstrap UCL	330.2
424	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	386
425			97.5% Chebyshev(Mean, Sd) UCL	433.4
426	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	526.5
427	95% Approximate Gamma UCL	316.7		
428	95% Adjusted Gamma UCL	318.6		
429				
430	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	316.7
431				
432	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
433	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
434	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
435				
436	Biota_Fish_Total PCBs			
437				
438	**General Statistics**			
439	Number of Valid Observations	36	Number of Distinct Observations	35
440				
441	**Raw Statistics**		**Log-transformed Statistics**	
442	Minimum	630.2	Minimum of Log Data	6.446
443	Maximum	7861	Maximum of Log Data	8.97
444	Mean	2583	Mean of log Data	7.715
445	Median	2255	SD of log Data	0.537
446	SD	1498		
447	Std. Error of Mean	249.6		
448	Coefficient of Variation	0.58		

Row	A–E	F	G–K	L
449	Skewness	1.684		
450				
451	**Relevant UCL Statistics**			
452	**Normal Distribution Test**		**Lognormal Distribution Test**	
453	Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.991
454	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
455	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
456				
457	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
458	95% Student's-t UCL	3004	95% H-UCL	3087
459	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	3637
460	95% Adjusted-CLT UCL (Chen-1995)	3068	97.5% Chebyshev (MVUE) UCL	4095
461	95% Modified-t UCL (Johnson-1978)	3016	99% Chebyshev (MVUE) UCL	4995
462				
463	**Gamma Distribution Test**		**Data Distribution**	
464	k star (bias corrected)	3.404	**Data appear Gamma Distributed at 5% Significance Level**	
465	Theta Star	758.7		
466	MLE of Mean	2583		
467	MLE of Standard Deviation	1400		
468	nu star	245.1		
469	Approximate Chi Square Value (.05)	209.8	**Nonparametric Statistics**	
470	Adjusted Level of Significance	0.0428	95% CLT UCL	2993
471	Adjusted Chi Square Value	208.4	95% Jackknife UCL	3004
472			95% Standard Bootstrap UCL	2979
473	Anderson-Darling Test Statistic	0.347	95% Bootstrap-t UCL	3108
474	Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	3159
475	Kolmogorov-Smirnov Test Statistic	0.11	95% Percentile Bootstrap UCL	3008
476	Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	3072
477	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	3671
478			97.5% Chebyshev(Mean, Sd) UCL	4142
479	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	5066
480	95% Approximate Gamma UCL	3016		
481	95% Adjusted Gamma UCL	3038		
482				
483	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	3016
484				
485	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
486	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
487	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
488				
489				
490				
491	**Biota_Fish_TCDD TEQ(PCBS) - mammal TEFs**			
492				
493	**General Statistics**			
494	Number of Valid Observations	36	Number of Distinct Observations	34
495				
496	**Raw Statistics**		**Log-transformed Statistics**	
497	Minimum	0.00251	Minimum of Log Data	-5.988
498	Maximum	0.0871	Maximum of Log Data	-2.44
499	Mean	0.0268	Mean of log Data	-3.853
500	Median	0.0228	SD of log Data	0.737
501	SD	0.019		
502	Std. Error of Mean	0.00316		
503	Coefficient of Variation	0.708		
504	Skewness	1.766		

	A–E	F	G–K	L
505				
506	Relevant UCL Statistics			
507	**Normal Distribution Test**		**Lognormal Distribution Test**	
508	Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Test Statistic	0.962
509	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
510	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
511				
512	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
513	95% Student's-t UCL	0.0321	95% H-UCL	0.0362
514	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0437
515	95% Adjusted-CLT UCL (Chen-1995)	0.033	97.5% Chebyshev (MVUE) UCL	0.0507
516	95% Modified-t UCL (Johnson-1978)	0.0323	99% Chebyshev (MVUE) UCL	0.0644
517				
518	**Gamma Distribution Test**		**Data Distribution**	
519	k star (bias corrected)	2.12	**Data appear Gamma Distributed at 5% Significance Level**	
520	Theta Star	0.0126		
521	MLE of Mean	0.0268		
522	MLE of Standard Deviation	0.0184		
523	nu star	152.7		
524	Approximate Chi Square Value (.05)	125.1	**Nonparametric Statistics**	
525	Adjusted Level of Significance	0.0428	95% CLT UCL	0.032
526	Adjusted Chi Square Value	124	95% Jackknife UCL	0.0321
527			95% Standard Bootstrap UCL	0.032
528	Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL	0.0336
529	Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	0.0352
530	Kolmogorov-Smirnov Test Statistic	0.12	95% Percentile Bootstrap UCL	0.0321
531	Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	0.033
532	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0406
533			97.5% Chebyshev(Mean, Sd) UCL	0.0465
534	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0583
535	95% Approximate Gamma UCL	0.0327		
536	95% Adjusted Gamma UCL	0.033		
537				
538	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.0327
539				
540	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
541	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
542	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
543				
544				
545	**Biota_Fish_TCDD TEQ(PCBS) - bird TEFs**			
546				
547	**General Statistics**			
548	Number of Valid Observations	36	Number of Distinct Observations	36
549				
550	**Raw Statistics**		**Log-transformed Statistics**	
551	Minimum	0.00522	Minimum of Log Data	-5.255
552	Maximum	0.403	Maximum of Log Data	-0.91
553	Mean	0.125	Mean of log Data	-2.601
554	Median	0.102	SD of log Data	1.205
555	SD	0.103		
556	Std. Error of Mean	0.0172		
557	Coefficient of Variation	0.826		
558	Skewness	0.664		
559				
560	**Relevant UCL Statistics**			

	A–E	F	G–K	L
561	**Normal Distribution Test**		**Lognormal Distribution Test**	
562	Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.906
563	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
564	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
565				
566	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
567	95% Student's-t UCL	0.154	95% H-UCL	0.262
568	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.306
569	95% Adjusted-CLT UCL (Chen-1995)	0.155	97.5% Chebyshev (MVUE) UCL	0.375
570	95% Modified-t UCL (Johnson-1978)	0.154	99% Chebyshev (MVUE) UCL	0.509
571				
572	**Gamma Distribution Test**		**Data Distribution**	
573	k star (bias corrected)	1.026	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
574	Theta Star	0.122		
575	MLE of Mean	0.125		
576	MLE of Standard Deviation	0.123		
577	nu star	73.89		
578	Approximate Chi Square Value (.05)	55.1	**Nonparametric Statistics**	
579	Adjusted Level of Significance	0.0428	95% CLT UCL	0.153
580	Adjusted Chi Square Value	54.36	95% Jackknife UCL	0.154
581			95% Standard Bootstrap UCL	0.152
582	Anderson-Darling Test Statistic	0.793	95% Bootstrap-t UCL	0.157
583	Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	0.155
584	Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	0.154
585	Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.152
586	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.2
587			97.5% Chebyshev(Mean, Sd) UCL	0.232
588	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.296
589	95% Approximate Gamma UCL	0.167		
590	95% Adjusted Gamma UCL	0.17		
591				
592	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.167
593				
594	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
595	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
596	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
597				
598				
599	**Biota_Fish_TCDD TEQ(PCBS) - fish TEFs**			
600				
601	**General Statistics**			
602	Number of Valid Observations	36	Number of Distinct Observations	36
603				
604	**Raw Statistics**		**Log-transformed Statistics**	
605	Minimum	0.0003849	Minimum of Log Data	-7.863
606	Maximum	0.00654	Maximum of Log Data	-5.03
607	Mean	0.00222	Mean of log Data	-6.264
608	Median	0.00198	SD of log Data	0.574
609	SD	0.00133		
610	Std. Error of Mean	0.0002213		
611	Coefficient of Variation	0.598		
612	Skewness	1.813		
613				
614	**Relevant UCL Statistics**			
615	**Normal Distribution Test**		**Lognormal Distribution Test**	
616	Shapiro Wilk Test Statistic	0.834	Shapiro Wilk Test Statistic	0.969

	A-F		G-L	
617	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
618	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
619				
620	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
621	95% Student's-t UCL	0.00259	95% H-UCL	0.00272
622	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.00322
623	95% Adjusted-CLT UCL (Chen-1995)	0.00266	97.5% Chebyshev (MVUE) UCL	0.00365
624	95% Modified-t UCL (Johnson-1978)	0.00261	99% Chebyshev (MVUE) UCL	0.00449
625				
626	**Gamma Distribution Test**		**Data Distribution**	
627	k star (bias corrected)	3.145	**Data appear Gamma Distributed at 5% Significance Level**	
628	Theta Star	0.0007061		
629	MLE of Mean	0.00222		
630	MLE of Standard Deviation	0.00125		
631	nu star	226.5		
632	Approximate Chi Square Value (.05)	192.6	**Nonparametric Statistics**	
633	Adjusted Level of Significance	0.0428	95% CLT UCL	0.00258
634	Adjusted Chi Square Value	191.2	95% Jackknife UCL	0.00259
635			95% Standard Bootstrap UCL	0.00258
636	Anderson-Darling Test Statistic	0.473	95% Bootstrap-t UCL	0.0027
637	Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	0.00282
638	Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	0.0026
639	Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	0.00265
640	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.00319
641			97.5% Chebyshev(Mean, Sd) UCL	0.0036
642	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.00442
643	95% Approximate Gamma UCL	0.00261		
644	95% Adjusted Gamma UCL	0.00263		
645				
646	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.00261
647				
648	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
649	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
650	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
651				
652				
653				
654	**Biota_Fish_TCDD TEQ(D/F) - mammal TEFs**			
655				
656	**General Statistics**			
657	Number of Valid Observations	36	Number of Distinct Observations	34
658				
659	**Raw Statistics**		**Log-transformed Statistics**	
660	Minimum	0.00595	Minimum of Log Data	-5.125
661	Maximum	1.426	Maximum of Log Data	0.355
662	Mean	0.184	Mean of log Data	-2.264
663	Median	0.166	SD of log Data	1.155
664	SD	0.245		
665	Std. Error of Mean	0.0408		
666	Coefficient of Variation	1.33		
667	Skewness	3.991		
668				
669	**Relevant UCL Statistics**			
670	**Normal Distribution Test**		**Lognormal Distribution Test**	
671	Shapiro Wilk Test Statistic	0.587	Shapiro Wilk Test Statistic	0.952
672	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935

	A–E	F	G–K	L
673	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
674				
675	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
676	95% Student's-t UCL	0.253	95% H-UCL	0.334
677	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.395
678	95% Adjusted-CLT UCL (Chen-1995)	0.28	97.5% Chebyshev (MVUE) UCL	0.481
679	95% Modified-t UCL (Johnson-1978)	0.258	99% Chebyshev (MVUE) UCL	0.649
680				
681	**Gamma Distribution Test**		**Data Distribution**	
682	k star (bias corrected)	0.942	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
683	Theta Star	0.196		
684	MLE of Mean	0.184		
685	MLE of Standard Deviation	0.19		
686	nu star	67.8		
687	Approximate Chi Square Value (.05)	49.85	**Nonparametric Statistics**	
688	Adjusted Level of Significance	0.0428	95% CLT UCL	0.251
689	Adjusted Chi Square Value	49.15	95% Jackknife UCL	0.253
690			95% Standard Bootstrap UCL	0.25
691	Anderson-Darling Test Statistic	0.788	95% Bootstrap-t UCL	0.316
692	Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	0.553
693	Kolmogorov-Smirnov Test Statistic	0.122	95% Percentile Bootstrap UCL	0.257
694	Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.29
695	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.362
696			97.5% Chebyshev(Mean, Sd) UCL	0.439
697	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.591
698	95% Approximate Gamma UCL	0.251		
699	95% Adjusted Gamma UCL	0.254		
700				
701	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.251
702				

Row				
703	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
704	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
705	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
706				
707				
708	Biota_Fish_TCDD TEQ(D/F) - bird TEFs			
709				
710	**General Statistics**			
711	Number of Valid Observations	36	Number of Distinct Observations	34
712				
713	**Raw Statistics**		**Log-transformed Statistics**	
714	Minimum	0.00586	Minimum of Log Data	-5.139
715	Maximum	1.447	Maximum of Log Data	0.369
716	Mean	0.193	Mean of log Data	-2.216
717	Median	0.175	SD of log Data	1.169
718	SD	0.249		
719	Std. Error of Mean	0.0415		
720	Coefficient of Variation	1.291		
721	Skewness	3.917		
722				
723	**Relevant UCL Statistics**			
724	**Normal Distribution Test**		**Lognormal Distribution Test**	
725	Shapiro Wilk Test Statistic	0.599	Shapiro Wilk Test Statistic	0.944
726	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
727	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
728				
729	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
730	95% Student's-t UCL	0.263	95% H-UCL	0.359
731	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.424
732	95% Adjusted-CLT UCL (Chen-1995)	0.29	97.5% Chebyshev (MVUE) UCL	0.516
733	95% Modified-t UCL (Johnson-1978)	0.267	99% Chebyshev (MVUE) UCL	0.698
734				
735	**Gamma Distribution Test**		**Data Distribution**	
736	k star (bias corrected)	0.946	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
737	Theta Star	0.204		
738	MLE of Mean	0.193		
739	MLE of Standard Deviation	0.198		
740	nu star	68.12		
741	Approximate Chi Square Value (.05)	50.13	**Nonparametric Statistics**	
742	Adjusted Level of Significance	0.0428	95% CLT UCL	0.261
743	Adjusted Chi Square Value	49.42	95% Jackknife UCL	0.263
744			95% Standard Bootstrap UCL	0.259
745	Anderson-Darling Test Statistic	0.844	95% Bootstrap-t UCL	0.335
746	Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	0.569
747	Kolmogorov-Smirnov Test Statistic	0.127	95% Percentile Bootstrap UCL	0.264
748	Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.29
749	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.373
750			97.5% Chebyshev(Mean, Sd) UCL	0.452
751	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.605
752	95% Approximate Gamma UCL	0.262		
753	95% Adjusted Gamma UCL	0.266		
754				
755	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.262
756				
757	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
758	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			

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

Biota_Fish_TCDD TEQ(D/F) - fish TEFs

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	36
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00586	Minimum of Log Data	-5.14
Maximum	1.431	Maximum of Log Data	0.359
Mean	0.185	Mean of log Data	-2.258
Median	0.167	SD of log Data	1.158
SD	0.246		
Std. Error of Mean	0.041		
Coefficient of Variation	1.327		
Skewness	3.98		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.589	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.255	95% H-UCL	0.338
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.399
95% Adjusted-CLT UCL (Chen-1995)	0.282	97.5% Chebyshev (MVUE) UCL	0.486
95% Modified-t UCL (Johnson-1978)	0.259	99% Chebyshev (MVUE) UCL	0.656
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.941	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	0.197		
MLE of Mean	0.185		
MLE of Standard Deviation	0.191		
nu star	67.72		
Approximate Chi Square Value (.05)	49.78	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	0.253
Adjusted Chi Square Value	49.08	95% Jackknife UCL	0.255
		95% Standard Bootstrap UCL	0.253
Anderson-Darling Test Statistic	0.784	95% Bootstrap-t UCL	0.322
Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	0.551
Kolmogorov-Smirnov Test Statistic	0.121	95% Percentile Bootstrap UCL	0.267
Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.289
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.364
		97.5% Chebyshev(Mean, Sd) UCL	0.442
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.593
95% Approximate Gamma UCL	0.252		
95% Adjusted Gamma UCL	0.256		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.252

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_ Lipids

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	34

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.093	Minimum of Log Data	0.739
Maximum	18	Maximum of Log Data	2.89
Mean	5.549	Mean of log Data	1.595
Median	4.7	SD of log Data	0.478
SD	3.098		
Std. Error of Mean	0.516		
Coefficient of Variation	0.558		
Skewness	2.15		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.82	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.421	95% H-UCL	6.439
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.5
95% Adjusted-CLT UCL (Chen-1995)	6.596	97.5% Chebyshev (MVUE) UCL	8.363
95% Modified-t UCL (Johnson-1978)	6.452	99% Chebyshev (MVUE) UCL	10.06
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.028	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.378		
MLE of Mean	5.549		
MLE of Standard Deviation	2.765		
nu star	290		
Approximate Chi Square Value (.05)	251.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	6.398
Adjusted Chi Square Value	249.9	95% Jackknife UCL	6.421
		95% Standard Bootstrap UCL	6.383
Anderson-Darling Test Statistic	0.433	95% Bootstrap-t UCL	6.717
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL	7.021
Kolmogorov-Smirnov Test Statistic	0.106	95% Percentile Bootstrap UCL	6.427
Kolmogorov-Smirnov 5% Critical Value	0.147	95% BCA Bootstrap UCL	6.64
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7.8
		97.5% Chebyshev(Mean, Sd) UCL	8.774
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.69
95% Approximate Gamma UCL	6.397		
95% Adjusted Gamma UCL	6.438		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6.397

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Sediment_Mudflats_Copper			
General Statistics			
Number of Valid Observations	21	Number of Distinct Observations	20
Raw Statistics		Log-transformed Statistics	
Minimum	36600	Minimum of Log Data	10.51
Maximum	577000	Maximum of Log Data	13.27
Mean	184781	Mean of log Data	11.96
Median	147000	SD of log Data	0.578
SD	126035		
Std. Error of Mean	27503		
Coefficient of Variation	0.682		
Skewness	2.143		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.743	Shapiro Wilk Test Statistic	0.926
Shapiro Wilk Critical Value	0.908	Shapiro Wilk Critical Value	0.908
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	232216	95% H-UCL	241255
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	288754
95% Adjusted-CLT UCL (Chen-1995)	243762	97.5% Chebyshev (MVUE) UCL	334463
95% Modified-t UCL (Johnson-1978)	234359	99% Chebyshev (MVUE) UCL	424250
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	2.732	Data appear Lognormal at 5% Significance Level	
Theta Star	67639		
MLE of Mean	184781		
MLE of Standard Deviation	111796		
nu star	114.7		
Approximate Chi Square Value (.05)	91.01	Nonparametric Statistics	
Adjusted Level of Significance	0.0383	95% CLT UCL	230019
Adjusted Chi Square Value	89.39	95% Jackknife UCL	232216
		95% Standard Bootstrap UCL	229221
Anderson-Darling Test Statistic	0.987	95% Bootstrap-t UCL	276183
Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL	466071
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	229924
Kolmogorov-Smirnov 5% Critical Value	0.191	95% BCA Bootstrap UCL	244395
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	304664

	A–E	F	G–K	L
51			97.5% Chebyshev(Mean, Sd) UCL	356537
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	458432
53	95% Approximate Gamma UCL	232960		
54	95% Adjusted Gamma UCL	237189		
55				
56	**Potential UCL to Use**		Use 95% H-UCL	241255
57				
58	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
59	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
60	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
61	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
62				
63	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
64	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
65	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
66	**Sediment_Mudflats_Lead**			
67				
68	**General Statistics**			
69	Number of Valid Observations	17	Number of Distinct Observations	17
70				
71	**Raw Statistics**		**Log-transformed Statistics**	
72	Minimum	114000	Minimum of Log Data	11.64
73	Maximum	763000	Maximum of Log Data	13.55
74	Mean	254471	Mean of log Data	12.34
75	Median	211000	SD of log Data	0.434
76	SD	148306		
77	Std. Error of Mean	35969		
78	Coefficient of Variation	0.583		
79	Skewness	2.789		
80				
81	**Relevant UCL Statistics**			
82	**Normal Distribution Test**		**Lognormal Distribution Test**	
83	Shapiro Wilk Test Statistic	0.681	Shapiro Wilk Test Statistic	0.904
84	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
85	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
86				
87	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
88	95% Student's-t UCL	317269	95% H-UCL	311903
89	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	368077
90	95% Adjusted-CLT UCL (Chen-1995)	339636	97.5% Chebyshev (MVUE) UCL	419021
91	95% Modified-t UCL (Johnson-1978)	321325	99% Chebyshev (MVUE) UCL	519091
92				
93	**Gamma Distribution Test**		**Data Distribution**	
94	k star (bias corrected)	4.112	**Data appear Lognormal at 5% Significance Level**	
95	Theta Star	61886		
96	MLE of Mean	254471		
97	MLE of Standard Deviation	125492		
98	nu star	139.8		
99	Approximate Chi Square Value (.05)	113.5	**Nonparametric Statistics**	
100	Adjusted Level of Significance	0.0346	95% CLT UCL	313635

101	Adjusted Chi Square Value	111	95% Jackknife UCL	317269
102			95% Standard Bootstrap UCL	310620
103	Anderson-Darling Test Statistic	0.976	95% Bootstrap-t UCL	384836
104	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	555827
105	Kolmogorov-Smirnov Test Statistic	0.245	95% Percentile Bootstrap UCL	318294
106	Kolmogorov-Smirnov 5% Critical Value	0.21	95% BCA Bootstrap UCL	341529
107	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	411258
108			97.5% Chebyshev(Mean, Sd) UCL	479100
109	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	612362
110	95% Approximate Gamma UCL	313493		
111	95% Adjusted Gamma UCL	320507		
112				
113	**Potential UCL to Use**		Use 95% Student's-t UCL	317269
114			or 95% Modified-t UCL	321325
115			or 95% H-UCL	311903
116				
117	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
118	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
119	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
120	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
121				
122	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
123	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
124	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
125				
126	**Sediment_Mudflats_Mercury**			
127				
128	**General Statistics**			
129	Number of Valid Observations	17	Number of Distinct Observations	13
130				
131	**Raw Statistics**		**Log-transformed Statistics**	
132	Minimum	652	Minimum of Log Data	6.48
133	Maximum	13400	Maximum of Log Data	9.503
134	Mean	2802	Mean of log Data	7.705
135	Median	2100	SD of log Data	0.62
136	SD	2842		
137	Std. Error of Mean	689.4		
138	Coefficient of Variation	1.014		
139	Skewness	3.613		
140				
141	**Relevant UCL Statistics**			
142	**Normal Distribution Test**		**Lognormal Distribution Test**	
143	Shapiro Wilk Test Statistic	0.51	Shapiro Wilk Test Statistic	0.863
144	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
145	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
146				
147	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
148	95% Student's-t UCL	4006	95% H-UCL	3762
149	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	4481
150	95% Adjusted-CLT UCL (Chen-1995)	4582	97.5% Chebyshev (MVUE) UCL	5270

	A-F		G-L	
151	95% Modified-t UCL (Johnson-1978)	4107	99% Chebyshev (MVUE) UCL	6822
152				
153	**Gamma Distribution Test**		**Data Distribution**	
154	k star (bias corrected)	1.934	**Data do not follow a Discernable Distribution (0.05)**	
155	Theta Star	1449		
156	MLE of Mean	2802		
157	MLE of Standard Deviation	2015		
158	nu star	65.74		
159	Approximate Chi Square Value (.05)	48.08	**Nonparametric Statistics**	
160	Adjusted Level of Significance	0.0346	95% CLT UCL	3936
161	Adjusted Chi Square Value	46.5	95% Jackknife UCL	4006
162			95% Standard Bootstrap UCL	3894
163	Anderson-Darling Test Statistic	1.56	95% Bootstrap-t UCL	6994
164	Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	9535
165	Kolmogorov-Smirnov Test Statistic	0.316	95% Percentile Bootstrap UCL	4076
166	Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	4824
167	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	5808
168			97.5% Chebyshev(Mean, Sd) UCL	7108
169	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	9662
170	95% Approximate Gamma UCL	3832		
171	95% Adjusted Gamma UCL	3962		
172				
173	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	5808
174				
175	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
176	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
177	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
178				
179	**Sediment_Mudflats_ Methylmercury**			
180				
181	**General Statistics**			
182	Number of Valid Observations	14	Number of Distinct Observations	14
183				
184	**Raw Statistics**		**Log-transformed Statistics**	
185	Minimum	2.4	Minimum of Log Data	0.875
186	Maximum	11.5	Maximum of Log Data	2.442
187	Mean	5.296	Mean of log Data	1.576
188	Median	4.62	SD of log Data	0.434
189	SD	2.481		
190	Std. Error of Mean	0.663		
191	Coefficient of Variation	0.468		
192	Skewness	1.3		
193				
194	**Relevant UCL Statistics**			
195	**Normal Distribution Test**		**Lognormal Distribution Test**	
196	Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.979
197	Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
198	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
199				
200	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	

201	95% Student's-t UCL	6.47	95% H-UCL	6.758
202	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	7.998
203	95% Adjusted-CLT UCL (Chen-1995)	6.632	97.5% Chebyshev (MVUE) UCL	9.176
204	95% Modified-t UCL (Johnson-1978)	6.508	99% Chebyshev (MVUE) UCL	11.49
205				
206	**Gamma Distribution Test**		**Data Distribution**	
207	k star (bias corrected)	4.508	**Data appear Normal at 5% Significance Level**	
208	Theta Star	1.175		
209	MLE of Mean	5.296		
210	MLE of Standard Deviation	2.494		
211	nu star	126.2		
212	Approximate Chi Square Value (.05)	101.3	**Nonparametric Statistics**	
213	Adjusted Level of Significance	0.0312	95% CLT UCL	6.386
214	Adjusted Chi Square Value	98.31	95% Jackknife UCL	6.47
215			95% Standard Bootstrap UCL	6.341
216	Anderson-Darling Test Statistic	0.259	95% Bootstrap-t UCL	7.079
217	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	6.998
218	Kolmogorov-Smirnov Test Statistic	0.121	95% Percentile Bootstrap UCL	6.379
219	Kolmogorov-Smirnov 5% Critical Value	0.229	95% BCA Bootstrap UCL	6.507
220	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	8.186
221			97.5% Chebyshev(Mean, Sd) UCL	9.437
222	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	11.89
223	95% Approximate Gamma UCL	6.6		
224	95% Adjusted Gamma UCL	6.799		
225				
226	**Potential UCL to Use**		Use 95% Student's-t UCL	6.47
227				
228	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
229	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
230	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
231				
232	**Sediment_Mudflats_LWM PAHs**			
233				
234	**General Statistics**			
235	Number of Valid Observations	17	Number of Distinct Observations	17
236				
237	**Raw Statistics**		**Log-transformed Statistics**	
238	Minimum	865	Minimum of Log Data	6.763
239	Maximum	12900	Maximum of Log Data	9.465
240	Mean	4830	Mean of log Data	8.298
241	Median	4400	SD of log Data	0.68
242	SD	2891		
243	Std. Error of Mean	701.1		
244	Coefficient of Variation	0.598		
245	Skewness	1.335		
246				
247	**Relevant UCL Statistics**			
248	**Normal Distribution Test**		**Lognormal Distribution Test**	
249	Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.906
250	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892

	A–E	F	G–K	L
251	Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
252				
253	Assuming Normal Distribution		Assuming Lognormal Distribution	
254	95% Student's-t UCL	6054	95% H-UCL	7391
255	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8755
256	95% Adjusted-CLT UCL (Chen-1995)	6226	97.5% Chebyshev (MVUE) UCL	10391
257	95% Modified-t UCL (Johnson-1978)	6092	99% Chebyshev (MVUE) UCL	13603
258				
259	Gamma Distribution Test		Data Distribution	
260	k star (bias corrected)	2.393	Data appear Gamma Distributed at 5% Significance Level	
261	Theta Star	2019		
262	MLE of Mean	4830		
263	MLE of Standard Deviation	3123		
264	nu star	81.36		
265	Approximate Chi Square Value (.05)	61.58	Nonparametric Statistics	
266	Adjusted Level of Significance	0.0346	95% CLT UCL	5984
267	Adjusted Chi Square Value	59.77	95% Jackknife UCL	6054
268			95% Standard Bootstrap UCL	5964
269	Anderson-Darling Test Statistic	0.521	95% Bootstrap-t UCL	6484
270	Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	7282
271	Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL	5967
272	Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	6164
273	Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7886
274			97.5% Chebyshev(Mean, Sd) UCL	9209
275	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11806
276	95% Approximate Gamma UCL	6383		
277	95% Adjusted Gamma UCL	6575		
278				
279	Potential UCL to Use		Use 95% Approximate Gamma UCL	6383
280				
281	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
282	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
283	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
284				
285				
286	Sediment_Mudflats_ HWM PAHs			
287				
288	General Statistics			
289	Number of Valid Observations	17	Number of Distinct Observations	17
290				
291	Raw Statistics		Log-transformed Statistics	
292	Minimum	5828	Minimum of Log Data	8.67
293	Maximum	52350	Maximum of Log Data	10.87
294	Mean	26200	Mean of log Data	10.05
295	Median	25580	SD of log Data	0.57
296	SD	11364		
297	Std. Error of Mean	2756		
298	Coefficient of Variation	0.434		
299	Skewness	0.185		
300				

Row	Left label	Left value	Right label	Right value
301	**Relevant UCL Statistics**			
302	**Normal Distribution Test**		**Lognormal Distribution Test**	
303	Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.837
304	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
305	**Data appear Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
306				
307	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
308	95% Student's-t UCL	31012	95% H-UCL	36856
309	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	43951
310	95% Adjusted-CLT UCL (Chen-1995)	30866	97.5% Chebyshev (MVUE) UCL	51289
311	95% Modified-t UCL (Johnson-1978)	31033	99% Chebyshev (MVUE) UCL	65704
312				
313	**Gamma Distribution Test**		**Data Distribution**	
314	k star (bias corrected)	3.545	**Data appear Normal at 5% Significance Level**	
315	Theta Star	7391		
316	MLE of Mean	26200		
317	MLE of Standard Deviation	13916		
318	nu star	120.5		
319	Approximate Chi Square Value (.05)	96.17	**Nonparametric Statistics**	
320	Adjusted Level of Significance	0.0346	95% CLT UCL	30734
321	Adjusted Chi Square Value	93.89	95% Jackknife UCL	31012
322			95% Standard Bootstrap UCL	30580
323	Anderson-Darling Test Statistic	0.87	95% Bootstrap-t UCL	30913
324	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	31240
325	Kolmogorov-Smirnov Test Statistic	0.28	95% Percentile Bootstrap UCL	30833
326	Kolmogorov-Smirnov 5% Critical Value	0.21	95% BCA Bootstrap UCL	30685
327	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	38214
328			97.5% Chebyshev(Mean, Sd) UCL	43413
329	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	53624
330	95% Approximate Gamma UCL	32834		
331	95% Adjusted Gamma UCL	33631		
332				
333	**Potential UCL to Use**		Use 95% Student's-t UCL	31012
334				
335	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
336	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
337	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
338				
339	Sediment_Mudflats_Dieldrin			
340				
341	**General Statistics**			
342	Number of Valid Observations	17	Number of Distinct Observations	15
343				
344	**Raw Statistics**		**Log-transformed Statistics**	
345	Minimum	0.75	Minimum of Log Data	-0.288
346	Maximum	130	Maximum of Log Data	4.868
347	Mean	11.06	Mean of log Data	1.4
348	Median	3.83	SD of log Data	1.031
349	SD	30.68		
350	Std. Error of Mean	7.441		

	A–E	F	G–K	L
351	Coefficient of Variation	2.773		
352	Skewness	4.108		
353				
354	**Relevant UCL Statistics**			
355	**Normal Distribution Test**		**Lognormal Distribution Test**	
356	Shapiro Wilk Test Statistic	0.303	Shapiro Wilk Test Statistic	0.731
357	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
358	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
359				
360	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
361	95% Student's-t UCL	24.06	95% H-UCL	13.89
362	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	14.58
363	95% Adjusted-CLT UCL (Chen-1995)	31.23	97.5% Chebyshev (MVUE) UCL	18.03
364	95% Modified-t UCL (Johnson-1978)	25.29	99% Chebyshev (MVUE) UCL	24.81
365				
366	**Gamma Distribution Test**		**Data Distribution**	
367	k star (bias corrected)	0.544	**Data do not follow a Discernable Distribution (0.05)**	
368	Theta Star	20.33		
369	MLE of Mean	11.06		
370	MLE of Standard Deviation	15		
371	nu star	18.51		
372	Approximate Chi Square Value (.05)	9.758	**Nonparametric Statistics**	
373	Adjusted Level of Significance	0.0346	95% CLT UCL	23.3
374	Adjusted Chi Square Value	9.097	95% Jackknife UCL	24.06
375			95% Standard Bootstrap UCL	22.51
376	Anderson-Darling Test Statistic	3.492	95% Bootstrap-t UCL	201.7
377	Anderson-Darling 5% Critical Value	0.788	95% Hall's Bootstrap UCL	115.4
378	Kolmogorov-Smirnov Test Statistic	0.45	95% Percentile Bootstrap UCL	25.92
379	Kolmogorov-Smirnov 5% Critical Value	0.219	95% BCA Bootstrap UCL	33.66
380	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	43.5
381			97.5% Chebyshev(Mean, Sd) UCL	57.54
382	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	85.11
383	95% Approximate Gamma UCL	20.98		
384	95% Adjusted Gamma UCL	22.51		
385				
386	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	43.5
387				
388	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
389	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
390	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
391				
392	**Sediment_Mudflats_Total DDx**			
393				
394	**General Statistics**			
395	Number of Valid Observations	17	Number of Distinct Observations	16
396				
397	**Raw Statistics**		**Log-transformed Statistics**	
398	Minimum	31.1	Minimum of Log Data	3.437
399	Maximum	817	Maximum of Log Data	6.706
400	Mean	110.2	Mean of log Data	4.254

	A–E	F	G–K	L
401	Median	62	SD of log Data	0.753
402	SD	184.7		
403	Std. Error of Mean	44.81		
404	Coefficient of Variation	1.676		
405	Skewness	3.937		
406				
407	**Relevant UCL Statistics**			
408	**Normal Distribution Test**		**Lognormal Distribution Test**	
409	Shapiro Wilk Test Statistic	0.395	Shapiro Wilk Test Statistic	0.769
410	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
411	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
412				
413	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
414	95% Student's-t UCL	188.4	95% H-UCL	144.4
415	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	169.3
416	95% Adjusted-CLT UCL (Chen-1995)	229.6	97.5% Chebyshev (MVUE) UCL	203
417	95% Modified-t UCL (Johnson-1978)	195.6	99% Chebyshev (MVUE) UCL	269.1
418				
419	**Gamma Distribution Test**		**Data Distribution**	
420	k star (bias corrected)	1.073	**Data do not follow a Discernable Distribution (0.05)**	
421	Theta Star	102.7		
422	MLE of Mean	110.2		
423	MLE of Standard Deviation	106.4		
424	nu star	36.48		
425	Approximate Chi Square Value (.05)	23.66	**Nonparametric Statistics**	
426	Adjusted Level of Significance	0.0346	95% CLT UCL	183.9
427	Adjusted Chi Square Value	22.58	95% Jackknife UCL	188.4
428			95% Standard Bootstrap UCL	181.6
429	Anderson-Darling Test Statistic	2.424	95% Bootstrap-t UCL	588.2
430	Anderson-Darling 5% Critical Value	0.761	95% Hall's Bootstrap UCL	454.5
431	Kolmogorov-Smirnov Test Statistic	0.337	95% Percentile Bootstrap UCL	195.8
432	Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL	246.8
433	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	305.5
434			97.5% Chebyshev(Mean, Sd) UCL	390
435	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	556
436	95% Approximate Gamma UCL	169.9		
437	95% Adjusted Gamma UCL	178.1		
438				
439	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	305.5
440				
441	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
442	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
443	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
444				
445				
446				
447	Sediment_Mudflats_ Total PCBs			
448				
449	**General Statistics**			
450	Number of Valid Observations	17	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	357.4	Minimum of Log Data	5.879
Maximum	18922	Maximum of Log Data	9.848
Mean	1918	Mean of log Data	6.862
Median	905.6	SD of log Data	0.871
SD	4393		
Std. Error of Mean	1065		
Coefficient of Variation	2.29		
Skewness	4.088		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.325	Shapiro Wilk Test Statistic	0.718
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3778	95% H-UCL	2388
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2710
95% Adjusted-CLT UCL (Chen-1995)	4799	97.5% Chebyshev (MVUE) UCL	3296
95% Modified-t UCL (Johnson-1978)	3954	99% Chebyshev (MVUE) UCL	4448
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.735	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2608		
MLE of Mean	1918		
MLE of Standard Deviation	2237		
nu star	25		
Approximate Chi Square Value (.05)	14.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	3671
Adjusted Chi Square Value	13.79	95% Jackknife UCL	3778
		95% Standard Bootstrap UCL	3615
Anderson-Darling Test Statistic	3.141	95% Bootstrap-t UCL	19795
Anderson-Darling 5% Critical Value	0.772	95% Hall's Bootstrap UCL	13936
Kolmogorov-Smirnov Test Statistic	0.397	95% Percentile Bootstrap UCL	4044
Kolmogorov-Smirnov 5% Critical Value	0.216	95% BCA Bootstrap UCL	5233
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6562
		97.5% Chebyshev(Mean, Sd) UCL	8572
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	12519
95% Approximate Gamma UCL	3282		
95% Adjusted Gamma UCL	3479		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	6562

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflats_TCDD TEQ(PCBs) - mammal TEFs

	A–E	F	G–K	L
501				
502	**General Statistics**			
503	Number of Valid Observations	17	Number of Distinct Observations	17
504				
505	**Raw Statistics**		**Log-transformed Statistics**	
506	Minimum	0.0005367	Minimum of Log Data	-7.53
507	Maximum	0.23	Maximum of Log Data	-1.47
508	Mean	0.0277	Mean of log Data	-4.207
509	Median	0.0169	SD of log Data	1.108
510	SD	0.0524		
511	Std. Error of Mean	0.0127		
512	Coefficient of Variation	1.891		
513	Skewness	4.045		
514				
515	**Relevant UCL Statistics**			
516	**Normal Distribution Test**		**Lognormal Distribution Test**	
517	Shapiro Wilk Test Statistic	0.357	Shapiro Wilk Test Statistic	0.713
518	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
519	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
520				
521	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
522	95% Student's-t UCL	0.0499	95% H-UCL	0.0603
523	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0603
524	95% Adjusted-CLT UCL (Chen-1995)	0.0619	97.5% Chebyshev (MVUE) UCL	0.0751
525	95% Modified-t UCL (Johnson-1978)	0.052	99% Chebyshev (MVUE) UCL	0.104
526				
527	**Gamma Distribution Test**		**Data Distribution**	
528	k star (bias corrected)	0.811	**Data do not follow a Discernable Distribution (0.05)**	
529	Theta Star	0.0342		
530	MLE of Mean	0.0277		
531	MLE of Standard Deviation	0.0308		
532	nu star	27.57		
533	Approximate Chi Square Value (.05)	16.6	**Nonparametric Statistics**	
534	Adjusted Level of Significance	0.0346	95% CLT UCL	0.0486
535	Adjusted Chi Square Value	15.71	95% Jackknife UCL	0.0499
536			95% Standard Bootstrap UCL	0.0475
537	Anderson-Darling Test Statistic	2.613	95% Bootstrap-t UCL	0.187
538	Anderson-Darling 5% Critical Value	0.769	95% Hall's Bootstrap UCL	0.176
539	Kolmogorov-Smirnov Test Statistic	0.349	95% Percentile Bootstrap UCL	0.0527
540	Kolmogorov-Smirnov 5% Critical Value	0.216	95% BCA Bootstrap UCL	0.0658
541	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0831
542			97.5% Chebyshev(Mean, Sd) UCL	0.107
543	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.154
544	95% Approximate Gamma UCL	0.046		
545	95% Adjusted Gamma UCL	0.0486		
546				
547	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	0.0831
548				
549	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
550	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			

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

Sediment_Mudflats_TCDD TEQ(PCBs) - bird TEFs

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	17
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.041	Minimum of Log Data	-3.193
Maximum	3.619	Maximum of Log Data	1.286
Mean	0.431	Mean of log Data	-1.399
Median	0.252	SD of log Data	0.865
SD	0.826		
Std. Error of Mean	0.2		
Coefficient of Variation	1.919		
Skewness	4.047		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.358	Shapiro Wilk Test Statistic	0.794
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.78	95% H-UCL	0.61
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.694
95% Adjusted-CLT UCL (Chen-1995)	0.97	97.5% Chebyshev (MVUE) UCL	0.844
95% Modified-t UCL (Johnson-1978)	0.813	99% Chebyshev (MVUE) UCL	1.138
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.891	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.483		
MLE of Mean	0.431		
MLE of Standard Deviation	0.456		
nu star	30.28		
Approximate Chi Square Value (.05)	18.72	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	0.76
Adjusted Chi Square Value	17.77	95% Jackknife UCL	0.78
		95% Standard Bootstrap UCL	0.747
Anderson-Darling Test Statistic	2.542	95% Bootstrap-t UCL	2.773
Anderson-Darling 5% Critical Value	0.765	95% Hall's Bootstrap UCL	2.519
Kolmogorov-Smirnov Test Statistic	0.372	95% Percentile Bootstrap UCL	0.828
Kolmogorov-Smirnov 5% Critical Value	0.215	95% BCA Bootstrap UCL	1.034
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.304
		97.5% Chebyshev(Mean, Sd) UCL	1.682
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2.424
95% Approximate Gamma UCL	0.697		
95% Adjusted Gamma UCL	0.734		

	A–F		G–L	
601	Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.304
602				
603	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
604	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
605	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
606				
607				
608	Sediment_Mudflat_TCDD TEQ(PCBs) - fish TEFs			
609				
610	General Statistics			
611	Number of Valid Observations	17	Number of Distinct Observations	17
612				
613	Raw Statistics		Log-transformed Statistics	
614	Minimum	0.0001585	Minimum of Log Data	-8.749
615	Maximum	0.0184	Maximum of Log Data	-3.997
616	Mean	0.00231	Mean of log Data	-6.587
617	Median	0.0014	SD of log Data	0.882
618	SD	0.00416		
619	Std. Error of Mean	0.00101		
620	Coefficient of Variation	1.8		
621	Skewness	4.04		
622				
623	Relevant UCL Statistics			
624	Normal Distribution Test		Lognormal Distribution Test	
625	Shapiro Wilk Test Statistic	0.361	Shapiro Wilk Test Statistic	0.763
626	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
627	Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
628				
629	Assuming Normal Distribution		Assuming Lognormal Distribution	
630	95% Student's-t UCL	0.00408	95% H-UCL	0.00352
631	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.00397
632	95% Adjusted-CLT UCL (Chen-1995)	0.00503	97.5% Chebyshev (MVUE) UCL	0.00484
633	95% Modified-t UCL (Johnson-1978)	0.00424	99% Chebyshev (MVUE) UCL	0.00654
634				
635	Gamma Distribution Test		Data Distribution	
636	k star (bias corrected)	0.947	Data do not follow a Discernable Distribution (0.05)	
637	Theta Star	0.00244		
638	MLE of Mean	0.00231		
639	MLE of Standard Deviation	0.00238		
640	nu star	32.21		
641	Approximate Chi Square Value (.05)	20.24	Nonparametric Statistics	
642	Adjusted Level of Significance	0.0346	95% CLT UCL	0.00397
643	Adjusted Chi Square Value	19.25	95% Jackknife UCL	0.00408
644			95% Standard Bootstrap UCL	0.00391
645	Anderson-Darling Test Statistic	2.616	95% Bootstrap-t UCL	0.0138
646	Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	0.0133
647	Kolmogorov-Smirnov Test Statistic	0.381	95% Percentile Bootstrap UCL	0.0043
648	Kolmogorov-Smirnov 5% Critical Value	0.215	95% BCA Bootstrap UCL	0.00534
649	Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.00671
650			97.5% Chebyshev(Mean, Sd) UCL	0.00862

	A–E	F	G–K	L
651	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0124
652	95% Approximate Gamma UCL	0.00368		
653	95% Adjusted Gamma UCL	0.00387		
654				
655	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	0.00671
656				
657	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
658	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
659	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
660				
661		**General UCL Statistics for Full Data Sets**		
662	**User Selected Options**			
663	From File	ProUCL input_a.wst		
664	Full Precision	OFF		
665	Confidence Coefficient	95%		
666	Number of Bootstrap Operations	2000		
667				
668	**Sediment_Mudflats_ TCDD TEQ(D/F) - mammal TEFs**			
669				
670		**General Statistics**		
671	Number of Valid Observations	17	Number of Distinct Observations	15
672				
673	**Raw Statistics**		**Log-transformed Statistics**	
674	Minimum	0.0683	Minimum of Log Data	-2.683
675	Maximum	13.63	Maximum of Log Data	2.613
676	2_	1.221	Mean of log Data	-0.876
677	Median	0.369	SD of log Data	1.166
678	SD	3.222		
679	Std. Error of Mean	0.781		
680	Coefficient of Variation	2.639		
681	Skewness	4.028		
682				
683		**Relevant UCL Statistics**		
684	**Normal Distribution Test**		**Lognormal Distribution Test**	
685	Shapiro Wilk Test Statistic	0.347	Shapiro Wilk Test Statistic	0.847
686	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
687	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
688				
689	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
690	95% Student's-t UCL	2.585	95% H-UCL	1.928
691	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.848
692	95% Adjusted-CLT UCL (Chen-1995)	3.322	97.5% Chebyshev (MVUE) UCL	2.313
693	95% Modified-t UCL (Johnson-1978)	2.712	99% Chebyshev (MVUE) UCL	3.227
694				
695	**Gamma Distribution Test**		**Data Distribution**	
696	k star (bias corrected)	0.515	**Data do not follow a Discernable Distribution (0.05)**	
697	Theta Star	2.37		
698	MLE of Mean	1.221		
699	MLE of Standard Deviation	1.701		
700	nu star	17.51		

	A B C D E	F	G H I J K	L
701	Approximate Chi Square Value (.05)	9.039	**Nonparametric Statistics**	
702	Adjusted Level of Significance	0.0346	95% CLT UCL	2.506
703	Adjusted Chi Square Value	8.406	95% Jackknife UCL	2.585
704			95% Standard Bootstrap UCL	2.469
705	Anderson-Darling Test Statistic	2.545	95% Bootstrap-t UCL	10.83
706	Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	9.423
707	Kolmogorov-Smirnov Test Statistic	0.375	95% Percentile Bootstrap UCL	2.771
708	Kolmogorov-Smirnov 5% Critical Value	0.22	95% BCA Bootstrap UCL	3.558
709	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	4.627
710			97.5% Chebyshev(Mean, Sd) UCL	6.1
711	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	8.995
712	95% Approximate Gamma UCL	2.365		
713	95% Adjusted Gamma UCL	2.543		
714				
715	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	4.627
716				
717	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
718	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
719	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
720				
721				
722	**Sediment_Mudflats_TCDD TEQ(D/F) - bird TEFs**			
723				
724	**General Statistics**			
725	Number of Valid Observations	17	Number of Distinct Observations	16
726				
727	**Raw Statistics**		**Log-transformed Statistics**	
728	Minimum	0.074	Minimum of Log Data	-2.604
729	Maximum	13.77	Maximum of Log Data	2.622
730	Mean	1.265	Mean of log Data	-0.779
731	Median	0.408	SD of log Data	1.139
732	SD	3.246		
733	Std. Error of Mean	0.787		
734	Coefficient of Variation	2.567		
735	Skewness	4.026		
736				
737	**Relevant UCL Statistics**			
738	**Normal Distribution Test**		**Lognormal Distribution Test**	
739	Shapiro Wilk Test Statistic	0.35	Shapiro Wilk Test Statistic	0.85
740	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
741	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
742				
743	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
744	95% Student's-t UCL	2.639	95% H-UCL	1.995
745	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.951
746	95% Adjusted-CLT UCL (Chen-1995)	3.381	97.5% Chebyshev (MVUE) UCL	2.437
747	95% Modified-t UCL (Johnson-1978)	2.767	99% Chebyshev (MVUE) UCL	3.391
748				
749	**Gamma Distribution Test**		**Data Distribution**	
750	k star (bias corrected)	0.54	**Data do not follow a Discernable Distribution (0.05)**	

Theta Star	2.341		
MLE of Mean	1.265		
MLE of Standard Deviation	1.721		
nu star	18.37		
Approximate Chi Square Value (.05)	9.657	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	2.56
Adjusted Chi Square Value	9	95% Jackknife UCL	2.639
		95% Standard Bootstrap UCL	2.509
Anderson-Darling Test Statistic	2.498	95% Bootstrap-t UCL	10.79
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	8.907
Kolmogorov-Smirnov Test Statistic	0.375	95% Percentile Bootstrap UCL	2.809
Kolmogorov-Smirnov 5% Critical Value	0.219	95% BCA Bootstrap UCL	3.667
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.696
		97.5% Chebyshev(Mean, Sd) UCL	6.181
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9.098
95% Approximate Gamma UCL	2.405		
95% Adjusted Gamma UCL	2.581		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	4.696

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflats_TCDD TEQ(D/F) - fish TEFs

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	16
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0677	Minimum of Log Data	-2.693
Maximum	13.63	Maximum of Log Data	2.613
Mean	1.22	Mean of log Data	-0.878
Median	0.367	SD of log Data	1.167
SD	3.222		
Std. Error of Mean	0.781		
Coefficient of Variation	2.641		
Skewness	4.029		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.347	Shapiro Wilk Test Statistic	0.847
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2.584	95% H-UCL	1.929
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.848
95% Adjusted-CLT UCL (Chen-1995)	3.321	97.5% Chebyshev (MVUE) UCL	2.313

95% Modified-t UCL (Johnson-1978)	2.711	99% Chebyshev (MVUE) UCL	3.227
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.515	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2.371		
MLE of Mean	1.22		
MLE of Standard Deviation	1.701		
nu star	17.5		
Approximate Chi Square Value (.05)	9.027	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	2.505
Adjusted Chi Square Value	8.395	95% Jackknife UCL	2.584
		95% Standard Bootstrap UCL	2.43
Anderson-Darling Test Statistic	2.546	95% Bootstrap-t UCL	10.73
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	9.139
Kolmogorov-Smirnov Test Statistic	0.376	95% Percentile Bootstrap UCL	2.734
Kolmogorov-Smirnov 5% Critical Value	0.22	95% BCA Bootstrap UCL	3.576
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.626
		97.5% Chebyshev(Mean, Sd) UCL	6.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8.995
95% Approximate Gamma UCL	2.364		
95% Adjusted Gamma UCL	2.542		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	4.626

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflats_TOC

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.77	Minimum of Log Data	1.327
Maximum	7.63	Maximum of Log Data	2.032
Mean	5.096	Mean of log Data	1.599
Median	4.59	SD of log Data	0.264
SD	1.487		
Std. Error of Mean	0.665		
Coefficient of Variation	0.292		
Skewness	1.718		

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

	A–F		G–L	
851	Warning: There are only 5 Values in this data			
852	Note: It should be noted that even though bootstrap methods may be performed on this data set,			
853	the resulting calculations may not be reliable enough to draw conclusions			
854				
855	The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.			
856				
857	**Relevant UCL Statistics**			
858	**Normal Distribution Test**		**Lognormal Distribution Test**	
859	Shapiro Wilk Test Statistic	0.826	Shapiro Wilk Test Statistic	0.89
860	Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
861	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
862				
863	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
864	95% Student's-t UCL	6.514	95% H-UCL	6.958
865	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	7.694
866	95% Adjusted-CLT UCL (Chen-1995)	6.736	97.5% Chebyshev (MVUE) UCL	8.822
867	95% Modified-t UCL (Johnson-1978)	6.599	99% Chebyshev (MVUE) UCL	11.04
868				
869	**Gamma Distribution Test**		**Data Distribution**	
870	k star (bias corrected)	6.926	**Data appear Normal at 5% Significance Level**	
871	Theta Star	0.736		
872	MLE of Mean	5.096		
873	MLE of Standard Deviation	1.936		
874	nu star	69.26		
875	Approximate Chi Square Value (.05)	51.1	**Nonparametric Statistics**	
876	Adjusted Level of Significance	0.0086	95% CLT UCL	6.19
877	Adjusted Chi Square Value	44.36	95% Jackknife UCL	6.514
878			95% Standard Bootstrap UCL	6.082
879	Anderson-Darling Test Statistic	0.466	95% Bootstrap-t UCL	8.218
880	Anderson-Darling 5% Critical Value	0.679	95% Hall's Bootstrap UCL	11.99
881	Kolmogorov-Smirnov Test Statistic	0.289	95% Percentile Bootstrap UCL	6.07
882	Kolmogorov-Smirnov 5% Critical Value	0.357	95% BCA Bootstrap UCL	6.414
883	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	7.995
884			97.5% Chebyshev(Mean, Sd) UCL	9.249
885	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	11.71
886	95% Approximate Gamma UCL	6.907		
887	95% Adjusted Gamma UCL	7.957		
888				
889	**Potential UCL to Use**		Use 95% Student's-t UCL	6.514
890				
891	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
892	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
893	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Sediment_Entire_Copper

General Statistics

Number of Valid Observations	165	Number of Distinct Observations	112

Raw Statistics		**Log-transformed Statistics**	
Minimum	22700	Minimum of Log Data	10.03
Maximum	577000	Maximum of Log Data	13.27
Mean	152415	Mean of log Data	11.83
Median	139000	SD of log Data	0.478
SD	73506		
Std. Error of Mean	5722		
Coefficient of Variation	0.482		
Skewness	2.228		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.161	Lilliefors Test Statistic	0.135
Lilliefors Critical Value	0.069	Lilliefors Critical Value	0.069
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	161881	95% H-UCL	164598
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	180036
95% Adjusted-CLT UCL (Chen-1995)	162888	97.5% Chebyshev (MVUE) UCL	191389
95% Modified-t UCL (Johnson-1978)	162047	99% Chebyshev (MVUE) UCL	213691

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.869	Data do not follow a Discernable Distribution (0.05)	
Theta Star	31304		
MLE of Mean	152415		
MLE of Standard Deviation	69074		
nu star	1607		
Approximate Chi Square Value (.05)	1515	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0485	95% CLT UCL	161828
Adjusted Chi Square Value	1514	95% Jackknife UCL	161881
		95% Standard Bootstrap UCL	161845
Anderson-Darling Test Statistic	3.236	95% Bootstrap-t UCL	163410
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	163503
Kolmogorov-Smirnov Test Statistic	0.109	95% Percentile Bootstrap UCL	162170
Kolmogorov-Smirnov 5% Critical Value	0.0728	95% BCA Bootstrap UCL	162938
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	177359
		97.5% Chebyshev(Mean, Sd) UCL	188152
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	209352

95% Approximate Gamma UCL	161682
95% Adjusted Gamma UCL	161765

Potential UCL to Use — Use 95% Student's-t UCL 161881
or 95% Modified-t UCL 162047

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Lead

General Statistics

Number of Valid Observations	119	Number of Distinct Observations	95

Raw Statistics		Log-transformed Statistics	
Minimum	36800	Minimum of Log Data	10.51
Maximum	763000	Maximum of Log Data	13.55
Mean	219469	Mean of log Data	12.2
Median	205000	SD of log Data	0.446
SD	105888		
Std. Error of Mean	9707		
Coefficient of Variation	0.482		
Skewness	2.425		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.179	Lilliefors Test Statistic	0.0971
Lilliefors Critical Value	0.0812	Lilliefors Critical Value	0.0812
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	235561	95% H-UCL	237213
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	261030
95% Adjusted-CLT UCL (Chen-1995)	237741	97.5% Chebyshev (MVUE) UCL	278762
95% Modified-t UCL (Johnson-1978)	235921	99% Chebyshev (MVUE) UCL	313593
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	5.246	Data do not follow a Discernable Distribution (0.05)	
Theta Star	41839		
MLE of Mean	219469		
MLE of Standard Deviation	95824		
nu star	1248		
Approximate Chi Square Value (.05)	1167	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	235435
Adjusted Chi Square Value	1166	95% Jackknife UCL	235561
		95% Standard Bootstrap UCL	235276
Anderson-Darling Test Statistic	2.375	95% Bootstrap-t UCL	237907
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	240068
Kolmogorov-Smirnov Test Statistic	0.118	95% Percentile Bootstrap UCL	235408

Kolmogorov-Smirnov 5% Critical Value	0.0847	95% BCA Bootstrap UCL	238912
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	261780
		97.5% Chebyshev(Mean, Sd) UCL	280088
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	316050
95% Approximate Gamma UCL	234704		
95% Adjusted Gamma UCL	234895		
Potential UCL to Use		Use 95% Student's-t UCL	235561
		or 95% Modified-t UCL	235921

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Mercury

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	75
Raw Statistics		**Log-transformed Statistics**	
Minimum	38.5	Minimum of Log Data	3.651
Maximum	13400	Maximum of Log Data	9.503
Mean	1987	Mean of log Data	7.377
Median	1895	SD of log Data	0.766
SD	1444		
Std. Error of Mean	131.8		
Coefficient of Variation	0.727		
Skewness	4.596		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.219	Lilliefors Test Statistic	0.215
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2205	95% H-UCL	2473
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2872
95% Adjusted-CLT UCL (Chen-1995)	2263	97.5% Chebyshev (MVUE) UCL	3190
95% Modified-t UCL (Johnson-1978)	2215	99% Chebyshev (MVUE) UCL	3814
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.401	Data do not follow a Discernable Distribution (0.05)	
Theta Star	827.4		
MLE of Mean	1987		
MLE of Standard Deviation	1282		
nu star	576.4		
Approximate Chi Square Value (.05)	521.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	2204
Adjusted Chi Square Value	521	95% Jackknife UCL	2205
		95% Standard Bootstrap UCL	2197

Anderson-Darling Test Statistic	4.881	95% Bootstrap-t UCL	2302
Anderson-Darling 5% Critical Value	0.762	95% Hall's Bootstrap UCL	2693
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL	2222
Kolmogorov-Smirnov 5% Critical Value	0.0852	95% BCA Bootstrap UCL	2275
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2562
		97.5% Chebyshev(Mean, Sd) UCL	2810
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3298
95% Approximate Gamma UCL	2195		
95% Adjusted Gamma UCL	2198		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	2562

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Methylmercury

General Statistics

Number of Valid Observations	73	Number of Distinct Observations	51
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.088	Minimum of Log Data	-2.43
Maximum	11.5	Maximum of Log Data	2.442
Mean	3.819	Mean of log Data	1.119
Median	3.3	SD of log Data	0.784
SD	2.309		
Std. Error of Mean	0.27		
Coefficient of Variation	0.605		
Skewness	1.097		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.123	Lilliefors Test Statistic	0.118
Lilliefors Critical Value	0.104	Lilliefors Critical Value	0.104
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.27	95% H-UCL	5.036
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.003
95% Adjusted-CLT UCL (Chen-1995)	4.301	97.5% Chebyshev (MVUE) UCL	6.808
95% Modified-t UCL (Johnson-1978)	4.275	99% Chebyshev (MVUE) UCL	8.39
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.327	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	1.642		
MLE of Mean	3.819		
MLE of Standard Deviation	2.504		
nu star	339.7		
Approximate Chi Square Value (.05)	298	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0467	95% CLT UCL	4.264

Adjusted Chi Square Value	297.2	95% Jackknife UCL	4.27
		95% Standard Bootstrap UCL	4.276
Anderson-Darling Test Statistic	0.543	95% Bootstrap-t UCL	4.286
Anderson-Darling 5% Critical Value	0.761	95% Hall's Bootstrap UCL	4.303
Kolmogorov-Smirnov Test Statistic	0.0794	95% Percentile Bootstrap UCL	4.284
Kolmogorov-Smirnov 5% Critical Value	0.106	95% BCA Bootstrap UCL	4.313
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.997
		97.5% Chebyshev(Mean, Sd) UCL	5.507
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6.509
95% Approximate Gamma UCL	4.354		
95% Adjusted Gamma UCL	4.365		
Potential UCL to Use		Use 95% Approximate Gamma UCL	4.354

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_ LMW PAHs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	119
Raw Statistics		**Log-transformed Statistics**	
Minimum	368.5	Minimum of Log Data	5.909
Maximum	337800	Maximum of Log Data	12.73
Mean	10541	Mean of log Data	8.491
Median	4487	SD of log Data	0.968
SD	33395		
Std. Error of Mean	3049		
Coefficient of Variation	3.168		
Skewness	8.48		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.391	Lilliefors Test Statistic	0.102
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	15595	95% H-UCL	9454
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11291
95% Adjusted-CLT UCL (Chen-1995)	18077	97.5% Chebyshev (MVUE) UCL	12829
95% Modified-t UCL (Johnson-1978)	15989	99% Chebyshev (MVUE) UCL	15850
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.758	Data do not follow a Discernable Distribution (0.05)	
Theta Star	13903		
MLE of Mean	10541		
MLE of Standard Deviation	12106		
nu star	182		

Approximate Chi Square Value (.05)	151.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	15556
Adjusted Chi Square Value	151.4	95% Jackknife UCL	15595
		95% Standard Bootstrap UCL	15483
Anderson-Darling Test Statistic	11.37	95% Bootstrap-t UCL	26406
Anderson-Darling 5% Critical Value	0.794	95% Hall's Bootstrap UCL	31883
Kolmogorov-Smirnov Test Statistic	0.24	95% Percentile Bootstrap UCL	16163
Kolmogorov-Smirnov 5% Critical Value	0.0875	95% BCA Bootstrap UCL	19830
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	23830
		97.5% Chebyshev(Mean, Sd) UCL	29580
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	40874
95% Approximate Gamma UCL	12639		
95% Adjusted Gamma UCL	12667		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	23830

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_HMW PAHs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	119
Raw Statistics		**Log-transformed Statistics**	
Minimum	0	Log Statistics Not Avaliable	
Maximum	285500		
Mean	32544		
Median	26888		
SD	31300		
Std. Error of Mean	2857		
Coefficient of Variation	0.962		
Skewness	5.015		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.205	Not Available	
Lilliefors Critical Value	0.0809		
Data not Normal at 5% Significance Level			
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	37281	95% H-UCL	N/A
Assuming Normal Distribution		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	37281	95% Adjusted-CLT UCL (Chen 1995)	38641
		95% Modified-t UCL (Johnson-1978)	37499
Gamma Distribution Test		**Data Distribution**	
Gamma Statistics Not Available		Data do not follow a Discernable Distribution (0.05)	

Potential UCL to Use

Use 95% Chebyshev (Mean, Sd) UCL	44998	95% CLT UCL	37244
		95% Jackknife UCL	37281
		95% Standard Bootstrap UCL	37152
		95% Bootstrap-t UCL	39353
		95% Hall's Bootstrap UCL	46445
		95% Percentile Bootstrap UCL	37805
		95% BCA Bootstrap UCL	38865
		95% Chebyshev(Mean, Sd) UCL	44998
		97.5% Chebyshev(Mean, Sd) UCL	50387
		99% Chebyshev(Mean, Sd) UCL	60973

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Dieldrin

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	71

Raw Statistics		Log-transformed Statistics	
Minimum	0.015	Minimum of Log Data	-4.2
Maximum	152	Maximum of Log Data	5.024
Mean	7.378	Mean of log Data	1.314
Median	4.2	SD of log Data	1.085
SD	18.17		
Std. Error of Mean	1.658		
Coefficient of Variation	2.462		
Skewness	6.954		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.344	Lilliefors Test Statistic	0.122
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	10.13	95% H-UCL	8.433
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.2
95% Adjusted-CLT UCL (Chen-1995)	11.23	97.5% Chebyshev (MVUE) UCL	11.73
95% Modified-t UCL (Johnson-1978)	10.3	99% Chebyshev (MVUE) UCL	14.75

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.843	Data do not follow a Discernable Distribution (0.05)	
Theta Star	8.748		
MLE of Mean	7.378		
MLE of Standard Deviation	8.034		
nu star	202.4		
Approximate Chi Square Value (.05)	170.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	10.11

Adjusted Chi Square Value	170.1	95% Jackknife UCL	10.13
		95% Standard Bootstrap UCL	10.11
Anderson-Darling Test Statistic	6.712	95% Bootstrap-t UCL	16.97
Anderson-Darling 5% Critical Value	0.79	95% Hall's Bootstrap UCL	23.83
Kolmogorov-Smirnov Test Statistic	0.219	95% Percentile Bootstrap UCL	10.45
Kolmogorov-Smirnov 5% Critical Value	0.0873	95% BCA Bootstrap UCL	11.65
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14.61
		97.5% Chebyshev(Mean, Sd) UCL	17.74
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	23.88
95% Approximate Gamma UCL	8.76		
95% Adjusted Gamma UCL	8.778		

Potential UCL to Use — Use 95% Chebyshev (Mean, Sd) UCL 14.61

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

		97.5% Chebyshev(Mean, Sd) UCL	1.413
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.901
95% Approximate Gamma UCL	0.702		
95% Adjusted Gamma UCL	0.704		

Potential UCL to Use — Use 95% Chebyshev (Mean, Sd) UCL 1.165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Total DDx

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	108
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.3	Minimum of Log Data	1.194
Maximum	2959	Maximum of Log Data	7.993
Mean	138.3	Mean of log Data	4.293
Median	65.85	SD of log Data	0.995
SD	304.4		
Std. Error of Mean	27.79		
Coefficient of Variation	2.201		
Skewness	7.331		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.329	Lilliefors Test Statistic	0.126
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	184.3	95% H-UCL	146.9

95% UCLs (Adjusted for Skewness)			
95% Adjusted-CLT UCL (Chen-1995)	203.9	95% Chebyshev (MVUE) UCL	176
95% Modified-t UCL (Johnson-1978)	187.4	97.5% Chebyshev (MVUE) UCL	200.5
		99% Chebyshev (MVUE) UCL	248.7

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.899	Data do not follow a Discernable Distribution (0.05)	
Theta Star	153.9		
MLE of Mean	138.3		
MLE of Standard Deviation	145.9		
nu star	215.7		
Approximate Chi Square Value (.05)	182.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	184
Adjusted Chi Square Value	182.3	95% Jackknife UCL	184.3
		95% Standard Bootstrap UCL	182.4
Anderson-Darling Test Statistic	7.499	95% Bootstrap-t UCL	231.7
Anderson-Darling 5% Critical Value	0.787	95% Hall's Bootstrap UCL	373.3
Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	186.4
Kolmogorov-Smirnov 5% Critical Value	0.0871	95% BCA Bootstrap UCL	215.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	259.4
		97.5% Chebyshev(Mean, Sd) UCL	311.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	414.7
95% Approximate Gamma UCL	163.2		
95% Adjusted Gamma UCL	163.6		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	259.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_Total PCBs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	118

Raw Statistics		Log-transformed Statistics	
Minimum	12.18	Minimum of Log Data	2.5
Maximum	18922	Maximum of Log Data	9.848
Mean	1261	Mean of log Data	6.76
Median	932	SD of log Data	0.876
SD	1958		
Std. Error of Mean	178.8		
Coefficient of Variation	1.553		
Skewness	7.007		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.354	Lilliefors Test Statistic	0.183
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1557	95% H-UCL	1499
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1770
95% Adjusted-CLT UCL (Chen-1995)	1677	97.5% Chebyshev (MVUE) UCL	1990
95% Modified-t UCL (Johnson-1978)	1576	99% Chebyshev (MVUE) UCL	2424

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.429	Data do not follow a Discernable Distribution (0.05)	
Theta Star	882.3		
MLE of Mean	1261		
MLE of Standard Deviation	1055		
nu star	343		
Approximate Chi Square Value (.05)	301.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	1555
Adjusted Chi Square Value	300.6	95% Jackknife UCL	1557
		95% Standard Bootstrap UCL	1548
Anderson-Darling Test Statistic	8.39	95% Bootstrap-t UCL	1885
Anderson-Darling 5% Critical Value	0.771	95% Hall's Bootstrap UCL	2770
Kolmogorov-Smirnov Test Statistic	0.241	95% Percentile Bootstrap UCL	1587
Kolmogorov-Smirnov 5% Critical Value	0.0859	95% BCA Bootstrap UCL	1785
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2040
		97.5% Chebyshev(Mean, Sd) UCL	2377
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3039
95% Approximate Gamma UCL	1436		
95% Adjusted Gamma UCL	1439		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	2040

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_TCDD TEQ (PCBs) - mammals TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	105

Raw Statistics		Log-transformed Statistics	
Minimum	3.13E-05	Minimum of Log Data	-10.37
Maximum	0.23	Maximum of Log Data	-1.47
Mean	0.0187	Mean of log Data	-4.406
Median	0.0146	SD of log Data	1.14
SD	0.0242		
Std. Error of Mean	0.00221		
Coefficient of Variation	1.293		
Skewness	6.315		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.284	Lilliefors Test Statistic	0.249
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809

Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0224	95% H-UCL	0.0299
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0364
95% Adjusted-CLT UCL (Chen-1995)	0.0237	97.5% Chebyshev (MVUE) UCL	0.0421
95% Modified-t UCL (Johnson-1978)	0.0226	99% Chebyshev (MVUE) UCL	0.0533
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.283	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0146		
MLE of Mean	0.0187		
MLE of Standard Deviation	0.0165		
nu star	308		
Approximate Chi Square Value (.05)	268.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	0.0224
Adjusted Chi Square Value	267.9	95% Jackknife UCL	0.0224
		95% Standard Bootstrap UCL	0.0224
Anderson-Darling Test Statistic	6.586	95% Bootstrap-t UCL	0.0259
Anderson-Darling 5% Critical Value	0.775	95% Hall's Bootstrap UCL	0.038
Kolmogorov-Smirnov Test Statistic	0.184	95% Percentile Bootstrap UCL	0.0225
Kolmogorov-Smirnov 5% Critical Value	0.0862	95% BCA Bootstrap UCL	0.0242
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0284
		97.5% Chebyshev(Mean, Sd) UCL	0.0325
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0407
95% Approximate Gamma UCL	0.0215		
95% Adjusted Gamma UCL	0.0215		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.0284

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_TCDD TEQ (PCBs) -birds TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	109
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.000405	Minimum of Log Data	-7.811
Maximum	3.619	Maximum of Log Data	1.286
Mean	0.278	Mean of log Data	-1.739
Median	0.21	SD of log Data	1.143
SD	0.395		
Std. Error of Mean	0.036		
Coefficient of Variation	1.422		
Skewness	6.21		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.305	Lilliefors Test Statistic	0.228
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.337	95% H-UCL	0.432
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.526
95% Adjusted-CLT UCL (Chen-1995)	0.359	97.5% Chebyshev (MVUE) UCL	0.609
95% Modified-t UCL (Johnson-1978)	0.341	99% Chebyshev (MVUE) UCL	0.771
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.208	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.23		
MLE of Mean	0.278		
MLE of Standard Deviation	0.253		
nu star	289.8		
Approximate Chi Square Value (.05)	251.4	Nonparametric Statistics	
Adjusted Level of Significance	0.048	95% CLT UCL	0.337
Adjusted Chi Square Value	251	95% Jackknife UCL	0.337
		95% Standard Bootstrap UCL	0.337
Anderson-Darling Test Statistic	6.408	95% Bootstrap-t UCL	0.393
Anderson-Darling 5% Critical Value	0.777	95% Hall's Bootstrap UCL	0.565
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL	0.34
Kolmogorov-Smirnov 5% Critical Value	0.0864	95% BCA Bootstrap UCL	0.364
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.435
		97.5% Chebyshev(Mean, Sd) UCL	0.503
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.636
95% Approximate Gamma UCL	0.32		
95% Adjusted Gamma UCL	0.321		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.435

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_TCDD TEQ (PCBs) - fish TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	120
Raw Statistics		Log-transformed Statistics	
Minimum	1E-05	Minimum of Log Data	-11.51
Maximum	0.0184	Maximum of Log Data	-3.997
Mean	0.00153	Mean of log Data	-6.841
Median	0.0012	SD of log Data	0.961
SD	0.00193		
Std. Error of Mean	0.000176		
Coefficient of Variation	1.256		

Skewness	6.432

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.309	Lilliefors Test Statistic	0.197
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.00183	95% H-UCL	0.00206
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.00245
95% Adjusted-CLT UCL (Chen-1995)	0.00193	97.5% Chebyshev (MVUE) UCL	0.00279
95% Modified-t UCL (Johnson-1978)	0.00184	99% Chebyshev (MVUE) UCL	0.00344
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.5	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00102		
MLE of Mean	0.00153		
MLE of Standard Deviation	0.00125		
nu star	359.9		
Approximate Chi Square Value (.05)	317	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	0.00182
Adjusted Chi Square Value	316.5	95% Jackknife UCL	0.00183
		95% Standard Bootstrap UCL	0.00183
Anderson-Darling Test Statistic	6.414	95% Bootstrap-t UCL	0.00204
Anderson-Darling 5% Critical Value	0.77	95% Hall's Bootstrap UCL	0.00302
Kolmogorov-Smirnov Test Statistic	0.189	95% Percentile Bootstrap UCL	0.00185
Kolmogorov-Smirnov 5% Critical Value	0.0858	95% BCA Bootstrap UCL	0.00197
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0023
		97.5% Chebyshev(Mean, Sd) UCL	0.00263
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.00328
95% Approximate Gamma UCL	0.00174		
95% Adjusted Gamma UCL	0.00174		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.0023

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_TCDD TEQ (D/F) - mammals TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	115
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.000276	Minimum of Log Data	-8.196
Maximum	13.63	Maximum of Log Data	2.613
Mean	0.592	Mean of log Data	-1.225
Median	0.294	SD of log Data	1.16

SD	1.443
Std. Error of Mean	0.132
Coefficient of Variation	2.44
Skewness	7.214

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.356	Lilliefors Test Statistic	0.168
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.81	95% H-UCL	0.742
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.904
95% Adjusted-CLT UCL (Chen-1995)	0.901	97.5% Chebyshev (MVUE) UCL	1.048
95% Modified-t UCL (Johnson-1978)	0.825	99% Chebyshev (MVUE) UCL	1.331
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.827	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.715		
MLE of Mean	0.592		
MLE of Standard Deviation	0.651		
nu star	198.5		
Approximate Chi Square Value (.05)	166.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	0.808
Adjusted Chi Square Value	166.5	95% Jackknife UCL	0.81
		95% Standard Bootstrap UCL	0.811
Anderson-Darling Test Statistic	8.966	95% Bootstrap-t UCL	1.11
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	1.721
Kolmogorov-Smirnov Test Statistic	0.239	95% Percentile Bootstrap UCL	0.817
Kolmogorov-Smirnov 5% Critical Value	0.0873	95% BCA Bootstrap UCL	0.943
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.166
		97.5% Chebyshev(Mean, Sd) UCL	1.414
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.903
95% Approximate Gamma UCL	0.704		
95% Adjusted Gamma UCL	0.705		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.166

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Sediment_Entire_TCDD TEQ (D/F) - birds TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	118
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.000288	Minimum of Log Data	-8.154

Maximum	13.77	Maximum of Log Data	2.622
Mean	0.624	Mean of log Data	-1.135
Median	0.347	SD of log Data	1.15
SD	1.459		
Std. Error of Mean	0.133		
Coefficient of Variation	2.337		
Skewness	7.172		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.356	Lilliefors Test Statistic	0.166
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.845	95% H-UCL	0.799
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.973
95% Adjusted-CLT UCL (Chen-1995)	0.937	97.5% Chebyshev (MVUE) UCL	1.127
95% Modified-t UCL (Johnson-1978)	0.86	99% Chebyshev (MVUE) UCL	1.429
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.865	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.722		
MLE of Mean	0.624		
MLE of Standard Deviation	0.671		
nu star	207.7		
Approximate Chi Square Value (.05)	175.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	0.844
Adjusted Chi Square Value	175	95% Jackknife UCL	0.845
		95% Standard Bootstrap UCL	0.841
Anderson-Darling Test Statistic	8.611	95% Bootstrap-t UCL	1.113
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	1.603
Kolmogorov-Smirnov Test Statistic	0.241	95% Percentile Bootstrap UCL	0.857
Kolmogorov-Smirnov 5% Critical Value	0.0872	95% BCA Bootstrap UCL	0.988
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.205
		97.5% Chebyshev(Mean, Sd) UCL	1.457
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.95
95% Approximate Gamma UCL	0.74		
95% Adjusted Gamma UCL	0.741		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.205

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Sediment_Entire_TCDD TEQ (D/F) - fish TEFs

General Statistics

Number of Valid Observations	120	Number of Distinct Observations	117

Raw Statistics		Log-transformed Statistics	
Minimum	0.000262	Minimum of Log Data	-8.249
Maximum	13.63	Maximum of Log Data	2.613
Mean	0.59	Mean of log Data	-1.228
Median	0.298	SD of log Data	1.162
SD	1.443		
Std. Error of Mean	0.132		
Coefficient of Variation	2.444		
Skewness	7.218		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.357	Lilliefors Test Statistic	0.166
Lilliefors Critical Value	0.0809	Lilliefors Critical Value	0.0809
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.809	95% H-UCL	0.742
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.904
95% Adjusted-CLT UCL (Chen-1995)	0.9	97.5% Chebyshev (MVUE) UCL	1.048
95% Modified-t UCL (Johnson-1978)	0.823	99% Chebyshev (MVUE) UCL	1.331

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.826	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.715		
MLE of Mean	0.59		
MLE of Standard Deviation	0.65		
nu star	198.2		
Approximate Chi Square Value (.05)	166.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.048	95% CLT UCL	0.807
Adjusted Chi Square Value	166.3	95% Jackknife UCL	0.809
		95% Standard Bootstrap UCL	0.808
Anderson-Darling Test Statistic	9.017	95% Bootstrap-t UCL	1.124
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	1.572
Kolmogorov-Smirnov Test Statistic	0.243	95% Percentile Bootstrap UCL	0.811
Kolmogorov-Smirnov 5% Critical Value	0.0873	95% BCA Bootstrap UCL	0.921
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.165
		97.5% Chebyshev(Mean, Sd) UCL	1.413
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.901
95% Approximate Gamma UCL	0.702		
95% Adjusted Gamma UCL	0.704		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Entire_TOC_a

General Statistics

Number of Valid Observations	53	Number of Distinct Observations	51

Raw Statistics		Log-transformed Statistics	
Minimum	0.42	Minimum of Log Data	-0.868
Maximum	24.2	Maximum of Log Data	3.186
Mean	6.253	Mean of log Data	1.65
Median	5.36	SD of log Data	0.628
SD	4.344		
Std. Error of Mean	0.597		
Coefficient of Variation	0.695		
Skewness	2.386		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.272	Lilliefors Test Statistic	0.168
Lilliefors Critical Value	0.122	Lilliefors Critical Value	0.122
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	7.253	95% H-UCL	7.531
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.875
95% Adjusted-CLT UCL (Chen-1995)	7.444	97.5% Chebyshev (MVUE) UCL	9.983
95% Modified-t UCL (Johnson-1978)	7.285	99% Chebyshev (MVUE) UCL	12.16

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	2.743	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2.28		
MLE of Mean	6.253		
MLE of Standard Deviation	3.776		
nu star	290.7		
Approximate Chi Square Value (.05)	252.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0455	95% CLT UCL	7.235
Adjusted Chi Square Value	251.2	95% Jackknife UCL	7.253
		95% Standard Bootstrap UCL	7.229
Anderson-Darling Test Statistic	2.164	95% Bootstrap-t UCL	7.605
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	7.53
Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL	7.267
Kolmogorov-Smirnov 5% Critical Value	0.123	95% BCA Bootstrap UCL	7.476
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.854
		97.5% Chebyshev(Mean, Sd) UCL	9.98
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	12.19
95% Approximate Gamma UCL	7.208		
95% Adjusted Gamma UCL	7.236		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	8.854

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Biota_Mummichog_COPPER			
General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	11
Raw Statistics		Log-transformed Statistics	
Minimum	2000	Minimum of Log Data	7.601
Maximum	4300	Maximum of Log Data	8.366
Mean	2767	Mean of log Data	7.9
Median	2700	SD of log Data	0.229
SD	654.3		
Std. Error of Mean	168.9		
Coefficient of Variation	0.236		
Skewness	0.789		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.927	Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3064	95% H-UCL	3099
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3484
95% Adjusted-CLT UCL (Chen-1995)	3081	97.5% Chebyshev (MVUE) UCL	3795
95% Modified-t UCL (Johnson-1978)	3070	99% Chebyshev (MVUE) UCL	4406
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	16.21	Data appear Normal at 5% Significance Level	
Theta Star	170.7		
MLE of Mean	2767		
MLE of Standard Deviation	687.2		
nu star	486.3		
Approximate Chi Square Value (.05)	436.1	Nonparametric Statistics	
Adjusted Level of Significance	0.0324	95% CLT UCL	3045
Adjusted Chi Square Value	430.3	95% Jackknife UCL	3064
		95% Standard Bootstrap UCL	3036
Anderson-Darling Test Statistic	0.309	95% Bootstrap-t UCL	3101
Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	3146
Kolmogorov-Smirnov Test Statistic	0.133	95% Percentile Bootstrap UCL	3040
Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	3067
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3503
		97.5% Chebyshev(Mean, Sd) UCL	3822
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	4448
95% Approximate Gamma UCL	3085		
95% Adjusted Gamma UCL	3127		
Potential UCL to Use		Use 95% Student's-t UCL	3064

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
Biota_Mummichog_LEAD			
General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	13
Raw Statistics		Log-transformed Statistics	
Minimum	380	Minimum of Log Data	5.94
Maximum	3900	Maximum of Log Data	8.269
Mean	1057	Mean of log Data	6.652
Median	530	SD of log Data	0.75
SD	1024		
Std. Error of Mean	264.4		
Coefficient of Variation	0.969		
Skewness	1.95		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.694	Shapiro Wilk Test Statistic	0.82
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1523	95% H-UCL	1649
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1899
95% Adjusted-CLT UCL (Chen-1995)	1635	97.5% Chebyshev (MVUE) UCL	2287
95% Modified-t UCL (Johnson-1978)	1545	99% Chebyshev (MVUE) UCL	3049
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.446	Data do not follow a Discernable Distribution (0.05)	
Theta Star	731.2		
MLE of Mean	1057		
MLE of Standard Deviation	879.3		
nu star	43.38		
Approximate Chi Square Value (.05)	29.28	Nonparametric Statistics	
Adjusted Level of Significance	0.0324	95% CLT UCL	1492
Adjusted Chi Square Value	27.85	95% Jackknife UCL	1523
		95% Standard Bootstrap UCL	1486
Anderson-Darling Test Statistic	1.461	95% Bootstrap-t UCL	1922
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	1739
Kolmogorov-Smirnov Test Statistic	0.27	95% Percentile Bootstrap UCL	1509
Kolmogorov-Smirnov 5% Critical Value	0.225	95% BCA Bootstrap UCL	1633
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2210
		97.5% Chebyshev(Mean, Sd) UCL	2709
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3688
95% Approximate Gamma UCL	1567		
95% Adjusted Gamma UCL	1647		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	2210
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			

113	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
114				
115				
116	Biota_Mummichog_MERCURY			
117				
118	General Statistics			
119	Number of Valid Observations	15	Number of Distinct Observations	10
120				
121	Raw Statistics		Log-transformed Statistics	
122	Minimum	36	Minimum of Log Data	3.584
123	Maximum	71	Maximum of Log Data	4.263
124	Mean	59.73	Mean of log Data	4.067
125	Median	65	SD of log Data	0.228
126	SD	12.12		
127	Std. Error of Mean	3.13		
128	Coefficient of Variation	0.203		
129	Skewness	-0.92		
130				
131	Relevant UCL Statistics			
132	Normal Distribution Test		Lognormal Distribution Test	
133	Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Test Statistic	0.813
134	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
135	Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
136				
137	Assuming Normal Distribution		Assuming Lognormal Distribution	
138	95% Student's-t UCL	65.25	95% H-UCL	67
139	95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	75.29
140	95% Adjusted-CLT UCL (Chen-1995)	64.09	97.5% Chebyshev (MVUE) UCL	81.97
141	95% Modified-t UCL (Johnson-1978)	65.12	99% Chebyshev (MVUE) UCL	95.1
142				
143	Gamma Distribution Test		Data Distribution	
144	k star (bias corrected)	18.03	Data do not follow a Discernable Distribution (0.05)	
145	Theta Star	3.313		
146	MLE of Mean	59.73		
147	MLE of Standard Deviation	14.07		
148	nu star	540.9		
149	Approximate Chi Square Value (.05)	487.9	Nonparametric Statistics	
150	Adjusted Level of Significance	0.0324	95% CLT UCL	64.88
151	Adjusted Chi Square Value	481.7	95% Jackknife UCL	65.25
152			95% Standard Bootstrap UCL	64.59
153	Anderson-Darling Test Statistic	1.134	95% Bootstrap-t UCL	64.63
154	Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	64.13
155	Kolmogorov-Smirnov Test Statistic	0.265	95% Percentile Bootstrap UCL	64.73
156	Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	63.8
157	Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	73.38
158			97.5% Chebyshev(Mean, Sd) UCL	79.28
159	Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	90.87
160	95% Approximate Gamma UCL	66.21		
161	95% Adjusted Gamma UCL	67.06		
162				
163	Potential UCL to Use		Use 95% Student's-t UCL	65.25
164			or 95% Modified-t UCL	65.12
165				
166	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
167	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
168	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			

	A–F	F	G–K	L
169				
170	**Note: For highly negative-skewed data, confidence limits**			
171	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
172	**reliable. Chen's and Johnson's methods provide**			
173	**adjustments for positvely skewed data sets.**			
174				
175				
176	Biota_Mummichog_Methyl Mercury			
177				
178	**General Statistics**			
179	Number of Valid Observations	15	Number of Distinct Observations	13
180				
181	**Raw Statistics**		**Log-transformed Statistics**	
182	Minimum	19	Minimum of Log Data	2.944
183	Maximum	69	Maximum of Log Data	4.234
184	Mean	48.93	Mean of log Data	3.801
185	Median	60	SD of log Data	0.47
186	SD	18.6		
187	Std. Error of Mean	4.802		
188	Coefficient of Variation	0.38		
189	Skewness	-0.636		
190				
191	**Relevant UCL Statistics**			
192	**Normal Distribution Test**		**Lognormal Distribution Test**	
193	Shapiro Wilk Test Statistic	0.825	Shapiro Wilk Test Statistic	0.796
194	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
195	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
196				
197	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
198	95% Student's-t UCL	57.39	95% H-UCL	64.51
199	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	76.46
200	95% Adjusted-CLT UCL (Chen-1995)	55.99	97.5% Chebyshev (MVUE) UCL	88.1
201	95% Modified-t UCL (Johnson-1978)	57.26	99% Chebyshev (MVUE) UCL	111
202				
203	**Gamma Distribution Test**		**Data Distribution**	
204	k star (bias corrected)	4.645	**Data do not follow a Discernable Distribution (0.05)**	
205	Theta Star	10.53		
206	MLE of Mean	48.93		
207	MLE of Standard Deviation	22.7		
208	nu star	139.3		
209	Approximate Chi Square Value (.05)	113.1	**Nonparametric Statistics**	
210	Adjusted Level of Significance	0.0324	95% CLT UCL	56.83
211	Adjusted Chi Square Value	110.2	95% Jackknife UCL	57.39
212			95% Standard Bootstrap UCL	56.53
213	Anderson-Darling Test Statistic	1.351	95% Bootstrap-t UCL	56
214	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	55.98
215	Kolmogorov-Smirnov Test Statistic	0.311	95% Percentile Bootstrap UCL	56.6
216	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	56.2
217	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	69.87
218			97.5% Chebyshev(Mean, Sd) UCL	78.92
219	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	96.72
220	95% Approximate Gamma UCL	60.3		
221	95% Adjusted Gamma UCL	61.9		
222				
223	**Potential UCL to Use**		Use 95% Student's-t UCL	57.39
224			or 95% Modified-t UCL	57.26

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Biota_Mummichog_ LMW PAHs

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	43.51	Minimum of Log Data	3.773
Maximum	177.1	Maximum of Log Data	5.177
Mean	75.81	Mean of log Data	4.245
Median	59.77	SD of log Data	0.403
SD	35.65		
Std. Error of Mean	9.205		
Coefficient of Variation	0.47		
Skewness	1.795		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.817	Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	92.02	95% H-UCL	93.55
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	110
95% Adjusted-CLT UCL (Chen-1995)	95.51	97.5% Chebyshev (MVUE) UCL	125.1
95% Modified-t UCL (Johnson-1978)	92.73	99% Chebyshev (MVUE) UCL	154.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	5.008	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	15.14		
MLE of Mean	75.81		
MLE of Standard Deviation	33.88		
nu star	150.2		
Approximate Chi Square Value (.05)	122.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	90.95
Adjusted Chi Square Value	119.9	95% Jackknife UCL	92.02
		95% Standard Bootstrap UCL	90.36
Anderson-Darling Test Statistic	0.521	95% Bootstrap-t UCL	98.05
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	113.4
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	91.61
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	95.87
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	115.9
		97.5% Chebyshev(Mean, Sd) UCL	133.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	167.4
95% Approximate Gamma UCL	92.67		
95% Adjusted Gamma UCL	95.02		

	A–E	F	G–K	L
281	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	92.67
282				
283	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
284	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
285	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
286				
287				
288	Biota_Mummichog_HMW PAHs			
289				
290	**General Statistics**			
291	Number of Valid Observations	15	Number of Distinct Observations	15
292				
293	**Raw Statistics**		**Log-transformed Statistics**	
294	Minimum	34.6	Minimum of Log Data	3.544
295	Maximum	504	Maximum of Log Data	6.223
296	Mean	120.2	Mean of log Data	4.463
297	Median	76.8	SD of log Data	0.766
298	SD	124.4		
299	Std. Error of Mean	32.11		
300	Coefficient of Variation	1.034		
301	Skewness	2.434		
302				
303	**Relevant UCL Statistics**			
304	**Normal Distribution Test**		**Lognormal Distribution Test**	
305	Shapiro Wilk Test Statistic	0.672	Shapiro Wilk Test Statistic	0.897
306	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
307	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
308				
309	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
310	95% Student's-t UCL	176.8	95% H-UCL	190
311	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	217.6
312	95% Adjusted-CLT UCL (Chen-1995)	194.6	97.5% Chebyshev (MVUE) UCL	262.7
313	95% Modified-t UCL (Johnson-1978)	180.2	99% Chebyshev (MVUE) UCL	351.1
314				
315	**Gamma Distribution Test**		**Data Distribution**	
316	k star (bias corrected)	1.388	**Data appear Lognormal at 5% Significance Level**	
317	Theta Star	86.66		
318	MLE of Mean	120.2		
319	MLE of Standard Deviation	102.1		
320	nu star	41.63		
321	Approximate Chi Square Value (.05)	27.84	**Nonparametric Statistics**	
322	Adjusted Level of Significance	0.0324	95% CLT UCL	173.1
323	Adjusted Chi Square Value	26.46	95% Jackknife UCL	176.8
324			95% Standard Bootstrap UCL	171
325	Anderson-Darling Test Statistic	1.035	95% Bootstrap-t UCL	234.1
326	Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	362.8
327	Kolmogorov-Smirnov Test Statistic	0.305	95% Percentile Bootstrap UCL	176
328	Kolmogorov-Smirnov 5% Critical Value	0.225	95% BCA Bootstrap UCL	189.5
329	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	260.2
330			97.5% Chebyshev(Mean, Sd) UCL	320.8
331	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	439.8
332	95% Approximate Gamma UCL	179.8		
333	95% Adjusted Gamma UCL	189.2		
334				
335	**Potential UCL to Use**		Use 95% H-UCL	190
336				

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.		
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.		
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.		
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.		
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)		
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.		

	General UCL Statistics for Full Data Sets
User Selected Options	
From File	ProUCL additional input.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Biota_Mummichog_Dieldrin

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	13
Raw Statistics		Log-transformed Statistics	
Minimum	3.5	Minimum of Log Data	1.253
Maximum	13	Maximum of Log Data	2.565
Mean	6.693	Mean of log Data	1.798
Median	5.4	SD of log Data	0.462
SD	3.23		
Std. Error of Mean	0.834		
Coefficient of Variation	0.483		
Skewness	0.774		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.855	Shapiro Wilk Test Statistic	0.895
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.162	95% H-UCL	8.635
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.23
95% Adjusted-CLT UCL (Chen-1995)	8.243	97.5% Chebyshev (MVUE) UCL	11.77
95% Modified-t UCL (Johnson-1978)	8.19	99% Chebyshev (MVUE) UCL	14.79
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	4.067	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	1.646		
MLE of Mean	6.693		
MLE of Standard Deviation	3.319		
nu star	122		
Approximate Chi Square Value (.05)	97.51	Nonparametric Statistics	
Adjusted Level of Significance	0.0324	95% CLT UCL	8.065
Adjusted Chi Square Value	94.82	95% Jackknife UCL	8.162
		95% Standard Bootstrap UCL	7.986
Anderson-Darling Test Statistic	0.743	95% Bootstrap-t UCL	8.418
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL	8.053
Kolmogorov-Smirnov Test Statistic	0.208	95% Percentile Bootstrap UCL	8.087

Row	A–E	F	G–K	L
393	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	8.06
394	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	10.33
395			97.5% Chebyshev(Mean, Sd) UCL	11.9
396	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	14.99
397	95% Approximate Gamma UCL	8.376		
398	95% Adjusted Gamma UCL	8.614		
399				
400	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	8.376
401				
402	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
403	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
404	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
405				
406	**Biota_Mummichog_ Total DDx**			
407				
408	**General Statistics**			
409	Number of Valid Observations	15	Number of Distinct Observations	15
410				
411	**Raw Statistics**		**Log-transformed Statistics**	
412	Minimum	25.35	Minimum of Log Data	3.233
413	Maximum	96.8	Maximum of Log Data	4.573
414	Mean	53.57	Mean of log Data	3.912
415	Median	44.7	SD of log Data	0.385
416	SD	20.78		
417	Std. Error of Mean	5.365		
418	Coefficient of Variation	0.388		
419	Skewness	0.694		
420				
421	**Relevant UCL Statistics**			
422	**Normal Distribution Test**		**Lognormal Distribution Test**	
423	Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Test Statistic	0.975
424	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
425	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
426				
427	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
428	95% Student's-t UCL	63.02	95% H-UCL	65.82
429	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	77.18
430	95% Adjusted-CLT UCL (Chen-1995)	63.42	97.5% Chebyshev (MVUE) UCL	87.4
431	95% Modified-t UCL (Johnson-1978)	63.18	99% Chebyshev (MVUE) UCL	107.5
432				
433	**Gamma Distribution Test**		**Data Distribution**	
434	k star (bias corrected)	5.978	**Data appear Normal at 5% Significance Level**	
435	Theta Star	8.96		
436	MLE of Mean	53.57		
437	MLE of Standard Deviation	21.91		
438	nu star	179.4		
439	Approximate Chi Square Value (.05)	149.4	**Nonparametric Statistics**	
440	Adjusted Level of Significance	0.0324	95% CLT UCL	62.39
441	Adjusted Chi Square Value	146	95% Jackknife UCL	63.02
442			95% Standard Bootstrap UCL	62.2
443	Anderson-Darling Test Statistic	0.272	95% Bootstrap-t UCL	64.1
444	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	63.65
445	Kolmogorov-Smirnov Test Statistic	0.172	95% Percentile Bootstrap UCL	62.2
446	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	63.12
447	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	76.95
448			97.5% Chebyshev(Mean, Sd) UCL	87.07

	A–E	F	G–K	L
449	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	106.9
450	95% Approximate Gamma UCL	64.32		
451	95% Adjusted Gamma UCL	65.8		
452				
453	**Potential UCL to Use**		Use 95% Student's-t UCL	63.02
454				
455	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
456	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
457	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
458				
459	**Biota_Mummichog_ Total PCB**			
460				
461	**General Statistics**			
462	Number of Valid Observations	15	Number of Distinct Observations	15
463				
464	**Raw Statistics**		**Log-transformed Statistics**	
465	Minimum	235.8	Minimum of Log Data	5.463
466	Maximum	932.6	Maximum of Log Data	6.838
467	Mean	513	Mean of log Data	6.155
468	Median	431.5	SD of log Data	0.424
469	SD	224.5		
470	Std. Error of Mean	57.97		
471	Coefficient of Variation	0.438		
472	Skewness	0.769		
473				
474	**Relevant UCL Statistics**			
475	**Normal Distribution Test**		**Lognormal Distribution Test**	
476	Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.946
477	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
478	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
479				
480	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
481	95% Student's-t UCL	615.1	95% H-UCL	645.7
482	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	761.7
483	95% Adjusted-CLT UCL (Chen-1995)	620.6	97.5% Chebyshev (MVUE) UCL	869.8
484	95% Modified-t UCL (Johnson-1978)	617	99% Chebyshev (MVUE) UCL	1082
485				
486	**Gamma Distribution Test**		**Data Distribution**	
487	k star (bias corrected)	4.862	**Data appear Normal at 5% Significance Level**	
488	Theta Star	105.5		
489	MLE of Mean	513		
490	MLE of Standard Deviation	232.6		
491	nu star	145.9		
492	Approximate Chi Square Value (.05)	119	**Nonparametric Statistics**	
493	Adjusted Level of Significance	0.0324	95% CLT UCL	608.3
494	Adjusted Chi Square Value	116	95% Jackknife UCL	615.1
495			95% Standard Bootstrap UCL	602.8
496	Anderson-Darling Test Statistic	0.494	95% Bootstrap-t UCL	626.2
497	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	608.5
498	Kolmogorov-Smirnov Test Statistic	0.181	95% Percentile Bootstrap UCL	608.4
499	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	611.5
500	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	765.7
501			97.5% Chebyshev(Mean, Sd) UCL	875
502	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	1090
503	95% Approximate Gamma UCL	629		
504	95% Adjusted Gamma UCL	645.2		

Row	A–E	F	G–K	L
505				
506	**Potential UCL to Use**		Use 95% Student's-t UCL	615.1
507				
508	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
509	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
510	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
511				
512	**Biota_Mummichog_TCDD TEQ(PCBs) - mammal TEFs**			
513				
514	**General Statistics**			
515	Number of Valid Observations	15	Number of Distinct Observations	15
516				
517	**Raw Statistics**		**Log-transformed Statistics**	
518	Minimum	0.00363	Minimum of Log Data	-5.619
519	Maximum	0.0117	Maximum of Log Data	-4.452
520	Mean	0.00705	Mean of log Data	-5.009
521	Median	0.00646	SD of log Data	0.342
522	SD	0.00247		
523	Std. Error of Mean	0.0006365		
524	Coefficient of Variation	0.35		
525	Skewness	0.732		
526				
527	**Relevant UCL Statistics**			
528	**Normal Distribution Test**		**Lognormal Distribution Test**	
529	Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.96
530	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
531	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
532				
533	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
534	95% Student's-t UCL	0.00817	95% H-UCL	0.00843
535	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0098
536	95% Adjusted-CLT UCL (Chen-1995)	0.00823	97.5% Chebyshev (MVUE) UCL	0.011
537	95% Modified-t UCL (Johnson-1978)	0.00819	99% Chebyshev (MVUE) UCL	0.0133
538				
539	**Gamma Distribution Test**		**Data Distribution**	
540	k star (bias corrected)	7.456	**Data appear Normal at 5% Significance Level**	
541	Theta Star	0.0009459		
542	MLE of Mean	0.00705		
543	MLE of Standard Deviation	0.00258		
544	nu star	223.7		
545	Approximate Chi Square Value (.05)	190.1	**Nonparametric Statistics**	
546	Adjusted Level of Significance	0.0324	95% CLT UCL	0.0081
547	Adjusted Chi Square Value	186.3	95% Jackknife UCL	0.00817
548			95% Standard Bootstrap UCL	0.00808
549	Anderson-Darling Test Statistic	0.367	95% Bootstrap-t UCL	0.00836
550	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.00813
551	Kolmogorov-Smirnov Test Statistic	0.166	95% Percentile Bootstrap UCL	0.00808
552	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.00812
553	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.00983
554			97.5% Chebyshev(Mean, Sd) UCL	0.011
555	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0134
556	95% Approximate Gamma UCL	0.0083		
557	95% Adjusted Gamma UCL	0.00847		
558				
559	**Potential UCL to Use**		Use 95% Student's-t UCL	0.00817
560				

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Mummichog_TCDD TEQ(PCBs) - bird TEFs

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	15
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0173	Minimum of Log Data	-4.059
Maximum	0.0734	Maximum of Log Data	-2.612
Mean	0.0392	Mean of log Data	-3.322
Median	0.0316	SD of log Data	0.42
SD	0.0168		
Std. Error of Mean	0.00434		
Coefficient of Variation	0.429		
Skewness	0.738		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0468	95% H-UCL	0.0493
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0581
95% Adjusted-CLT UCL (Chen-1995)	0.0472	97.5% Chebyshev (MVUE) UCL	0.0663
95% Modified-t UCL (Johnson-1978)	0.047	99% Chebyshev (MVUE) UCL	0.0823
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.996	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00785		
MLE of Mean	0.0392		
MLE of Standard Deviation	0.0175		
nu star	149.9		
Approximate Chi Square Value (.05)	122.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.0463
Adjusted Chi Square Value	119.5	95% Jackknife UCL	0.0468
		95% Standard Bootstrap UCL	0.0462
Anderson-Darling Test Statistic	0.663	95% Bootstrap-t UCL	0.0486
Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.0468
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL	0.0462
Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.0468
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0581
		97.5% Chebyshev(Mean, Sd) UCL	0.0663
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0824
95% Approximate Gamma UCL	0.0479		
95% Adjusted Gamma UCL	0.0492		
Potential UCL to Use		Use 95% Student's-t UCL	0.0468

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

Row	Label (A–E)	F	Label (G–K)	L
617	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
618				
619				
620	Biota_Mummichog_TCDD TEQ(PCBs) - fish TEFs			
621				
622	**General Statistics**			
623	Number of Valid Observations	15	Number of Distinct Observations	15
624				
625	**Raw Statistics**		**Log-transformed Statistics**	
626	Minimum	0.0002679	Minimum of Log Data	-8.225
627	Maximum	0.0008961	Maximum of Log Data	-7.017
628	Mean	0.0005418	Mean of log Data	-7.577
629	Median	0.0004796	SD of log Data	0.347
630	SD	0.0001911		
631	Std. Error of Mean	4.934E-05		
632	Coefficient of Variation	0.353		
633	Skewness	0.683		
634				
635	**Relevant UCL Statistics**			
636	**Normal Distribution Test**		**Lognormal Distribution Test**	
637	Shapiro Wilk Test Statistic	0.918	Shapiro Wilk Test Statistic	0.962
638	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
639	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
640				
641	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
642	95% Student's-t UCL	0.0006287	95% H-UCL	0.0006501
643	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0007565
644	95% Adjusted-CLT UCL (Chen-1995)	0.0006323	97.5% Chebyshev (MVUE) UCL	0.0008495
645	95% Modified-t UCL (Johnson-1978)	0.0006302	99% Chebyshev (MVUE) UCL	0.00103
646				
647	**Gamma Distribution Test**		**Data Distribution**	
648	k star (bias corrected)	7.258	**Data appear Normal at 5% Significance Level**	
649	Theta Star	7.466E-05		
650	MLE of Mean	0.0005418		
651	MLE of Standard Deviation	0.0002011		
652	nu star	217.7		
653	Approximate Chi Square Value (.05)	184.6	**Nonparametric Statistics**	
654	Adjusted Level of Significance	0.0324	95% CLT UCL	0.000623
655	Adjusted Chi Square Value	180.8	95% Jackknife UCL	0.0006287
656			95% Standard Bootstrap UCL	0.00062
657	Anderson-Darling Test Statistic	0.359	95% Bootstrap-t UCL	0.0006481
658	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	0.000631
659	Kolmogorov-Smirnov Test Statistic	0.142	95% Percentile Bootstrap UCL	0.0006219
660	Kolmogorov-Smirnov 5% Critical Value	0.222	95% BCA Bootstrap UCL	0.0006305
661	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0007569
662			97.5% Chebyshev(Mean, Sd) UCL	0.00085
663	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.00103
664	95% Approximate Gamma UCL	0.0006391		
665	95% Adjusted Gamma UCL	0.0006524		
666				
667	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0006287
668				
669	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
670	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
671	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
672				

Biota_Mummichog_TCDD TEQ(D/F) - mammal TEFs

General Statistics

Number of Valid Observations	15	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0114	Minimum of Log Data	-4.476
Maximum	0.0801	Maximum of Log Data	-2.525
Mean	0.0348	Mean of log Data	-3.509
Median	0.0255	SD of log Data	0.561
SD	0.0204		
Std. Error of Mean	0.00527		
Coefficient of Variation	0.587		
Skewness	1.044		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.044	95% H-UCL	0.0482
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0573
95% Adjusted-CLT UCL (Chen-1995)	0.0449	97.5% Chebyshev (MVUE) UCL	0.0671
95% Modified-t UCL (Johnson-1978)	0.0443	99% Chebyshev (MVUE) UCL	0.0863
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.845	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0122		
MLE of Mean	0.0348		
MLE of Standard Deviation	0.0206		
nu star	85.34		
Approximate Chi Square Value (.05)	65.05	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.0434
Adjusted Chi Square Value	62.87	95% Jackknife UCL	0.044
		95% Standard Bootstrap UCL	0.043
Anderson-Darling Test Statistic	0.567	95% Bootstrap-t UCL	0.0471
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0444
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.0433
Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.044
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0577
		97.5% Chebyshev(Mean, Sd) UCL	0.0676
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0871
95% Approximate Gamma UCL	0.0456		
95% Adjusted Gamma UCL	0.0472		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0456

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Mummichog_TCDD TEQ(D/F) - bird TEFs

	A–E	F	G–K	L
729				
730	**General Statistics**			
731	Number of Valid Observations	15	Number of Distinct Observations	15
732				
733	**Raw Statistics**		**Log-transformed Statistics**	
734	Minimum	0.0123	Minimum of Log Data	-4.395
735	Maximum	0.084	Maximum of Log Data	-2.477
736	Mean	0.0365	Mean of log Data	-3.457
737	Median	0.027	SD of log Data	0.555
738	SD	0.0213		
739	Std. Error of Mean	0.00549		
740	Coefficient of Variation	0.582		
741	Skewness	1.053		
742				
743	**Relevant UCL Statistics**			
744	**Normal Distribution Test**		**Lognormal Distribution Test**	
745	Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.951
746	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
747	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
748				
749	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
750	95% Student's-t UCL	0.0462	95% H-UCL	0.0504
751	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0598
752	95% Adjusted-CLT UCL (Chen-1995)	0.0471	97.5% Chebyshev (MVUE) UCL	0.07
753	95% Modified-t UCL (Johnson-1978)	0.0464	99% Chebyshev (MVUE) UCL	0.09
754				
755	**Gamma Distribution Test**		**Data Distribution**	
756	k star (bias corrected)	2.897	**Data appear Gamma Distributed at 5% Significance Level**	
757	Theta Star	0.0126		
758	MLE of Mean	0.0365		
759	MLE of Standard Deviation	0.0214		
760	nu star	86.92		
761	Approximate Chi Square Value (.05)	66.43	**Nonparametric Statistics**	
762	Adjusted Level of Significance	0.0324	95% CLT UCL	0.0455
763	Adjusted Chi Square Value	64.23	95% Jackknife UCL	0.0462
764			95% Standard Bootstrap UCL	0.0452
765	Anderson-Darling Test Statistic	0.567	95% Bootstrap-t UCL	0.0488
766	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0464
767	Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	0.0459
768	Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.0462
769	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0604
770			97.5% Chebyshev(Mean, Sd) UCL	0.0708
771	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0911
772	95% Approximate Gamma UCL	0.0477		
773	95% Adjusted Gamma UCL	0.0494		
774				
775	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.0477
776				
777	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
778	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
779	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
780				
781				
782	**Biota_Mummichog_TCDD TEQ(PCBs) - fish TEFs**			
783				
784	**General Statistics**			

Number of Valid Observations	15	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0115	Minimum of Log Data	-4.469
Maximum	0.0806	Maximum of Log Data	-2.519
Mean	0.0349	Mean of log Data	-3.504
Median	0.0257	SD of log Data	0.561
SD	0.0205		
Std. Error of Mean	0.00529		
Coefficient of Variation	0.587		
Skewness	1.05		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.865	Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0442	95% H-UCL	0.0484
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0575
95% Adjusted-CLT UCL (Chen-1995)	0.0451	97.5% Chebyshev (MVUE) UCL	0.0673
95% Modified-t UCL (Johnson-1978)	0.0445	99% Chebyshev (MVUE) UCL	0.0867
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.848	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0123		
MLE of Mean	0.0349		
MLE of Standard Deviation	0.0207		
nu star	85.45		
Approximate Chi Square Value (.05)	65.14	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0324	95% CLT UCL	0.0436
Adjusted Chi Square Value	62.96	95% Jackknife UCL	0.0442
		95% Standard Bootstrap UCL	0.043
Anderson-Darling Test Statistic	0.56	95% Bootstrap-t UCL	0.0465
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0443
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.0438
Kolmogorov-Smirnov 5% Critical Value	0.223	95% BCA Bootstrap UCL	0.044
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.058
		97.5% Chebyshev(Mean, Sd) UCL	0.0679
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0875
95% Approximate Gamma UCL	0.0458		
95% Adjusted Gamma UCL	0.0474		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0458

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Mummichog_Lipids

General Statistics			
Number of Valid Observations	15	Number of Distinct Observations	8

	A–E	F	G–K	L
841				
842	**Raw Statistics**		**Log-transformed Statistics**	
843	Minimum	1.4	Minimum of Log Data	0.336
844	Maximum	3.1	Maximum of Log Data	1.131
845	Mean	1.9	Mean of log Data	0.614
846	Median	1.8	SD of log Data	0.241
847	SD	0.488		
848	Std. Error of Mean	0.126		
849	Coefficient of Variation	0.257		
850	Skewness	1.078		
851				
852				
853	**Relevant UCL Statistics**			
854	**Normal Distribution Test**		**Lognormal Distribution Test**	
855	Shapiro Wilk Test Statistic	0.877	Shapiro Wilk Test Statistic	0.913
856	Shapiro Wilk Critical Value	0.881	Shapiro Wilk Critical Value	0.881
857	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
858				
859	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
860	95% Student's-t UCL	2.122	95% H-UCL	2.141
861	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	2.417
862	95% Adjusted-CLT UCL (Chen-1995)	2.145	97.5% Chebyshev (MVUE) UCL	2.641
863	95% Modified-t UCL (Johnson-1978)	2.128	99% Chebyshev (MVUE) UCL	3.082
864				
865	**Gamma Distribution Test**		**Data Distribution**	
866	k star (bias corrected)	14.35	**Data appear Gamma Distributed at 5% Significance Level**	
867	Theta Star	0.132		
868	MLE of Mean	1.9		
869	MLE of Standard Deviation	0.501		
870	nu star	430.6		
871	Approximate Chi Square Value (.05)	383.5	**Nonparametric Statistics**	
872	Adjusted Level of Significance	0.0324	95% CLT UCL	2.107
873	Adjusted Chi Square Value	378.1	95% Jackknife UCL	2.122
874			95% Standard Bootstrap UCL	2.104
875	Anderson-Darling Test Statistic	0.562	95% Bootstrap-t UCL	2.191
876	Anderson-Darling 5% Critical Value	0.735	95% Hall's Bootstrap UCL	2.174
877	Kolmogorov-Smirnov Test Statistic	0.159	95% Percentile Bootstrap UCL	2.107
878	Kolmogorov-Smirnov 5% Critical Value	0.221	95% BCA Bootstrap UCL	2.14
879	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	2.45
880			97.5% Chebyshev(Mean, Sd) UCL	2.688
881	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	3.155
882	95% Approximate Gamma UCL	2.133		
883	95% Adjusted Gamma UCL	2.164		
884				
885	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	2.133
886				
887	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
888	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
889	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			

General UCL Statistics for Full Data Sets			
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Biota_Crab_Copper			
General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		Log-transformed Statistics	
Minimum	16209	Minimum of Log Data	9.693
Maximum	30605	Maximum of Log Data	10.33
Mean	22494	Mean of log Data	10.01
Median	22271	SD of log Data	0.18
SD	4110		
Std. Error of Mean	876.3		
Coefficient of Variation	0.183		
Skewness	0.458		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.947	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	24002	95% H-UCL	24126
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	26282
95% Adjusted-CLT UCL (Chen-1995)	24026	97.5% Chebyshev (MVUE) UCL	27922
95% Modified-t UCL (Johnson-1978)	24016	99% Chebyshev (MVUE) UCL	31144
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	27.79	Data appear Normal at 5% Significance Level	
Theta Star	809.6		
MLE of Mean	22494		
MLE of Standard Deviation	4267		
nu star	1223		
Approximate Chi Square Value (.05)	1142	Nonparametric Statistics	
Adjusted Level of Significance	0.0386	95% CLT UCL	23935
Adjusted Chi Square Value	1137	95% Jackknife UCL	24002
		95% Standard Bootstrap UCL	23925
Anderson-Darling Test Statistic	0.385	95% Bootstrap-t UCL	24131
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	24002
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL	23927
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	23982
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	26313
		97.5% Chebyshev(Mean, Sd) UCL	27966
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	31213
95% Approximate Gamma UCL	24072		
95% Adjusted Gamma UCL	24195		
Potential UCL to Use		Use 95% Student's-t UCL	24002

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_Lead

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	201.4	Minimum of Log Data	5.305
Maximum	656.2	Maximum of Log Data	6.486
Mean	327.3	Mean of log Data	5.747
Median	302	SD of log Data	0.293
SD	108.2		
Std. Error of Mean	23.07		
Coefficient of Variation	0.331		
Skewness	1.593		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.862	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	367	95% H-UCL	367.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	416.4
95% Adjusted-CLT UCL (Chen-1995)	373.6	97.5% Chebyshev (MVUE) UCL	455.4
95% Modified-t UCL (Johnson-1978)	368.3	99% Chebyshev (MVUE) UCL	532
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	9.984	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	32.78		
MLE of Mean	327.3		
MLE of Standard Deviation	103.6		
nu star	439.3		
Approximate Chi Square Value (.05)	391.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	365.2
Adjusted Chi Square Value	388.4	95% Jackknife UCL	367
		95% Standard Bootstrap UCL	365
Anderson-Darling Test Statistic	0.508	95% Bootstrap-t UCL	379.8
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	389.5
Kolmogorov-Smirnov Test Statistic	0.148	95% Percentile Bootstrap UCL	363.4
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	370.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	427.9
		97.5% Chebyshev(Mean, Sd) UCL	471.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	556.8
95% Approximate Gamma UCL	367.1		
95% Adjusted Gamma UCL	370.2		
Potential UCL to Use		Use 95% Approximate Gamma UCL	367.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Biota_Crab_Mercury

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	86.1	Minimum of Log Data	4.456
Maximum	190.2	Maximum of Log Data	5.248
Mean	136.5	Mean of log Data	4.892
Median	135.9	SD of log Data	0.23
SD	29.99		
Std. Error of Mean	6.395		
Coefficient of Variation	0.22		
Skewness	-0.0754		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.969	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	147.5	95% H-UCL	149.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	166.1
95% Adjusted-CLT UCL (Chen-1995)	146.9	97.5% Chebyshev (MVUE) UCL	178.9
95% Modified-t UCL (Johnson-1978)	147.5	99% Chebyshev (MVUE) UCL	204
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	17.81	**Data appear Normal at 5% Significance Level**	
Theta Star	7.662		
MLE of Mean	136.5		
MLE of Standard Deviation	32.34		
nu star	783.8		
Approximate Chi Square Value (.05)	719.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	147
Adjusted Chi Square Value	715.3	95% Jackknife UCL	147.5
		95% Standard Bootstrap UCL	146.6
Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL	147.4
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL	147.3
Kolmogorov-Smirnov Test Statistic	0.114	95% Percentile Bootstrap UCL	147
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	146.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	164.4
		97.5% Chebyshev(Mean, Sd) UCL	176.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	200.1
95% Approximate Gamma UCL	148.6		
95% Adjusted Gamma UCL	149.6		
Potential UCL to Use		Use 95% Student's-t UCL	147.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Biota_Crab_Methyl Mercury

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	65.14	Minimum of Log Data	4.177
Maximum	170.6	Maximum of Log Data	5.14
Mean	115.1	Mean of log Data	4.714
Median	117.8	SD of log Data	0.265
SD	28.44		
Std. Error of Mean	6.064		
Coefficient of Variation	0.247		
Skewness	-0.117		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	125.5	95% H-UCL	128.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	144
95% Adjusted-CLT UCL (Chen-1995)	124.9	97.5% Chebyshev (MVUE) UCL	156.5
95% Modified-t UCL (Johnson-1978)	125.5	99% Chebyshev (MVUE) UCL	180.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.73	**Data appear Normal at 5% Significance Level**	
Theta Star	8.381		
MLE of Mean	115.1		
MLE of Standard Deviation	31.06		
nu star	604.3		
Approximate Chi Square Value (.05)	548.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	125.1
Adjusted Chi Square Value	544.3	95% Jackknife UCL	125.5
		95% Standard Bootstrap UCL	124.9
Anderson-Darling Test Statistic	0.304	95% Bootstrap-t UCL	126.1
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	125.2
Kolmogorov-Smirnov Test Statistic	0.109	95% Percentile Bootstrap UCL	124.9
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	125.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	141.5
		97.5% Chebyshev(Mean, Sd) UCL	153
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	175.4
95% Approximate Gamma UCL	126.9		
95% Adjusted Gamma UCL	127.8		
Potential UCL to Use		Use 95% Student's-t UCL	125.5

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Biota_Crab_LMW PAHs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	19.73	Minimum of Log Data	2.982
Maximum	292.3	Maximum of Log Data	5.678
Mean	80.04	Mean of log Data	4.145
Median	54.11	SD of log Data	0.655
SD	69.74		
Std. Error of Mean	14.87		
Coefficient of Variation	0.871		
Skewness	2.373		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.674	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	105.6	95% H-UCL	106.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	127.3
95% Adjusted-CLT UCL (Chen-1995)	112.5	97.5% Chebyshev (MVUE) UCL	148.9
95% Modified-t UCL (Johnson-1978)	106.9	99% Chebyshev (MVUE) UCL	191.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.98	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	40.43		
MLE of Mean	80.04		
MLE of Standard Deviation	56.89		
nu star	87.1		
Approximate Chi Square Value (.05)	66.59	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	104.5
Adjusted Chi Square Value	65.25	95% Jackknife UCL	105.6
		95% Standard Bootstrap UCL	104.2
Anderson-Darling Test Statistic	1.044	95% Bootstrap-t UCL	141.3
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	239.2
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL	104.8
Kolmogorov-Smirnov 5% Critical Value	0.188	95% BCA Bootstrap UCL	113.8
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	144.8
		97.5% Chebyshev(Mean, Sd) UCL	172.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	228
95% Approximate Gamma UCL	104.7		
95% Adjusted Gamma UCL	106.8		

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Biota_Crab_Dieldrin

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	2.431	Minimum of Log Data	0.888
Maximum	14.49	Maximum of Log Data	2.673
Mean	6.328	Mean of log Data	1.776
Median	5.967	SD of log Data	0.38
SD	2.547		
Std. Error of Mean	0.543		
Coefficient of Variation	0.403		
Skewness	1.555		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.978
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.263	95% H-UCL	7.425
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.606
95% Adjusted-CLT UCL (Chen-1995)	7.414	97.5% Chebyshev (MVUE) UCL	9.593
95% Modified-t UCL (Johnson-1978)	7.293	99% Chebyshev (MVUE) UCL	11.53
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.395	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.99		
MLE of Mean	6.328		
MLE of Standard Deviation	2.503		
nu star	281.4		
Approximate Chi Square Value (.05)	243.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	7.222
Adjusted Chi Square Value	240.9	95% Jackknife UCL	7.263
		95% Standard Bootstrap UCL	7.213
Anderson-Darling Test Statistic	0.3	95% Bootstrap-t UCL	7.535
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	7.916
Kolmogorov-Smirnov Test Statistic	0.116	95% Percentile Bootstrap UCL	7.247
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	7.365
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.696
		97.5% Chebyshev(Mean, Sd) UCL	9.72
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11.73
95% Approximate Gamma UCL	7.312		
95% Adjusted Gamma UCL	7.392		

Potential UCL to Use		Use 95% Approximate Gamma UCL	7.312

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_Total DDx

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	30.17	Minimum of Log Data	3.407
Maximum	104.4	Maximum of Log Data	4.649
Mean	65.35	Mean of log Data	4.148
Median	64.85	SD of log Data	0.263
SD	16.31		
Std. Error of Mean	3.478		
Coefficient of Variation	0.25		
Skewness	0.315		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	71.33	95% H-UCL	72.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	81.66
95% Adjusted-CLT UCL (Chen-1995)	71.32	97.5% Chebyshev (MVUE) UCL	88.67
95% Modified-t UCL (Johnson-1978)	71.37	99% Chebyshev (MVUE) UCL	102.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.89	**Data appear Normal at 5% Significance Level**	
Theta Star	4.705		
MLE of Mean	65.35		
MLE of Standard Deviation	17.54		
nu star	611		
Approximate Chi Square Value (.05)	554.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	71.07
Adjusted Chi Square Value	550.7	95% Jackknife UCL	71.33
		95% Standard Bootstrap UCL	70.89
Anderson-Darling Test Statistic	0.26	95% Bootstrap-t UCL	71.41
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	71.93
Kolmogorov-Smirnov Test Statistic	0.0968	95% Percentile Bootstrap UCL	70.75
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	71.37
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	80.5
		97.5% Chebyshev(Mean, Sd) UCL	87.06
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	99.95
95% Approximate Gamma UCL	71.98		
95% Adjusted Gamma UCL	72.51		

Potential UCL to Use		Use 95% Student's-t UCL	71.33

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_Total PCB

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	154	Minimum of Log Data	5.037
Maximum	576.9	Maximum of Log Data	6.358
Mean	320.5	Mean of log Data	5.722
Median	291.5	SD of log Data	0.317
SD	103.8		
Std. Error of Mean	22.12		
Coefficient of Variation	0.324		
Skewness	0.841		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.937	Shapiro Wilk Test Statistic	0.979
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	358.6	95% H-UCL	365.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	416.5
95% Adjusted-CLT UCL (Chen-1995)	361.1	97.5% Chebyshev (MVUE) UCL	458.1
95% Modified-t UCL (Johnson-1978)	359.2	99% Chebyshev (MVUE) UCL	539.8
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	9.142	**Data appear Normal at 5% Significance Level**	
Theta Star	35.06		
MLE of Mean	320.5		
MLE of Standard Deviation	106		
nu star	402.2		
Approximate Chi Square Value (.05)	356.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	356.9
Adjusted Chi Square Value	353.6	95% Jackknife UCL	358.6
		95% Standard Bootstrap UCL	356.9
Anderson-Darling Test Statistic	0.351	95% Bootstrap-t UCL	362.4
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	362.7
Kolmogorov-Smirnov Test Statistic	0.123	95% Percentile Bootstrap UCL	357.6
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	360.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	416.9
		97.5% Chebyshev(Mean, Sd) UCL	458.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	540.6
95% Approximate Gamma UCL	361.4		
95% Adjusted Gamma UCL	364.6		
Potential UCL to Use		Use 95% Student's-t UCL	358.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_TCDD TEQ(PCBs) - mammal TEFs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00175	Minimum of Log Data	-6.349
Maximum	0.012	Maximum of Log Data	-4.424
Mean	0.00813	Mean of log Data	-4.881
Median	0.0084	SD of log Data	0.436
SD	0.00247		
Std. Error of Mean	0.0005262		
Coefficient of Variation	0.303		
Skewness	-0.886		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.926	Shapiro Wilk Test Statistic	0.745
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.00904	95% H-UCL	0.01
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0118
95% Adjusted-CLT UCL (Chen-1995)	0.00889	97.5% Chebyshev (MVUE) UCL	0.0133
95% Modified-t UCL (Johnson-1978)	0.00902	99% Chebyshev (MVUE) UCL	0.0162
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.438	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00126		
MLE of Mean	0.00813		
MLE of Standard Deviation	0.0032		
nu star	283.3		
Approximate Chi Square Value (.05)	245.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.009
Adjusted Chi Square Value	242.6	95% Jackknife UCL	0.00904
		95% Standard Bootstrap UCL	0.00898
Anderson-Darling Test Statistic	1.331	95% Bootstrap-t UCL	0.00892
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	0.0089
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	0.00898
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	0.00887
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0104
		97.5% Chebyshev(Mean, Sd) UCL	0.0114
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0134
95% Approximate Gamma UCL	0.00939		
95% Adjusted Gamma UCL	0.00949		
Potential UCL to Use		Use 95% Student's-t UCL	0.00904

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

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

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Biota_Crab_TCDD TEQ(PCBs) - bird TEFs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	21
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0505	Minimum of Log Data	-2.986
Maximum	0.111	Maximum of Log Data	-2.197
Mean	0.0903	Mean of log Data	-2.419
Median	0.0908	SD of log Data	0.179
SD	0.0142		
Std. Error of Mean	0.00303		
Coefficient of Variation	0.158		
Skewness	-1.135		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk Test Statistic	0.845
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0955	95% H-UCL	0.0969
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.106
95% Adjusted-CLT UCL (Chen-1995)	0.0945	97.5% Chebyshev (MVUE) UCL	0.112
95% Modified-t UCL (Johnson-1978)	0.0954	99% Chebyshev (MVUE) UCL	0.125
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	31	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00291		
MLE of Mean	0.0903		
MLE of Standard Deviation	0.0162		
nu star	1364		
Approximate Chi Square Value (.05)	1279	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.0953
Adjusted Chi Square Value	1273	95% Jackknife UCL	0.0955
		95% Standard Bootstrap UCL	0.095
Anderson-Darling Test Statistic	0.886	95% Bootstrap-t UCL	0.0949
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	0.0949
Kolmogorov-Smirnov Test Statistic	0.214	95% Percentile Bootstrap UCL	0.0947
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0945
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.103
		97.5% Chebyshev(Mean, Sd) UCL	0.109
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.12
95% Approximate Gamma UCL	0.0962		
95% Adjusted Gamma UCL	0.0967		
Potential UCL to Use		Use 95% Student's-t UCL	0.0955

	A	B	C	D	E	F	G	H	I	J	K	L	M
617													
618	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
619	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)												
620	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.												
621													
622	Note: For highly negative-skewed data, confidence limits												
623	(e.g., Chen, Johnson, Lognormal, and Gamma) may not be												
624	reliable. Chen's and Johnson's methods provide												
625	adjustments for positvely skewed data sets.												
626													
627													
628	Biota_Crab_TCDD TEQ(PCBs) - fish TEFs												
629													
630	General Statistics												
631	Number of Valid Observations					22	Number of Distinct Observations					22	
632													
633	Raw Statistics						Log-transformed Statistics						
634	Minimum					0.0003164	Minimum of Log Data					-8.058	
635	Maximum					0.00106	Maximum of Log Data					-6.85	
636	Mean					0.0007351	Mean of log Data					-7.247	
637	Median					0.0007421	SD of log Data					0.272	
638	SD					0.0001727							
639	Std. Error of Mean					3.681E-05							
640	Coefficient of Variation					0.235							
641	Skewness					-0.445							
642													
643	Relevant UCL Statistics												
644	Normal Distribution Test						Lognormal Distribution Test						
645	Shapiro Wilk Test Statistic					0.967	Shapiro Wilk Test Statistic					0.887	
646	Shapiro Wilk Critical Value					0.911	Shapiro Wilk Critical Value					0.911	
647	Data appear Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level						
648													
649	Assuming Normal Distribution						Assuming Lognormal Distribution						
650	95% Student's-t UCL					0.0007984	95% H-UCL					0.0008232	
651	95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL					0.0009262	
652	95% Adjusted-CLT UCL (Chen-1995)					0.0007919	97.5% Chebyshev (MVUE) UCL					0.00101	
653	95% Modified-t UCL (Johnson-1978)					0.0007979	99% Chebyshev (MVUE) UCL					0.00117	
654													
655	Gamma Distribution Test						Data Distribution						
656	k star (bias corrected)					13.89	Data appear Normal at 5% Significance Level						
657	Theta Star					5.292E-05							
658	MLE of Mean					0.0007351							
659	MLE of Standard Deviation					0.0001972							
660	nu star					611.2							
661	Approximate Chi Square Value (.05)					554.8	Nonparametric Statistics						
662	Adjusted Level of Significance					0.0386	95% CLT UCL					0.0007957	
663	Adjusted Chi Square Value					550.8	95% Jackknife UCL					0.0007984	
664							95% Standard Bootstrap UCL					0.0007933	
665	Anderson-Darling Test Statistic					0.589	95% Bootstrap-t UCL					0.000797	
666	Anderson-Darling 5% Critical Value					0.742	95% Hall's Bootstrap UCL					0.0007945	
667	Kolmogorov-Smirnov Test Statistic					0.15	95% Percentile Bootstrap UCL					0.0007948	
668	Kolmogorov-Smirnov 5% Critical Value					0.185	95% BCA Bootstrap UCL					0.0007926	
669	Data appear Gamma Distributed at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL					0.0008956	
670							97.5% Chebyshev(Mean, Sd) UCL					0.000965	
671	Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL					0.0011	
672	95% Approximate Gamma UCL					0.0008098							

Row				
673	95% Adjusted Gamma UCL	0.0008156		
674				
675	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0007984
676				
677	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
678	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
679	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
680				
681	**Note: For highly negative-skewed data, confidence limits**			
682	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
683	**reliable. Chen's and Johnson's methods provide**			
684	**adjustments for positvely skewed data sets.**			
685				
686				
687	**Biota_Crab_TCDD TEQ(D/F) - mammal TEFs**			
688				
689	**General Statistics**			
690	Number of Valid Observations	22	Number of Distinct Observations	20
691				
692	**Raw Statistics**		**Log-transformed Statistics**	
693	Minimum	0.026	Minimum of Log Data	-3.649
694	Maximum	0.0898	Maximum of Log Data	-2.411
695	Mean	0.0566	Mean of log Data	-2.914
696	Median	0.0569	SD of log Data	0.307
697	SD	0.016		
698	Std. Error of Mean	0.00341		
699	Coefficient of Variation	0.283		
700	Skewness	0.0702		
701				
702	**Relevant UCL Statistics**			
703	**Normal Distribution Test**		**Lognormal Distribution Test**	
704	Shapiro Wilk Test Statistic	0.982	Shapiro Wilk Test Statistic	0.952
705	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
706	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
707				
708	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
709	95% Student's-t UCL	0.0625	95% H-UCL	0.0644
710	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0732
711	95% Adjusted-CLT UCL (Chen-1995)	0.0623	97.5% Chebyshev (MVUE) UCL	0.0803
712	95% Modified-t UCL (Johnson-1978)	0.0625	99% Chebyshev (MVUE) UCL	0.0943
713				
714	**Gamma Distribution Test**		**Data Distribution**	
715	k star (bias corrected)	10.44	**Data appear Normal at 5% Significance Level**	
716	Theta Star	0.00542		
717	MLE of Mean	0.0566		
718	MLE of Standard Deviation	0.0175		
719	nu star	459.4		
720	Approximate Chi Square Value (.05)	410.7	**Nonparametric Statistics**	
721	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0622
722	Adjusted Chi Square Value	407.3	95% Jackknife UCL	0.0625
723			95% Standard Bootstrap UCL	0.0622
724	Anderson-Darling Test Statistic	0.278	95% Bootstrap-t UCL	0.0626
725	Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	0.0626
726	Kolmogorov-Smirnov Test Statistic	0.101	95% Percentile Bootstrap UCL	0.0623
727	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0622
728	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0715

		97.5% Chebyshev(Mean, Sd) UCL	0.0779
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0905
95% Approximate Gamma UCL	0.0633		
95% Adjusted Gamma UCL	0.0639		
Potential UCL to Use		Use 95% Student's-t UCL	0.0625

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Crab_TCDD TEQ(D/F) - bird TEFs

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	21
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0308	Minimum of Log Data	-3.481
Maximum	0.0981	Maximum of Log Data	-2.322
Mean	0.067	Mean of log Data	-2.734
Median	0.0681	SD of log Data	0.265
SD	0.0158		
Std. Error of Mean	0.00336		
Coefficient of Variation	0.235		
Skewness	-0.351		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.919
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0727	95% H-UCL	0.0747
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0839
95% Adjusted-CLT UCL (Chen-1995)	0.0722	97.5% Chebyshev (MVUE) UCL	0.0911
95% Modified-t UCL (Johnson-1978)	0.0727	99% Chebyshev (MVUE) UCL	0.105
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	14.28	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00469		
MLE of Mean	0.067		
MLE of Standard Deviation	0.0177		
nu star	628.4		
Approximate Chi Square Value (.05)	571.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.0725
Adjusted Chi Square Value	567.1	95% Jackknife UCL	0.0727
		95% Standard Bootstrap UCL	0.0724
Anderson-Darling Test Statistic	0.433	95% Bootstrap-t UCL	0.0724
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	0.0727
Kolmogorov-Smirnov Test Statistic	0.147	95% Percentile Bootstrap UCL	0.0723
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0718
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0816
		97.5% Chebyshev(Mean, Sd) UCL	0.0879
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.1

Row	A–E	F	G–K	L
785	95% Approximate Gamma UCL	0.0737		
786	95% Adjusted Gamma UCL	0.0742		
787				
788	**Potential UCL to Use**		Use 95% Student's-t UCL	0.0727
789				
790	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
791	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
792	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
793				
794	**Note: For highly negative-skewed data, confidence limits**			
795	**(e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
796	**reliable. Chen's and Johnson's methods provide**			
797	**adjustments for positvely skewed data sets.**			
798				
799				
800	**Biota_Crab_TCDD TEQ(D/F) - fish TEFs**			
801				
802	**General Statistics**			
803	Number of Valid Observations	22	Number of Distinct Observations	21
804				
805	**Raw Statistics**		**Log-transformed Statistics**	
806	Minimum	0.0262	Minimum of Log Data	-3.643
807	Maximum	0.0903	Maximum of Log Data	-2.405
808	Mean	0.0572	Mean of log Data	-2.902
809	Median	0.0575	SD of log Data	0.304
810	SD	0.0159		
811	Std. Error of Mean	0.0034		
812	Coefficient of Variation	0.279		
813	Skewness	0.0374		
814				
815	**Relevant UCL Statistics**			
816	**Normal Distribution Test**		**Lognormal Distribution Test**	
817	Shapiro Wilk Test Statistic	0.983	Shapiro Wilk Test Statistic	0.95
818	Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
819	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
820				
821	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
822	95% Student's-t UCL	0.0631	95% H-UCL	0.065
823	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0738
824	95% Adjusted-CLT UCL (Chen-1995)	0.0628	97.5% Chebyshev (MVUE) UCL	0.0809
825	95% Modified-t UCL (Johnson-1978)	0.0631	99% Chebyshev (MVUE) UCL	0.0949
826				
827	**Gamma Distribution Test**		**Data Distribution**	
828	k star (bias corrected)	10.67	**Data appear Normal at 5% Significance Level**	
829	Theta Star	0.00536		
830	MLE of Mean	0.0572		
831	MLE of Standard Deviation	0.0175		
832	nu star	469.7		
833	Approximate Chi Square Value (.05)	420.4	**Nonparametric Statistics**	
834	Adjusted Level of Significance	0.0386	95% CLT UCL	0.0628
835	Adjusted Chi Square Value	417	95% Jackknife UCL	0.0631
836			95% Standard Bootstrap UCL	0.0626
837	Anderson-Darling Test Statistic	0.288	95% Bootstrap-t UCL	0.0633
838	Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	0.063
839	Kolmogorov-Smirnov Test Statistic	0.1	95% Percentile Bootstrap UCL	0.0625
840	Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.0625

	A	B	C	D	E	F	G	H	I	J	K	L	M
841	**Data appear Gamma Distributed at 5% Significance Level**						95% Chebyshev(Mean, Sd) UCL					0.072	
842							97.5% Chebyshev(Mean, Sd) UCL					0.0784	
843	**Assuming Gamma Distribution**						99% Chebyshev(Mean, Sd) UCL					0.091	
844	95% Approximate Gamma UCL					0.0639							
845	95% Adjusted Gamma UCL					0.0644							
846													
847	**Potential UCL to Use**						Use 95% Student's-t UCL					0.0631	
848													
849	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**												
850	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**												
851	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**												
852													

	A	B	C	D	E	F	G	H	I	J	K	L
1				General UCL Statistics for Full Data Sets								
2			User Selected Options									
3			From File	WorkSheet.wst								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	Biota_Fish_COPPER											
10												
11							General Statistics					
12					Number of Valid Observations	36					Number of Distinct Observations	34
13												
14			Raw Statistics						Log-transformed Statistics			
15					Minimum	404.7					Minimum of Log Data	6.003
16					Maximum	50900					Maximum of Log Data	10.84
17					Mean	4632					Mean of log Data	7.412
18					Median	855					SD of log Data	1.281
19					SD	9585						
20					Std. Error of Mean	1597						
21					Coefficient of Variation	2.069						
22					Skewness	3.86						
23												
24							Relevant UCL Statistics					
25			Normal Distribution Test						Lognormal Distribution Test			
26					Shapiro Wilk Test Statistic	0.48					Shapiro Wilk Test Statistic	0.815
27					Shapiro Wilk Critical Value	0.935					Shapiro Wilk Critical Value	0.935
28			Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level			
29												
30			Assuming Normal Distribution						Assuming Lognormal Distribution			
31					95% Student's-t UCL	7331					95% H-UCL	6773
32			95% UCLs (Adjusted for Skewness)								95% Chebyshev (MVUE) UCL	7760
33					95% Adjusted-CLT UCL (Chen-1995)	8358					97.5% Chebyshev (MVUE) UCL	9554
34					95% Modified-t UCL (Johnson-1978)	7503					99% Chebyshev (MVUE) UCL	13078
35												
36			Gamma Distribution Test						Data Distribution			
37					k star (bias corrected)	0.569			Data do not follow a Discernable Distribution (0.05)			
38					Theta Star	8145						
39					MLE of Mean	4632						
40					MLE of Standard Deviation	6143						
41					nu star	40.95						
42					Approximate Chi Square Value (.05)	27.28			Nonparametric Statistics			
43					Adjusted Level of Significance	0.0428					95% CLT UCL	7260
44					Adjusted Chi Square Value	26.78					95% Jackknife UCL	7331
45											95% Standard Bootstrap UCL	7241
46					Anderson-Darling Test Statistic	3.875					95% Bootstrap-t UCL	11010
47					Anderson-Darling 5% Critical Value	0.803					95% Hall's Bootstrap UCL	18623
48					Kolmogorov-Smirnov Test Statistic	0.321					95% Percentile Bootstrap UCL	7577
49					Kolmogorov-Smirnov 5% Critical Value	0.154					95% BCA Bootstrap UCL	8440
50			Data not Gamma Distributed at 5% Significance Level								95% Chebyshev(Mean, Sd) UCL	11596
51											97.5% Chebyshev(Mean, Sd) UCL	14609
52			Assuming Gamma Distribution								99% Chebyshev(Mean, Sd) UCL	20527
53					95% Approximate Gamma UCL	6952						
54					95% Adjusted Gamma UCL	7084						
55												
56			Potential UCL to Use								Use 95% Chebyshev (Mean, Sd) UCL	11596

	A–E	F	G–K	L
57				
58	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
59	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
60	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
61				
62				
63	**Biota_Fish_LEAD**			
64				
65	**General Statistics**			
66	Number of Valid Observations	29	Number of Distinct Observations	25
67				
68	**Raw Statistics**		**Log-transformed Statistics**	
69	Minimum	51.85	Minimum of Log Data	3.948
70	Maximum	2170	Maximum of Log Data	7.683
71	Mean	410.6	Mean of log Data	5.797
72	Median	310	SD of log Data	0.648
73	SD	373.3		
74	Std. Error of Mean	69.32		
75	Coefficient of Variation	0.909		
76	Skewness	3.956		
77				
78	**Relevant UCL Statistics**			
79	**Normal Distribution Test**		**Lognormal Distribution Test**	
80	Shapiro Wilk Test Statistic	0.582	Shapiro Wilk Test Statistic	0.938
81	Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
82	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
83				
84	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
85	95% Student's-t UCL	528.6	95% H-UCL	524
86	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	628.9
87	95% Adjusted-CLT UCL (Chen-1995)	579.1	97.5% Chebyshev (MVUE) UCL	726.8
88	95% Modified-t UCL (Johnson-1978)	537.1	99% Chebyshev (MVUE) UCL	919
89				
90	**Gamma Distribution Test**		**Data Distribution**	
91	k star (bias corrected)	2.191	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
92	Theta Star	187.4		
93	MLE of Mean	410.6		
94	MLE of Standard Deviation	277.4		
95	nu star	127.1		
96	Approximate Chi Square Value (.05)	102	**Nonparametric Statistics**	
97	Adjusted Level of Significance	0.0407	95% CLT UCL	524.7
98	Adjusted Chi Square Value	100.7	95% Jackknife UCL	528.6
99			95% Standard Bootstrap UCL	522
100	Anderson-Darling Test Statistic	0.976	95% Bootstrap-t UCL	658.7
101	Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	1011
102	Kolmogorov-Smirnov Test Statistic	0.149	95% Percentile Bootstrap UCL	537.6
103	Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	599.9
104	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	712.8
105			97.5% Chebyshev(Mean, Sd) UCL	843.5
106	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	1100
107	95% Approximate Gamma UCL	511.4		
108	95% Adjusted Gamma UCL	518.2		
109				
110	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	511.4
111				
112	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_MERCURY

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	31
Raw Statistics		**Log-transformed Statistics**	
Minimum	46	Minimum of Log Data	3.829
Maximum	630.9	Maximum of Log Data	6.447
Mean	194.8	Mean of log Data	5.031
Median	160	SD of log Data	0.726
SD	137.7		
Std. Error of Mean	22.96		
Coefficient of Variation	0.707		
Skewness	1.333		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.88	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	233.6	95% H-UCL	257.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	311
95% Adjusted-CLT UCL (Chen-1995)	238	97.5% Chebyshev (MVUE) UCL	360.2
95% Modified-t UCL (Johnson-1978)	234.5	99% Chebyshev (MVUE) UCL	456.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.056	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	94.77		
MLE of Mean	194.8		
MLE of Standard Deviation	135.9		
nu star	148		
Approximate Chi Square Value (.05)	120.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	232.6
Adjusted Chi Square Value	119.8	95% Jackknife UCL	233.6
		95% Standard Bootstrap UCL	231.8
Anderson-Darling Test Statistic	0.31	95% Bootstrap-t UCL	244.9
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	239.7
Kolmogorov-Smirnov Test Statistic	0.0775	95% Percentile Bootstrap UCL	234.1
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	234.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	294.9
		97.5% Chebyshev(Mean, Sd) UCL	338.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	423.3
95% Approximate Gamma UCL	238.5		
95% Adjusted Gamma UCL	240.7		
Potential UCL to Use		Use 95% Approximate Gamma UCL	238.5

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

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_Methyl Mercury

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	33
Raw Statistics		**Log-transformed Statistics**	
Minimum	39	Minimum of Log Data	3.664
Maximum	534.8	Maximum of Log Data	6.282
Mean	184.2	Mean of log Data	4.956
Median	145.4	SD of log Data	0.764
SD	129.4		
Std. Error of Mean	21.56		
Coefficient of Variation	0.702		
Skewness	0.973		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	220.6	95% H-UCL	250.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	303.2
95% Adjusted-CLT UCL (Chen-1995)	223.4	97.5% Chebyshev (MVUE) UCL	352.9
95% Modified-t UCL (Johnson-1978)	221.2	99% Chebyshev (MVUE) UCL	450.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.922	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	95.83		
MLE of Mean	184.2		
MLE of Standard Deviation	132.9		
nu star	138.4		
Approximate Chi Square Value (.05)	112.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	219.6
Adjusted Chi Square Value	111.1	95% Jackknife UCL	220.6
		95% Standard Bootstrap UCL	218
Anderson-Darling Test Statistic	0.373	95% Bootstrap-t UCL	225.7
Anderson-Darling 5% Critical Value	0.759	95% Hall's Bootstrap UCL	221.8
Kolmogorov-Smirnov Test Statistic	0.09	95% Percentile Bootstrap UCL	220.5
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	224.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	278.2
		97.5% Chebyshev(Mean, Sd) UCL	318.8
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	398.7
95% Approximate Gamma UCL	227.2		
95% Adjusted Gamma UCL	229.3		
Potential UCL to Use		Use 95% Approximate Gamma UCL	227.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_ LMW PAHs

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	35
Raw Statistics		Log-transformed Statistics	
Minimum	42.46	Minimum of Log Data	3.749
Maximum	368.9	Maximum of Log Data	5.911
Mean	199.1	Mean of log Data	5.137
Median	206.4	SD of log Data	0.615
SD	99.15		
Std. Error of Mean	16.53		
Coefficient of Variation	0.498		
Skewness	0.057		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk Test Statistic	0.91
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	227	95% H-UCL	253.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	301.9
95% Adjusted-CLT UCL (Chen-1995)	226.4	97.5% Chebyshev (MVUE) UCL	344.1
95% Modified-t UCL (Johnson-1978)	227	99% Chebyshev (MVUE) UCL	427.1
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.084	Data appear Normal at 5% Significance Level	
Theta Star	64.55		
MLE of Mean	199.1		
MLE of Standard Deviation	113.4		
nu star	222		
Approximate Chi Square Value (.05)	188.5	Nonparametric Statistics	
Adjusted Level of Significance	0.0428	95% CLT UCL	226.2
Adjusted Chi Square Value	187.1	95% Jackknife UCL	227
		95% Standard Bootstrap UCL	225.5
Anderson-Darling Test Statistic	0.717	95% Bootstrap-t UCL	227.4
Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	226
Kolmogorov-Smirnov Test Statistic	0.144	95% Percentile Bootstrap UCL	225
Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	228.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	271.1
		97.5% Chebyshev(Mean, Sd) UCL	302.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	363.5
95% Approximate Gamma UCL	234.4		
95% Adjusted Gamma UCL	236.2		
Potential UCL to Use		Use 95% Student's-t UCL	227
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
Biota_Fish_ HMW PAHs			
General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	36

Raw Statistics		**Log-transformed Statistics**	
Minimum	7.45	Minimum of Log Data	2.008
Maximum	453	Maximum of Log Data	6.116
Mean	101.8	Mean of log Data	4.308
Median	83.7	SD of log Data	0.824
SD	91.83		
Std. Error of Mean	15.31		
Coefficient of Variation	0.902		
Skewness	2.339		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.98
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	127.7	95% H-UCL	141.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	171.9
95% Adjusted-CLT UCL (Chen-1995)	133.4	97.5% Chebyshev (MVUE) UCL	201.6
95% Modified-t UCL (Johnson-1978)	128.7	99% Chebyshev (MVUE) UCL	260.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.609	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	63.26		
MLE of Mean	101.8		
MLE of Standard Deviation	80.25		
nu star	115.9		
Approximate Chi Square Value (.05)	92.02	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	127
Adjusted Chi Square Value	91.05	95% Jackknife UCL	127.7
		95% Standard Bootstrap UCL	126.5
Anderson-Darling Test Statistic	0.507	95% Bootstrap-t UCL	140
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	145.5
Kolmogorov-Smirnov Test Statistic	0.129	95% Percentile Bootstrap UCL	127.9
Kolmogorov-Smirnov 5% Critical Value	0.149	95% BCA Bootstrap UCL	132.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	168.5
		97.5% Chebyshev(Mean, Sd) UCL	197.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	254.1
95% Approximate Gamma UCL	128.2		
95% Adjusted Gamma UCL	129.5		
Potential UCL to Use		Use 95% Approximate Gamma UCL	128.2
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
Biota_Fish_Dieldrin			
General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	33
Raw Statistics		**Log-transformed Statistics**	

Minimum	7.178	Minimum of Log Data	1.971
Maximum	88	Maximum of Log Data	4.477
Mean	32.18	Mean of log Data	3.309
Median	30.11	SD of log Data	0.596
SD	18.42		
Std. Error of Mean	3.069		
Coefficient of Variation	0.572		
Skewness	1.09		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.921	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	37.36	95% H-UCL	39.93
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	47.49
95% Adjusted-CLT UCL (Chen-1995)	37.82	97.5% Chebyshev (MVUE) UCL	53.98
95% Modified-t UCL (Johnson-1978)	37.46	99% Chebyshev (MVUE) UCL	66.72
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.995	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	10.74		
MLE of Mean	32.18		
MLE of Standard Deviation	18.59		
nu star	215.6		
Approximate Chi Square Value (.05)	182.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	37.23
Adjusted Chi Square Value	181.3	95% Jackknife UCL	37.36
		95% Standard Bootstrap UCL	37.27
Anderson-Darling Test Statistic	0.21	95% Bootstrap-t UCL	38.13
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	38.09
Kolmogorov-Smirnov Test Statistic	0.0973	95% Percentile Bootstrap UCL	37.3
Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	37.35
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	45.56
		97.5% Chebyshev(Mean, Sd) UCL	51.34
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	62.72
95% Approximate Gamma UCL	37.99		
95% Adjusted Gamma UCL	38.28		
Potential UCL to Use		Use 95% Approximate Gamma UCL	37.99

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_Total DDx

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	35
Raw Statistics		**Log-transformed Statistics**	
Minimum	131.5	Minimum of Log Data	4.879
Maximum	923	Maximum of Log Data	6.828
Mean	276.4	Mean of log Data	5.513
Median	233.8	SD of log Data	0.451

	A	B	C	D	E	F	G	H	I	J	K	L
393					SD	150.8						
394					Std. Error of Mean	25.13						
395					Coefficient of Variation	0.546						
396					Skewness	2.4						
397												
398	**Relevant UCL Statistics**											
399	**Normal Distribution Test**						**Lognormal Distribution Test**					
400					Shapiro Wilk Test Statistic	0.785					Shapiro Wilk Test Statistic	0.944
401					Shapiro Wilk Critical Value	0.935					Shapiro Wilk Critical Value	0.935
402	**Data not Normal at 5% Significance Level**						**Data appear Lognormal at 5% Significance Level**					
403												
404	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
405					95% Student's-t UCL	318.9					95% H-UCL	316.8
406	**95% UCLs (Adjusted for Skewness)**										95% Chebyshev (MVUE) UCL	367
407					95% Adjusted-CLT UCL (Chen-1995)	328.5					97.5% Chebyshev (MVUE) UCL	407.3
408					95% Modified-t UCL (Johnson-1978)	320.6					99% Chebyshev (MVUE) UCL	486.5
409												
410	**Gamma Distribution Test**						**Data Distribution**					
411					k star (bias corrected)	4.39	**Data appear Gamma Distributed at 5% Significance Level**					
412					Theta Star	62.97						
413					MLE of Mean	276.4						
414					MLE of Standard Deviation	131.9						
415					nu star	316.1						
416					Approximate Chi Square Value (.05)	275.9	**Nonparametric Statistics**					
417					Adjusted Level of Significance	0.0428					95% CLT UCL	317.8
418					Adjusted Chi Square Value	274.2					95% Jackknife UCL	318.9
419											95% Standard Bootstrap UCL	317.7
420					Anderson-Darling Test Statistic	0.704					95% Bootstrap-t UCL	333.8
421					Anderson-Darling 5% Critical Value	0.751					95% Hall's Bootstrap UCL	366
422					Kolmogorov-Smirnov Test Statistic	0.125					95% Percentile Bootstrap UCL	319.8
423					Kolmogorov-Smirnov 5% Critical Value	0.147					95% BCA Bootstrap UCL	330.2
424	**Data appear Gamma Distributed at 5% Significance Level**										95% Chebyshev(Mean, Sd) UCL	386
425											97.5% Chebyshev(Mean, Sd) UCL	433.4
426	**Assuming Gamma Distribution**										99% Chebyshev(Mean, Sd) UCL	526.5
427					95% Approximate Gamma UCL	316.7						
428					95% Adjusted Gamma UCL	318.6						
429												
430	**Potential UCL to Use**										Use 95% Approximate Gamma UCL	316.7
431												
432	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
433	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
434	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
435												
436	Biota_Fish_Total PCBs											
437												
438	**General Statistics**											
439					Number of Valid Observations	36					Number of Distinct Observations	35
440												
441	**Raw Statistics**						**Log-transformed Statistics**					
442					Minimum	630.2					Minimum of Log Data	6.446
443					Maximum	7861					Maximum of Log Data	8.97
444					Mean	2583					Mean of log Data	7.715
445					Median	2255					SD of log Data	0.537
446					SD	1498						
447					Std. Error of Mean	249.6						
448					Coefficient of Variation	0.58						

Skewness	1.684		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.861	Shapiro Wilk Test Statistic	0.991
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3004	95% H-UCL	3087
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3637
95% Adjusted-CLT UCL (Chen-1995)	3068	97.5% Chebyshev (MVUE) UCL	4095
95% Modified-t UCL (Johnson-1978)	3016	99% Chebyshev (MVUE) UCL	4995
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.404	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	758.7		
MLE of Mean	2583		
MLE of Standard Deviation	1400		
nu star	245.1		
Approximate Chi Square Value (.05)	209.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	2993
Adjusted Chi Square Value	208.4	95% Jackknife UCL	3004
		95% Standard Bootstrap UCL	2979
Anderson-Darling Test Statistic	0.347	95% Bootstrap-t UCL	3108
Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	3159
Kolmogorov-Smirnov Test Statistic	0.11	95% Percentile Bootstrap UCL	3008
Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	3072
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3671
		97.5% Chebyshev(Mean, Sd) UCL	4142
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	5066
95% Approximate Gamma UCL	3016		
95% Adjusted Gamma UCL	3038		
Potential UCL to Use		Use 95% Approximate Gamma UCL	3016
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
Biota_Fish_TCDD TEQ(PCBS) - mammal TEFs			
General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	34
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00251	Minimum of Log Data	-5.988
Maximum	0.0871	Maximum of Log Data	-2.44
Mean	0.0268	Mean of log Data	-3.853
Median	0.0228	SD of log Data	0.737
SD	0.019		
Std. Error of Mean	0.00316		
Coefficient of Variation	0.708		
Skewness	1.766		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.836	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0321	95% H-UCL	0.0362
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0437
95% Adjusted-CLT UCL (Chen-1995)	0.033	97.5% Chebyshev (MVUE) UCL	0.0507
95% Modified-t UCL (Johnson-1978)	0.0323	99% Chebyshev (MVUE) UCL	0.0644
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.12	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0126		
MLE of Mean	0.0268		
MLE of Standard Deviation	0.0184		
nu star	152.7		
Approximate Chi Square Value (.05)	125.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	0.032
Adjusted Chi Square Value	124	95% Jackknife UCL	0.0321
		95% Standard Bootstrap UCL	0.032
Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL	0.0336
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	0.0352
Kolmogorov-Smirnov Test Statistic	0.12	95% Percentile Bootstrap UCL	0.0321
Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	0.033
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0406
		97.5% Chebyshev(Mean, Sd) UCL	0.0465
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0583
95% Approximate Gamma UCL	0.0327		
95% Adjusted Gamma UCL	0.033		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0327

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_TCDD TEQ(PCBS) - bird TEFs

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	36
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00522	Minimum of Log Data	-5.255
Maximum	0.403	Maximum of Log Data	-0.91
Mean	0.125	Mean of log Data	-2.601
Median	0.102	SD of log Data	1.205
SD	0.103		
Std. Error of Mean	0.0172		
Coefficient of Variation	0.826		
Skewness	0.664		

Relevant UCL Statistics

Row	A–E	F	G–K	L
561	**Normal Distribution Test**		**Lognormal Distribution Test**	
562	Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.906
563	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
564	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
565				
566	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
567	95% Student's-t UCL	0.154	95% H-UCL	0.262
568	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.306
569	95% Adjusted-CLT UCL (Chen-1995)	0.155	97.5% Chebyshev (MVUE) UCL	0.375
570	95% Modified-t UCL (Johnson-1978)	0.154	99% Chebyshev (MVUE) UCL	0.509
571				
572	**Gamma Distribution Test**		**Data Distribution**	
573	k star (bias corrected)	1.026	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
574	Theta Star	0.122		
575	MLE of Mean	0.125		
576	MLE of Standard Deviation	0.123		
577	nu star	73.89		
578	Approximate Chi Square Value (.05)	55.1	**Nonparametric Statistics**	
579	Adjusted Level of Significance	0.0428	95% CLT UCL	0.153
580	Adjusted Chi Square Value	54.36	95% Jackknife UCL	0.154
581			95% Standard Bootstrap UCL	0.152
582	Anderson-Darling Test Statistic	0.793	95% Bootstrap-t UCL	0.157
583	Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	0.155
584	Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	0.154
585	Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.152
586	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.2
587			97.5% Chebyshev(Mean, Sd) UCL	0.232
588	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.296
589	95% Approximate Gamma UCL	0.167		
590	95% Adjusted Gamma UCL	0.17		
591				
592	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.167
593				
594	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
595	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
596	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
597				
598				
599	**Biota_Fish_TCDD TEQ(PCBS) - fish TEFs**			
600				
601	**General Statistics**			
602	Number of Valid Observations	36	Number of Distinct Observations	36
603				
604	**Raw Statistics**		**Log-transformed Statistics**	
605	Minimum	0.0003849	Minimum of Log Data	-7.863
606	Maximum	0.00654	Maximum of Log Data	-5.03
607	Mean	0.00222	Mean of log Data	-6.264
608	Median	0.00198	SD of log Data	0.574
609	SD	0.00133		
610	Std. Error of Mean	0.0002213		
611	Coefficient of Variation	0.598		
612	Skewness	1.813		
613				
614	**Relevant UCL Statistics**			
615	**Normal Distribution Test**		**Lognormal Distribution Test**	
616	Shapiro Wilk Test Statistic	0.834	Shapiro Wilk Test Statistic	0.969

	A–E	F	G–K	L
617	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
618	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
619				
620	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
621	95% Student's-t UCL	0.00259	95% H-UCL	0.00272
622	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.00322
623	95% Adjusted-CLT UCL (Chen-1995)	0.00266	97.5% Chebyshev (MVUE) UCL	0.00365
624	95% Modified-t UCL (Johnson-1978)	0.00261	99% Chebyshev (MVUE) UCL	0.00449
625				
626	**Gamma Distribution Test**		**Data Distribution**	
627	k star (bias corrected)	3.145	**Data appear Gamma Distributed at 5% Significance Level**	
628	Theta Star	0.0007061		
629	MLE of Mean	0.00222		
630	MLE of Standard Deviation	0.00125		
631	nu star	226.5		
632	Approximate Chi Square Value (.05)	192.6	**Nonparametric Statistics**	
633	Adjusted Level of Significance	0.0428	95% CLT UCL	0.00258
634	Adjusted Chi Square Value	191.2	95% Jackknife UCL	0.00259
635			95% Standard Bootstrap UCL	0.00258
636	Anderson-Darling Test Statistic	0.473	95% Bootstrap-t UCL	0.0027
637	Anderson-Darling 5% Critical Value	0.753	95% Hall's Bootstrap UCL	0.00282
638	Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	0.0026
639	Kolmogorov-Smirnov 5% Critical Value	0.148	95% BCA Bootstrap UCL	0.00265
640	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.00319
641			97.5% Chebyshev(Mean, Sd) UCL	0.0036
642	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.00442
643	95% Approximate Gamma UCL	0.00261		
644	95% Adjusted Gamma UCL	0.00263		
645				
646	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.00261
647				
648	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
649	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
650	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
651				
652				
653				
654	**Biota_Fish_TCDD TEQ(D/F) - mammal TEFs**			
655				
656	**General Statistics**			
657	Number of Valid Observations	36	Number of Distinct Observations	34
658				
659	**Raw Statistics**		**Log-transformed Statistics**	
660	Minimum	0.00595	Minimum of Log Data	-5.125
661	Maximum	1.426	Maximum of Log Data	0.355
662	Mean	0.184	Mean of log Data	-2.264
663	Median	0.166	SD of log Data	1.155
664	SD	0.245		
665	Std. Error of Mean	0.0408		
666	Coefficient of Variation	1.33		
667	Skewness	3.991		
668				
669	**Relevant UCL Statistics**			
670	**Normal Distribution Test**		**Lognormal Distribution Test**	
671	Shapiro Wilk Test Statistic	0.587	Shapiro Wilk Test Statistic	0.952
672	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935

	A	B	C	D	E	F	G	H	I	J	K	L
673	Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level					
674												
675	Assuming Normal Distribution						Assuming Lognormal Distribution					
676	95% Student's-t UCL					0.253	95% H-UCL					0.334
677	95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL					0.395
678	95% Adjusted-CLT UCL (Chen-1995)					0.28	97.5% Chebyshev (MVUE) UCL					0.481
679	95% Modified-t UCL (Johnson-1978)					0.258	99% Chebyshev (MVUE) UCL					0.649
680												
681	Gamma Distribution Test						Data Distribution					
682	k star (bias corrected)					0.942	Data Follow Appr. Gamma Distribution at 5% Significance Level					
683	Theta Star					0.196						
684	MLE of Mean					0.184						
685	MLE of Standard Deviation					0.19						
686	nu star					67.8						
687	Approximate Chi Square Value (.05)					49.85	Nonparametric Statistics					
688	Adjusted Level of Significance					0.0428	95% CLT UCL					0.251
689	Adjusted Chi Square Value					49.15	95% Jackknife UCL					0.253
690							95% Standard Bootstrap UCL					0.25
691	Anderson-Darling Test Statistic					0.788	95% Bootstrap-t UCL					0.316
692	Anderson-Darling 5% Critical Value					0.776	95% Hall's Bootstrap UCL					0.553
693	Kolmogorov-Smirnov Test Statistic					0.122	95% Percentile Bootstrap UCL					0.257
694	Kolmogorov-Smirnov 5% Critical Value					0.151	95% BCA Bootstrap UCL					0.29
695	Data follow Appr. Gamma Distribution at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL					0.362
696							97.5% Chebyshev(Mean, Sd) UCL					0.439
697	Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL					0.591
698	95% Approximate Gamma UCL					0.251						
699	95% Adjusted Gamma UCL					0.254						
700												
701	Potential UCL to Use						Use 95% Approximate Gamma UCL					0.251
702												

703	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
704	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
705	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			
706				
707				
708	Biota_Fish_TCDD TEQ(D/F) - bird TEFs			
709				
710	**General Statistics**			
711	Number of Valid Observations	36	Number of Distinct Observations	34
712				
713	**Raw Statistics**		**Log-transformed Statistics**	
714	Minimum	0.00586	Minimum of Log Data	-5.139
715	Maximum	1.447	Maximum of Log Data	0.369
716	Mean	0.193	Mean of log Data	-2.216
717	Median	0.175	SD of log Data	1.169
718	SD	0.249		
719	Std. Error of Mean	0.0415		
720	Coefficient of Variation	1.291		
721	Skewness	3.917		
722				
723	**Relevant UCL Statistics**			
724	**Normal Distribution Test**		**Lognormal Distribution Test**	
725	Shapiro Wilk Test Statistic	0.599	Shapiro Wilk Test Statistic	0.944
726	Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
727	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
728				
729	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
730	95% Student's-t UCL	0.263	95% H-UCL	0.359
731	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.424
732	95% Adjusted-CLT UCL (Chen-1995)	0.29	97.5% Chebyshev (MVUE) UCL	0.516
733	95% Modified-t UCL (Johnson-1978)	0.267	99% Chebyshev (MVUE) UCL	0.698
734				
735	**Gamma Distribution Test**		**Data Distribution**	
736	k star (bias corrected)	0.946	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
737	Theta Star	0.204		
738	MLE of Mean	0.193		
739	MLE of Standard Deviation	0.198		
740	nu star	68.12		
741	Approximate Chi Square Value (.05)	50.13	**Nonparametric Statistics**	
742	Adjusted Level of Significance	0.0428	95% CLT UCL	0.261
743	Adjusted Chi Square Value	49.42	95% Jackknife UCL	0.263
744			95% Standard Bootstrap UCL	0.259
745	Anderson-Darling Test Statistic	0.844	95% Bootstrap-t UCL	0.335
746	Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	0.569
747	Kolmogorov-Smirnov Test Statistic	0.127	95% Percentile Bootstrap UCL	0.264
748	Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.29
749	**Data follow Appr. Gamma Distribution at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.373
750			97.5% Chebyshev(Mean, Sd) UCL	0.452
751	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.605
752	95% Approximate Gamma UCL	0.262		
753	95% Adjusted Gamma UCL	0.266		
754				
755	**Potential UCL to Use**		Use 95% Approximate Gamma UCL	0.262
756				
757	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
758	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			

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

Biota_Fish_TCDD TEQ(D/F) - fish TEFs

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	36
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.00586	Minimum of Log Data	-5.14
Maximum	1.431	Maximum of Log Data	0.359
Mean	0.185	Mean of log Data	-2.258
Median	0.167	SD of log Data	1.158
SD	0.246		
Std. Error of Mean	0.041		
Coefficient of Variation	1.327		
Skewness	3.98		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.589	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.255	95% H-UCL	0.338
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.399
95% Adjusted-CLT UCL (Chen-1995)	0.282	97.5% Chebyshev (MVUE) UCL	0.486
95% Modified-t UCL (Johnson-1978)	0.259	99% Chebyshev (MVUE) UCL	0.656
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.941	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	0.197		
MLE of Mean	0.185		
MLE of Standard Deviation	0.191		
nu star	67.72		
Approximate Chi Square Value (.05)	49.78	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	0.253
Adjusted Chi Square Value	49.08	95% Jackknife UCL	0.255
		95% Standard Bootstrap UCL	0.253
Anderson-Darling Test Statistic	0.784	95% Bootstrap-t UCL	0.322
Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	0.551
Kolmogorov-Smirnov Test Statistic	0.121	95% Percentile Bootstrap UCL	0.267
Kolmogorov-Smirnov 5% Critical Value	0.151	95% BCA Bootstrap UCL	0.289
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.364
		97.5% Chebyshev(Mean, Sd) UCL	0.442
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.593
95% Approximate Gamma UCL	0.252		
95% Adjusted Gamma UCL	0.256		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.252

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Biota_Fish_ Lipids

General Statistics			
Number of Valid Observations	36	Number of Distinct Observations	34
Raw Statistics		**Log-transformed Statistics**	
Minimum	2.093	Minimum of Log Data	0.739
Maximum	18	Maximum of Log Data	2.89
Mean	5.549	Mean of log Data	1.595
Median	4.7	SD of log Data	0.478
SD	3.098		
Std. Error of Mean	0.516		
Coefficient of Variation	0.558		
Skewness	2.15		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.82	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.421	95% H-UCL	6.439
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.5
95% Adjusted-CLT UCL (Chen-1995)	6.596	97.5% Chebyshev (MVUE) UCL	8.363
95% Modified-t UCL (Johnson-1978)	6.452	99% Chebyshev (MVUE) UCL	10.06
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.028	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.378		
MLE of Mean	5.549		
MLE of Standard Deviation	2.765		
nu star	290		
Approximate Chi Square Value (.05)	251.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	6.398
Adjusted Chi Square Value	249.9	95% Jackknife UCL	6.421
		95% Standard Bootstrap UCL	6.383
Anderson-Darling Test Statistic	0.433	95% Bootstrap-t UCL	6.717
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL	7.021
Kolmogorov-Smirnov Test Statistic	0.106	95% Percentile Bootstrap UCL	6.427
Kolmogorov-Smirnov 5% Critical Value	0.147	95% BCA Bootstrap UCL	6.64
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7.8
		97.5% Chebyshev(Mean, Sd) UCL	8.774
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.69
95% Approximate Gamma UCL	6.397		
95% Adjusted Gamma UCL	6.438		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6.397

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	A	B	C	D	E	F	G	H	I	J	K	L
1				General UCL Statistics for Full Data Sets								
2			User Selected Options									
3			From File	WorkSheet.wst								
4			Full Precision	OFF								
5			Confidence Coefficient	95%								
6			Number of Bootstrap Operations	2000								
7												
8												
9	Sediment_Mudflats_Copper											
10												
11						General Statistics						
12					Number of Valid Observations	21					Number of Distinct Observations	20
13												
14			Raw Statistics						Log-transformed Statistics			
15					Minimum	36600					Minimum of Log Data	10.51
16					Maximum	577000					Maximum of Log Data	13.27
17					Mean	184781					Mean of log Data	11.96
18					Median	147000					SD of log Data	0.578
19					SD	126035						
20					Std. Error of Mean	27503						
21					Coefficient of Variation	0.682						
22					Skewness	2.143						
23												
24						Relevant UCL Statistics						
25			Normal Distribution Test						Lognormal Distribution Test			
26					Shapiro Wilk Test Statistic	0.743					Shapiro Wilk Test Statistic	0.926
27					Shapiro Wilk Critical Value	0.908					Shapiro Wilk Critical Value	0.908
28			Data not Normal at 5% Significance Level						Data appear Lognormal at 5% Significance Level			
29												
30			Assuming Normal Distribution						Assuming Lognormal Distribution			
31					95% Student's-t UCL	232216					95% H-UCL	241255
32			95% UCLs (Adjusted for Skewness)								95% Chebyshev (MVUE) UCL	288754
33					95% Adjusted-CLT UCL (Chen-1995)	243762					97.5% Chebyshev (MVUE) UCL	334463
34					95% Modified-t UCL (Johnson-1978)	234359					99% Chebyshev (MVUE) UCL	424250
35												
36			Gamma Distribution Test						Data Distribution			
37					k star (bias corrected)	2.732			Data appear Lognormal at 5% Significance Level			
38					Theta Star	67639						
39					MLE of Mean	184781						
40					MLE of Standard Deviation	111796						
41					nu star	114.7						
42					Approximate Chi Square Value (.05)	91.01			Nonparametric Statistics			
43					Adjusted Level of Significance	0.0383					95% CLT UCL	230019
44					Adjusted Chi Square Value	89.39					95% Jackknife UCL	232216
45											95% Standard Bootstrap UCL	229221
46					Anderson-Darling Test Statistic	0.987					95% Bootstrap-t UCL	276183
47					Anderson-Darling 5% Critical Value	0.749					95% Hall's Bootstrap UCL	466071
48					Kolmogorov-Smirnov Test Statistic	0.201					95% Percentile Bootstrap UCL	229924
49					Kolmogorov-Smirnov 5% Critical Value	0.191					95% BCA Bootstrap UCL	244395
50			Data not Gamma Distributed at 5% Significance Level								95% Chebyshev(Mean, Sd) UCL	304664

	A–E	F	G–K	L
51			97.5% Chebyshev(Mean, Sd) UCL	356537
52	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	458432
53	95% Approximate Gamma UCL	232960		
54	95% Adjusted Gamma UCL	237189		
55				
56	**Potential UCL to Use**		Use 95% H-UCL	241255
57				
58	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
59	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
60	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
61	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
62				
63	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
64	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
65	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
66	**Sediment_Mudflats_Lead**			
67				
68	**General Statistics**			
69	Number of Valid Observations	17	Number of Distinct Observations	17
70				
71	**Raw Statistics**		**Log-transformed Statistics**	
72	Minimum	114000	Minimum of Log Data	11.64
73	Maximum	763000	Maximum of Log Data	13.55
74	Mean	254471	Mean of log Data	12.34
75	Median	211000	SD of log Data	0.434
76	SD	148306		
77	Std. Error of Mean	35969		
78	Coefficient of Variation	0.583		
79	Skewness	2.789		
80				
81	**Relevant UCL Statistics**			
82	**Normal Distribution Test**		**Lognormal Distribution Test**	
83	Shapiro Wilk Test Statistic	0.681	Shapiro Wilk Test Statistic	0.904
84	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
85	**Data not Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
86				
87	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
88	95% Student's-t UCL	317269	95% H-UCL	311903
89	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	368077
90	95% Adjusted-CLT UCL (Chen-1995)	339636	97.5% Chebyshev (MVUE) UCL	419021
91	95% Modified-t UCL (Johnson-1978)	321325	99% Chebyshev (MVUE) UCL	519091
92				
93	**Gamma Distribution Test**		**Data Distribution**	
94	k star (bias corrected)	4.112	**Data appear Lognormal at 5% Significance Level**	
95	Theta Star	61886		
96	MLE of Mean	254471		
97	MLE of Standard Deviation	125492		
98	nu star	139.8		
99	Approximate Chi Square Value (.05)	113.5	**Nonparametric Statistics**	
100	Adjusted Level of Significance	0.0346	95% CLT UCL	313635

	A–F		G–L	
101	Adjusted Chi Square Value	111	95% Jackknife UCL	317269
102			95% Standard Bootstrap UCL	310620
103	Anderson-Darling Test Statistic	0.976	95% Bootstrap-t UCL	384836
104	Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	555827
105	Kolmogorov-Smirnov Test Statistic	0.245	95% Percentile Bootstrap UCL	318294
106	Kolmogorov-Smirnov 5% Critical Value	0.21	95% BCA Bootstrap UCL	341529
107	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	411258
108			97.5% Chebyshev(Mean, Sd) UCL	479100
109	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	612362
110	95% Approximate Gamma UCL	313493		
111	95% Adjusted Gamma UCL	320507		
112				
113	**Potential UCL to Use**		Use 95% Student's-t UCL	317269
114			or 95% Modified-t UCL	321325
115			or 95% H-UCL	311903
116				
117	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
118	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
119	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
120	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
121				
122	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
123	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
124	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
125				
126	**Sediment_Mudflats_Mercury**			
127				
128	**General Statistics**			
129	Number of Valid Observations	17	Number of Distinct Observations	13
130				
131	**Raw Statistics**		**Log-transformed Statistics**	
132	Minimum	652	Minimum of Log Data	6.48
133	Maximum	13400	Maximum of Log Data	9.503
134	Mean	2802	Mean of log Data	7.705
135	Median	2100	SD of log Data	0.62
136	SD	2842		
137	Std. Error of Mean	689.4		
138	Coefficient of Variation	1.014		
139	Skewness	3.613		
140				
141	**Relevant UCL Statistics**			
142	**Normal Distribution Test**		**Lognormal Distribution Test**	
143	Shapiro Wilk Test Statistic	0.51	Shapiro Wilk Test Statistic	0.863
144	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
145	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
146				
147	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
148	95% Student's-t UCL	4006	95% H-UCL	3762
149	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	4481
150	95% Adjusted-CLT UCL (Chen-1995)	4582	97.5% Chebyshev (MVUE) UCL	5270

	A–E	F	G–K	L
151	95% Modified-t UCL (Johnson-1978)	4107	99% Chebyshev (MVUE) UCL	6822
152				
153	**Gamma Distribution Test**		**Data Distribution**	
154	k star (bias corrected)	1.934	**Data do not follow a Discernable Distribution (0.05)**	
155	Theta Star	1449		
156	MLE of Mean	2802		
157	MLE of Standard Deviation	2015		
158	nu star	65.74		
159	Approximate Chi Square Value (.05)	48.08	**Nonparametric Statistics**	
160	Adjusted Level of Significance	0.0346	95% CLT UCL	3936
161	Adjusted Chi Square Value	46.5	95% Jackknife UCL	4006
162			95% Standard Bootstrap UCL	3894
163	Anderson-Darling Test Statistic	1.56	95% Bootstrap-t UCL	6994
164	Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	9535
165	Kolmogorov-Smirnov Test Statistic	0.316	95% Percentile Bootstrap UCL	4076
166	Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	4824
167	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	5808
168			97.5% Chebyshev(Mean, Sd) UCL	7108
169	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	9662
170	95% Approximate Gamma UCL	3832		
171	95% Adjusted Gamma UCL	3962		
172				
173	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	5808
174				
175	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
176	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
177	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
178				
179	**Sediment_Mudflats_ Methylmercury**			
180				
181	**General Statistics**			
182	Number of Valid Observations	14	Number of Distinct Observations	14
183				
184	**Raw Statistics**		**Log-transformed Statistics**	
185	Minimum	2.4	Minimum of Log Data	0.875
186	Maximum	11.5	Maximum of Log Data	2.442
187	Mean	5.296	Mean of log Data	1.576
188	Median	4.62	SD of log Data	0.434
189	SD	2.481		
190	Std. Error of Mean	0.663		
191	Coefficient of Variation	0.468		
192	Skewness	1.3		
193				
194	**Relevant UCL Statistics**			
195	**Normal Distribution Test**		**Lognormal Distribution Test**	
196	Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.979
197	Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
198	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
199				
200	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	

	A–E	F	G–K	L
201	95% Student's-t UCL	6.47	95% H-UCL	6.758
202	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	7.998
203	95% Adjusted-CLT UCL (Chen-1995)	6.632	97.5% Chebyshev (MVUE) UCL	9.176
204	95% Modified-t UCL (Johnson-1978)	6.508	99% Chebyshev (MVUE) UCL	11.49
205				
206	**Gamma Distribution Test**		**Data Distribution**	
207	k star (bias corrected)	4.508	**Data appear Normal at 5% Significance Level**	
208	Theta Star	1.175		
209	MLE of Mean	5.296		
210	MLE of Standard Deviation	2.494		
211	nu star	126.2		
212	Approximate Chi Square Value (.05)	101.3	**Nonparametric Statistics**	
213	Adjusted Level of Significance	0.0312	95% CLT UCL	6.386
214	Adjusted Chi Square Value	98.31	95% Jackknife UCL	6.47
215			95% Standard Bootstrap UCL	6.341
216	Anderson-Darling Test Statistic	0.259	95% Bootstrap-t UCL	7.079
217	Anderson-Darling 5% Critical Value	0.738	95% Hall's Bootstrap UCL	6.998
218	Kolmogorov-Smirnov Test Statistic	0.121	95% Percentile Bootstrap UCL	6.379
219	Kolmogorov-Smirnov 5% Critical Value	0.229	95% BCA Bootstrap UCL	6.507
220	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	8.186
221			97.5% Chebyshev(Mean, Sd) UCL	9.437
222	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	11.89
223	95% Approximate Gamma UCL	6.6		
224	95% Adjusted Gamma UCL	6.799		
225				
226	**Potential UCL to Use**		Use 95% Student's-t UCL	6.47
227				
228	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
229	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
230	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
231				
232	**Sediment_Mudflats_LWM PAHs**			
233				
234	**General Statistics**			
235	Number of Valid Observations	17	Number of Distinct Observations	17
236				
237	**Raw Statistics**		**Log-transformed Statistics**	
238	Minimum	865	Minimum of Log Data	6.763
239	Maximum	12900	Maximum of Log Data	9.465
240	Mean	4830	Mean of log Data	8.298
241	Median	4400	SD of log Data	0.68
242	SD	2891		
243	Std. Error of Mean	701.1		
244	Coefficient of Variation	0.598		
245	Skewness	1.335		
246				
247	**Relevant UCL Statistics**			
248	**Normal Distribution Test**		**Lognormal Distribution Test**	
249	Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.906
250	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6054	95% H-UCL	7391
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8755
95% Adjusted-CLT UCL (Chen-1995)	6226	97.5% Chebyshev (MVUE) UCL	10391
95% Modified-t UCL (Johnson-1978)	6092	99% Chebyshev (MVUE) UCL	13603
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.393	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	2019		
MLE of Mean	4830		
MLE of Standard Deviation	3123		
nu star	81.36		
Approximate Chi Square Value (.05)	61.58	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	5984
Adjusted Chi Square Value	59.77	95% Jackknife UCL	6054
		95% Standard Bootstrap UCL	5964
Anderson-Darling Test Statistic	0.521	95% Bootstrap-t UCL	6484
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	7282
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL	5967
Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	6164
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7886
		97.5% Chebyshev(Mean, Sd) UCL	9209
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11806
95% Approximate Gamma UCL	6383		
95% Adjusted Gamma UCL	6575		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6383

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflats_ HWM PAHs

General Statistics			
Number of Valid Observations	17	Number of Distinct Observations	17
Raw Statistics		**Log-transformed Statistics**	
Minimum	5828	Minimum of Log Data	8.67
Maximum	52350	Maximum of Log Data	10.87
Mean	26200	Mean of log Data	10.05
Median	25580	SD of log Data	0.57
SD	11364		
Std. Error of Mean	2756		
Coefficient of Variation	0.434		
Skewness	0.185		

	A	B	C	D	E	F	G	H	I	J	K	L
301	Relevant UCL Statistics											
302	Normal Distribution Test						Lognormal Distribution Test					
303	Shapiro Wilk Test Statistic					0.945	Shapiro Wilk Test Statistic					0.837
304	Shapiro Wilk Critical Value					0.892	Shapiro Wilk Critical Value					0.892
305	Data appear Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
306												
307	Assuming Normal Distribution						Assuming Lognormal Distribution					
308	95% Student's-t UCL					31012	95% H-UCL					36856
309	95% UCLs (Adjusted for Skewness)						95% Chebyshev (MVUE) UCL					43951
310	95% Adjusted-CLT UCL (Chen-1995)					30866	97.5% Chebyshev (MVUE) UCL					51289
311	95% Modified-t UCL (Johnson-1978)					31033	99% Chebyshev (MVUE) UCL					65704
312												
313	Gamma Distribution Test						Data Distribution					
314	k star (bias corrected)					3.545	Data appear Normal at 5% Significance Level					
315	Theta Star					7391						
316	MLE of Mean					26200						
317	MLE of Standard Deviation					13916						
318	nu star					120.5						
319	Approximate Chi Square Value (.05)					96.17	Nonparametric Statistics					
320	Adjusted Level of Significance					0.0346	95% CLT UCL					30734
321	Adjusted Chi Square Value					93.89	95% Jackknife UCL					31012
322							95% Standard Bootstrap UCL					30580
323	Anderson-Darling Test Statistic					0.87	95% Bootstrap-t UCL					30913
324	Anderson-Darling 5% Critical Value					0.742	95% Hall's Bootstrap UCL					31240
325	Kolmogorov-Smirnov Test Statistic					0.28	95% Percentile Bootstrap UCL					30833
326	Kolmogorov-Smirnov 5% Critical Value					0.21	95% BCA Bootstrap UCL					30685
327	Data not Gamma Distributed at 5% Significance Level						95% Chebyshev(Mean, Sd) UCL					38214
328							97.5% Chebyshev(Mean, Sd) UCL					43413
329	Assuming Gamma Distribution						99% Chebyshev(Mean, Sd) UCL					53624
330	95% Approximate Gamma UCL					32834						
331	95% Adjusted Gamma UCL					33631						
332												
333	Potential UCL to Use						Use 95% Student's-t UCL					31012
334												
335	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
336	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
337	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.											
338												
339	Sediment_Mudflats_Dieldrin											
340												
341	General Statistics											
342	Number of Valid Observations					17	Number of Distinct Observations					15
343												
344	Raw Statistics						Log-transformed Statistics					
345	Minimum					0.75	Minimum of Log Data					-0.288
346	Maximum					130	Maximum of Log Data					4.868
347	Mean					11.06	Mean of log Data					1.4
348	Median					3.83	SD of log Data					1.031
349	SD					30.68						
350	Std. Error of Mean					7.441						

Row	A–E	F	G–K	L
351	Coefficient of Variation	2.773		
352	Skewness	4.108		
353				
354	**Relevant UCL Statistics**			
355	**Normal Distribution Test**		**Lognormal Distribution Test**	
356	Shapiro Wilk Test Statistic	0.303	Shapiro Wilk Test Statistic	0.731
357	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
358	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
359				
360	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
361	95% Student's-t UCL	24.06	95% H-UCL	13.89
362	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	14.58
363	95% Adjusted-CLT UCL (Chen-1995)	31.23	97.5% Chebyshev (MVUE) UCL	18.03
364	95% Modified-t UCL (Johnson-1978)	25.29	99% Chebyshev (MVUE) UCL	24.81
365				
366	**Gamma Distribution Test**		**Data Distribution**	
367	k star (bias corrected)	0.544	**Data do not follow a Discernable Distribution (0.05)**	
368	Theta Star	20.33		
369	MLE of Mean	11.06		
370	MLE of Standard Deviation	15		
371	nu star	18.51		
372	Approximate Chi Square Value (.05)	9.758	**Nonparametric Statistics**	
373	Adjusted Level of Significance	0.0346	95% CLT UCL	23.3
374	Adjusted Chi Square Value	9.097	95% Jackknife UCL	24.06
375			95% Standard Bootstrap UCL	22.51
376	Anderson-Darling Test Statistic	3.492	95% Bootstrap-t UCL	201.7
377	Anderson-Darling 5% Critical Value	0.788	95% Hall's Bootstrap UCL	115.4
378	Kolmogorov-Smirnov Test Statistic	0.45	95% Percentile Bootstrap UCL	25.92
379	Kolmogorov-Smirnov 5% Critical Value	0.219	95% BCA Bootstrap UCL	33.66
380	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	43.5
381			97.5% Chebyshev(Mean, Sd) UCL	57.54
382	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	85.11
383	95% Approximate Gamma UCL	20.98		
384	95% Adjusted Gamma UCL	22.51		
385				
386	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	43.5
387				
388	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
389	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
390	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
391				
392	**Sediment_Mudflats_Total DDx**			
393				
394	**General Statistics**			
395	Number of Valid Observations	17	Number of Distinct Observations	16
396				
397	**Raw Statistics**		**Log-transformed Statistics**	
398	Minimum	31.1	Minimum of Log Data	3.437
399	Maximum	817	Maximum of Log Data	6.706
400	Mean	110.2	Mean of log Data	4.254

	A	B	C	D	E	F	G	H	I	J	K	L
401					Median	62					SD of log Data	0.753
402					SD	184.7						
403					Std. Error of Mean	44.81						
404					Coefficient of Variation	1.676						
405					Skewness	3.937						
406												
407						**Relevant UCL Statistics**						
408			**Normal Distribution Test**						**Lognormal Distribution Test**			
409					Shapiro Wilk Test Statistic	0.395					Shapiro Wilk Test Statistic	0.769
410					Shapiro Wilk Critical Value	0.892					Shapiro Wilk Critical Value	0.892
411			**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**			
412												
413			**Assuming Normal Distribution**						**Assuming Lognormal Distribution**			
414					95% Student's-t UCL	188.4					95% H-UCL	144.4
415			**95% UCLs (Adjusted for Skewness)**								95% Chebyshev (MVUE) UCL	169.3
416					95% Adjusted-CLT UCL (Chen-1995)	229.6					97.5% Chebyshev (MVUE) UCL	203
417					95% Modified-t UCL (Johnson-1978)	195.6					99% Chebyshev (MVUE) UCL	269.1
418												
419			**Gamma Distribution Test**						**Data Distribution**			
420					k star (bias corrected)	1.073			**Data do not follow a Discernable Distribution (0.05)**			
421					Theta Star	102.7						
422					MLE of Mean	110.2						
423					MLE of Standard Deviation	106.4						
424					nu star	36.48						
425					Approximate Chi Square Value (.05)	23.66			**Nonparametric Statistics**			
426					Adjusted Level of Significance	0.0346					95% CLT UCL	183.9
427					Adjusted Chi Square Value	22.58					95% Jackknife UCL	188.4
428											95% Standard Bootstrap UCL	181.6
429					Anderson-Darling Test Statistic	2.424					95% Bootstrap-t UCL	588.2
430					Anderson-Darling 5% Critical Value	0.761					95% Hall's Bootstrap UCL	454.5
431					Kolmogorov-Smirnov Test Statistic	0.337					95% Percentile Bootstrap UCL	195.8
432					Kolmogorov-Smirnov 5% Critical Value	0.214					95% BCA Bootstrap UCL	246.8
433			**Data not Gamma Distributed at 5% Significance Level**								95% Chebyshev(Mean, Sd) UCL	305.5
434											97.5% Chebyshev(Mean, Sd) UCL	390
435			**Assuming Gamma Distribution**								99% Chebyshev(Mean, Sd) UCL	556
436					95% Approximate Gamma UCL	169.9						
437					95% Adjusted Gamma UCL	178.1						
438												
439			**Potential UCL to Use**								Use 95% Chebyshev (Mean, Sd) UCL	305.5
440												
441						**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**						
442						**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**						
443						**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**						
444												
445												
446												
447	**Sediment_Mudflats_ Total PCBs**											
448												
449						**General Statistics**						
450					Number of Valid Observations	17					Number of Distinct Observations	17

	A	B	C	D	E	F	G	H	I	J	K	L
451												
452	Raw Statistics						Log-transformed Statistics					
453					Minimum	357.4					Minimum of Log Data	5.879
454					Maximum	18922					Maximum of Log Data	9.848
455					Mean	1918					Mean of log Data	6.862
456					Median	905.6					SD of log Data	0.871
457					SD	4393						
458					Std. Error of Mean	1065						
459					Coefficient of Variation	2.29						
460					Skewness	4.088						
461												
462	Relevant UCL Statistics											
463	Normal Distribution Test						Lognormal Distribution Test					
464					Shapiro Wilk Test Statistic	0.325					Shapiro Wilk Test Statistic	0.718
465					Shapiro Wilk Critical Value	0.892					Shapiro Wilk Critical Value	0.892
466	Data not Normal at 5% Significance Level						Data not Lognormal at 5% Significance Level					
467												
468	Assuming Normal Distribution						Assuming Lognormal Distribution					
469					95% Student's-t UCL	3778					95% H-UCL	2388
470	95% UCLs (Adjusted for Skewness)										95% Chebyshev (MVUE) UCL	2710
471					95% Adjusted-CLT UCL (Chen-1995)	4799					97.5% Chebyshev (MVUE) UCL	3296
472					95% Modified-t UCL (Johnson-1978)	3954					99% Chebyshev (MVUE) UCL	4448
473												
474	Gamma Distribution Test						Data Distribution					
475					k star (bias corrected)	0.735	Data do not follow a Discernable Distribution (0.05)					
476					Theta Star	2608						
477					MLE of Mean	1918						
478					MLE of Standard Deviation	2237						
479					nu star	25						
480					Approximate Chi Square Value (.05)	14.61	Nonparametric Statistics					
481					Adjusted Level of Significance	0.0346					95% CLT UCL	3671
482					Adjusted Chi Square Value	13.79					95% Jackknife UCL	3778
483											95% Standard Bootstrap UCL	3615
484					Anderson-Darling Test Statistic	3.141					95% Bootstrap-t UCL	19795
485					Anderson-Darling 5% Critical Value	0.772					95% Hall's Bootstrap UCL	13936
486					Kolmogorov-Smirnov Test Statistic	0.397					95% Percentile Bootstrap UCL	4044
487					Kolmogorov-Smirnov 5% Critical Value	0.216					95% BCA Bootstrap UCL	5233
488	Data not Gamma Distributed at 5% Significance Level										95% Chebyshev(Mean, Sd) UCL	6562
489											97.5% Chebyshev(Mean, Sd) UCL	8572
490	Assuming Gamma Distribution										99% Chebyshev(Mean, Sd) UCL	12519
491					95% Approximate Gamma UCL	3282						
492					95% Adjusted Gamma UCL	3479						
493												
494	Potential UCL to Use										Use 95% Chebyshev (Mean, Sd) UCL	6562
495												
496	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
497	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
498	and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.											
499												
500	Sediment_Mudflats_TCDD TEQ(PCBs) - mammal TEFs											

	A–E	F	G–K	L
501				
502	**General Statistics**			
503	Number of Valid Observations	17	Number of Distinct Observations	17
504				
505	**Raw Statistics**		**Log-transformed Statistics**	
506	Minimum	0.0005367	Minimum of Log Data	-7.53
507	Maximum	0.23	Maximum of Log Data	-1.47
508	Mean	0.0277	Mean of log Data	-4.207
509	Median	0.0169	SD of log Data	1.108
510	SD	0.0524		
511	Std. Error of Mean	0.0127		
512	Coefficient of Variation	1.891		
513	Skewness	4.045		
514				
515	**Relevant UCL Statistics**			
516	**Normal Distribution Test**		**Lognormal Distribution Test**	
517	Shapiro Wilk Test Statistic	0.357	Shapiro Wilk Test Statistic	0.713
518	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
519	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
520				
521	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
522	95% Student's-t UCL	0.0499	95% H-UCL	0.0603
523	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	0.0603
524	95% Adjusted-CLT UCL (Chen-1995)	0.0619	97.5% Chebyshev (MVUE) UCL	0.0751
525	95% Modified-t UCL (Johnson-1978)	0.052	99% Chebyshev (MVUE) UCL	0.104
526				
527	**Gamma Distribution Test**		**Data Distribution**	
528	k star (bias corrected)	0.811	**Data do not follow a Discernable Distribution (0.05)**	
529	Theta Star	0.0342		
530	MLE of Mean	0.0277		
531	MLE of Standard Deviation	0.0308		
532	nu star	27.57		
533	Approximate Chi Square Value (.05)	16.6	**Nonparametric Statistics**	
534	Adjusted Level of Significance	0.0346	95% CLT UCL	0.0486
535	Adjusted Chi Square Value	15.71	95% Jackknife UCL	0.0499
536			95% Standard Bootstrap UCL	0.0475
537	Anderson-Darling Test Statistic	2.613	95% Bootstrap-t UCL	0.187
538	Anderson-Darling 5% Critical Value	0.769	95% Hall's Bootstrap UCL	0.176
539	Kolmogorov-Smirnov Test Statistic	0.349	95% Percentile Bootstrap UCL	0.0527
540	Kolmogorov-Smirnov 5% Critical Value	0.216	95% BCA Bootstrap UCL	0.0658
541	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	0.0831
542			97.5% Chebyshev(Mean, Sd) UCL	0.107
543	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.154
544	95% Approximate Gamma UCL	0.046		
545	95% Adjusted Gamma UCL	0.0486		
546				
547	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	0.0831
548	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
549	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
550				

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

Sediment_Mudflats_TCDD TEQ(PCBs) - bird TEFs

General Statistics			
Number of Valid Observations	17	Number of Distinct Observations	17
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.041	Minimum of Log Data	-3.193
Maximum	3.619	Maximum of Log Data	1.286
Mean	0.431	Mean of log Data	-1.399
Median	0.252	SD of log Data	0.865
SD	0.826		
Std. Error of Mean	0.2		
Coefficient of Variation	1.919		
Skewness	4.047		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.358	Shapiro Wilk Test Statistic	0.794
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.78	95% H-UCL	0.61
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.694
95% Adjusted-CLT UCL (Chen-1995)	0.97	97.5% Chebyshev (MVUE) UCL	0.844
95% Modified-t UCL (Johnson-1978)	0.813	99% Chebyshev (MVUE) UCL	1.138
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.891	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.483		
MLE of Mean	0.431		
MLE of Standard Deviation	0.456		
nu star	30.28		
Approximate Chi Square Value (.05)	18.72	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	0.76
Adjusted Chi Square Value	17.77	95% Jackknife UCL	0.78
		95% Standard Bootstrap UCL	0.747
Anderson-Darling Test Statistic	2.542	95% Bootstrap-t UCL	2.773
Anderson-Darling 5% Critical Value	0.765	95% Hall's Bootstrap UCL	2.519
Kolmogorov-Smirnov Test Statistic	0.372	95% Percentile Bootstrap UCL	0.828
Kolmogorov-Smirnov 5% Critical Value	0.215	95% BCA Bootstrap UCL	1.034
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.304
		97.5% Chebyshev(Mean, Sd) UCL	1.682
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2.424
95% Approximate Gamma UCL	0.697		
95% Adjusted Gamma UCL	0.734		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.304

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflat_TCDD TEQ(PCBs) - fish TEFs

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	17
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0001585	Minimum of Log Data	-8.749
Maximum	0.0184	Maximum of Log Data	-3.997
Mean	0.00231	Mean of log Data	-6.587
Median	0.0014	SD of log Data	0.882
SD	0.00416		
Std. Error of Mean	0.00101		
Coefficient of Variation	1.8		
Skewness	4.04		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.361	Shapiro Wilk Test Statistic	0.763
Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.00408	95% H-UCL	0.00352
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.00397
95% Adjusted-CLT UCL (Chen-1995)	0.00503	97.5% Chebyshev (MVUE) UCL	0.00484
95% Modified-t UCL (Johnson-1978)	0.00424	99% Chebyshev (MVUE) UCL	0.00654
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.947	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.00244		
MLE of Mean	0.00231		
MLE of Standard Deviation	0.00238		
nu star	32.21		
Approximate Chi Square Value (.05)	20.24	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	0.00397
Adjusted Chi Square Value	19.25	95% Jackknife UCL	0.00408
		95% Standard Bootstrap UCL	0.00391
Anderson-Darling Test Statistic	2.616	95% Bootstrap-t UCL	0.0138
Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	0.0133
Kolmogorov-Smirnov Test Statistic	0.381	95% Percentile Bootstrap UCL	0.0043
Kolmogorov-Smirnov 5% Critical Value	0.215	95% BCA Bootstrap UCL	0.00534
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.00671
		97.5% Chebyshev(Mean, Sd) UCL	0.00862

	A-F	F	G-K	L
651	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	0.0124
652	95% Approximate Gamma UCL	0.00368		
653	95% Adjusted Gamma UCL	0.00387		
654				
655	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	0.00671
656				
657	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
658	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
659	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
660				
661		**General UCL Statistics for Full Data Sets**		
662	**User Selected Options**			
663	From File	ProUCL input_a.wst		
664	Full Precision	OFF		
665	Confidence Coefficient	95%		
666	Number of Bootstrap Operations	2000		
667				
668	**Sediment_Mudflats_ TCDD TEQ(D/F) - mammal TEFs**			
669				
670		**General Statistics**		
671	Number of Valid Observations	17	Number of Distinct Observations	15
672				
673	**Raw Statistics**		**Log-transformed Statistics**	
674	Minimum	0.0683	Minimum of Log Data	-2.683
675	Maximum	13.63	Maximum of Log Data	2.613
676	2_	1.221	Mean of log Data	-0.876
677	Median	0.369	SD of log Data	1.166
678	SD	3.222		
679	Std. Error of Mean	0.781		
680	Coefficient of Variation	2.639		
681	Skewness	4.028		
682				
683		**Relevant UCL Statistics**		
684	**Normal Distribution Test**		**Lognormal Distribution Test**	
685	Shapiro Wilk Test Statistic	0.347	Shapiro Wilk Test Statistic	0.847
686	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
687	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
688				
689	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
690	95% Student's-t UCL	2.585	95% H-UCL	1.928
691	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.848
692	95% Adjusted-CLT UCL (Chen-1995)	3.322	97.5% Chebyshev (MVUE) UCL	2.313
693	95% Modified-t UCL (Johnson-1978)	2.712	99% Chebyshev (MVUE) UCL	3.227
694				
695	**Gamma Distribution Test**		**Data Distribution**	
696	k star (bias corrected)	0.515	**Data do not follow a Discernable Distribution (0.05)**	
697	Theta Star	2.37		
698	MLE of Mean	1.221		
699	MLE of Standard Deviation	1.701		
700	nu star	17.51		

	A	B	C	D	E	F	G	H	I	J	K	L
701			Approximate Chi Square Value (.05)			9.039			Nonparametric Statistics			
702			Adjusted Level of Significance			0.0346					95% CLT UCL	2.506
703			Adjusted Chi Square Value			8.406					95% Jackknife UCL	2.585
704											95% Standard Bootstrap UCL	2.469
705			Anderson-Darling Test Statistic			2.545					95% Bootstrap-t UCL	10.83
706			Anderson-Darling 5% Critical Value			0.791					95% Hall's Bootstrap UCL	9.423
707			Kolmogorov-Smirnov Test Statistic			0.375					95% Percentile Bootstrap UCL	2.771
708			Kolmogorov-Smirnov 5% Critical Value			0.22					95% BCA Bootstrap UCL	3.558
709	**Data not Gamma Distributed at 5% Significance Level**										95% Chebyshev(Mean, Sd) UCL	4.627
710											97.5% Chebyshev(Mean, Sd) UCL	6.1
711	**Assuming Gamma Distribution**										99% Chebyshev(Mean, Sd) UCL	8.995
712			95% Approximate Gamma UCL			2.365						
713			95% Adjusted Gamma UCL			2.543						
714												
715	**Potential UCL to Use**										Use 95% Chebyshev (Mean, Sd) UCL	4.627
716												
717	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**											
718	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**											
719	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**											
720												
721												
722	**Sediment_Mudflats_TCDD TEQ(D/F) - bird TEFs**											
723												
724	**General Statistics**											
725			Number of Valid Observations			17					Number of Distinct Observations	16
726												
727	**Raw Statistics**						**Log-transformed Statistics**					
728					Minimum	0.074					Minimum of Log Data	-2.604
729					Maximum	13.77					Maximum of Log Data	2.622
730					Mean	1.265					Mean of log Data	-0.779
731					Median	0.408					SD of log Data	1.139
732					SD	3.246						
733					Std. Error of Mean	0.787						
734					Coefficient of Variation	2.567						
735					Skewness	4.026						
736												
737	**Relevant UCL Statistics**											
738	**Normal Distribution Test**						**Lognormal Distribution Test**					
739			Shapiro Wilk Test Statistic			0.35					Shapiro Wilk Test Statistic	0.85
740			Shapiro Wilk Critical Value			0.892					Shapiro Wilk Critical Value	0.892
741	**Data not Normal at 5% Significance Level**						**Data not Lognormal at 5% Significance Level**					
742												
743	**Assuming Normal Distribution**						**Assuming Lognormal Distribution**					
744					95% Student's-t UCL	2.639					95% H-UCL	1.995
745	**95% UCLs (Adjusted for Skewness)**										95% Chebyshev (MVUE) UCL	1.951
746			95% Adjusted-CLT UCL (Chen-1995)			3.381					97.5% Chebyshev (MVUE) UCL	2.437
747			95% Modified-t UCL (Johnson-1978)			2.767					99% Chebyshev (MVUE) UCL	3.391
748												
749	**Gamma Distribution Test**						**Data Distribution**					
750					k star (bias corrected)	0.54	**Data do not follow a Discernable Distribution (0.05)**					

	A–E	F	G–K	L
751	Theta Star	2.341		
752	MLE of Mean	1.265		
753	MLE of Standard Deviation	1.721		
754	nu star	18.37		
755	Approximate Chi Square Value (.05)	9.657	**Nonparametric Statistics**	
756	Adjusted Level of Significance	0.0346	95% CLT UCL	2.56
757	Adjusted Chi Square Value	9	95% Jackknife UCL	2.639
758			95% Standard Bootstrap UCL	2.509
759	Anderson-Darling Test Statistic	2.498	95% Bootstrap-t UCL	10.79
760	Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	8.907
761	Kolmogorov-Smirnov Test Statistic	0.375	95% Percentile Bootstrap UCL	2.809
762	Kolmogorov-Smirnov 5% Critical Value	0.219	95% BCA Bootstrap UCL	3.667
763	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	4.696
764			97.5% Chebyshev(Mean, Sd) UCL	6.181
765	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	9.098
766	95% Approximate Gamma UCL	2.405		
767	95% Adjusted Gamma UCL	2.581		
768				
769	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	4.696
770				
771	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
772	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
773	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
774				
775				
776	**Sediment_Mudflats_TCDD TEQ(D/F) - fish TEFs**			
777				
778	**General Statistics**			
779	Number of Valid Observations	17	Number of Distinct Observations	16
780				
781	**Raw Statistics**		**Log-transformed Statistics**	
782	Minimum	0.0677	Minimum of Log Data	-2.693
783	Maximum	13.63	Maximum of Log Data	2.613
784	Mean	1.22	Mean of log Data	-0.878
785	Median	0.367	SD of log Data	1.167
786	SD	3.222		
787	Std. Error of Mean	0.781		
788	Coefficient of Variation	2.641		
789	Skewness	4.029		
790				
791	**Relevant UCL Statistics**			
792	**Normal Distribution Test**		**Lognormal Distribution Test**	
793	Shapiro Wilk Test Statistic	0.347	Shapiro Wilk Test Statistic	0.847
794	Shapiro Wilk Critical Value	0.892	Shapiro Wilk Critical Value	0.892
795	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
796				
797	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
798	95% Student's-t UCL	2.584	95% H-UCL	1.929
799	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	1.848
800	95% Adjusted-CLT UCL (Chen-1995)	3.321	97.5% Chebyshev (MVUE) UCL	2.313

95% Modified-t UCL (Johnson-1978)	2.711	99% Chebyshev (MVUE) UCL	3.227
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.515	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2.371		
MLE of Mean	1.22		
MLE of Standard Deviation	1.701		
nu star	17.5		
Approximate Chi Square Value (.05)	9.027	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	2.505
Adjusted Chi Square Value	8.395	95% Jackknife UCL	2.584
		95% Standard Bootstrap UCL	2.43
Anderson-Darling Test Statistic	2.546	95% Bootstrap-t UCL	10.73
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	9.139
Kolmogorov-Smirnov Test Statistic	0.376	95% Percentile Bootstrap UCL	2.734
Kolmogorov-Smirnov 5% Critical Value	0.22	95% BCA Bootstrap UCL	3.576
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.626
		97.5% Chebyshev(Mean, Sd) UCL	6.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8.995
95% Approximate Gamma UCL	2.364		
95% Adjusted Gamma UCL	2.542		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	4.626

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sediment_Mudflats_TOC

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.77	Minimum of Log Data	1.327
Maximum	7.63	Maximum of Log Data	2.032
Mean	5.096	Mean of log Data	1.599
Median	4.59	SD of log Data	0.264
SD	1.487		
Std. Error of Mean	0.665		
Coefficient of Variation	0.292		
Skewness	1.718		

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Row	A–F	F	G–K	L
851	Warning: There are only 5 Values in this data			
852	Note: It should be noted that even though bootstrap methods may be performed on this data set,			
853	the resulting calculations may not be reliable enough to draw conclusions			
854				
855	The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.			
856				
857	**Relevant UCL Statistics**			
858	**Normal Distribution Test**		**Lognormal Distribution Test**	
859	Shapiro Wilk Test Statistic	0.826	Shapiro Wilk Test Statistic	0.89
860	Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
861	**Data appear Normal at 5% Significance Level**		**Data appear Lognormal at 5% Significance Level**	
862				
863	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
864	95% Student's-t UCL	6.514	95% H-UCL	6.958
865	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	7.694
866	95% Adjusted-CLT UCL (Chen-1995)	6.736	97.5% Chebyshev (MVUE) UCL	8.822
867	95% Modified-t UCL (Johnson-1978)	6.599	99% Chebyshev (MVUE) UCL	11.04
868				
869	**Gamma Distribution Test**		**Data Distribution**	
870	k star (bias corrected)	6.926	**Data appear Normal at 5% Significance Level**	
871	Theta Star	0.736		
872	MLE of Mean	5.096		
873	MLE of Standard Deviation	1.936		
874	nu star	69.26		
875	Approximate Chi Square Value (.05)	51.1	**Nonparametric Statistics**	
876	Adjusted Level of Significance	0.0086	95% CLT UCL	6.19
877	Adjusted Chi Square Value	44.36	95% Jackknife UCL	6.514
878			95% Standard Bootstrap UCL	6.082
879	Anderson-Darling Test Statistic	0.466	95% Bootstrap-t UCL	8.218
880	Anderson-Darling 5% Critical Value	0.679	95% Hall's Bootstrap UCL	11.99
881	Kolmogorov-Smirnov Test Statistic	0.289	95% Percentile Bootstrap UCL	6.07
882	Kolmogorov-Smirnov 5% Critical Value	0.357	95% BCA Bootstrap UCL	6.414
883	**Data appear Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	7.995
884			97.5% Chebyshev(Mean, Sd) UCL	9.249
885	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	11.71
886	95% Approximate Gamma UCL	6.907		
887	95% Adjusted Gamma UCL	7.957		
888				
889	**Potential UCL to Use**		Use 95% Student's-t UCL	6.514
890				
891	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
892	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
893	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			

ATTACHMENT 4

HUMAN HEALTH RISK: CURRENT CONDITIONS

Attachment 4

TABLE 4-1 (RAGS PT. D TABLE 3.1 RME)

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

Lower Passaic River

Scenario Timeframe: Current
Medium: Fish
Exposure Medium: Fish

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Fish	TCDD-TEQ (D/F)	mg/kg	0.0000624	0.000101 (Log)	0.000576	0.000101	mg/kg	95% BCA Bootstrap	(2)
	TCDD-TEQ (PCBs)	mg/kg	0.000012	0.000016 (Log)	0.00007	0.000016	mg/gkg	95% BCA Bootstrap	(2)
	Total PCBs	mg/kg	1.22	1.7 (Log)	5.60	1.7	mg/kg	95% BCA Bootstrap	(2)
	4,4'-DDD	mg/kg	0.058	0.069 (NA)	0.32	0.069	mg/kg	95% KM(BCA)	Nonparametric
	4,4'-DDE	mg/kg	0.099	0.12 (Gamma)	0.42	0.12	mg/kg	95% Approximate Gamma	Gamma
	4,4'-DDT	mg/kg	0.0046	0.0045 (NA)	0.014	0.0045	mg/kg	95% KM(t)	Nonparametric
	Total Chlordane	mg/kg	0.044	0.062 (Log)	0.28	0.062	mg/kg	95% BCA Bootstrap	(2)
	Dieldrin	mg/kg	0.019	0.025 (Gamma)	0.10	0.025	mg/kg	95% Approximate Gamma	Gamma
	Methyl mercury	mg/kg	0.30	0.36 (Gamma)	0.83	0.36	mg/kg	95% Approximate Gamma	Gamma

(1) NA - distribution not determined; Log - lognormal distribution; Gamma - gamma distribution.

(2) ProUCL recommended the H-UCL statistic for the lognormal distribution of these data; however, per Table 9 of the ProUCL Technical Guidance, an alternative UCL was used instead based on the standard deviation and sample number.

TABLE 4-2 (RAGS PT. D TABLE 3.1 RME)
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current
Medium: Crab
Exposure Medium: Crab

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Crab	TCDD TEQ (D/F)	mg/kg	0.000067	0.000075 (Normal)	0.00012	0.000075	mg/kg	95% Student's t	Normal
	TCDD TEQ (PCBs)	mg/kg	0.000010	0.000011 (Normal)	0.000017	0.000011	mg/kg	95% Student's t	Normal
	Total PCBs	mg/kg	0.32	0.37 (Normal)	0.69	0.37	mg/kg	95% Student's t	Normal
	4,4'-DDD	mg/kg	0.021	0.022 (Gamma, Log)	0.036	0.022	mg/kg	95% KM (BCA)	Nonparametric
	4,4'-DDE	mg/kg	0.052	0.057 (Normal)	0.077	0.057	mg/kg	95% Student's t	Normal
	4,4'-DDT	mg/kg	0.0029	0.0034 (Gamma, Log)	0.012	0.0034	mg/kg	95% KM (Percentile Bootstrap)	Nonparametric
	Total Chlordane	mg/kg	0.0049	0.0057 (Normal)	0.0094	0.0057	mg/kg	95% Student's-t UCL	Normal
	Dieldrin	mg/kg	0.0074	0.0084 (Gamma, Normal)	0.013	0.0084	mg/kg	95% KM (t)	Nonparametric
	Methyl mercury	mg/kg	0.16	0.17 (Normal)	0.23	0.17	mg/kg	95% Student's-t UCL	Normal

(1) NA - distribution not determined; Log - lognormal.

(1) NA - distribution not determined; Log - lognormal distribution; Gamma - gamma distribution.
(2) ProUCL recommended the H-UCL statistic for the lognormal distribution of these data; however, per Table 9 of the ProUCL Technical Guidance, the Student's-t UCL

Attachment 4

TABLE 4-3 (RAGS PT. D TABLE 3.1 CT)
EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current
Medium: Fish
Exposure Medium: Fish

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Fish	TCDD-TEQ (D/F)	mg/kg	0.0000624	0.000101 (Log)	0.000576	0.000101	mg/kg	95% BCA Bootstrap	(2)
	TCDD-TEQ (PCBs)	mg/kg	0.000012	0.000016 (Log)	0.00007	0.000016	mg/gkg	95% BCA Bootstrap	(2)
	Total PCBs	mg/kg	1.22	1.7 (Log)	5.60	1.7	mg/kg	95% BCA Bootstrap	(2)
	4,4'-DDD	mg/kg	0.058	0.069 (NA)	0.32	0.069	mg/kg	95% KM(BCA)	Nonparametric
	4,4'-DDE	mg/kg	0.099	0.12 (Gamma)	0.42	0.12	mg/kg	95% Approximate Gamma	Gamma
	4,4'-DDT	mg/kg	0.0046	0.0045 (NA)	0.014	0.0045	mg/kg	95% KM(t)	Nonparametric
	Total Chlordane	mg/kg	0.044	0.062 (Log)	0.28	0.062	mg/kg	95% BCA Bootstrap	(2)
	Dieldrin	mg/kg	0.019	0.025 (Gamma)	0.10	0.025	mg/kg	95% Approximate Gamma	Gamma
	Methyl mercury	mg/kg	0.30	0.36 (Gamma)	0.83	0.36	mg/kg	95% Approximate Gamma	Gamma

(1) NA - distribution not determined; Log - lognormal distribution; Gamma - gamma distribution.

(2) ProUCL recommended the H-UCL statistic for the lognormal distribution of these data; however, per Table 9 of the ProUCL Technical Guidance, the Student's-t UCL was used instead based on the standard deviation and sample number.

Attachment 4

TABLE 4-4 (RAGS PT. D TABLE 3.1 CT)
EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current
Medium: Crab
Exposure Medium: Crab

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Crab	TCDD TEQ (D/F)	mg/kg	0.000067	0.000075 (Normal)	0.00012	0.000075	mg/kg	95% Student's t	Normal
	TCDD TEQ (PCBs)	mg/kg	0.000010	0.000011 (Normal)	0.000017	0.000011	mg/kg	95% Student's t	Normal
	Total PCBs	mg/kg	0.32	0.37 (Normal)	0.69	0.37	mg/kg	95% Student's t	Normal
	4,4'-DDD	mg/kg	0.021	0.022 (Gamma, Log)	0.036	0.022	mg/kg	95% KM (BCA)	Nonparametric
	4,4'-DDE	mg/kg	0.052	0.057 (Normal)	0.077	0.057	mg/kg	95% Student's t	Normal
	4,4'-DDT	mg/kg	0.0029	0.0034 (Gamma, Log)	0.012	0.0034	mg/kg	95% KM (Percentile Bootstrap)	Nonparametric
	Total Chlordane	mg/kg	0.0049	0.0057 (Normal)	0.0094	0.0057	mg/kg	95% Student's-t UCL	Normal
	Dieldrin	mg/kg	0.0074	0.0084 (Gamma, Normal)	0.013	0.0084	mg/kg	95% KM (t)	Nonparametric
	Methyl mercury	mg/kg	0.16	0.17 (Normal)	0.23	0.17	mg/kg	95% Student's-t UCL	Normal

(1) log - lognormal; N - normal; NA - not normal or lognormal

Attachment 4

TABLE 4-5 (RAGS PT.D TABLE 4.1)
VALUES USED FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_f	Chemical Concentration in Fish	mg/kg wet weight	Site-specific		Same as RME		$Intake = \frac{C_f \times IR_f \times EF \times FI \times (1 - Loss) \times ED \times CF}{BW \times AT}$
	IR_f	Ingestion rate of Fish	g/day	34.6	USEPA Region 2, 2012	3.85	USEPA Region 2, 2012	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on A4 annunlized ingestion rate	
	ED	Exposure Duration	years	24	USEPA, 1989	9	USEPA, 1997b	
	CL	Cooking Loss	g/g	0	Assumes 100% chemical remains in fish	Chemical-specific	--	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989)	70	Mean adult body weight, makes and females (USEPA, 1989)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	8760	ED (years) x 365 days/year	3285	ED (years) x 365 days/year	

Attachment 4

TABLE 4-6 (RAGS PT.D TABLE 4.1)
VALUES FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Receptor Population: Angler (Adolescent)
Receptor Age: 7- 18 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_f	Chemical Concentration in Fish	mg/kg wet weight	Site-specific		Same as RME		$Intake = \frac{C_f \times IR_f \times EF \times FI \times (1 - Loss) \times ED \times CF}{BW \times AT}$
	IR_f	Ingestion rate of Fish	g/day	23.1	2/3 the adult ingestion rate (USEPA, 1997b)	2.57	2/3 the adult ingestion rate (USEPA, 1997b)	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on an annualized ingestion rate	
	ED	Exposure Duration	years	12	Assumed	6	EPA default (USEPA, 1991)	
	CL	Cooking Loss	g/g	0	Assumes 100% chemical remains in fish	Chemical-specific	--	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	52	Mean weight, males and females age 7-18 (USEPA, 2008b)	52	Mean weight, males and females age 7-18 (USEPA, 2008b)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	4380	ED (years) x 365 days/year	2190	ED (years) x 365 days/year	

Attachment 4

TABLE 4-7 (RAGS PT. D TABLE 4.1)
VALUES FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Receptor Population: Angler (Child)
Receptor Age: 0 - 6 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_f	Chemical Concentration in Fish	mg/kg wet weight	Site-specific		Same as RME		$Intake = \frac{C_f \times IR_f \times EF \times FI \times (1 - Loss) \times ED \times CF}{BW \times AT}$
	IR_f	Ingestion rate of Fish	g/day	11.5	1/3 of the adult ingestion rate (USEPA, 1997b)	1.28	1/3 of the adult ingestion rate (USEPA, 1997b)	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on an annualized ingestion rate	
	ED	Exposure Duration	years	6	EPA default (USEPA, 1991a)	3	Assumed	
	Loss	Cooking Loss	g/g	0	Assumes 100% chemical remains in fish	Chemical-specific	--	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	15	Mean child weight (USEPA, 1989)	15	Mean child weight (USEPA, 1989)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	2190	ED (years) x 365 days/year	1095	ED (years) x 365 days/year	

TABLE 4-8 (RAGS PT. D TABLE 4.1)
VALUES USED FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Crab
Exposure Medium: Crab
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_b	Chemical Concentration in Crab	mg/kg wet weight	Site-specific		Same as RME		$$Intake = \frac{C_b \times IR_b \times EF \times FI \times (1 - Loss) \times ED \times CF}{BW \times AT}$$
	IR_b	Ingestion rate of Crab	g/day	20.9	USEPA Region 2, 2012	3.0	USEPA Region 2, 2012	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on an annualized ingestion rate	
	ED	Exposure Duration	years	24	USEPA, 1989	9	USEPA, 1997b	
	CL	Cooking Loss	g/g	0	Assumes 100% chemical remains in crab	20% for PCBs; 0 for all other COPCs	Zabik et al., 1992	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989)	70	Mean adult body weight, males and females (USEPA, 1989)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	8760	ED (years) x 365 days/year	3285	ED (years) x 365 days/year	

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TABLE 4-9 (RAGS PT. D TABLE 4.1)
VALUES FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Crab
Exposure Medium: Crab
Receptor Population: Angler (Adolescent)
Receptor Age: 7 - 18 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_b	Chemical Concentration in Crab	mg/kg wet weight	Site-specific		Same as RME		$Intake = \frac{C_b \times IR_b \times EF \times FI \times (1 - Loss) \times ED \times CF}{BW \times AT}$
	IR_b	Ingestion rate of Crab	g/day	13.9	2/3 the adult ingestion rate (USEPA, 1997b)	2.0	2/3 the adult ingestion rate (USEPA, 1997b)	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on an annualized ingestion rate	
	ED	Exposure Duration	years	12	Assumed (from age 10 through 18)	6	Standard EPA default (USEPA, 1991a)	
	CL	Cooking Loss	g/g	0	Assumes 100% chemical remains in fish	20% for PCBs; 0 for all other COPCs	Zabik et al., 1992	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	52	Mean weight, males and females age 7-18 (USEPA, 2008b)	52	Mean weight, males and females age 7-18 (USEPA, 2008b)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	4380	ED (years) x 365 days/year	2190	ED (years) x 365 days/year	

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TABLE 4-10 (RAGS PT. D TABLE 4.1)
VALUES FOR DAILY INTAKE CALCULATIONS
Lower Passaic River

Scenario Timeframe: Current/Future
Medium: Crab
Exposure Medium: Crab
Receptor Population: Angler (Child)
Receptor Age: 0 - 6 Years

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_b	Chemical Concentration in Crab	mg/kg wet weight	Site-specific		Same as RME		$\text{Intake} = \frac{C_b \times IR_b \times EF \times FI \times (1-\text{Loss}) \times ED \times CF}{BW \times AT}$
	IR_b	Ingestion rate of Crab	g/day	6.97	1/3 of the adult ingestion rate (USEPA, 1997b)	1.0	1/3 of the adult ingestion rate (USEPA, 1997b)	
	FI	Fraction from Source	unitless	1	Assumes 100% exposure is from Passaic River	1	Assumes 100% exposure is from Passaic River	
	EF	Exposure Frequency	days/year	365	USEPA, 1989	365	Based on an annualized ingestion rate	
	ED	Exposure Duration	years	6	Standard EPA default (USEPA, 1991a)	3	Assumed	
	Loss	Cooking Loss	g/g	0	Assumes 100% chemical remains in crab	20% for PCBs; 0 for all other COPCs	Zabik et a., 1992	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	15	Standard EPA default (USEPA, 1991a)	15	Standard EPA default (USEPA, 1991a)	
	AT-C	Averaging Time (Cancer)	days	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	25550	70-year lifetime exposure x 365 days/year (USEPA, 1989)	
	AT-NC	Averaging Time (Noncancer)	days	2190	ED (years) x 365 days/year	1095	ED (years) x 365 days/year	

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TABLE 4-11 (RAGS PT. D TABLE 5.1)
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Lower Passaic River

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
TCDD TEQ	Chronic	7.00E-10	mg/kg-day	100%	7.00E-10	mg/kg-day	Dermal, Developmental, Immunological, Reproductive	30	IRIS	2/17/2012
Total PCBs [2]	Chronic	2.0E-05	mg/kg-day	100%	2.0E-05	mg/kg-day	Immune System, eye	300	IRIS	2/28/2011
4,4'-DDD	--	--	--	--	--	--	--	--	IRIS	2/28/2011
4,4'-DDE	--	--	--	--	--	--	--	--	IRIS	2/28/2011
4,4'-DDT	Chronic	5.0E-04	mg/kg-day	100%	5.0E-04	mg/kg-day	liver	100	IRIS	2/28/2011
Chlordane	Chronic	5.0E-04	mg/kg-day	100%	5.0E-04	mg/kg-day	liver	300	IRIS	2/28/2011
Dieldrin	Chronic	5.0E-05	mg/kg-day	100%	5.0E-05	mg/kg-day	liver	100	IRIS	2/28/2011
Methylmercury	Chronic	1.0E-04	mg/kg-day	100%	1.0E-04	mg/kg-day	central nervous system	10	IRIS	2/28/2011

Footnote Instructions:

(1) RAGS Part E, Supplimental Guidance for Dermal Risk Assessment

(2) Based on the noncancer toxicity values for Aroclor 1254.

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TABLE 4-12 (RAGS PT D TABLE 6.1)
CANCER TOXICITY DATA -- ORAL/DERMAL
Lower Passaic River

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description (2)	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
TCDD TEQ	1.50E+05	$(mg/kg\text{-}day)^{-1}$	100%	1.50E+05	$(mg/kg\text{-}day)^{-1}$	B2	HEAST	07/31/97
Total PCBs	2.00E+00	$(mg/kg\text{-}day)^{-1}$	100%	2.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
Total PCBs (3)	1.00E+00	$(mg/kg\text{-}day)^{-1}$	100%	1.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
4,4'-DDD	2.40E-01	$(mg/kg\text{-}day)^{-1}$	100%	2.40E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
4,4'-DDE	3.40E-01	$(mg/kg\text{-}day)^{-1}$	100%	3.40E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
4,4'-DDT	3.40E-01	$(mg/kg\text{-}day)^{-1}$	100%	3.40E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
Chlordane	3.50E-01	$(mg/kg\text{-}day)^{-1}$	100%	3.50E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
Dieldrin	1.60E+01	$(mg/kg\text{-}day)^{-1}$	100%	1.60E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/28/2011
Methylmercury	--	--	100%	--	--	C	IRIS	2/28/2011

(1) RAGS Part E, Suppliemental Guidance for Dermal Risk Assessment

(2) Weight of eveidence: B2 - probable human carcinogen; C- possible human carcinogen

(3) Central estimate slope factor for exposures to PCBs via ingestion of fish

IRIS - Integrated Risk Information System

HEAST - Health Effects Assessment Summary Tables

Attachment 4

TABLE 4-13 (RAGS PT D TABLE 7a.1 RME)
CALCULATION OF CHEMICAL CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	1.7E-08	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-03
				TCDD TEQ (PCBs)	2E-05	mg/kg	2.7E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-04
				Total PCBs	2E+00	mg/kg	2.9E-04	mg/kg-day	2.0E+00	(mg/kg-day)-1	6.E-04
				4,4'-DDD	7E-02	mg/kg	1.2E-05	mg/kg-day	2.4E-01	(mg/kg-day)-1	3.E-06
				4,4'-DDE	1E-01	mg/kg	2.2E-05	mg/kg-day	3.4E-01	(mg/kg-day)-1	7.E-06
				4,4'-DDT	5E-03	mg/kg	7.6E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-07
				Total Chlordane	6E-02	mg/kg	1.1E-05	mg/kg-day	3.5E-01	(mg/kg-day)-1	4.E-06
				Dieldrin	3E-02	mg/kg	4.2E-06	mg/kg-day	1.6E+01	(mg/kg-day)-1	7.E-05
				Methyl mercury	4E-01	mg/kg	6.1E-05	mg/kg-day	--	--	ND
			Exp. Route Total								4.E-03
		Exposure Point Total									4.E-03
	Exposure Medium Total										4.E-03
Medium Total											4.E-03
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	7.7E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-03
				TCDD TEQ (PCBs)	1E-05	mg/kg	1.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04
				Total PCBs	4E-01	mg/kg	3.8E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	8.E-05
				4,4'-DDD	2E-02	mg/kg	2.3E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	5.E-07
				4,4'-DDE	6E-02	mg/kg	5.8E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-06
				4,4'-DDT	3E-03	mg/kg	3.5E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				Total Chlordane	6E-03	mg/kg	5.8E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-07
				Dieldrin	8E-03	mg/kg	8.6E-07	mg/kg-day	1.6E+01	(mg/kg-day)-1	1.E-05
				Methyl mercury	2E-01	mg/kg	1.7E-05	mg/kg-day	--	--	ND
			Exp. Route Total								1.E-03
		Exposure Point Total									1.E-03
	Exposure Medium Total										1.E-03
Medium Total											1.E-03

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

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TABLE 4-14 (RAGS PT D TABLE 7a.1 RME)
CALCULATION OF CHEMICAL CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe:	Current/Future
Receptor Population:	Angler (Adolescent)
Receptor Age:	7 - 18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	7.6E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-03
				TCDD TEQ (PCBs)	2E-05	mg/kg	1.2E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04
				Total PCBs	2E+00	mg/kg	1.3E-04	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-04
				4,4'-DDD	7E-02	mg/kg	5.3E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-06
				4,4'-DDE	1E-01	mg/kg	9.9E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06
				4,4'-DDT	5E-03	mg/kg	3.4E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				Total Chlordane	6E-02	mg/kg	4.7E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-06
				Dieldrin	3E-02	mg/kg	1.9E-06	mg/kg-day	1.6E+01	(mg/kg-day)-1	3.E-05
				Methyl mercury	4E-01	mg/kg	2.7E-05	mg/kg-day	--	--	ND
			Exp. Route Total								2.E-03
		Exposure Point Total									2.E-03
	Exposure Medium Total										2.E-03
Medium Total											
Crab				TCDD TEQ	8E-05	mg/kg	3.4E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-04
				TCDD TEQ (PCBs)	1E-05	mg/kg	5.0E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	8.E-05
				Total PCBs	4E-01	mg/kg	1.7E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-05
				4,4'-DDD	2E-02	mg/kg	1.0E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-07
				4,4'-DDE	6E-02	mg/kg	2.6E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	9.E-07
				4,4'-DDT	3E-03	mg/kg	1.6E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-08
				Total Chlordane	6E-03	mg/kg	2.6E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	9.E-08
				Dieldrin	8E-03	mg/kg	3.8E-07	mg/kg-day	1.6E+01	(mg/kg-day)-1	6.E-06
				Methyl mercury	2E-01	mg/kg	7.8E-06	mg/kg-day	--	--	ND
			Exp. Route Total								6.E-04
		Exposure Point Total									6.E-04
	Exposure Medium Total										6.E-04
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-15 (RAGS PT D TABLE 7a.1 RME)
CALCULATION OF CHEMICAL CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	6.6E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-03
				TCDD TEQ (PCBs)	2E-05	mg/kg	1.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04
				Total PCBs	2E+00	mg/kg	1.1E-04	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-04
				4,4'-DDD	7E-02	mg/kg	4.5E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-06
				4,4'-DDE	1E-01	mg/kg	8.5E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06
				4,4'-DDT	5E-03	mg/kg	3.0E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				Total Chlordane	6E-02	mg/kg	4.1E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-06
				Dieldrin	3E-02	mg/kg	1.6E-06	mg/kg-day	1.6E+01	(mg/kg-day)-1	3.E-05
				Methyl mercury	4E-01	mg/kg	2.4E-05	mg/kg-day	--	--	ND
			Exp. Route Total								1.E-03
		Exposure Point Total									1.E-03
	Exposure Medium Total										1.E-03
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	3.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-04
				TCDD TEQ (PCBs)	1E-05	mg/kg	4.4E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-05
				Total PCBs	4E-01	mg/kg	1.5E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-05
				4,4'-DDD	2E-02	mg/kg	8.8E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-07
				4,4'-DDE	6E-02	mg/kg	2.3E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	8.E-07
				4,4'-DDT	3E-03	mg/kg	1.4E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-08
				Total Chlordane	6E-03	mg/kg	2.3E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	8.E-08
				Dieldrin	8E-03	mg/kg	3.3E-07	mg/kg-day	1.6E+01	(mg/kg-day)-1	5.E-06
				Methyl mercury	2E-01	mg/kg	6.8E-06	mg/kg-day	--	--	ND
			Exp. Route Total								5.E-04
		Exposure Point Total									5.E-04
	Exposure Medium Total										5.E-04
Medium Total											

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

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TABLE 4-16 (RAGS PT D TABLE 7b.1 RME)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	4.9E-08	mg/kg-day	7.0E-10	mg/kg-day	71
				TCDD TEQ (PCBs)	2E-05	mg/kg	7.9E-09	mg/kg-day	7.0E-10	mg/kg-day	11
				Total PCBs	2E+00	mg/kg	8.4E-04	mg/kg-day	2.0E-05	mg/kg-day	42
				4,4'-DDD	7E-02	mg/kg	3.4E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	6.4E-05	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	2.2E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Total Chlordane	6E-02	mg/kg	3.1E-05	mg/kg-day	5.0E-04	mg/kg-day	0.06
				Dieldrin	3E-02	mg/kg	1.2E-05	mg/kg-day	5.0E-05	mg/kg-day	0.2
				Methyl mercury	4E-01	mg/kg	1.8E-04	mg/kg-day	1.0E-04	mg/kg-day	2
			Exp. Route Total								126
		Exposure Point Total									126
	Exposure Medium Total										126
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	2.2E-08	mg/kg-day	7.0E-10	mg/kg-day	32
				TCDD TEQ (PCBs)	1E-05	mg/kg	3.3E-09	mg/kg-day	7.0E-10	mg/kg-day	5
				Total PCBs	4E-01	mg/kg	1.1E-04	mg/kg-day	2.0E-05	mg/kg-day	6
				4,4'-DDD	2E-02	mg/kg	6.6E-06	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	1.7E-05	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	1.0E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Total Chlordane	6E-03	mg/kg	1.7E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Dieldrin	8E-03	mg/kg	2.5E-06	mg/kg-day	5.0E-05	mg/kg-day	0.05
				Methyl mercury	2E-01	mg/kg	5.1E-05	mg/kg-day	1.0E-04	mg/kg-day	0.5
			Exp. Route Total								43
		Exposure Point Total									43
	Exposure Medium Total										43
Medium Total											

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

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TABLE 4-17 (RAGS PT D TABLE 7b.1 RME)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adolescent)
Receptor Age: 7 - 18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	4.4E-08	mg/kg-day	7.0E-10	mg/kg-day	63
				TCDD TEQ (PCBs)	2E-05	mg/kg	7.1E-09	mg/kg-day	7.0E-10	mg/kg-day	10
				Total PCBs	2E+00	mg/kg	7.6E-04	mg/kg-day	2.0E-05	mg/kg-day	38
				4,4'-DDD	7E-02	mg/kg	3.1E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	5.8E-05	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	2.0E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Total Chlordane	6E-02	mg/kg	2.8E-05	mg/kg-day	5.0E-04	mg/kg-day	0.06
				Dieldrin	3E-02	mg/kg	1.1E-05	mg/kg-day	5.0E-05	mg/kg-day	0.2
				Methyl mercury	4E-01	mg/kg	1.6E-04	mg/kg-day	1.0E-04	mg/kg-day	2
			Exp. Route Total								113
		Exposure Point Total									113
	Exposure Medium Total										113
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	2.0E-08	mg/kg-day	7.0E-10	mg/kg-day	29
				TCDD TEQ (PCBs)	1E-05	mg/kg	2.9E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				Total PCBs	4E-01	mg/kg	9.9E-05	mg/kg-day	2.0E-05	mg/kg-day	5
				4,4'-DDD	2E-02	mg/kg	5.9E-06	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	1.5E-05	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	9.1E-07	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Total Chlordane	6E-03	mg/kg	1.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Dieldrin	8E-03	mg/kg	2.2E-06	mg/kg-day	5.0E-05	mg/kg-day	0.04
				Methyl mercury	2E-01	mg/kg	4.5E-05	mg/kg-day	1.0E-04	mg/kg-day	0.5
			Exp. Route Total								38
		Exposure Point Total									38
	Exposure Medium Total										38
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-18 (RAGS PT D TABLE 7.b.1 RME)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	7.7E-08	mg/kg-day	7.0E-10	mg/kg-day	110
				TCDD TEQ (PCBs)	2E-05	mg/kg	1.2E-08	mg/kg-day	7.0E-10	mg/kg-day	18
				Total PCBs	2E+00	mg/kg	1.3E-03	mg/kg-day	2.0E-05	mg/kg-day	65
				4,4'-DDD	7E-02	mg/kg	5.3E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	1.0E-04	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	3.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.007
				Total Chlordane	6E-02	mg/kg	4.8E-05	mg/kg-day	5.0E-04	mg/kg-day	0.1
				Dieldrin	3E-02	mg/kg	1.9E-05	mg/kg-day	5.0E-05	mg/kg-day	0.4
				Methyl mercury	4E-01	mg/kg	2.8E-04	mg/kg-day	1.0E-04	mg/kg-day	3
			Exp. Route Total								195
		Exposure Point Total									195
	Exposure Medium Total										195
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	3.5E-08	mg/kg-day	7.0E-10	mg/kg-day	50
				TCDD TEQ (PCBs)	1E-05	mg/kg	5.1E-09	mg/kg-day	7.0E-10	mg/kg-day	7
				Total PCBs	4E-01	mg/kg	1.7E-04	mg/kg-day	2.0E-05	mg/kg-day	9
				4,4'-DDD	2E-02	mg/kg	1.0E-05	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	2.6E-05	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	1.6E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Total Chlordane	6E-03	mg/kg	2.6E-06	mg/kg-day	5.0E-04	mg/kg-day	0.005
				Dieldrin	8E-03	mg/kg	3.9E-06	mg/kg-day	5.0E-05	mg/kg-day	0.1
				Methyl mercury	2E-01	mg/kg	7.9E-05	mg/kg-day	1.0E-04	mg/kg-day	0.8
			Exp. Route Total								67
		Exposure Point Total									67
	Exposure Medium Total										67
Medium Total											

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-19 (RAGS PT D TABLE 7a.1 CT)
CALCULATION OF CHEMICAL CANCER RISKS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	3.6E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-05
				TCDD TEQ (PCBs)	2E-05	mg/kg	9.1E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-05
				Total PCBs	2E+00	mg/kg	9.6E-06	mg/kg-day	1.0E+00	(mg/kg-day)-1	1.E-05
				4,4'-DDD	7E-02	mg/kg	3.4E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	8.E-08
				4,4'-DDE	1E-01	mg/kg	6.0E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07
				4,4'-DDT	5E-03	mg/kg	2.2E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	8.E-09
				Total Chlordane	6E-02	mg/kg	2.9E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-07
				Dieldrin	3E-02	mg/kg	1.2E-07	mg/kg-day	1.6E+01	(mg/kg-day)-1	2.E-06
				Methyl mercury	4E-01	mg/kg	2.5E-06	mg/kg-day	--	--	ND
			Exp. Route Total								8.E-05
		Exposure Point Total									8.E-05
	Exposure Medium Total										8.E-05
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	4.1E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	6.E-05
				TCDD TEQ (PCBs)	1E-05	mg/kg	4.9E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-06
				Total PCBs	4E-01	mg/kg	1.6E-06	mg/kg-day	1.0E+00	(mg/kg-day)-1	2.E-06
				4,4'-DDD	2E-02	mg/kg	1.2E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	3.E-08
				4,4'-DDE	6E-02	mg/kg	3.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				4,4'-DDT	3E-03	mg/kg	1.9E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-09
				Total Chlordane	6E-03	mg/kg	3.1E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-08
				Dieldrin	8E-03	mg/kg	4.6E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	7.E-07
				Methyl mercury	2E-01	mg/kg	9.4E-07	mg/kg-day	--	--	ND
			Exp. Route Total								7.E-05
		Exposure Point Total									7.E-05
	Exposure Medium Total										7.E-05
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-20 (RAGS PT D TABLE 7a.1 CT)
CALCULATION OF CHEMICAL CANCER RISKS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adolescent)
Receptor Age: 7 - 18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	2.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05
				TCDD TEQ (PCBs)	2E-05	mg/kg	5.4E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	8.E-06
				Total PCBs	2E+00	mg/kg	5.8E-06	mg/kg-day	1.0E+00	(mg/kg-day)-1	6.E-06
				4,4'-DDD	7E-02	mg/kg	2.0E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	5.E-08
				4,4'-DDE	1E-01	mg/kg	3.6E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				4,4'-DDT	5E-03	mg/kg	1.3E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-09
				Total Chlordane	6E-02	mg/kg	1.8E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	6.E-08
				Dieldrin	3E-02	mg/kg	7.4E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	1.E-06
				Methyl mercury	4E-01	mg/kg	1.5E-06	mg/kg-day	--	(mg/kg-day)-1	ND
			Exp. Route Total								5.E-05
		Exposure Point Total									5.E-05
	Exposure Medium Total										5.E-05
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	2.5E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-05
				TCDD TEQ (PCBs)	1E-05	mg/kg	2.9E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-06
				Total PCBs	4E-01	mg/kg	9.8E-07	mg/kg-day	1.0E+00	(mg/kg-day)-1	1.E-06
				4,4'-DDD	2E-02	mg/kg	7.3E-08	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-08
				4,4'-DDE	6E-02	mg/kg	1.9E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-08
				4,4'-DDT	3E-03	mg/kg	1.1E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	4.E-09
				Total Chlordane	6E-03	mg/kg	1.9E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	7.E-09
				Dieldrin	8E-03	mg/kg	2.8E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	4.E-07
				Methyl mercury	2E-01	mg/kg	5.6E-07	mg/kg-day	--	(mg/kg-day)-1	ND
			Exp. Route Total								4.E-05
		Exposure Point Total									4.E-05
	Exposure Medium Total										4.E-05
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-21 (RAGS PT D TABLE 7a.1 CT)
CALCULATION OF CHEMICAL CANCER RISKS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	1.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05
				TCDD TEQ (PCBs)	2E-05	mg/kg	4.7E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-06
				Total PCBs	2E+00	mg/kg	5.0E-06	mg/kg-day	1.0E+00	(mg/kg-day)-1	5.E-06
				4,4'-DDD	7E-02	mg/kg	1.8E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	4.E-08
				4,4'-DDE	1E-01	mg/kg	3.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07
				4,4'-DDT	5E-03	mg/kg	1.2E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	4.E-09
				Total Chlordane	6E-02	mg/kg	1.5E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	5.E-08
				Dieldrin	3E-02	mg/kg	6.4E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	1.E-06
				Methyl mercury	4E-01	mg/kg	1.3E-06	mg/kg-day	--	(mg/kg-day)-1	ND
			Exp. Route Total								4.E-05
		Exposure Point Total									4.E-05
	Exposure Medium Total										4.E-05
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	2.1E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05
				TCDD TEQ (PCBs)	1E-05	mg/kg	2.5E-11	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-06
				Total PCBs	4E-01	mg/kg	8.5E-07	mg/kg-day	1.0E+00	(mg/kg-day)-1	8.E-07
				4,4'-DDD	2E-02	mg/kg	6.3E-08	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-08
				4,4'-DDE	6E-02	mg/kg	1.6E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-08
				4,4'-DDT	3E-03	mg/kg	9.7E-09	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-09
				Total Chlordane	6E-03	mg/kg	1.6E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	6.E-09
				Dieldrin	8E-03	mg/kg	2.4E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	4.E-07
				Methyl mercury	2E-01	mg/kg	4.9E-07	mg/kg-day	--	(mg/kg-day)-1	ND
			Exp. Route Total								4.E-05
		Exposure Point Total									4.E-05
	Exposure Medium Total										4.E-05
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 4-22 (RAGS PT D TABLE 7b.1 CT)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	2.8E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	2E-05	mg/kg	7.0E-10	mg/kg-day	7.0E-10	mg/kg-day	1.0
				Total PCBs	2E+00	mg/kg	7.5E-05	mg/kg-day	2.0E-05	mg/kg-day	4
				4,4'-DDD	7E-02	mg/kg	2.7E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	4.6E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	1.7E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0003
				Total Chlordane	6E-02	mg/kg	2.3E-06	mg/kg-day	5.0E-04	mg/kg-day	0.005
				Dieldrin	3E-02	mg/kg	9.6E-07	mg/kg-day	5.0E-05	mg/kg-day	0.02
				Methyl mercury	4E-01	mg/kg	2.0E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								9
		Exposure Point Total									9
	Exposure Medium Total										9
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	3.2E-09	mg/kg-day	7.0E-10	mg/kg-day	5
				TCDD TEQ (PCBs)	1E-05	mg/kg	3.8E-10	mg/kg-day	7.0E-10	mg/kg-day	0.5
				Total PCBs	4E-01	mg/kg	1.3E-05	mg/kg-day	2.0E-05	mg/kg-day	0.6
				4,4'-DDD	2E-02	mg/kg	9.4E-07	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	2.4E-06	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	1.5E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0003
				Total Chlordane	6E-03	mg/kg	2.4E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0005
				Dieldrin	8E-03	mg/kg	3.6E-07	mg/kg-day	5.0E-05	mg/kg-day	0.01
				Methyl mercury	2E-01	mg/kg	7.3E-06	mg/kg-day	1.0E-04	mg/kg-day	0.07
			Exp. Route Total								6
		Exposure Point Total									6
	Exposure Medium Total										6
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

Attachment 4

TABLE 4-23 (RAGS PT D TABLE 7b.1 CT)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Adolescent)
Receptor Age: 7 - 18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	2.5E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	2E-05	mg/kg	6.3E-10	mg/kg-day	7.0E-10	mg/kg-day	1
				Total PCBs	2E+00	mg/kg	6.7E-05	mg/kg-day	2.0E-05	mg/kg-day	3
				4,4'-DDD	7E-02	mg/kg	2.4E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	4.2E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	1.6E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0003
				Total Chlordane	6E-02	mg/kg	2.1E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Dieldrin	3E-02	mg/kg	8.6E-07	mg/kg-day	5.0E-05	mg/kg-day	0.02
				Methyl mercury	4E-01	mg/kg	1.8E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								8
		Exposure Point Total									8
	Exposure Medium Total										8
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	2.9E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	1E-05	mg/kg	3.4E-10	mg/kg-day	7.0E-10	mg/kg-day	0.5
				Total PCBs	4E-01	mg/kg	1.1E-05	mg/kg-day	2.0E-05	mg/kg-day	0.6
				4,4'-DDD	2E-02	mg/kg	8.5E-07	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	2.2E-06	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	1.3E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0003
				Total Chlordane	6E-03	mg/kg	2.2E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0004
				Dieldrin	8E-03	mg/kg	3.2E-07	mg/kg-day	5.0E-05	mg/kg-day	0.01
				Methyl mercury	2E-01	mg/kg	6.5E-06	mg/kg-day	1.0E-04	mg/kg-day	0.07
			Exp. Route Total								5
		Exposure Point Total									5
	Exposure Medium Total										5
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 4-24 (RAGS PT D TABLE 7b.1 CT)
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
CENTRAL TENDENCY
Lower Passaic River

Scenario Timeframe: Current/Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	1E-04	mg/kg	4.35E-09	mg/kg-day	7.0E-10	mg/kg-day	6
				TCDD TEQ (PCBs)	2E-05	mg/kg	1.09E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				Total PCBs	2E+00	mg/kg	1.16E-04	mg/kg-day	2.0E-05	mg/kg-day	6
				4,4'-DDD	7E-02	mg/kg	4.12E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	7.21E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	2.69E-07	mg/kg-day	5.0E-04	mg/kg-day	0.001
				Total Chlordane	6E-02	mg/kg	3.54E-06	mg/kg-day	5.0E-04	mg/kg-day	0.01
				Dieldrin	3E-02	mg/kg	1.49E-06	mg/kg-day	5.0E-05	mg/kg-day	0.03
				Methyl mercury	4E-01	mg/kg	3.07E-05	mg/kg-day	1.0E-04	mg/kg-day	0.3
			Exp. Route Total								14
		Exposure Point Total									14
	Exposure Medium Total										14
Medium Total											
Crab				TCDD TEQ (D/F)	8E-05	mg/kg	5.0E-09	mg/kg-day	7.0E-10	mg/kg-day	7
				TCDD TEQ (PCBs)	1E-05	mg/kg	5.9E-10	mg/kg-day	7.0E-10	mg/kg-day	1
				Total PCBs	4E-01	mg/kg	2.0E-05	mg/kg-day	2.0E-05	mg/kg-day	1
				4,4'-DDD	2E-02	mg/kg	1.5E-06	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	3.8E-06	mg/kg-day	--	--	ND
				4,4'-DDT	3E-03	mg/kg	2.3E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0005
				Total Chlordane	6E-03	mg/kg	3.8E-07	mg/kg-day	5.0E-04	mg/kg-day	0.001
				Dieldrin	8E-03	mg/kg	5.6E-07	mg/kg-day	5.0E-05	mg/kg-day	0.01
				Methyl mercury	2E-01	mg/kg	1.1E-05	mg/kg-day	1.0E-04	mg/kg-day	0.1
			Exp. Route Total								9
		Exposure Point Total									9
	Exposure Medium Total										9
Medium Total											

ND - not determined because a toxicity value is not available for this exposure route.
mg/kg - milligram per kilogram

ATTACHMENT 5

CRITICAL BODY RESIDUES FOR FISH AND AVIAN EMBRYOS

ATTACHMENT 5

Table 5-1.
CBR-Based Hazard Quotients for Estimated Fish Embryo Tissue - Generic Fish

COPEC	Generic Fish[a]	Units	Trout Female/ Egg BMF[b]	Fish TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						LCL	UCL	LCL	UCL
Dioxins					**TEQ**				
2,3,7,8-TCDD	2.4E-04	ug/g	0.69	1	2.4E-04				
1,2,3,7,8-PeCDD	2.7E-06	ug/g	0.67	1	2.5E-06				
1,2,3,7,8-PeCDF	1.6E-06	ug/g	-	0.05					
2,3,4,7,8-PeCDF	1.3E-05	ug/g	0.60	0.5	5.4E-06				
1,2,3,6,7,8-HxCDD	5.1E-06	ug/g	-	0.01					
1,2,3,4,6,7,8-HpCDD	1.1E-05	ug/g	-	0.001					
OCDD	1.4E-05	ug/g	-	0.0001					
1,2,3,4,7,8-HxCDF	1.0E-05	ug/g	-	0.1					
1,2,3,6,7,8-HxCDF	3.5E-06	ug/g	-	0.1					
2,3,7,8-TCDF	8.2E-06	ug/g	0.71	0.05	4.1E-07				
1,2,3,4,7,8-HxCDD	1.2E-06	ug/g	-	0.5					
1,2,3,7,8,9-HxCDD	1.1E-06	ug/g	-	0.01					
1,2,3,7,8,9-HxCDF	na	ug/g	-	0.1					
2,3,4,6,7,8-HxCDF	1.4E-06	ug/g	-	0.1					
1,2,3,4,6,7,8-HpCDF	6.8E-06	ug/g	-	0.01					
1,2,3,4,7,8,9-HpCDF	na	ug/g	-	0.01					
OCDF	1.5E-06	ug/g	-	0.0001					
Total Dioxin/Furan Congeners					2.4E-04	7.2E-06	8.6E-05	**3.4E+01**	**2.8E+00**
							TEQ (D/F)	**3.4E+01**	**2.8E+00**

ATTACHMENT 5

Table 5-1.
CBR-Based Hazard Quotients for Estimated Fish Embryo Tissue - Generic Fish

COPEC	Generic Fish[a]	Units	Trout Female/ Egg BMF[b]	Fish TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						LCL	UCL	LCL	UCL
PCBs					**TEQ**				
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	2.7E-03	ug/g	-	0.000005					
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	#N/A	ug/g	-	0.000005					
2,3,3',4,4',5-Hexachlorobiphenyl (156)	2.2E-02	ug/g	-	0.000005					
2,3,3',4,4'-Pentachlorobiphenyl (105)	4.9E-02	ug/g	0.67	0.000005	2.3E-07				
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	9.0E-03	ug/g	-	0.000005					
2,3',4,4',5'-Pentachlorobiphenyl (123)	2.6E-03	ug/g	-	0.000005					
2,3,4,4',5-Pentachlorobiphenyl (114)	3.4E-03	ug/g	-	0.000005					
2,3',4,4',5-Pentachlorobiphenyl (118)	1.3E-01	ug/g	0.67	0.000005	6.2E-07				
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	na	ug/g	0.43	0.00005					
3,3',4,4',5-Pentachlorobiphenyl (126)	2.7E-04	ug/g	0.61	0.005	1.1E-06				
3,3',4,4'-Tetrachlorobiphenyl (77)	2.9E-03	ug/g	0.71	0.0001	2.9E-07				
3,4,4',5-Tetrachlorobiphenyl (81)	1.9E-04	ug/g	0.65	0.0005	8.6E-08				
Total PCB Congeners					2.4E-06	7.2E-06	8.6E-05	3.3E-01	2.7E-02
							TEQ (PCBs)	3.3E-01	2.7E-02
							Total TCDD TEQ	**3.4E+01**	**2.9E+00**

Notes:

[a] EPCs for generic fish tissue, see Attachment 1.

[b] Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % egg) from Cook *et al.* , 2003.

[c] Fish egg concentrations (mg/kg wet weight) estimated by multiplying the adult fish tissue concentration by the BMF and the ratio of the egg to female fish percent lipid and congener-specific TEF. The following lipid contents were assumed:

5.9 Average American eel/white perch lipid percent in Lower Passaic River samples.

8.2 Average Lake trout egg lipid percentage (Cook *et al.* , 2003).

[d] Critical Body Residues (CBRs) thresholds derived as the Lower and Upper 95% Confidence Levels derived by Steevens *et al.* , 2005 (0.088 and 1.05 ngTCDD/glipid, respectively).

[e] Hazard Quotient is the ratio of the estimated tissue concentration to the LCL or UCL CBR.

HQs for shaded analytes not included in the HI totals.

#N/A, na - Not available/applicable.

ATTACHMENT 5

Table 5-2.
CBR-Based Hazard Quotients for Estimated Fish Embryo Tissue - Mummichog

COPEC	Mummichog EPC[a]	Units	Trout Female/ Egg BMF[b]	Fish TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						LCL	UCL	LCL	UCL
Dioxins					**TEQ**				
2,3,7,8-TCDD	4.4E-05	ug/g	0.69	1	1.3E-04				
1,2,3,7,8-PeCDD	4.0E-07	ug/g	0.67	1	1.2E-06				
1,2,3,7,8-PeCDF	3.1E-07	ug/g	-	0.05					
2,3,4,7,8-PeCDF	1.5E-06	ug/g	0.60	0.5	1.9E-06				
1,2,3,6,7,8-HxCDD	4.6E-07	ug/g	-	0.01					
1,2,3,4,6,7,8-HpCDD	5.2E-06	ug/g	-	0.001					
OCDD	6.5E-05	ug/g	-	0.0001					
1,2,3,4,7,8-HxCDF	1.4E-06	ug/g	-	0.1					
1,2,3,6,7,8-HxCDF	3.6E-07	ug/g	-	0.1					
2,3,7,8-TCDF	1.3E-06	ug/g	0.71	0.05	2.0E-07				
1,2,3,4,7,8-HxCDD	2.3E-07	ug/g	-	0.5					
1,2,3,7,8,9-HxCDD	3.6E-07	ug/g	-	0.01					
1,2,3,7,8,9-HxCDF	na	ug/g	-	0.1					
2,3,4,6,7,8-HxCDF	2.8E-07	ug/g	-	0.1					
1,2,3,4,6,7,8-HpCDF	5.4E-06	ug/g	-	0.01					
1,2,3,4,7,8,9-HpCDF	5.1E-05	ug/g	-	0.01					
OCDF	6.9E-06	ug/g	-	0.0001					
Total Dioxin/Furan Congeners					1.4E-04	7.2E-06	8.6E-05	**1.9E+01**	**1.6E+00**
							TEQ (D/F)	**1.9E+01**	**1.6E+00**

ATTACHMENT 5

Table 5-2.
CBR-Based Hazard Quotients for Estimated Fish Embryo Tissue - Mummichog

COPEC	Mummichog EPC[a]	Units	Trout Female/ Egg BMF[b]	Fish TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						LCL	UCL	LCL	UCL
PCBs					**TEQ**				
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	3.4E-04	ug/g	-	0.000005					
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	#N/A	ug/g	-	0.000005					
2,3,3',4,4',5-Hexachlorobiphenyl (156)	3.2E-03	ug/g	-	0.000005					
2,3,3',4,4'-Pentachlorobiphenyl (105)	8.6E-03	ug/g	0.67	0.000005	1.2E-07				
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	1.4E-03	ug/g	-	0.000005					
2,3',4,4',5'-Pentachlorobiphenyl (123)	5.0E-04	ug/g	-	0.000005					
2,3,4,4',5-Pentachlorobiphenyl (114)	6.3E-04	ug/g	-	0.000005					
2,3',4,4',5-Pentachlorobiphenyl (118)	2.4E-02	ug/g	0.67	0.000005	3.4E-07				
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	na	ug/g	0.43	0.00005					
3,3',4,4',5-Pentachlorobiphenyl (126)	6.9E-05	ug/g	0.61	0.005	9.1E-07				
3,3',4,4'-Tetrachlorobiphenyl (77)	6.7E-04	ug/g	0.71	0.0001	2.1E-07				
3,4,4',5-Tetrachlorobiphenyl (81)	na	ug/g	0.65	0.0005					
Total PCB Congeners					1.6E-06	7.2E-06	8.6E-05	2.2E-01	1.8E-02
							TEQ (PCBs)	2.2E-01	1.8E-02
							Total TCDD TEQ	**1.9E+01**	**1.6E+00**

Notes:

[a] EPCs for mummichog tissue, see Attachment 1.

[b] Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % egg) from Cook *et al.* , 2003.

[c] Fish egg concentrations (mg/kg wet weight) estimated by multiplying the adult fish tissue concentration by the BMF and the ratio of the egg to female fish percent lipid and congener-specific TEF. The following lipid contents were assumed:

1.9 Average mummichog lipid percent in Lower Passaic River samples.

8.2 Average Lake trout egg lipid percentage (Cook *et al.* , 2003).

[d] Critical Body Residues (CBRs) thresholds derived as the Lower and Upper 95% Confidence Levels derived by Steevens *et al.* , 2005 (0.088 and 1.05 ngTCDD/glipid, respectively).

[e] Hazard Quotient is the ratio of the estimated tissue concentration to the LCL or UCL CBR.

HQs for shaded analytes not included in the HI totals.

#N/A, na - Not available/applicable.

ATTACHEMENT 5

Table 5-3.
Summary of Biomagnification Factors for Gull Embryo Tissue

Analyte	Gull (Adult Whole Body)[b]		Gulls (Liver)[b]		Gulls (Egg)[b]		Alewife[b]		Gull BMF (Whole Body:Alewife) (ww)[c]		Gull BMF (Whole Body:Alewife) (lipid basis)[c]		Gull Egg/Whole Body (lipid basis)[c]		Gull Egg/Alewife (lipid basis)[c]
Total DDT[d]	14	3.2	3.5	1.5	5.4	1.5	0.16		88	20	24		0.56	0.25	**13**
Dieldrin	0.28	0.09	0.12	0.04	0.12	0.04	0.017		16	5.1	4.5		0.63	0.24	**2.8**
Aroclor, Total	47	8.7	12	5.6	16	3.7	0.505		93	17	25		0.47	0.19	**12**
2,3,7,8-TCDD	127	37	72	30	83	19	4		32	9.2	8.6		0.81	0.33	**7.0**
1,2,3,4,6,7,8-HpCDD	6.8	4.9	25	20	6	0	nd		nc	nc	nc		1.60	0.43	
1,2,3,4,7,8-HxCDF	6.3	2.2	26	9.9	4.2	1.9	nd		nc	nc	nc		0.88	0.47	
1,2,3,6,7,8-HxCDD	20	2.5	40	15	16	5.8	1		20	2.5	5.4		1.10	0.68	**6.0**
1,2,3,6,7,8-HxCDF	6.3	2.3	22	9.9	4	1.2	nd		nc	nc	nc		0.84	0.4	
1,2,3,7,8-PeCDD	14	3.4	14	4.5	9.7	2.9	1		14	3.4	3.8		0.88	0.38	**3.3**
2,3,4,7,8-PeCDF	13	5.4	26	10	8.9	5.1	2		7	2.7	1.8		0.89	0.52	**1.6**
2,3,7,8-TCDF	2.6	1.3	2.4	1.3	nd		2		1	0.6	0.35		-	nc	
OCDD	7.6	4.8	40	27	8	4	nd		nc	nc	nc		1.60	0.92	
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	**1.7**	**0.315**	**0.42**	**0.20**	**0.50**	**0.11**	**0.012**		**121**	**25**	**33**		**0.39**	**0.15**	**13**
2,3,3',4,4',5-Hexachlorobiphenyl (156)	**3.6**	**0.7**	**0.91**	**0.406**	**1.3**	**0.305**	**0.031375**		**94**	**19.06**	**26**		**0.52**	**0.22**	**13**
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	0.54	0.12	0.07	0.03	0.08	0.01	0.003		180	41	49		0.22	0.09	**11**
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.51	0.08	0.22	0.12	0.1	0.04	0.005		102	16	28		0.22	0.08	**6.1**
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	**3.6**	**0.7**	**0.91**	**0.406**	**1.3**	**0.305**	**0.031375**		**94**	**19.06**	**26**		**0.52**	**0.22**	**13**
2,3,4,4',5-Pentachlorobiphenyl (114)	**1.5**	**0.352**	**0.41**	**0.212**	**0.576**	**0.16**	**0.029**		**57**	**12.32**	**15**		**0.52**	**0.19**	**8.0**
2,3',4,4',5-Pentachlorobiphenyl (118)	3.4	0.67	0.91	0.41	1.3	0.33	0.042		81	16	22		0.51	0.19	**11**
2,3',4,4',5'-Pentachlorobiphenyl (123)	**1.5**	**0.352**	**0.41**	**0.212**	**0.576**	**0.16**	**0.029**		**57**	**12.32**	**15**		**0.52**	**0.19**	**8.0**
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	**3.6**	**0.7**	**0.91**	**0.406**	**1.3**	**0.305**	**0.031375**		**94**	**19.06**	**26**		**0.52**	**0.22**	**13**
3,3',4,4',5-Pentachlorobiphenyl (126)	**1.5**	**0.352**	**0.41**	**0.212**	**0.58**	**0.16**	**0.029**		**57**	**12.32**	**15**		**0.52**	**0.19**	**8.0**
3,3',4,4'-Tetrachlorobiphenyl (77)	**0.5**	**0.138**	**0.15**	**0.07**	**0.17**	**0.053**	**0.014**		**41**	**10.7**	**12**		**0.52**	**0.2**	**6.0**
3,4,4',5-Tetrachlorobiphenyl (81)	**0.5**	**0.138**	**0.15**	**0.07**	**0.17**	**0.053**	**0.014**		**41**	**10.7**	**12**		**0.52**	**0.2**	**6.0**
Lipids (%)	10.3	2.2	4.2	0.9	7.7	0.8	2.8								

Notes:

a. Octanol-water partition coefficients as provided in USEPA, 1998 and supplemented by a query of the SRS Interactive LogKow database, 2003 (www.esc.syrres.com/interkow/kowdemo.htm).

b. Average wet-weight tissue concentrations (and standard deviations) measured in herring gulls (Lake Ontario) (Braune and Norstrom, 1989). All units in mg/kg except dioxins/furan congeners which are reported in ng/kg. nd - not detected, nc - not calculated.

c. Biomagnification Factors (BMFs) estimated as the ratio of the concentration (wet weight or lipid-normalized) in gull tissue divided by fish (or secondary tissue) concentration (wet weight or lipid-normalized). Stipled and bold formatting indicates pcb congeners whose uptake factors are based on homolouge group means (Braune and Norstrom, 1989).

d. Value for 4,4'-DDE.

ATTACHMENT 5

Table 5-4.
CBR-Based Hazard Quotients for Estimated Piscivorous Bird Embryo Tissue - Generic Fish Diet

COPEC	Generic Fish[a]	Units	Trout Female/ Egg BMF[b]	TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						NOAEL	LOAEL	NOAEL	LOAEL
Pesticides									
Dieldrin	3.8E-02	ug/g	2.8	na	1.4E-01	2.0E-01	8.1E+00	7.1E-01	1.7E-02
Total DDx	3.2E-01	ug/g	13.3	na	5.6E+00	5.0E-01	3.0E+00	**1.1E+01**	**1.9E+00**
							Total Pesticides	**1.2E+01**	**1.9E+00**
PCB - Aroclors									
Aroclor, Total	3.0E+00	ug/g	11.9	na	4.7E+01	7.0E-01	1.3E+00	**6.7E+01**	**3.6E+01**
							Total Aroclors	**6.7E+01**	**3.6E+01**
Dioxins					**TEQ**				
2,3,7,8-TCDD	2.4E-04	ug/g	7.0	1	2.2E-03				
1,2,3,7,8-PeCDD	2.7E-06	ug/g	3.3	1	1.2E-05				
1,2,3,7,8-PeCDF	1.6E-06	ug/g	#N/A	0.1					
2,3,4,7,8-PeCDF	1.3E-05	ug/g	1.6	1	2.7E-05				
1,2,3,6,7,8-HxCDD	5.1E-06	ug/g	6.0	0.01	4.0E-07				
1,2,3,4,6,7,8-HpCDD	1.1E-05	ug/g		0.001					
OCDD	1.4E-05	ug/g		0.0001					
1,2,3,4,7,8-HxCDF	1.0E-05	ug/g		0.1					
1,2,3,6,7,8-HxCDF	3.5E-06	ug/g		0.1					
2,3,7,8-TCDF	8.2E-06	ug/g		1					
1,2,3,4,7,8-HxCDD	1.2E-06	ug/g	#N/A	0.05					
1,2,3,7,8,9-HxCDD	1.1E-06	ug/g	#N/A	0.1					
1,2,3,7,8,9-HxCDF	na	ug/g	#N/A	0.1					
2,3,4,6,7,8-HxCDF	1.4E-06	ug/g	#N/A	0.1					
1,2,3,4,6,7,8-HpCDF	6.8E-06	ug/g	#N/A	0.01					
1,2,3,4,7,8,9-HpCDF	na	ug/g	#N/A	0.01					
OCDF	1.5E-06	ug/g	#N/A	0.0001					
Total Dioxin/Furan Congeners					2.3E-03	5.9E-05	1.5E-04	**3.9E+01**	**1.5E+01**
							TEQ (D/F)	**3.9E+01**	**1.5E+01**

ATTACHMENT 5

Table 5-4.
CBR-Based Hazard Quotients for Estimated Piscivorous Bird Embryo Tissue - Generic Fish Diet

COPEC	Generic Fish[a]	Units	Trout Female/ Egg BMF[b]	TEF	Estimated Egg Tissue Concentration[c]	CBR[d]		Hazard Quotients[e]	
						NOAEL	LOAEL	NOAEL	LOAEL
PCBs					**TEQ**				
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	2.7E-03	ug/g	12.8	0.00001	4.6E-07				
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	#N/A	ug/g	10.8	0.0001					
2,3,3',4,4',5-Hexachlorobiphenyl (156)	2.2E-02	ug/g	13.3	0.0001	3.8E-05				
2,3,3',4,4'-Pentachlorobiphenyl (105)	4.9E-02	ug/g	6.1	0.0001	3.9E-05				
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	9.0E-03	ug/g	13.3	0.00001	1.6E-06				
2,3',4,4',5'-Pentachlorobiphenyl (123)	2.6E-03	ug/g	8.0	0.00001	2.7E-07				
2,3,4,4',5-Pentachlorobiphenyl (114)	3.4E-03	ug/g	8.0	0.0001	3.6E-06				
2,3',4,4',5-Pentachlorobiphenyl (118)	1.3E-01	ug/g	11.2	0.00001	1.9E-05				
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	na	ug/g	13.3	0.001					
3,3',4,4',5-Pentachlorobiphenyl (126)	2.7E-04	ug/g	8.0	0.1	2.8E-04				
3,3',4,4'-Tetrachlorobiphenyl (77)	2.9E-03	ug/g	6.0	0.05	1.2E-03				
3,4,4',5-Tetrachlorobiphenyl (81)	1.9E-04	ug/g	6.0	0.1	1.5E-04				
Total PCB Congeners					1.7E-03	5.9E-05	1.5E-04	**2.9E+01**	**1.1E+01**
							TEQ (PCBs)	**2.9E+01**	**1.1E+01**
							Total TCDD TEQ	**6.7E+01**	**2.6E+01**
							Total	**1.8E+02**	**7.9E+01**

Notes:

[a] EPCs for generic fish tissue, see Attachment 1.

[b] Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % gull egg) presented in Table 5-1 (Attachment 5).

[c] Egg concentration for avian insectivore receptor (mg/kg wet weight) estimated by multiplying the fish tissue concentration by the BMF and the ratio of the egg to fish percent lipid and the congener-specific TEF. The following lipid contents were assumed:

5.9 Average generic fish lipid percent in Lower Passaic River samples.

7.7 Average gull egg lipid percentage (Braune and Norstrom, 1989).

[d] Critical Body Residues (CBRs) are obtained from summary of tissue effects data discussed in Section 4.2.

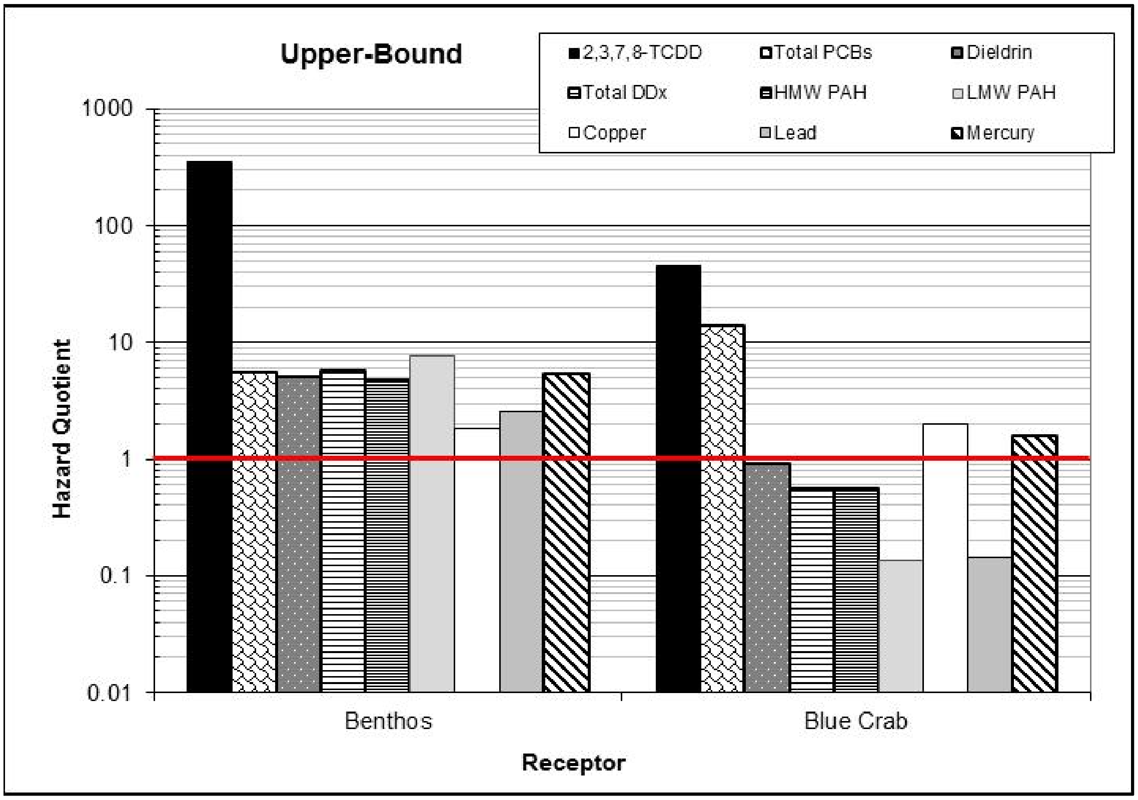
[e] Hazard Quotient is the ratio of the estimated tissue concentration to the NOAEL or LOAEL CBR.

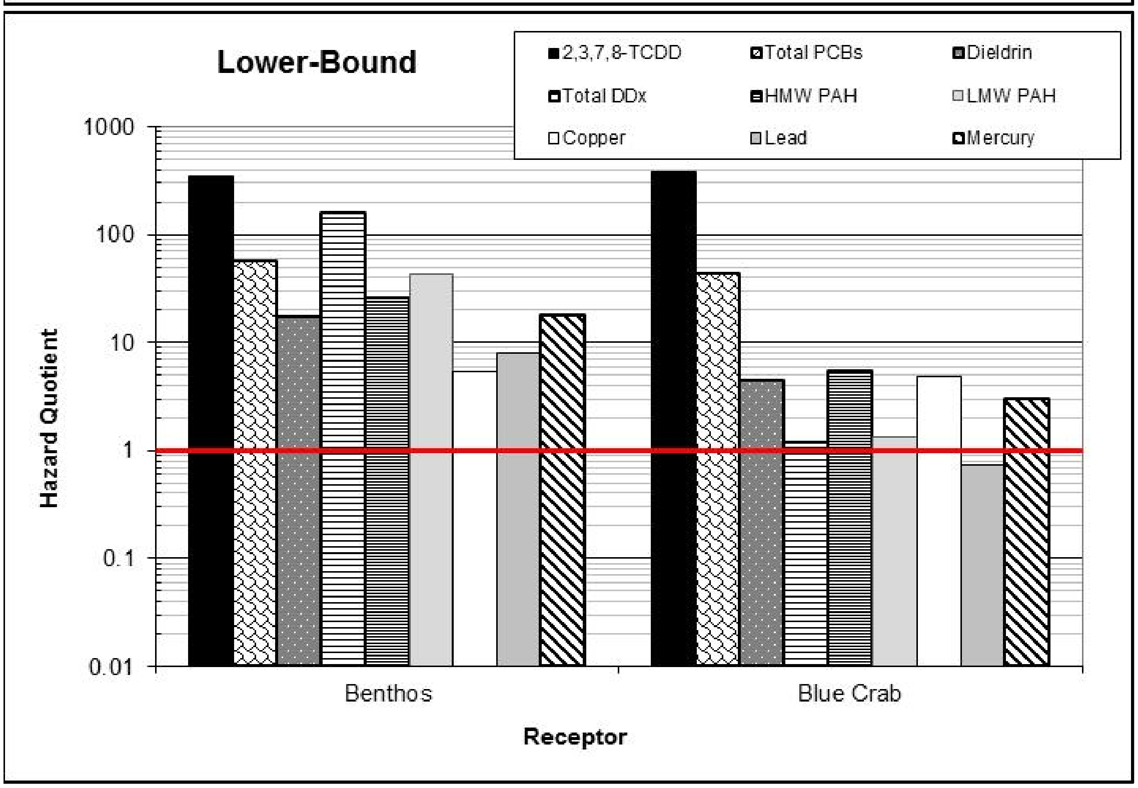
HQs for shaded analytes not included in the HI totals.

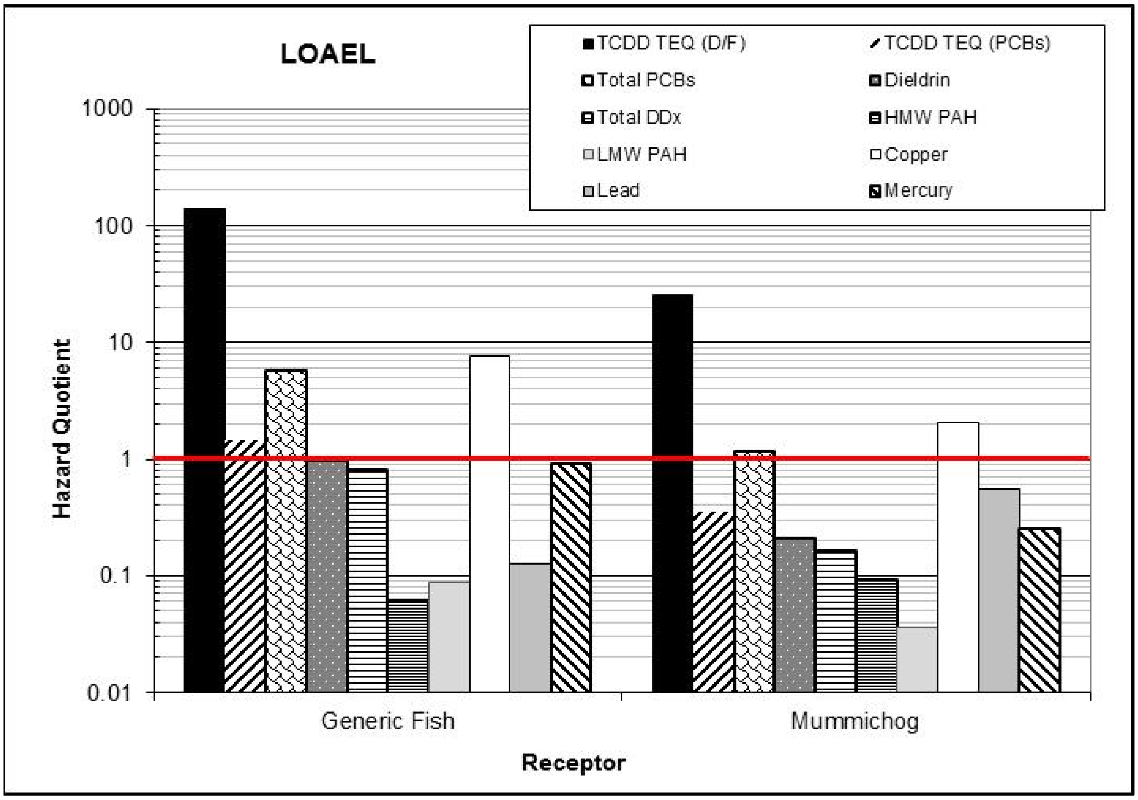
#N/A, na - Not available/applicable.

ATTACHMENT 6

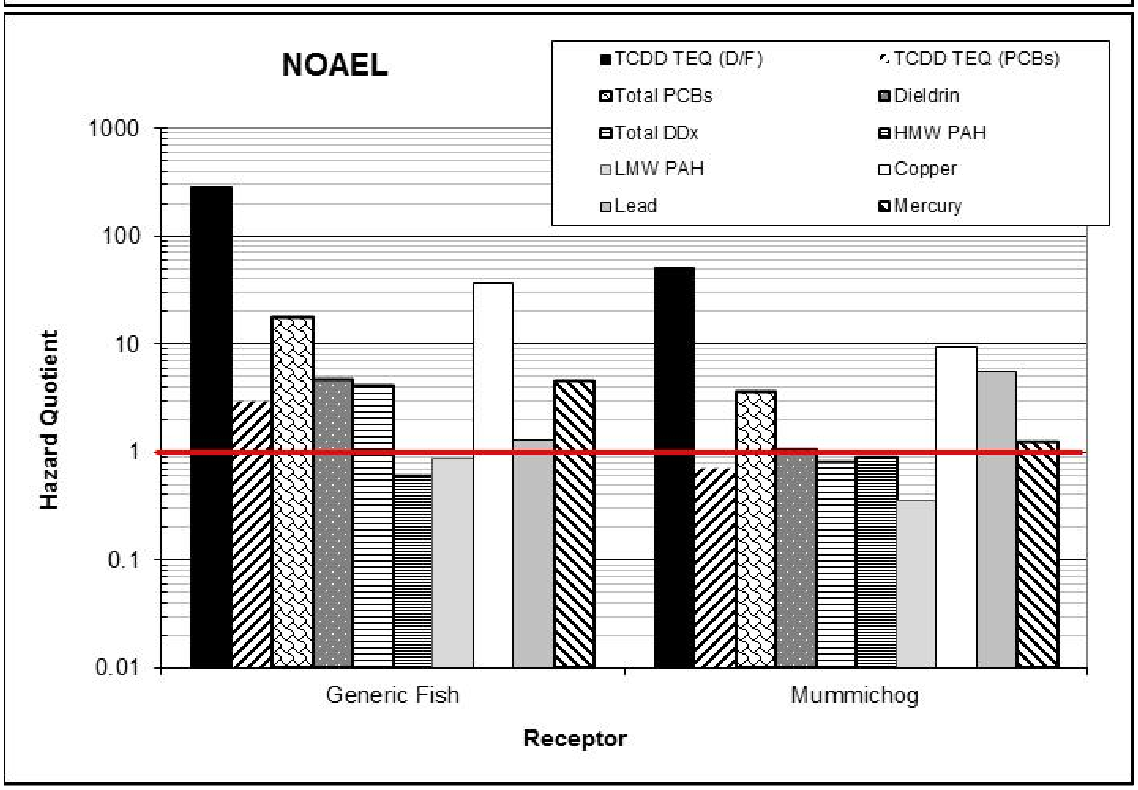
ECOLOGICAL RISK: CURRENT CONDITIONS


Upper-Bound
2,3,7,8-TCDD
Total PCBs
Dieldrin
Total DDx
HMW PAH
LMW PAH
Copper
Lead
Mercury
1000
100
10
1
0.1
0.01
Hazard Quotient
Benthos
Blue Crab
Receptor

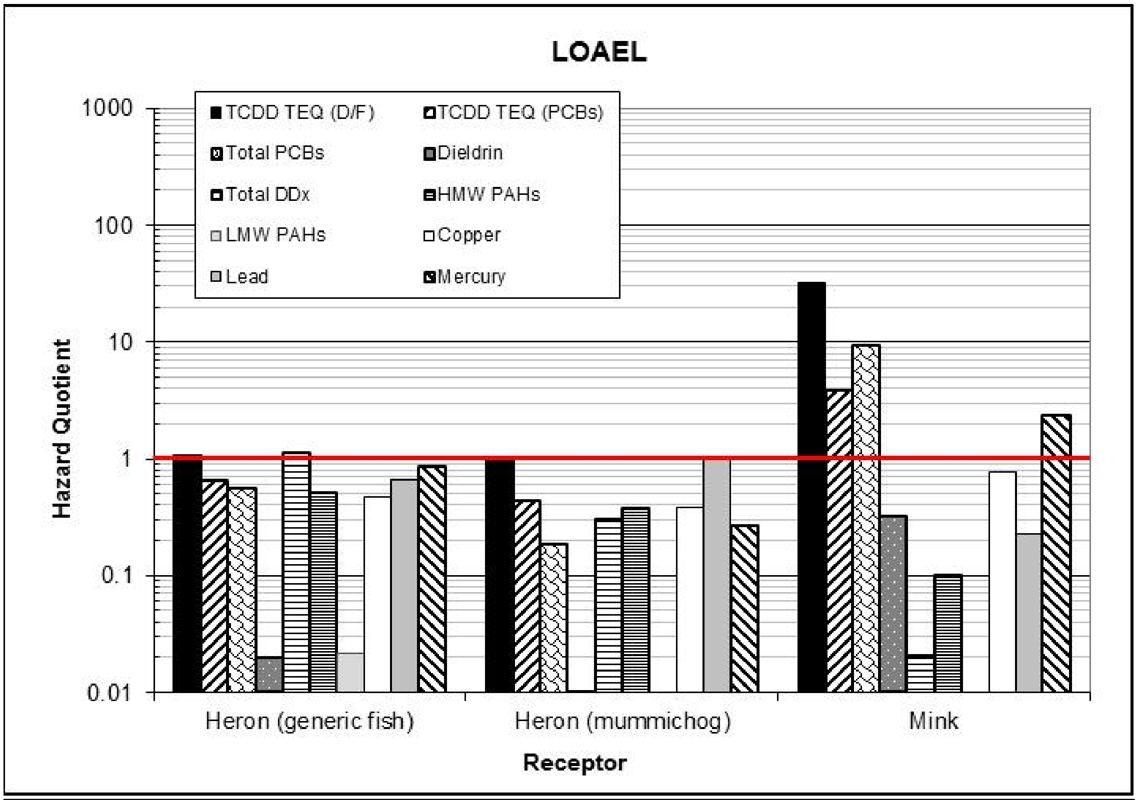

Lower-Bound
2,3,7,8-TCDD
Total PCBs
Dieldrin
Total DDx
HMW PAH
LMW PAH
Copper
Lead
Mercury
1000
100
10
1
0.1
0.01
Hazard Quotient
Benthos
Blue Crab
Receptor



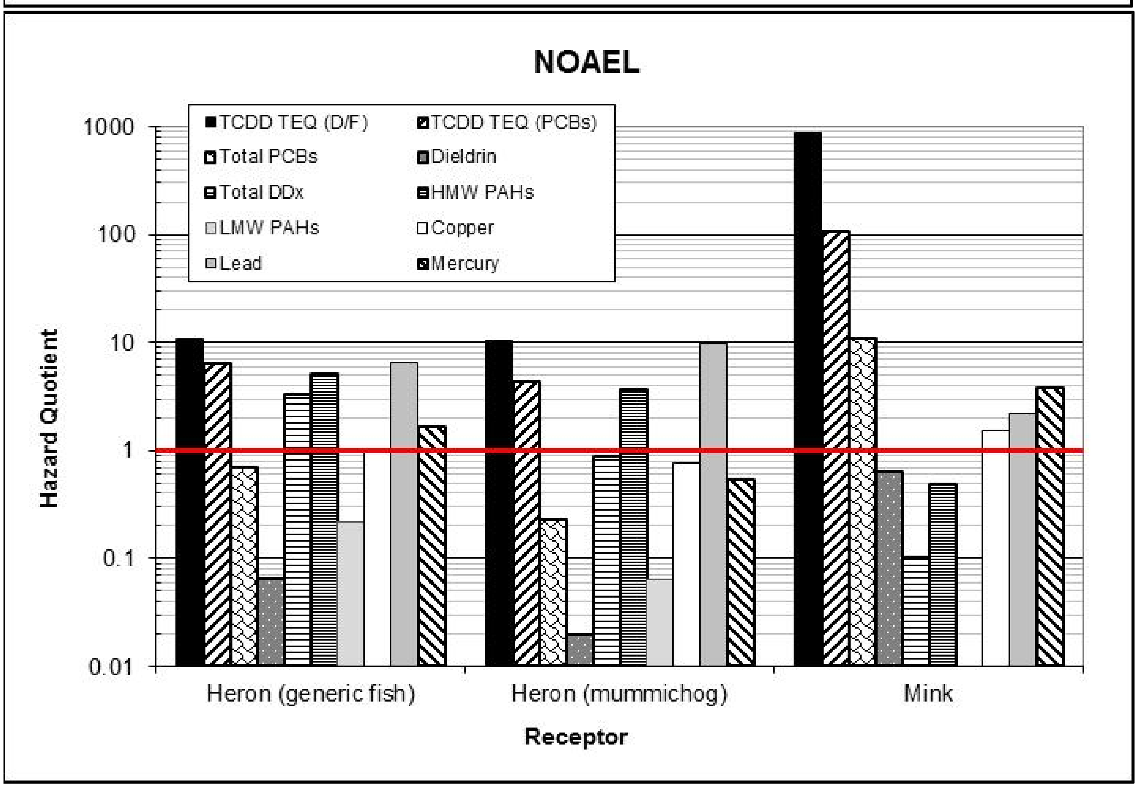
LOAEL
TCDD TEQ (D/F)
TCDD TEQ (PCBs)
Total PCBs
Dieldrin
Total DDx
HMW PAH
LMW PAH
Copper
Lead
Mercury
1000
100
10
1
0.1
0.01
Hazard Quotient
Generic Fish
Mummichog
Receptor



NOAEL
TCDD TEQ (D/F)
TCDD TEQ (PCBs)
Total PCBs
Dieldrin
Total DDx
HMW PAH
LMW PAH
Copper
Lead
Mercury
1000
100
10
1
0.1
0.01
Hazard Quotient
Generic Fish
Mummichog
Receptor



LOAEL
Hazard Quotient
1000
100
10
1
0.1
0.01
TCDD TEQ (D/F)
TCDD TEQ (PCBs)
Total PCBs
Dieldrin
Total DDx
HMW PAHs
LMW PAHs
Copper
Lead
Mercury
Heron (generic fish)
Heron (mummichog)
Mink
Receptor



NOAEL
Hazard Quotient
1000
100
10
1
0.1
0.01
TCDD TEQ (D/F)
TCDD TEQ (PCBs)
Total PCBs
Dieldrin
Total DDx
HMW PAHs
LMW PAHs
Copper
Lead
Mercury
Heron (generic fish)
Heron (mummichog)
Mink
Receptor

Table 6-1.
Summary of Selected Critical Body Residue Values for Estuarine Macroinvertebrate, Fish and Avian Embryo Tissue

COPEC	Test Organism		Endpoint	Reference	Uncertainty Factors			CBRs		Units	Notes
	Scientific Name	Common Name			UF_C	UF_L	UF_I	NOAEL	LOAEL		
Benthic Invertebrate Tissue											
2,3,7,8-TCDD	*Crassostrea virginica*	eastern oyster	reproduction	Wintermyer & Cooper, 2003	1	-	1	0.00000015	0.0000013	µg/g ww	Significant reduction in # of veligar larvae from fertilized eggs (4 vs 82) and fertilization (23.3% versus 53.7%) at Arthur Kill location (LOAEL) compared to Sandy Hook (NOAEL). Extrapolation factors were deemed unnecessary on account of the sensitive nature of the endpoint and receptor.
Total PCBs	*Crassostrea virginica*	eastern oyster	reproduction	Chu *et al*., 2000; Chu *et al*., 2003	1	-	1	0.008	0.026	µg/g ww	Egg tissue LOAEL (400 ngPCB/g) interpolated estimate experimental daily dose (.35 µg PCBs) based on ~200 and 671 ng PCB/g egg tissue concentrations for 0.1 and 1 µg PCB/day regimen (Chu et al, 2003); LOAEL converted to ww assuming 80% water and egg concentration converted to an equivalent maternal tissue concentration based on ratio of lipids - ~25% eggs (Kang *et al*., 2003) and ~8% adult tissue.
Dieldrin	*Penaeus duorarum*	pink shrimp	survival	Parrish *et al*., 1973	10	-	1	0.0016	0.008	µg/g ww	The LOAEL is based on body burden in shrimp associated with 25% mortality in animals exposed for 96 hours to a water concentration of 0.9 µg/l (Table 1); NOAEL is based on the experimental control in which all animals survived. A 10-fold A-C afactor was applied because the exposure was only 96 hours; however, no additional IS factor was deemed warranted as the pink shrimp appears to be among the most sensitive marine invertebrates.
Total DDx	*Penaeus duorarum*	pink shrimp	survival	Nimmo *et al*., 1970	1	-	1	0.06	0.13	µg/g ww	The LOAEL is based on body burden of shrimp that died within 28 days following exposure to 0.14 ppb DDT; NOAEL is total DDx in whole body shrimp that survived exposure to 0.05 ppb DDT for 56 days. No extrapolation factors were deemed necessary because study results are comparable to lowest ERED invertebrate tissue residue for invertebrate tissue based on survival, growth, and reproductive endpoints in the same species (Parrish et al., 1973; 0.08 and 0.01 µg/g ww for LOAEL and NOAEL, respectively).
LMW PAHs	*Nereis arenaceodentata*	polychaete worm	reproduction	Emery & Dillon, 1996	1	10	1	0.078	0.78	µg/g ww	Phenanthrene exposure associated with a ~33% decrease in fecundity (199 vs 299 eggs/brood) and 36% decrease in juvenile production (128 vs 201/brood). A 10-fold NOAEL-LOAEL EF applied; other EFs were not considered necessary due to the nature of the endpoint, chronic study exposure duration and study is among the lowest tissue residue effect levels for this class of compounds in the ERED database.
HMW PAHs	*Mytilus edulis*	blue mussel	reproduction	Eertman *et al*., 1995	1	10	1	0.022	0.22	µg/g ww	4-w exposure to fluoranthene with impaired gametogenesis including deformation of gametes and follicles; LOAEL based on the lowest exposure at 4 weeks adjusted assuming a 80% water content in mussels. A 10-fold LOAEL-NOAEL factor applied but others were not deemed necessary based on the sensitive nature of the endpoint.
Copper	*Macoma balthica*	Balthic macoma	survival	Absil *et al*., 1996	1	-	1	5	12	µg/g ww	LOAEL derived as the dw tissue concentration at Day 40 post exposure associated with a mean cumulative mortality of 46% (Copper + Food and Copper treatments, Table 2 & Figure 4); NOAEL based on tissue concentration associated with no deaths (Copper + EDTA treatment). LOAEL converted to ww assuming 80% water in mussels. No EF was deemed necessary due to the relatively sensitivity of bivalve mussels to copper exposure.
Lead	*Hyalella azteca*	amphipod	survival	Borgmann & Norwood, 1999	5	-	2	0.5	2.6	µg/g ww	The LOAEL is based on the 4-week LC_{25} (126nmol/g, Table 4); converted to µg/g ww basis by multiplying by mw (207 ngmol/ng), CF (1000ng/µg) and CF (0.2 dw/ww - assuming 80% moisture content). A 2-fold interspecies extrapolation factor was applied to the LOAEL and 5-fold A-C factor was applied - the IS factor to account for potential more sensitive species and the A-C to account for the specific endpoint (LC_{25}). For the latter a 5-fold factor was considered adequate due to the steep slope of the fitted regression equation between survival (mortality) and tissue burden.
Mercury	*Acartia tonsa* and *A. hudsonica*	copepods	reproduction	Hook & Fisher, 2002	1	-	1	0.048	0.095	µg/g ww	LOAEL based on reported tissue concentration of copepods were fed Hg contaminated phytoplankton for 4-hour exposure - 2.37 nmol/g dw as the LOAEL concentration resulting in a 50 reduction in eggs produced; NOAEL value estimated from Figure 1 (no egg depression at tissue concentrations µp to 1.2 nmol/g dw). LOAEL converted to ww assuming 80% water in copepods. No extrapolation factors were deemed necessary based on the sensitive nature of the endpoint (egg depression) and the presumed relative sensitivity of these zooplankton to mercury.

ATTACHMENT 6

Table 6-1.
Summary of Selected Critical Body Residue Values for Estuarine Macroinvertebrate, Fish and Avian Embryo Tissue

COPEC	Test Organism		Endpoint	Reference	Uncertainty Factors			CBRs		Units	Notes
	Scientific Name	Common Name			UF_C	UF_L	UF_I	NOAEL	LOAEL		
Fish Tissue											
2,3,7,8-TCDD	*Fundulus heteroclitus*	mummichog	behavior (prey capture ability), growth	Couillard *et al*., 2011	1	-	1	8.9E-07	1.8E-06	µg/g ww	Larval mummichog derived from eggs topically applied with 0.1 µl of 100pgPCB126/l had a tissue residue of 710 pg/g ww (Couillard et al., 2008); study NOAEL and LOAEL are based on eggs treated with 25pg/l and 50pg/l so assuming linear relationship between egg treatment and larval tissue residue this equates to larval tissue residues of 180 and 360 pgPCB126/g ww, respectively. Larval concentrations were converted to TCDD toxic equivalency by multiply by the WHO fish TEF (i.e., 0.005). No extrapolation factors were deemed necessary because of the nature of the endpoint and the µse of mummichogs from a naive population, which have been demonstrated to be as sensitive to PCB126 as lake trout based on EROD induction (Couillard et al., 2008).
Total PCBs	*Salmo salar*	Atlantic salmon	behavior (smolt seawater preference	Lerner *et al*., 2007	1	-	1	0.17	0.53	µg/g ww	NOAEL and LOAEL values based on mean concentrations in smolt derived from yolk-sac larvae exposed to 1 and 10 µg/l Arocloar 1254; a substantial decrease in volitional preference for seawater was observed in the high treatment group. No extrapolation factors were deemed necessary based on the sensitive nature of the endpoint and the known sensitivity and of salmonids and relevancy to the Lower Passaic River ichthyofauna.
Dieldrin	*Salmo gairdneri*	rainbow trout	survival	Shubat & Curtis, 1986	2	-	1	0.008	0.04	µg/g ww	LOAEL - reduced survival of fish following sixteen weeks exposure to 0.08 µg/l dieldrin in water and maintenance diet (no dieldrin); NOAEL based on 0.04 µg/l dieldrin exposure (Table 1). A 2-fold SC-C factor was applied to the results for the subchronic (4 month duration) study; no IS was deemed warranted because of the documented sensitivity of salmonids to organochlorine pesticide compounds.
Total DDx	-	various spp.	growth, reproduction, survival, behavior	Beckvar *et al*., 2005	1	5	1	0.078	0.39	µg/g ww	5th percentile LER with 5-fold NOAEL/LOAEL extrapolation factor applied; other EF not necessary due to µsed of the 5th percentile statistic.
LMW PAHs	*Pimephales prome*	fathead minnow	reproduction (decreased # eggs laid)	Hall & Oris, 1991	1	10	5	0.26	2.6	µg/g ww	Decreased reproductive output was observed in all treatment levels (0.6, 12, and 20 µg/L aqueous exposures for 6 weeks). LOAEL is interpolated (polynomial regression fit to data) female carcass concentrations associated with the 0.6 treatment level adjusted by a 5-fold interspecific EF; no A-C adjustment was deemed necessary based on the nature of the endpoint and ta 10-fold N-L factor applied to estimate the NOAEL.
HMW PAHs	*Psettichthys melanostichus*	Pacific sand sole	survival (reduced egg hatching success)	Hose *et al*., 1982	1	10	1	0.21	2.1	µg/g ww	LOAEL based on estimated benzo(a)pyrene concentration in yolk-sac larva from an experimental treatment that resulted in reduced egg hatching success (0.10 ppb aqueous exposure). A 10-fold LOAEL - NOAEL factor was aplied and No other EF was considered necessary due to the sensitive endpoint and life stage. Assumed that lipid content of larvae and adult fish are equivalent.
Copper	*Mugil cephalus*	striped mullet	survival	Zyadah & Abdel-Baky, 2000	5	-	1	0.32	1.5	µg/g ww	LOAEL derived at the 24-hour exposure to 10ppm copper, a treatment that was acutely toxic to these animals; NOAEL based on the 5ppm treatment; 5-fold A-C factor applied due to the short exposure period but other EF were not included due the documented sensitivity of this species to BaP.
Lead	*Salvelinus fontinalis*	brook trout	reproductive (reduced egg hatchability)	Holcombe *et al*. 1976	1	10	1	0.4	4	µg/g ww	Deformed spine in third generation; following 1st and 2nd generation exposure to 119 µg/L for µp to 2 years. Tissue residue in eggs of 0.402 µg/g ww (assuming 80% water) reeduced third generation embryo hatchability due to spine deformities
Mercury	-	various spp.	growth, reproduction, survival, behavior	Beckvar *et al*., 2005	1	5	1	0.052	0.26	µg/g ww	5th percentile LER with 5-fold NOAEL/LOAEL extrapolation factor applied; other EF not necessary due to µsed of the 5th percentile statistic.
Fish - Egg Tissue											
2,3,7,8-TCDD	-	various spp.	survival	Steevens *et al.*, 2005	1	1	1	0.0000072	0.000086	µg/g ww	Based on the 5th percentile of development effect concentrations (TEQs) summarized in Table 3-4.

ATTACHMENT 6

Table 6-1.
Summary of Selected Critical Body Residue Values for Estuarine Macroinvertebrate, Fish and Avian Embryo Tissue

COPEC	Test Organism		Endpoint	Reference	Uncertainty Factors			CBRs		Units	Notes
	Scientific Name	Common Name			UF_C	UF_L	UF_I	NOAEL	LOAEL		
Avian - Egg Tissue											
2,3,7,8-TCDD	-	various spp.	reproduction	USEPA, 2003	1	1	1	0.000059	0.00015	µg/g ww	Based on the 5th percentile of development effect concentrations (TEQs) summarized in Table 3-4.
Total PCBs	*Gallus gallus domesticus*	chicken	reproduction	Chapman, 2003	1	-	1	0.7	1.3	µg/g ww	NOAEL and LOAEL based on threshold ingestion doses (for Aroclor 1248) values obtained from Table 1. No EFs were applied because values derived µsing the chicken, which is known to be senstive to PCB effects.
Dieldrin	*Tyto alba*	barn owl	reproduction	Mendenhall *et al*., 1983	1	-	1	0.2	8.1	µg/g ww	Shell thickness reduced by 5.5% compared to control, no embyronic toxicity. Due to the sensitive endpoint and sensitive receptor, no extrapolation factors were applied.
Total DDx	*Pelecanus occidentalis*	brown pelican	reproduction (eggshell thinning)	Blus, 1984	1	-	1	0.5	3.0	µg/g ww	LOAEL is the "critical value" or the lowest level of DDE that would result in severely lowered reproductive success and population decline; NOAEL value is based on the range (ND to 1 µg/g, where success was lower than expected). Due to the sensitivity of this species no IS factor was deemed necessary.
LMW PAHs								na	na		
HMW PAHs	*Gallus gallus domesticus*	chicken	reproduction	Anwer & Mehrotra, 1988	1	10	1	0.1	1	µg/g ww	Significant growth retardation (body weight, leg length) effects following egg yolk injection (BaP) were observed at the 50 but not 5 µg/egg dose levels ; converted to a whole egg concentration assuming 50 g egg weight. Due to the sensitive endpoint and sensitive (gallinaceous) receptor, no extrapolation factors were applied.
Copper								na	na		
Lead								na	na		
Mercury	*Thryothorus ludovicianus*	Carolina wren	reproductive (nest success)	Jackson, 2011	1	10	1	0.011	0.11	µg/g ww	The LOAEL based on the egg concentration associated with a predicted 10% reduction in nest success based on a regression analysis.

Notes:

a.The following µncertainty Factors (Ufs) were applied µsing professional judgement: UF_C - converting short-term (acute) to long-term (chronic) exposures; UF_L - converting lowest observed adverse effect levels (LOAELs) to estimated no observed adverse effect levels (NOAELs); and UF_I - accounting for differences in sensitivity among different species or taxa.

b. Separate Critical Body Residues (CBRs) are derived for the lower and µpper bound of the toxicological threshold concentration (i.e., NOAELs and LOAELs).

Table 6-2.
Summary of Toxicity Reference Values for Aquatic-Dependent Wildlife Receptors

COPEC	Test Organism		Endpoint	Reference	Uncertainty Factors[a]			TRVs[b]		Units	Notes
	Scientific Name	Common Name			UF_C	UF_L	UF_I	NOAEL	LOAEL		
Avian - Ingestion											
2,3,7,8-TCDD	*Phasianus colchicus*	pheasant	mortality, growth, reproduction	Nosek et al., 1992a,b as cited in USEPA, 1995	1	-	5	2.8E-06	2.8E-05	µg/g-day	LOAEL based on dosing (equivalent to 140 pg/g-day) that resulted in significant decrease in egg production and complete mortality of embryos; no significant difference between control and the other treatment levels (1.4 and 14 pg/g-day). A 5-fold interspecific EF was applied because the pheasant is not the most sensitive avian receptor (Nosek, 1992b; Cohen-Barnhouse, 2010).
Total PCBs	*Gallus gallus domesticus*	chicken	reproduction	Chapman, 2003	1	-	1	0.4	0.5	µg/g-day	NOAEL and LOAEL based on threshold ingestion doses (for Aroclor 1248) values obtained from Table 1. No EFs were applied because values derived µsing the chicken, which is known to be senstive to PCB effects.
Dieldrin	*Numida meleagris*	Crowned guinea fowl	survival	Wiese *et al* ., 1968 as cited in USEPA, 2007	1	-	1	0.054	0.18	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for avifauna. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Total DDx	*Pelecanus occidentalis*	brown pelican	reproduction	Anderson *et al.* , 1975 as cited in USEPA, 1995 (GLI)	1	3	1	0.009	0.027	µg/g-day	LOAEL dose estimated in USEPA (1995) based on mean anchovy concentration (0.15 ppm total DDx) reported by Anderson et al., 1975; 1977, which was estimated to result in fledgling rate 30 percent below that estimated for long term population stability (USEPA, 1995). 3 fold extrapolation factor applied.
LMW PAHs	*Agaleius phoenicius*	redwing blackbird	survival	Shafer *et a* l, 1983	5	10	3	0.67	6.7	µg/g-day	Schafer et al. (1983) demonstrated thatacenaphthene, fluorene, anthracene, andphenanthrene are acutely toxic (48-h LD50) inred-winged blackbirds at concentrations of101, 101, 111, and 113 mg/kg body weight,respectively. Along with a 10 fold EF between LOAEL and NOAEL, a 5 fold EF between acute and chronic endpoints and a 3-fold interspecific EF were selected based on professional judgement.
HMW PAHs	*Columba livia*	pigeon	reproduction	Hough *et al* ., 1993	1	10	3	0.048	0.48	µg/g-day	Experimental pigeons were injected once weekly, intramuscularly, with BaP (10mg/kg body weight) and long term dosing resulted in complete infertility in females; LOAEL derived by converting the experimental dosing to a daily dose. The NOAEL was derived from the LOAEL assuming a 10-fold extrapolation factor and a 3-fold interspecific EF was also applied.
Copper	*Melagris gallopavo*	turkey	growth	Kashani *et al* ., 1986 as cited in USEPA, 2007	1	-	1	2.3	4.7	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for avifauna. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Lead	*Coturnix japonica*	Japanese quail	reproduction	Edens & Garlich, 1983 as cited in USEPA,	1	-	1	0.19	1.9	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for avifauna. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Mercury	*Anas platyrhynchos*	mallard	reproduction	Heinz, 1974, 1975, 1979 as derived in USEPA, 1995	1	2	3	0.013	0.026	µg/g-day	USEPA, 1995 derived a LOAEL of 0.5 ppm (as methylmercury) based on adverse reproductive effects documented in the Heinz et al studies; this equates to a LOAEL dose of 0.078 µg/g-day based on the average food ingestion rate for treated mallards (0..156 kg/kg day). The USEPA (1995) extrapolation factors were considered appropriate and were applied to develop the final NOAEL/LOAEL: a 3-fold interspecies EF and a 2-fold LOAEL - NOAEL factor (due to the fact that the identified LOAEL appeared to be near the threshold for effects. No Acute - Chronic EF was necessary based on the chronic exposure and nature of the endpoints considered.

ATTACHMENT 6

Table 6-2.
Summary of Toxicity Reference Values for Aquatic-Dependent Wildlife Receptors

COPEC	Test Organism		Endpoint	Reference	Uncertainty Factors[a]			TRVs[b]		Units	Notes
	Scientific Name	Common Name			UF_C	UF_L	UF_I	NOAEL	LOAEL		
Mammal - Ingestion											
2,3,7,8-TCDD	*Mustela vison*	mink	reproduction	Tillitt *et al* ., 1996	1	1	1	8.0E-08	2.2E-06	µg/g-day	NOAEL and LOAEL values obtained from Table 7. No EFs were applied because the mink is considered to be one of the most sensitive mammalian species to dioxin-like effects and the values are based on a chronic endpoint.
Total PCBs	*Mustela vison*	mink	reproduction	Chapman, 2003	1	-	1	0.069	0.082	µg/g-day	Threshold dietary concentration NOAEL and LOAEL values obtained from Table 1 and converted to equivalent daily dose µsing body weight (1 kg) and daily ingestion rate (0.137 kg-day) summarized in Sample et al. 1996. No EFs were applied because the mink is considered to be one of the most sensitive mammalian species to dioxin-like effects and the values are based on a chronic endpoint.
Dieldrin	*Rattus norvegicus*	rat	reproduction	Harr *et al* ., 1970 as cited in USEPA, 2005	1	-	1	0.015	0.03	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for wildlife. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Total DDx	*Rattus norvegicus*	rat	reproduction	Fitzhugh, 1948; as cited in Sample *et a* l., 1966	1	-	1	0.8	4	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for wildlife. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
LMW PAHs	*Rattus norvegicus*	rat	growth	Navarro *et al* ., 1991 as cited in USEPA, 2007	1	-	1	50	150	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result (for naphthalene) presented in the USEPA Eco SSL document for wildlife. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
HMW PAHs	*Mus musculus*	mouse	growth	Culp *et al* ., 1998 as cited in USEPA, 2007	1	-	1	0.62	3.1	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result (for benzo[a]pyrene) presented in the USEPA Eco SSL document for wildlife. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Copper	*Mustela vison*	mink	reproduction	Aulerich, 1982 at cited in USEPA, 2007	1	-	1	3.4	6.8	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for wildlife. Due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary.
Lead	*Rattus norvegicus*	rat	reproduction	Grant *et al* ., 1980 as cited in USEPA, 2005	1	-	1	0.71	7	µg/g-day	NOAEL and LOAEL values were selected as the lowest relevant bounded study result presented in the USEPA Eco SSL document for wildlife. Although the exposure was via drinking water consumption dietary exposure route rather than dietary this study was deemed most appropriate and due to the conservative approach µtilized, no interspecific or acute chronic extrapolation factors were deemed necessary .
Mercury	*Mustela vison*	mink	growth, reproduction	Wobeser *et al* ., 1976a,b as derived in USEPA, 1995	10	1	1	0.016	0.027	µg/g-day	Wobeser (1976b) fed adult female mink rations containing methylmercury for µp to 93 days. Clinical signs of mercury intoxication were observed at the diet concentration of 1.8 ppm total mercury. These exposures were converted to daily dose estimes µsing a body weight of 1 kg and food ingestion rate of 0.15 kg/day. Following USEPA 1995, only a 10 fold subchronic - chronic EF was applied based on the consideration of pathological alterations in the nervous system but no associated clinical evidence of toxicity observed at the 1.1 ppm level.

Notes:

a.The following µncertainty Factors (Ufs) were applied µsing professional judgement: UF_C - converting short-term (acute) to long-term (chronic) exposures; UF_L - converting lowest observed adverse effect levels (LOAELs) to estimated no observed adverse effect levels (NOAELs); and UF_I - accounting for differences in sensitivity among different species or taxa.

b. Separate Toxicity Reference Values (TRVs) are derived for the lower and upper bound of the toxicological threshold concentration (i.e., NOAELs and LOAELs).

Table 6-3.
Summary of Baseline Hazard Quotients for Benthic Macroinvertebrates Based on Sediment Benchmarks - Entire

COPEC	Units	Sediment Benchmark[a] Lower-Bound		Sediment Benchmark[a] Upper-Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	170	**5E+00**	**2E+00**
Lead	µg/g	30	1	94	1	240	**8E+00**	**3E+00**
Mercury	µg/g	0.14	1	0.48	1	2.6	**2E+01**	**5E+00**
						Total Inorganics/Metals	**3E+01**	**1E+01**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	24	**4E+01**	**8E+00**
HMW PAHs	µg/g	1.7	2	9.6	2	45	**3E+01**	**5E+00**
						Total PAHs	**7E+01**	**1E+01**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	0.015	**2E+01**	**5E+00**
Total DDx	µg/g	0.0016	2	0.046	2	0.26	**2E+02**	**6E+00**
						Total Pesticides	**2E+02**	**1E+01**
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	2.0	**6E+01**	**6E+00**
						Total PCBs	**6E+01**	**6E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.0011	**3E+02**	**3E+02**
						Total TCDD	**3E+02**	**3E+02**
						Total HI	**7E+02**	**4E+02**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005). The "Sig Only" approach defines toxic samples as those where there is less than 90% suvivial in the test and the results are significantly different from the negative control samples.

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Arthur Kill and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration (EPC) is based on the 95% Upper Confidence Level on the arithmetic mean of the values in the assessment data set as discussed in the text, rounded to two significant figures. EPCs are summarized in Table 4-1.

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 6-4.
Summary of Baseline Hazard Quotients for Benthic Macroinvertebrates Based on Sediment Benchmarks - Mudflats

COPEC	Units	Sediment Benchmark[a]				Sediment EPC[b]	Hazard Quotients[c]	
		Lower-Bound		Upper-Bound			Lower	Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	220	**7E+00**	**2E+00**
Lead	µg/g	30	1	94	1	320	**1E+01**	**3E+00**
Mercury	µg/g	0.14	1	0.48	1	5.8	**4E+01**	**1E+01**
						Total Inorganics/Metals	**6E+01**	**2E+01**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	6.4	**1E+01**	**2E+00**
HMW PAHs	µg/g	1.7	2	9.6	2	31	**2E+01**	**3E+00**
						Total PAHs	**3E+01**	**5E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	0.044	**5E+01**	**2E+01**
Total DDx	µg/g	0.0016	2	0.046	2	0.31	**2E+02**	**7E+00**
						Total Pesticides	**2E+02**	**2E+01**
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	6.6	**2E+02**	**2E+01**
						Total PCBs	**2E+02**	**2E+01**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.0045	**1E+03**	**1E+03**
						Total TCDD	**1E+03**	**1E+03**
						Total HI	**2E+03**	**1E+03**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005). The "Sig Only" approach defines toxic samples as those where there is less than 90% suvivial in the test and the results are significantly different from the negative control samples.

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Arthur Kill and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration (EPC) is based on the 95% Upper Confidence Level on the arithmetic mean of the values in the assessment data set as discussed in the text, rounded to two significant figures. EPCs are summarized in Table 4-1.

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 6-5.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue - Baseline Conditions

COPEC	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	24	5	12	*Macoma balthica*	Mortality - LD_{11}	1	**5E+00**	**2E+00**
Lead	µg/g	0.37	0.5	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	7E-01	1E-01
Mercury	µg/g	0.15	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**3E+00**	**2E+00**
						Total Inorganics/Metals		**9E+00**	**4E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.10	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4	**1E+00**	1E-01
HMW PAHs	µg/g	0.12	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	**6E+00**	6E-01
						Total PAHs		**7E+00**	7E-01
Pesticides									
Dieldrin	µg/g	0.0073	0.0016	0.008	*Penaeus duorarum*	Mortality - LOED	6	**5E+00**	9E-01
Total DDx	µg/g	0.071	0.06	0.13	*Penaeus duorarum*	Mortality - LOED	7	**1E+00**	5E-01
						Total Pesticides		**6E+00**	**1E+00**
PCBs (Aroclors)									
Total PCBs	µg/g	0.36	0.008	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**4E+01**	**1E+01**
						Total PCBs		**4E+01**	**1E+01**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.000058	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**4E+02**	**4E+01**
						Total TCDD		**4E+02**	**4E+01**
						Total HI		**5E+02**	**6E+01**

Notes:

[a] Exposure Point Concentrations (95% UCLs) based on blue crab tissue data as presented in Table 4-1.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR. Consistent with RAGs, only one significant figure is presented.

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Table 6-6.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue - Baseline Conditions

COPEC	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	12	0.32	1.5	*Mugil cephalus*	Mortality	1	**4E+01**	**8E+00**
Lead	µg/g	0.51	0.4	4	*Salvelinus fontinalis*	Reproduction	2	**1E+00**	1E-01
Mercury	µg/g	0.24	0.052	0.26	*various species*	LER_5	3	**5E+00**	9E-01
						Total Inorganics/Metals		**4E+01**	**9E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.23	0.26	2.6	*Pimephales promelas*	Reproduction	4	9E-01	9E-02
HMW PAHs	µg/g	0.13	0.21	2.1	*Psettichthys melanostictus*	Mortality - LD_{51}	5	6E-01	6E-02
						Total PAHs		**1E+00**	1E-01
Pesticides									
Dieldrin	µg/g	0.038	0.008	0.04	*Salmo gairdneri*	Mortality	6	**5E+00**	9E-01
Total DDx	µg/g	0.32	0.078	0.39	various species	LER_5	7	**4E+00**	8E-01
						Total Pesticides		**9E+00**	**2E+00**
PCBs (Aroclors)									
Total PCBs	µg/g	3.0	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**2E+01**	**6E+00**
						Total PCBs		**2E+01**	**6E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00025	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+02**	**1E+02**
TCDD TEQ (PCBs)	µg/g	0.0000026	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+00**	**1E+00**
						Total TCDD		**3E+02**	**1E+02**
						Total HI		**4E+02**	**2E+02**

Notes:

[a] Exposure Point Concentrations (95% UCLs) based on generic fish tissue data as presented in Table 4-1; TCDD Toxic Equivalencies based on fish TEF values.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR. Consistent with RAGs, only one significant figure is presented.

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Table 6-7.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue - Baseline Conditions

COPEC	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	3.1	0.32	1.5	*Mugil cephalus*	Mortality	1	**1E+01**	**2E+00**
Lead	µg/g	2.2	0.4	4	*Salvelinus fontinalis*	Reproduction	2	**6E+00**	6E-01
Mercury	µg/g	0.065	0.052	0.26	various species	LER_5	3	**1E+00**	3E-01
						Total Inorganics/Metals		**2E+01**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.093	0.26	2.6	*Pimephales promelas*	Reproduction	4	4E-01	4E-02
HMW PAHs	µg/g	0.19	0.21	2.1	*Psettichthys melanostictus*	Mortality - LD_{51}	4	9E-01	9E-02
						Total PAHs		**1E+00**	1E-01
Pesticides									
Dieldrin	µg/g	0.0084	0.008	0.04	*Salmo gairdneri*	Mortality	7	**1E+00**	2E-01
Total DDx	µg/g	0.063	0.078	0.39	various species	LER_5	3	8E-01	2E-01
						Total Pesticides		**2E+00**	4E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.62	0.17	0.53	*Salmo salar*	Behavior (survival)	6	**4E+00**	**1E+00**
						Total PCBs		**4E+00**	**1E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000046	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	8	**5E+01**	**3E+01**
TCDD TEQ (PCBs)	µg/g	0.00000063	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	8	7E-01	3E-01
						Total TCDD		**5E+01**	**3E+01**
						Total HI		**8E+01**	**3E+01**

Notes:

[a] Exposure Point Concentrations (95% UCLs) based on mummichog tissue data as presented in Table 4-1; TCDD Toxic Equivalencies based on fish TEF values.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR. Consistent with RAGs, only one significant figure is presented.

ATTACHMENT 6

TABLE 6-8
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment (entire sediment data set) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (entire sediment data set)
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	STIMATED DAILY INTAKE VIA SEDIMENT INGESTI(	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 6

TABLE 6-9

JLATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment (entire sediment data set) / I

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (entire sediment data set)
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.7E+02	mg/kg	8.5E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.7E-01	1.8E-01
Lead	2.4E+02	mg/kg	1.2E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	6.4E+00	6.4E-01
Mercury	4.4E-03	mg/kg	2.2E-05	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.7E-03	8.6E-04
LMW PAHs	2.4E+01	mg/kg	1.2E-01	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	1.8E-01	1.8E-02
HMW PAHs	4.5E+01	mg/kg	2.3E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.8E+00	4.8E-01
Total PCBs	2.0E+00	mg/kg	1.0E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.6E-02	2.1E-02
Dieldrin	1.5E-02	mg/kg	7.5E-05	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.4E-03	4.2E-04
Total DDx	2.6E-01	mg/kg	1.3E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.5E-01	4.9E-02
TCDD TEQ (D/F)	1.2E-03	mg/kg	6.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.2E+00	2.2E-01
TCDD TEQ (PCBs)	4.4E-04	mg/kg	2.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.0E-01	8.0E-02
							HAZARD INDICES:	1.5E+01	1.7E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-8.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 6

TABLE 6-10
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 6

TABLE 6-11
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	3.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.6E-01	7.9E-02
Lead	3.7E-01	mg/kg	5.7E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.0E-02	3.0E-03
Mercury	1.3E-01	mg/kg	1.9E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.5E-01	7.4E-02
LMW PAHs	1.0E-01	mg/kg	1.6E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	2.4E-03	2.4E-04
HMW PAHs	1.2E-01	mg/kg	1.9E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.9E-02	3.9E-03
Total PCBs	3.6E-01	mg/kg	5.5E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.4E-02	1.1E-02
Dieldrin	7.3E-03	mg/kg	1.1E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	2.1E-03	6.3E-04
Total DDx	7.1E-02	mg/kg	1.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.2E-01	4.1E-02
TCDD TEQ (D/F)	7.3E-05	mg/kg	1.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.0E-01	4.0E-02
TCDD TEQ (PCBs)	9.6E-05	mg/kg	1.5E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.3E-01	5.3E-02
							HAZARD INDICES:	1.4E+00	3.1E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-10.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-12
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Generic Fish / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Generic Fish
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 6

TABLE 6-13
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Generic Fish / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Generic Fish
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	1.0E+00	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.4E-01	2.2E-01
Lead	5.1E-01	mg/kg	4.5E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.4E-01	2.4E-02
Mercury	2.3E-01	mg/kg	2.0E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.5E+00	7.6E-01
LMW PAHs	2.3E-01	mg/kg	2.0E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	3.0E-02	3.0E-03
HMW PAHs	1.3E-01	mg/kg	1.1E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.3E-01	2.3E-02
Total PCBs	3.0E+00	mg/kg	2.6E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	6.6E-01	5.3E-01
Dieldrin	3.8E-02	mg/kg	3.3E-03	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	6.2E-02	1.8E-02
Total DDx	3.2E-01	mg/kg	2.8E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.1E+00	1.0E+00
TCDD TEQ (D/F)	2.6E-04	mg/kg	2.3E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.2E+00	8.2E-01
TCDD TEQ (PCBs)	1.7E-04	mg/kg	1.5E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.2E+00	5.2E-01
							HAZARD INDICES:	2.0E+01	3.9E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-12.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-14
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON
TOTAL RISK (HI): 3.6E+01

COPEC	Exposure Medium[a] Surface Water	Sediment (entire)	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		2.2E+00		4.0E-01	8.2E+00	*1.1E+01*	*30%*
Lead		6.4E+00		3.0E-02	2.4E-01	*6.7E+00*	*18%*
TCDD TEQ (PCBs)		8.0E-01		5.3E-01	5.2E+00	*6.5E+00*	*18%*
HMW PAHs		4.8E+00		3.9E-02	2.3E-01	*5.1E+00*	*14%*
Total DDx		1.5E-01		1.2E-01	3.1E+00	*3.3E+00*	9%
Mercury		1.7E-03		1.5E-01	1.5E+00	*1.7E+00*	5%
Copper		3.7E-01		1.6E-01	4.4E-01	9.7E-01	3%
Total PCBs		2.6E-02		1.4E-02	6.6E-01	7.0E-01	2%
LMW PAHs		1.8E-01		2.4E-03	3.0E-02	2.1E-01	1%
Dieldrin		1.4E-03		2.1E-03	6.2E-02	6.5E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E+01**	**-**	**1.4E+00**	**2.0E+01**	**3.6E+01**	
PERCENTAGE OF TOTAL RISK		**41%**		**4%**	**55%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-15
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (visitor w/ generic fish diet)
RECEPTOR: HERON
TOTAL RISK (HI): 5.9E+00

COPEC	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment (entire)	Aquatic Plants	Aquatic Invertebrates	Fish		
Total DDx		4.9E-02		4.1E-02	1.0E+00	*1.1E+00*	*19%*
TCDD TEQ (D/F)		2.2E-01		4.0E-02	8.2E-01	*1.1E+00*	*18%*
Mercury		8.6E-04		7.4E-02	7.6E-01	8.4E-01	*14%*
Lead		6.4E-01		3.0E-03	2.4E-02	6.7E-01	*11%*
TCDD TEQ (PCBs)		8.0E-02		5.3E-02	5.2E-01	6.5E-01	*11%*
Total PCBs		2.1E-02		1.1E-02	5.3E-01	5.6E-01	9%
HMW PAHs		4.8E-01		3.9E-03	2.3E-02	5.1E-01	9%
Copper		1.8E-01		7.9E-02	2.2E-01	4.8E-01	8%
LMW PAHs		1.8E-02		2.4E-04	3.0E-03	2.1E-02	0%
Dieldrin		4.2E-04		6.3E-04	1.8E-02	1.9E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.7E+00**	**-**	**3.1E-01**	**3.9E+00**	**5.9E+00**	
PERCENTAGE OF TOTAL RISK		**29%**		**5%**	**66%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 6

TABLE 6-16
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment (mudflats) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (mudflats)
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	STIMATED DAILY INTAKE VIA SEDIMENT INGESTI(	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 6-17
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment (mudflats) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (mudflats)
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.2E+02	mg/kg	1.1E+00	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	5.0E-01	2.4E-01
Lead	3.2E+02	mg/kg	1.7E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	8.7E+00	**8**.7E-01
Mercury	6.5E-03	mg/kg	3.3E-05	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.6E-03	1.3E-03
LMW PAHs	6.4E+00	mg/kg	3.3E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	4.9E-02	4.9E-03
HMW PAHs	3.1E+01	mg/kg	1.6E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.3E+00	3.3E-01
Total PCBs	6.6E+00	mg/kg	3.4E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	8.4E-02	6.7E-02
Dieldrin	4.4E-02	mg/kg	2.2E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	4.1E-03	1.2E-03
Total DDx	3.1E-01	mg/kg	1.6E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.7E-01	5.8E-02
TCDD TEQ (D/F)	4.7E-03	mg/kg	2.4E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.6E+00	8.6E-01
TCDD TEQ (PCBs)	1.3E-03	mg/kg	6.7E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.4E+00	2.4E-01
							HAZARD INDICES:	2.4E+01	2.7E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-16.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-18
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE 6-19
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	3.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.6E-01	7.9E-02
Lead	3.7E-01	mg/kg	5.7E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.0E-02	3.0E-03
Mercury	1.3E-01	mg/kg	1.9E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.5E-01	7.4E-02
LMW PAHs	1.0E-01	mg/kg	1.6E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	2.4E-03	2.4E-04
HMW PAHs	1.2E-01	mg/kg	1.9E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.9E-02	3.9E-03
Total PCBs	3.6E-01	mg/kg	5.5E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.4E-02	1.1E-02
Dieldrin	7.3E-03	mg/kg	1.1E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	2.1E-03	6.3E-04
Total DDx	7.1E-02	mg/kg	1.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.2E-01	4.1E-02
TCDD TEQ (D/F)	7.3E-05	mg/kg	1.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.0E-01	4.0E-02
TCDD TEQ (PCBs)	9.6E-05	mg/kg	1.5E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.3E-01	5.3E-02
							HAZARD INDICES:	1.4E+00	3.1E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-18.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-20
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 6-21

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	3.1E+00	mg/kg	2.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.2E-01	5.7E-02
Lead	2.2E+00	mg/kg	1.9E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E+00	1.0E-01
Mercury	5.7E-02	mg/kg	5.0E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.9E-01	1.9E-01
LMW PAHs	9.3E-02	mg/kg	8.1E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	1.2E-02	1.2E-03
HMW PAHs	1.9E-01	mg/kg	1.7E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.5E-01	3.5E-02
Total PCBs	6.2E-01	mg/kg	5.4E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.3E-01	1.1E-01
Dieldrin	8.4E-03	mg/kg	7.3E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.4E-02	4.1E-03
Total DDx	6.3E-02	mg/kg	5.5E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	6.1E-01	2.0E-01
TCDD TEQ (D/F)	4.8E-05	mg/kg	4.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E+00	1.5E-01
TCDD TEQ (PCBs)	4.7E-05	mg/kg	4.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E+00	1.5E-01
							HAZARD INDICES:	5.6E+00	1.0E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-20.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 6-22
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 3.1E+01

COPEC	Exposure Medium[a] Surface Water		Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		8.6E+00		4.0E-01	1.5E+00	*1.1E+01*	*34%*
Lead		8.7E+00		3.0E-02	1.0E+00	*9.7E+00*	*32%*
TCDD TEQ (PCBs)		2.4E+00		5.3E-01	1.5E+00	*4.4E+00*	*14%*
HMW PAHs		3.3E+00		3.9E-02	3.5E-01	*3.7E+00*	*12%*
Total DDx		1.7E-01		1.2E-01	6.1E-01	9.1E-01	3%
Copper		5.0E-01		1.6E-01	1.2E-01	7.7E-01	3%
Mercury		2.6E-03		1.5E-01	3.9E-01	5.4E-01	2%
Total PCBs		8.4E-02		1.4E-02	1.3E-01	2.3E-01	1%
LMW PAHs		4.9E-02		2.4E-03	1.2E-02	6.4E-02	0%
Dieldrin		4.1E-03		2.1E-03	1.4E-02	2.0E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.4E+01**	**-**	**1.4E+00**	**5.6E+00**	**3.1E+01**	
PERCENTAGE OF TOTAL RISK		**77%**		**5%**	**18%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE 6-23
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (visitor w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 4.0E+00

COPEC	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment (mudflat)	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		8.6E-01		4.0E-02	1.5E-01	*1.1E+00*	*26%*
Lead		8.7E-01		3.0E-03	1.0E-01	9.7E-01	*24%*
TCDD TEQ (PCBs)		2.4E-01		5.3E-02	1.5E-01	4.4E-01	*11%*
Copper		2.4E-01		7.9E-02	5.7E-02	3.8E-01	10%
HMW PAHs		3.3E-01		3.9E-03	3.5E-02	3.7E-01	9%
Total DDx		5.8E-02		4.1E-02	2.0E-01	3.0E-01	8%
Mercury		1.3E-03		7.4E-02	1.9E-01	2.7E-01	7%
Total PCBs		6.7E-02		1.1E-02	1.1E-01	1.9E-01	5%
LMW PAHs		4.9E-03		2.4E-04	1.2E-03	6.4E-03	0%
Dieldrin		1.2E-03		6.3E-04	4.1E-03	5.9E-03	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.7E+00**	**-**	**3.1E-01**	**1.0E+00**	**4.0E+00**	
PERCENTAGE OF TOTAL RISK		**67%**		**8%**	**25%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-24
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	ESTIMATED DAILY INTAKE VIA SEDIMENT INGEST	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE 6-25
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME
RECEPTOR: MINK

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.7E+02	mg/kg	9.9E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.9E-01	1.5E-01
Lead	2.4E+02	mg/kg	1.4E+00	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	2.0E+00	2.0E-01
Mercury	4.4E-03	mg/kg	2.6E-05	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.6E-03	9.7E-04
LMW PAHs	2.4E+01	mg/kg	1.4E-01	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	2.9E-03	9.6E-04
HMW PAHs	4.5E+01	mg/kg	2.7E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	4.4E-01	8.7E-02
Total PCBs	2.0E+00	mg/kg	1.2E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	1.8E-01	1.5E-01
Dieldrin	1.5E-02	mg/kg	8.8E-05	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	5.9E-03	2.9E-03
Total DDx	2.6E-01	mg/kg	1.6E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.0E-03	3.9E-04
TCDD TEQ (D/F)	1.2E-03	mg/kg	7.0E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	8.8E+01	3.1E+00
TCDD TEQ (PCBs)	2.8E-05	mg/kg	1.7E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.1E+00	7.6E-02
							HAZARD INDICES:	9.3E+01	3.8E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-24.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 6-26
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE 6-27
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME
RECEPTOR: MINK

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	1.4E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	4.3E-01	2.1E-01
Lead	3.7E-01	mg/kg	2.2E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	3.1E-02	3.2E-03
Mercury	1.3E-01	mg/kg	7.6E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	4.7E-01	2.8E-01
LMW PAHs	1.0E-01	mg/kg	6.3E-03	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	1.3E-04	4.2E-05
HMW PAHs	1.2E-01	mg/kg	7.3E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.2E-02	2.4E-03
Total PCBs	3.6E-01	mg/kg	2.2E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	3.1E-01	2.6E-01
Dieldrin	7.3E-03	mg/kg	4.4E-04	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	2.9E-02	1.5E-02
Total DDx	7.1E-02	mg/kg	4.3E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.4E-03	1.1E-03
TCDD TEQ (D/F)	6.3E-05	mg/kg	3.8E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.7E+01	1.7E+00
TCDD TEQ (PCBs)	9.0E-06	mg/kg	5.4E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	6.8E+00	2.4E-01
							HAZARD INDICES:	5.5E+01	2.7E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-26.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-28
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 6-29
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME
RECEPTOR: MINK

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	2.8E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	8.2E-01	4.1E-01
Lead	5.1E-01	mg/kg	1.2E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.7E-01	1.8E-02
Mercury	2.3E-01	mg/kg	5.5E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.4E+00	2.0E+00
LMW PAHs	2.3E-01	mg/kg	5.5E-02	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	1.1E-03	3.6E-04
HMW PAHs	1.3E-01	mg/kg	3.1E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	5.0E-02	1.0E-02
Total PCBs	3.0E+00	mg/kg	7.3E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	1.1E+01	8.9E+00
Dieldrin	3.8E-02	mg/kg	9.2E-03	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	6.1E-01	3.1E-01
Total DDx	3.2E-01	mg/kg	7.6E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	9.5E-02	1.9E-02
TCDD TEQ (D/F)	2.5E-04	mg/kg	6.0E-05	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	7.6E+02	2.7E+01
TCDD TEQ (PCBs)	3.3E-05	mg/kg	7.9E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	9.8E+01	3.5E+00
							HAZARD INDICES:	8.7E+02	4.2E+01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-28.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-30
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME
RECEPTOR: MINK
TOTAL RISK (HI): 1.0E+03

COPEC	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		8.8E+01		4.7E+01	7.6E+02	*8.9E+02*	*87%*
TCDD TEQ (PCBs)		2.1E+00		6.8E+00	9.8E+01	*1.1E+02*	*11%*
Total PCBs		1.8E-01		3.1E-01	1.1E+01	*1.1E+01*	1%
Mercury		1.6E-03		4.7E-01	3.4E+00	*3.9E+00*	0%
Lead		2.0E+00		3.1E-02	1.7E-01	*2.2E+00*	0%
Copper		2.9E-01		4.3E-01	8.2E-01	*1.5E+00*	0%
Dieldrin		5.9E-03		2.9E-02	6.1E-01	6.5E-01	0%
HMW PAHs		4.4E-01		1.2E-02	5.0E-02	5.0E-01	0%
Total DDx		2.0E-03		5.4E-03	9.5E-02	1.0E-01	0%
LMW PAHs		2.9E-03		1.3E-04	1.1E-03	4.1E-03	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.3E+01**	**-**	**5.5E+01**	**8.7E+02**	**1.0E+03**	
PERCENTAGE OF TOTAL RISK		**9%**		**5%**	**85%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-31
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME
RECEPTOR: MINK
TOTAL RISK (HI): 4.9E+01

COPEC	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		3.1E+00		1.7E+00	2.7E+01	*3.2E+01*	*65%*
Total PCBs		1.5E-01		2.6E-01	8.9E+00	*9.3E+00*	*19%*
TCDD TEQ (PCBs)		7.6E-02		2.4E-01	3.5E+00	*3.8E+00*	8%
Mercury		9.7E-04		2.8E-01	2.0E+00	*2.3E+00*	5%
Copper		1.5E-01		2.1E-01	4.1E-01	7.7E-01	2%
Dieldrin		2.9E-03		1.5E-02	3.1E-01	3.2E-01	1%
Lead		2.0E-01		3.2E-03	1.8E-02	2.2E-01	0%
HMW PAHs		8.7E-02		2.4E-03	1.0E-02	1.0E-01	0%
Total DDx		3.9E-04		1.1E-03	1.9E-02	2.1E-02	0%
LMW PAHs		9.6E-04		4.2E-05	3.6E-04	1.4E-03	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**3.8E+00**	**-**	**2.7E+00**	**4.2E+01**	**4.9E+01**	
PERCENTAGE OF TOTAL RISK		**8%**		**6%**	**87%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-32
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment (entire sediment data set) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (entire sediment data set)
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	STIMATED DAILY INTAKE VIA SEDIMENT INGESTI(	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

EPA/600/R-93/187a; December 1993; Washington, D.C.

Walsberg, G.E. and J.R.King, Jr., 1978. The relationship of the external surface area of birds to skin surface area and body mass;

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TABLE 6-33

JLATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment (entire sediment data set) / I

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (entire sediment data set)
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.7E+02	mg/kg	1.5E+00	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	6.3E-01	3.1E-01
Lead	2.4E+02	mg/kg	2.1E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-**d**	1.1E+01	1.1E+00
Mercury	4.4E-03	mg/kg	3.8E-05	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.0E-03	1.5E-03
LMW PAHs	2.4E+01	mg/kg	2.1E-01	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	3.1E-01	3.1E-02
HMW PAHs	4.5E+01	mg/kg	4.0E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.3E+00	8.3E-01
Total PCBs	2.0E+00	mg/kg	1.8E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	4.5E-02	3.6E-02
Dieldrin	1.5E-02	mg/kg	1.3E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	2.4E-03	7.2E-04
Total DDx	2.6E-01	mg/kg	2.3E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.5E-01	8.5E-02
TCDD TEQ (D/F)	1.2E-03	mg/kg	1.1E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.8E+00	3.8E-01
TCDD TEQ (PCBs)	4.4E-04	mg/kg	3.8E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.4E+00	1.4E-01
							HAZARD INDICES:	2.6E+01	2.9E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-32.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-34
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.
Windward, 2012. Avian Community Survey Data Report for the Lower Passaic River Study Area - Winter and Spring 2011; draft, prepared for Cooperating Parities Group (CPG) July.

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TABLE 6-35
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	6.3E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.8E-01	1.4E-01
Lead	3.7E-01	mg/kg	9.7E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	5.1E-02	5.1E-03
Mercury	1.3E-01	mg/kg	3.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.6E-01	1.3E-01
LMW PAHs	1.0E-01	mg/kg	2.8E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	4.1E-03	4.1E-04
HMW PAHs	1.2E-01	mg/kg	3.2E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.7E-02	6.7E-03
Total PCBs	3.6E-01	mg/kg	9.5E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.4E-02	1.9E-02
Dieldrin	7.3E-03	mg/kg	1.9E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	3.6E-03	1.1E-03
Total DDx	7.1E-02	mg/kg	1.9E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.1E-01	7.0E-02
TCDD TEQ (D/F)	7.3E-05	mg/kg	1.9E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.9E-01	6.9E-02
TCDD TEQ (PCBs)	9.6E-05	mg/kg	2.5E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	9.0E-01	9.0E-02
							HAZARD INDICES:	2.5E+00	5.2E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-34.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 6-36
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Generic Fish / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Generic Fish
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

Windward, 2012. Avian Community Survey Data Report for the Lower Passaic River Study Area - Winter and Spring 2011; draft, prepared for Cooperating Parities Group (CPG) July.

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TABLE 6-37
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Generic Fish / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Generic Fish
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	1.7E+00	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.6E-01	3.7E-01
Lead	5.1E-01	mg/kg	7.7E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.0E-01	4.0E-02
Mercury	2.3E-01	mg/kg	3.4E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.6E+00	1.3E+00
LMW PAHs	2.3E-01	mg/kg	3.4E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	5.1E-02	5.1E-03
HMW PAHs	1.3E-01	mg/kg	1.9E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.0E-01	4.0E-02
Total PCBs	3.0E+00	mg/kg	4.5E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-**d**	1.1E+00	9.0E-01
Dieldrin	3.8E-02	mg/kg	5.7E-03	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.1E-01	3.2E-02
Total DDx	3.2E-01	mg/kg	4.7E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	5.3E+00	1.8E+00
TCDD TEQ (D/F)	2.6E-04	mg/kg	3.9E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.4E+01	1.4E+00
TCDD TEQ (PCBs)	1.7E-04	mg/kg	2.5E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.9E+00	8.9E-01
							HAZARD INDICES:	3.4E+01	6.8E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-36.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 6-38
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON
TOTAL RISK (HI): 6.2E+01

COPEC	Exposure Medium[a] Surface Water	Sediment (entire)	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		3.8E+00		6.9E-01	1.4E+01	*1.9E+01*	*30%*
Lead		1.1E+01		5.1E-02	4.0E-01	*1.1E+01*	*18%*
TCDD TEQ (PCBs)		1.4E+00		9.0E-01	8.9E+00	*1.1E+01*	*18%*
HMW PAHs		8.3E+00		6.7E-02	4.0E-01	*8.7E+00*	*14%*
Total DDx		2.5E-01		2.1E-01	5.3E+00	*5.7E+00*	9%
Mercury		3.0E-03		2.6E-01	2.6E+00	*2.9E+00*	5%
Copper		6.3E-01		2.8E-01	7.6E-01	*1.7E+00*	3%
Total PCBs		4.5E-02		2.4E-02	1.1E+00	*1.2E+00*	2%
LMW PAHs		3.1E-01		4.1E-03	5.1E-02	3.7E-01	1%
Dieldrin		2.4E-03		3.6E-03	1.1E-01	1.1E-01	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.6E+01**	**-**	**2.5E+00**	**3.4E+01**	**6.2E+01**	
PERCENTAGE OF TOTAL RISK		**41%**		**4%**	**55%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-39
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (resident w/ generic fish diet)
RECEPTOR: HERON
TOTAL RISK (HI): 1.0E+01

COPEC	Exposure Medium[a] Surface Water	Sediment (entire)	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		8.5E-02		7.0E-02	1.8E+00	*1.9E+00*	*19%*
TCDD TEQ (D/F)		3.8E-01		6.9E-02	1.4E+00	*1.9E+00*	*18%*
Mercury		1.5E-03		1.3E-01	1.3E+00	*1.4E+00*	*14%*
Lead		1.1E+00		5.1E-03	4.0E-02	*1.1E+00*	*11%*
TCDD TEQ (PCBs)		1.4E-01		9.0E-02	8.9E-01	*1.1E+00*	*11%*
Total PCBs		3.6E-02		1.9E-02	9.0E-01	9.6E-01	9%
HMW PAHs		8.3E-01		6.7E-03	4.0E-02	8.7E-01	9%
Copper		3.1E-01		1.4E-01	3.7E-01	8.1E-01	8%
LMW PAHs		3.1E-02		4.1E-04	5.1E-03	3.7E-02	0%
Dieldrin		7.2E-04		1.1E-03	3.2E-02	3.3E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.9E+00**	**-**	**5.2E-01**	**6.8E+00**	**1.0E+01**	
PERCENTAGE OF TOTAL RISK		**29%**		**5%**	**66%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 6-40
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment (mudflats) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (mudflats)
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	STIMATED DAILY INTAKE VIA SEDIMENT INGESTIO	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.
EPA/600/R-93/187a; December 1993; Washington, D.C.
Walsberg, G.E. and J.R.King, Jr., 1978. The relationship of the external surface area of birds to skin surface area and body mass;

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TABLE 6-41

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment (mudflats) / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment (mudflats)
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.2E+02	mg/kg	2.0E+00	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	8.5E-01	4.2E-01
Lead	3.2E+02	mg/kg	2.8E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.5E+01	1.5E+00
Mercury	6.5E-03	mg/kg	5.7E-05	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.4E-03	2.2E-03
LMW PAHs	6.4E+00	mg/kg	5.6E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	8.4E-02	8.4E-03
HMW PAHs	3.1E+01	mg/kg	2.7E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.7E+00	5.7E-01
Total PCBs	6.6E+00	mg/kg	5.8E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.4E-01	1.2E-01
Dieldrin	4.4E-02	mg/kg	3.8E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	7.1E-03	2.1E-03
Total DDx	3.1E-01	mg/kg	2.7E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.0E-01	1.0E-01
TCDD TEQ (D/F)	4.7E-03	mg/kg	4.1E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E+01	1.5E+00
TCDD TEQ (PCBs)	1.3E-03	mg/kg	1.1E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.1E+00	4.1E-01
							HAZARD INDICES:	4.1E+01	4.6E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-40.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 6-42
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.
Windward, 2012. Avian Community Survey Data Report for the Lower Passaic River Study Area - Winter and Spring 2011; draft, prepared for Cooperating Parities Group (CPG) July.

ATTACHMENT 6

TABLE 6-43
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	6.3E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.8E-01	1.4E-01
Lead	3.7E-01	mg/kg	9.7E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	5.1E-02	5.1E-03
Mercury	1.3E-01	mg/kg	3.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.6E-01	1.3E-01
LMW PAHs	1.0E-01	mg/kg	2.8E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	4.1E-03	4.1E-04
HMW PAHs	1.2E-01	mg/kg	3.2E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.7E-02	6.7E-03
Total PCBs	3.6E-01	mg/kg	9.5E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.4E-02	1.9E-02
Dieldrin	7.3E-03	mg/kg	1.9E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	3.6E-03	1.1E-03
Total DDx	7.1E-02	mg/kg	1.9E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.1E-01	7.0E-02
TCDD TEQ (D/F)	7.3E-05	mg/kg	1.9E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.9E-01	6.9E-02
TCDD TEQ (PCBs)	9.6E-05	mg/kg	2.5E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	9.0E-01	9.0E-02
							HAZARD INDICES:	2.5E+00	5.2E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-42.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 6

TABLE 6-44
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	Windward, 2012	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

Windward, 2012. Avian Community Survey Data Report for the Lower Passaic River Study Area - Winter and Spring 2011; draft, prepared for Cooperating Parities Group (CPG) July.

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TABLE 6-45
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON

COPEC	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	3.1E+00	mg/kg	4.6E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.0E-01	9.8E-02
Lead	2.2E+00	mg/kg	3.3E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.7E+00	1.7E-01
Mercury	5.7E-02	mg/kg	8.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	6.6E-01	3.3E-01
LMW PAHs	9.3E-02	mg/kg	1.4E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	2.1E-02	2.1E-03
HMW PAHs	1.9E-01	mg/kg	2.8E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.9E-01	5.9E-02
Total PCBs	6.2E-01	mg/kg	9.2E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.3E-01	1.8E-01
Dieldrin	8.4E-03	mg/kg	1.3E-03	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	2.3E-02	7.0E-03
Total DDx	6.3E-02	mg/kg	9.4E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.0E+00	3.5E-01
TCDD TEQ (D/F)	4.8E-05	mg/kg	7.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.6E+00	2.6E-01
TCDD TEQ (PCBs)	4.7E-05	mg/kg	7.0E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.5E+00	2.5E-01
							HAZARD INDICES:	9.6E+00	1.7E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-44.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 6-46
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 5.3E+01

COPEC	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment (mudflat)	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.5E+01		6.9E-01	2.6E+00	*1.8E+01*	*34%*
Lead		1.5E+01		5.1E-02	1.7E+00	*1.7E+01*	*32%*
TCDD TEQ (PCBs)		4.1E+00		9.0E-01	2.5E+00	*7.5E+00*	*14%*
HMW PAHs		5.7E+00		6.7E-02	5.9E-01	*6.4E+00*	*12%*
Total DDx		3.0E-01		2.1E-01	1.0E+00	*1.6E+00*	3%
Copper		8.5E-01		2.8E-01	2.0E-01	*1.3E+00*	3%
Mercury		4.4E-03		2.6E-01	6.6E-01	9.2E-01	2%
Total PCBs		1.4E-01		2.4E-02	2.3E-01	4.0E-01	1%
LMW PAHs		8.4E-02		4.1E-03	2.1E-02	1.1E-01	0%
Dieldrin		7.1E-03		3.6E-03	2.3E-02	3.4E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**4.1E+01**	**-**	**2.5E+00**	**9.6E+00**	**5.3E+01**	
PERCENTAGE OF TOTAL RISK		**77%**		**5%**	**18%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 6

TABLE 6-47
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: RME (resident w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 6.8E+00

COPEC	Exposure Medium[a] Surface Water	Sediment (mudflat)	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		1.5E+00		6.9E-02	2.6E-01	*1.8E+00*	*26%*
Lead		1.5E+00		5.1E-03	1.7E-01	*1.7E+00*	*24%*
TCDD TEQ (PCBs)		4.1E-01		9.0E-02	2.5E-01	7.5E-01	*11%*
Copper		4.2E-01		1.4E-01	9.8E-02	6.5E-01	10%
HMW PAHs		5.7E-01		6.7E-03	5.9E-02	6.4E-01	9%
Total DDx		1.0E-01		7.0E-02	3.5E-01	5.2E-01	8%
Mercury		2.2E-03		1.3E-01	3.3E-01	4.6E-01	7%
Total PCBs		1.2E-01		1.9E-02	1.8E-01	3.2E-01	5%
LMW PAHs		8.4E-03		4.1E-04	2.1E-03	1.1E-02	0%
Dieldrin		2.1E-03		1.1E-03	7.0E-03	1.0E-02	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**4.6E+00**	**-**	**5.2E-01**	**1.7E+00**	**6.8E+00**	
PERCENTAGE OF TOTAL RISK		**67%**		**8%**	**25%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 7

DEVELOPMENT OF EPCs FOR FUTURE CONDITIONS AND RISK SENSITIVITY ANALYSIS

In order to evaluate the effectiveness of the remedial alternatives, potential future risks to human health and ecological receptors were calculated assuming four remediation alternatives (as described in the FFS):

- Alternative 1: No Action
- Alternative 2: Deep Dredging with Backfill
- Alternative 3: Capping with Dredging for Flooding and Navigation
- Alternative 4: Focused Capping with Dredging for Flooding

The same COPCs/COPECs evaluated for the baseline scenarios were also selected as COPCs/COPECs for the future scenarios. All environmental media evaluated in the baseline risk scenarios were also evaluated in the future risk scenarios. For human health, exposure to COPCs via ingestion of fish and blue crab was of concern, while exposure to COPECs in sediment, fish, and blue crab was of concern for the ecological receptors. Contaminant transport models (HydroQual, 2007) were employed to predict surface sediment concentrations for each of the remediation scenarios as average annual concentrations for the COPCs/COPECs over a 30-year time period post-remediation to coincide with the total exposure duration of 30 years used in the HHRA. Remedy construction was assumed to begin in March 2018; however, each of the active remedial alternatives varied with respect to remedy completion. Therefore, the actual 30-year exposure duration time period varied for each active alternative. Table 7-1 summarizes the remedy construction schedule for each of the alternatives and the beginning and end year for the 30-year exposure duration time period. These annualized sediment concentrations were then used to develop EPCs for sediment, fish, and blue crab for each of the remediation alternatives.

Future sediment concentrations for mercury, Total PCBs, DDD, DDE, DDT, Total DDx, TCDD TEQ (PCBs) and TCDD TEQ (D/F) were estimated using the Lower Passaic River-Newark Bay (LPR-NB) (based largely on the model developed for NY/NJ Harbor Contaminant Assessment and Reduction Project [CARP] [HydroQual, 2007]). Not all of the COPCs/COPECs could be modeled using the LPR-NB Model; therefore, results for copper, lead, chlordane and HMW PAHs were obtained from the Empirical Mass Balance Model (EMBM) that is described in Appendix C. Dieldrin and LMW PAHs could not be forecasted with either model due to geochemical constructs inherent in both models; therefore, these COPCs/COPECs could not be included in the future risk evaluations. Model descriptions are provided in Appendix B for the LPR-NB Model and Appendix C for the EMBM. The following subsections explain how the predicted average annualized surface sediment concentrations generated from the models were used to derive EPCs for the future risk assessments.

7.1 Calculations of Future EPCs

For each remedial alternative, the models generated average annualized surface sediment concentrations for the FFS Study Area over time. An example of the data generated from the models for the risk assessments is provided in Table 7-2. Figure 7-1 shows the annual average surface sediment concentrations over time predicted by the LPR-NB Model under each of the remedial alternatives and Figure 7-2 shows the annual average surface sediment concentrations over time predicted by the EMBM under each of the remedial alternatives. Surface sediment concentrations modeled using the LPR-NB exhibit an overall decreasing trend; however, concentrations continue to fluctuate over time due to resuspension of legacy sediments and/or contributions from outside sources. Surface sediment concentrations modeled using the EMBM exhibit increasing concentrations over time immediately following completion of the remedial action and appears to begin leveling off and reaching equilibrium after approximately 30 years. Calculation of future exposure point concentrations (EPCs) for sediment was strictly based on the predicted average annualized surface sediment concentrations generated from the models.

For protection of human health, future EPCs were developed for the COPCs in order to account for the variable nature of the surface sediment concentrations over a 30-year time period (as depicted on Figures 7-1 and 7-2) and the exposure duration (ED) component of the risk/hazard equation. Therefore, a sliding scale of annual averages based on the ED for each receptor (*e.g.*, 6 years for the child and 24 years for the adult) and when each exposure period might begin and end was determined for the total 30-year ED time period. The maximum annual rolling average for the receptor-specific ED was selected for EPC to ensure the EPC was not biased low because of a downward trend (*i.e*., Figure 7-1) or because the annual average was derived soon after the remedy was completed (*i.e*., Figure 7-2). As such, the maximum annual average of all 6-year time periods for the child and 24-year time periods for the adult is used to evaluate exposure risk for each receptor.

Table 7-3 presents the six-year and 24-year rolling annual average sediment concentrations for Total PCBs as an example of how the maximum annual averages were determined based on the sliding ED scale process. For each alternative, six- and 24-year rolling averages were calculated, depending on the remedy implementation date for that alterative (see Table 7-1) and continuing 30 years post implementation. The yellow highlighted cells in Table 7-3 indicate sediment concentrations during remedy implementation (which were not used to calculate rolling averages), while the orange highlighted cells depict the concentrations within the 30-year ED time period. Maximum rolling average sediment concentrations identified within the 30-year ED time period, denoted as bolded text in Table 7-3, were then selected to calculate the biota tissue EPC. Table 7-4 summarizes the maximum rolling annual average sediment concentrations for all COPCs used to determine future biota tissue EPCs for each of the receptors and remedial alternatives for the future modeled HHRA.

For ecological receptors, sediment EPCs were represented by average annual concentrations estimated for the first year immediately following completion of the remediation and at 30 years post implementation.

Unlike the current risk assessment which uses 95 percent upper confidence limits UCLs as the EPCs, the EPCs used to assess future conditions are based on average sediment concentrations generated directly from a deterministic model (either the LPR-NB or EMBM model, depending on the COPEC), as discussed above. Because the EPCs are based upon modeled projections of future concentrations, the typical approach used in Superfund risk assessments of calculating a 95 percent UCL on a mean concentration is not applicable. One reason for its inapplicability is that the use of the 95 percent UCL calculation is based upon the idea that the estimate of the mean EPC from a finite sample set is uncertain and is a function of the number of samples available to estimate the true mean. However, when a model is used to predict the EPC there is no corollary to sample size; with a model an almost unlimited number of model-predicted values can be calculated. As the number of model-projected concentration estimates increases (in time or space), the model mean and model 95 percent UCL (calculated from the finite number of model estimates) converge to the same value.

Future EPCs for biota were estimated from the modeled sediment concentrations using the results of analyses conducted to develop site-specific sediment-tissue relationships for the FFS Study Area (as described in detail in Appendix A, Data Evaluation Report No. 6). As fully described in Appendix A, a statistical analysis of tissue chemistry data was conducted for American eel, white perch, blue crab and mummichog (species evaluated in the risk assessments) and corresponding Lower Passaic River and regional surface sediment contaminant concentrations. During this statistical analysis, two statistical regression models were developed to describe the relationship between chemical concentrations in fish or invertebrate tissue and surface sediment. Models were developed for primary risk-driving COPCs and COPECs in whole body biota tissue of American eel, blue crab, and mummichog and for fillet tissue of white perch. In addition to the sediment concentration of a given chemical, lipid content, sediment iron and organic carbon concentrations were included in the selected models used to predict biota tissue concentrations. The regression model derived for mercury was based on tissue chemistry data for elemental mercury, which was more extensively analyzed than methylmercury. It was conservatively assumed that mercury tissue residues in FFS Study Area biota consist entirely of the methylmercury form. This conservative assumption will tend to overestimate risks.

In most cases, it was determined that the functional relationship between COPC and COPEC concentrations in sediment and biological tissue could best be described using regression models. However, Biota Sediment Accumulation Factors (BSAFs) were calculated to estimate Total PCB concentrations in white perch and American eel, and Bioaccumulation Factors (BAFs) were calculated to estimate copper concentrations in white perch, American eel and mummichog based on concentrations of these constituents in sediment. The statistical regression models for organic and inorganic contaminants that were determined to best describe the relationship between the analytical chemistry data in tissue residues and sediment are shown with Table 7-5, which provides four example calculations for deriving tissue concentrations from sediment concentrations for select COPC/COPECs for each of the receptors. Table 7-6 summarizes the regression model coefficients (*i.e.*, β_i terms), BSAF and BAF values for all COPCs/COPECs for all species.

Table 7-7 summarizes the specific f_L values for each tissue and species (*i.e.*, American eel, white perch, mummichog and crab) used to estimate future exposure concentrations as well as develop sediment PRGs. The site-specific f_{OC} value is the average fractional total organic carbon concentration (*i.e.*, 0.0466 g/g sediment) in surficial sediment samples throughout the FFS Study Area, and is presented in Table 7-8. Table 7-8 also presents the site-specific f_{iron} value (0.0251 g per g sediment) is the average fractional iron concentration in surficial sediment samples throughout the FFS Study Area.

For purposes of developing future tissue EPCs for the HHRA, it is assumed that they are based on fillet tissue concentrations, rather than whole fish tissue concentrations, for the white perch and American eel. This assumption is consistent with the HHRA, wherein exposure point concentrations for consumption of fish were derived using fillet tissue samples. The regression analyses for the American eel, however, were conducted using whole body samples because the number of fillet samples was not sufficient to develop a robust relationship between sediment and tissue concentrations. Therefore, chemical-specific "tissue multipliers" are applied to the American eel tissue concentrations to convert the whole tissue concentrations to fillet tissue concentrations. The tissue multiplier is the ratio of the average fillet tissue concentration to the average whole body tissue concentration and was derived using the 2009 late summer/early fall data (Appendix A). Equation 1 was used to estimate future American eel fillet tissue concentrations for human health COPCs:

$$C_F = C_W \times \frac{Lipid{-}normalized\ mean\ fillet\ concentation\ for\ COPC\ X}{Lipid{-}normalized\ mean\ whole\ body\ concentration\ for\ COPC\ X} \times \frac{Fillet\ lipid\ fraction}{Whole\ body\ lipid\ fraction}$$

Equation 1

where:

C_F: Fish fillet tissue concentration (µg COPC or COPEC/g biota)

C_W: Whole body fish tissue concentration (µg COPC or COPEC/g biota)

Similarly, whole body multipliers were applied to the available white perch fillet data to estimate appropriate tissue concentrations for use in developing EPC for the BERA. Equation 2 was used to estimate future whole body tissue concentrations for ecological COPECs in white perch:

$$C_W = C_F \times \frac{\text{Lipid-normalized mean whole body concentration for COPEC Y}}{\text{Lipid-normalized mean fillet concentration for COPEC Y}} \times \frac{\text{Whole body lipid fraction}}{\text{Fillet lipid fraction}}$$

Equation 2

No multipliers were necessary for blue crab tissue because the tissue type (*e.g*., muscle + hepatopancreas) evaluated in both the baseline HHRA and BERA is consistent with the dataset used in the regression analyses. The approach used to estimate future whole-body mummichog tissue is similar and differed only in the specific regression model parameters and average lipid content assumed.

Tables 7-9 summarizes the predicted biota EPCs used in the future modeled HHRA. The EPC for fish in the HHRA is the average of the white perch and American eel tissue concentrations (*i.e*., average of the C_f). Table 7-10 summarizes the sediment and biota EPCs used in the future modeled BERA.

7.2 Future Risk Sensitivity Analysis

Measured sediment and tissue concentrations were used to estimate baseline exposures for the residue- and dose-based analyses. One of the primary uncertainties associated with application of these sediment and tissue data to the risk assessment are analytical chemistry measurement errors. Additional sources of uncertainty include how well the data used to estimate environmental exposures represent actual exposures, therelative appropriateness of specific ecotoxicological and exposure parameters applied for the risk estimate, and various assumptions regarding the spatial and temporal context of the risk estimates to the risk questions being evaluated. Measured data are not available to estimate future risks, and EPCs were modeled as discussed in Section 7.1. There are two primary sources of additional variability and uncertainty[1] associated with the development of futurecast EPCs arising from the contaminant fate and transport model and the regression models developed to predicted uptake into biota: those associated with modeled sediment concentrations and estimated biota tissue concentrations. Subsections 7.2.1 and 7.2.2, respectively discuss the impacts of modeled sediment and tissue uncertainties on the future modeled BERA results presented in Section 5. The following subsections (*i.e*., 7.2.3 and 7.2.4) evaluate the effects of spatial and temporal variability on the BERA conclusions. Recognizing that ecological receptors with limited mobility might experience higher or lower than average exposure concentrations, percentile concentrations were used to evaluate variability and uncertainty in the risk estimates.

7.2.1 Uncertainties Associated with Modeled Sediment Concentrations

Given the substantial complexities of the LPR-NB modeling effort (which includes hydrodynamics and sediment transport, a eutrophication model, and a contaminant fate and transport model components), it was determined that quantitative approaches to assess model uncertainties such as Monte Carlo Analyses would not be conducted due to project schedule constraints.would not As an alternative, an approach discussed in USEPA's 2005 Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, which relies on consideration of residuals between model results and data (Connolly and Tonelli[2], 1985) was adopted. The uncertainty propagated through the models was evaluated using this approach with the exposure concentrations generated by the fate and transport model. Appendix B provides details on the approach used to estimate median relative error (MRE) values for the modeled contaminants.

[1] Although different and may require separate treatments in the analysis, the distinction between uncertainty (*i.e.*, ignorance about a poorly characterized phenomenon, which may be reducible given further study; extrinsic property) and variability (*i.e.*, diversity in a well characterized population that is not generally reducible through further study; intrinsic property) can be overdrawn from a risk management perspective (Morgan, 1998) and a bright line distinction is not attempted here.
[2] Connolly, J.P. and R. Tonelli, 1985. Modelling kepone in the striped bass food chain of the James River Estuary; *Estuarine Coastal Shelf Sci*. 20:349-355.

The lower- and upper-bound scale factors were estimated by subtracting and adding, respectively, the median residual error (MRE) terms to the annualized average concentrations for contaminant/year combinations of interest. Scale factors are only available for the the LPR-NB Model and quantification of the uncertainties associated with the COPECs that relied on the EMBM projections was not conducted.

Lower- and upper-bound sediment concentrations for the HHRA COPCs and the BERA COPECs modeled using the LPR-NB Model at the end of the assessment period for each remedial alternative are presented in Tables 7-11 and 7-12, respectively. Lower-bound scale factors range from 0.44 (TCDD TEQ [PCBs] – fish) to 0.89 (Total DDx); values for TCDD TEQ [PCBs], with scale factors for TCDD TEQ (PCBs) (fish and mammals) and mercury being lowest. For the upper-bound, scale factors range from 1.11 (Total DDx) to 1.56 TCDD TEQ [PCBs] – fish), with the values for the majority of COPECs ranging from 1.27 to 1.35 and the scale factors for TCDD TEQ (PCBs) (fish and mammals) and mercury being highest (Table 7-11 and -12). Thus, sediment concentration estimates for TCDD TEQ (PCBs) and mercury are most uncertain, with the confidence bands for the majority of COPECs in the range of ± 30 percent of the annualized average concentrations.

To show the variability of the forecast concentrations on total risk/hazard estimates for human health, upper and lower bounds on cancer risk and noncancer health hazard were calculated for all of the COPCs for the sportsman/angler for consumption of both fish and crab scenarios. The tissue EPCs for future exposures were derived using site-specific and chemical-specific sediment-tissue relationships (e.g., sediment-tissue regressions) as described previously in Section 7.1. Figure 7-3 shows the upper and lower bounds on the future modeled total cancer risks and noncancer health hazards.

To evaluate uncertainties associated with the the residue- and dose-based analyses, it was necessary to develop adjusted scale factors for both tissue and wildlife dose estimates because of the non-linear nature of the sediment-tissue relationships for the majority of the COPECs. Due to the non-linear relationship established for many of the biological tissue type and COPEC combinations, this analysis required additional calculations to derive scaling factors for the residue- and dose-based assessment endpoints (*i.e.*, crab and fish tissue/CBR and heron and mink modeled dose/TRV). Following application of the sediment scale factors to establish confidence bands around the sediment concentrations, the sediment-tissue regression models were used to estimate tissue residues for comparison to CBRs and for input into the wildlife dose calculation models. The resulting lower- and upper-bound tissue concentrations were compared to those based on the sediment EPCs (*i.e.*, based on the annual average model estimates) to derive corresponding tissue scale factors, which were estimated as the ratio of either the lower- or upper-bound tissue concentration divided by the tissue concentrations associated with the annualized average concentrations (Table 7-13). In the case of the dose-assessment, the scaled sediment concentrations and resulting tissue concentrations were input into the same exposure models used to estimate wildlife exposures, and the HQs derived from comparison the the dose estimates with TRVs were compared to those based on the future EPCs to estimate the lower- and upper-scaling ratios for the dose-based endpoints (*i.e.*, heron, assuming either generic fish or mummichog diet, and mink). Lower- and upper wildlife-dose adjusted scale factors (Table 7-14) were derived by dividing HQs estimated using the lower- and upper-bound sediment and associated prey tissue concentrations by the HQs estimated using the EPCs (*i.e.*, annualized average concentrations).

Tables 7-12 and 7-13 present the adjusted scaling factors for tissue residues and dose estimates, respectively. Tissue adjusted scale factors are fairly consistent across the three tissue types (*i.e.*, generic fish, mummichog, and blue crab) varying by no more than ten percent[3]. Lower-bound tissue-adjusted scale factors range from 0.5 to 1.0 with the same COPECs identified above for sediment scale factors at

[3] The sole exception is the upper-bound values for TCDD TEQ (PCBs) – mammals with calculated value of 1.3 for mummichog and 1.5 for the other tissue types.

the low end of the range (TCDD TEQ [PCBs] [fish and mammals] and mercury). The upper-bound tissue scale factors range from 1.0 to 1.5 (Tale 7-13). The wildlife dose-adjusted scale factors, which essentially represent an integration of the sediment and tissue scale factors (dependent on the specific dietary exposure assumptions), are consistent with the results for the other scale factors.

To evaluate the significance of model uncertainty on the modeled future BERA hazard estimates, the geometric mean of the HQs calculated based on the lower- and upper-bound benchmarks (or NOAEL and LOAEL) were multiplied by the appropriate lower and upper bound scale factors (Table 7-12 through 7-14). The results of this analysis are shown in Figures 7-4 through 7-10. The results are based on the sediment concentrations 30 years following implementation of each remediation alternative for the top four risk driving COPECs estimated using the the LPR-NB model. The geometric mean HQs and the associated uncertainty (*i.e.*, error bars) are presented graphically on a logarithm scale that ranges from HQs of 0.01 to 1,000[4].

Macroinvertebrates. The HQs associated with sediment benchmarks are shown in Figure 7-4. The most variable sediment HQs were associated with the 2,3,7,8-TCDD[5] HQ under the No Action remediation alternative, which ranged from 72 to 150. As is the case with the majority of these figures, the error bars associated with the HQs are small relative to the difference between the values and an HQ of one (*i.e.*, indicated by the red line in the figures). As a result, consideration of model uncertainty does not generally impact the modeled future ecological risk assessment conclusions discussed in Section 5. The blue crab tissue HQs are shown in Figure 7-5 and exhibit less variability than the sediment benchmark-based HQs. The scaled HQs for 2,3,7,8-TCDD under the No Action alternative are the most variable HQ (56 to 100). In some instance, such as for mercury under the No Action and Focused Capping with Dredging for Flooding alternatives, the blue crab HQs are close to 1 with the error bars extending slightly above and below an HQ of 1. However, for all other COPECs graphed, the HQs are consistently above or below and HQ of 1.

Fish. The generic fish tissue HQs are shown in Figure 7-6. DDx has an HQ of 1.0 with very little variability under the Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill alternatives. All other COPECs graphed are consistently above or below an HQ of 1. The mummichog tissue HQs are presented in Figure 7-7 and most HQs are less than 1. The TCDD TEQ (D/F) HQ ranges from 12 to 19 under the No Action alternative and ranges from 8 to 12 under the Focused Capping with Dredging for Flooding alternative. The TCDD TEQ (D/F) HQs approximate 1 under the other two alternatives. The only other HQ that slightly exceeds 1 is Total PCBs under the No Action alternative.

Wildlife. Heron HQs associated with the consumption of generic fish are presented in Figure 7-8, and the heron HQs associated with the consumption of mummichog specifically are presented in Figure 7-9. All heron HQs shown on these figures are less than 3, and based on the consumption of mummichog all HQs (and associated error bars) are less than 1. When based on the consumption of generic fish, the Total DDx HQs are at or slightly above 1 for all remediation alternatives. Other than for Total DDX, all HQs are below 1 for the Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill alternatives. All graphed COPECs have HQs of approximately 1 (with some slight variation above and below 1) under the No Action and Focused Capping with Dredging for Flooding alternatives.

[4] This wide ranging HQ scale was keep consistent to facilitate comparison between the various receptors and remediation alternatives.
[5] Visually the error bar associated with mercury appears rather large or equivalent to that of 2,3,7,8-TCDD, but the HQ range is approximately 2 to 6 for the No Action alternative.

Mink HQs are presented in Figure 7-10. The graphed COPECs under the No Action and Focused Capping with Dredging for Flooding alternatives consistently have HQs above 1. For the other two alternatives (Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill), TCDD TEQ (D/F) HQs are consistently above 1, Total PCBs HQs are consistently below 1 and the TCDD TEQ (PCBs) and mercury HQs approximate 1 with some slight variation ranging above and below a HQ of 1.

In summary, the risks associated with direct sediment exposures, bioaccumulation of COPECs in tissues, and consumption contaminated prey are similar for the entire confidence range of exposures. Risk conclusions would generally not be affected if actual exposure concentrations are higher or lower than annualized average concentrations predicted for each of the alternatives. Therefore, the use of annualized average concentrations provides a reasonable estimate of future ecological risks.

7.2.2 Uncertainties Associated with Estimated Biota Tissue Concentrations

The second source of uncertainty unique to the future risk exposure assessment relates to the estimation of biota tissue concentrations. Section 7.1 describes the process of developing biota EPCs that were used in the human and ecological risk assessment and the DER No. 6 (Appendix A) and also describes the development of the site-specific sediment-tissue contaminant relationships.

The regression coefficient of determination (R^2) [6], which is interpreted as representing the percent of variation shared between two variables, for the models developed in Appendix A are summarized in Table 7-15. Although interpretion of these values becomes challenging for non-linear models, they provide a simplistic method of evaluating the relative uncertainty across the various combinations of species and contaminant relationships. Pertinent observations include the following:

- Weak inverse relationship between lead and mercury concentrations in surficial sediment and in American eel tissues.
- Generally weaker relationships between inorganic concentrations in sediment and tissue compared to organic COPECs. Excluding the American eel values mentioned in the previous bullet, R^2 values for copper, lead and mercury in species other than American eel range from 5.7% (mercury/white perch) to 31% (lead/mummichog). R^2 values for Total DDx, Total PCBs and 2,3,7,8-TCDD for the four species range from 24% (Total DDx/mummichog) to 91-92%(2,3,7,8-TCDD in white perch and blue crab, respectively).
- The only value available for copper is for blue crab[7] but the lead and mercury values for the various species appear comparable. With the exception of the lead value for the mummichog model (R^2 = 31%), all absolute values for inorganic COPECs fall between 0 and 30% indicating only a “weak” relationship between sediment and tissue chemistry.
- R^2 values for Total DDx and Total PCBs indicate a “moderate” relationship between sediments and tissues with values ranging from 24% (actually considered a “weak” relationship falling between 0 and 30%) and 62%.
- Relationship between 2,3,7,8-TCDD in Lower Passaic River surficial sediment and tissue appears strong with R^2 values ranging from 70% to 91-92%.

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[6] The correlation coefficient r, is a statistical measure of the strength of relationship between two variables (or a dependent variable and multiple independent variables) ranging from -1 to +1 with positive values representing direct correspondence and negative values representing inverse relationships. Absolute values between 0-0.3 are generally interpreted to indicate a “weak” (positive/negative) relationship; values between 0.3 and 0.7, a “moderate” relationship and values between 0.7 and 1.0 a “strong” relationship. R^2, referred to as the coefficient of determination, is the square of the correlation coefficient.

[7] Interpretation of this relationship is complicated by the fact that crustaceans (and other arthopods and molluscs) blood is typically copper- rather than iron-based as in other animals.

Table 7-16 provides normalized standard errors (*i.e.*, standard error divided by the uptake term) for the species/COPEC combinations (*i.e*., copper and Total PCBs) for which BSAFs and BAFs were developed rather than regression models. The normalized standard errors provide information on both the absolute and relative importance of this source of uncertainty. A higher normalized standard error indicates a higher range of variability in the sediment and tissue chemistry data used to develop the BSAFs and BAFs. With the exception of the normalized standard error for copper in American eel (93%), values are low, ranging from 4.3% (copper/white perch) to 11% (Total PCBs/American eel). Of the species for which uptake factors were developed, those for the American eel are associated with the greatest attendant uncertainties.

In summary, with the exception of 2,3,7,8-TCDD, the relationships between sediment and fish tissue based on models developed are weak, and there are likely other factors influencing COPEC concentrations in fish. Site-derived BAFs and BSAFs are much stronger predictors of fish tissue concentrations. Therefore, the estimated future concentrations of 2,3,7,8-TCDD in all fish tissue, PCBs in white perch and American eel, and copper in white perch and mummichog have the lowest uncertainty while there is a fair amount of uncertainty associated with tissue concentrations of other COPECs.

7.2.3 Impact of Spatial Variability and Uptake Uncertainties on Future Risk Estimates

In order to better understand the uncertainties associated with predicted model sediment exposures, the 5th and 95th percentile estimates of the model sediment concentration output distribution for each of the COPECs were evaluated. It is important to recognize that the percentiles are based on the population of values for the entire set of model grids rather than probabilistic sampling such as Monte Carlo- or bootstrap-derived estimates. Consequently, this analysis considers the variability in spatial exposure estimates from the deterministic the LPR-NB Model model output along with the percentile estimates from the EMBM projections. Tables 7-17 and 7-18 provide summaries statistics (annualized average, and 5th and 95th percentiles for all COPECs modeled in the the LPR-NB Model and EMBM, respectively, for each of the remedial alternatives. Table 7-19 presents summary statistics for those analytes (including mercury, Total PCBs and 2,3,7,8-TCDD) that were modeled in both the LPR-NB Model and EMBM and which provide information on the consistency between these two approaches.

Table 7-20 summarizes the ratios of the estimated 5th and 95th percentile values to the annualized verage sediment concentrations used to predict sediment exposures 30 years into the future and these are plotted in Figure 7-11 for each of the remedial alternatives. The greater the difference from 100% (higher or lower) in these normalized ratios, the greater the variability around the annualized average concentration. Across all remedial alternatives, the relative difference in the copper and lead 5th and 95th percentiles compared to the estimated average concentrations is much lower than for mercury and the organic COPECs[8]. The 5th percentile ranges between 80% and 88%, and the 95th percentile ranges from 115 to 144 percent of the average copper and lead concentrations (Table 7-20). The average mercury concentration estimated for the different remedial alternatives is bracketed by a 5th percentile estimate

[8] These ratios are useful in understanding the modeled predicted variability in sediment concentrations and hence risk estimates – 5 percent and 95 percent of all modeled grids are predicted to have a sediment concentration of COPEC x less than or equal to the 5th and 95th percentile values, respectively. Because of the linearity in the equations relating exposure to risks, the percent differences between the 5th and 95th ratios to the average model predicted concentrations corresponds to the same expected differences in the risk. For example, if the future risk estimate (*i.e.*, HQ) for a given combination of receptor, endpoint, model year and remedial alternative scenario is 10, a 5th percentile ratio of 10% would be interpreted as indicating that the HQ would be expected to be 1 or less in 5 percent of the modeled grids. Similarly, if the 95th percentile ratio was 270%, then 95 percent of all modeled grids are expected to have a HQ of 27 or less (or equivalently, that only 5 percent of grids would be expected to have HQs that exceeded this value). Although these examples assume that the average grid area is a relevant scale for evaluating a given assessment endpoint (*e.g.*, population stability of species x), which is certainly not the case for vertebrate receptors, this approach provides a reasonable way of quantifying the relative variability across the different remedial alternatives and among the various COPECs.

ranging from 1 to 15 percent of the average and a 95th percentile estimate ranging from 282 to 378 percent of the average concentration. This range is typical of those for the organic COPECs. Overall, 2,3,7,8-TCDD is the most variable COPEC with 5th percentile concentrations ranging from 1 to 10 percent and 95th percentile concentrations ranging from 300 to 686 percent of the average concentration, respectively. However, the maximum 95th percentile estimates for organic COPECs vary by remedial alternative with ranges of 292-686% (No Action), 298-396% (Capping with Dredging for Flooding and Navigation), 292-383% (Deep Dredging with Backfill) and 236-487% (Focused Capping for Flooding); the organic COPECs with the highest 95th percentile estimates for each of these remedial alternatives are 2,3,7,8-TCDD, Total DDx, mammalian TCDD TEQ (PCBs) and Total DDx, respectively (Table 7-20).

The output distribution of predicted surficial sediment concentrations for the Focused Capping for Flooding alternative 30 years post remedy implementation has the lowest ratio of 5th percentile to average concentration ratios for mercury and the organic COPECs (Table 7-20). The 5th percentile to average concentration ratios are 1 for all COPECs for this alternative compared to 10-22 (No Action), 4-6 (Capping with Dredging for Flooding and Navigation) and 3-5 (Deep Dredging with Backfill. Among the COPECs evaluated, variability in the ratio of the 95^{th} percentile is least for copper and lead and highest for Total DDx and 2,3,7,8-TCDD. These findings have bearing onof the interpretation of the risk estimates as discussed below.

Table 7-21 summarizes the HIs for the various endpoint receptors estimated at a point in time 30 years after remedy implementation. As discussed in further detail in Section 5.2, estimated future ecological risks are highest for the No Action remedial alternative followed by the Focused Capping with Dredging for Flooding alternative and lowest for the Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill alternatives.

Differences in exposure scale related to receptor size and mobility affect how an organism experiences spatial heterogeneity, including heterogeneity in contaminant concentrations. Although individual receptors that are wide-ranging will likely encounter greater spatial heterogeneity, there is greater integration across the range of environmental variability and, as a consequence, less variability in exposures and risks when considered from the perspective of the level of biological organization (*e.g.,* population, community) appropriate to the particular assessment endpoint. Due to this integration, wide-ranging receptors are considered to view environmental exposures in a more fine-grained manner than do less mobile receptors. The impacts of the spatial variability in the modeled sediment concentrations and uncertainties in the bioaccumulation regression models on the future risks estimates for macroinvertebrates, fish and wildlife are discussed in the following sections. DER No. 6 provides information on a second important source of variability (*i.e*., temporal) in the risk analysis

Macroinvertebrates. Risk estimates for the macroinvertebrates are the highest of all receptor endpoints evaluated, with geometric mean HIs ranging from 10 (Capping with Dredging for Flooding and Navigation) to 200 (No Action) (Table 7-21). Of all the endpoint receptors evaluated, spatial heterogeneity is of greatest relevance to macroinvertebrates (which will encounter their environment in a more coarse-grained fashion than more mobile receptors), particularly along the various environmental gradients encountered through the lower eight miles of the Passaic River. The spatial variability in HIs for the primary risk drivers for this endpoint (including Total DDx, Total PCBs and 2,3,7,8-TCDD [Table 5-5]) range on the order of approximately 1 percent to nearly 700 percent (Table 7-20) of the annualized average concentration depending on the remedial alternative. The fate and transport model would thus predict that there may be a portion of the benthic habitat that poses minimal risks (*i.e.*, risk estimates less than 1) to less motile infaunal benthic invertebrate species whereas the likelihood of adverse effects will be much greater than that predicted by the average sediment concentration in some areas. As discussed in Section 4, the screening benchmarks used to evaluate this receptor group are likely the most conservative of those used in the BERA.

For the residue-based analysis of blue crab tissue, geometric mean HIs for the remedial alternatives range from 10 (Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill Placement) to 100 (No Action and Focused Capping for Flooding) (Table 7-21), with 2,3,7,8-TCDD and copper accounting for a majority of the estimated risk (Table 5-6). Compared to the relatively immobile infaunal benthos, blue crabs will encounter their environment in a more fine-grained and homogeneous fashion (Ricklefs and Miller, 1999) and will integrate exposure much more effectively throughout the estuary. As a result, there is likely less variability and associated uncertainty in the risks encountered by individual receptors within the Lower Passaic River blue crab population than for in-place benthos. Nonetheless, if certain life stages remain in localized areas within the lower eight miles for sufficient time for quasi-equilibrium conditions between sediment and tissue to develop, information in Table 7-20 suggests that risk could be higher or lower than estimated using the average concentration, depending on the how mobile a particular life stage is. As discussed in Section 7.2.2, uncertainty associated with the sediment-tissue relationships also contributes to the variability in actual exposures and residue-based risks experienced by the blue crab.

Fish Tissue. Geometric mean HIs for the generic fish range from 10 (Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill Placement) to 200 (No Action and Focused Capping for Flooding) (Table 7-20); for mummichog, HIs are lower ranging from 4 to 20. TCDD TEQ (D/F) and copper are the primary risk contributors to both receptors for the residue-based endpoint (Tables 5-7 and 5-8). Of the two, mummichogs will likely experience greater variability in contaminant exposure concentrations due to their more limited mobility (*i.e*., groups of individuals may experience higher or lower than average exposure depending on their location). Therefore, risk estimates are projected to be more variable (across individual receptors within the population in the lower eight miles of the Passaic River) than more wide-ranging species. As presented in Figure 7-11, the estimated spatial variability associated with copper is relatively small (on the order of 20-30 percent); however, lower and upper bounds on the sediment exposure point concentration (EPC) for TCDD TEQ (D/F) based on fish TEFs is 1% to greater than 650% (Table 7-20). It is possible that local sub-populations of forage fish will experience greater risks than other fish species due to greater spatial heterogeneity in sediment concentrations.

The future modeled BERA analysis presented in Section 5 indicates that the Capping with Dredging for Flooding and Navigation and the Deep Dredging with Backfill alternatives would eliminate most of the residue-based risks to fish, with TCDD TEQ (D/F) by the end of the 30 evaluation period. Thus, it is unlikely that even localized subpopulations will experience exposures that exceed the threshold HQ value of one in the future, although it is possible for the Focused Capping with Dredging for Flooding and No Action alternatives. The coefficient of determination for the 2,3,7,8-TCDD regression models for American eel, white perch and mummichog are 85%, 92% and 70% (Table 7-15), respectively, suggesting that the uptake models contribute relatively little uncertainty to the future tissue concentration estimates.

Wildlife. The geometric mean HIs for the heron range from 4 (Capping with Dredging for Flooding and Navigation and Deep Dredging with Backfill) to 10 (No Action and Focused Capping with Dredging for Flooding) (Table 7-21); for mink, the HIs are higher for each remedial alternative, ranging from 10 to 200. TCDD TEQ (PCBs) and lead are the primary risk contributors the heron, whereas Total TCDD TEQ (with contribution from both dioxin/furan and PCBs congeners), Total PCBs and mercury are potentially important to the mink, also depending on the particular alternative (Table 5-10). Being the most mobile of the receptors evaluated, the heron has the potential to integrate dietary exposures throughout the lower eight miles of the Passaic River in the most fine-grained fashion. If this is the case, then the average conditions assumed in the future exposure assessment are probably reasonable assumptions, although differences in habitat suitability and individual preferences may be important considerations, as this receptor may prefer to feed in some areas over others.

Piscivorous mammals such as the mink would be expected to integrate contaminant exposures in a fashion somewhere between benthos (coarse-grained) and the birds (fine-grained)[9]. As a result, consideration of the spatial variability predicted in the the LPR-NB Model could be important for risk estimates, depending on feeding behavior and preferences within the Lower Passaic River system. As indicated in Table 7-20 (and see Figure 7-11), the estimated spatial variability associated the primary risk contributors for this receptor are large, with lower and upper bounds on the sediment exposure point for TCDD TEQ (D/F) is 1% to 658% and for TCDD TEQ (PCBs) is 1% to 383%. Under conservative exposure assumptions (including chronic feeding on fish whose tissues residues are strongly linked to localized sediment concentrations), some individual mink could encounter risks that were on the order of 6-7 times higher than others, resulting in a higher likelihood of adverse reproductive effects being realized. The future modeled BERA analysis presented in Section 5 indicates that the Capping with Dredging for Flooding and Navigation and the Deep Dredging with Backfill alternatives would eliminate most of the dose-based risks to the mink, with geometric mean Total TCDD TEQ HQs of 5 and 7 estimated, respectively, at the end of the 30 evaluation period (Table 5-10). The future BERA predicts that mink will experience elevated risks under either the Focused Capping with Dredging for Flooding and No Action alternatives, and exposure risks could be higher with consideration given to spatial variability in model output and uncertainties in the sediment-tissue relationships.

7.2.4 Impact of Temporal Variability and Uptake Uncertainties on Future Risk Estimates

Appendix B discusses some of the important physical factors that influence seasonal variation in contaminant concentrations in the water column and sediments. Weather and hydrological factors can influence river flows and contaminant loadings (upriver as well as atmospheric), current speed (affecting degree of sediment resuspension) and geochemistry as affected by temperature and salt content among other factors. Many studies have documented substantial within year variability in exogenous carbon and nutrient inputs as well as metal and organic contaminant loadings in estuaries (Luoma *et al*., 1990; Wong *et al*., 1999[10]). Biological factors that affect exposures include life history patterns and life-stage dependent differences prey preferences and microhabitat utilization and both physiochemical (e.g., AVS) and biological (e.g., lipid content) factors can also influence the bioavailability of contaminants in abiotic compartments. DER No. 6 (Appendix A) discusses one potentially important source of uncertainty in the regression models used to quantify sediment tissue relationships for blue crab, American eel, white perch and mummichog related to the strenghth of linkage between sediment chemistry and contaminant residues measured in biota collected from the Lower Passaic River. For species that annually migrate in and out of the estuary or Lower Passaic River, some time is required before tissue residues have equilibrated to local conditions. An assessment of annual life cycle movement patterns of blue crab and white perch was conducted and compared with tissue collection dates to evaluate the potential impact of this source of uncertainty. Because almost all tissue data used to characterize both current and modeled future (by applying the derived sediment-tissue regression models) conditions were collected in the Lower Passaic River at times outside of dispersal/migratory periods, it was concluded that this issue contributes relatively little uncertainty to the exposure (and risk calculations).

The quantitiative contaminant fate and transport model used to model future sediment concentrations (Appendix B) utilized historical flood frequency data to predict year-to-year variability in flooding events and used a 7 year flood cycle to predict future large flooding events. Future flood years in the model were selected based on historic trends and indicate which years are expected to be flood years. Modeled

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[9] This depends on various receptor-specific attributes including size, life stage, diet, and relative mobility and other behaviors.

[10] Luoma, S.N., R. Dagovitz and E. Axtmann, 1990. Temporally intensive study of trace metals in sediments and bivalves from a large river-estuarine system: Suisun Bay/Delta in San Francisco Bay; *Sci. Total Environ*. 97/98:685-712; Wong, C.S., F.A. Whitney, D.W. Crawford, K. Iseki, R.J. Matear, W.K. Johnson, J.S. Page and D. Timothy, 1999. Seasonal and interannual variability in particle fluxes of carbon, nitrogen and silicon from time series of sediment traps at Ocean Station P, 1982}1993: relationship to changes in subarctic primary productivity; *Deep-Sea Research II* 46:2735-2760.

future ecological risks were estimated for both initial conditions following the completion of each active remedial alternative (and assumed year 2019 for the no action alternative) as summarized in Table 7-21. Variability was introduced into the analysis attributable to the particular year selected to represent the end of the 30 year assessment period (*i.e*., 2048, 2049, 2053 and 2059 for Alternatives, 1, 4, 2, and 3, respectively) as they terminated in different portions of the 7-year flooding cycle. The average sediment concentrations and summary statistics for 2,3,7,8-TCDD, Total mercury, Total DDx and Total PCBs for years 2041 through 2059 (last year modeled) are summarized in Table 7-22. Summary statistics (including average, minimum, maximimum, 95th percentile, standard deviation and coefficient of variation (CV) are presented along with relative percent difference (RPDs[11]) estimates based on the minimum and maximum annual average concentration for each COPEC for years 2041 through 2059. The lower-bound RPDs range from 7 (mercury) to 14 (2,3,7,8-TCDD) percent with the lower-bound RPDs for both Total DDx and Total PCBs equal to 8 percent. The upper-bound RPDs range from 3 (Total DDx) to 9 (2,3,7,8-TCDD) percent. The RPD was also calculated for each COPEC as the difference between the minimum and maximum annual average modeled estimates divdided by the maximum annual average concentration over the years 2041 through 2059. The RPD serves as a measure of variability amongst years resulting from variability in annual flooding. The range-based RPDs range from 11 (Total DDx) to 21 (2,3,7,8-TCDD) with values for mercury and Total PCBs equal to 14 and 15 percent, respectively. Thus, the largest difference between the modeled sediment concentration for a flood year and a corresponding year at the "trough" of the cycle would be 21 percent in the case of 2,3,7,8-TCDD and concentrations could be approximately 10 percent lower or greater than estimated if an "average" year was selected. The impacts of this year-to-year variability for the other three COPECs is less (*i.e*., approximately 5 – 7 percent lower or greater relative to typical conditions).

In summary, receptor exposures may vary temporally both withing and amongst years. Variations due to differences in exposure and uptake resulting from life stage differences, migration patterns, and variability oranic and contaminant inputs to the FFS Study Area are an uncertainty in the assessment. The the LPR-NB and EMBM models attempted to capture differences in exposure over time resulting from flooding cycles.

[11] The RPDs were calculated as the absolute difference between either the minimum or maximum modeled annual average concentration for years 2041 through 2059 and the average concentration over that period divided by the average concentration.

Tables

Table 7-1. Remedy Construction Schedule

Description	Remedy Construction Period	30-Year Time Period
Alt 1: No Action	Mar-2018	2019 - 2048
Alt 2: Deep Dredging with Backfill	1-Mar-2018 through 30-Jul-2029	2030 - 2059
Alt 3: Capping with Dredging for Flooding and Navigation	1-Mar-2018 through 1-Dec-2022	2023 - 2052
Alt 4: Focused Capping with Dredging for Flooding	1-Mar-2018 through 20-May-2019	2020 - 2049

Table 7-2. Model Output Example of Predicted Annual Average Sediment Concentrations for Total PCBs for Alternative 1 (No Action)

Total PCBs (ug/kg)											
Construction Start Date	**Construction End Date**	**Area-Weighted Annual Average**	**Minimum**	**Maximum**	**Standard Deviation**	**5th Percentile**	**25th Percentile**	**50th Percentile**	**75th Percentile**	**95th Percentile**	**99th Percentile**
2019	2019	1497	65	6770	1098	213	704	1275	2107	3349	6400
2020	2020	1405	57	6262	1045	219	640	1115	1892	3123	5948
2021	2021	1300	48	5750	1044	175	511	1014	1793	3269	5454
2022	2022	1229	45	5188	1011	156	447	858	1718	3149	5011
2023	2023	1168	42	4679	989	142	398	755	1693	3049	4603
2024	2024	1143	40	5602	980	201	442	744	1655	3116	5284
2025	2025	1149	41	6512	997	210	455	690	1659	2811	5994
2026	2026	1131	40	6136	975	203	437	667	1681	2797	5690
2027	2027	1089	45	5289	983	158	407	668	1689	3187	5072
2028	2028	1097	47	4881	1033	157	365	621	1692	3359	4791
2029	2029	1045	41	4632	991	151	314	590	1658	3163	4557
2030	2030	1026	44	4543	971	129	278	538	1697	3191	4506
2031	2031	1011	42	4365	953	131	263	519	1656	3057	4363
2032	2032	1015	38	6581	1049	135	254	505	1625	3119	6033
2033	2033	990	36	6264	1024	132	240	487	1597	3025	5766
2034	2034	984	36	5973	1010	111	232	483	1602	2946	5551
2035	2035	947	33	5617	985	100	216	455	1576	2850	5271
2036	2036	909	30	5155	963	88	185	443	1502	2779	4882
2037	2037	887	28	4491	932	77	177	435	1494	2733	4364
2038	2038	870	26	4342	921	83	174	421	1464	2691	4251
2039	2039	904	27	5232	920	135	249	457	1440	2667	4942
2040	2040	960	28	6291	962	141	291	528	1490	2664	5714
2041	2041	940	27	5995	937	130	289	472	1482	2614	5464
2042	2042	907	54	5211	963	121	251	480	1426	2914	5001
2043	2043	926	48	4854	1013	111	229	404	1550	3137	4769
2044	2044	898	47	4611	972	112	208	415	1544	3013	4550
2045	2045	905	36	4521	943	100	196	379	1571	2985	4270
2046	2046	899	35	4348	932	102	182	362	1607	2935	4098
2047	2047	911	45	6585	1030	114	178	353	1661	2783	6035
2048	2048	890	46	6360	1006	107	167	349	1591	2627	5834
2049	2049	889	47	6044	989	93	160	346	1653	2554	5573
2050	2050	859	44	5478	950	85	155	341	1545	2454	5116
2051	2051	826	39	4773	913	79	140	331	1516	2378	4559
2052	2052	814	37	4547	899	68	138	316	1499	2329	4374
2053	2053	803	36	4386	887	75	139	319	1492	2320	4241
2054	2054	821	25	5255	900	113	184	354	1394	2576	4906
2055	2055	869	22	6285	958	112	220	366	1479	2603	5702
2056	2056	861	22	5973	939	108	222	370	1455	2562	5452
2057	2057	835	44	5184	957	114	197	351	1426	2811	5022
2058	2058	865	41	4881	997	98	183	348	1557	3127	4787
2059	2059	841	40	4593	955	94	172	344	1565	2985	4531

Table 7-3. Example Calculation of Six-Year and 24-Year Rolling Annual Average Sediment Concentrations for Total PCBs

COPC	6-Year Annual Rolling Averages		Alt 1: No Action	Alt 3: Capping with Dredging for Flooding and Navigation[(a)]	Alt 2: Deep Dredging with Backfill[(b)]	Alt 4: Focused Capping with Dredging for Flooding[(c)]
Total PCBs	2019	2024	**1290**	749	954	830
Total PCBs	2020	2025	1232	535	835	**771**
Total PCBs	2021	2026	1187	344	736	733
Total PCBs	2022	2027	1152	189	653	704
Total PCBs	2023	2028	1130	**107**	570	685
Total PCBs	2024	2029	1109	105	473	669
Total PCBs	2025	2030	1090	94	370	661
Total PCBs	2026	2031	1067	80	270	650
Total PCBs	2027	2032	1047	70	185	644
Total PCBs	2028	2033	1031	61	118	641
Total PCBs	2029	2034	1012	53	77	637
Total PCBs	2030	2035	995	48	72	637
Total PCBs	2031	2036	976	48	72	626
Total PCBs	2032	2037	955	48	71	613
Total PCBs	2033	2038	931	47	68	599
Total PCBs	2034	2039	917	52	84	592
Total PCBs	2035	2040	913	59	107	589
Total PCBs	2036	2041	912	62	116	585
Total PCBs	2037	2042	911	66	121	582
Total PCBs	2038	2043	918	69	**123**	583
Total PCBs	2039	2044	923	71	**123**	582
Total PCBs	2040	2045	923	64	100	585
Total PCBs	2041	2046	913	56	73	584
Total PCBs	2042	2047	908	52	64	586
Total PCBs	2043	2048	905	48	61	590
Total PCBs	2044	2049	899	44	60	592
Total PCBs	2045	2050	892	42	61	597
Total PCBs	2046	2051	879	42	65	591
Total PCBs	2047	2052	865	42	65	581
Total PCBs	2048	2053	847	42	63	572
Total PCBs	2049	2054	835	46	72	567
Total PCBs	2050	2055	832	51	85	567
Total PCBs	2051	2056	833	54	90	565
Total PCBs	2052	2057	834	57	92	563
Total PCBs	2053	2058	842	59	93	564
Total PCBs	2054	2059	849	61	92	563

24-Year Annual Rolling Averages		Alt 1: No Action	Alt 3: Capping with Dredging for Flooding and Navigation[(a)]	Alt 2: Deep Dredging with Backfill[(b)]	Alt 4: Focused Capping with Dredging for Flooding[(c)]
2019	2042	**1067**	240	379	675
2020	2043	1043	183	325	**654**
2021	2044	1022	133	278	640
2022	2045	1005	92	239	630
2023	2046	992	**69**	207	624
2024	2047	981	67	181	620
2025	2048	971	64	156	615
2026	2049	960	60	131	610
2027	2050	948	57	109	606
2028	2051	937	55	92	602
2029	2052	926	53	81	598
2030	2053	915	51	79	595
2031	2054	907	52	81	591
2032	2055	901	53	**85**	589
2033	2056	895	54	**85**	586
2034	2057	888	54	**85**	583
2035	2058	883	54	**85**	580
2036	2059	879	54	84	577

(a) Remedy Implementation Mar-2018 through Dec-2022; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

(b) Remedy Implementation Mar-2018 through Jul-2029; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

(c) Remedy Implementation Mar-2018 through May-2019; cells highlighted yellow were not used to compute rolling averages as the remedy was in progress.

Notes:

Orange-highlighted cells indicate the 30-year expoure duration time period for the remedial alternative.

Bolded number indicates the maximum annual rolling averge.

units are ug/kg

Table 7-4. Summary of Future Modeled Rolling Annual Average Sediment Concentrations Used to Calculate Biota Tissue EPCs for the HHRA

COPC	Alternative 1 (µg/kg)			Alternative 2 (µg/kg)		
	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average	Maximum 6-Year Rolling Annual Average	Maximum 12-Year Rolling Annual Average	Maximum 24-Year Rolling Annual Average
TCDD TEQ (D/F)[(a)]	0.444	0.432	0.392	0.055	0.034	0.027
TCDD TEQ (PCBs)	0.049	0.046	0.042	0.007	0.007	0.006
Total PCBs	1290	1190	1067	123	97	85
DDD	26.7	24.0	21.2	2.4	2.2	1.9
DDE	32.9	31.1	28.3	4.4	3.6	3.3
DDT	24.0	21.7	19.4	3.5	3.4	3.0
Methylmercury[(b)]	1922	1708	1450	191	183	156
Chlordane	25	25	25	16	15	12
COPC	**Alternative 3 (µg/kg)**			**Alternative 4 (µg/kg)**		
	Maximum 6-Year Rolling Annual Average	**Maximum 12-Year Rolling Annual Average**	**Maximum 24-Year Rolling Annual Average**	**Maximum 6-Year Rolling Annual Average**	**Maximum 12-Year Rolling Annual Average**	**Maximum 24-Year Rolling Annual Average**
TCDD TEQ (D/F) [(a)]	0.041	0.027	0.024	0.225	0.213	0.203
TCDD TEQ (PCBs)	0.006	0.005	0.005	0.033	0.031	0.029
Total PCBs	107	80	69	771	711	654
DDD	2.1	1.7	1.5	15.8	14.2	12.8
DDE	3.8	2.9	2.6	20.0	18.6	17.2
DDT	2.7	2.3	2.2	16.9	15.1	13.7
Methylmercury[(b)]	227	177	143	1278	1134	996
Chlordane	16	15	12	21	20	19

Units = microgram per kilogram (µg/kg)

(a) Note that the regression model derived for TCDD TEQ (D/F) was based on analytical tissue data for 2,3,7,8-TCDD due to a lack of congener-specific analytical results in the historical tissue dataset. Therefore, a decision was made to use the modeled sediment results for 2,3,7,8-TCDD, rather than the combined TCDD TEQ (D/F) modeled data under the assumption that data for elemental mercury and methylmercury are assumed to be equivalent.

(b) Note that the regression model derived for methylmercury was based on analytical tissue data for elemental mercury due to a lack of methylmercury analytical results in the historical tissue dataset. Therefore, a decision was made to use the modeled sediment results for elemental mercury under the assumption that data for elemental mercury and methylmercury are assumed to be equivalent

Table 7-5. Models and Example Model Parameters for Estimating Tissue Concentrations from Future Modeled Sediment Concentrations Based on Site-Specific Sediment-Tissue Relationships

TCDD TEQ (D/F)	Model	C_s pg/g	f_{OC}	BSAF	BAF	f_L	β_0 unitless	β_1 unitless	β_2 unitless	f_{iron} unitless	C_f pg/g	C_f mg/kg	Tissue Multiplier[(a)] unitless	C_f mg/kg
White Perch	1	213	0.047	NA	NA	0.050	-0.00391	0.95369	1.34306	NA	55	0.000055	1.0	0.000055
American Eel	1	213	0.047	NA	NA	0.067	0.09158	0.63439	1.18168	NA	9.4	0.0000094	0.60	0.0000057
Blue Crab	1	213	0.047	NA	NA	0.015	-2.54116	0.93792	0.54587	NA	22	0.000022	1.0	0.000022
Mummichog	1	213	0.047	NA	NA	0.019	1.59216	0.70923	1.25932	NA	13	0.000013	1.0	0.000013
Total PCBs	**Model**	**C_s ug/kg**	**f_{OC}**	**BSAF unitless**	**BAF unitless**	**f_L**	**β_0 unitless**	**β_1 unitless**	**β_2 unitless**	**f_{iron} unitless**	**C_f ug/kg**	**C_f mg/kg**	**Tissue Multiplier[(a)] unitless**	**C_f mg/kg**
White Perch	2	711	0.047	0.9176	NA	0.050	NA	NA	NA	NA	697	0.70	1.0	0.70
American Eel	2	711	0.047	0.9914	NA	0.067	NA	NA	NA	NA	1012	1.01	0.60	0.61
Blue Crab	1	711	0.047	NA	NA	0.015	2.29300	0.66351	0.73142	NA	279	0.28	1.0	0.28
Mummichog	1	711	0.047	NA	NA	0.019	-2.42699	0.94874	0.30150	NA	249	0.25	1.0	0.25
Copper	**Model**	**C_s mg/kg**	**f_{OC}**	**BSAF unitless**	**BAF unitless**	**f_L**	**β_0 unitless**	**β_1 unitless**	**β_2 unitless**	**f_{iron} unitless**	**C_f mg/kg**	**C_f mg/kg**	**Tissue Multiplier[(a)] unitless**	**C_f mg/kg**
White Perch	2	45	0.047	NA	0.00006	0.050	NA	NA	NA	0.025	0.11	0.11	24	2.6
American Eel	2	45	0.047	NA	0.00015	0.067	NA	NA	NA	0.025	0.27	0.27	1.0	0.27
Blue Crab	1	45	0.047	NA	NA	0.015	-7.68181	1.24169	NA	0.025	5.1	5.1	1.0	5.1
Mummichog	2	45	0.047	NA	0.00053	0.019	NA	NA	NA	0.025	0.95	0.95	1.0	0.95
Mercury	**Model**	**C_s mg/kg**	**f_{OC}**	**BSAF unitless**	**BAF unitless**	**f_L**	**β_0 unitless**	**β_1 unitless**	**β_2 unitless**	**f_{iron} unitless**	**C_f mg/kg**	**C_f mg/kg**	**Tissue Multiplier[(a)] unitless**	**C_f mg/kg**
White Perch	1	1.1	0.047	NA	NA	0.050	-2.83869	0.37470	NA	0.025	0.24	0.24	1.0	0.24
American Eel	1	1.1	0.047	NA	NA	0.067	-3.07897	0.37470	NA	0.025	0.19	0.19	1.5	0.28
Blue Crab	1	1.1	0.047	NA	NA	0.015	-3.91147	0.37470	NA	0.025	0.084	0.084	1.0	0.084
Mummichog	1	1.1	0.047	NA	NA	0.019	-4.81036	0.37470	NA	0.025	0.034	0.034	1.0	0.034

Organic COPC/COPEC

Model 1:

$$C_f = e^\wedge \left[\beta_0 + \beta_1 * \ln(C_s / f_{OC}) + \beta_2 * \ln(f_L)\right]$$

Model 2:

$$C_f = \text{BSAF} * (C_s / f_{OC}) * f_L$$

Inorganic COPC/COPEC:

Model 1:

$$C_f = e^\wedge \left[\beta_0 + \beta_1 * \ln(C_s / f_{\text{iron}})\right]$$

Model 2:

$$C_f = \text{BAF} * (C_s / f_{\text{iron}})$$

Where,
C_f = tissue concentration
Cs = sediment concentration
f_{iron} = concentration of iron in sediment, expressed as a fraction (unitless)
f_L = lipid content in tissue (unitless)
f_{oc} = fraction of total organic carbon in sediment (unitless)
BSAF – biota sediment accumulation factor
BAF – bioaccumulation factor

(a) Chemical-specific "tissue multipliers" are applied to the American eel to convert the whole tissue PRGs to fillet tissue concentrations for use in the HHRA. The fillet multiplier is the ratio of the average fillet tissue concentration to the average whole body tissue concentration, and was derived using the 2009 late summer/early fall data (Appendix A). Similarly, tissue multipliers were applied to the available white perch fillet data to estimate appropriate tissue concentrations for use in the BERA. No multipliers were necessary for blue crab tissue because the tissue type (e.g., muscle + hepatopancreas) evaluated in both the baseline HHRA and BERA is consistent with the dataset used in the regression analyses.
(b) Fish Tissue concentrations are estimated for the whole fish for use in the BERA. However, for the HHRA, it is assumed that tissue concentrations s are based on fillet concentration rather than whole fish concentrations for the white perch and American eel. This assumption is consistent with the baseline HHRA wherein EPCs for consumption of fish were derived using fillet tissue samples.

pg/g – picograms per gram
ug/kg – micrograms per kilogram
mg/kg – milligram per kilogram

Tissue Multipliers Used to Convert Between Whole Body and Fillet Data/Fillet and Whole Body Data

Risk Assessment	Species	Organic COPC/COPEC	Mercury	Copper
HHRA	American eel	0.6	1.5	NA
BERA	White perch	3.7	0.63	24

NA – not applicable

Table 7-6. Summary of Parameter Coefficients for Uptake Models

COPC/COPEC	Species	Model(a)	β_0	β_1	β_2	BSAF Factor	BSAF Std Dev	Units	R^2
Organic Parameters									
2,3,7,8-TCDD	American Eel	1	0.09158	0.63439	1.18168			pg/g	0.850
2,3,7,8-TCDD	Blue Crab	1	-2.54116	0.93792	0.54587			pg/g	0.923
2,3,7,8-TCDD	Mummichog	1	1.59216	0.70923	1.25932			pg/g	0.698
2,3,7,8-TCDD	White Perch	1	-0.00391	0.95369	1.34306			pg/g	0.911
Total PCB	American Eel	2				0.9914	0.5566	ug/kg	
Total PCB	Blue Crab	1	2.2930	0.6635	0.7314			ug/kg	0.302
Total PCB	Mummichog	1	-2.4270	0.9487	0.3015			ug/kg	0.374
Total PCB	White Perch	2				0.9176	0.2889	ug/kg	
Dieldrin	American Eel	1	-2.32814	1.55071	0.84101			ug/kg	0.572
Dieldrin	Blue Crab	1	0.24536	0.35411	0.09025			ug/kg	0.134
Dieldrin	Mummichog	1	9.66352	0.06595	2.04146			ug/kg	0.636
Dieldrin	White Perch	1	2.78549	0.34235	0.57399			ug/kg	0.112
Total Chlordane	American Eel	1	3.44662	0.34651	0.65800			ug/kg	0.532
Total Chlordane	Blue Crab	1	4.55313	0.15523	0.98158			ug/kg	0.571
Total Chlordane	Mummichog	1	4.44414	0.76803	1.71386			ug/kg	0.831
Total Chlordane	White Perch	1	4.74107	0.42766	1.13363			ug/kg	0.730
Total DDx	American Eel	1	5.22982	0.29569	0.77243			ug/kg	0.624
Total DDx	Blue Crab	1	-0.46665	0.65774	0.16833			ug/kg	0.390
Total DDx	Mummichog	1	3.73575	0.35613	0.72683			ug/kg	0.238
Total DDx	White Perch	1	6.70305	0.34445	1.35177			ug/kg	0.564
HMW PAH	American Eel	1	-3.38267	0.65048	1.06779			ug/kg	0.561
HMW PAH	Blue Crab	1	-4.58837	0.67763	0.40568			ug/kg	0.161
HMW PAH	Mummichog	1	-9.73635	0.63814	-1.31243			ug/kg	0.190
HMW PAH	White Perch	1	-8.68349	1.02374	0.55762			ug/kg	0.790
LMW PAH	American Eel	1	-3.54429	0.69343	0.28305			ug/kg	0.270
LMW PAH	Blue Crab	1	-2.92707	0.48874	0.03414			ug/kg	0.128
LMW PAH	Mummichog	1	2.51498	0.33456	0.62366			ug/kg	0.105
LMW PAH	White Perch	1	-2.90347	0.83321	0.88768			ug/kg	0.789
Total PAH	American Eel	1	-3.95028	0.67295	0.37867			ug/kg	0.429
Total PAH	Blue Crab	1	-4.52659	0.66322	0.24278			ug/kg	0.183
Total PAH	Mummichog	1	-1.47361	0.44458	-0.04640			ug/kg	0.080
Total PAH	White Perch	1	-3.94124	0.82210	0.83788			ug/kg	0.845
Inorganic Parameters									
COPC/COPEC	**Species**	**Model(a)**	**β_0**	**β_1**	**β_2**	**BAF Factor**	**BAF Std Dev**	**Units**	**R^2**
Copper	American Eel	2				0.00015	0.00063	mg/kg	
Copper	Blue Crab	1	-7.682	1.242				mg/kg	0.161
Copper	Mummichog	2				0.00053	0.00015	mg/kg	
Copper	White Perch	2				0.00006	0.00001	mg/kg	
Lead	American Eel	1	-7.921	0.755				mg/kg	-0.0754
Lead	Blue Crab	1	-8.552	0.755				mg/kg	0.115
Lead	Mummichog	1	-7.136	0.755				mg/kg	0.305
Lead	White Perch	1	-11.63	0.755				mg/kg	0.152
Mercury	American Eel	1	-3.079	0.375				mg/kg	-0.0346
Mercury	Blue Crab	1	-3.911	0.375				mg/kg	0.206
Mercury	Mummichog	1	-4.810	0.375				mg/kg	0.077
Mercury	White Perch	1	-2.839	0.375				mg/kg	0.057

(a) Model equations are provided on Table 7-5.
BAF – bioaccumulation factor
BSAF – biota sediment accumulation factor
COPC/COPEC – chemical of potential concern/chemical of potential ecological concern
R^2 - is the correlation coefficient between observed values and predicted values; R^2 is determined for regression analysis only (model 1), not model 2.
Std Dev – standard deviation
pg/g – picograms per gram
µg/kg – micrograms per kilogram
mg/kg – milligram per kilogram

Table 7-7. Specific Average Lipid Fraction Values for Each Tissue and Species

Species	Number of Samples	Tissue Type(s)	Average Lipid Fraction (f_L) (standard deviation)
White perch	11	Fillet (with skin)	0.0226 (0.00700)
American eel	10	Whole body (8), reconstituted whole body (2)	0.0699 (0.0302)
Mummichog	15	Whole body	0.0190 (0.00488)
Blue crab	22	Muscle/hepatopancreas	0.0154 (0.00502)

Table 7-8. Summary Statistics[(a)] for Total Organic Carbon and Iron in Surface Sediments from the Lower Eight Miles of the Lower Passaic River

Analyte	Sample Count	Mean	Median	Minimum	Maximum	Standard Deviation	Standard Error
Total Organic Carbon Content (Unitless)	136	0.0466	0.041	0.0038	0.24	0.0315	0.00270
Iron Content (Unitless)	136	0.0251	0.026	0.0069	0.041	0.00629	0.00054

(a) EPA 2008, 2008 CPG, 2009 CPG and 2010 CPG 0-6 inch surface sediment samples were included in above analysis.

Table 7-9. Summary of Future Human Health Biota Exposure Point Concentrations

Alternative	COPC	Fish[d] (mg/kg) Maximum 6-Year Rolling Annual Average	Fish[d] (mg/kg) Maximum 12-Year Rolling Annual Average	Fish[d] (mg/kg) Maximum 24-Year Rolling Annual Average	Blue Crab (mg/kg) Maximum 6-Year Rolling Annual Average	Blue Crab (mg/kg) Maximum 12-Year Rolling Annual Average	Blue Crab (mg/kg) Maximum 24-Year Rolling Annual Average
Alternative 1: No Action	TCDD TEQ (D/F)[a]	0.000060	0.000054	0.000053	0.000044	0.000042	0.000039
	TCDD TEQ (PCBs)[b]	0.000045	0.000042	0.000038	0.000048	0.000045	0.000043
	Total PCBs	1.2	1.1	0.98	0.41	0.39	0.37
	4,4'-DDD[c]	0.11	0.10	0.10	0.020	0.019	0.017
	4,4'-DDE[c]	0.12	0.11	0.11	0.023	0.022	0.021
	4,4'-DDT[c]	0.10	0.10	0.098	0.019	0.018	0.016
	Total Chlordane	0.042	0.042	0.042	0.0042	0.0042	0.0042
	Methyl mercury	0.32	0.31	0.29	0.10	0.097	0.092
Alternative 2: Deep Dredging with Backfill	TCDD TEQ (D/F)[a]	0.0000088	0.0000056	0.0000046	0.0000061	0.0000039	0.0000031
	TCDD TEQ (PCBs)[b]	0.0000061	0.0000060	0.0000055	0.000013	0.000012	0.000012
	Total PCBs	0.11	0.089	0.079	0.087	0.074	0.068
	4,4'-DDD[c]	0.050	0.048	0.046	0.0041	0.0039	0.0035
	4,4'-DDE[c]	0.060	0.057	0.055	0.0062	0.0054	0.0051
	4,4'-DDT[c]	0.056	0.056	0.053	0.0053	0.0052	0.0048
	Total Chlordane	0.035	0.034	0.032	0.0039	0.0039	0.0038
	Methyl mercury	0.14	0.13	0.13	0.043	0.042	0.040
Alternative 3: Capping with Dredging for Flooding and Navigation	TCDD TEQ (D/F)[a]	0.0000067	0.0000046	0.0000041	0.0000047	0.0000032	0.0000028
	TCDD TEQ (PCBs)[b]	0.0000051	0.0000044	0.0000043	0.000011	0.000010	0.0000099
	Total PCBs	0.098	0.074	0.063	0.079	0.066	0.059
	4,4'-DDD[c]	0.048	0.044	0.043	0.0038	0.0033	0.0030
	4,4'-DDE[c]	0.058	0.053	0.051	0.0056	0.0047	0.0044
	4,4'-DDT[c]	0.052	0.049	0.048	0.0045	0.0040	0.0039
	Total Chlordane	0.035	0.034	0.032	0.0039	0.0039	0.0038
	Methyl mercury	0.14	0.13	0.12	0.046	0.042	0.038
Alternative 4: Focused Capping with Dredging for Flooding	TCDD TEQ (D/F)[a]	0.000032	0.000030	0.000029	0.000023	0.000022	0.000021
	TCDD TEQ (PCBs)[b]	0.000030	0.000028	0.000027	0.000036	0.000035	0.000033
	Total PCBs	0.71	0.65	0.60	0.29	0.28	0.26
	4,4'-DDD[c]	0.091	0.088	0.085	0.014	0.013	0.012
	4,4'-DDE[c]	0.099	0.096	0.094	0.017	0.016	0.015
	4,4'-DDT[c]	0.093	0.090	0.087	0.015	0.014	0.013
	Total Chlordane	0.039	0.039	0.038	0.0041	0.0041	0.0040
	Methyl mercury	0.28	0.13	0.25	0.087	0.042	0.080

Units = milligram per kilogram (mg/kg)

(a) Based on the sediment model output for 2,3,7,8-TCDD and BSAF for 2,3,7,8-TCDD.

(b) Based on the BSAF for Total PCBs.

(c) Based on the BSAF derived for Total DDx.

(d) The EPC for fish in the HHRA is the average of the white perch and American eel concentrations.

Table 7-10. Summary of Future Modeled EPCs for the future modeled BERA

Remedial Alternative	COPEC	Sediment Concentration		Generic Fish	Forage Fish	Blue Crab	Generic Fish	Forage Fish	Blue Crab
		2019	2048	2019			2048		
No Action	Copper	1.6E+02	1.3E+02	5.1E+00	3.3E+00	2.4E+01	4.2E+00	2.8E+00	1.9E+01
	Lead	2.5E+02	2.0E+02	3.5E-01	8.2E-01	2.0E-01	2.9E-01	6.9E-01	1.7E-01
	Mercury	2.3E+00	1.1E+00	2.2E-01	4.4E-02	1.1E-01	1.7E-01	3.3E-02	8.1E-02
	MHMW PAHs	4.3E+01	4.3E+01	8.2E-02	6.8E-02	2.0E-02	8.2E-02	6.8E-02	2.0E-02
	Total DDx	9.8E-02	5.9E-02	4.8E-01	3.6E-02	4.7E-02	4.0E-01	3.0E-02	3.4E-02
	Total PCBs	1.5E+00	8.9E-01	3.8E+00	5.0E-01	4.5E-01	2.2E+00	3.1E-01	3.2E-01
	TEQ PCB-mammals	5.4E-05	3.3E-05	3.0E-05	5.0E-06	6.0E-06	1.9E-05	3.5E-06	3.8E-06
	TEQ D/F-mammals	5.6E-04	3.8E-04	2.6E-04	2.6E-05	5.3E-05	1.8E-04	2.0E-05	3.8E-05
	TEQ PCB-birds	3.8E-04	2.2E-04	1.8E-04	2.0E-05	3.7E-05	1.1E-04	1.4E-05	2.3E-05
	TEQ D/F-birds	5.9E-04	4.1E-04	2.8E-04	2.7E-05	5.7E-05	1.9E-04	2.1E-05	4.0E-05
	TEQ PCB-fishs	3.5E-06	2.1E-06	2.4E-06	7.1E-07	4.6E-07	1.5E-06	4.9E-07	2.8E-07
	TEQ D/F-fishs	5.6E-04	3.8E-04	2.6E-04	2.6E-05	5.3E-05	1.8E-04	2.0E-05	3.8E-05
	TCDD	5.1E-04	3.5E-04	2.4E-04	2.4E-05	4.9E-05	1.7E-04	1.8E-05	3.4E-05
		2023	2052	2023			2052		
Capping with Dredging for Flooding and Navigation	Copper	4.5E+00	6.1E+01	1.4E-01	9.3E-02	2.8E-01	1.9E+00	1.3E+00	7.2E+00
	Lead	6.9E+00	9.3E+01	2.3E-02	5.4E-02	1.3E-02	1.6E-01	3.9E-01	9.4E-02
	Mercury	2.1E-01	8.2E-02	9.1E-02	1.8E-02	4.4E-02	6.4E-02	1.3E-02	3.1E-02
	MHMW PAHs	2.0E+00	2.8E+01	4.2E-03	9.6E-03	2.5E-03	5.4E-02	5.2E-02	1.5E-02
	Total DDx	7.4E-03	4.8E-03	2.0E-01	1.4E-02	8.7E-03	1.8E-01	1.2E-02	6.5E-03
	Total PCBs	9.1E-02	4.0E-02	2.3E-01	3.5E-02	7.1E-02	1.0E-01	1.6E-02	4.1E-02
	TEQ PCB-mammals	5.6E-06	4.0E-06	3.6E-06	9.9E-07	7.1E-07	2.7E-06	7.9E-07	5.2E-07
	TEQ D/F-mammals	2.4E-05	9.4E-06	1.4E-05	2.8E-06	2.8E-06	5.8E-06	1.4E-06	1.2E-06
	TEQ PCB-birds	2.6E-05	1.3E-05	1.5E-05	2.9E-06	3.0E-06	8.0E-06	1.8E-06	1.6E-06
	TEQ D/F-birds	2.7E-05	1.0E-05	1.5E-05	3.0E-06	3.1E-06	6.2E-06	1.5E-06	1.2E-06
	TEQ PCB-fishs	3.2E-07	2.0E-07	2.8E-07	1.3E-07	4.8E-08	1.9E-07	9.5E-08	3.2E-08
	TEQ D/F-fishs	2.4E-05	9.0E-06	1.4E-05	2.8E-06	2.8E-06	5.6E-06	1.4E-06	1.1E-06
		2030	2059	2030			2059		
Deep Dredging with Backfill Placement	Copper	4.4E+00	6.0E+01	1.4E-01	9.0E-02	2.7E-01	1.9E+00	1.2E+00	7.0E+00
	Lead	6.7E+00	9.1E+01	2.2E-02	5.3E-02	1.3E-02	1.6E-01	3.8E-01	9.2E-02
	Mercury	1.2E-01	9.3E-02	7.4E-02	1.5E-02	3.6E-02	6.7E-02	1.3E-02	3.2E-02
	MHMW PAHs	2.0E+00	2.8E+01	4.2E-03	9.6E-03	2.5E-03	5.4E-02	5.2E-02	1.5E-02
	Total DDx	5.7E-03	5.6E-03	1.9E-01	1.3E-02	7.3E-03	1.8E-01	1.3E-02	7.2E-03
	Total PCBs	5.6E-02	5.1E-02	1.4E-01	2.2E-02	5.1E-02	1.3E-01	2.0E-02	4.8E-02
	TEQ PCB-mammals	3.2E-06	4.7E-06	2.2E-06	6.7E-07	4.2E-07	3.1E-06	8.7E-07	6.0E-07
	TEQ D/F-mammals	2.0E-05	1.2E-05	1.1E-05	2.4E-06	2.3E-06	7.5E-06	1.7E-06	1.5E-06
	TEQ PCB-birds	1.7E-05	1.6E-05	9.8E-06	2.1E-06	2.0E-06	9.3E-06	2.1E-06	1.9E-06
	TEQ D/F-birds	2.1E-05	1.3E-05	1.2E-05	2.5E-06	2.4E-06	8.0E-06	1.8E-06	1.6E-06
	TEQ PCB-fishs	1.8E-07	2.4E-07	1.7E-07	8.6E-08	2.8E-08	2.2E-07	1.1E-07	3.7E-08
	TEQ D/F-fishs	1.9E-05	1.2E-05	1.1E-05	2.4E-06	2.3E-06	7.3E-06	1.7E-06	1.5E-06
		2020	2049	2020			2049		
Focused Capping with Dredging for Flooding	Copper	9.0E+01	1.0E+02	2.8E+00	1.8E+00	1.2E+01	3.3E+00	2.1E+00	1.4E+01
	Lead	1.4E+02	1.5E+02	2.2E-01	5.3E-01	1.3E-01	2.4E-01	5.7E-01	1.4E-01
	Mercury	1.6E+00	8.6E-01	1.9E-01	3.8E-02	9.3E-02	1.5E-01	3.0E-02	7.4E-02
	MHMW PAHs	2.4E+01	3.6E+01	4.6E-02	4.7E-02	1.4E-02	7.0E-02	6.1E-02	1.8E-02
	Total DDx	6.4E-02	3.9E-02	4.1E-01	3.1E-02	3.6E-02	3.5E-01	2.6E-02	2.6E-02
	Total PCBs	9.1E-01	5.9E-01	2.3E+00	3.1E-01	3.3E-01	1.5E+00	2.1E-01	2.5E-01
	TEQ PCB-mammals	3.7E-05	2.5E-05	2.1E-05	3.8E-06	4.2E-06	1.5E-05	2.9E-06	3.0E-06
	TEQ D/F-mammals	2.9E-04	2.1E-04	1.4E-04	1.6E-05	2.9E-05	1.1E-04	1.3E-05	2.1E-05
	TEQ PCB-birds	2.3E-04	1.5E-04	1.2E-04	1.4E-05	2.4E-05	7.6E-05	1.0E-05	1.5E-05
	TEQ D/F-birds	3.2E-04	2.3E-04	1.5E-04	1.7E-05	3.1E-05	1.1E-04	1.4E-05	2.3E-05
	TEQ PCB-fishs	2.3E-06	1.5E-06	1.6E-06	5.3E-07	3.1E-07	1.1E-06	4.0E-07	2.1E-07
	TEQ D/F-fishs	2.9E-04	2.1E-04	1.4E-04	1.6E-05	2.9E-05	1.0E-04	1.3E-05	2.1E-05

Units = milligram per kilogram (mg/kg)

Table 7-11. LPR-NB Modeled Concentrations among the Remedial Alternatives[(a)] for the HHRA

	Scale Factor		No Action						Capping with Dredging for Flooding and Navigation					
			Maximum 6-year Annual Average			Maximum 24-year Annual Average			Maximum 6-year Annual Average			Maximum 24-year Annual Average		
COPC	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
2,3,7,8-TCDD	6.50E-01	1.35E+00	4.44E-04	2.88E-04	5.99E-04	3.92E-04	2.55E-04	5.29E-04	4.10E-05	2.66E-05	5.53E-05	2.38E-05	1.55E-05	3.21E-05
TCDD TEQ (PCBs)	4.80E-01	1.52E+00	4.94E-05	2.37E-05	7.51E-05	4.17E-05	2.00E-05	6.34E-05	5.50E-06	2.64E-06	8.36E-06	4.63E-06	2.22E-06	7.04E-06
Total PCBs	7.30E-01	1.27E+00	1.29E+00	9.42E-01	1.64E+00	1.07E+00	7.79E-01	1.36E+00	1.07E-01	7.81E-02	1.36E-01	6.87E-02	5.02E-02	8.73E-02
4,4'-DDD	6.70E-01	1.33E+00	2.67E-02	1.79E-02	3.54E-02	2.12E-02	1.42E-02	2.82E-02	2.12E-03	1.42E-03	2.82E-03	1.49E-03	9.98E-04	1.98E-03
4,4'-DDE	6.60E-01	1.34E+00	3.29E-02	2.17E-02	4.40E-02	2.83E-02	1.86E-02	3.79E-02	3.80E-03	2.51E-03	5.09E-03	2.58E-03	1.70E-03	3.46E-03
4,4'-DDT	6.00E-02	1.94E+00	2.40E-02	1.44E-03	4.66E-02	1.94E-02	1.16E-03	3.76E-02	2.72E-03	1.63E-04	5.28E-03	2.18E-03	1.31E-04	4.24E-03
Methylmercury	5.60E-01	1.44E+00	1.92E+00	1.08E+00	2.77E+00	1.45E+00	8.12E-01	2.09E+00	2.27E-01	1.27E-01	3.27E-01	1.43E-01	7.98E-02	2.05E-01
	Scale Factor		Deep Dredging with Backfill						Focused Capping for Flooding					
			Maximum 6-year Annual Average			Maximum 24-year Annual Average			Maximum 6-year Annual Average			Maximum 24-year Annual Average		
COPC	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
2,3,7,8-TCDD	6.50E-01	1.35E+00	5.49E-05	3.57E-05	7.41E-05	2.67E-05	1.74E-05	3.61E-05	2.25E-04	1.46E-04	3.03E-04	2.03E-04	1.32E-04	2.74E-04
TCDD TEQ (PCBs)	4.80E-01	1.52E+00	6.66E-06	3.20E-06	1.01E-05	5.94E-06	2.85E-06	9.03E-06	3.31E-05	1.59E-05	5.03E-05	2.91E-05	1.40E-05	4.42E-05
Total PCBs	7.30E-01	1.27E+00	1.23E-01	8.99E-02	1.56E-01	8.55E-02	6.24E-02	1.09E-01	7.71E-01	5.63E-01	9.79E-01	6.54E-01	4.78E-01	8.31E-01
4,4'-DDD	6.70E-01	1.33E+00	2.36E-03	1.58E-03	3.13E-03	1.87E-03	1.26E-03	2.49E-03	1.58E-02	1.06E-02	2.10E-02	1.28E-02	8.54E-03	1.70E-02
4,4'-DDE	6.60E-01	1.34E+00	4.36E-03	2.88E-03	5.85E-03	3.31E-03	2.19E-03	4.44E-03	2.00E-02	1.32E-02	2.69E-02	1.72E-02	1.14E-02	2.31E-02
4,4'-DDT	6.00E-02	1.94E+00	3.49E-03	2.09E-04	6.76E-03	2.98E-03	1.79E-04	1.83E-02	1.69E-02	1.01E-03	3.27E-02	1.37E-02	8.24E-04	2.66E-02
Methylmercury	5.60E-01	1.44E+00	1.91E-01	1.07E-01	2.75E-01	1.56E-01	8.71E-02	2.24E-01	1.28E+00	7.16E-01	1.84E+00	9.96E-01	5.58E-01	1.43E+00

Units = milligram per kilogram (mg/kg)

Table 7-12. LPR-NB Modeled Concentrations among the Remedial Alternatives[(a)] for the BERA

COPEC	Units	Scale Factor		Remedial Alternative											
				No Action			Capping with Dredging for Flooding and Navigation			Deep Dredging with Backfill			Focused Capping for Flooding		
		Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Mercury	µg/Kg	0.56	1.44	1.09E+03	6.09E+02	1.57E+03	8.19E+01	4.59E+01	1.18E+02	9.29E+01	5.20E+01	1.34E+02	8.56E+02	4.79E+02	1.23E+03
Total DDx	µg/Kg	0.89	1.11	5.86E+01	5.22E+01	6.51E+01	4.84E+00	4.31E+00	5.37E+00	5.63E+00	5.01E+00	6.25E+00	3.93E+01	3.50E+01	4.36E+01
Total PCBs	µg/Kg	0.73	1.27	8.90E+02	6.50E+02	1.13E+03	4.05E+01	2.95E+01	5.14E+01	5.09E+01	3.71E+01	6.46E+01	5.92E+02	4.32E+02	7.51E+02
TCDD TEQ (PCBs) – mammal	µg/Kg	0.48	1.52	3.30E-02	1.58E-02	5.02E-02	4.03E-03	1.94E-03	6.13E-03	4.69E-03	2.25E-03	7.13E-03	2.54E-02	1.22E-02	3.87E-02
TCDD TEQ (PCBs) – bird	µg/Kg	0.71	1.29	2.24E-01	1.59E-01	2.89E-01	1.33E-02	9.47E-03	1.72E-02	1.57E-02	1.11E-02	2.03E-02	1.48E-01	1.05E-01	1.91E-01
TCDD TEQ (PCBs) – fish	µg/Kg	0.44	1.56	2.07E-03	9.13E-04	3.24E-03	2.04E-04	8.99E-05	3.19E-04	2.38E-04	1.05E-04	3.71E-04	1.54E-03	6.78E-04	2.40E-03
TCDD TEQ (D/F) – mammal	µg/Kg	0.70	1.30	3.84E-01	2.69E-01	4.99E-01	9.39E-03	6.57E-03	1.22E-02	1.24E-02	8.67E-03	1.61E-02	2.11E-01	1.48E-01	2.74E-01
TCDD TEQ (D/F) – bird	µg/Kg	0.67	1.33	4.07E-01	2.72E-01	5.41E-01	1.01E-02	6.77E-03	1.34E-02	1.33E-02	8.91E-03	1.77E-02	2.27E-01	1.52E-01	3.02E-01
TCDD TEQ (D/F) – fish	µg/Kg	0.70	1.30	3.83E-01	2.68E-01	4.98E-01	8.99E-03	6.29E-03	1.17E-02	1.20E-02	8.37E-03	1.55E-02	2.11E-01	1.47E-01	2.74E-01
2,3,7,8-TCDD	µg/Kg	0.65	1.35	3.51E-01	2.28E-01	4.74E-01	6.96E-03	4.52E-03	9.39E-03	9.56E-03	6.22E-03	1.29E-02	1.88E-01	1.22E-01	2.54E-01

(a) Lower and upper bounds around the median relative error; modeled sediment concentrations estimated 30 years following remedial implementation.

Table 7-13. Summary of Lower- and Upper-Bound Scaling Factors for Sediment and Biological Tissue Residues

COPEC	Sediment Scale Factors		Tissue Scale Factors					
			Piscivorous Fish	Forage Fish	Blue Crab	Piscivorous Fish	Forage Fish	Blue Crab
	Lower-Bound	Upper-Bound	Lower-Bound			Upper-Bound		
Mercury	0.55	1.45	0.8	0.8	0.8	1.1	1.1	1.1
Total DDx	0.89	1.11	1.0	1.0	0.9	1.0	1.0	1.1
Total PCBs	0.73	1.27	0.7	0.7	0.8	1.3	1.3	1.2
TEQ PCB-mammals	0.48	1.52	0.5	0.6	0.5	1.5	1.3	1.5
TEQ D/F-mammals	0.70	1.30	0.7	0.8	0.7	1.3	1.2	1.3
TEQ PCB-birds	0.71	1.29	0.7	0.8	0.7	1.3	1.2	1.3
TEQ D/F-birds	0.67	1.33	0.7	0.8	0.7	1.3	1.2	1.3
TEQ PCB-fishs	0.44	1.56	0.5	0.6	0.5	1.5	1.4	1.5
TEQ D/F-fishs	0.70	1.30	0.7	0.8	0.7	1.3	1.2	1.3
TCDD	0.65	1.32						

Table 7-14. Summary of Lower- and Upper-Bound Scaling Factors for Wildlife Dose Estimates

COPEC	Wildlife Scale Factors					
	Heron (Generic Fish Diet)	Heron (Mummichog Diet)	Mink (Generic Fish Diet)	Heron (Generic Fish Diet)	Heron (Mummichog Diet)	Mink (Generic Fish Diet)
	Lower-Bound			Upper-Bound		
Mercury	0.7	0.7	0.8	1.2	1.3	1.2
Total DDx	1.0	0.9	1.0	1.0	1.0	1.0
Total PCBs	0.7	0.7	0.7	1.3	1.2	1.3
TEQ PCB-mammals			0.5			1.5
TEQ D/F-mammals			0.7			1.3
TEQ PCB-birds	0.7	0.7		1.3	1.2	
TEQ D/F-birds	0.7	0.7		1.3	1.3	

Table 7-15. Summary of BAFs and BSAFs Correlation Coefficients for Sediment-Tissue Relationships

COPEC	Species			
	American Eel	Blue Crab	Mummichog	White Perch
Bioaccumulation Factor (BAF) R^2 Value				
Copper	NA	16%	NA	NA
Lead	-7.5%	11%	31%	15%
Mercury	-3.5	21%	7.7%	5.7%
Biota Sediment Accumulation Factor (BSAF) R^2 Value				
Total DDx	62%	39%	24%	56%
Total PCBs	NA	42%	37%	NA
2,3,7,8-TCDD	85%	92%	70%	91%

R^2 - correlation coefficient between observed values and predicted values; R^2 determined for BAF/BSAF based on regression analysis only.

NA - R^2 not available, BAF/BSAF not based on regression analysis.

Table 7-16. Normalized Standard Errors[(a)] for Site-Derived BSAFs and BAFs used to Estimate Future Tissue Concentrations

COPEC	Species				
	White perch	American eel	Generic Fish	Blue crab	Mummichog
Total PCB	7.9%	11%	NA	NA	NA
Copper	4.3%	93%	NA	NA	4.7%

(a) Standard errors (se) on the arithmetic means uptake factors are presented in Table 7-5. Values are the ratio of the standard error to the BSAF or BAF and expressed as a percentage.

Table 7-17. Summary Statistics for the LPR-NB Model COPEC Sediment Concentrations[(a)]

COPEC	Units	Remedial Alternative											
		No Action			Capping with Dredging for Flooding and Navigation			Deep Dredging with Backfill			Focused Capping for Flooding		
		Mean	5th	95th	Mean	5th	95th	Mean	5th	95th	Mean	5th	95th
Copper	mg/Kg	1.3E+02	1.1E+02	1.6E+02	6.1E+01	5.1E+01	8.8E+01	6.0E+01	5.0E+01	8.6E+01	1.0E+02	8.8E+01	1.3E+02
Lead	mg/Kg	2.0E+02	1.6E+02	2.3E+02	9.3E+01	7.9E+01	1.2E+02	9.1E+01	7.7E+01	1.2E+02	1.5E+02	1.3E+02	1.8E+02
Mercury	mg/Kg	1.1E+00	1.6E-01	3.1E+00	8.2E-02	5.1E-03	3.1E-01	9.3E-02	4.2E-03	2.8E-01	8.6E-01	1.0E-02	2.9E+00
Total DDx	mg/Kg	5.9E-02	1.3E-02	1.8E-01	4.8E-03	2.7E-04	1.9E-02	5.6E-03	2.1E-04	1.7E-02	3.9E-02	4.7E-04	1.9E-01
Total PCBs	mg/Kg	8.9E-01	1.1E-01	2.6E+00	4.0E-02	2.1E-03	1.5E-01	5.1E-02	1.8E-03	1.6E-01	5.9E-01	4.0E-03	2.0E+00
TCDD TEQ (PCBs) – mammal	mg/Kg	3.3E-05	5.2E-06	9.9E-05	4.0E-06	2.1E-07	1.5E-05	4.7E-06	1.7E-07	1.8E-05	2.5E-05	3.5E-07	5.9E-05
TCDD TEQ (PCBs) – bird	mg/Kg	2.2E-04	2.8E-05	6.5E-04	1.3E-05	7.4E-07	4.8E-05	1.6E-05	6.4E-07	5.3E-05	1.5E-04	1.5E-06	5.2E-04
TCDD TEQ (PCBs) – fish	mg/Kg	2.1E-06	2.7E-07	6.9E-06	2.0E-07	1.1E-08	7.6E-07	2.4E-07	8.9E-09	9.0E-07	1.5E-06	1.8E-08	4.0E-06
TCDD TEQ (D/F) – mammal	mg/Kg	3.8E-04	4.1E-05	2.5E-03	9.4E-06	4.0E-07	2.8E-05	1.2E-05	4.4E-07	3.5E-05	2.1E-04	1.3E-06	8.3E-04
TCDD TEQ (D/F) – bird	mg/Kg	4.1E-04	4.3E-05	2.6E-03	1.0E-05	4.6E-07	3.0E-05	1.3E-05	4.8E-07	3.8E-05	2.3E-04	1.4E-06	8.8E-04
TCDD TEQ (D/F) – fish	mg/Kg	3.8E-04	4.0E-05	2.5E-03	9.0E-06	3.8E-07	2.7E-05	1.2E-05	4.3E-07	3.5E-05	2.1E-04	1.3E-06	8.3E-04
2,3,7,8-TCDD	mg/Kg	3.5E-04	3.6E-05	2.4E-03	7.0E-06	2.7E-07	2.1E-05	9.6E-06	3.3E-07	3.0E-05	1.9E-04	1.1E-06	7.8E-04

(a) 5th and 95th percentiles of the modeled sediment concentrations estimated 30 years following remedial implementation.

Table 7-18. Summary Statistics for EMBM COPEC Sediment Concentrations[(a)]

COPEC	Units	Remedial Alternative											
		No Action			Capping with Dredging for Flooding and Navigation			Deep Dredging with Backfill			Focused Capping for Flooding		
		Mean	5th	95th	Mean	5th	95th	Mean	5th	95th	Mean	5th	95th
Copper	mg/Kg	1.3E+02	1.1E+02	1.6E+02	6.1E+01	5.1E+01	8.8E+01	6.0E+01	5.0E+01	8.6E+01	1.0E+02	8.8E+01	1.3E+02
Lead	mg/Kg	2.0E+02	1.6E+02	2.3E+02	9.3E+01	7.9E+01	1.2E+02	9.1E+01	7.7E+01	1.2E+02	1.5E+02	1.3E+02	1.8E+02
Mercury	mg/Kg	1.7E+00	1.4E+00	2.2E+00	7.3E-01	5.6E-01	1.2E+00	6.9E-01	5.3E-01	1.1E+00	1.3E+00	1.1E+00	1.7E+00
Total PCBs	mg/Kg	9.6E-01	7.2E-01	1.2E+00	3.5E-01	2.9E-01	5.2E-01	3.4E-01	2.8E-01	5.0E-01	7.0E-01	5.6E-01	9.0E-01
2,3,7,8-TCDD	mg/Kg	2.6E-04	1.4E-04	3.6E-04	5.0E-05	2.8E-05	8.8E-05	4.2E-05	2.2E-05	8.0E-05	1.7E-04	9.9E-05	2.5E-04

(a) 5th and 95th percentiles of the modeled sediment concentrations estimated 30 years following remedial implementation.

Table 7-19. Comparison of Summary Statistics for the LPR-NB Model and EMBM Modeled Sediment Concentrations - Joint COPECs[(a)]

COPEC[(b)]	Model	Units	Remedial Alternative											
			No Action			Capping with Dredging for Flooding and Navigation			Deep Dredging with Backfill			Focused Capping for Flooding		
			Mean	5th	95th	Mean	5th	95th	Mean	5th	95th	Mean	5th	95th
Mercury	LPR-NB	mg/Kg	1.1E+00	1.6E-01	3.1E+00	8.2E-02	5.1E-03	3.1E-01	9.3E-02	4.2E-03	2.8E-01	8.6E-01	1.0E-02	2.9E+00
Mercury	EMBM	mg/Kg	1.7E+00	1.4E+00	2.2E+00	7.3E-01	5.6E-01	1.2E+00	6.9E-01	5.3E-01	1.1E+00	1.3E+00	1.1E+00	1.7E+00
Total PCBs	LPR-NB	mg/Kg	8.9E-01	1.1E-01	2.6E+00	4.0E-02	2.1E-03	1.5E-01	5.1E-02	1.8E-03	1.6E-01	5.9E-01	4.0E-03	2.0E+00
Total PCBs	EMBM	mg/Kg	9.6E-01	7.2E-01	1.2E+00	3.5E-01	2.9E-01	5.2E-01	3.4E-01	2.8E-01	5.0E-01	7.0E-01	5.6E-01	9.0E-01
2,3,7,8-TCDD	LPR-NB	mg/Kg	3.5E-04	3.6E-05	2.4E-03	7.0E-06	2.7E-07	2.1E-05	9.6E-06	3.3E-07	3.0E-05	1.9E-04	1.1E-06	7.8E-04
2,3,7,8-TCDD	EMBM	mg/Kg	2.6E-04	1.4E-04	3.6E-04	5.0E-05	2.8E-05	8.8E-05	4.2E-05	2.2E-05	8.0E-05	1.7E-04	9.9E-05	2.5E-04

(a) Mean and 5th and 95th percentiles of the modeled sediment concentrations; based on model estimates for 30 years following remedial implementation.
(b) COPECs with sediment concentrations estimated by both the LPR-NB Model and EMBM models.

Table 7-20. Relative Variability in Modeled COPEC Distributions among the Remedial Alternatives[(a)]

COPEC	Remedial Alternative							
	No Action		Capping with Dredging for Flooding and Navigation		Deep Dredging with Backfill		Focused Capping for Flooding	
	5%	95%	5%	95%	5%	95%	5%	95%
Copper	85%	123%	84%	144%	83%	143%	88%	130%
Lead	80%	115%	85%	129%	85%	132%	87%	120%
Mercury	15%	282%	6%	378%	5%	301%	1%	337%
Total DDx	22%	305%	6%	396%	4%	304%	1%	487%
Total PCBs	12%	292%	5%	375%	4%	314%	1%	339%
TCDD TEQ (PCBs) mammal	16%	300%	5%	375%	4%	383%	1%	236%
TCDD TEQ (PCBs) - bird	13%	295%	6%	369%	4%	331%	1%	347%
TCDD TEQ (PCBs) - fish	13%	329%	6%	380%	4%	375%	1%	267%
TCDD TEQ (D/F) - mammal	11%	658%	4%	298%	4%	292%	1%	395%
TCDD TEQ (D/F) - bird	10%	634%	5%	300%	4%	292%	1%	383%
TCDD TEQ (D/F) - fish	11%	658%	4%	300%	4%	292%	1%	395%
2,3,7,8-TCDD	10%	686%	4%	300%	3%	313%	1%	411%

Ratios of 5th and 95th percentiles to the modeled arithmetic mean sediment estimates; based on model estimates for 30 years following remedial implementation. Smaller 5th percentile and larger 95th percentile values indicate greater variability.

Table 7-21. Summary of Hazard Index Estimates for 30 Years Following Remedy Implementation for Endpoint Receptors

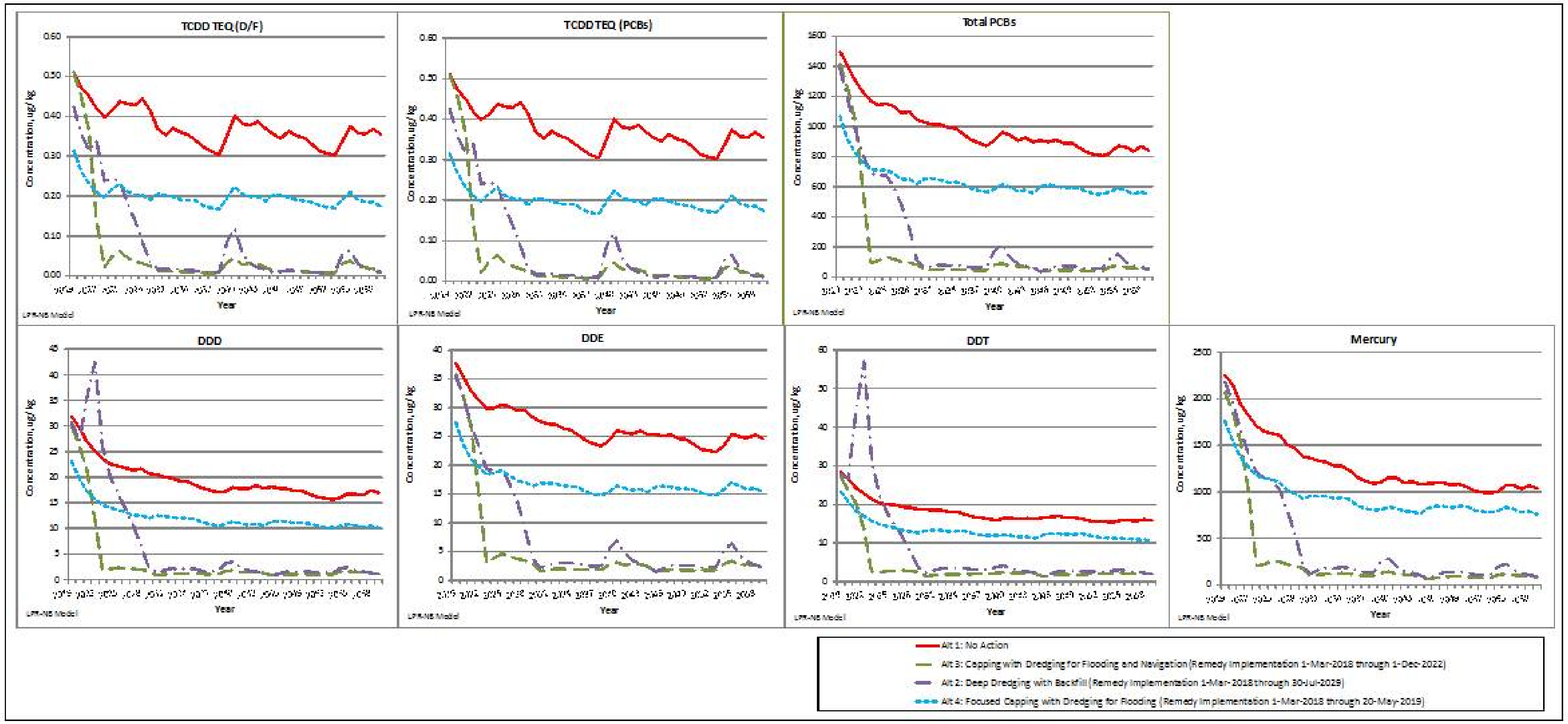
Endpoint Recptors	No Action	Capping with Dredging for Flooding and Navigation	Deep Dredging with Backfill Placement	Focused Capping with Dredging for Flooding
Benthos (sediment benchmarks)	200	10	20	100
Crab CBR	100	10	10	100
Generic Fish CBR	200	10	10	100
Mummichog CBR	20	4	4	20
Heron Diet (generic fish)	10	4	4	10
Mink Diet (generic fish)	200	10	10	100

Values are geometric mean values of lower- and upper-bound total HI values from Tables 5-8 through 5-14.

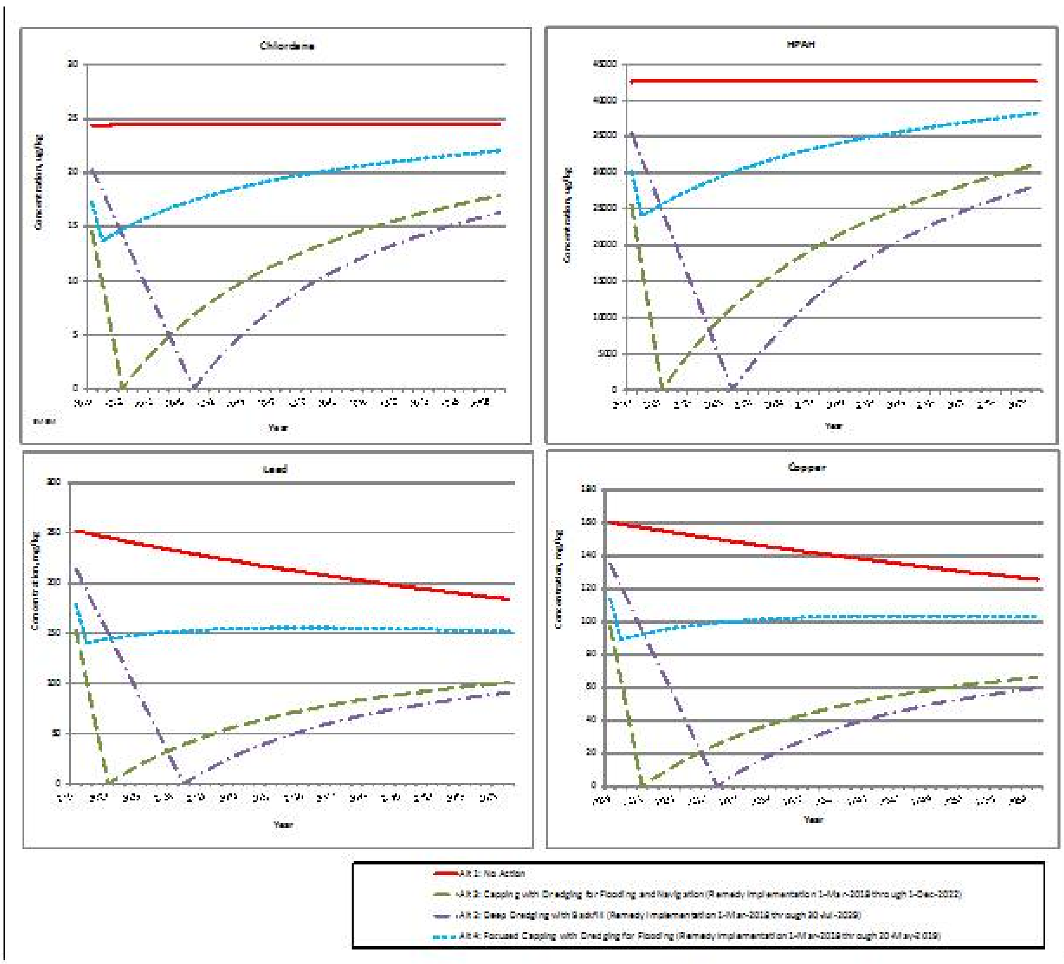
Table 7-22. Annual Average Modeled Concentrations and Summary Statistics for Select COPECs in Surficial Sediments for Last Nineteen Modeled Years

Year	Units	COPEC			
		TCDD	Total Hg	Total DDx	Total PCBs
2041	ug/Kg-DW	3.8E-01	1.2E+03	6.0E+01	9.4E+02
2042	ug/Kg-DW	3.8E-01	1.1E+03	6.0E+01	9.1E+02
2043	ug/Kg-DW	3.9E-01	1.1E+03	6.1E+01	9.3E+02
2044	ug/Kg-DW	3.7E-01	1.1E+03	6.0E+01	9.0E+02
2045	ug/Kg-DW	3.5E-01	1.1E+03	6.0E+01	9.1E+02
2046	ug/Kg-DW	3.5E-01	1.1E+03	6.0E+01	9.0E+02
2047	ug/Kg-DW	3.6E-01	1.1E+03	6.0E+01	9.1E+02
2048	ug/Kg-DW	3.5E-01	1.1E+03	5.9E+01	8.9E+02
2049	ug/Kg-DW	3.5E-01	1.1E+03	5.9E+01	8.9E+02
2050	ug/Kg-DW	3.3E-01	1.1E+03	5.7E+01	8.6E+02
2051	ug/Kg-DW	3.1E-01	1.0E+03	5.5E+01	8.3E+02
2052	ug/Kg-DW	3.1E-01	1.0E+03	5.4E+01	8.1E+02
2053	ug/Kg-DW	3.0E-01	1.0E+03	5.4E+01	8.0E+02
2054	ug/Kg-DW	3.4E-01	1.0E+03	5.5E+01	8.2E+02
2055	ug/Kg-DW	3.7E-01	1.1E+03	5.8E+01	8.7E+02
2056	ug/Kg-DW	3.6E-01	1.1E+03	5.8E+01	8.6E+02
2057	ug/Kg-DW	3.6E-01	1.0E+03	5.7E+01	8.3E+02
2058	ug/Kg-DW	3.7E-01	1.1E+03	5.9E+01	8.6E+02
2059	ug/Kg-DW	3.5E-01	1.1E+03	5.8E+01	8.4E+02
Summary Statistics:					
Minimum		3.0E-01	1.0E+03	5.4E+01	8.0E+02
Average		3.5E-01	1.1E+03	5.8E+01	8.7E+02
Maximum		3.8E-01	1.2E+03	6.0E+01	9.4E+02
95th Percentile		3.8E-01	1.1E+03	6.0E+01	9.3E+02
Standard Deviation		2.4E-02	4.3E+01	2.2E+00	4.0E+01
Coefficient of Variation		6.9%	4.0%	3.8%	4.6%
Relative Percent Difference:					
Low		14%	7%	8%	8%
High		9%	7%	3%	8%
Range		21%	14%	11%	15%

Figures



Annual Average Sediment Concentrations Predicted by the LPR-NB Model	Figure 7-1
Lower Eight Miles of the Lower Passaic River	2014

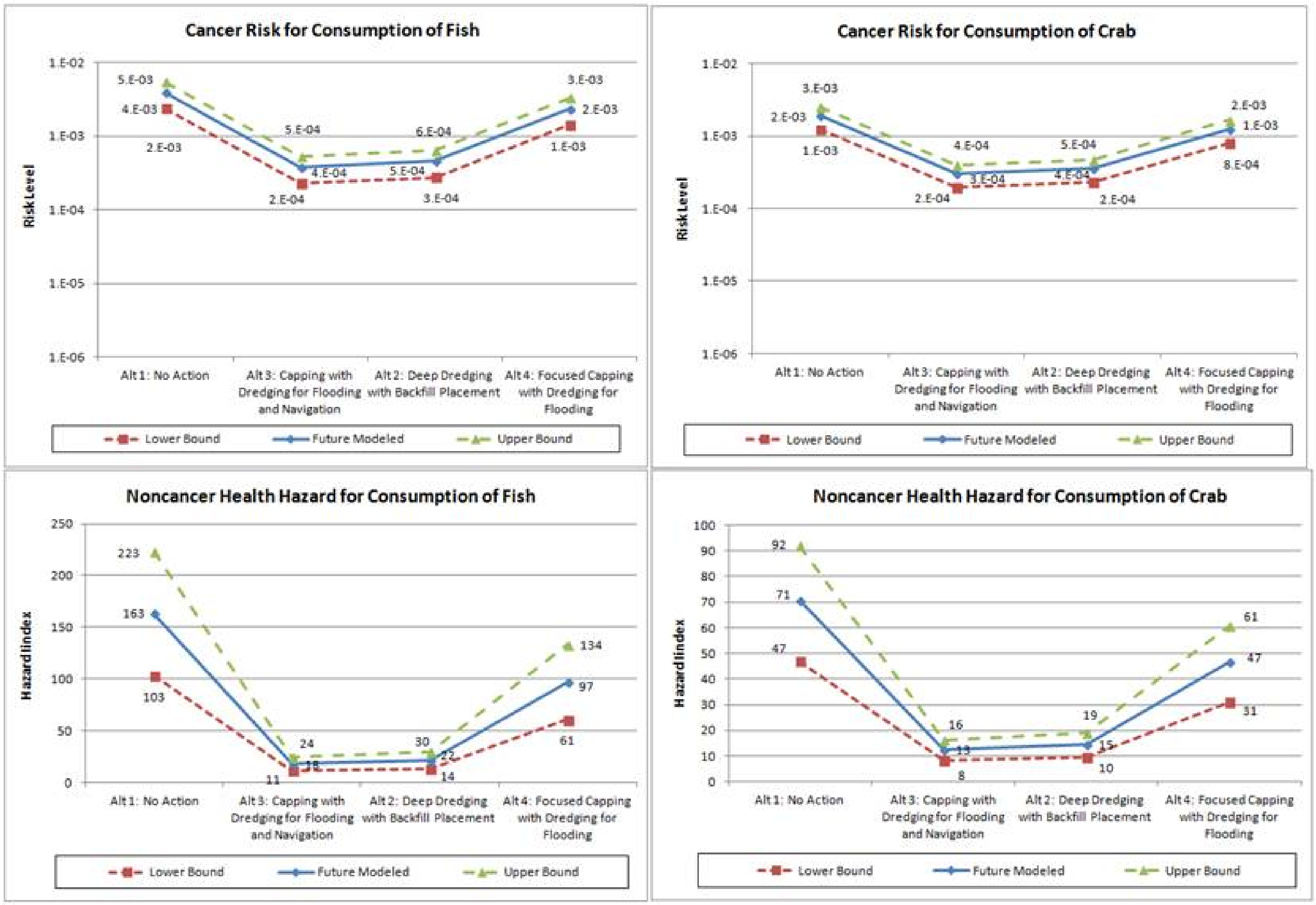


Annual Average Sediment Concentrations Predicted by the EMBM

Lower Eight Miles of the Lower Passaic River

Figure 7-2

2014

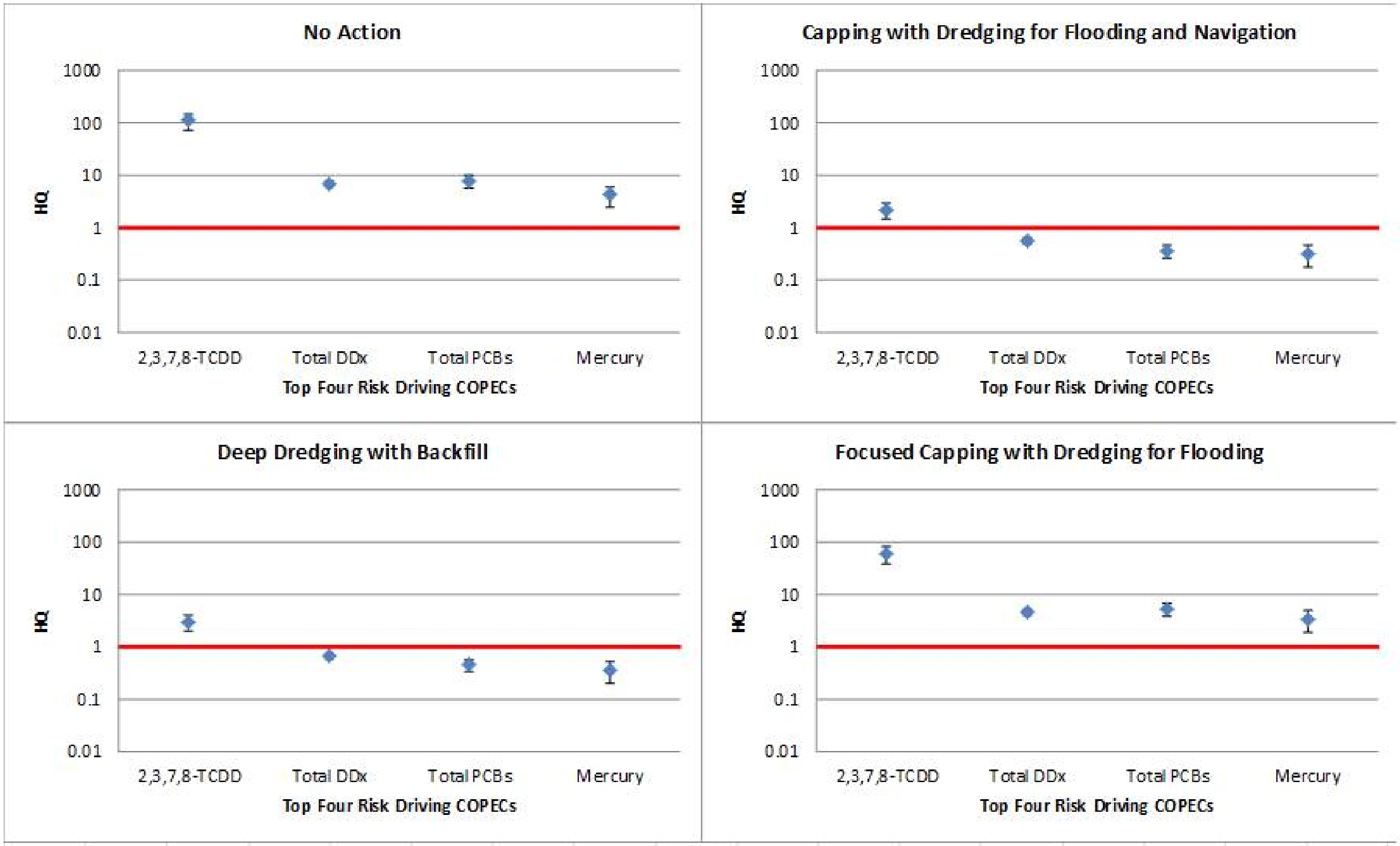


Upper and Lower Bounds on the Future Modeled Cancer Risks and Noncancer Health Hazards

Lower Eight Miles of the Lower Passaic River

Figure 7-3

2014

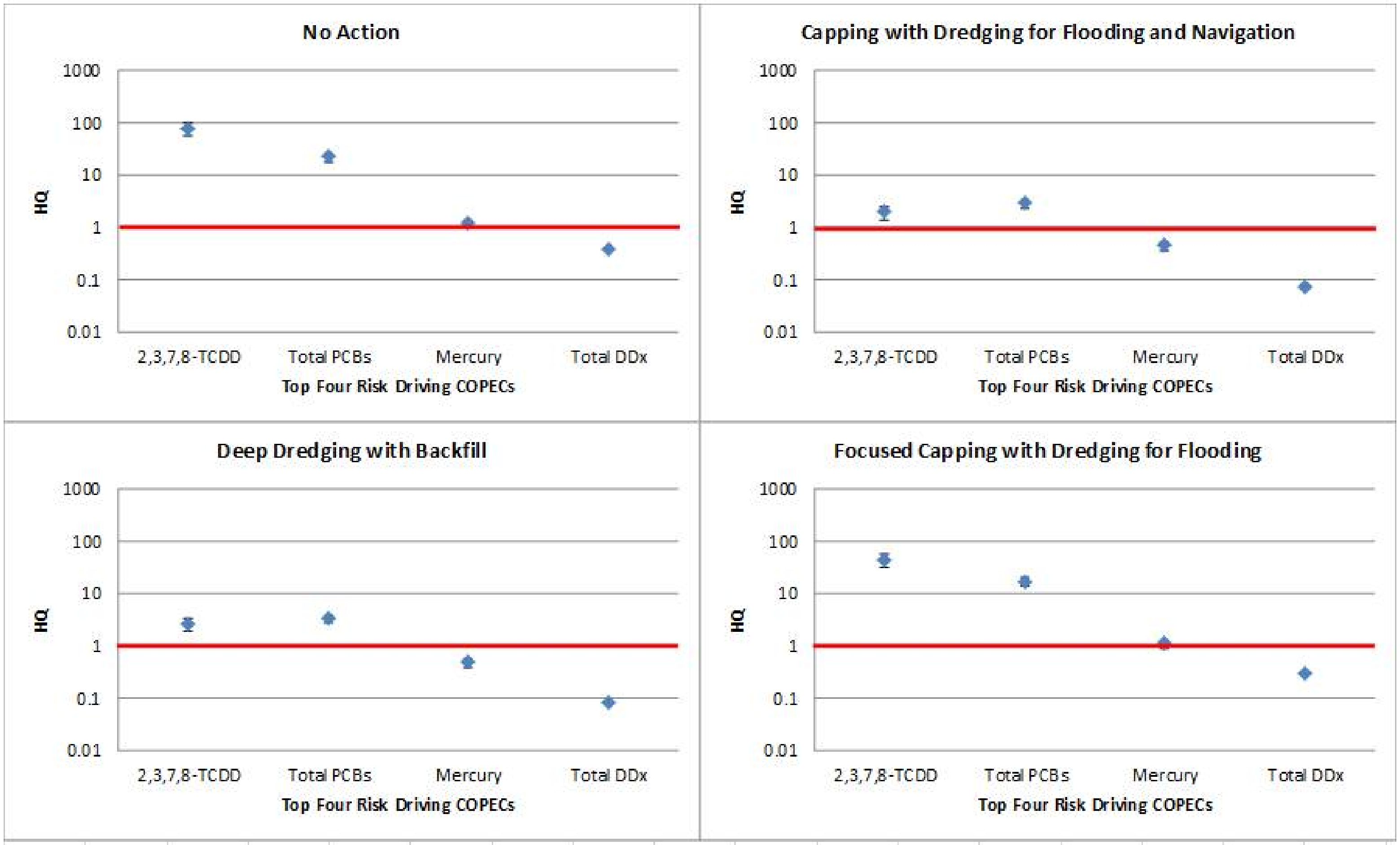


Hazards Quotients Based on the Geometric Mean of Lower- and Upper-Bound Sediment Benchmarks 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Sediment Scaling Factors

Lower Eight Miles of the Lower Passaic River

Figure 7-4

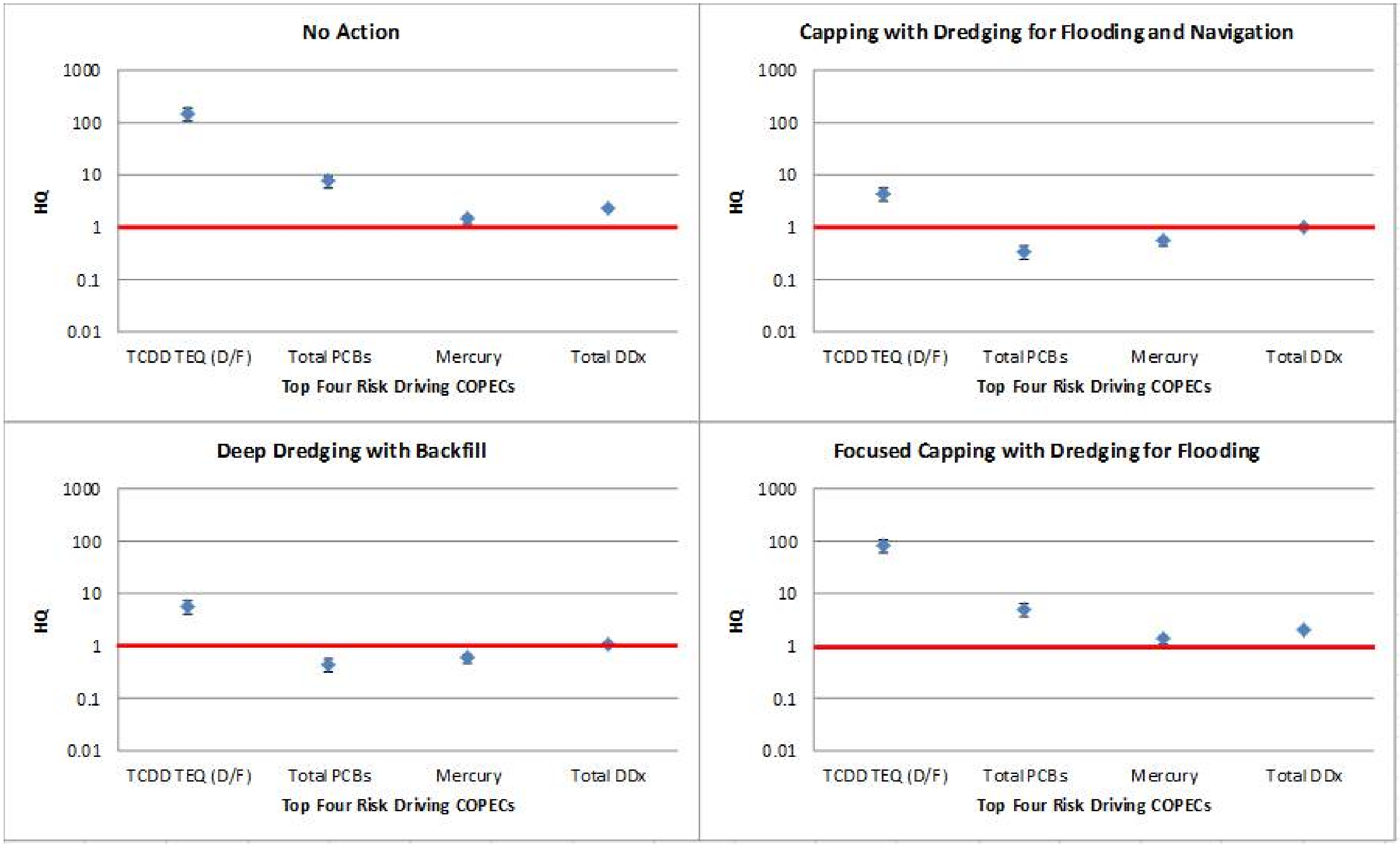
2014



Hazards Quotients Based on the Geometric Mean of Lower- and Upper-Bound Crab CBRs 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Tissue Scaling Factors)
Lower Eight Miles of the Lower Passaic River

Figure 7-5

2014

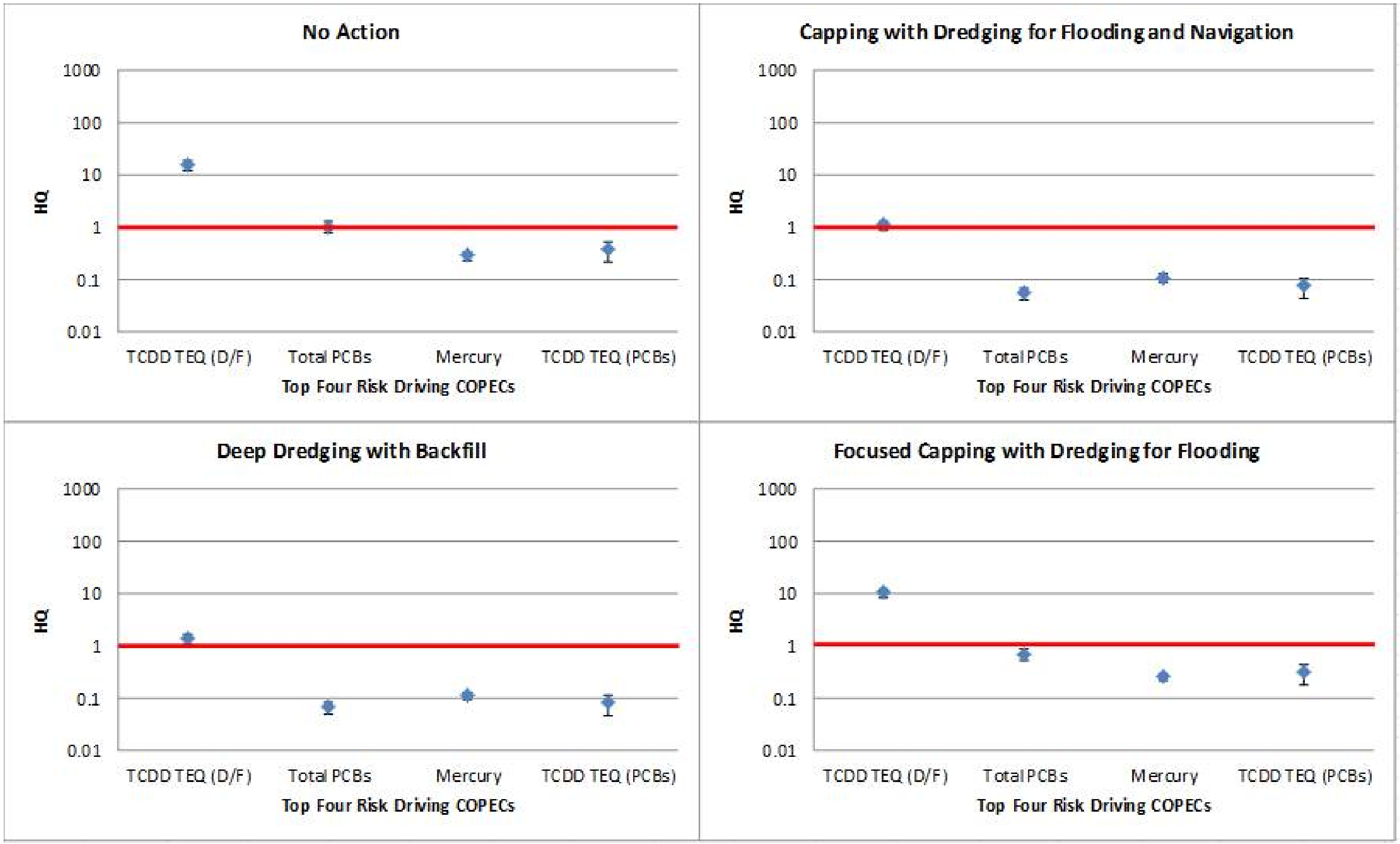


Hazards Quotients Based on the Geometric Mean of Lower- and Upper Bound Generic Fish CBRs 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Tissue Scaling Factors)

Lower Eight Miles of the Lower Passaic River

Figure 7-6

2014

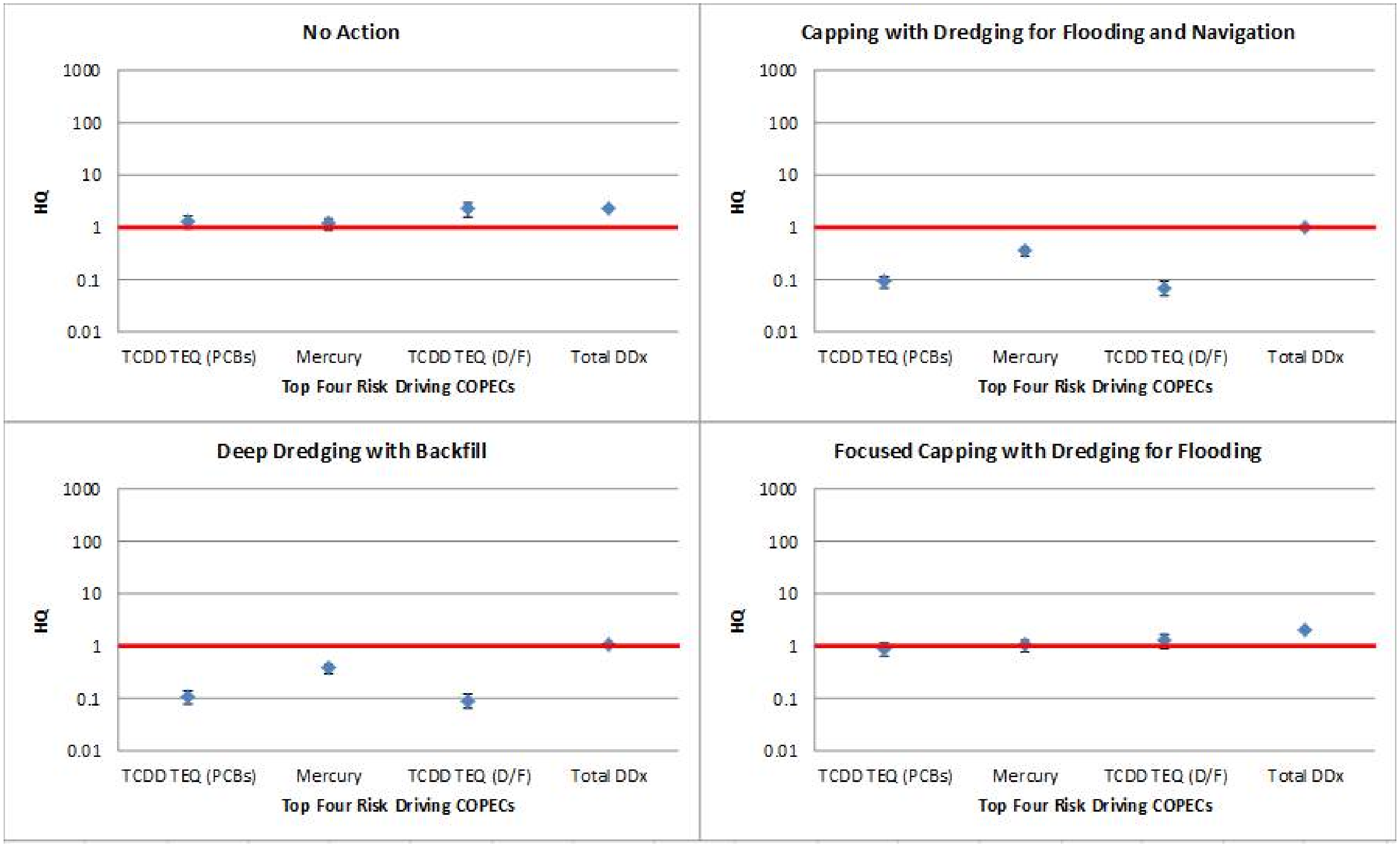


Hazards Quotients Based on the Geometric Mean of Lower- and Upper Bound Mummichog CBRs 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Tissue Scaling Factors)

Lower Eight Miles of the Lower Passaic River

Figure 7-7

2014

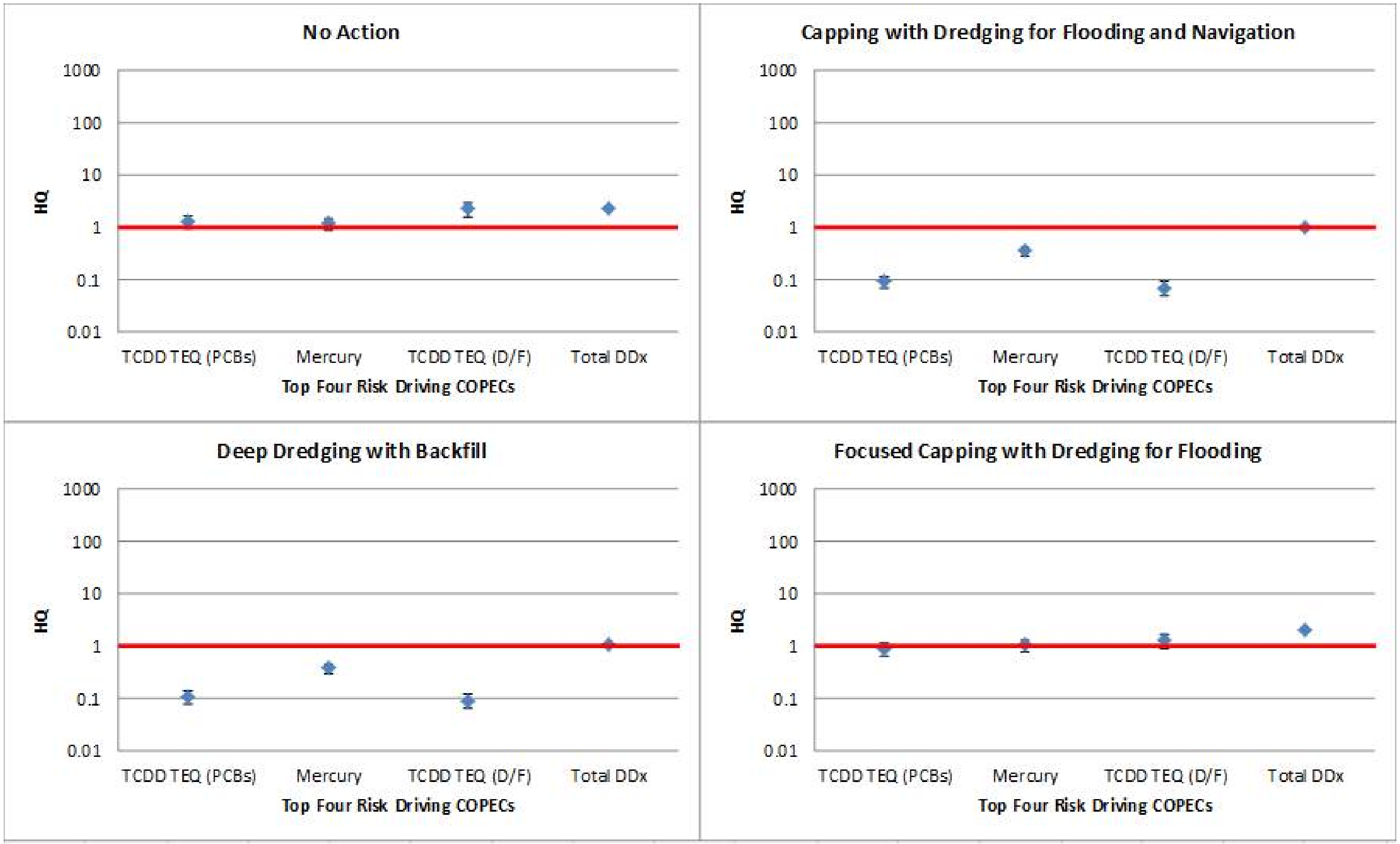


Hazards Quotients Based on the Geometric Mean of Lower- and Upper Bound Heron (Generic Fish) Dose Modeling 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Wildlife Scaling Factors)

Lower Eight Miles of the Lower Passaic River

Figure 7-8

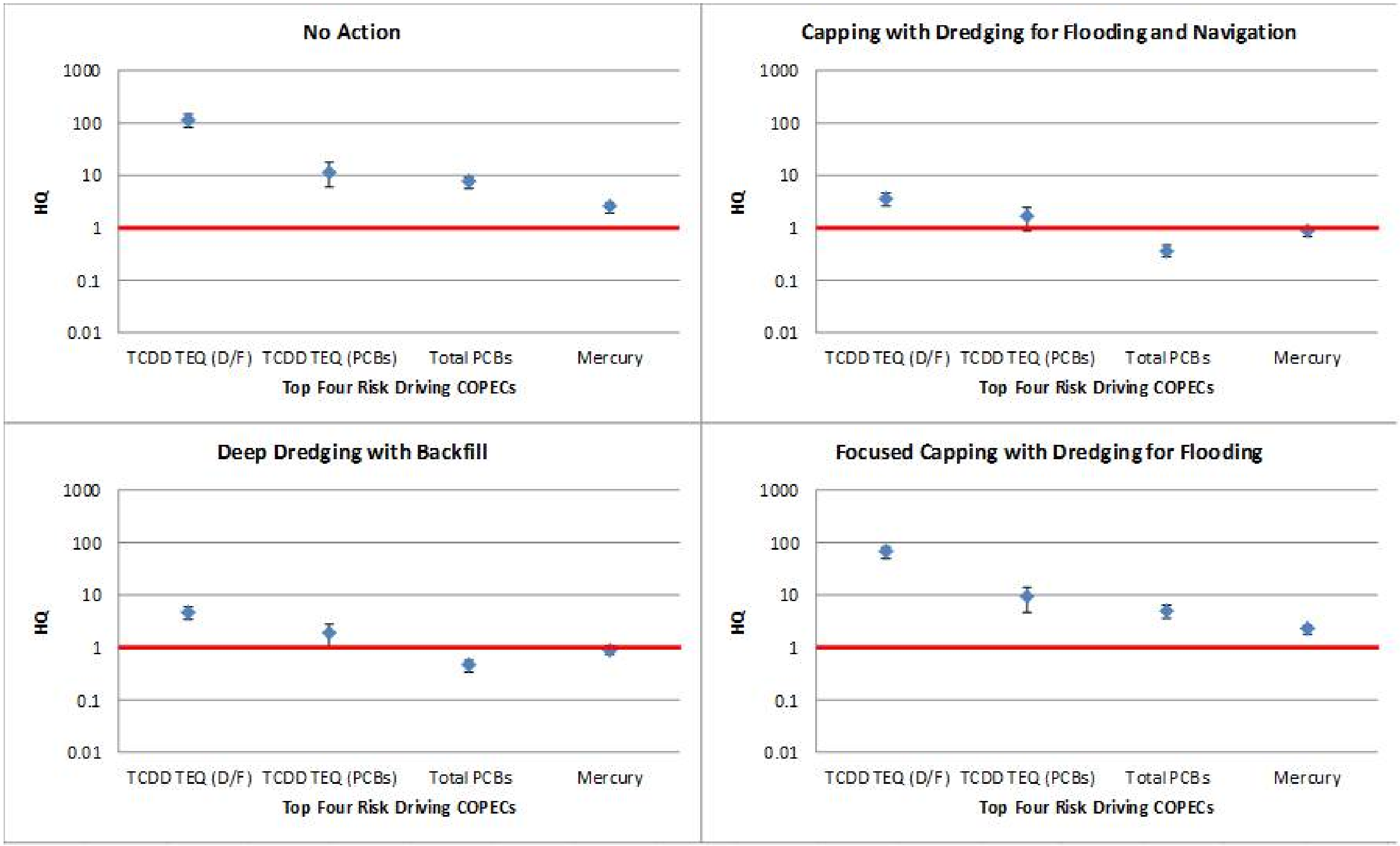
2014



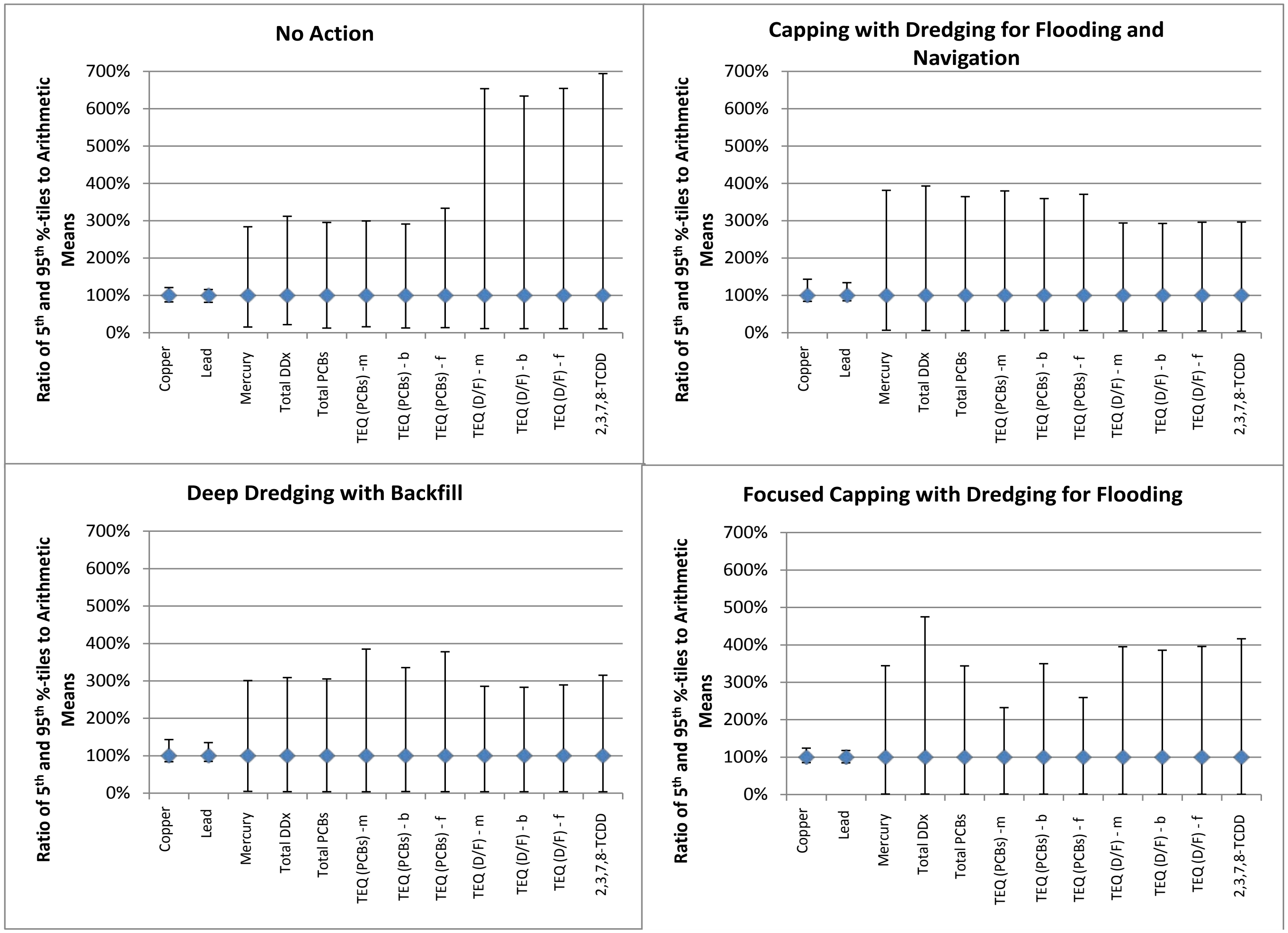
Hazards Quotients Based on the Geometric Mean of Lower- and Upper Bound Heron (Mummichog) Dose Modeling 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Wildlife Scaling Factors)
Lower Eight Miles of the Lower Passaic River

Figure 7-9

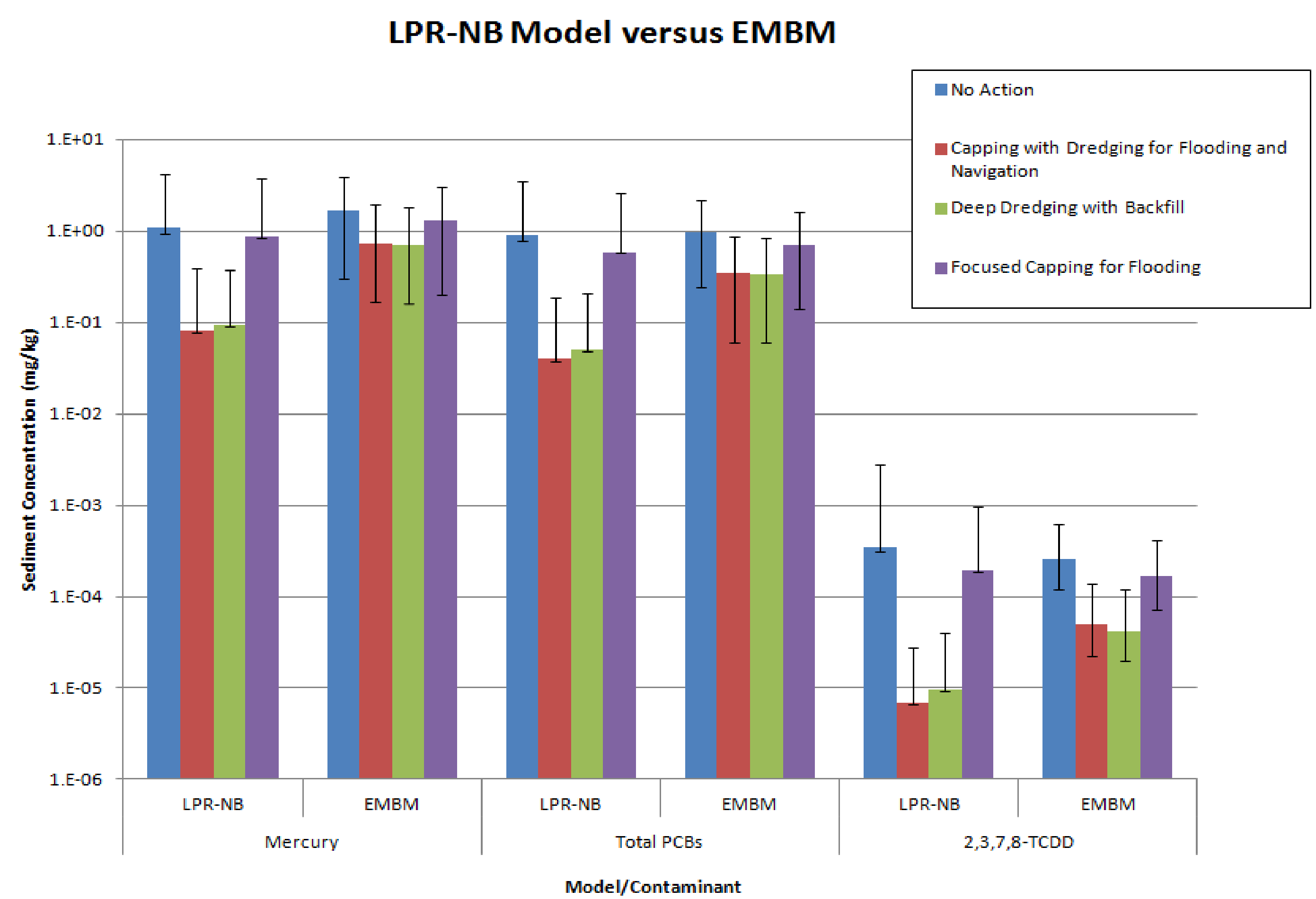
2014



Hazards Quotients Based on the Geometric Mean of Lower- and Upper Bound Mink (Generic Fish) Dose Modeling 30 Years Following Implementation of Each Remedial Alternative (Error Bars Represent Confidence Bands Based on Wildlife Scaling Factors) *Lower Eight Miles of the Lower Passaic River*	Figure 7-10 2014



Ratios of 5th and 95th Percentile Modeled Predicted Arithmetic Mean Sediment Concentrations at the End of the 30 Year Evaluation Period for Each Remedial Alternative *Lower Eight Miles of the Lower Passaic River*	Figure 7-11 2014



Comparison of the LPR-NB Model and EMBM Annual Average Sediment Estimates 30 Years Following Implementation of Each Remedial Alternative (Error Bars Based on 5th and 95th Percentile Estimates)

Lower Eight Miles of the Lower Passaic River

Figure 7-12

2014

ATTACHMENT 8

HUMAN HEALTH RISK: FUTURE MODELED CONDITIONS FOR REMEDIAL ALTERNATIVES

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TABLE 8-1
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 3: FULL CAPPING - MAXIMUM 6 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Child)
Receptor Age: 0 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	7E-06	mg/kg	4.4E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-05	5.15E-09	mg/kg-day	7.0E-10	mg/kg-day	7
				TCDD TEQ (PCBs)	5E-06	mg/kg	3.3E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-05	3.88E-09	mg/kg-day	7.0E-10	mg/kg-day	6
				Total PCBs	1E-01	mg/kg	6.5E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	1.E-05	7.55E-05	mg/kg-day	2.0E-05	mg/kg-day	4
				4,4'-DDD	5E-02	mg/kg	3.2E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	8.E-07	3.68E-05	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	3.8E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-06	4.44E-05	mg/kg-day	--	--	ND
				4,4'-DDT	5E-02	mg/kg	3.4E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-06	3.98E-05	mg/kg-day	5.0E-04	mg/kg-day	0.08
				Total Chlordane	4E-02	mg/kg	2.3E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	8.E-07	2.70E-05	mg/kg-day	5.0E-04	mg/kg-day	0.05
				Methyl mercury	1E-01	mg/kg	9.5E-06	mg/kg-day	--	--	ND	1.11E-04	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								1.E-04					18
		Exposure Point Total									1.E-04					18
	Exposure Medium Total										1.E-04					18
Medium Total																
Crab				TCDD TEQ (D/F)	5E-06	mg/kg	1.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05	2.2E-09	mg/kg-day	7.0E-10	mg/kg-day	3
				TCDD TEQ (PCBs)	1E-05	mg/kg	4.4E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-05	5.2E-09	mg/kg-day	7.0E-10	mg/kg-day	7
				Total PCBs	8E-02	mg/kg	3.2E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	6.E-06	3.7E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	4E-03	mg/kg	1.5E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	4.E-08	1.8E-06	mg/kg-day	--	--	ND
				4,4'-DDE	6E-03	mg/kg	2.2E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	8.E-08	2.6E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	1.8E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-08	2.1E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Total Chlordane	4E-03	mg/kg	1.6E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	5.E-08	1.8E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Methyl mercury	5E-02	mg/kg	1.8E-06	mg/kg-day	--	--	ND	2.1E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								1.E-04					13
		Exposure Point Total									1.E-04					13
	Exposure Medium Total										1.E-04					13

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-2
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 3: FULL CAPPING - MAXIMUM 24 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	4.E-06	mg/kg	7.0E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-04	2.03E-09	mg/kg-day	7.0E-10	mg/kg-day	3
				TCDD TEQ (PCBs)	4.E-06	mg/kg	7.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-04	2.11E-09	mg/kg-day	7.0E-10	mg/kg-day	3
				Total PCBs	6.E-02	mg/kg	1.1E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-05	3.13E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	4.E-02	mg/kg	7.2E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-06	2.11E-05	mg/kg-day	--	--	ND
				4,4'-DDE	5.E-02	mg/kg	8.7E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	2.52E-05	mg/kg-day	--	--	ND
				4,4'-DDT	5.E-02	mg/kg	8.2E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	2.39E-05	mg/kg-day	5.0E-04	mg/kg-day	0.05
				Total Chlordane	3.E-02	mg/kg	5.4E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-06	1.58E-05	mg/kg-day	5.0E-04	mg/kg-day	0.03
				Methyl mercury	1.E-01	mg/kg	2.1E-05	mg/kg-day	--	--	ND	6.01E-05	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								2.E-04					8
		Exposure Point Total									2.E-04					8
	Exposure Medium Total										2.E-04					8
Medium Total																
Crab				TCDD TEQ (D/F)	3E-06	mg/kg	2.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-05	8.4E-10	mg/kg-day	7.0E-10	mg/kg-day	1
				TCDD TEQ (PCBs)	1E-05	mg/kg	1.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04	3.0E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				Total PCBs	6E-02	mg/kg	6.1E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	1.E-05	1.8E-05	mg/kg-day	2.0E-05	mg/kg-day	1
				4,4'-DDD	3E-03	mg/kg	3.1E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	7.E-08	9.1E-07	mg/kg-day	--	--	ND
				4,4'-DDE	4E-03	mg/kg	4.5E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	1.3E-06	mg/kg-day	--	--	ND
				4,4'-DDT	4E-03	mg/kg	4.0E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07	1.2E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Total Chlordane	4E-03	mg/kg	3.8E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-07	1.1E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Methyl mercury	4E-02	mg/kg	3.9E-06	mg/kg-day	--	--	ND	1.1E-05	mg/kg-day	1.0E-04	mg/kg-day	0.1
			Exp. Route Total								2.E-04					6
		Exposure Point Total									2.E-04					6
	Exposure Medium Total										2.E-04					6

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-3
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 2: FULL DREDGING - MAXIMUM 6 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	9E-06	mg/kg	5.8E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	9.E-05	6.72E-09	mg/kg-day	7.0E-10	mg/kg-day	10
				TCDD TEQ (PCBs)	6E-06	mg/kg	4.0E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	6.E-05	4.70E-09	mg/kg-day	7.0E-10	mg/kg-day	7
				Total PCBs	1E-01	mg/kg	7.4E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	1.E-05	8.69E-05	mg/kg-day	2.0E-05	mg/kg-day	4
				4,4'-DDD	5E-02	mg/kg	3.3E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	8.E-07	3.80E-05	mg/kg-day	--	--	ND
				4,4'-DDE	6E-02	mg/kg	4.0E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-06	4.64E-05	mg/kg-day	--	--	ND
				4,4'-DDT	6E-02	mg/kg	3.7E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-06	4.31E-05	mg/kg-day	5.0E-04	mg/kg-day	0.09
				Total Chlordane	4E-02	mg/kg	2.3E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	8.E-07	2.69E-05	mg/kg-day	5.0E-04	mg/kg-day	0.05
				Methyl mercury	1E-01	mg/kg	8.9E-06	mg/kg-day	--	--	ND	1.04E-04	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								2.E-04					22
		Exposure Point Total									2.E-04					22
	Exposure Medium Total										2.E-04					22
Medium Total																
Crab				TCDD TEQ (D/F)	6E-06	mg/kg	2.4E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-05	2.8E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	1E-05	mg/kg	5.0E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	8.E-05	5.9E-09	mg/kg-day	7.0E-10	mg/kg-day	8
				Total PCBs	9E-02	mg/kg	3.5E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	7.E-06	4.1E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	4E-03	mg/kg	1.6E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	4.E-08	1.9E-06	mg/kg-day	--	--	ND
				4,4'-DDE	6E-03	mg/kg	2.4E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	8.E-08	2.9E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	2.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	7.E-08	2.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.005
				Total Chlordane	4E-03	mg/kg	1.6E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	5.E-08	1.8E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Methyl mercury	4E-02	mg/kg	1.7E-06	mg/kg-day	--	--	ND	2.0E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								1.E-04					15
		Exposure Point Total									1.E-04					15
	Exposure Medium Total										1.E-04					15

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-4
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 2: FULL DREDGING - MAXIMUM 24 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	5.E-06	mg/kg	7.7E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-04	2.26E-09	mg/kg-day	7.0E-10	mg/kg-day	3
				TCDD TEQ (PCBs)	5.E-06	mg/kg	9.3E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-04	2.70E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				Total PCBs	8.E-02	mg/kg	1.3E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-05	3.89E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	5.E-02	mg/kg	7.8E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-06	2.28E-05	mg/kg-day	--	--	ND
				4,4'-DDE	6.E-02	mg/kg	9.4E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	2.74E-05	mg/kg-day	--	--	ND
				4,4'-DDT	5.E-02	mg/kg	9.1E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	2.64E-05	mg/kg-day	5.0E-04	mg/kg-day	0.05
				Total Chlordane	3.E-02	mg/kg	5.4E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-06	1.58E-05	mg/kg-day	5.0E-04	mg/kg-day	0.03
				Methyl mercury	1.E-01	mg/kg	2.1E-05	mg/kg-day	--	--	ND	6.21E-05	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								3.E-04					10
		Exposure Point Total									3.E-04					10
	Exposure Medium Total										3.E-04					10
Medium Total																
Crab				TCDD TEQ (D/F)	3E-06	mg/kg	3.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-05	9.3E-10	mg/kg-day	7.0E-10	mg/kg-day	1
				TCDD TEQ (PCBs)	1E-05	mg/kg	1.2E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04	3.5E-09	mg/kg-day	7.0E-10	mg/kg-day	5
				Total PCBs	7E-02	mg/kg	7.0E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	1.E-05	2.0E-05	mg/kg-day	2.0E-05	mg/kg-day	1
				4,4'-DDD	4E-03	mg/kg	3.6E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	9.E-08	1.1E-06	mg/kg-day	--	--	ND
				4,4'-DDE	5E-03	mg/kg	5.3E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	1.5E-06	mg/kg-day	--	--	ND
				4,4'-DDT	5E-03	mg/kg	4.9E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	1.4E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Total Chlordane	4E-03	mg/kg	3.8E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-07	1.1E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Methyl mercury	4E-02	mg/kg	4.1E-06	mg/kg-day	--	--	ND	1.2E-05	mg/kg-day	1.0E-04	mg/kg-day	0.1
			Exp. Route Total								2.E-04					7
		Exposure Point Total									2.E-04					7
	Exposure Medium Total										2.E-04					7

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-5
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER
HAZARDS Alt 4: FOCUSED CAPPING - MAXIMUM 6 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Child)
Receptor Age: 0 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	3E-05	mg/kg	2.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	2.44E-08	mg/kg-day	7.0E-10	mg/kg-day	35
				TCDD TEQ (PCBs)	3E-05	mg/kg	2.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	2.33E-08	mg/kg-day	7.0E-10	mg/kg-day	33
				Total PCBs	7E-01	mg/kg	4.6E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	9.E-05	5.42E-04	mg/kg-day	2.0E-05	mg/kg-day	27
				4,4'-DDD	9E-02	mg/kg	6.0E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-06	7.01E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	6.5E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-06	7.57E-05	mg/kg-day	--	--	ND
				4,4'-DDT	9E-02	mg/kg	6.1E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-06	7.16E-05	mg/kg-day	5.0E-04	mg/kg-day	0.1
				Total Chlordane	4E-02	mg/kg	2.6E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	9.E-07	3.00E-05	mg/kg-day	5.0E-04	mg/kg-day	0.06
				Methyl mercury	3E-01	mg/kg	1.8E-05	mg/kg-day	--	--	ND	2.12E-04	mg/kg-day	1.0E-04	mg/kg-day	2
			Exp. Route Total								7.E-04					97
		Exposure Point Total									7.E-04					97
	Exposure Medium Total										7.E-04					97
Medium Total																
Crab				TCDD TEQ (D/F)	2E-05	mg/kg	9.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-04	1.1E-08	mg/kg-day	7.0E-10	mg/kg-day	15
				TCDD TEQ (PCBs)	4E-05	mg/kg	1.5E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-04	1.7E-08	mg/kg-day	7.0E-10	mg/kg-day	24
				Total PCBs	3E-01	mg/kg	1.2E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-05	1.4E-04	mg/kg-day	2.0E-05	mg/kg-day	7
				4,4'-DDD	1E-02	mg/kg	5.7E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-07	6.7E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	6.7E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	7.8E-06	mg/kg-day	--	--	ND
				4,4'-DDT	1E-02	mg/kg	6.0E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	7.0E-06	mg/kg-day	5.0E-04	mg/kg-day	0.01
				Total Chlordane	4E-03	mg/kg	1.6E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	6.E-08	1.9E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Methyl mercury	9E-02	mg/kg	3.5E-06	mg/kg-day	--	--	ND	4.1E-05	mg/kg-day	1.0E-04	mg/kg-day	0.4
			Exp. Route Total								4.E-04					47
		Exposure Point Total									4.E-04					47
	Exposure Medium Total										4.E-04					47

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-6
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 4: FOCUSED CAPPING - MAXIMUM 24 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Intake/Exposure Concentration Value	Cancer Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Non-Cancer Intake/Exposure Concentration Value	Non-Cancer Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Fish			Ingestion	TCDD TEQ (D/F)	3.E-05	mg/kg	4.9E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-04	1.43E-08	mg/kg-day	7.0E-10	mg/kg-day	20
				TCDD TEQ (PCBs)	3.E-05	mg/kg	4.5E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-04	1.32E-08	mg/kg-day	7.0E-10	mg/kg-day	19
				Total PCBs	6.E-01	mg/kg	1.0E-04	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-04	2.97E-04	mg/kg-day	2.0E-05	mg/kg-day	15
				4,4'-DDD	9.E-02	mg/kg	1.4E-05	mg/kg-day	2.4E-01	(mg/kg-day)-1	3.E-06	4.21E-05	mg/kg-day	--	--	ND
				4,4'-DDE	9.E-02	mg/kg	1.6E-05	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-06	4.64E-05	mg/kg-day	--	--	ND
				4,4'-DDT	9.E-02	mg/kg	1.5E-05	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-06	4.32E-05	mg/kg-day	5.0E-04	mg/kg-day	0.09
				Total Chlordane	4.E-02	mg/kg	6.4E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-06	1.88E-05	mg/kg-day	5.0E-04	mg/kg-day	0.04
				Methyl mercury	3.E-01	mg/kg	4.3E-05	mg/kg-day	--	(mg/kg-day)-1	ND	1.24E-04	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								2.E-03					55
		Exposure Point Total									2.E-03					55
	Exposure Medium Total										2.E-03					55
Medium Total																
Crab				TCDD TEQ (D/F)	2E-05	mg/kg	2.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	6.2E-09	mg/kg-day	7.0E-10	mg/kg-day	9
				TCDD TEQ (PCBs)	3E-05	mg/kg	3.4E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-04	1.0E-08	mg/kg-day	7.0E-10	mg/kg-day	14
				Total PCBs	3E-01	mg/kg	2.7E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	5.E-05	7.9E-05	mg/kg-day	2.0E-05	mg/kg-day	4
				4,4'-DDD	1E-02	mg/kg	1.3E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	3.E-07	3.7E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	1.6E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-07	4.5E-06	mg/kg-day	--	--	ND
				4,4'-DDT	1E-02	mg/kg	1.3E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	5.E-07	3.9E-06	mg/kg-day	5.0E-04	mg/kg-day	0.008
				Total Chlordane	4E-03	mg/kg	4.1E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-07	1.2E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Methyl mercury	8E-02	mg/kg	8.1E-06	mg/kg-day	--	(mg/kg-day)-1	ND	2.4E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								9.E-04					27
		Exposure Point Total									9.E-04					27
	Exposure Medium Total										9.E-04					27

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-7
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER
HAZARDS Alt 1: NO ACTION - MAXIMUM 6 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	6E-05	mg/kg	3.9E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	6.E-04	4.58E-08	mg/kg-day	7.0E-10	mg/kg-day	65
				TCDD TEQ (PCBs)	5E-05	mg/kg	3.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	4.E-04	3.47E-08	mg/kg-day	7.0E-10	mg/kg-day	50
				Total PCBs	1E+00	mg/kg	7.8E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-04	9.07E-04	mg/kg-day	2.0E-05	mg/kg-day	45
				4,4'-DDD	1E-01	mg/kg	7.1E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-06	8.30E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	7.6E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	8.88E-05	mg/kg-day	--	--	ND
				4,4'-DDT	1E-01	mg/kg	6.9E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-06	8.02E-05	mg/kg-day	5.0E-04	mg/kg-day	0.2
				Total Chlordane	4E-02	mg/kg	2.7E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-06	3.21E-05	mg/kg-day	5.0E-04	mg/kg-day	0.06
				Methyl mercury	3E-01	mg/kg	2.1E-05	mg/kg-day	--	--	ND	2.47E-04	mg/kg-day	1.0E-04	mg/kg-day	2
			Exp. Route Total								1.E-03					163
		Exposure Point Total									1.E-03					163
	Exposure Medium Total										1.E-03					163
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	1.7E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	2.0E-08	mg/kg-day	7.0E-10	mg/kg-day	29
				TCDD TEQ (PCBs)	5E-05	mg/kg	1.9E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	2.2E-08	mg/kg-day	7.0E-10	mg/kg-day	32
				Total PCBs	4E-01	mg/kg	1.7E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-05	1.9E-04	mg/kg-day	2.0E-05	mg/kg-day	10
				4,4'-DDD	2E-02	mg/kg	8.1E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-07	9.4E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	9.2E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-07	1.1E-05	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	7.5E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-07	8.8E-06	mg/kg-day	5.0E-04	mg/kg-day	0.02
				Total Chlordane	4E-03	mg/kg	1.7E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	6.E-08	1.9E-06	mg/kg-day	5.0E-04	mg/kg-day	0.004
				Methyl mercury	1E-01	mg/kg	4.1E-06	mg/kg-day	--	--	ND	4.7E-05	mg/kg-day	1.0E-04	mg/kg-day	0.5
			Exp. Route Total								6.E-04					71
		Exposure Point Total									6.E-04					71
	Exposure Medium Total										6.E-04					71

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-8
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER
HAZARDS Alt 1: NO ACTION - MAXIMUM 12 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adolescent)
Receptor Age: 7 - 18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				Cancer Risk	Non-Cancer Hazard Calculations				Hazard Quotient
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk			Intake/Exposure Concentration		RfD/RfC		
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	5E-05	mg/kg	4.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	6.E-04	2.39E-08	mg/kg-day	7.0E-10	mg/kg-day	34
				TCDD TEQ (PCBs)	4E-05	mg/kg	3.2E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	5.E-04	1.88E-08	mg/kg-day	7.0E-10	mg/kg-day	27
				Total PCBs	1E+00	mg/kg	8.3E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-04	4.85E-04	mg/kg-day	2.0E-05	mg/kg-day	24
				4,4'-DDD	1E-01	mg/kg	8.0E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-06	4.65E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	8.7E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	5.06E-05	mg/kg-day	--	--	ND
				4,4'-DDT	1E-01	mg/kg	7.7E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-06	4.50E-05	mg/kg-day	5.0E-04	mg/kg-day	0.09
				Total Chlordane	4E-02	mg/kg	3.2E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-06	1.86E-05	mg/kg-day	5.0E-04	mg/kg-day	0.04
				Methyl mercury	3E-01	mg/kg	2.3E-05	mg/kg-day	--	--	ND	1.37E-04	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								1.E-03					87
		Exposure Point Total									1.E-03					87
	Exposure Medium Total										1.E-03					87
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	1.9E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	1.1E-08	mg/kg-day	7.0E-10	mg/kg-day	16
				TCDD TEQ (PCBs)	5E-05	mg/kg	2.1E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-04	1.2E-08	mg/kg-day	7.0E-10	mg/kg-day	17
				Total PCBs	4E-01	mg/kg	1.8E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	4.E-05	1.1E-04	mg/kg-day	2.0E-05	mg/kg-day	5
				4,4'-DDD	2E-02	mg/kg	8.7E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-07	5.0E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	1.0E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-07	6.0E-06	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	8.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-07	4.7E-06	mg/kg-day	5.0E-04	mg/kg-day	0.009
				Total Chlordane	4E-03	mg/kg	1.9E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	7.E-08	1.1E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Methyl mercury	1E-01	mg/kg	4.5E-06	mg/kg-day	--	--	ND	2.6E-05	mg/kg-day	1.0E-04	mg/kg-day	0.3
			Exp. Route Total								6.E-04					39
		Exposure Point Total									6.E-04					39
	Exposure Medium Total										6.E-04					39

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-9
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS Alt 1: NO ACTION - MAXIMUM 24 YEAR PERIOD (RME)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	5.E-05	mg/kg	9.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-03	2.63E-08	mg/kg-day	7.0E-10	mg/kg-day	38
				TCDD TEQ (PCBs)	4.E-05	mg/kg	6.5E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	1.E-03	1.89E-08	mg/kg-day	7.0E-10	mg/kg-day	27
				Total PCBs	1.E+00	mg/kg	1.7E-04	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-04	4.84E-04	mg/kg-day	2.0E-05	mg/kg-day	24
				4,4'-DDD	1.E-01	mg/kg	1.7E-05	mg/kg-day	2.4E-01	(mg/kg-day)-1	4.E-06	4.97E-05	mg/kg-day	--	--	ND
				4,4'-DDE	1.E-01	mg/kg	1.9E-05	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-06	5.45E-05	mg/kg-day	--	--	ND
				4,4'-DDT	1.E-01	mg/kg	1.7E-05	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-06	4.83E-05	mg/kg-day	5.0E-04	mg/kg-day	0.1
				Total Chlordane	4.E-02	mg/kg	7.1E-06	mg/kg-day	3.5E-01	(mg/kg-day)-1	2.E-06	2.07E-05	mg/kg-day	5.0E-04	mg/kg-day	0.04
				Methyl mercury	3.E-01	mg/kg	4.9E-05	mg/kg-day	--	--	ND	1.43E-04	mg/kg-day	1.0E-04	mg/kg-day	1
			Exp. Route Total								3.E-03					90
		Exposure Point Total									3.E-03					90
	Exposure Medium Total										3.E-03					90
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	4.0E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	6.E-04	1.2E-08	mg/kg-day	7.0E-10	mg/kg-day	17
				TCDD TEQ (PCBs)	4E-05	mg/kg	4.4E-09	mg/kg-day	1.5E+05	(mg/kg-day)-1	7.E-04	1.3E-08	mg/kg-day	7.0E-10	mg/kg-day	18
				Total PCBs	4E-01	mg/kg	3.7E-05	mg/kg-day	2.0E+00	(mg/kg-day)-1	7.E-05	1.1E-04	mg/kg-day	2.0E-05	mg/kg-day	5
				4,4'-DDD	2E-02	mg/kg	1.8E-06	mg/kg-day	2.4E-01	(mg/kg-day)-1	4.E-07	5.2E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	2.2E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	7.E-07	6.3E-06	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	1.7E-06	mg/kg-day	3.4E-01	(mg/kg-day)-1	6.E-07	4.9E-06	mg/kg-day	5.0E-04	mg/kg-day	0.01
				Total Chlordane	4E-03	mg/kg	4.3E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	1.E-07	1.2E-06	mg/kg-day	5.0E-04	mg/kg-day	0.002
				Methyl mercury	9E-02	mg/kg	9.4E-06	mg/kg-day	--	--	ND	2.7E-05	mg/kg-day	1.0E-04	mg/kg-day	0.3
			Exp. Route Total								1.E-03					40
		Exposure Point Total									1.E-03					40
	Exposure Medium Total										1.E-03					40

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-10
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
NO ACTION - MAXIMUM 6 YEAR PERIOD (CTE)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Child)
Receptor Age: 1 - 6 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	6E-05	mg/kg	1.1E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	2.6E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	5E-05	mg/kg	1.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	2.7E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				Total PCBs	1E+00	mg/kg	3.0E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	6.E-06	7.1E-05	mg/kg-day	2.0E-05	mg/kg-day	4
				4,4'-DDD	1E-01	mg/kg	2.8E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	7.E-08	6.5E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	2.8E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	9.E-08	6.4E-06	mg/kg-day	--	--	ND
				4,4'-DDT	1E-01	mg/kg	2.7E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	9.E-08	6.3E-06	mg/kg-day	5.0E-04	mg/kg-day	0.01
				Total Chlordane	4E-02	mg/kg	1.0E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	4.E-08	2.4E-06	mg/kg-day	5.0E-04	mg/kg-day	0.005
				Methyl mercury	3E-01	mg/kg	1.2E-06	mg/kg-day	--	--	ND	2.7E-05	mg/kg-day	1.0E-04	mg/kg-day	0.3
			Exp. Route Total								4.E-05					11
		Exposure Point Total									4.E-05					11
	Exposure Medium Total										4.E-05					11
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	1.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	2.9E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				TCDD TEQ (PCBs)	5E-05	mg/kg	1.1E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	2.5E-09	mg/kg-day	7.0E-10	mg/kg-day	4
				Total PCBs	4E-01	mg/kg	9.5E-07	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-06	2.2E-05	mg/kg-day	2.0E-05	mg/kg-day	1
				4,4'-DDD	2E-02	mg/kg	5.8E-08	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-08	1.3E-06	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	6.6E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-08	1.5E-06	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	5.4E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-08	1.3E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Total Chlordane	4E-03	mg/kg	1.2E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	4.E-09	2.8E-07	mg/kg-day	5.0E-04	mg/kg-day	0.001
				Methyl mercury	1E-01	mg/kg	2.9E-07	mg/kg-day	--	--	ND	6.8E-06	mg/kg-day	1.0E-04	mg/kg-day	0.07
			Exp. Route Total								4.E-05					9
		Exposure Point Total									4.E-05					9
	Exposure Medium Total										4.E-05					9

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-11
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
NO ACTION - MAXIMUM 12 YEARS (CTE)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adolescent)
Receptor Age: 7-18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	5E-05	mg/kg	1.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	1.4E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				TCDD TEQ (PCBs)	4E-05	mg/kg	1.3E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	1.5E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				Total PCBs	1E+00	mg/kg	3.2E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	6.E-06	3.8E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	1E-01	mg/kg	3.1E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	7.E-08	3.6E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1E-01	mg/kg	3.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07	3.7E-06	mg/kg-day	--	--	ND
				4,4'-DDT	1E-01	mg/kg	3.0E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	1.E-07	3.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.007
				Total Chlordane	4E-02	mg/kg	1.2E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	4.E-08	1.4E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Methyl mercury	3E-01	mg/kg	1.3E-06	mg/kg-day	--	--	ND	1.5E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								4.E-05					6
		Exposure Point Total									4.E-05					6
	Exposure Medium Total										4.E-05					6
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	1.4E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	1.6E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				TCDD TEQ (PCBs)	5E-05	mg/kg	1.2E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	2.E-05	1.4E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				Total PCBs	4E-01	mg/kg	1.0E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	2.E-06	1.2E-05	mg/kg-day	2.0E-05	mg/kg-day	0.6
				4,4'-DDD	2E-02	mg/kg	6.2E-08	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-08	7.3E-07	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	7.4E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-08	8.6E-07	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	5.8E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-08	6.8E-07	mg/kg-day	5.0E-04	mg/kg-day	0.001
				Total Chlordane	4E-03	mg/kg	1.4E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	5.E-09	1.6E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0003
				Methyl mercury	1E-01	mg/kg	3.2E-07	mg/kg-day	--	--	ND	3.7E-06	mg/kg-day	1.0E-04	mg/kg-day	0.04
			Exp. Route Total								4.E-05					5
		Exposure Point Total									4.E-05					5
	Exposure Medium Total										4.E-05					5

ND - not determined because a toxicity value is unavailable for this exposure route.
mg/kg - milligram per kilogram

TABLE 8-12
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
NO ACTION - MAXIMUM 24 YEAR PERIOD (CTE)
Lower Passaic River

Scenario Timeframe: Future
Receptor Population: Angler (Adult)
Receptor Age: >18 Years

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Fish			Ingestion	TCDD TEQ (D/F)	5.E-05	mg/kg	1.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05	1.5E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				TCDD TEQ (PCBs)	4.E-05	mg/kg	1.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05	1.5E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				Total PCBs	1.E+00	mg/kg	4.8E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	1.E-05	3.8E-05	mg/kg-day	2.0E-05	mg/kg-day	2
				4,4'-DDD	1.E-01	mg/kg	5.0E-07	mg/kg-day	2.4E-01	(mg/kg-day)-1	1.E-07	3.9E-06	mg/kg-day	--	--	ND
				4,4'-DDE	1.E-01	mg/kg	5.1E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	3.9E-06	mg/kg-day	--	--	ND
				4,4'-DDT	1.E-01	mg/kg	4.8E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	2.E-07	3.8E-06	mg/kg-day	5.0E-04	mg/kg-day	0.008
				Total Chlordane	4.E-02	mg/kg	2.0E-07	mg/kg-day	3.5E-01	(mg/kg-day)-1	7.E-08	1.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.003
				Methyl mercury	3.E-01	mg/kg	2.0E-06	mg/kg-day	--	--	ND	1.6E-05	mg/kg-day	1.0E-04	mg/kg-day	0.2
			Exp. Route Total								7.E-05					6
		Exposure Point Total									7.E-05					6
	Exposure Medium Total										7.E-05					6
Medium Total																
Crab				TCDD TEQ (D/F)	4E-05	mg/kg	2.1E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05	1.7E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				TCDD TEQ (PCBs)	4E-05	mg/kg	1.9E-10	mg/kg-day	1.5E+05	(mg/kg-day)-1	3.E-05	1.5E-09	mg/kg-day	7.0E-10	mg/kg-day	2
				Total PCBs	4E-01	mg/kg	1.6E-06	mg/kg-day	2.0E+00	(mg/kg-day)-1	3.E-06	1.3E-05	mg/kg-day	2.0E-05	mg/kg-day	0.6
				4,4'-DDD	2E-02	mg/kg	9.6E-08	mg/kg-day	2.4E-01	(mg/kg-day)-1	2.E-08	7.5E-07	mg/kg-day	--	--	ND
				4,4'-DDE	2E-02	mg/kg	1.2E-07	mg/kg-day	3.4E-01	(mg/kg-day)-1	4.E-08	9.0E-07	mg/kg-day	--	--	ND
				4,4'-DDT	2E-02	mg/kg	9.0E-08	mg/kg-day	3.4E-01	(mg/kg-day)-1	3.E-08	7.0E-07	mg/kg-day	5.0E-04	mg/kg-day	0.001
				Total Chlordane	4E-03	mg/kg	2.3E-08	mg/kg-day	3.5E-01	(mg/kg-day)-1	8.E-09	1.8E-07	mg/kg-day	5.0E-04	mg/kg-day	0.0004
				Methyl mercury	9E-02	mg/kg	5.0E-07	mg/kg-day	--	--	ND	3.9E-06	mg/kg-day	1.0E-04	mg/kg-day	0.04
			Exp. Route Total								6.E-05					5
		Exposure Point Total									6.E-05					5
	Exposure Medium Total										6.E-05					5

ND - not determined because toxicity values are not available for this exposure route.
mg/kg - milligram per kilogram

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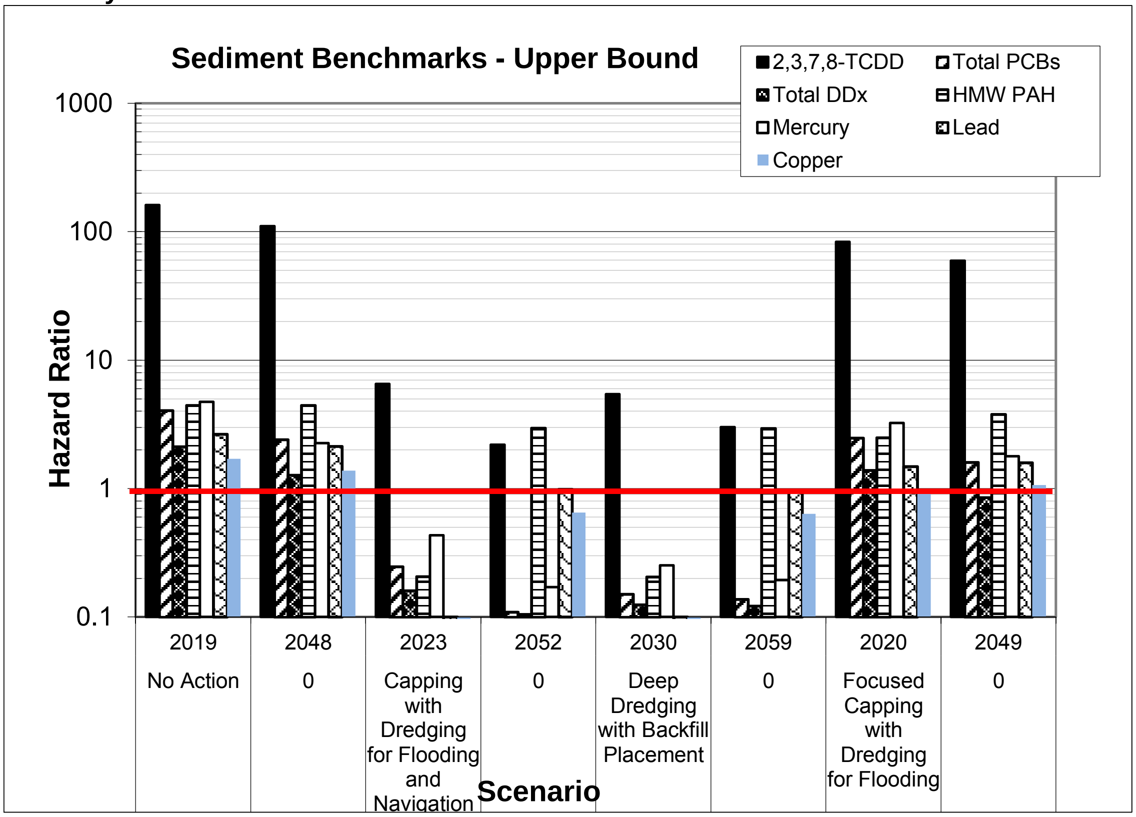
ECOLOGICAL RISK: FUTURE MODELED CONDITIONS FOR REMEDIAL ALTERNATIVES

ATTACHMENT 9

Figure 9-1
Summary of Sediment Benchmark Hazard Ratios for Modeled Future Conditions - Benthos



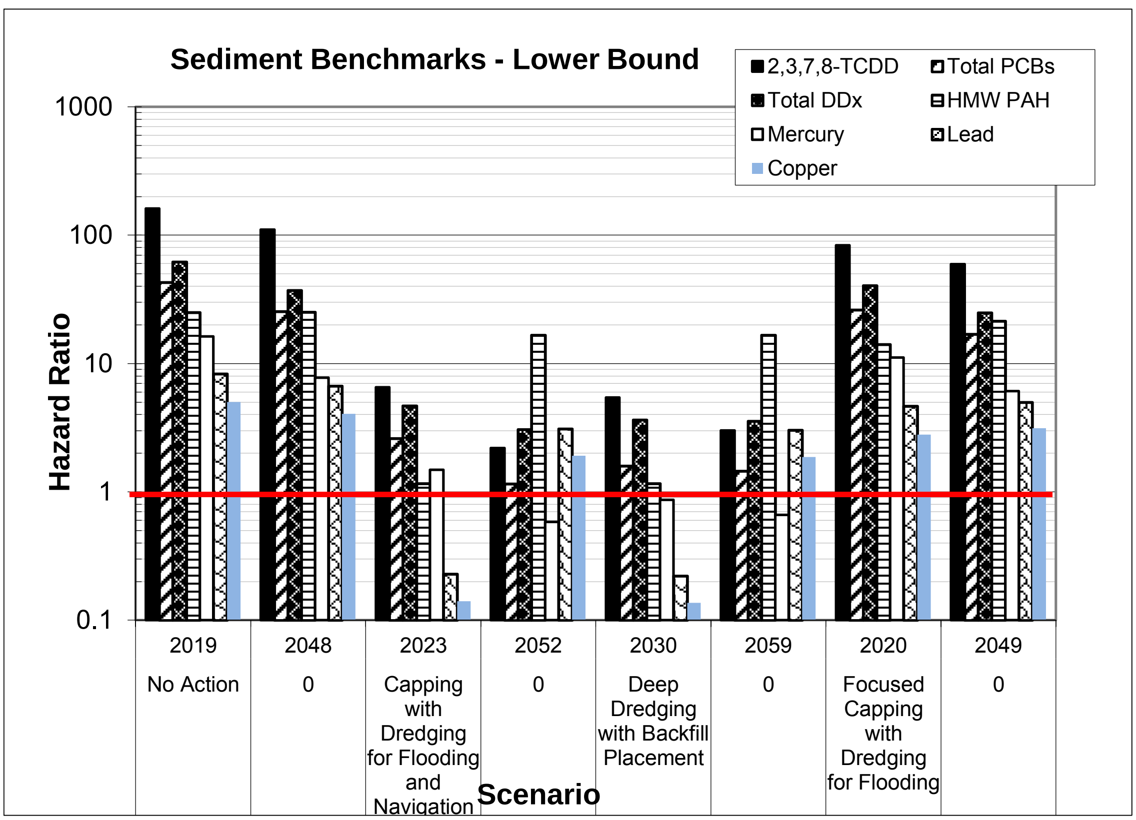


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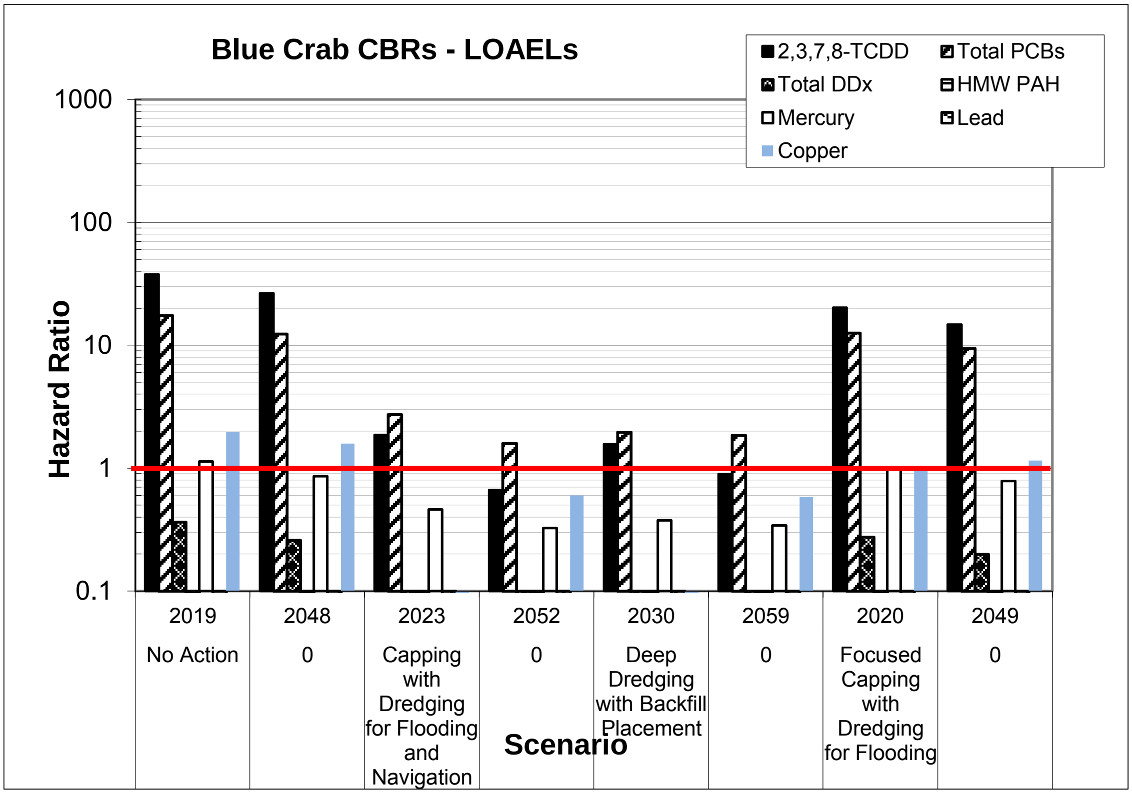
Figure 9-2
Summary of CBR-Based Hazard Ratios for Modeled Future Conditions - Crab Tissue



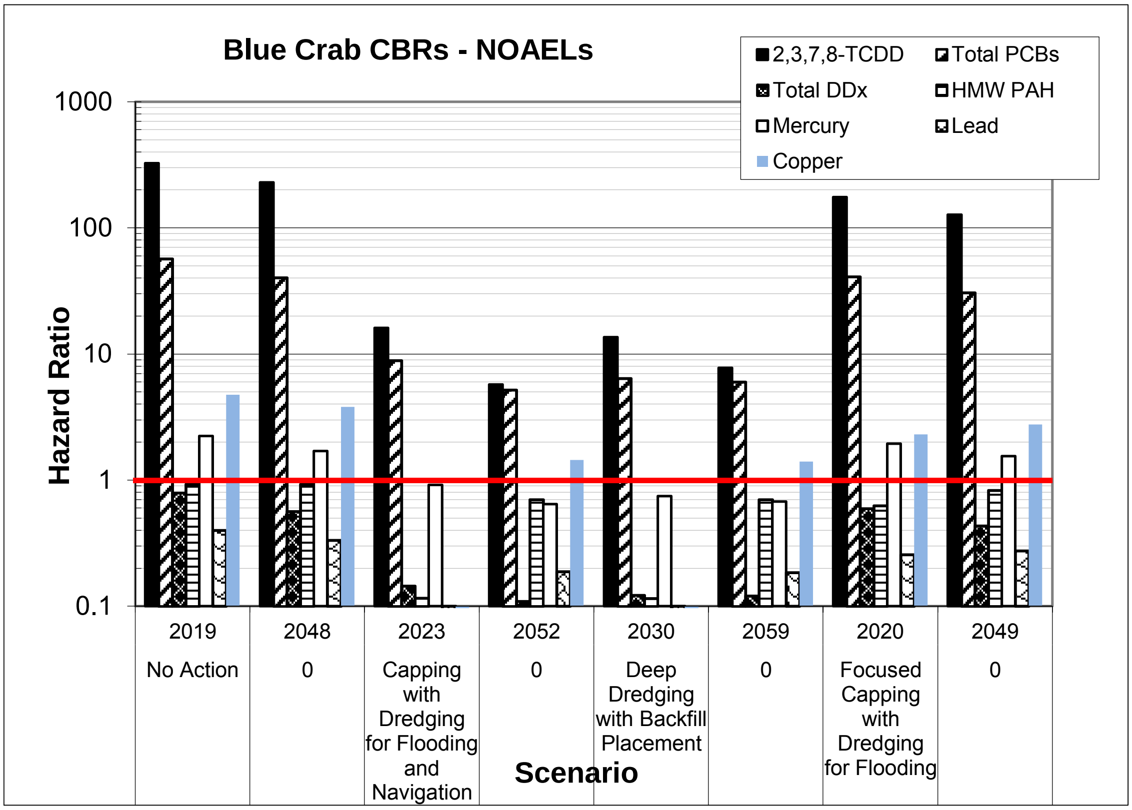
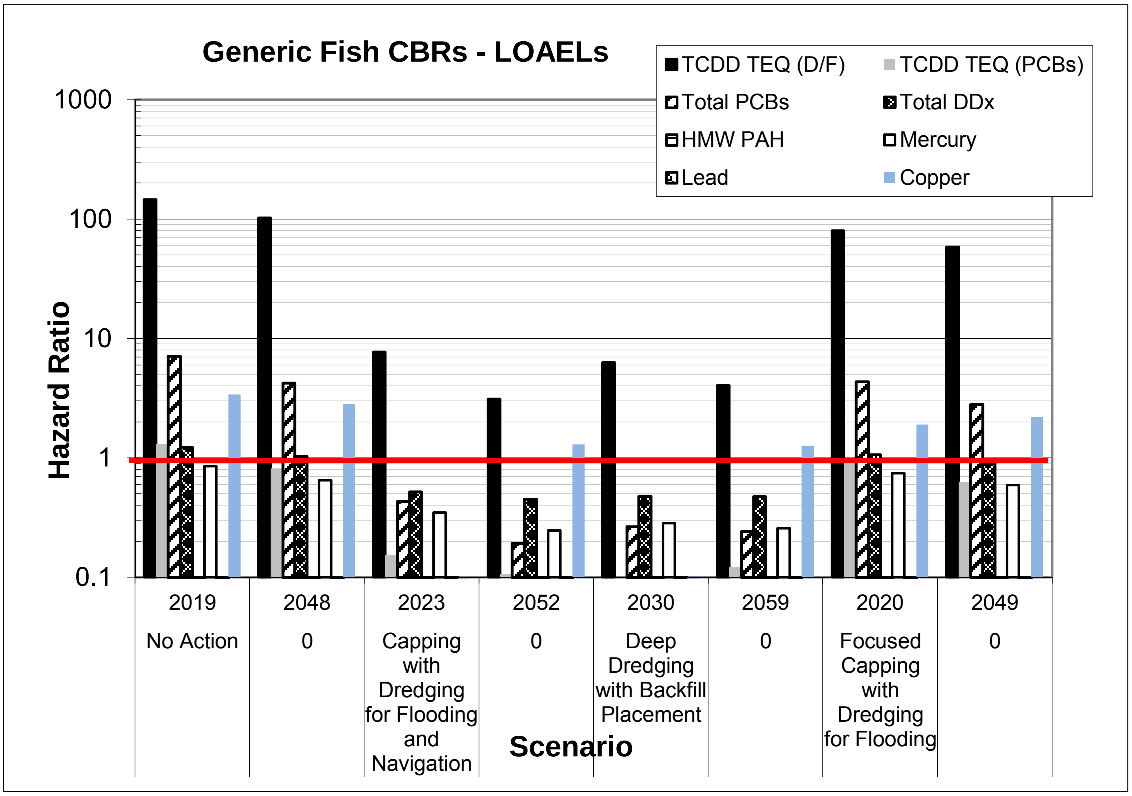


Figure 9-3.
Summary of CBR-Based Hazard Ratios for Modeled Future Conditions - Generic Fish Tissue



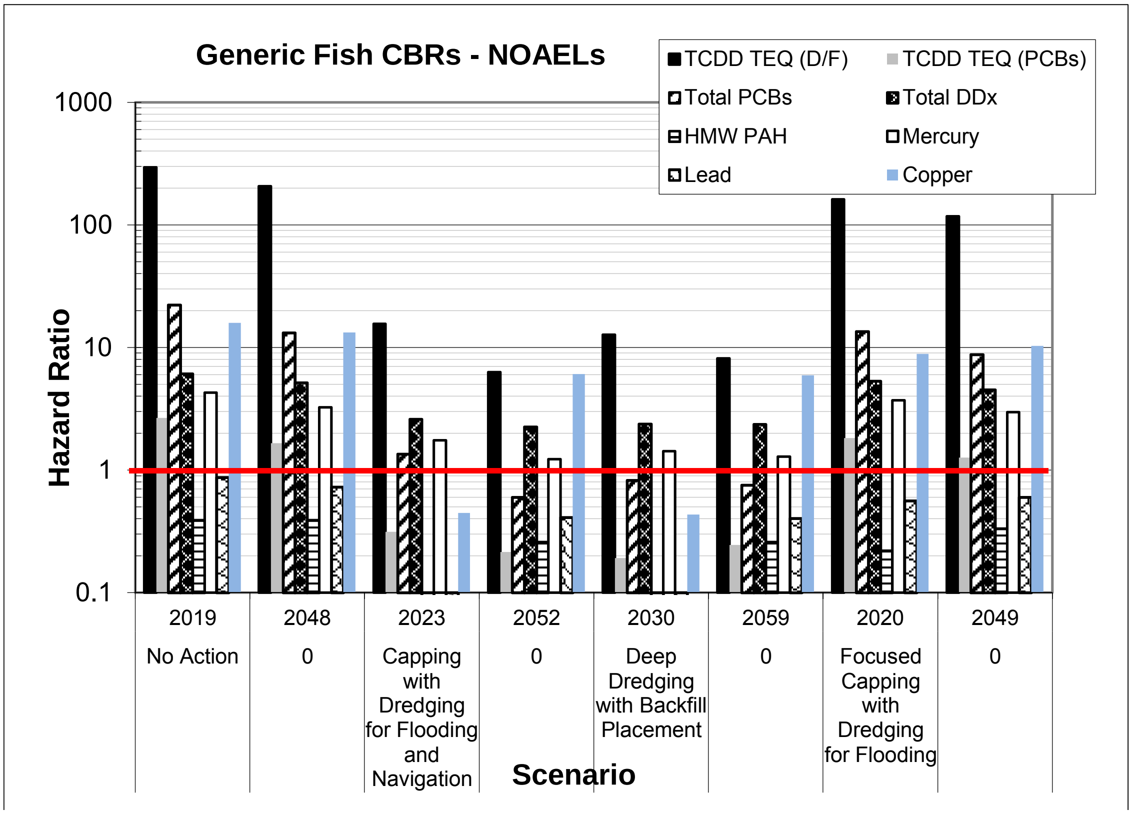


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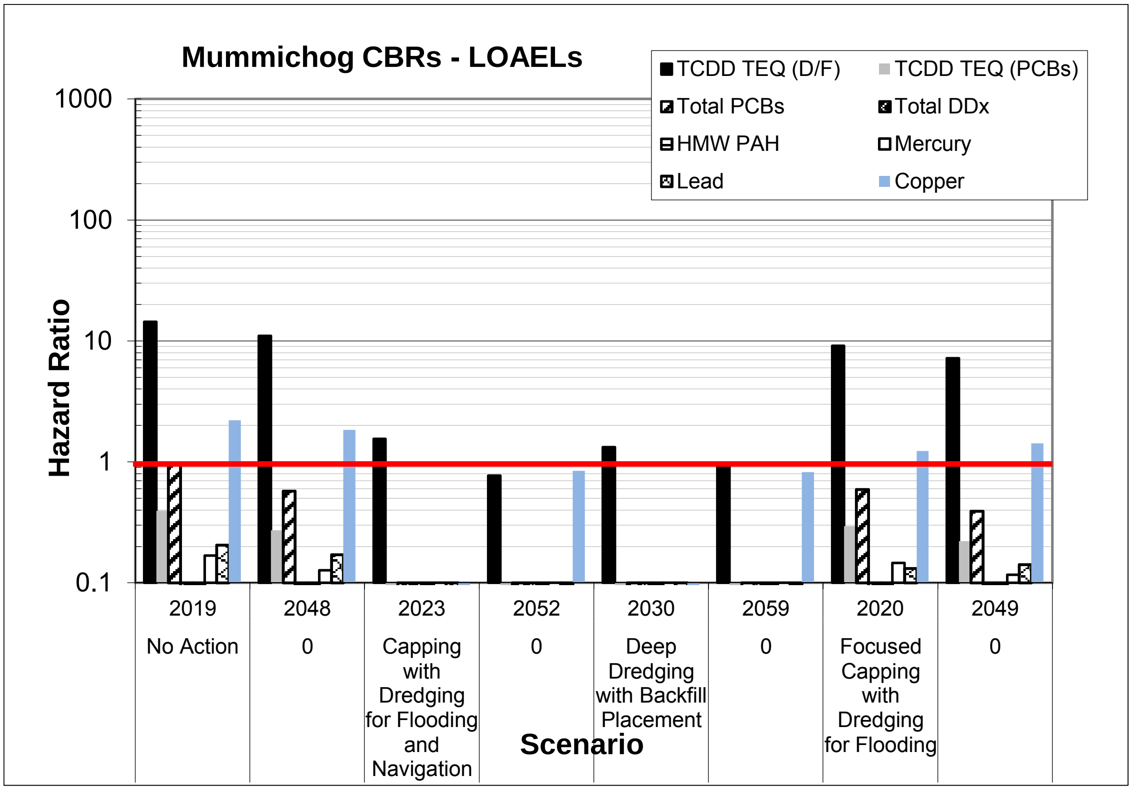
Figure 9-4.
Summary of CBR-Based Hazard Ratios for Modeled Future Conditions - Mummichog Tissue



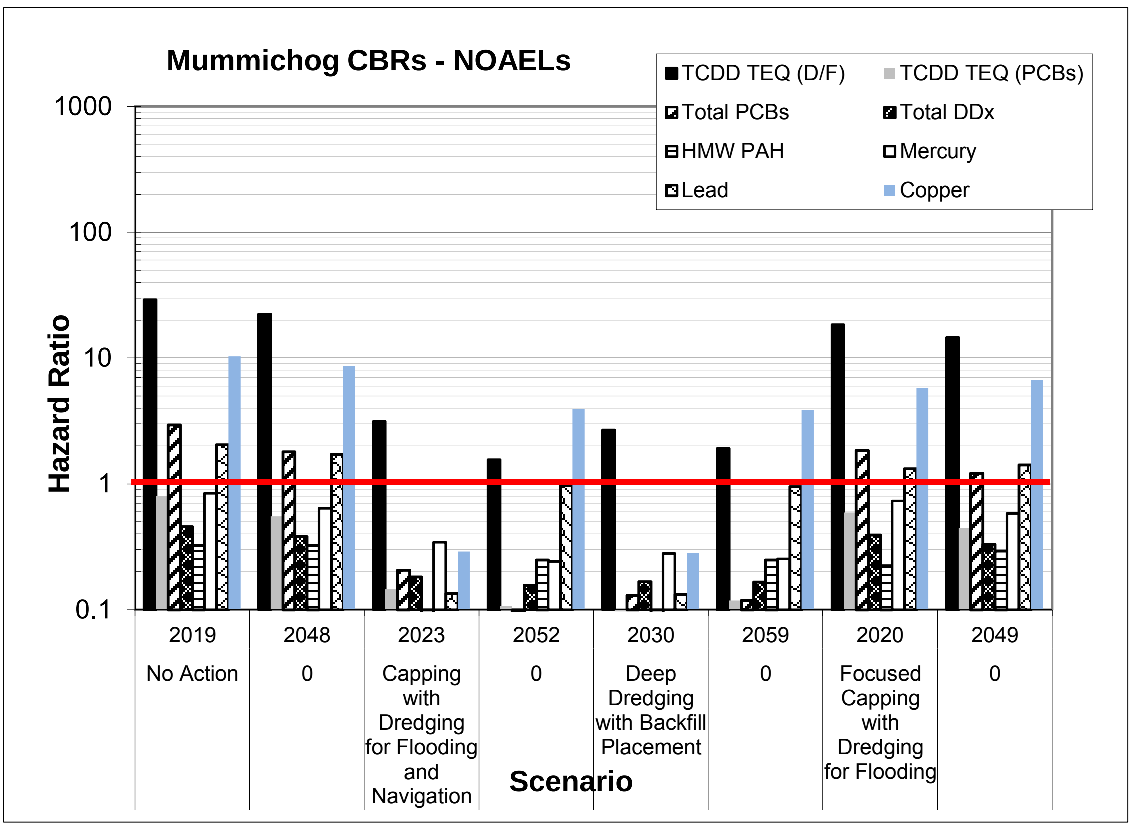


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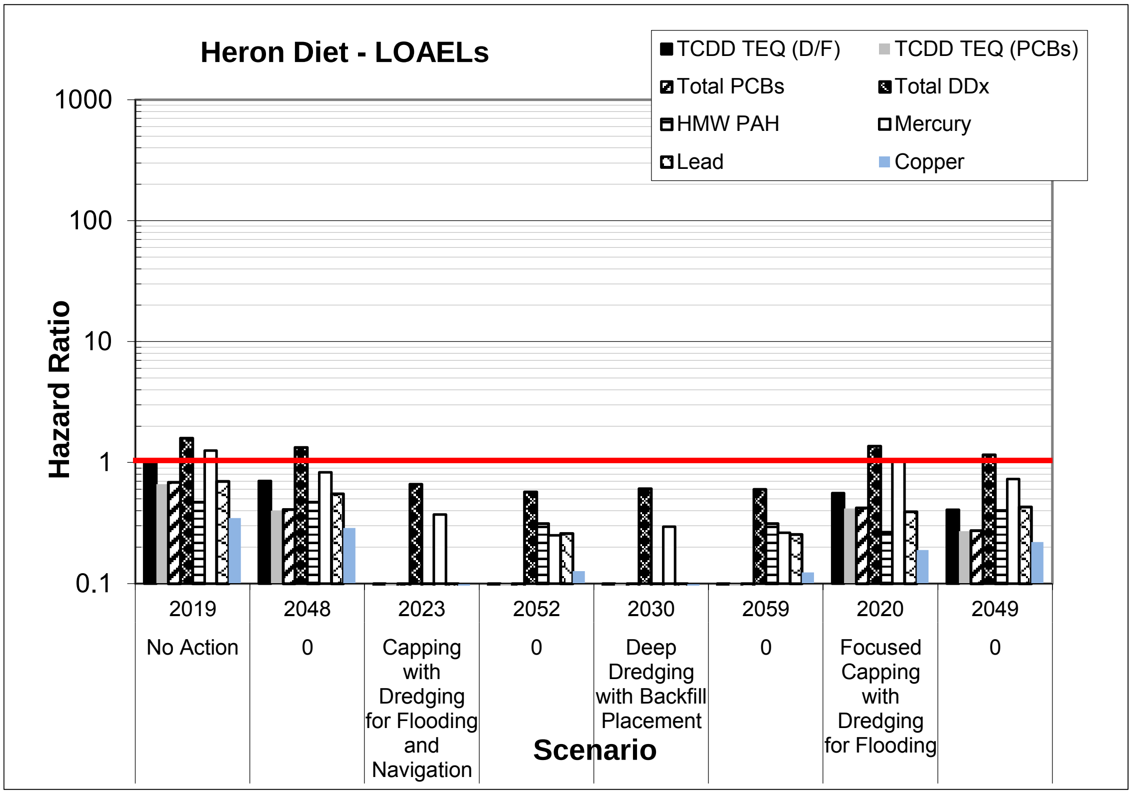
Figure 9-5.
Summary of Wildlife Risk Assessment Under Different Remedial Scenarios - Heron



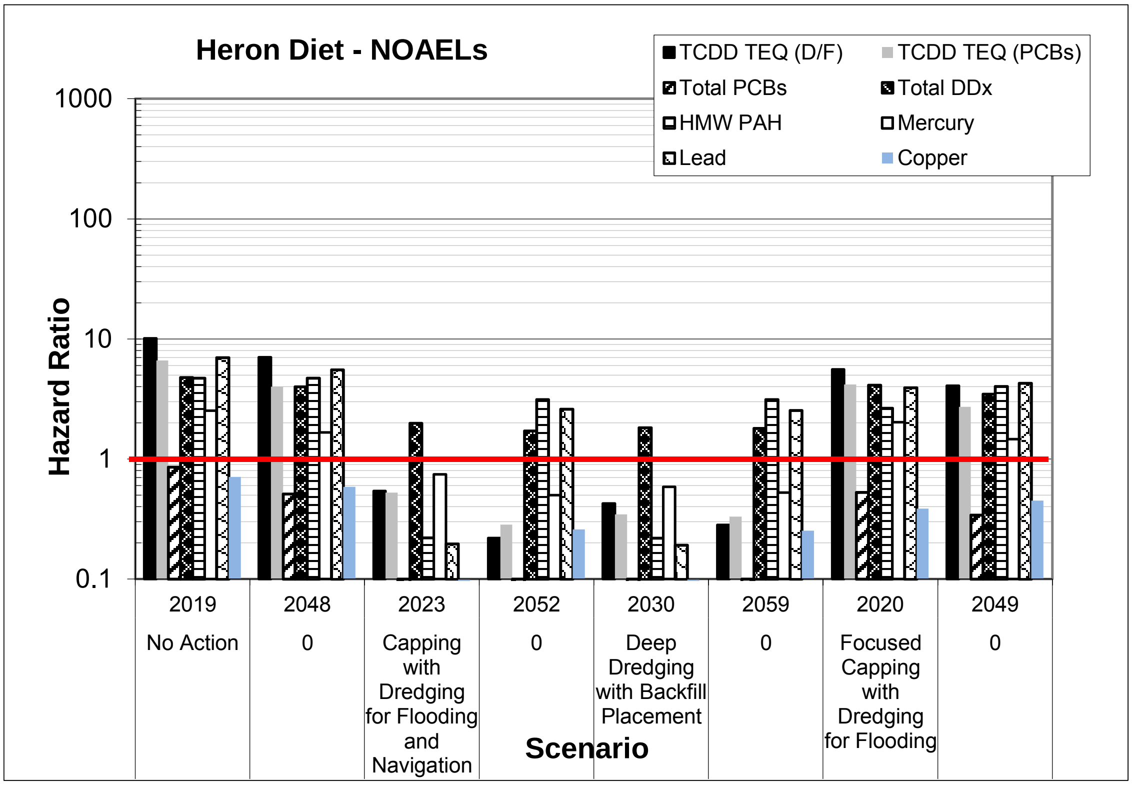


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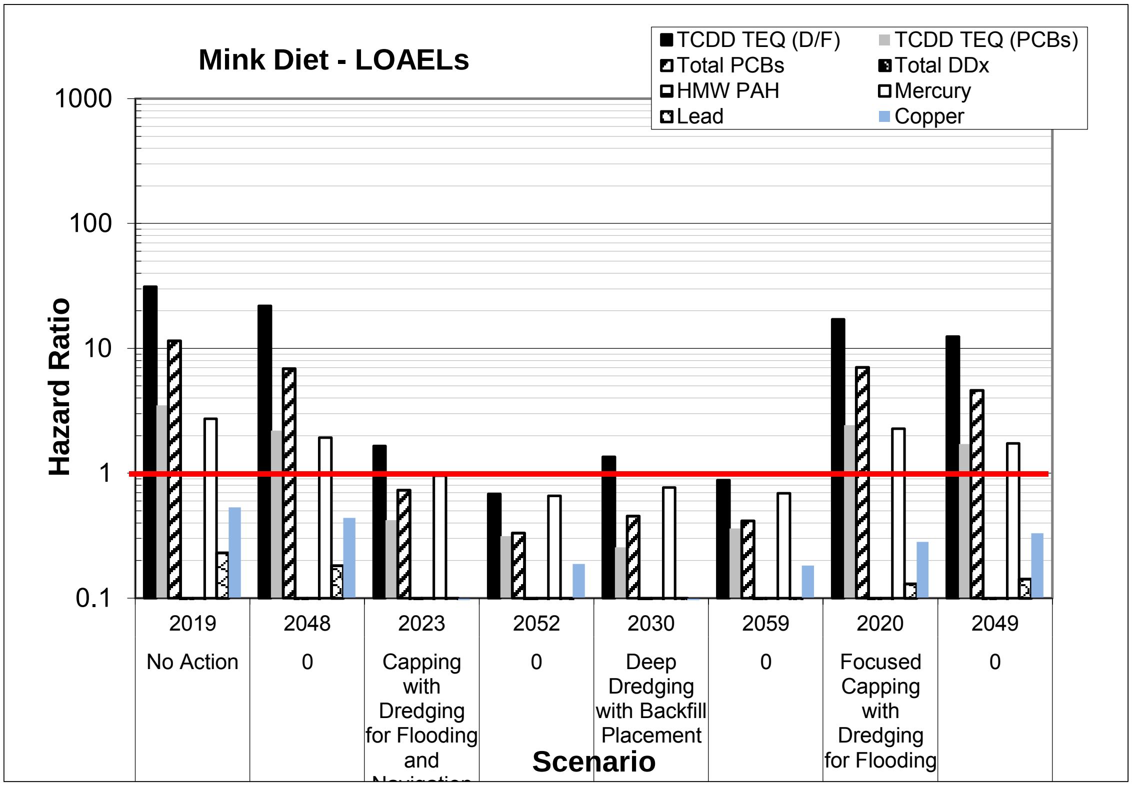
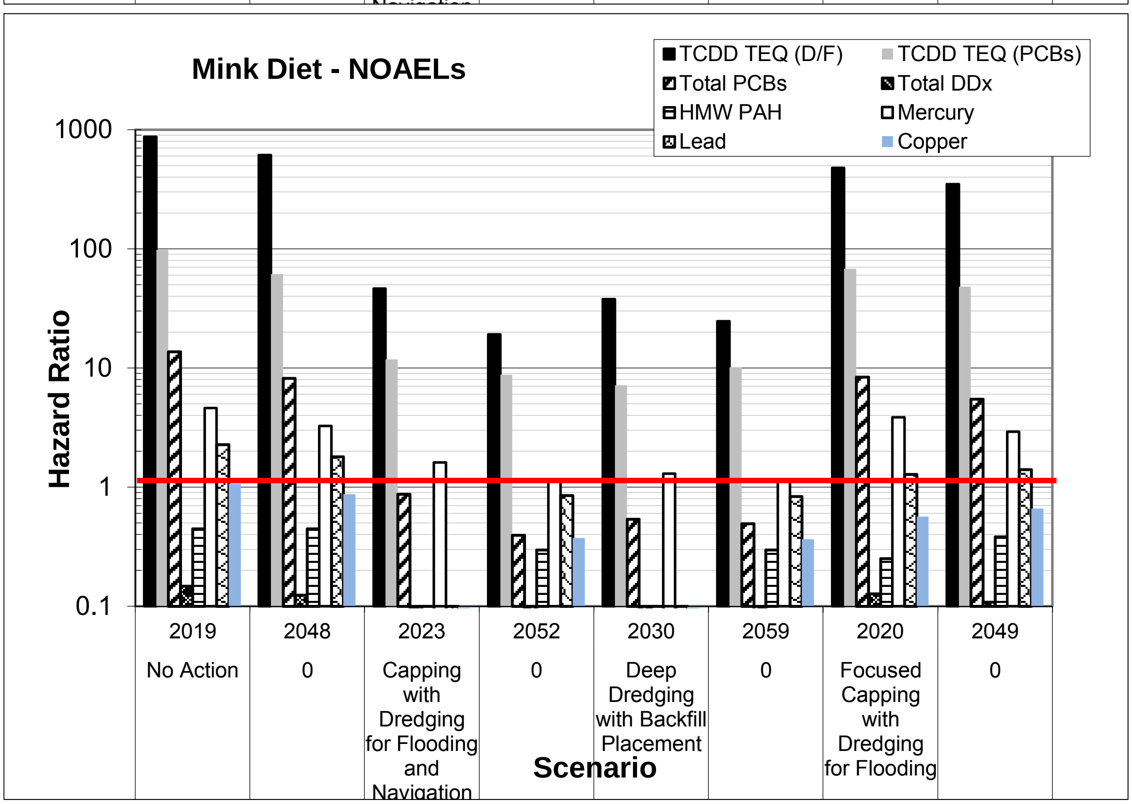
Figure 9-6.
Summary of Wildlife Risk Assessment Under Different Remedial Scenarios - Mink





ATTACHMENT 9

Table 9-1.
Summary of Sediment Benchmark Comparisons for Benthic Macroinvertebrates Based on Modeled Future Conditions - No Action (2019)

COPEC	Units	*Sediment Benchmark*[a] Lower Bound		*Sediment Benchmark*[a] Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	160	**5E+00**	**2E+00**
Lead	µg/g	30	1	94	1	250	**8E+00**	**3E+00**
Mercury	µg/g	0.14	1	0.48	1	2.3	**2E+01**	**5E+00**
						Total Inorganics/Metals	**3E+01**	**9E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	43	**3E+01**	**4E+00**
						Total PAHs	**3E+01**	**4E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.098	**6E+01**	**2E+00**
						Total Pesticides	**6E+01**	**2E+00**
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	1.5	**4E+01**	**4E+00**
						Total PCBs	**4E+01**	**4E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.00051	**2E+02**	**2E+02**
						Total TCDD	**2E+02**	**2E+02**
						Total HI	**3E+02**	**2E+02**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant figu

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-2.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - No Action (2048)

COPEC	Units	*Sediment Benchmark* [a] Lower Bound		*Sediment Benchmark* [a] Upper Bound		Sediment EPC [b]	Hazard Quotients [c] Lower	Hazard Quotients [c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	130	**4E+00**	**1E+00**
Lead	µg/g	30	1	94	1	200	**7E+00**	**2E+00**
Mercury	µg/g	0.14	1	0.48	1	1.1	**8E+00**	**2E+00**
						Total Inorganics/Metals	**2E+01**	**6E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	43	**3E+01**	**4E+00**
						Total PAHs	**3E+01**	**4E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.059	**4E+01**	**1E+00**
						Total Pesticides	**4E+01**	**1E+00**
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.89	**3E+01**	**2E+00**
						Total PCBs	**3E+01**	**2E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.00035	**1E+02**	**1E+02**
						Total TCDD	**1E+02**	**1E+02**
						Total HI	**2E+02**	**1E+02**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant figu

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-3.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2023)

COPEC	Units	*Sediment Benchmark* [a]				Sediment EPC[b]	Hazard Quotients[c]	
		Lower Bound		Upper Bound			Lower	Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	4.5	1E-01	5E-02
Lead	µg/g	30	1	94	1	6.9	2E-01	7E-02
Mercury	µg/g	0.14	1	0.48	1	0.21	**1E+00**	4E-01
						Total Inorganics/Metals	**2E+00**	6E-01
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	2.0	**1E+00**	2E-01
						Total PAHs	**1E+00**	2E-01
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.0074	**5E+00**	2E-01
						Total Pesticides	**5E+00**	2E-01
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.091	**3E+00**	2E-01
						Total PCBs	**3E+00**	2E-01
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.000021	**7E+00**	**7E+00**
						Total TCDD	**7E+00**	7E+00
						Total HI	**2E+01**	**8E+00**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-4.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2052)

COPEC	Units	*Sediment Benchmark*[a] Lower Bound		*Sediment Benchmark*[a] Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	61	**2E+00**	7E-01
Lead	µg/g	30	1	94	1	93	**3E+00**	1E+00
Mercury	µg/g	0.14	1	0.48	1	0.082	6E-01	2E-01
						Total Inorganics/Metals	**6E+00**	**2E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	28	**2E+01**	**3E+00**
						Total PAHs	**2E+01**	**3E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.0048	**3E+00**	1E-01
						Total Pesticides	**3E+00**	1E-01
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.040	**1E+00**	1E-01
						Total PCBs	**1E+00**	1E-01
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.0000070	**2E+00**	**2E+00**
						Total TCDD	**2E+00**	**2E+00**
						Total HI	**3E+01**	**7E+00**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-5.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Deep Dredging with Backfill (2030)

COPEC	Units	*Sediment Benchmark* [a] Lower Bound		*Sediment Benchmark* [a] Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	4.4	1E-01	5E-02
Lead	µg/g	30	1	94	1	6.7	2E-01	7E-02
Mercury	µg/g	0.14	1	0.48	1	0.12	9E-01	3E-01
						Total Inorganics/Metals	**1E+00**	4E-01
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	2.0	**1E+00**	2E-01
						Total PAHs	**1E+00**	2E-01
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.0057	**4E+00**	1E-01
						Total Pesticides	**4E+00**	1E-01
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.056	**2E+00**	2E-01
						Total PCBs	**2E+00**	2E-01
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.000017	**5E+00**	**5E+00**
						Total TCDD	**5E+00**	**5E+00**
						Total HI	**1E+01**	**6E+00**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-6.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Deep Dredging with Backfill (2059)

COPEC	Units	*Sediment Benchmark* [a] Lower Bound		*Sediment Benchmark* [a] Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	60	**2E+00**	6E-01
Lead	µg/g	30	1	94	1	91	**3E+00**	1E+00
Mercury	µg/g	0.14	1	0.48	1	0.093	7E-01	2E-01
						Total Inorganics/Metals	**6E+00**	**2E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	28	**2E+01**	**3E+00**
						Total PAHs	**2E+01**	**3E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.0056	**4E+00**	1E-01
						Total Pesticides	**4E+00**	1E-01
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.051	**1E+00**	1E-01
						Total PCBs	**1E+00**	1E-01
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.0000096	**3E+00**	**3E+00**
						Total TCDD	**3E+00**	**3E+00**
						Total HI	**3E+01**	**8E+00**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-7.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Focused Capping with Dredging for Flooding (2020)

COPEC	Units	*Sediment Benchmark* [a] Lower Bound		*Sediment Benchmark* [a] Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Hazard Quotients[c] Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	90	**3E+00**	1E+00
Lead	µg/g	30	1	94	1	140	**5E+00**	**1E+00**
Mercury	µg/g	0.14	1	0.48	1	1.6	**1E+01**	**3E+00**
						Total Inorganics/Metals	**2E+01**	**6E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	24	**1E+01**	**2E+00**
						Total PAHs	**1E+01**	**2E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.064	**4E+01**	**1E+00**
						Total Pesticides	**4E+01**	**1E+00**
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.91	**3E+01**	**2E+00**
						Total PCBs	**3E+01**	**2E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.00026	**8E+01**	**8E+01**
						Total TCDD	**8E+01**	**8E+01**
						Total HI	**2E+02**	**1E+02**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-8.
Sediment Benchmark Hazard Quotients for Benthic Macroinvertebrates Based on Modeled Future Conditions - Focused Capping with Dredging for Flooding (2049)

COPEC	Units	*Sediment Benchmark* [a]				Sediment EPC[b]	Hazard Quotients[c]	
		Lower Bound		Upper Bound			Lower	Upper
Inorganics/Metals								
Copper	µg/g	32	1	94	1	100	**3E+00**	**1E+00**
Lead	µg/g	30	1	94	1	150	**5E+00**	**2E+00**
Mercury	µg/g	0.14	1	0.48	1	0.86	**6E+00**	**2E+00**
						Total Inorganics/Metals	**1E+01**	**4E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	µg/g	0.55	2	3.2	2	-		
HMW PAHs	µg/g	1.7	2	9.6	2	36	**2E+01**	**4E+00**
						Total PAHs	**2E+01**	**4E+00**
Pesticides								
Dieldrin	µg/g	0.00083	1	0.0029	1	-		
Total DDx	µg/g	0.0016	2	0.046	2	0.039	**2E+01**	9E-01
						Total Pesticides	**2E+01**	9E-01
PCBs (Aroclors)								
Total PCBs	µg/g	0.035	1	0.37	1	0.59	**2E+01**	**2E+00**
						Total PCBs	**2E+01**	**2E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	µg/g	0.0000032	3	-		0.00019	**6E+01**	**6E+01**
						Total TCDD	**6E+01**	6E+01
						Total HI	**1E+02**	**7E+01**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al* . (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the annual average modeled sediment concentrations (top 15 cms) rounded to 2 significant fig

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

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Table 9-9.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - No Action (2019)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	24	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**5E+00**	**2E+00**
Lead	µg/g	0.20	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	4E-01	8E-02
Mercury	µg/g	0.11	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**2E+00**	**1E+00**
						Total Inorganics/Metals		**7E+00**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.020	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	9E-01	9E-02
						Total PAHs		9E-01	9E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.047	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	8E-01	4E-01
						Total Pesticides		8E-01	4E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.45	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**6E+01**	**2E+01**
						Total PCBs		**6E+01**	**2E+01**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.000049	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**3E+02**	**4E+01**
						Total TCDD		**3E+02**	**4E+01**
						Total HI		**4E+02**	**6E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-10.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - No Action (2048)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	19	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**4E+00**	**2E+00**
Lead	µg/g	0.17	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	3E-01	6E-02
Mercury	µg/g	0.081	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**2E+00**	9E-01
						Total Inorganics/Metals		**6E+00**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.020	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	9E-01	9E-02
						Total PAHs		9E-01	9E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.034	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	6E-01	3E-01
						Total Pesticides		6E-01	3E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.32	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**4E+01**	**1E+01**
						Total PCBs		**4E+01**	**1E+01**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.000034	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**2E+02**	**3E+01**
						Total TCDD		**2E+02**	**3E+01**
						Total HI		**3E+02**	**4E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-11.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2023)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.28	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	6E-02	2E-02
Lead	µg/g	0.013	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	3E-02	5E-03
Mercury	µg/g	0.044	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	9E-01	5E-01
						Total Inorganics/Metals		1E+00	5E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.0025	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	1E-01	1E-02
						Total PAHs		1E-01	1E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.0087	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	1E-01	7E-02
						Total Pesticides		1E-01	7E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.071	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**9E+00**	**3E+00**
						Total PCBs		**9E+00**	**3E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.0000024	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**2E+01**	**2E+00**
						Total TCDD		**2E+01**	**2E+00**
						Total HI		**3E+01**	**5E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-12.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2052)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	7.2	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**1E+00**	6E-01
Lead	µg/g	0.094	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	2E-01	4E-02
Mercury	µg/g	0.031	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	6E-01	3E-01
						Total Inorganics/Metals		**2E+00**	1E+00
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.015	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	7E-01	7E-02
						Total PAHs		7E-01	7E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.0065	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	1E-01	5E-02
						Total Pesticides		1E-01	5E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.041	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**5E+00**	**2E+00**
						Total PCBs		**5E+00**	**2E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.00000086	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**6E+00**	7E-01
						Total TCDD		**6E+00**	7E-01
						Total HI		**1E+01**	**3E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-13.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Deep Dredging with Backfill (2030)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.27	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	5E-02	2E-02
Lead	µg/g	0.013	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	3E-02	5E-03
Mercury	µg/g	0.036	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	7E-01	4E-01
						Total Inorganics/Metals		8E-01	4E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.0025	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	1E-01	1E-02
						Total PAHs		1E-01	1E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.0073	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	1E-01	6E-02
						Total Pesticides		1E-01	6E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.051	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**6E+00**	**2E+00**
						Total PCBs		**6E+00**	**2E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.0000020	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**1E+01**	**2E+00**
						Total TCDD		**1E+01**	**2E+00**
						Total HI		**2E+01**	**4E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-14.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Deep Dredging with Backfill (2059)

Chemical	Units	EPC[a]	CBR[b] NOAEL	CBR[b] LOAEL	Species	Endpoint	Reference[c]	Hazard Quotients[d] NOAEL	Hazard Quotients[d] LOAEL
Inorganics/Metals									
Copper	µg/g	7.0	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**1E+00**	6E-01
Lead	µg/g	0.092	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	2E-01	4E-02
Mercury	µg/g	0.032	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	7E-01	3E-01
						Total Inorganics/Metals		**2E+00**	1E+00
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.015	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	7E-01	7E-02
						Total PAHs		7E-01	7E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.0072	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	1E-01	6E-02
						Total Pesticides		1E-01	6E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.048	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**6E+00**	**2E+00**
						Total PCBs		**6E+00**	**2E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.0000012	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**8E+00**	9E-01
						Total TCDD		**8E+00**	9E-01
						Total HI		**2E+01**	**4E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-15.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2020)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	12	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**2E+00**	1E+00
Lead	µg/g	0.13	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	3E-01	5E-02
Mercury	µg/g	0.093	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**2E+00**	1E+00
						Total Inorganics/Metals		**5E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.014	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	6E-01	6E-02
						Total PAHs		6E-01	6E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.036	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	6E-01	3E-01
						Total Pesticides		6E-01	3E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.33	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**4E+01**	**1E+01**
						Total PCBs		**4E+01**	**1E+01**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.000026	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**2E+02**	**2E+01**
						Total TCDD		**2E+02**	**2E+01**
						Total HI		**2E+02**	**4E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-16.
CBR-Based Hazard Quotients for COPECs in Blue Crab Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2049)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	14	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**3E+00**	**1E+00**
Lead	µg/g	0.14	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	3E-01	5E-02
Mercury	µg/g	0.074	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**2E+00**	8E-01
						Total Inorganics/Metals		**5E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4		
HMW PAHs	µg/g	0.018	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	8E-01	8E-02
						Total PAHs		8E-01	8E-02
Pesticides									
Dieldrin	µg/g	-	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6		
Total DDx	µg/g	0.026	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	4E-01	2E-01
						Total Pesticides		4E-01	2E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.25	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**3E+01**	**9E+00**
						Total PCBs		**3E+01**	**9E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.000019	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**1E+02**	**1E+01**
						Total TCDD		**1E+02**	**1E+01**
						Total HI		**2E+02**	**3E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al* ., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al* ., 1995; 6. Parrish *et al* ., 1973; 7. Nimmo *et al.* , 1970; 8. Chu *et al* ., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-17.
BR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - No Action (2019)

Chemical	Units	EPC[a]	CBR[b] NOAEL	CBR[b] LOAEL	Species	Endpoint	Reference[c]	Hazard Quotients[d] NOAEL	Hazard Quotients[d] LOAEL
Inorganics/Metals									
Copper	µg/g	5.1	0.32	1.5	*Mugil cephalus*	Mortality	1	**2E+01**	**3E+00**
Lead	µg/g	0.35	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	9E-01	9E-02
Mercury	µg/g	0.22	0.052	0.26	*various species*	LER_5	3	**4E+00**	9E-01
						Total Inorganics/Metals		**2E+01**	**4E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.082	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	4E-01	4E-02
						Total PAHs		4E-01	4E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.48	0.078	0.39	various species	LER_5	7	**6E+00**	**1E+00**
						Total Pesticides		**6E+00**	**1E+00**
PCBs (Aroclors)									
Total PCBs	µg/g	3.8	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**2E+01**	**7E+00**
						Total PCBs		**2E+01**	**7E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00026	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+02**	**1E+02**
TCDD TEQ (PCBs)	µg/g	0.0000024	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+00**	**1E+00**
						Total TCDD		**3E+02**	**1E+02**
						Total HI		**3E+02**	**2E+02**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-18.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - No Action (2048)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	4.2	0.32	1.5	*Mugil cephalus*	Mortality	1	**1E+01**	**3E+00**
Lead	µg/g	0.29	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	7E-01	7E-02
Mercury	µg/g	0.17	0.052	0.26	*various species*	LER_5	3	**3E+00**	6E-01
						Total Inorganics/Metals		**2E+01**	**4E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.082	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	4E-01	4E-02
						Total PAHs		4E-01	4E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.40	0.078	0.39	various species	LER_5	7	**5E+00**	**1E+00**
						Total Pesticides		**5E+00**	**1E+00**
PCBs (Aroclors)									
Total PCBs	µg/g	2.2	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**1E+01**	**4E+00**
						Total PCBs		**1E+01**	**4E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00018	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+02**	**1E+02**
TCDD TEQ (PCBs)	µg/g	0.0000015	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+00**	8E-01
						Total TCDD		**2E+02**	**1E+02**
						Total HI		**2E+02**	**1E+02**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-19.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2023)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.14	0.32	1.5	*Mugil cephalus*	Mortality	1	4E-01	1E-01
Lead	µg/g	0.023	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	6E-02	6E-03
Mercury	µg/g	0.091	0.052	0.26	*various species*	LER_5	3	**2E+00**	3E-01
						Total Inorganics/Metals		**2E+00**	4E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.0042	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-02	2E-03
						Total PAHs		2E-02	2E-03
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.20	0.078	0.39	various species	LER_5	7	**3E+00**	5E-01
						Total Pesticides		**3E+00**	5E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.23	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**1E+00**	4E-01
						Total PCBs		**1E+00**	4E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000014	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+01**	**8E+00**
TCDD TEQ (PCBs)	µg/g	0.00000028	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	3E-01	2E-01
						Total TCDD		**2E+01**	**8E+00**
						Total HI		**2E+01**	**9E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-20.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2052)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.9	0.32	1.5	*Mugil cephalus*	Mortality	1	**6E+00**	**1E+00**
Lead	µg/g	0.16	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	4E-01	4E-02
Mercury	µg/g	0.064	0.052	0.26	*various species*	LER_5	3	**1E+00**	2E-01
						Total Inorganics/Metals		**8E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.054	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.18	0.078	0.39	various species	LER_5	7	**2E+00**	5E-01
						Total Pesticides		**2E+00**	5E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.10	0.17	0.53	*Salmo salar*	Behavior (survival)	8	6E-01	2E-01
						Total PCBs		6E-01	2E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000056	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**6E+00**	**3E+00**
TCDD TEQ (PCBs)	µg/g	0.00000019	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	2E-01	1E-01
						Total TCDD		**6E+00**	**3E+00**
						Total HI		**2E+01**	**5E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-21.
BR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - Deep Dredging with Backfill (2030)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.14	0.32	1.5	*Mugil cephalus*	Mortality	1	4E-01	9E-02
Lead	µg/g	0.022	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	6E-02	6E-03
Mercury	µg/g	0.074	0.052	0.26	*various species*	LER_5	3	**1E+00**	3E-01
						Total Inorganics/Metals		**2E+00**	4E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.0042	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-02	2E-03
						Total PAHs		2E-02	2E-03
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.19	0.078	0.39	various species	LER_5	7	**2E+00**	5E-01
						Total Pesticides		**2E+00**	5E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.14	0.17	0.53	*Salmo salar*	Behavior (survival)	8	8E-01	3E-01
						Total PCBs		8E-01	3E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000011	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**1E+01**	**6E+00**
TCDD TEQ (PCBs)	µg/g	0.00000017	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	2E-01	9E-02
						Total TCDD		**1E+01**	**6E+00**
						Total HI		**2E+01**	**7E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-22.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions -Deep Dredging with Backfill (2059)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.9	0.32	1.5	*Mugil cephalus*	Mortality	1	**6E+00**	**1E+00**
Lead	µg/g	0.16	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	4E-01	4E-02
Mercury	µg/g	0.067	0.052	0.26	*various species*	LER_5	3	**1E+00**	3E-01
						Total Inorganics/Metals		**8E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.054	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.18	0.078	0.39	various species	LER_5	7	**2E+00**	5E-01
						Total Pesticides		**2E+00**	5E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.13	0.17	0.53	*Salmo salar*	Behavior (survival)	8	8E-01	2E-01
						Total PCBs		8E-01	2E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000073	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**8E+00**	**4E+00**
TCDD TEQ (PCBs)	µg/g	0.00000022	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	2E-01	1E-01
						Total TCDD		**8E+00**	**4E+00**
						Total HI		**2E+01**	**6E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-23.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2020)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	2.8	0.32	1.5	*Mugil cephalus*	Mortality	1	**9E+00**	**2E+00**
Lead	µg/g	0.22	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	6E-01	6E-02
Mercury	µg/g	0.19	0.052	0.26	*various species*	LER_5	3	**4E+00**	7E-01
						Total Inorganics/Metals		**1E+01**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.046	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-01	2E-02
						Total PAHs		2E-01	2E-02
PCBs (Aroclors)									
Total PCBs	µg/g	2.3	0.1700	0.530	*Salmo salar*	Behavior (survival)	6	**1E+01**	**4E+00**
						Total PCBs	7	**1E+01**	**4E+00**
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	7		
Total DDx	µg/g	0.41	0.078	0.39	various species	LER_5	8	**5E+00**	**1E+00**
						Total Pesticides		**5E+00**	**1E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00014	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+02**	**8E+01**
TCDD TEQ (PCBs)	µg/g	0.0000016	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+00**	9E-01
						Total TCDD		**2E+02**	**8E+01**
						Total HI		**2E+02**	**9E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-24.
CBR-Based Hazard Quotients for COPECs in Generic Fish Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2049)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	3.3	0.32	1.5	*Mugil cephalus*	Mortality	1	**1E+01**	**2E+00**
Lead	µg/g	0.24	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	6E-01	6E-02
Mercury	µg/g	0.15	0.052	0.26	*various species*	LER_5	3	**3E+00**	6E-01
						Total Inorganics/Metals		**1E+01**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.070	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.35	0.078	0.39	various species	LER_5	7	**5E+00**	9E-01
						Total Pesticides		**5E+00**	9E-01
PCBs (Aroclors)									
Total PCBs	µg/g	1.5	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**9E+00**	**3E+00**
						Total PCBs		**9E+00**	**3E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00010	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**1E+02**	**6E+01**
TCDD TEQ (PCBs)	µg/g	0.0000011	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**1E+00**	6E-01
						Total TCDD		**1E+02**	**6E+01**
						Total HI		**1E+02**	**7E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-25.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - No Action (2019)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	3.3	0.32	1.5	*Mugil cephalus*	Mortality	1	**1E+01**	**2E+00**
Lead	µg/g	0.82	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	**2E+00**	2E-01
Mercury	µg/g	0.044	0.052	0.26	*various species*	LER_5	3	8E-01	2E-01
						Total Inorganics/Metals		**1E+01**	**3E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.068	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.036	0.078	0.39	various species	LER_5	7	5E-01	9E-02
						Total Pesticides		5E-01	9E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.50	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**3E+00**	9E-01
						Total PCBs		**3E+00**	9E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000026	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+01**	**1E+01**
TCDD TEQ (PCBs)	µg/g	0.00000071	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	8E-01	4E-01
						Total TCDD		**3E+01**	**1E+01**
						Total HI		**5E+01**	**2E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-26.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - No Action (2048)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	2.8	0.32	1.5	*Mugil cephalus*	Mortality	1	**9E+00**	**2E+00**
Lead	µg/g	0.69	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	**2E+00**	2E-01
Mercury	µg/g	0.033	0.052	0.26	*various species*	LER5	3	6E-01	1E-01
						Total Inorganics/Metals		**1E+01**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.068	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.030	0.078	0.39	various species	LER_5	7	4E-01	8E-02
						Total Pesticides		4E-01	8E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.31	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**2E+00**	6E-01
						Total PCBs		**2E+00**	6E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000020	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+01**	**1E+01**
TCDD TEQ (PCBs)	µg/g	0.00000049	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	6E-01	3E-01
						Total TCDD		**2E+01**	**1E+01**
						Total HI		**4E+01**	**1E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-27.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2023)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.093	0.32	1.5	*Mugil cephalus*	Mortality	1	3E-01	6E-02
Lead	µg/g	0.054	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	1E-01	1E-02
Mercury	µg/g	0.018	0.052	0.26	*various species*	LER5	3	3E-01	7E-02
						Total Inorganics/Metals		8E-01	1E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.0096	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	5E-02	5E-03
						Total PAHs		5E-02	5E-03
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.014	0.078	0.39	various species	LER_5	7	2E-01	4E-02
						Total Pesticides		2E-01	4E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.035	0.17	0.53	*Salmo salar*	Behavior (survival)	8	2E-01	7E-02
						Total PCBs		2E-01	7E-02
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000028	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+00**	**2E+00**
TCDD TEQ (PCBs)	µg/g	0.00000013	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	1E-01	7E-02
						Total TCDD		**3E+00**	**2E+00**
						Total HI		**4E+00**	**2E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-28.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Capping with Dredging for Flooding and Navigation (2052)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.3	0.32	1.5	*Mugil cephalus*	Mortality	1	**4E+00**	8E-01
Lead	µg/g	0.39	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	1E+00	1E-01
Mercury	µg/g	0.013	0.052	0.26	*various species*	LER5	3	2E-01	5E-02
						Total Inorganics/Metals		**5E+00**	1E+00
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.052	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-01	2E-02
						Total PAHs		2E-01	2E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.012	0.078	0.39	various species	LER_5	7	2E-01	3E-02
						Total Pesticides		2E-01	3E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.016	0.17	0.53	*Salmo salar*	Behavior (survival)	8	1E-01	3E-02
						Total PCBs		1E-01	3E-02
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000014	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+00**	8E-01
TCDD TEQ (PCBs)	µg/g	0.000000095	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	1E-01	5E-02
						Total TCDD		**2E+00**	8E-01
						Total HI		**7E+00**	**2E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-29.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Deep Dredging with Backfill (2030)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	0.090	0.32	1.5	*Mugil cephalus*	Mortality	1	3E-01	6E-02
Lead	µg/g	0.053	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	1E-01	1E-02
Mercury	µg/g	0.015	0.052	0.26	*various species*	LER5	3	3E-01	6E-02
						Total Inorganics/Metals		7E-01	1E-01
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.0096	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	5E-02	5E-03
						Total PAHs		5E-02	5E-03
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.013	0.078	0.39	various species	LER_5	7	2E-01	3E-02
						Total Pesticides		2E-01	3E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.022	0.17	0.53	*Salmo salar*	Behavior (survival)	8	1E-01	4E-02
						Total PCBs		1E-01	4E-02
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000024	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**3E+00**	**1E+00**
TCDD TEQ (PCBs)	µg/g	0.000000086	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	1E-01	5E-02
						Total TCDD		**3E+00**	**1E+00**
						Total HI		**4E+00**	**2E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-30.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Deep Dredging with Backfill (2059)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.2	0.32	1.5	*Mugil cephalus*	Mortality	1	**4E+00**	8E-01
Lead	µg/g	0.38	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	9E-01	9E-02
Mercury	µg/g	0.013	0.052	0.26	*various species*	LER5	3	3E-01	5E-02
						Total Inorganics/Metals		**5E+00**	1E+00
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.052	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-01	2E-02
						Total PAHs		2E-01	2E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.013	0.078	0.39	various species	LER_5	7	2E-01	3E-02
						Total Pesticides		2E-01	3E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.020	0.17	0.53	*Salmo salar*	Behavior (survival)	8	1E-01	4E-02
						Total PCBs		1E-01	4E-02
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000017	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+00**	9E-01
TCDD TEQ (PCBs)	µg/g	0.00000011	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	1E-01	6E-02
						Total TCDD		**2E+00**	**1E+00**
						Total HI		**8E+00**	**2E+00**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-31.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2020)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.8	0.32	1.5	*Mugil cephalus*	Mortality	1	**6E+00**	**1E+00**
Lead	µg/g	0.53	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	**1E+00**	1E-01
Mercury	µg/g	0.038	0.052	0.26	*various species*	LER5	3	7E-01	1E-01
						Total Inorganics/Metals		**8E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.047	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	2E-01	2E-02
						Total PAHs		2E-01	2E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.031	0.078	0.39	various species	LER_5	7	4E-01	8E-02
						Total Pesticides		4E-01	8E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.31	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**2E+00**	6E-01
						Total PCBs		**2E+00**	6E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000016	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+01**	**9E+00**
TCDD TEQ (PCBs)	µg/g	0.00000053	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	6E-01	3E-01
						Total TCDD		**2E+01**	**9E+00**
						Total HI		**3E+01**	**1E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al* ., 1976; 3. Beckvar *et al* ., 2005; 4. Hall & Oris, 1991; 5. Hose *et al* ., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al* ., 2005; 8. Lerner *et al* ., 2007; 9. Couillard *et al* ., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-32.
CBR-Based Hazard Quotients for COPECs in Mummichog Tissue: Modeled Future Conditions - Focused Capping with Dredging for Flooding (2049)

Chemical	Units	EPC[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	2.1	0.32	1.5	*Mugil cephalus*	Mortality	1	**7E+00**	**1E+00**
Lead	µg/g	0.57	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	**1E+00**	1E-01
Mercury	µg/g	0.030	0.052	0.26	*various species*	LER5	3	6E-01	1E-01
						Total Inorganics/Metals		**9E+00**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	-	0.26	2.6	*Pimephales promelas*	Reproduction	4		
HMW PAHs	µg/g	0.061	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	3E-01	3E-02
						Total PAHs		3E-01	3E-02
Pesticides									
Dieldrin	µg/g	-	0.0080	0.040	*Salmo gairdneri*	Mortality	6		
Total DDx	µg/g	0.026	0.078	0.39	various species	LER_5	7	3E-01	7E-02
						Total Pesticides		3E-01	7E-02
PCBs (Aroclors)									
Total PCBs	µg/g	0.21	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**1E+00**	4E-01
						Total PCBs		**1E+00**	4E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.000013	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**1E+01**	**7E+00**
TCDD TEQ (PCBs)	µg/g	0.00000040	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	4E-01	2E-01
						Total TCDD		**2E+01**	**7E+00**
						Total HI		**3E+01**	**1E+01**

Notes:

[a] Exposure Point Concentrations were derived by multipling modeled average surficial sediment concentrations by site-specific uptake factors as discussed in Attachment 7.

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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TABLE 9-33
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-34
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.6E+02	mg/kg	8.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.6E-01	1.8E-01
Lead	2.5E+02	mg/kg	1.3E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	6.8E+00	6.8E-01
Mercury	2.3E+00	mg/kg	1.2E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.0E-01	4.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.6E+00	4.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	9.8E-02	mg/kg	5.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	5.6E-02	1.9E-02
Total PCBs	1.5E+00	mg/kg	7.7E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.9E-02	1.5E-02
TCDD TEQ (PCBs)	3.8E-04	mg/kg	2.0E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	7.0E-01	7.0E-02
TCDD TEQ (D/F)	5.9E-04	mg/kg	3.0E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.1E+00	1.1E-01
							HAZARD INDICES:	1.5E+01	2.0E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-33.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-35
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-36
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	3.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.6E-01	7.8E-02
Lead	2.0E-01	mg/kg	3.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.6E-02	1.6E-03
Mercury	1.1E-01	mg/kg	1.7E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.3E-01	6.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	3.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.5E-03	6.5E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.7E-02	mg/kg	7.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	8.1E-02	2.7E-02
Total PCBs	4.5E-01	mg/kg	7.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.8E-02	1.4E-02
TCDD TEQ (PCBs)	3.7E-05	mg/kg	5.8E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.1E-01	2.1E-02
TCDD TEQ (D/F)	5.7E-05	mg/kg	8.7E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.1E-01	3.1E-02
							HAZARD INDICES:	9.3E-01	2.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-35.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-37
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-38
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	5.1E+00	mg/kg	4.4E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.9E-01	9.5E-02
Lead	3.5E-01	mg/kg	3.0E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.6E-01	1.6E-02
Mercury	2.2E-01	mg/kg	1.9E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.5E+00	7.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	8.2E-02	mg/kg	7.1E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.5E-01	1.5E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.8E-01	mg/kg	4.2E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.6E+00	1.5E+00
Total PCBs	3.8E+00	mg/kg	3.3E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	8.2E-01	6.6E-01
TCDD TEQ (PCBs)	1.8E-04	mg/kg	1.6E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.7E+00	5.7E-01
TCDD TEQ (D/F)	2.8E-04	mg/kg	2.4E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.7E+00	8.7E-01
							HAZARD INDICES:	2.2E+01	4.5E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-37.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-39
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 3.7E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.1E+00		3.1E-01	8.7E+00	*1.0E+01*	*27%*
Lead		6.8E+00		1.6E-02	1.6E-01	*7.0E+00*	*19%*
TCDD TEQ (PCBs)		7.0E-01		2.1E-01	5.7E+00	*6.6E+00*	*18%*
Total DDx		5.6E-02		8.1E-02	4.6E+00	*4.8E+00*	*13%*
HPAH		4.6E+00		6.5E-03	1.5E-01	*4.7E+00*	*13%*
Mercury		9.0E-01		1.3E-01	1.5E+00	*2.5E+00*	7%
Total PCBs		1.9E-02		1.8E-02	8.2E-01	8.6E-01	2%
Copper		3.6E-01		1.6E-01	1.9E-01	7.1E-01	2%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E+01**	**-**	**9.3E-01**	**2.2E+01**	**3.7E+01**	
PERCENTAGE OF TOTAL RISK		**39%**		**2%**	**59%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-40
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 6.7E+00

Analyte	Exposure Medium[a]					Combined	Percent
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	HQs[b]	Contribution[c]
Total DDx		1.9E-02		2.7E-02	1.5E+00	*1.6E+00*	*24%*
Mercury		4.5E-01		6.4E-02	7.5E-01	*1.3E+00*	*19%*
TCDD TEQ (D/F)		1.1E-01		3.1E-02	8.7E-01	*1.0E+00*	*15%*
Lead		6.8E-01		1.6E-03	1.6E-02	7.0E-01	*10%*
Total PCBs		1.5E-02		1.4E-02	6.6E-01	6.9E-01	*10%*
TCDD TEQ (PCBs)		7.0E-02		2.1E-02	5.7E-01	6.6E-01	10%
HPAH		4.6E-01		6.5E-04	1.5E-02	4.7E-01	7%
Copper		1.8E-01		7.8E-02	9.5E-02	3.5E-01	5%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.0E+00**	**-**	**2.4E-01**	**4.5E+00**	**6.7E+00**	
PERCENTAGE OF TOTAL RISK		**29%**		**4%**	**67%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-41
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	STIMATED DAILY INTAKE VIA SEDIMENT INGESTIO	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-42
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.3E+02	mg/kg	6.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.0E-01	1.5E-01
Lead	2.0E+02	mg/kg	1.0E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	5.4E+00	5.4E-01
Mercury	1.1E+00	mg/kg	5.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.3E-01	2.2E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.6E+00	4.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.9E-02	mg/kg	3.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.4E-02	1.1E-02
Total PCBs	8.9E-01	mg/kg	4.6E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.1E-02	9.2E-03
TCDD TEQ (PCBs)	2.2E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.1E-01	4.1E-02
TCDD TEQ (D/F)	4.1E-04	mg/kg	2.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	7.5E-01	7.5E-02
							HAZARD INDICES:	1.2E+01	1.5E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-41.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-43
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-44
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+01	mg/kg	2.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.3E-01	6.2E-02
Lead	1.7E-01	mg/kg	2.6E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.4E-02	1.4E-03
Mercury	8.1E-02	mg/kg	1.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.7E-02	4.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	3.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.5E-03	6.5E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.4E-02	mg/kg	5.2E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	5.8E-02	1.9E-02
Total PCBs	3.2E-01	mg/kg	5.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-02	9.9E-03
TCDD TEQ (PCBs)	2.3E-05	mg/kg	3.5E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.2E-01	1.2E-02
TCDD TEQ (D/F)	4.0E-05	mg/kg	6.1E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.2E-01	2.2E-02
							HAZARD INDICES:	6.6E-01	1.8E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-43.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-45
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-46

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.2E+00	mg/kg	3.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.6E-01	7.9E-02
Lead	2.9E-01	mg/kg	2.5E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.3E-01	1.3E-02
Mercury	1.7E-01	mg/kg	1.5E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.1E+00	5.7E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	8.2E-02	mg/kg	7.1E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.5E-01	1.5E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.0E-01	mg/kg	3.5E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.9E+00	1.3E+00
Total PCBs	2.2E+00	mg/kg	2.0E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	4.9E-01	3.9E-01
TCDD TEQ (PCBs)	1.1E-04	mg/kg	9.7E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.5E+00	3.5E-01
TCDD TEQ (D/F)	1.9E-04	mg/kg	1.7E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.1E+00	6.1E-01
							HAZARD INDICES:	1.6E+01	3.3E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-45.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-47
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: HERON (w/ generic fish diet)	
TOTAL RISK (HI):	**2.8E+01**

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		7.5E-01		2.2E-01	6.1E+00	*7.1E+00*	*25%*
Lead		5.4E+00		1.4E-02	1.3E-01	*5.5E+00*	*20%*
HPAH		4.6E+00		6.5E-03	1.5E-01	*4.7E+00*	*17%*
TCDD TEQ (PCBs)		4.1E-01		1.2E-01	3.5E+00	*4.0E+00*	*14%*
Total DDx		3.4E-02		5.8E-02	3.9E+00	*4.0E+00*	*14%*
Mercury		4.3E-01		9.7E-02	1.1E+00	*1.7E+00*	6%
Copper		3.0E-01		1.3E-01	1.6E-01	5.9E-01	2%
Total PCBs		1.1E-02		1.2E-02	4.9E-01	5.1E-01	2%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+01**	**-**	**6.6E-01**	**1.6E+01**	**2.8E+01**	
PERCENTAGE OF TOTAL RISK		**42%**		**2%**	**55%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-48
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study -Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: HERON (w/ generic fish diet)	
TOTAL RISK (HI):	**5.0E+00**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		1.1E-02		1.9E-02	1.3E+00	*1.3E+00*	*27%*
Mercury		2.2E-01		4.8E-02	5.7E-01	8.3E-01	*17%*
TCDD TEQ (D/F)		7.5E-02		2.2E-02	6.1E-01	7.1E-01	*14%*
Lead		5.4E-01		1.4E-03	1.3E-02	5.5E-01	*11%*
HPAH		4.6E-01		6.5E-04	1.5E-02	4.7E-01	9%
Total PCBs		9.2E-03		9.9E-03	3.9E-01	4.1E-01	8%
TCDD TEQ (PCBs)		4.1E-02		1.2E-02	3.5E-01	4.0E-01	8%
Copper		1.5E-01		6.2E-02	7.9E-02	2.9E-01	6%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E+00**	**-**	**1.8E-01**	**3.3E+00**	**5.0E+00**	
PERCENTAGE OF TOTAL RISK		**30%**		**4%**	**67%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-49
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-50
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.5E+00	mg/kg	2.3E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.0E-02	4.9E-03
Lead	6.9E+00	mg/kg	3.5E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.9E-01	1.9E-02
Mercury	2.1E-01	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.2E-02	4.1E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.0E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.1E-01	2.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.4E-03	mg/kg	3.8E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.2E-03	1.4E-03
Total PCBs	9.1E-02	mg/kg	4.7E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-03	9.4E-04
TCDD TEQ (PCBs)	2.6E-05	mg/kg	1.3E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.7E-02	4.7E-03
TCDD TEQ (D/F)	2.7E-05	mg/kg	1.4E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.9E-02	4.9E-03
							HAZARD INDICES:	5.9E-01	9.8E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-49.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-51
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-52
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E-01	mg/kg	4.3E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.9E-03	9.2E-04
Lead	1.3E-02	mg/kg	2.0E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-03	1.1E-04
Mercury	4.4E-02	mg/kg	6.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	5.2E-02	2.6E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	3.9E-05	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.2E-04	8.2E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	8.7E-03	mg/kg	1.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.5E-02	5.0E-03
Total PCBs	7.1E-02	mg/kg	1.1E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.7E-03	2.2E-03
TCDD TEQ (PCBs)	3.0E-06	mg/kg	4.6E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.6E-02	1.6E-03
TCDD TEQ (D/F)	3.1E-06	mg/kg	4.7E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.7E-02	1.7E-03
							HAZARD INDICES:	1.1E-01	3.8E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-51.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-53
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-54
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E-01	mg/kg	1.2E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	5.4E-03	2.7E-03
Lead	2.3E-02	mg/kg	2.0E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-02	1.1E-03
Mercury	9.1E-02	mg/kg	7.9E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	6.1E-01	3.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.2E-03	mg/kg	3.7E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	7.6E-03	7.6E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.0E-01	mg/kg	1.8E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.0E+00	6.5E-01
Total PCBs	2.3E-01	mg/kg	2.0E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.0E-02	4.0E-02
TCDD TEQ (PCBs)	1.5E-05	mg/kg	1.3E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.6E-01	4.6E-02
TCDD TEQ (D/F)	1.5E-05	mg/kg	1.3E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.7E-01	4.7E-02
							HAZARD INDICES:	3.6E+00	1.1E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-53.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-55
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)	
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation	
RECEPTOR: HERON (w/ generic fish diet)	
TOTAL RISK (HI):	**4.3E+00**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		4.2E-03		1.5E-02	2.0E+00	*2.0E+00*	*46%*
Mercury		8.2E-02		5.2E-02	6.1E-01	7.4E-01	*17%*
TCDD TEQ (D/F)		4.9E-02		1.7E-02	4.7E-01	5.4E-01	*13%*
TCDD TEQ (PCBs)		4.7E-02		1.6E-02	4.6E-01	5.3E-01	*12%*
HPAH		2.1E-01		8.2E-04	7.6E-03	2.2E-01	5%
Lead		1.9E-01		1.1E-03	1.1E-02	2.0E-01	5%
Total PCBs		1.2E-03		2.7E-03	5.0E-02	5.4E-02	1%
Copper		1.0E-02		1.9E-03	5.4E-03	1.7E-02	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.9E-01**	**-**	**1.1E-01**	**3.6E+00**	**4.3E+00**	
PERCENTAGE OF TOTAL RISK		**14%**		**2%**	**84%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 9-56

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 1.2E+00

Analyte	Exposure Medium[a]					Combined	Percent
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	HQs[b]	Contribution[c]
Total DDx		1.4E-03		5.0E-03	6.5E-01	6.6E-01	*54%*
Mercury		4.1E-02		2.6E-02	3.1E-01	3.7E-01	*30%*
TCDD TEQ (D/F)		4.9E-03		1.7E-03	4.7E-02	5.4E-02	4%
TCDD TEQ (PCBs)		4.7E-03		1.6E-03	4.6E-02	5.3E-02	4%
Total PCBs		9.4E-04		2.2E-03	4.0E-02	4.3E-02	4%
HPAH		2.1E-02		8.2E-05	7.6E-04	2.2E-02	2%
Lead		1.9E-02		1.1E-04	1.1E-03	2.0E-02	2%
Copper		4.9E-03		9.2E-04	2.7E-03	8.5E-03	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.8E-02**	**-**	**3.8E-02**	**1.1E+00**	**1.2E+00**	
PERCENTAGE OF TOTAL RISK		**8%**		**3%**	**89%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 9-57
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE 9-58
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.1E+01	mg/kg	3.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.4E-01	6.7E-02
Lead	9.3E+01	mg/kg	4.8E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E+00	2.5E-01
Mercury	8.2E-02	mg/kg	4.2E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.2E-02	1.6E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.5E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.0E+00	3.0E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.8E-03	mg/kg	2.5E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.8E-03	9.2E-04
Total PCBs	4.0E-02	mg/kg	2.1E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.2E-04	4.2E-04
TCDD TEQ (PCBs)	1.3E-05	mg/kg	6.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.5E-02	2.5E-03
TCDD TEQ (D/F)	1.0E-05	mg/kg	5.2E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.9E-02	1.9E-03
							HAZARD INDICES:	5.8E+00	6.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-57.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-59
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation:
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{invert} = C_{sed} * BAF_{invert}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-60
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.2E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.8E-02	2.4E-02
Lead	9.4E-02	mg/kg	1.4E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.6E-03	7.6E-04
Mercury	3.1E-02	mg/kg	4.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.7E-02	1.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	2.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.0E-03	5.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.5E-03	mg/kg	1.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.1E-02	3.7E-03
Total PCBs	4.1E-02	mg/kg	6.4E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.6E-03	1.3E-03
TCDD TEQ (PCBs)	1.6E-06	mg/kg	2.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.9E-03	8.9E-04
TCDD TEQ (D/F)	1.2E-06	mg/kg	1.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.8E-03	6.8E-04
							HAZARD INDICES:	1.3E-01	5.0E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-59.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-61
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-62

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+00	mg/kg	1.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.4E-02	3.6E-02
Lead	1.6E-01	mg/kg	1.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.5E-02	7.5E-03
Mercury	6.4E-02	mg/kg	5.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.3E-01	2.2E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.4E-02	mg/kg	4.8E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	9.9E-02	9.9E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.8E-01	mg/kg	1.5E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.7E+00	5.7E-01
Total PCBs	1.0E-01	mg/kg	8.9E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.2E-02	1.8E-02
TCDD TEQ (PCBs)	8.0E-06	mg/kg	7.0E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.5E-01	2.5E-02
TCDD TEQ (D/F)	6.2E-06	mg/kg	5.4E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.9E-01	1.9E-02
							HAZARD INDICES:	2.9E+00	9.0E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-61.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-63

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 8.7E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		3.0E+00		5.0E-03	9.9E-02	*3.1E+00*	*36%*
Lead		2.5E+00		7.6E-03	7.5E-02	*2.6E+00*	*30%*
Total DDx		2.8E-03		1.1E-02	1.7E+00	*1.7E+00*	*20%*
Mercury		3.2E-02		3.7E-02	4.3E-01	5.0E-01	6%
TCDD TEQ (PCBs)		2.5E-02		8.9E-03	2.5E-01	2.8E-01	3%
Copper		1.4E-01		4.8E-02	7.4E-02	2.6E-01	3%
TCDD TEQ (D/F)		1.9E-02		6.8E-03	1.9E-01	2.2E-01	3%
Total PCBs		5.2E-04		1.6E-03	2.2E-02	2.4E-02	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.8E+00**	**-**	**1.3E-01**	**2.9E+00**	**8.7E+00**	
PERCENTAGE OF TOTAL RISK		**66%**		**1%**	**33%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-64

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 1.6E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Total DDx		9.2E-04		3.7E-03	5.7E-01	5.7E-01	*36%*
HPAH		3.0E-01		5.0E-04	9.9E-03	3.1E-01	*20%*
Lead		2.5E-01		7.6E-04	7.5E-03	2.6E-01	*16%*
Mercury		1.6E-02		1.8E-02	2.2E-01	2.5E-01	*16%*
Copper		6.7E-02		2.4E-02	3.6E-02	1.3E-01	8%
TCDD TEQ (PCBs)		2.5E-03		8.9E-04	2.5E-02	2.8E-02	2%
TCDD TEQ (D/F)		1.9E-03		6.8E-04	1.9E-02	2.2E-02	1%
Total PCBs		4.2E-04		1.3E-03	1.8E-02	2.0E-02	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**6.4E-01**	**-**	**5.0E-02**	**9.0E-01**	**1.6E+00**	
PERCENTAGE OF TOTAL RISK		**40%**		**3%**	**56%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 9-65
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-66
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.4E+00	mg/kg	2.3E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	9.8E-03	4.8E-03
Lead	6.7E+00	mg/kg	3.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.8E-01	1.8E-02
Mercury	1.2E-01	mg/kg	6.2E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.8E-02	2.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.0E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.1E-01	2.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.7E-03	mg/kg	3.0E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.3E-03	1.1E-03
Total PCBs	5.6E-02	mg/kg	2.9E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	7.2E-04	5.7E-04
TCDD TEQ (PCBs)	1.7E-05	mg/kg	8.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.0E-02	3.0E-03
TCDD TEQ (D/F)	2.1E-05	mg/kg	1.1E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.8E-02	3.8E-03
							HAZARD INDICES:	5.2E-01	7.6E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-65.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-67

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-68

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.7E-01	mg/kg	4.2E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.8E-03	8.9E-04
Lead	1.3E-02	mg/kg	2.0E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-03	1.0E-04
Mercury	3.6E-02	mg/kg	5.5E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.2E-02	2.1E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	3.9E-05	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.2E-04	8.2E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.3E-03	mg/kg	1.1E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.3E-02	4.2E-03
Total PCBs	5.1E-02	mg/kg	7.9E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.0E-03	1.6E-03
TCDD TEQ (PCBs)	2.0E-06	mg/kg	3.0E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.1E-02	1.1E-03
TCDD TEQ (D/F)	2.4E-06	mg/kg	3.7E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-02	1.3E-03
							HAZARD INDICES:	8.5E-02	3.0E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-67.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-69
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION $EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$ Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-70
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E-01	mg/kg	1.2E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	5.3E-03	2.6E-03
Lead	2.2E-02	mg/kg	2.0E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-02	1.0E-03
Mercury	7.4E-02	mg/kg	6.5E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	5.0E-01	2.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.2E-03	mg/kg	3.6E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	7.6E-03	7.6E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.9E-01	mg/kg	1.6E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.8E+00	6.0E-01
Total PCBs	1.4E-01	mg/kg	1.2E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	3.1E-02	2.5E-02
TCDD TEQ (PCBs)	9.8E-06	mg/kg	8.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.1E-01	3.1E-02
TCDD TEQ (D/F)	1.2E-05	mg/kg	1.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.8E-01	3.8E-02
							HAZARD INDICES:	3.0E+00	9.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-69.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-71

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 3.6E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Total DDx		3.3E-03		1.3E-02	1.8E+00	*1.8E+00*	*50%*
Mercury		4.8E-02		4.2E-02	5.0E-01	5.9E-01	*16%*
TCDD TEQ (D/F)		3.8E-02		1.3E-02	3.8E-01	4.3E-01	*12%*
TCDD TEQ (PCBs)		3.0E-02		1.1E-02	3.1E-01	3.5E-01	10%
HPAH		2.1E-01		8.2E-04	7.6E-03	2.2E-01	6%
Lead		1.8E-01		1.0E-03	1.0E-02	1.9E-01	5%
Total PCBs		7.2E-04		2.0E-03	3.1E-02	3.3E-02	1%
Copper		9.8E-03		1.8E-03	5.3E-03	1.7E-02	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.2E-01**	**-**	**8.5E-02**	**3.0E+00**	**3.6E+00**	
PERCENTAGE OF TOTAL RISK		**14%**		**2%**	**83%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-72

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 1.1E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		1.1E-03		4.2E-03	6.0E-01	6.1E-01	*58%*
Mercury		2.4E-02		2.1E-02	2.5E-01	2.9E-01	*28%*
TCDD TEQ (D/F)		3.8E-03		1.3E-03	3.8E-02	4.3E-02	4%
TCDD TEQ (PCBs)		3.0E-03		1.1E-03	3.1E-02	3.5E-02	3%
Total PCBs		5.7E-04		1.6E-03	2.5E-02	2.7E-02	3%
HPAH		2.1E-02		8.2E-05	7.6E-04	2.2E-02	2%
Lead		1.8E-02		1.0E-04	1.0E-03	1.9E-02	2%
Copper		4.8E-03		8.9E-04	2.6E-03	8.3E-03	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**7.6E-02**	**-**	**3.0E-02**	**9.5E-01**	**1.1E+00**	
PERCENTAGE OF TOTAL RISK		**7%**		**3%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-73

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-74

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.0E+01	mg/kg	3.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.3E-01	6.6E-02
Lead	9.1E+01	mg/kg	4.7E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E+00	2.5E-01
Mercury	9.3E-02	mg/kg	4.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.7E-02	1.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.5E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.0E+00	3.0E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.6E-03	mg/kg	2.9E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.2E-03	1.1E-03
Total PCBs	5.1E-02	mg/kg	2.6E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	6.5E-04	5.2E-04
TCDD TEQ (PCBs)	1.6E-05	mg/kg	8.1E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.9E-02	2.9E-03
TCDD TEQ (D/F)	1.3E-05	mg/kg	6.8E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.4E-02	2.4E-03
							HAZARD INDICES:	5.7E+00	6.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-73.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-75
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-76

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.0E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.7E-02	2.3E-02
Lead	9.2E-02	mg/kg	1.4E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.5E-03	7.5E-04
Mercury	3.2E-02	mg/kg	5.0E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.8E-02	1.9E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	2.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.0E-03	5.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.2E-03	mg/kg	1.1E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.2E-02	4.1E-03
Total PCBs	4.8E-02	mg/kg	7.4E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.9E-03	1.5E-03
TCDD TEQ (PCBs)	1.9E-06	mg/kg	2.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.0E-02	1.0E-03
TCDD TEQ (D/F)	1.6E-06	mg/kg	2.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.9E-03	8.9E-04
							HAZARD INDICES:	1.3E-01	5.1E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-75.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-77

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-78

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+00	mg/kg	1.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.2E-02	3.5E-02
Lead	1.6E-01	mg/kg	1.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.4E-02	7.4E-03
Mercury	6.7E-02	mg/kg	5.9E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.5E-01	2.3E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.4E-02	mg/kg	4.7E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	9.9E-02	9.9E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.8E-01	mg/kg	1.6E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.8E+00	6.0E-01
Total PCBs	1.3E-01	mg/kg	1.1E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.8E-02	2.2E-02
TCDD TEQ (PCBs)	9.3E-06	mg/kg	8.2E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.9E-01	2.9E-02
TCDD TEQ (D/F)	8.0E-06	mg/kg	7.0E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.5E-01	2.5E-02
							HAZARD INDICES:	3.1E+00	9.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-77.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dos

ATTACHMENT 9

TABLE 9-79

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 8.9E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		3.0E+00		5.0E-03	9.9E-02	*3.1E+00*	*35%*
Lead		2.5E+00		7.5E-03	7.4E-02	*2.5E+00*	*29%*
Total DDx		3.2E-03		1.2E-02	1.8E+00	*1.8E+00*	*20%*
Mercury		3.7E-02		3.8E-02	4.5E-01	5.3E-01	6%
TCDD TEQ (PCBs)		2.9E-02		1.0E-02	2.9E-01	3.3E-01	4%
TCDD TEQ (D/F)		2.4E-02		8.9E-03	2.5E-01	2.8E-01	3%
Copper		1.3E-01		4.7E-02	7.2E-02	2.5E-01	3%
Total PCBs		6.5E-04		1.9E-03	2.8E-02	3.1E-02	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.7E+00**	**-**	**1.3E-01**	**3.1E+00**	**8.9E+00**	
PERCENTAGE OF TOTAL RISK		**64%**		**1%**	**34%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-80

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 1.6E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Total DDx		1.1E-03		4.1E-03	6.0E-01	6.0E-01	*37%*
HPAH		3.0E-01		5.0E-04	9.9E-03	3.1E-01	*19%*
Mercury		1.8E-02		1.9E-02	2.3E-01	2.6E-01	*16%*
Lead		2.5E-01		7.5E-04	7.4E-03	2.5E-01	*15%*
Copper		6.6E-02		2.3E-02	3.5E-02	1.2E-01	8%
TCDD TEQ (PCBs)		2.9E-03		1.0E-03	2.9E-02	3.3E-02	2%
TCDD TEQ (D/F)		2.4E-03		8.9E-04	2.5E-02	2.8E-02	2%
Total PCBs		5.2E-04		1.5E-03	2.2E-02	2.4E-02	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**6.4E-01**	**-**	**5.1E-02**	**9.5E-01**	**1.6E+00**	
PERCENTAGE OF TOTAL RISK		**39%**		**3%**	**58%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-81

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-82

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	9.0E+01	mg/kg	4.6E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.0E-01	9.8E-02
Lead	1.4E+02	mg/kg	7.2E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.8E+00	3.8E-01
Mercury	1.6E+00	mg/kg	8.0E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	6.2E-01	3.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.4E+01	mg/kg	1.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.6E+00	2.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.4E-02	mg/kg	3.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.6E-02	1.2E-02
Total PCBs	9.1E-01	mg/kg	4.7E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-02	9.4E-03
TCDD TEQ (PCBs)	2.3E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.3E-01	4.3E-02
TCDD TEQ (D/F)	3.2E-04	mg/kg	1.6E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.8E-01	5.8E-02
							HAZARD INDICES:	8.3E+00	1.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-81.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-83

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-84

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	1.8E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.7E-02	3.8E-02
Lead	1.3E-01	mg/kg	2.0E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-02	1.0E-03
Mercury	9.3E-02	mg/kg	1.4E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.1E-01	5.5E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.4E-02	mg/kg	2.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.4E-03	4.4E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.6E-02	mg/kg	5.5E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	6.1E-02	2.0E-02
Total PCBs	3.3E-01	mg/kg	5.1E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.3E-02	1.0E-02
TCDD TEQ (PCBs)	2.4E-05	mg/kg	3.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-01	1.3E-02
TCDD TEQ (D/F)	3.1E-05	mg/kg	4.9E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.7E-01	1.7E-02
							HAZARD INDICES:	5.8E-01	1.6E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-83.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-85

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-86

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E+00	mg/kg	2.5E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.1E-01	5.3E-02
Lead	2.2E-01	mg/kg	2.0E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-01	1.0E-02
Mercury	1.9E-01	mg/kg	1.7E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.3E+00	6.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.6E-02	mg/kg	4.0E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.4E-02	8.4E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.1E-01	mg/kg	3.6E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.0E+00	1.3E+00
Total PCBs	2.3E+00	mg/kg	2.0E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.0E-01	4.0E-01
TCDD TEQ (PCBs)	1.2E-04	mg/kg	1.0E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.6E+00	3.6E-01
TCDD TEQ (D/F)	1.5E-04	mg/kg	1.4E-05	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.8E+00	4.8E-01
							HAZARD INDICES:	1.5E+01	3.3E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-85.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-87

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 2.3E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		5.8E-01		1.7E-01	4.8E+00	*5.6E+00*	*24%*
TCDD TEQ (PCBs)		4.3E-01		1.3E-01	3.6E+00	*4.2E+00*	*18%*
Total DDx		3.6E-02		6.1E-02	4.0E+00	*4.1E+00*	*18%*
Lead		3.8E+00		1.0E-02	1.0E-01	*3.9E+00*	*17%*
HPAH		2.6E+00		4.4E-03	8.4E-02	*2.7E+00*	*11%*
Mercury		6.2E-01		1.1E-01	1.3E+00	*2.0E+00*	9%
Total PCBs		1.2E-02		1.3E-02	5.0E-01	5.3E-01	2%
Copper		2.0E-01		7.7E-02	1.1E-01	3.9E-01	2%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**8.3E+00**	**-**	**5.8E-01**	**1.5E+01**	**2.3E+01**	
PERCENTAGE OF TOTAL RISK		**35%**		**2%**	**62%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-88

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 4.6E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		1.2E-02		2.0E-02	1.3E+00	*1.4E+00*	*30%*
Mercury		3.1E-01		5.5E-02	6.5E-01	*1.0E+00*	*22%*
TCDD TEQ (D/F)		5.8E-02		1.7E-02	4.8E-01	5.6E-01	*12%*
Total PCBs		9.4E-03		1.0E-02	4.0E-01	4.2E-01	9%
TCDD TEQ (PCBs)		4.3E-02		1.3E-02	3.6E-01	4.2E-01	9%
Lead		3.8E-01		1.0E-03	1.0E-02	3.9E-01	8%
HPAH		2.6E-01		4.4E-04	8.4E-03	2.7E-01	6%
Copper		9.8E-02		3.8E-02	5.3E-02	1.9E-01	4%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+00**	**-**	**1.6E-01**	**3.3E+00**	**4.6E+00**	
PERCENTAGE OF TOTAL RISK		**25%**		**3%**	**71%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-89
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-90

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.0E+02	mg/kg	5.3E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.3E-01	1.1E-01
Lead	1.5E+02	mg/kg	7.9E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.2E+00	4.2E-01
Mercury	8.6E-01	mg/kg	4.4E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.4E-01	1.7E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	3.6E+01	mg/kg	1.9E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.9E+00	3.9E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.9E-02	mg/kg	2.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.2E-02	7.5E-03
Total PCBs	5.9E-01	mg/kg	3.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	7.6E-03	6.1E-03
TCDD TEQ (PCBs)	1.5E-04	mg/kg	7.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.7E-01	2.7E-02
TCDD TEQ (D/F)	2.3E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.2E-01	4.2E-02
							HAZARD INDICES:	9.4E+00	1.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-89.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-91
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-92

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ generic fish

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E+01	mg/kg	2.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	9.3E-02	4.5E-02
Lead	1.4E-01	mg/kg	2.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-02	1.1E-03
Mercury	7.4E-02	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.8E-02	4.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.8E-02	mg/kg	2.8E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.9E-03	5.9E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.6E-02	mg/kg	4.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.4E-02	1.5E-02
Total PCBs	2.5E-01	mg/kg	3.8E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	9.5E-03	7.6E-03
TCDD TEQ (PCBs)	1.5E-05	mg/kg	2.4E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.5E-02	8.5E-03
TCDD TEQ (D/F)	2.3E-05	mg/kg	3.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-01	1.3E-02
							HAZARD INDICES:	4.6E-01	1.3E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-91.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dos

ATTACHMENT 9

TABLE 9-93
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Eel/Perch / HERON (w/ generic fish diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-94
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Eel/Perch / HERON (w/ generic fish

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: Eel/Perch
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	3.3E+00	mg/kg	2.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.2E-01	6.1E-02
Lead	2.4E-01	mg/kg	2.1E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-01	1.1E-02
Mercury	1.5E-01	mg/kg	1.3E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.0E+00	5.2E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	7.0E-02	mg/kg	6.1E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.3E-01	1.3E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.5E-01	mg/kg	3.1E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.4E+00	1.1E+00
Total PCBs	1.5E+00	mg/kg	1.3E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	3.3E-01	2.6E-01
TCDD TEQ (PCBs)	7.6E-05	mg/kg	6.6E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.4E+00	2.4E-01
TCDD TEQ (D/F)	1.1E-04	mg/kg	9.9E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.5E+00	3.5E-01
							HAZARD INDICES:	1.1E+01	2.6E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-93.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dos

ATTACHMENT 9

TABLE 9-95

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 2.1E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Lead		4.2E+00		1.1E-02	1.1E-01	*4.3E+00*	*21%*
TCDD TEQ (D/F)		4.2E-01		1.3E-01	3.5E+00	*4.1E+00*	*19%*
HPAH		3.9E+00		5.9E-03	1.3E-01	*4.0E+00*	*19%*
Total DDx		2.2E-02		4.4E-02	3.4E+00	*3.5E+00*	*17%*
TCDD TEQ (PCBs)		2.7E-01		8.5E-02	2.4E+00	*2.7E+00*	*13%*
Mercury		3.4E-01		8.8E-02	1.0E+00	*1.5E+00*	7%
Copper		2.3E-01		9.3E-02	1.2E-01	4.5E-01	2%
Total PCBs		7.6E-03		9.5E-03	3.3E-01	3.4E-01	2%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.4E+00**	**-**	**4.6E-01**	**1.1E+01**	**2.1E+01**	
PERCENTAGE OF TOTAL RISK		**45%**		**2%**	**53%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 9-96

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ generic fish diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ generic fish diet)
TOTAL RISK (HI): 3.9E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Total DDx		7.5E-03		1.5E-02	1.1E+00	*1.2E+00*	*30%*
Mercury		1.7E-01		4.4E-02	5.2E-01	7.3E-01	*19%*
Lead		4.2E-01		1.1E-03	1.1E-02	4.3E-01	*11%*
TCDD TEQ (D/F)		4.2E-02		1.3E-02	3.5E-01	4.1E-01	*10%*
HPAH		3.9E-01		5.9E-04	1.3E-02	4.0E-01	*10%*
Total PCBs		6.1E-03		7.6E-03	2.6E-01	2.7E-01	7%
TCDD TEQ (PCBs)		2.7E-02		8.5E-03	2.4E-01	2.7E-01	7%
Copper		1.1E-01		4.5E-02	6.1E-02	2.2E-01	6%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+00**	**-**	**1.3E-01**	**2.6E+00**	**3.9E+00**	
PERCENTAGE OF TOTAL RISK		**30%**		**3%**	**66%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-97
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-98

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.6E+02	mg/kg	8.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.6E-01	1.8E-01
Lead	2.5E+02	mg/kg	1.3E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	6.8E+00	6.8E-01
Mercury	2.3E+00	mg/kg	1.2E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.0E-01	4.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.6E+00	4.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	9.8E-02	mg/kg	5.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	5.6E-02	1.9E-02
Total PCBs	1.5E+00	mg/kg	7.7E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.9E-02	1.5E-02
TCDD TEQ (PCBs)	3.8E-04	mg/kg	2.0E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	7.0E-01	7.0E-02
TCDD TEQ (D/F)	5.9E-04	mg/kg	3.0E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.1E+00	1.1E-01
							HAZARD INDICES:	1.5E+01	2.0E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-97.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE 9-99
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-100
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	3.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.6E-01	7.8E-02
Lead	2.0E-01	mg/kg	3.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.6E-02	1.6E-03
Mercury	1.1E-01	mg/kg	1.7E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.3E-01	6.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	3.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.5E-03	6.5E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.7E-02	mg/kg	7.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	8.1E-02	2.7E-02
Total PCBs	4.5E-01	mg/kg	7.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.8E-02	1.4E-02
TCDD TEQ (PCBs)	3.7E-05	mg/kg	5.8E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.1E-01	2.1E-02
TCDD TEQ (D/F)	5.7E-05	mg/kg	8.7E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.1E-01	3.1E-02
							HAZARD INDICES:	9.3E-01	2.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-99.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-101
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-102

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	3.3E+00	mg/kg	2.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.3E-01	6.1E-02
Lead	8.2E-01	mg/kg	7.2E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.8E-01	3.8E-02
Mercury	4.4E-02	mg/kg	3.8E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.9E-01	1.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	6.8E-02	mg/kg	5.9E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.2E-01	1.2E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.6E-02	mg/kg	3.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.5E-01	1.2E-01
Total PCBs	5.0E-01	mg/kg	4.4E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.1E-01	8.7E-02
TCDD TEQ (PCBs)	2.0E-05	mg/kg	1.7E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.2E-01	6.2E-02
TCDD TEQ (D/F)	2.7E-05	mg/kg	2.4E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.5E-01	8.5E-02
							HAZARD INDICES:	2.8E+00	6.1E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-101.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-103

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: HERON (w/ mummichog diet)	
TOTAL RISK (HI):	**1.8E+01**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Lead		6.8E+00		1.6E-02	3.8E-01	*7.2E+00*	*40%*
HPAH		4.6E+00		6.5E-03	1.2E-01	*4.7E+00*	*26%*
TCDD TEQ (D/F)		1.1E+00		3.1E-01	8.5E-01	*2.2E+00*	*12%*
Mercury		9.0E-01		1.3E-01	2.9E-01	*1.3E+00*	7%
TCDD TEQ (PCBs)		7.0E-01		2.1E-01	6.2E-01	*1.5E+00*	8%
Copper		3.6E-01		1.6E-01	1.3E-01	6.4E-01	4%
Total DDx		5.6E-02		8.1E-02	3.5E-01	4.8E-01	3%
Total PCBs		1.9E-02		1.8E-02	1.1E-01	1.5E-01	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E+01**	**-**	**9.3E-01**	**2.8E+00**	**1.8E+01**	
PERCENTAGE OF TOTAL RISK		**79%**		**5%**	**16%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-104

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: HERON (w/ mummichog diet)	
TOTAL RISK (HI):	**2.8E+00**

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Lead		6.8E-01		1.6E-03	3.8E-02	7.2E-01	*26%*
Mercury		4.5E-01		6.4E-02	1.5E-01	6.6E-01	*23%*
HPAH		4.6E-01		6.5E-04	1.2E-02	4.7E-01	*17%*
Copper		1.8E-01		7.8E-02	6.1E-02	3.1E-01	*11%*
TCDD TEQ (D/F)		1.1E-01		3.1E-02	8.5E-02	2.2E-01	8%
Total DDx		1.9E-02		2.7E-02	1.2E-01	1.6E-01	6%
TCDD TEQ (PCBs)		7.0E-02		2.1E-02	6.2E-02	1.5E-01	5%
Total PCBs		1.5E-02		1.4E-02	8.7E-02	1.2E-01	4%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.0E+00**	**-**	**2.4E-01**	**6.1E-01**	**2.8E+00**	
PERCENTAGE OF TOTAL RISK		**70%**		**8%**	**22%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-105

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-106
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.3E+02	mg/kg	6.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.0E-01	1.5E-01
Lead	2.0E+02	mg/kg	1.0E+00	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	5.4E+00	5.4E-01
Mercury	1.1E+00	mg/kg	5.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.3E-01	2.2E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.6E+00	4.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.9E-02	mg/kg	3.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.4E-02	1.1E-02
Total PCBs	8.9E-01	mg/kg	4.6E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.1E-02	9.2E-03
TCDD TEQ (PCBs)	2.2E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.1E-01	4.1E-02
TCDD TEQ (D/F)	4.1E-04	mg/kg	2.1E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	7.5E-01	7.5E-02
							HAZARD INDICES:	1.2E+01	1.5E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-105.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-107
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-108

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+01	mg/kg	2.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.3E-01	6.2E-02
Lead	1.7E-01	mg/kg	2.6E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.4E-02	1.4E-03
Mercury	8.1E-02	mg/kg	1.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.7E-02	4.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	3.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	6.5E-03	6.5E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.4E-02	mg/kg	5.2E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	5.8E-02	1.9E-02
Total PCBs	3.2E-01	mg/kg	5.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-02	9.9E-03
TCDD TEQ (PCBs)	2.3E-05	mg/kg	3.5E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.2E-01	1.2E-02
TCDD TEQ (D/F)	4.0E-05	mg/kg	6.1E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.2E-01	2.2E-02
							HAZARD INDICES:	6.6E-01	1.8E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-107.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-109
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-110

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E+00	mg/kg	2.4E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.0E-01	5.1E-02
Lead	6.9E-01	mg/kg	6.0E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.2E-01	3.2E-02
Mercury	3.3E-02	mg/kg	2.9E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.2E-01	1.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	6.8E-02	mg/kg	5.9E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.2E-01	1.2E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.0E-02	mg/kg	2.6E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.9E-01	9.6E-02
Total PCBs	3.1E-01	mg/kg	2.7E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	6.7E-02	5.3E-02
TCDD TEQ (PCBs)	1.4E-05	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.2E-01	4.2E-02
TCDD TEQ (D/F)	2.1E-05	mg/kg	1.8E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.5E-01	6.5E-02
							HAZARD INDICES:	2.2E+00	4.6E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-109.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-111

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: HERON (w/ mummichog diet)	
TOTAL RISK (HI):	**1.5E+01**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Lead		5.4E+00		1.4E-02	3.2E-01	*5.7E+00*	*39%*
HPAH		4.6E+00		6.5E-03	1.2E-01	*4.7E+00*	*32%*
TCDD TEQ (D/F)		7.5E-01		2.2E-01	6.5E-01	*1.6E+00*	*11%*
TCDD TEQ (PCBs)		4.1E-01		1.2E-01	4.2E-01	9.6E-01	7%
Mercury		4.3E-01		9.7E-02	2.2E-01	7.5E-01	5%
Copper		3.0E-01		1.3E-01	1.0E-01	5.3E-01	4%
Total DDx		3.4E-02		5.8E-02	2.9E-01	3.8E-01	3%
Total PCBs		1.1E-02		1.2E-02	6.7E-02	9.1E-02	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+01**	**-**	**6.6E-01**	**2.2E+00**	**1.5E+01**	
PERCENTAGE OF TOTAL RISK		**81%**		**4%**	**15%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-112

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
EXPOSURE POINT: RME - No Action
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 2.1E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Lead		5.4E-01		1.4E-03	3.2E-02	5.7E-01	*27%*
HPAH		4.6E-01		6.5E-04	1.2E-02	4.7E-01	*22%*
Mercury		2.2E-01		4.8E-02	1.1E-01	3.7E-01	*18%*
Copper		1.5E-01		6.2E-02	5.1E-02	2.6E-01	*12%*
TCDD TEQ (D/F)		7.5E-02		2.2E-02	6.5E-02	1.6E-01	8%
Total DDx		1.1E-02		1.9E-02	9.6E-02	1.3E-01	6%
TCDD TEQ (PCBs)		4.1E-02		1.2E-02	4.2E-02	9.6E-02	4%
Total PCBs		9.2E-03		9.9E-03	5.3E-02	7.2E-02	3%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E+00**	**-**	**1.8E-01**	**4.6E-01**	**2.1E+00**	
PERCENTAGE OF TOTAL RISK		**70%**		**8%**	**22%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-113

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-114

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.5E+00	mg/kg	2.3E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.0E-02	4.9E-03
Lead	6.9E+00	mg/kg	3.5E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.9E-01	1.9E-02
Mercury	2.1E-01	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.2E-02	4.1E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.0E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.1E-01	2.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.4E-03	mg/kg	3.8E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.2E-03	1.4E-03
Total PCBs	9.1E-02	mg/kg	4.7E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-03	9.4E-04
TCDD TEQ (PCBs)	2.6E-05	mg/kg	1.3E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.7E-02	4.7E-03
TCDD TEQ (D/F)	2.7E-05	mg/kg	1.4E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.9E-02	4.9E-03
							HAZARD INDICES:	5.9E-01	9.8E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-113.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-115
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-116

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E-01	mg/kg	4.3E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.9E-03	9.2E-04
Lead	1.3E-02	mg/kg	2.0E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-03	1.1E-04
Mercury	4.4E-02	mg/kg	6.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	5.2E-02	2.6E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	3.9E-05	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.2E-04	8.2E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	8.7E-03	mg/kg	1.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.5E-02	5.0E-03
Total PCBs	7.1E-02	mg/kg	1.1E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.7E-03	2.2E-03
TCDD TEQ (PCBs)	3.0E-06	mg/kg	4.6E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.6E-02	1.6E-03
TCDD TEQ (D/F)	3.1E-06	mg/kg	4.7E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.7E-02	1.7E-03
							HAZARD INDICES:	1.1E-01	3.8E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-115.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-117
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-118
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	9.3E-02	mg/kg	8.1E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.5E-03	1.7E-03
Lead	5.4E-02	mg/kg	4.7E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E-02	2.5E-03
Mercury	1.8E-02	mg/kg	1.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.2E-01	6.0E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	9.6E-03	mg/kg	8.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.7E-02	1.7E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.4E-02	mg/kg	1.2E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.4E-01	4.6E-02
Total PCBs	3.5E-02	mg/kg	3.1E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	7.7E-03	6.1E-03
TCDD TEQ (PCBs)	2.9E-06	mg/kg	2.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	9.2E-02	9.2E-03
TCDD TEQ (D/F)	3.0E-06	mg/kg	2.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	9.3E-02	9.3E-03
							HAZARD INDICES:	5.0E-01	1.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-117.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-119

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 1.2E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Mercury		8.2E-02		5.2E-02	1.2E-01	2.5E-01	*21%*
HPAH		2.1E-01		8.2E-04	1.7E-02	2.3E-01	*19%*
Lead		1.9E-01		1.1E-03	2.5E-02	2.1E-01	*18%*
TCDD TEQ (D/F)		4.9E-02		1.7E-02	9.3E-02	1.6E-01	*13%*
Total DDx		4.2E-03		1.5E-02	1.4E-01	1.6E-01	*13%*
TCDD TEQ (PCBs)		4.7E-02		1.6E-02	9.2E-02	1.6E-01	*13%*
Copper		1.0E-02		1.9E-03	3.5E-03	1.5E-02	1%
Total PCBs		1.2E-03		2.7E-03	7.7E-03	1.2E-02	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.9E-01**	**-**	**1.1E-01**	**5.0E-01**	**1.2E+00**	
PERCENTAGE OF TOTAL RISK		**49%**		**9%**	**42%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-120

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 2.7E-01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Mercury		4.1E-02		2.6E-02	6.0E-02	1.3E-01	*47%*
Total DDx		1.4E-03		5.0E-03	4.6E-02	5.3E-02	*19%*
Total PCBs		9.4E-04		2.2E-03	6.1E-03	9.3E-03	3%
HPAH		2.1E-02		8.2E-05	1.7E-03	2.3E-02	8%
Lead		1.9E-02		1.1E-04	2.5E-03	2.1E-02	8%
TCDD TEQ (PCBs)		4.7E-03		1.6E-03	9.2E-03	1.6E-02	6%
TCDD TEQ (D/F)		4.9E-03		1.7E-03	9.3E-03	1.6E-02	6%
Copper		4.9E-03		9.2E-04	1.7E-03	7.6E-03	3%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.8E-02**	**-**	**3.8E-02**	**1.4E-01**	**2.7E-01**	
PERCENTAGE OF TOTAL RISK		**36%**		**14%**	**50%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-121

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-122
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.1E+01	mg/kg	3.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.4E-01	6.7E-02
Lead	9.3E+01	mg/kg	4.8E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E+00	2.5E-01
Mercury	8.2E-02	mg/kg	4.2E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.2E-02	1.6E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.5E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.0E+00	3.0E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.8E-03	mg/kg	2.5E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.8E-03	9.2E-04
Total PCBs	4.0E-02	mg/kg	2.1E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.2E-04	4.2E-04
TCDD TEQ (PCBs)	1.3E-05	mg/kg	6.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.5E-02	2.5E-03
TCDD TEQ (D/F)	1.0E-05	mg/kg	5.2E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.9E-02	1.9E-03
							HAZARD INDICES:	5.8E+00	6.4E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-121.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-123
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-124

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.2E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.8E-02	2.4E-02
Lead	9.4E-02	mg/kg	1.4E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.6E-03	7.6E-04
Mercury	3.1E-02	mg/kg	4.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.7E-02	1.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	2.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.0E-03	5.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.5E-03	mg/kg	1.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.1E-02	3.7E-03
Total PCBs	4.1E-02	mg/kg	6.4E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.6E-03	1.3E-03
TCDD TEQ (PCBs)	1.6E-06	mg/kg	2.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.9E-03	8.9E-04
TCDD TEQ (D/F)	1.2E-06	mg/kg	1.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.8E-03	6.8E-04
							HAZARD INDICES:	1.3E-01	5.0E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-123.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-125

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-126

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.3E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.8E-02	2.4E-02
Lead	3.9E-01	mg/kg	3.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.8E-01	1.8E-02
Mercury	1.3E-02	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.5E-02	4.2E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.2E-02	mg/kg	4.6E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	9.5E-02	9.5E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.2E-02	mg/kg	1.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.2E-01	4.0E-02
Total PCBs	1.6E-02	mg/kg	1.4E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	3.6E-03	2.8E-03
TCDD TEQ (PCBs)	1.8E-06	mg/kg	1.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.7E-02	5.7E-03
TCDD TEQ (D/F)	1.5E-06	mg/kg	1.3E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.7E-02	4.7E-03
							HAZARD INDICES:	6.3E-01	1.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-125.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-127

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 6.5E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		3.0E+00		5.0E-03	9.5E-02	*3.1E+00*	*48%*
Lead		2.5E+00		7.6E-03	1.8E-01	*2.7E+00*	*41%*
Copper		1.4E-01		4.8E-02	4.8E-02	2.3E-01	4%
Mercury		3.2E-02		3.7E-02	8.5E-02	1.5E-01	2%
Total DDx		2.8E-03		1.1E-02	1.2E-01	1.3E-01	2%
TCDD TEQ (PCBs)		2.5E-02		8.9E-03	5.7E-02	9.1E-02	1%
TCDD TEQ (D/F)		1.9E-02		6.8E-03	4.7E-02	7.2E-02	1%
Total PCBs		5.2E-04		1.6E-03	3.6E-03	5.7E-03	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.8E+00**	**-**	**1.3E-01**	**6.3E-01**	**6.5E+00**	
PERCENTAGE OF TOTAL RISK		**88%**		**2%**	**10%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-128

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 8.4E-01

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
HPAH		3.0E-01		5.0E-04	9.5E-03	3.1E-01	*37%*
Lead		2.5E-01		7.6E-04	1.8E-02	2.7E-01	*32%*
Copper		6.7E-02		2.4E-02	2.4E-02	1.1E-01	*14%*
Mercury		1.6E-02		1.8E-02	4.2E-02	7.7E-02	9%
Total DDx		9.2E-04		3.7E-03	4.0E-02	4.4E-02	5%
TCDD TEQ (PCBs)		2.5E-03		8.9E-04	5.7E-03	9.1E-03	1%
TCDD TEQ (D/F)		1.9E-03		6.8E-04	4.7E-03	7.2E-03	1%
Total PCBs		4.2E-04		1.3E-03	2.8E-03	4.5E-03	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**6.4E-01**	**-**	**5.0E-02**	**1.5E-01**	**8.4E-01**	
PERCENTAGE OF TOTAL RISK		**77%**		**6%**	**17%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-129

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-130
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.4E+00	mg/kg	2.3E-02	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	9.8E-03	4.8E-03
Lead	6.7E+00	mg/kg	3.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.8E-01	1.8E-02
Mercury	1.2E-01	mg/kg	6.2E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.8E-02	2.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.0E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.1E-01	2.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.7E-03	mg/kg	3.0E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.3E-03	1.1E-03
Total PCBs	5.6E-02	mg/kg	2.9E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	7.2E-04	5.7E-04
TCDD TEQ (PCBs)	1.7E-05	mg/kg	8.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.0E-02	3.0E-03
TCDD TEQ (D/F)	2.1E-05	mg/kg	1.1E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.8E-02	3.8E-03
							HAZARD INDICES:	5.2E-01	7.6E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-129.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-131

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-132

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.7E-01	mg/kg	4.2E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.8E-03	8.9E-04
Lead	1.3E-02	mg/kg	2.0E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-03	1.0E-04
Mercury	3.6E-02	mg/kg	5.5E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	4.2E-02	2.1E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	3.9E-05	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.2E-04	8.2E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.3E-03	mg/kg	1.1E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.3E-02	4.2E-03
Total PCBs	5.1E-02	mg/kg	7.9E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.0E-03	1.6E-03
TCDD TEQ (PCBs)	2.0E-06	mg/kg	3.0E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.1E-02	1.1E-03
TCDD TEQ (D/F)	2.4E-06	mg/kg	3.7E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-02	1.3E-03
							HAZARD INDICES:	8.5E-02	3.0E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-131.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-133
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-134

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	9.0E-02	mg/kg	7.9E-03	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	3.4E-03	1.7E-03
Lead	5.3E-02	mg/kg	4.6E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.4E-02	2.4E-03
Mercury	1.5E-02	mg/kg	1.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.8E-02	4.9E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	9.6E-03	mg/kg	8.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.7E-02	1.7E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.3E-02	mg/kg	1.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.3E-01	4.2E-02
Total PCBs	2.2E-02	mg/kg	1.9E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	4.8E-03	3.9E-03
TCDD TEQ (PCBs)	2.1E-06	mg/kg	1.9E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.7E-02	6.7E-03
TCDD TEQ (D/F)	2.5E-06	mg/kg	2.2E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	7.8E-02	7.8E-03
							HAZARD INDICES:	4.2E-01	1.2E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-133.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-135

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)	
EXPOSURE POINT: RME - Deep Dredging with Backfill	
RECEPTOR: HERON (w/ mummichog diet)	
TOTAL RISK (HI):	**1.0E+00**

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		2.1E-01		8.2E-04	1.7E-02	2.3E-01	*22%*
Lead		1.8E-01		1.0E-03	2.4E-02	2.1E-01	*20%*
Mercury		4.8E-02		4.2E-02	9.8E-02	1.9E-01	*18%*
Total DDx		3.3E-03		1.3E-02	1.3E-01	1.4E-01	*14%*
TCDD TEQ (D/F)		3.8E-02		1.3E-02	7.8E-02	1.3E-01	*13%*
TCDD TEQ (PCBs)		3.0E-02		1.1E-02	6.7E-02	1.1E-01	*11%*
Copper		9.8E-03		1.8E-03	3.4E-03	1.5E-02	1%
Total PCBs		7.2E-04		2.0E-03	4.8E-03	7.5E-03	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.2E-01**	**-**	**8.5E-02**	**4.2E-01**	**1.0E+00**	
PERCENTAGE OF TOTAL RISK		**51%**		**8%**	**41%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-136

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 2.2E-01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Mercury		2.4E-02		2.1E-02	4.9E-02	9.4E-02	*42%*
Total DDx		1.1E-03		4.2E-03	4.2E-02	4.7E-02	*21%*
HPAH		2.1E-02		8.2E-05	1.7E-03	2.3E-02	*10%*
Lead		1.8E-02		1.0E-04	2.4E-03	2.1E-02	9%
TCDD TEQ (D/F)		3.8E-03		1.3E-03	7.8E-03	1.3E-02	6%
TCDD TEQ (PCBs)		3.0E-03		1.1E-03	6.7E-03	1.1E-02	5%
Copper		4.8E-03		8.9E-04	1.7E-03	7.4E-03	3%
Total PCBs		5.7E-04		1.6E-03	3.9E-03	6.0E-03	3%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**7.6E-02**	**-**	**3.0E-02**	**1.2E-01**	**2.2E-01**	
PERCENTAGE OF TOTAL RISK		**34%**		**14%**	**52%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-137

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-138

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.0E+01	mg/kg	3.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.3E-01	6.6E-02
Lead	9.1E+01	mg/kg	4.7E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E+00	2.5E-01
Mercury	9.3E-02	mg/kg	4.8E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.7E-02	1.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.5E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.0E+00	3.0E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.6E-03	mg/kg	2.9E-05	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.2E-03	1.1E-03
Total PCBs	5.1E-02	mg/kg	2.6E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	6.5E-04	5.2E-04
TCDD TEQ (PCBs)	1.6E-05	mg/kg	8.1E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.9E-02	2.9E-03
TCDD TEQ (D/F)	1.3E-05	mg/kg	6.8E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.4E-02	2.4E-03
							HAZARD INDICES:	5.7E+00	6.4E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-137.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-139
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-140
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.0E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.7E-02	2.3E-02
Lead	9.2E-02	mg/kg	1.4E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	7.5E-03	7.5E-04
Mercury	3.2E-02	mg/kg	5.0E-04	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.8E-02	1.9E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	2.4E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.0E-03	5.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.2E-03	mg/kg	1.1E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.2E-02	4.1E-03
Total PCBs	4.8E-02	mg/kg	7.4E-04	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.9E-03	1.5E-03
TCDD TEQ (PCBs)	1.9E-06	mg/kg	2.9E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.0E-02	1.0E-03
TCDD TEQ (D/F)	1.6E-06	mg/kg	2.5E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.9E-03	8.9E-04
							HAZARD INDICES:	1.3E-01	5.1E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-139.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-141

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-142
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.7E-02	2.3E-02
Lead	3.8E-01	mg/kg	3.3E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.7E-01	1.7E-02
Mercury	1.3E-02	mg/kg	1.2E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.9E-02	4.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.2E-02	mg/kg	4.6E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	9.5E-02	9.5E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.3E-02	mg/kg	1.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.3E-01	4.2E-02
Total PCBs	2.0E-02	mg/kg	1.8E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	4.4E-03	3.5E-03
TCDD TEQ (PCBs)	2.1E-06	mg/kg	1.8E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	6.4E-02	6.4E-03
TCDD TEQ (D/F)	1.8E-06	mg/kg	1.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.7E-02	5.7E-03
							HAZARD INDICES:	6.6E-01	1.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-141.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-143

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 6.5E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		3.0E+00		5.0E-03	9.5E-02	*3.1E+00*	*48%*
Lead		2.5E+00		7.5E-03	1.7E-01	*2.6E+00*	*41%*
Copper		1.3E-01		4.7E-02	4.7E-02	2.3E-01	4%
Mercury		3.7E-02		3.8E-02	8.9E-02	1.6E-01	3%
Total DDx		3.2E-03		1.2E-02	1.3E-01	1.4E-01	2%
TCDD TEQ (PCBs)		2.9E-02		1.0E-02	6.4E-02	1.0E-01	2%
TCDD TEQ (D/F)		2.4E-02		8.9E-03	5.7E-02	9.0E-02	1%
Total PCBs		6.5E-04		1.9E-03	4.4E-03	6.9E-03	0%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.7E+00**	**-**	**1.3E-01**	**6.6E-01**	**6.5E+00**	
PERCENTAGE OF TOTAL RISK		**88%**		**2%**	**10%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-144

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)	
EXPOSURE POINT: RME - Deep Dredging with Backfill	
RECEPTOR: HERON (w/ mummichog diet)	
TOTAL RISK (HI):	**8.4E-01**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
HPAH		3.0E-01		5.0E-04	9.5E-03	3.1E-01	*37%*
Lead		2.5E-01		7.5E-04	1.7E-02	2.6E-01	*31%*
Copper		6.6E-02		2.3E-02	2.3E-02	1.1E-01	*13%*
Mercury		1.8E-02		1.9E-02	4.4E-02	8.2E-02	10%
Total DDx		1.1E-03		4.1E-03	4.2E-02	4.7E-02	6%
TCDD TEQ (PCBs)		2.9E-03		1.0E-03	6.4E-03	1.0E-02	1%
TCDD TEQ (D/F)		2.4E-03		8.9E-04	5.7E-03	9.0E-03	1%
Total PCBs		5.2E-04		1.5E-03	3.5E-03	5.5E-03	1%
LPAH		-		-	-		
Dieldrin		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**6.4E-01**	**-**	**5.1E-02**	**1.5E-01**	**8.4E-01**	
PERCENTAGE OF TOTAL RISK		**76%**		**6%**	**18%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-145
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-146

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	9.0E+01	mg/kg	4.6E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.0E-01	9.8E-02
Lead	1.4E+02	mg/kg	7.2E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.8E+00	3.8E-01
Mercury	1.6E+00	mg/kg	8.0E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	6.2E-01	3.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.4E+01	mg/kg	1.2E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.6E+00	2.6E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.4E-02	mg/kg	3.3E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.6E-02	1.2E-02
Total PCBs	9.1E-01	mg/kg	4.7E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.2E-02	9.4E-03
TCDD TEQ (PCBs)	2.3E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.3E-01	4.3E-02
TCDD TEQ (D/F)	3.2E-04	mg/kg	1.6E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.8E-01	5.8E-02
							HAZARD INDICES:	8.3E+00	1.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-145.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-147
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-148
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	1.8E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.7E-02	3.8E-02
Lead	1.3E-01	mg/kg	2.0E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.0E-02	1.0E-03
Mercury	9.3E-02	mg/kg	1.4E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.1E-01	5.5E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.4E-02	mg/kg	2.1E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	4.4E-03	4.4E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.6E-02	mg/kg	5.5E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	6.1E-02	2.0E-02
Total PCBs	3.3E-01	mg/kg	5.1E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	1.3E-02	1.0E-02
TCDD TEQ (PCBs)	2.4E-05	mg/kg	3.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-01	1.3E-02
TCDD TEQ (D/F)	3.1E-05	mg/kg	4.9E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.7E-01	1.7E-02
							HAZARD INDICES:	5.8E-01	1.6E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-147.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-149

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-150

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.8E+00	mg/kg	1.6E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.0E-02	3.4E-02
Lead	5.3E-01	mg/kg	4.6E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.4E-01	2.4E-02
Mercury	3.8E-02	mg/kg	3.3E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.6E-01	1.3E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.7E-02	mg/kg	4.1E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.6E-02	8.6E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.1E-02	mg/kg	2.7E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.0E-01	9.9E-02
Total PCBs	3.1E-01	mg/kg	2.7E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	6.8E-02	5.5E-02
TCDD TEQ (PCBs)	1.4E-05	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.4E-01	4.4E-02
TCDD TEQ (D/F)	1.7E-05	mg/kg	1.5E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	5.4E-01	5.4E-02
							HAZARD INDICES:	2.0E+00	4.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-149.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-151

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 1.1E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Lead		3.8E+00		1.0E-02	2.4E-01	*4.1E+00*	*37%*
HPAH		2.6E+00		4.4E-03	8.6E-02	*2.7E+00*	*25%*
TCDD TEQ (D/F)		5.8E-01		1.7E-01	5.4E-01	*1.3E+00*	*12%*
TCDD TEQ (PCBs)		4.3E-01		1.3E-01	4.4E-01	1.0E+00	9%
Mercury		6.2E-01		1.1E-01	2.6E-01	9.8E-01	9%
Total DDx		3.6E-02		6.1E-02	3.0E-01	4.0E-01	4%
Copper		2.0E-01		7.7E-02	7.0E-02	3.5E-01	3%
Total PCBs		1.2E-02		1.3E-02	6.8E-02	9.3E-02	1%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**8.3E+00**	**-**	**5.8E-01**	**2.0E+00**	**1.1E+01**	
PERCENTAGE OF TOTAL RISK		**76%**		**5%**	**18%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-152

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 1.8E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Mercury		3.1E-01		5.5E-02	1.3E-01	4.9E-01	*28%*
Lead		3.8E-01		1.0E-03	2.4E-02	4.1E-01	*23%*
HPAH		2.6E-01		4.4E-04	8.6E-03	2.7E-01	*15%*
Copper		9.8E-02		3.8E-02	3.4E-02	1.7E-01	10%
Total DDx		1.2E-02		2.0E-02	9.9E-02	1.3E-01	7%
TCDD TEQ (D/F)		5.8E-02		1.7E-02	5.4E-02	1.3E-01	7%
TCDD TEQ (PCBs)		4.3E-02		1.3E-02	4.4E-02	1.0E-01	6%
Total PCBs		9.4E-03		1.0E-02	5.5E-02	7.4E-02	4%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+00**	**-**	**1.6E-01**	**4.5E-01**	**1.8E+00**	
PERCENTAGE OF TOTAL RISK		**66%**		**9%**	**25%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-153
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-154

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.0E+02	mg/kg	5.3E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	2.3E-01	1.1E-01
Lead	1.5E+02	mg/kg	7.9E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.2E+00	4.2E-01
Mercury	8.6E-01	mg/kg	4.4E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	3.4E-01	1.7E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	3.6E+01	mg/kg	1.9E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.9E+00	3.9E-01
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.9E-02	mg/kg	2.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.2E-02	7.5E-03
Total PCBs	5.9E-01	mg/kg	3.0E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	7.6E-03	6.1E-03
TCDD TEQ (PCBs)	1.5E-04	mg/kg	7.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	2.7E-01	2.7E-02
TCDD TEQ (D/F)	2.3E-04	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.2E-01	4.2E-02
							HAZARD INDICES:	9.4E+00	1.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-153.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-155

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-156

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E+01	mg/kg	2.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	9.3E-02	4.5E-02
Lead	1.4E-01	mg/kg	2.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.1E-02	1.1E-03
Mercury	7.4E-02	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.8E-02	4.4E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.8E-02	mg/kg	2.8E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.9E-03	5.9E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.6E-02	mg/kg	4.0E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	4.4E-02	1.5E-02
Total PCBs	2.5E-01	mg/kg	3.8E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	9.5E-03	7.6E-03
TCDD TEQ (PCBs)	1.5E-05	mg/kg	2.4E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	8.5E-02	8.5E-03
TCDD TEQ (D/F)	2.3E-05	mg/kg	3.6E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.3E-01	1.3E-02
							HAZARD INDICES:	4.6E-01	1.3E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-155.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-157

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON (w/ mummichog diet

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-158

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.1E+00	mg/kg	1.9E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	8.1E-02	4.0E-02
Lead	5.7E-01	mg/kg	5.0E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.6E-01	2.6E-02
Mercury	3.0E-02	mg/kg	2.6E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.0E-01	1.0E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	0.0E+00	0.0E+00
HPAH	6.1E-02	mg/kg	5.4E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.1E-01	1.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.6E-02	mg/kg	2.3E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.5E-01	8.4E-02
Total PCBs	2.1E-01	mg/kg	1.8E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	4.5E-02	3.6E-02
TCDD TEQ (PCBs)	1.0E-05	mg/kg	8.9E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.2E-01	3.2E-02
TCDD TEQ (D/F)	1.4E-05	mg/kg	1.2E-06	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.3E-01	4.3E-02
							HAZARD INDICES:	1.7E+00	3.7E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-157.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-159

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 1.2E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
Lead		4.2E+00		1.1E-02	2.6E-01	*4.4E+00*	*39%*
HPAH		3.9E+00		5.9E-03	1.1E-01	*4.0E+00*	*35%*
TCDD TEQ (D/F)		4.2E-01		1.3E-01	4.3E-01	9.7E-01	8%
TCDD TEQ (PCBs)		2.7E-01		8.5E-02	3.2E-01	6.7E-01	6%
Mercury		3.4E-01		8.8E-02	2.0E-01	6.3E-01	5%
Copper		2.3E-01		9.3E-02	8.1E-02	4.1E-01	4%
Total DDx		2.2E-02		4.4E-02	2.5E-01	3.2E-01	3%
Total PCBs		7.6E-03		9.5E-03	4.5E-02	6.2E-02	1%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.4E+00**	**-**	**4.6E-01**	**1.7E+00**	**1.2E+01**	
PERCENTAGE OF TOTAL RISK		**81%**		**4%**	**15%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE 9-160

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON (w/ mummichog diet)

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: Future (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: HERON (w/ mummichog diet)
TOTAL RISK (HI): 1.7E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Lead		4.2E-01		1.1E-03	2.6E-02	4.4E-01	*26%*
HPAH		3.9E-01		5.9E-04	1.1E-02	4.0E-01	*24%*
Mercury		1.7E-01		4.4E-02	1.0E-01	3.2E-01	*19%*
Copper		1.1E-01		4.5E-02	4.0E-02	2.0E-01	*12%*
Total DDx		7.5E-03		1.5E-02	8.4E-02	1.1E-01	6%
TCDD TEQ (D/F)		4.2E-02		1.3E-02	4.3E-02	9.7E-02	6%
TCDD TEQ (PCBs)		2.7E-02		8.5E-03	3.2E-02	6.7E-02	4%
Total PCBs		6.1E-03		7.6E-03	3.6E-02	5.0E-02	3%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+00**	**-**	**1.3E-01**	**3.7E-01**	**1.7E+00**	
PERCENTAGE OF TOTAL RISK		**70%**		**8%**	**22%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-161
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
1
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.00	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	57%	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-162

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.6E+02	mg/kg	9.7E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.8E-01	1.4E-01
Lead	2.5E+02	mg/kg	1.5E+00	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	2.1E+00	2.2E-01
Mercury	2.3E+00	mg/kg	1.4E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	8.5E-01	5.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.6E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	4.1E-01	8.3E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	9.8E-02	mg/kg	5.9E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	7.4E-04	1.5E-04
Total PCBs	1.5E+00	mg/kg	9.0E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	1.3E-01	1.1E-01
TCDD TEQ (PCBs)	5.4E-05	mg/kg	3.3E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.1E+00	1.5E-01
TCDD TEQ (D/F)	5.6E-04	mg/kg	3.4E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.2E+01	1.5E+00
							HAZARD INDICES:	5.0E+01	2.7E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-161.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-163

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRAT	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-164

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.4E+01	mg/kg	1.4E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	4.2E-01	2.1E-01
Lead	2.0E-01	mg/kg	1.2E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.7E-02	1.7E-03
Mercury	1.1E-01	mg/kg	6.5E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	4.0E-01	2.4E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	1.2E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.0E-03	4.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.7E-02	mg/kg	2.9E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.6E-03	7.1E-04
Total PCBs	4.5E-01	mg/kg	2.7E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.0E-01	3.3E-01
TCDD TEQ (PCBs)	6.0E-06	mg/kg	3.6E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.5E+00	1.6E-01
TCDD TEQ (D/F)	5.3E-05	mg/kg	3.2E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.0E+01	1.4E+00
							HAZARD INDICES:	4.6E+01	2.4E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-163.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-165
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTIC	mg/kg-d	calculated		FISH INTAKE-INGESTION $EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$ Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-166
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	5.1E+00	mg/kg	1.2E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	3.6E-01	1.8E-01
Lead	3.5E-01	mg/kg	8.4E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.2E-01	1.2E-02
Mercury	2.2E-01	mg/kg	5.4E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-**d**	3.3E+00	2.0E+00
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	8.2E-02	mg/kg	2.0E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	3.2E-02	6.3E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.8E-01	mg/kg	1.1E-01	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.4E-01	2.9E-02
Total PCBs	3.8E+00	mg/kg	9.1E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	1.3E+01	1.1E+01
TCDD TEQ (PCBs)	3.0E-05	mg/kg	7.1E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	8.9E+01	3.2E+00
TCDD TEQ (D/F)	2.6E-04	mg/kg	6.3E-05	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	7.9E+02	2.8E+01
							HAZARD INDICES:	9.0E+02	4.5E+01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-165.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-167
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: MINK	
TOTAL RISK (HI):	**9.9E+02**

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		4.2E+01		4.0E+01	7.9E+02	*8.7E+02*	*88%*
TCDD TEQ (PCBs)		4.1E+00		4.5E+00	8.9E+01	*9.8E+01*	10%
Total PCBs		1.3E-01		4.0E-01	1.3E+01	*1.4E+01*	1%
Mercury		8.5E-01		4.0E-01	3.3E+00	*4.6E+00*	0%
Lead		2.1E+00		1.7E-02	1.2E-01	*2.3E+00*	0%
Copper		2.8E-01		4.2E-01	3.6E-01	*1.1E+00*	0%
HPAH		4.1E-01		2.0E-03	3.2E-02	4.5E-01	0%
Total DDx		7.4E-04		3.6E-03	1.4E-01	1.5E-01	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**5.0E+01**	**-**	**4.6E+01**	**9.0E+02**	**9.9E+02**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-168
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2019)
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK
TOTAL RISK (HI): 5.0E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.5E+00		1.4E+00	2.8E+01	3.1E+01	63%
Total PCBs		1.1E-01		3.3E-01	1.1E+01	1.2E+01	23%
TCDD TEQ (PCBs)		1.5E-01		1.6E-01	3.2E+00	3.5E+00	7%
Mercury		5.1E-01		2.4E-01	2.0E+00	2.7E+00	5%
Copper		1.4E-01		2.1E-01	1.8E-01	5.3E-01	1%
Lead		2.2E-01		1.7E-03	1.2E-02	2.3E-01	0%
HPAH		8.3E-02		4.0E-04	6.3E-03	9.0E-02	0%
Total DDx		1.5E-04		7.1E-04	2.9E-02	3.0E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.7E+00**	**-**	**2.4E+00**	**4.5E+01**	**5.0E+01**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-169
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-170

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.3E+02	mg/kg	8.1E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.4E-01	1.2E-01
Lead	2.0E+02	mg/kg	1.2E+00	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.7E+00	1.7E-01
Mercury	1.1E+00	mg/kg	6.5E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	4.1E-01	2.4E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.3E+01	mg/kg	2.6E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	4.1E-01	8.3E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.9E-02	mg/kg	3.5E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.4E-04	8.8E-05
Total PCBs	8.9E-01	mg/kg	5.4E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	7.8E-02	6.5E-02
TCDD TEQ (PCBs)	3.3E-05	mg/kg	2.0E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.5E+00	8.9E-02
TCDD TEQ (D/F)	3.8E-04	mg/kg	2.3E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.9E+01	1.0E+00
							HAZARD INDICES:	3.4E+01	1.8E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-169.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-171
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-172

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+01	mg/kg	1.1E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	3.4E-01	1.7E-01
Lead	1.7E-01	mg/kg	1.0E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.4E-02	1.4E-03
Mercury	8.1E-02	mg/kg	4.9E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.1E-01	1.8E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E-02	mg/kg	1.2E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.0E-03	4.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.4E-02	mg/kg	2.0E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.5E-03	5.1E-04
Total PCBs	3.2E-01	mg/kg	1.9E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	2.8E-01	2.4E-01
TCDD TEQ (PCBs)	3.8E-06	mg/kg	2.3E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.8E+00	1.0E-01
TCDD TEQ (D/F)	3.8E-05	mg/kg	2.3E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.8E+01	1.0E+00
							HAZARD INDICES:	3.2E+01	1.7E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-171.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-173

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION $EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-174

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.2E+00	mg/kg	1.0E+00	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	3.0E-01	1.5E-01
Lead	2.9E-01	mg/kg	7.0E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	9.9E-02	1.0E-02
Mercury	1.7E-01	mg/kg	4.1E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.5E+00	1.5E+00
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	8.2E-02	mg/kg	2.0E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	3.2E-02	6.3E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.0E-01	mg/kg	9.7E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-01	2.4E-02
Total PCBs	2.2E+00	mg/kg	5.4E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	7.8E+00	6.6E+00
TCDD TEQ (PCBs)	1.9E-05	mg/kg	4.5E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	5.6E+01	2.0E+00
TCDD TEQ (D/F)	1.8E-04	mg/kg	4.4E-05	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	5.6E+02	2.0E+01
							HAZARD INDICES:	6.2E+02	3.0E+01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-173.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-175
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)	
EXPOSURE POINT: RME - No Action	
RECEPTOR: MINK	
TOTAL RISK (HI):	**6.9E+02**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		2.9E+01		2.8E+01	5.6E+02	*6.1E+02*	*89%*
TCDD TEQ (PCBs)		2.5E+00		2.8E+00	5.6E+01	*6.1E+01*	9%
Total PCBs		7.8E-02		2.8E-01	7.8E+00	*8.2E+00*	1%
Mercury		4.1E-01		3.1E-01	2.5E+00	*3.3E+00*	0%
Lead		1.7E+00		1.4E-02	9.9E-02	*1.8E+00*	0%
Copper		2.4E-01		3.4E-01	3.0E-01	8.7E-01	0%
HPAH		4.1E-01		2.0E-03	3.2E-02	4.5E-01	0%
Total DDx		4.4E-04		2.5E-03	1.2E-01	1.2E-01	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**3.4E+01**	**-**	**3.2E+01**	**6.2E+02**	**6.9E+02**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-176
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2048)
EXPOSURE POINT: RME - No Action
RECEPTOR: MINK
TOTAL RISK (HI): 3.4E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.0E+00		1.0E+00	2.0E+01	*2.2E+01*	*65%*
Total PCBs		6.5E-02		2.4E-01	6.6E+00	*6.9E+00*	*20%*
TCDD TEQ (PCBs)		8.9E-02		1.0E-01	2.0E+00	*2.2E+00*	7%
Mercury		2.4E-01		1.8E-01	1.5E+00	*1.9E+00*	6%
Copper		1.2E-01		1.7E-01	1.5E-01	4.4E-01	1%
Lead		1.7E-01		1.4E-03	1.0E-02	1.8E-01	1%
HPAH		8.3E-02		4.0E-04	6.3E-03	9.0E-02	0%
Total DDx		8.8E-05		5.1E-04	2.4E-02	2.5E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.8E+00**	**-**	**1.7E+00**	**3.0E+01**	**3.4E+01**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-177
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-178

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.5E+00	mg/kg	2.7E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	8.0E-03	4.0E-03
Lead	6.9E+00	mg/kg	4.1E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	5.8E-02	5.9E-03
Mercury	2.1E-01	mg/kg	1.3E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	7.8E-02	4.6E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.2E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.9E-02	3.8E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.4E-03	mg/kg	4.5E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.6E-05	1.1E-05
Total PCBs	9.1E-02	mg/kg	5.5E-04	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	8.0E-03	6.7E-03
TCDD TEQ (PCBs)	5.6E-06	mg/kg	3.3E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.2E-01	1.5E-02
TCDD TEQ (D/F)	2.4E-05	mg/kg	1.5E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.8E+00	6.6E-02
							HAZARD INDICES:	2.4E+00	1.5E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-177.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-179
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-180
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E-01	mg/kg	1.7E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	5.0E-03	2.5E-03
Lead	1.3E-02	mg/kg	7.9E-04	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.1E-03	1.1E-04
Mercury	4.4E-02	mg/kg	2.6E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.7E-01	9.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	1.5E-04	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.5E-04	4.9E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	8.7E-03	mg/kg	5.2E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.5E-04	1.3E-04
Total PCBs	7.1E-02	mg/kg	4.3E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	6.2E-02	5.2E-02
TCDD TEQ (PCBs)	7.1E-07	mg/kg	4.3E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	5.3E-01	1.9E-02
TCDD TEQ (D/F)	2.8E-06	mg/kg	1.7E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.1E+00	7.6E-02
							HAZARD INDICES:	2.9E+00	2.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-179.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-181

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-182

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E-01	mg/kg	3.4E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.0E-02	5.1E-03
Lead	2.3E-02	mg/kg	5.5E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.8E-03	7.9E-04
Mercury	9.1E-02	mg/kg	2.2E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.4E+00	8.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.2E-03	mg/kg	1.0E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.6E-03	3.2E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.0E-01	mg/kg	4.9E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.1E-02	1.2E-02
Total PCBs	2.3E-01	mg/kg	5.5E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	8.0E-01	6.7E-01
TCDD TEQ (PCBs)	3.6E-06	mg/kg	8.7E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.1E+01	3.9E-01
TCDD TEQ (D/F)	1.4E-05	mg/kg	3.4E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.2E+01	1.5E+00
							HAZARD INDICES:	5.5E+01	3.4E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-181.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-183
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK
TOTAL RISK (HI): 6.1E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.8E+00		2.1E+00	4.2E+01	*4.6E+01*	*76%*
TCDD TEQ (PCBs)		4.2E-01		5.3E-01	1.1E+01	*1.2E+01*	*19%*
Mercury		7.8E-02		1.7E-01	1.4E+00	*1.6E+00*	3%
Total PCBs		8.0E-03		6.2E-02	8.0E-01	8.7E-01	1%
Lead		5.8E-02		1.1E-03	7.8E-03	6.7E-02	0%
Total DDx		5.6E-05		6.5E-04	6.1E-02	6.2E-02	0%
Copper		8.0E-03		5.0E-03	1.0E-02	2.3E-02	0%
HPAH		1.9E-02		2.5E-04	1.6E-03	2.1E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.4E+00**	**-**	**2.9E+00**	**5.5E+01**	**6.1E+01**	
PERCENTAGE OF TOTAL RISK		**4%**		**5%**	**91%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-184
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2023)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK
TOTAL RISK (HI): 3.8E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		6.6E-02		7.6E-02	1.5E+00	*1.7E+00*	*44%*
Mercury		4.6E-02		9.8E-02	8.1E-01	9.5E-01	*25%*
Total PCBs		6.7E-03		5.2E-02	6.7E-01	7.3E-01	*19%*
TCDD TEQ (PCBs)		1.5E-02		1.9E-02	3.9E-01	4.2E-01	*11%*
Total DDx		1.1E-05		1.3E-04	1.2E-02	1.2E-02	0%
Copper		4.0E-03		2.5E-03	5.1E-03	1.2E-02	0%
Lead		5.9E-03		1.1E-04	7.9E-04	6.8E-03	0%
HPAH		3.8E-03		4.9E-05	3.2E-04	4.2E-03	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.5E-01**	**-**	**2.5E-01**	**3.4E+00**	**3.8E+00**	
PERCENTAGE OF TOTAL RISK		**4%**		**7%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-185

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-186
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.1E+01	mg/kg	3.7E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.1E-01	5.4E-02
Lead	9.3E+01	mg/kg	5.6E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.9E-01	8.0E-02
Mercury	8.2E-02	mg/kg	4.9E-04	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.1E-02	1.8E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.7E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.8E-01	5.5E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.8E-03	mg/kg	2.9E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.6E-05	7.3E-06
Total PCBs	4.0E-02	mg/kg	2.4E-04	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	3.5E-03	3.0E-03
TCDD TEQ (PCBs)	4.0E-06	mg/kg	2.4E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.0E-01	1.1E-02
TCDD TEQ (D/F)	9.4E-06	mg/kg	5.7E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	7.1E-01	2.5E-02
							HAZARD INDICES:	2.2E+00	2.5E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-185.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-187
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-188

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.2E+00	mg/kg	4.3E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.3E-01	6.4E-02
Lead	9.4E-02	mg/kg	5.7E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	8.0E-03	8.1E-04
Mercury	3.1E-02	mg/kg	1.9E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.2E-01	6.9E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	9.3E-04	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.5E-03	3.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.5E-03	mg/kg	3.9E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.9E-04	9.9E-05
Total PCBs	4.1E-02	mg/kg	2.5E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	3.6E-02	3.0E-02
TCDD TEQ (PCBs)	5.2E-07	mg/kg	3.2E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.9E-01	1.4E-02
TCDD TEQ (D/F)	1.2E-06	mg/kg	7.0E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	8.7E-01	3.1E-02
							HAZARD INDICES:	1.6E+00	2.1E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-187.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-189

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION $EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$ Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-190

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+00	mg/kg	4.7E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.4E-01	6.9E-02
Lead	1.6E-01	mg/kg	3.9E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	5.6E-02	5.6E-03
Mercury	6.4E-02	mg/kg	1.5E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	9.6E-01	5.7E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.4E-02	mg/kg	1.3E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.1E-02	4.2E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.8E-01	mg/kg	4.2E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.3E-02	1.1E-02
Total PCBs	1.0E-01	mg/kg	2.5E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	3.6E-01	3.0E-01
TCDD TEQ (PCBs)	2.7E-06	mg/kg	6.5E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	8.1E+00	2.9E-01
TCDD TEQ (D/F)	5.8E-06	mg/kg	1.4E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.8E+01	6.3E-01
							HAZARD INDICES:	2.7E+01	1.9E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-189.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-191

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK
TOTAL RISK (HI): 3.1E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		7.1E-01		8.7E-01	1.8E+01	*1.9E+01*	*62%*
TCDD TEQ (PCBs)		3.0E-01		3.9E-01	8.1E+00	*8.8E+00*	*28%*
Mercury		3.1E-02		1.2E-01	9.6E-01	*1.1E+00*	4%
Lead		7.9E-01		8.0E-03	5.6E-02	8.5E-01	3%
Total PCBs		3.5E-03		3.6E-02	3.6E-01	4.0E-01	1%
Copper		1.1E-01		1.3E-01	1.4E-01	3.7E-01	1%
HPAH		2.8E-01		1.5E-03	2.1E-02	3.0E-01	1%
Total DDx		3.6E-05		4.9E-04	5.3E-02	5.3E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.2E+00**	**-**	**1.6E+00**	**2.7E+01**	**3.1E+01**	
PERCENTAGE OF TOTAL RISK		**7%**		**5%**	**88%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-192
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2052)
EXPOSURE POINT: RME - Capping with Dredging for Flooding and Navigation
RECEPTOR: MINK
TOTAL RISK (HI): 2.3E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		2.5E-02		3.1E-02	6.3E-01	6.8E-01	***29%***
Mercury		1.8E-02		6.9E-02	5.7E-01	6.6E-01	*28%*
Total PCBs		3.0E-03		3.0E-02	3.0E-01	3.3E-01	*14%*
TCDD TEQ (PCBs)		1.1E-02		1.4E-02	2.9E-01	3.1E-01	*13%*
Copper		5.4E-02		6.4E-02	6.9E-02	1.9E-01	8%
Lead		8.0E-02		8.1E-04	5.6E-03	8.7E-02	4%
HPAH		5.5E-02		3.0E-04	4.2E-03	6.0E-02	3%
Total DDx		7.3E-06		9.9E-05	1.1E-02	1.1E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.5E-01**	**-**	**2.1E-01**	**1.9E+00**	**2.3E+00**	
PERCENTAGE OF TOTAL RISK		**11%**		**9%**	**80%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-193

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-194

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	4.4E+00	mg/kg	2.6E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	7.8E-03	3.9E-03
Lead	6.7E+00	mg/kg	4.0E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	5.6E-02	5.7E-03
Mercury	1.2E-01	mg/kg	7.3E-04	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	4.6E-02	2.7E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.0E+00	mg/kg	1.2E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.9E-02	3.8E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.7E-03	mg/kg	3.5E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.3E-05	8.7E-06
Total PCBs	5.6E-02	mg/kg	3.4E-04	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.9E-03	4.1E-03
TCDD TEQ (PCBs)	3.2E-06	mg/kg	1.9E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.4E-01	8.6E-03
TCDD TEQ (D/F)	2.0E-05	mg/kg	1.2E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.5E+00	5.3E-02
							HAZARD INDICES:	1.9E+00	1.1E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-193.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-195
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-196

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.7E-01	mg/kg	1.6E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	4.8E-03	2.4E-03
Lead	1.3E-02	mg/kg	7.7E-04	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.1E-03	1.1E-04
Mercury	3.6E-02	mg/kg	2.2E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.3E-01	8.0E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.5E-03	mg/kg	1.5E-04	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.5E-04	4.9E-05
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.3E-03	mg/kg	4.4E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.5E-04	1.1E-04
Total PCBs	5.1E-02	mg/kg	3.1E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.5E-02	3.8E-02
TCDD TEQ (PCBs)	4.2E-07	mg/kg	2.6E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.2E-01	1.1E-02
TCDD TEQ (D/F)	2.3E-06	mg/kg	1.4E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.7E+00	6.2E-02
							HAZARD INDICES:	2.2E+00	1.9E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-195.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-197

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-198
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E-01	mg/kg	3.4E-02	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	9.9E-03	4.9E-03
Lead	2.2E-02	mg/kg	5.4E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.6E-03	7.7E-04
Mercury	7.4E-02	mg/kg	1.8E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.1E+00	6.6E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.2E-03	mg/kg	1.0E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.6E-03	3.2E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.9E-01	mg/kg	4.5E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.6E-02	1.1E-02
Total PCBs	1.4E-01	mg/kg	3.4E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.9E-01	4.1E-01
TCDD TEQ (PCBs)	2.2E-06	mg/kg	5.3E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	6.6E+00	2.3E-01
TCDD TEQ (D/F)	1.1E-05	mg/kg	2.8E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.5E+01	1.2E+00
							HAZARD INDICES:	4.3E+01	2.6E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-197.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-199

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK
TOTAL RISK (HI): 4.7E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		1.5E+00		1.7E+00	3.5E+01	*3.8E+01*	*81%*
TCDD TEQ (PCBs)		2.4E-01		3.2E-01	6.6E+00	*7.1E+00*	*15%*
Mercury		4.6E-02		1.3E-01	1.1E+00	*1.3E+00*	3%
Total PCBs		4.9E-03		4.5E-02	4.9E-01	5.4E-01	1%
Lead		5.6E-02		1.1E-03	7.6E-03	6.5E-02	0%
Total DDx		4.3E-05		5.5E-04	5.6E-02	5.7E-02	0%
Copper		7.8E-03		4.8E-03	9.9E-03	2.2E-02	0%
HPAH		1.9E-02		2.5E-04	1.6E-03	2.1E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.9E+00**	**-**	**2.2E+00**	**4.3E+01**	**4.7E+01**	
PERCENTAGE OF TOTAL RISK		**4%**		**5%**	**91%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-200

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2030)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK
TOTAL RISK (HI): 2.9E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		5.3E-02		6.2E-02	1.2E+00	*1.3E+00*	*47%*
Mercury		2.7E-02		8.0E-02	6.6E-01	7.7E-01	*27%*
Total PCBs		4.1E-03		3.8E-02	4.1E-01	4.5E-01	*16%*
TCDD TEQ (PCBs)		8.6E-03		1.1E-02	2.3E-01	2.5E-01	9%
Total DDx		8.7E-06		1.1E-04	1.1E-02	1.1E-02	0%
Copper		3.9E-03		2.4E-03	4.9E-03	1.1E-02	0%
Lead		5.7E-03		1.1E-04	7.7E-04	6.6E-03	0%
HPAH		3.8E-03		4.9E-05	3.2E-04	4.2E-03	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.1E-01**	**-**	**1.9E-01**	**2.6E+00**	**2.9E+00**	
PERCENTAGE OF TOTAL RISK		**4%**		**7%**	**90%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-201

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-202

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.0E+01	mg/kg	3.6E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.1E-01	5.3E-02
Lead	9.1E+01	mg/kg	5.5E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.7E-01	7.8E-02
Mercury	9.3E-02	mg/kg	5.6E-04	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.5E-02	2.1E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.8E+01	mg/kg	1.7E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.7E-01	5.5E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	5.6E-03	mg/kg	3.4E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.2E-05	8.5E-06
Total PCBs	5.1E-02	mg/kg	3.1E-04	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.4E-03	3.7E-03
TCDD TEQ (PCBs)	4.7E-06	mg/kg	2.8E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.5E-01	1.3E-02
TCDD TEQ (D/F)	1.2E-05	mg/kg	7.5E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	9.3E-01	3.3E-02
							HAZARD INDICES:	2.5E+00	2.6E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-201.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-203

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-204

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.0E+00	mg/kg	4.2E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.2E-01	6.2E-02
Lead	9.2E-02	mg/kg	5.6E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.8E-03	7.9E-04
Mercury	3.2E-02	mg/kg	2.0E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.2E-01	7.2E-02
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.5E-02	mg/kg	9.3E-04	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.5E-03	3.0E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	7.2E-03	mg/kg	4.4E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.4E-04	1.1E-04
Total PCBs	4.8E-02	mg/kg	2.9E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.2E-02	3.5E-02
TCDD TEQ (PCBs)	6.0E-07	mg/kg	3.6E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.6E-01	1.6E-02
TCDD TEQ (D/F)	1.5E-06	mg/kg	9.1E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.1E+00	4.0E-02
							HAZARD INDICES:	1.9E+00	2.3E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-203.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-205
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION $EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$ Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation: $C_{fish} = C_{sed} * BAF_{fish}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-206

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.9E+00	mg/kg	4.6E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.3E-01	6.7E-02
Lead	1.6E-01	mg/kg	3.9E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	5.5E-02	5.5E-03
Mercury	6.7E-02	mg/kg	1.6E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	1.0E+00	6.0E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	5.4E-02	mg/kg	1.3E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.1E-02	4.2E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	1.8E-01	mg/kg	4.4E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.6E-02	1.1E-02
Total PCBs	1.3E-01	mg/kg	3.1E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.5E-01	3.8E-01
TCDD TEQ (PCBs)	3.1E-06	mg/kg	7.4E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	9.3E+00	3.3E-01
TCDD TEQ (D/F)	7.5E-06	mg/kg	1.8E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.3E+01	8.1E-01
							HAZARD INDICES:	3.4E+01	2.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-205.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-207
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK
TOTAL RISK (HI): 3.8E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		9.3E-01		1.1E+00	2.3E+01	*2.5E+01*	*65%*
TCDD TEQ (PCBs)		3.5E-01		4.6E-01	9.3E+00	*1.0E+01*	*27%*
Mercury		3.5E-02		1.2E-01	1.0E+00	*1.2E+00*	3%
Lead		7.7E-01		7.8E-03	5.5E-02	8.3E-01	2%
Total PCBs		4.4E-03		4.2E-02	4.5E-01	4.9E-01	1%
Copper		1.1E-01		1.2E-01	1.3E-01	3.6E-01	1%
HPAH		2.7E-01		1.5E-03	2.1E-02	3.0E-01	1%
Total DDx		4.2E-05		5.4E-04	5.6E-02	5.6E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.5E+00**	**-**	**1.9E+00**	**3.4E+01**	**3.8E+01**	
PERCENTAGE OF TOTAL RISK		**7%**		**5%**	**89%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-208
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2059)
EXPOSURE POINT: RME - Deep Dredging with Backfill
RECEPTOR: MINK
TOTAL RISK (HI): 2.7E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		3.3E-02		4.0E-02	8.1E-01	8.8E-01	*33%*
Mercury		2.1E-02		7.2E-02	6.0E-01	6.9E-01	*26%*
Total PCBs		3.7E-03		3.5E-02	3.8E-01	4.2E-01	*15%*
TCDD TEQ (PCBs)		1.3E-02		1.6E-02	3.3E-01	3.6E-01	*13%*
Copper		5.3E-02		6.2E-02	6.7E-02	1.8E-01	7%
Lead		7.8E-02		7.9E-04	5.5E-03	8.5E-02	3%
HPAH		5.5E-02		3.0E-04	4.2E-03	5.9E-02	2%
Total DDx		8.5E-06		1.1E-04	1.1E-02	1.1E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.6E-01**	**-**	**2.3E-01**	**2.2E+00**	**2.7E+00**	
PERCENTAGE OF TOTAL RISK		**10%**		**8%**	**82%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-209

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-210

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	9.0E+01	mg/kg	5.4E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.6E-01	7.9E-02
Lead	1.4E+02	mg/kg	8.5E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.2E+00	1.2E-01
Mercury	1.6E+00	mg/kg	9.4E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	5.9E-01	3.5E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	2.4E+01	mg/kg	1.4E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.3E-01	4.7E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	6.4E-02	mg/kg	3.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.8E-04	9.6E-05
Total PCBs	9.1E-01	mg/kg	5.5E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	8.0E-02	6.7E-02
TCDD TEQ (PCBs)	3.7E-05	mg/kg	2.2E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.8E+00	9.9E-02
TCDD TEQ (D/F)	2.9E-04	mg/kg	1.8E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.2E+01	7.9E-01
							HAZARD INDICES:	2.7E+01	1.6E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-209.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-211
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-212

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.2E+01	mg/kg	7.0E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.0E-01	1.0E-01
Lead	1.3E-01	mg/kg	7.7E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.1E-02	1.1E-03
Mercury	9.3E-02	mg/kg	5.6E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.5E-01	2.1E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.4E-02	mg/kg	8.3E-04	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.3E-03	2.7E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.6E-02	mg/kg	2.1E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.7E-03	5.4E-04
Total PCBs	3.3E-01	mg/kg	2.0E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	2.9E-01	2.4E-01
TCDD TEQ (PCBs)	4.2E-06	mg/kg	2.5E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.1E+00	1.1E-01
TCDD TEQ (D/F)	2.9E-05	mg/kg	1.8E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.2E+01	7.9E-01
							HAZARD INDICES:	2.6E+01	1.5E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-211.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-213
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-214

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.8E+00	mg/kg	6.9E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.0E-01	1.0E-01
Lead	2.2E-01	mg/kg	5.4E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.6E-02	7.7E-03
Mercury	1.9E-01	mg/kg	4.6E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.9E+00	1.7E+00
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	4.6E-02	mg/kg	1.1E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.8E-02	3.6E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	4.1E-01	mg/kg	1.0E-01	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-01	2.5E-02
Total PCBs	2.3E+00	mg/kg	5.5E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	8.0E+00	6.8E+00
TCDD TEQ (PCBs)	2.1E-05	mg/kg	5.0E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	6.2E+01	2.2E+00
TCDD TEQ (D/F)	1.4E-04	mg/kg	3.5E-05	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.3E+02	1.5E+01
							HAZARD INDICES:	5.1E+02	2.6E+01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-213.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-215

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK
TOTAL RISK (HI): 5.6E+02

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		2.2E+01		2.2E+01	4.3E+02	*4.8E+02*	*85%*
TCDD TEQ (PCBs)		2.8E+00		3.1E+00	6.2E+01	*6.8E+01*	*12%*
Total PCBs		8.0E-02		2.9E-01	8.0E+00	*8.4E+00*	2%
Mercury		5.9E-01		3.5E-01	2.9E+00	*3.8E+00*	1%
Lead		1.2E+00		1.1E-02	7.6E-02	*1.3E+00*	0%
Copper		1.6E-01		2.0E-01	2.0E-01	5.6E-01	0%
HPAH		2.3E-01		1.3E-03	1.8E-02	2.5E-01	0%
Total DDx		4.8E-04		2.7E-03	1.2E-01	1.3E-01	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.7E+01**	**-**	**2.6E+01**	**5.1E+02**	**5.6E+02**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-216

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2020)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK
TOTAL RISK (HI): 2.9E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		7.9E-01		7.9E-01	1.5E+01	*1.7E+01*	*58%*
Total PCBs		6.7E-02		2.4E-01	6.8E+00	*7.1E+00*	*24%*
TCDD TEQ (PCBs)		9.9E-02		1.1E-01	2.2E+00	*2.4E+00*	8%
Mercury		3.5E-01		2.1E-01	1.7E+00	*2.3E+00*	8%
Copper		7.9E-02		1.0E-01	1.0E-01	2.8E-01	1%
Lead		1.2E-01		1.1E-03	7.7E-03	1.3E-01	0%
HPAH		4.7E-02		2.7E-04	3.6E-03	5.0E-02	0%
Total DDx		9.6E-05		5.4E-04	2.5E-02	2.6E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.6E+00**	**-**	**1.5E+00**	**2.6E+01**	**2.9E+01**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-217

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-218

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.0E+02	mg/kg	6.2E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.8E-01	9.2E-02
Lead	1.5E+02	mg/kg	9.3E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.3E+00	1.3E-01
Mercury	8.6E-01	mg/kg	5.2E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	3.2E-01	1.9E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	3.6E+01	mg/kg	2.2E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	3.5E-01	7.1E-02
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.9E-02	mg/kg	2.4E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.0E-04	5.9E-05
Total PCBs	5.9E-01	mg/kg	3.6E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	5.2E-02	4.3E-02
TCDD TEQ (PCBs)	2.5E-05	mg/kg	1.5E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.9E+00	6.8E-02
TCDD TEQ (D/F)	2.1E-04	mg/kg	1.3E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.6E+01	5.7E-01
							HAZARD INDICES:	2.0E+01	1.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-217.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-219
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-220

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.4E+01	mg/kg	8.3E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.4E-01	1.2E-01
Lead	1.4E-01	mg/kg	8.3E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.2E-02	1.2E-03
Mercury	7.4E-02	mg/kg	4.5E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.8E-01	1.7E-01
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	1.8E-02	mg/kg	1.1E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	1.8E-03	3.6E-04
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	2.6E-02	mg/kg	1.6E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.0E-03	3.9E-04
Total PCBs	2.5E-01	mg/kg	1.5E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	2.1E-01	1.8E-01
TCDD TEQ (PCBs)	3.0E-06	mg/kg	1.8E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.2E+00	7.9E-02
TCDD TEQ (D/F)	2.1E-05	mg/kg	1.3E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.6E+01	5.8E-01
							HAZARD INDICES:	1.9E+01	1.1E+00

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-219.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-221

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-222

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	3.3E+00	mg/kg	7.9E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	2.3E-01	1.2E-01
Lead	2.4E-01	mg/kg	5.8E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	8.1E-02	8.3E-03
Mercury	1.5E-01	mg/kg	3.7E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.3E+00	1.4E+00
LPAH	0.0E+00	mg/kg	0.0E+00	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	0.0E+00	0.0E+00
HPAH	7.0E-02	mg/kg	1.7E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.7E-02	5.4E-03
Dieldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	0.0E+00	0.0E+00
Total DDx	3.5E-01	mg/kg	8.5E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.1E-01	2.1E-02
Total PCBs	1.5E+00	mg/kg	3.6E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	5.2E+00	4.4E+00
TCDD TEQ (PCBs)	1.5E-05	mg/kg	3.5E-06	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.4E+01	1.6E+00
TCDD TEQ (D/F)	1.1E-04	mg/kg	2.5E-05	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	3.2E+02	1.1E+01
							HAZARD INDICES:	3.7E+02	1.9E+01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 9-221.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-223
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK
TOTAL RISK (HI): 4.1E+02

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		1.6E+01		1.6E+01	3.2E+02	*3.5E+02*	*86%*
TCDD TEQ (PCBs)		1.9E+00		2.2E+00	4.4E+01	*4.8E+01*	*12%*
Total PCBs		5.2E-02		2.1E-01	5.2E+00	*5.5E+00*	1%
Mercury		3.2E-01		2.8E-01	2.3E+00	*2.9E+00*	1%
Lead		1.3E+00		1.2E-02	8.1E-02	*1.4E+00*	0%
Copper		1.8E-01		2.4E-01	2.3E-01	6.6E-01	0%
HPAH		3.5E-01		1.8E-03	2.7E-02	3.8E-01	0%
Total DDx		3.0E-04		2.0E-03	1.1E-01	1.1E-01	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.0E+01**	**-**	**1.9E+01**	**3.7E+02**	**4.1E+02**	
PERCENTAGE OF TOTAL RISK		**5%**		**5%**	**90%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-224
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: FUTURE (2049)
EXPOSURE POINT: RME - Focused Capping with Dredging for Flooding
RECEPTOR: MINK
TOTAL RISK (HI): 2.1E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
TCDD TEQ (D/F)		5.7E-01		5.8E-01	1.1E+01	*1.2E+01*	*59%*
Total PCBs		4.3E-02		1.8E-01	4.4E+00	*4.6E+00*	*22%*
Mercury		1.9E-01		1.7E-01	1.4E+00	*1.7E+00*	8%
TCDD TEQ (PCBs)		6.8E-02		7.9E-02	1.6E+00	*1.7E+00*	8%
Copper		9.2E-02		1.2E-01	1.2E-01	3.3E-01	2%
Lead		1.3E-01		1.2E-03	8.3E-03	1.4E-01	1%
HPAH		7.1E-02		3.6E-04	5.4E-03	7.6E-02	0%
Total DDx		5.9E-05		3.9E-04	2.1E-02	2.2E-02	0%
Dieldrin		-		-	-		
LPAH		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.2E+00**	**-**	**1.1E+00**	**1.9E+01**	**2.1E+01**	
PERCENTAGE OF TOTAL RISK		**6%**		**5%**	**89%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

Table 9-225.
Summary of Benchmark-Based Hazard Quotients for COPEC Concentrations in Surficial Sediment: Background Conditions

COPEC	Units	*Sediment Benchmark*[a] Lower Bound		Upper Bound		Sediment EPC[b]	Hazard Quotients[c] Lower	Upper
Inorganics/Metals								
Copper	μg/g	32	1	94	1	63	**2E+00**	7E-01
Lead	μg/g	30	1	94	1	130	**4E+00**	**1E+00**
Mercury	μg/g	0.14	1	0.48	1	0.72	**5E+00**	**2E+00**
						Total Inorganics/Metals	**1E+01**	**4E+00**
Semivolatile Organics (PAHs)								
LMW PAHs	μg/g	0.55	2	3.2	2	7.9	**1E+01**	**3E+00**
HMW PAHs	μg/g	1.7	2	9.6	2	53	**3E+01**	**6E+00**
						Total PAHs	**5E+01**	**8E+00**
Pesticides								
Dieldrin	μg/g	0.00083	1	0.0029	1	0.0050	**6E+00**	**2E+00**
Total DDx	μg/g	0.0016	2	0.046	2	0.030	**2E+01**	7E-01
						Total Pesticides	**3E+01**	**2E+00**
PCBs (Aroclors)								
Total PCBs	μg/g	0.035	1	0.37	1	0.46	**1E+01**	**1E+00**
						Total PCBs	**1E+01**	**1E+00**
Dioxin-like Compounds								
2,3,7,8-TCDD	μg/g	0.0000032	3	-		0.0000020	6E-01	6E-01
						Total TCDD	6E-01	
						Total HI	**1E+02**	**2E+01**

Notes:

a. For each COPEC, 2 sediment benchmarks were identified to bound the range of concentrations over which adverse ecological effects are increasingly likely to occur.

[1] Logistic model point estimates for T20 amd T50 (concentrations corresponding to a 20% and 50% probability of observing sediment toxicity, respectively), values based on" Sig Only" classification toxic samples (USEPA, 2005).

[2] Lower and upper bound benchmark estimates based on ER-L = Effects Range-Low and ER-M =Effects Range-Median values from Long *et al*. (1995), respectively (as summarized in Buchman, 2008).

[3] Value for 2,3,7,8-TCDD derived by USFWS (Kubiak et al., 2007) using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper (2003).

b. Exposure Point Concentration based on the average surficial sediment concentrations for background locations as summarized in the Ch

c. Hazard Quotient (HQ) is the ratio of the EPC to either the lower- or upper-bound sediment benchmark value. Consistent with RAGs, only one significant figure is presented.

Table 9-226.
Summary of Critical Body Residue-Based Hazard Quotients for COPECs in Blue Crab Tissue: Background Conditions

Chemical	Units	Exposure Point Concentrations (EPCs)[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	7.5	5.0	12	*Macoma balthica*	Mortality - LD_{11}	1	**1E+00**	6E-01
Lead	µg/g	0.12	0.50	2.6	*Hyalella azteca*	Mortality - LD_{25}	2	2E-01	5E-02
Mercury	µg/g	0.070	0.048	0.095	*Acartia tonsa*	Reproduction - ED_{50}	3	**1E+00**	7E-01
						Total Inorganics/Metals		**3E+00**	**1E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.017	0.078	0.78	*Nereis arenaceodentata*	Reproduction - LOED	4	2E-01	2E-02
HMW PAHs	µg/g	0.024	0.022	0.22	*Mytilus edulis*	Reproduction - LOED	5	**1E+00**	1E-01
						Total PAHs		**1E+00**	1E-01
Pesticides									
Dieldrin	µg/g	0.0046	0.0016	0.0080	*Penaeus duorarum*	Mortality - LOED	6	**3E+00**	6E-01
Total DDx	µg/g	0.022	0.060	0.13	*Penaeus duorarum*	Mortality - LOED	7	4E-01	2E-01
						Total Pesticides		**3E+00**	7E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.21	0.0080	0.026	*Crassostrea virginica*	Reproduction - LOED	8	**3E+01**	**8E+00**
						Total PCBs		**3E+01**	**8E+00**
Dioxin-like Compounds									
2,3,7,8-TCDD	µg/g	0.00000027	0.00000015	0.0000013	*Crassostrea virginica*	Reproduction - LOED	9	**2E+00**	2E-01
						Total TCDD		**2E+00**	2E-01
						Total HI		**4E+01**	**1E+01**

Notes:

[a] Tissue EPCs estimated using average background surficial sediment concentration inputs for contaminant uptake models discussed in Appendix A (DER #6).

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Absil *et al*., 1996; 2. Borgmann & Norwood, 1999; 3. Hook & Fisher, 2002; 4. Emery & Dillon, 1996; 5. Eertman *et al*., 1995; 6. Parrish *et al*., 1973; 7. Nimmo *et al.*, 1970; 8. Chu *et al*., 2000, 2003; 9. Wintermyer & Cooper, 2003.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

Table 9-227.
Summary of Critical Body Residue-Based Hazard Quotients for COPECs in Generic Fish Tissue: Background Conditions

Chemical	Units	Exposure Point Concentrations (EPCs)[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	2.0	0.32	1.5	*Mugil cephalus*	Mortality	1	**6E+00**	**1E+00**
Lead	µg/g	0.21	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	5E-01	5E-02
Mercury	µg/g	0.14	0.052	0.26	*various species*	LER_5	3	**3E+00**	6E-01
						Total Inorganics/Metals		**1E+01**	**2E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.19	0.26	2.6	*Pimephales promelas*	Reproduction	4	7E-01	7E-02
HMW PAHs	µg/g	0.10	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	5E-01	5E-02
						Total PAHs		**1E+00**	1E-01
Pesticides									
Dieldrin	µg/g	0.034	0.0080	0.040	*Salmo gairdneri*	Mortality	6	**4E+00**	8E-01
Total DDx	µg/g	0.32	0.078	0.39	various species	LER_5	7	**4E+00**	8E-01
						Total Pesticides		**8E+00**	**2E+00**
PCBs (Aroclors)									
Total PCBs	µg/g	1.2	0.17	0.53	*Salmo salar*	Behavior (survival)	8	**7E+00**	**2E+00**
						Total PCBs		**7E+00**	**2E+00**
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.0000014	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	**2E+00**	8E-01
TCDD TEQ (PCBs)	µg/g	-	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9		
						Total TCDD		**2E+00**	8E-01
						Total HI		**3E+01**	**7E+00**

Notes:

[a] Tissue EPCs estimated using average background surficial sediment concentration inputs for contaminant uptake models discussed in Appendix A (DER #6).

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

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Table 9-228.
Summary of Critical Body Residue-Based Hazard Quotients for COPECs in Mummichog Tissue: Background Conditions

Chemical	Units	Exposure Point Concentrations (EPCs)[a]	CBR[b]		Species	Endpoint	Reference[c]	Hazard Quotients[d]	
			NOAEL	LOAEL				NOAEL	LOAEL
Inorganics/Metals									
Copper	µg/g	1.3	0.32	1.5	*Mugil cephalus*	Mortality	1	**4E+00**	9E-01
Lead	µg/g	0.50	0.40	4.0	*Salvelinus fontinalis*	Reproduction	2	**1E+00**	1E-01
Mercury	µg/g	0.028	0.052	0.26	*various species*	LER_5	3	5E-01	1E-01
						Total Inorganics/Metals		**6E+00**	**1E+00**
Semivolatile Organics (PAHs)									
LMW PAHs	µg/g	0.058	0.26	2.6	*Pimephales promelas*	Reproduction	4	2E-01	2E-02
HMW PAHs	µg/g	0.078	0.21	2.1	*melanostictus*	Mortality - LD_{51}	5	4E-01	4E-02
						Total PAHs		6E-01	6E-02
Pesticides									
Dieldrin	µg/g	0.0066	0.0080	0.040	*Salmo gairdneri*	Mortality	6	8E-01	2E-01
Total DDx	µg/g	0.023	0.078	0.39	various species	LER_5	7	3E-01	6E-02
						Total Pesticides		**1E+00**	2E-01
PCBs (Aroclors)									
Total PCBs	µg/g	0.16	0.17	0.53	*Salmo salar*	Behavior (survival)	8	1E+00	3E-01
						Total PCBs		1E+00	3E-01
Dioxin-like Compounds									
TCDD TEQ (D/F)	µg/g	0.00000048	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9	5E-01	3E-01
TCDD TEQ (PCBs)	µg/g	-	0.00000089	0.0000018	*Fundulus heteroclitus*	Behavior (growth)	9		
						Total TCDD		5E-01	3E-01
						Total HI		**9E+00**	**2E+00**

Notes:

[a] Tissue EPCs estimated using average background surficial sediment concentration inputs for contaminant uptake models discussed in Appendix A (DER #6).

[b] Derivation of Critical Body Residues (CBRs) is summarized in Table 6-1 in Attachment 6.

[c] 1. Zyadah & Abdel-Baky, 2000; 2. Holcombe *et al*., 1976; 3. Beckvar *et al*., 2005; 4. Hall & Oris, 1991; 5. Hose *et al*., 1982; 6. Shubat & Curtis, 1986; 7. Beckvar *et al*., 2005; 8. Lerner *et al*., 2007; 9. Couillard *et al*., 2011.

[d] Hazard Quotient is the ratio of the EPC to the NOAEL or LOAEL CBR.

ATTACHMENT 9

Table 9-229.

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:
Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-230.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.3E+01	mg/kg	3.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.4E-01	6.9E-02
Lead	1.3E+02	mg/kg	6.7E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.5E+00	3.5E-01
Mercury	7.2E-01	mg/kg	3.7E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.8E-01	1.4E-01
LMW PAHs	7.9E+00	mg/kg	4.1E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	6.1E-02	6.1E-03
HMW PAHs	5.3E+01	mg/kg	2.7E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.7E+00	5.7E-01
Total PCBs	4.6E-01	mg/kg	2.4E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.9E-03	4.7E-03
Dieldrin	5.0E-03	mg/kg	2.6E-05	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	4.8E-04	1.4E-04
Total DDx	3.0E-02	mg/kg	1.5E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.7E-02	5.7E-03
TCDD TEQ (D/F)	2.0E-06	mg/kg	1.0E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.7E-03	3.7E-04
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	9.7E+00	1.1E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-8.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-231.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-232.

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.5E+00	mg/kg	1.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	5.0E-02	2.4E-02
Lead	1.2E-01	mg/kg	1.9E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	9.8E-03	9.8E-04
Mercury	7.0E-02	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.3E-02	4.1E-02
LMW PAHs	1.7E-02	mg/kg	2.6E-04	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	3.8E-04	3.8E-05
HMW PAHs	2.4E-02	mg/kg	3.6E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	7.6E-03	7.6E-04
Total PCBs	2.1E-01	mg/kg	3.2E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	8.0E-03	6.4E-03
Dieldrin	4.6E-03	mg/kg	7.1E-05	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.3E-03	3.9E-04
Total DDx	2.2E-02	mg/kg	3.4E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.7E-02	1.2E-02
TCDD TEQ (D/F)	2.7E-07	mg/kg	4.2E-09	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E-03	1.5E-04
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	2.0E-01	8.7E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-10.

b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-233.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE 9-234.

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.0E+00	mg/kg	1.7E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	7.6E-02	3.7E-02
Lead	2.1E-01	mg/kg	1.8E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	9.7E-02	9.7E-03
Mercury	1.4E-01	mg/kg	1.3E-02	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	9.7E-01	4.9E-01
LMW PAHs	1.9E-01	mg/kg	1.7E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	2.5E-02	2.5E-03
HMW PAHs	1.0E-01	mg/kg	8.8E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.8E-01	1.8E-02
Total PCBs	1.2E+00	mg/kg	1.0E-01	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	2.5E-01	2.0E-01
Dieldrin	3.4E-02	mg/kg	2.9E-03	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	5.4E-02	1.6E-02
Total DDx	3.2E-01	mg/kg	2.8E-02	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.1E+00	1.0E+00
TCDD TEQ (D/F)	1.4E-06	mg/kg	1.2E-07	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	4.4E-02	4.4E-03
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	4.8E+00	1.8E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-12.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-235.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: Background (visitor w/ generic fish diet)
RECEPTOR: HERON
TOTAL RISK (HI): 1.5E+01

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		5.7E+00		7.6E-03	1.8E-01	*5.9E+00*	*40%*
Lead		3.5E+00		9.8E-03	9.7E-02	*3.6E+00*	*25%*
Total DDx		1.7E-02		3.7E-02	3.1E+00	*3.2E+00*	*22%*
Mercury		2.8E-01		8.3E-02	9.7E-01	*1.3E+00*	9%
Total PCBs		5.9E-03		8.0E-03	2.5E-01	2.7E-01	2%
Copper		1.4E-01		5.0E-02	7.6E-02	2.7E-01	2%
LPAH		6.1E-02		3.8E-04	2.5E-02	8.6E-02	1%
Dieldrin		4.8E-04		1.3E-03	5.4E-02	5.6E-02	0%
TCDD TEQ (D/F)		3.7E-03		1.5E-03	4.4E-02	5.0E-02	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.7E+00**	**-**	**2.0E-01**	**4.8E+00**	**1.5E+01**	
PERCENTAGE OF TOTAL RISK		**66%**		**1%**	**33%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE 9-236.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE	
EXPOSURE POINT: Background (visitor w/ generic fish diet)	
RECEPTOR: HERON	
TOTAL RISK (HI):	**3.1E+00**

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total DDx		5.7E-03		1.2E-02	1.0E+00	*1.1E+00*	*35%*
Mercury		1.4E-01		4.1E-02	4.9E-01	6.7E-01	*22%*
HPAH		5.7E-01		7.6E-04	1.8E-02	5.9E-01	*19%*
Lead		3.5E-01		9.8E-04	9.7E-03	3.6E-01	*12%*
Total PCBs		4.7E-03		6.4E-03	2.0E-01	2.1E-01	7%
Copper		6.9E-02		2.4E-02	3.7E-02	1.3E-01	4%
Dieldrin		1.4E-04		3.9E-04	1.6E-02	1.7E-02	1%
LPAH		6.1E-03		3.8E-05	2.5E-03	8.6E-03	0%
TCDD TEQ (D/F)		3.7E-04		1.5E-04	4.4E-03	5.0E-03	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.1E+00**	**-**	**8.7E-02**	**1.8E+00**	**3.1E+00**	
PERCENTAGE OF TOTAL RISK		**38%**		**3%**	**60%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-237.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	ESTIMATED DAILY INTAKE VIA SEDIMENT INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.019	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-238.

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.3E+01	mg/kg	3.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	1.4E-01	6.9E-02
Lead	1.3E+02	mg/kg	6.7E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.5E+00	3.5E-01
Mercury	7.2E-01	mg/kg	3.7E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	2.8E-01	1.4E-01
LMW PAHs	7.9E+00	mg/kg	4.1E-02	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	6.1E-02	6.1E-03
HMW PAHs	5.3E+01	mg/kg	2.7E-01	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	5.7E+00	5.7E-01
Total PCBs	4.6E-01	mg/kg	2.4E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	5.9E-03	4.7E-03
Dieldrin	5.0E-03	mg/kg	2.6E-05	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	4.8E-04	1.4E-04
Total DDx	3.0E-02	mg/kg	1.5E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	1.7E-02	5.7E-03
TCDD TEQ (D/F)	2.0E-06	mg/kg	1.0E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	3.7E-03	3.7E-04
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	9.7E+00	1.1E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-16.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE 9-239.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	15%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-240.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.5E+00	mg/kg	1.2E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	5.0E-02	2.4E-02
Lead	1.2E-01	mg/kg	1.9E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	9.8E-03	9.8E-04
Mercury	7.0E-02	mg/kg	1.1E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	8.3E-02	4.1E-02
LMW PAHs	1.7E-02	mg/kg	2.6E-04	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	3.8E-04	3.8E-05
HMW PAHs	2.4E-02	mg/kg	3.6E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	7.6E-03	7.6E-04
Total PCBs	2.1E-01	mg/kg	3.2E-03	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	8.0E-03	6.4E-03
Dieldrin	4.6E-03	mg/kg	7.1E-05	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.3E-03	3.9E-04
Total DDx	2.2E-02	mg/kg	3.4E-04	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	3.7E-02	1.2E-02
TCDD TEQ (D/F)	2.7E-07	mg/kg	4.2E-09	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E-03	1.5E-04
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	2.0E-01	8.7E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-18.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-241.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} *$ SFF * EF *
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.39	Kushlan, 1978	
	P_{fish}	PERCENT FISH IN DIET	unitless	85%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Bayer, 1978	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	58%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	2.2	USEPA, 1993	

References:

Bayer,R.D., 1978. Aspects of an Oregon estuarine great blue heron population; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

Kushlan, J.A., 1978. Feeding ecology of wading birds; In: Sprunt, A., J. Ogden, S. Winkler, eds. Wading Birds; Natl. Audubon Soc. Res. Rep. 7:213-217.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-242.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Mummichog / HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: Mummichog
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	1.3E+00	mg/kg	1.1E-01	mg/kg-d	2.3E+00	4.7E+00	mg/kg-d	4.9E-02	2.4E-02
Lead	5.0E-01	mg/kg	4.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.3E-01	2.3E-02
Mercury	2.8E-02	mg/kg	2.5E-03	mg/kg-d	1.3E-02	2.6E-02	mg/kg-d	1.9E-01	9.5E-02
LMW PAHs	5.8E-02	mg/kg	5.1E-03	mg/kg-d	6.7E-01	6.7E+00	mg/kg-d	7.6E-03	7.6E-04
HMW PAHs	7.8E-02	mg/kg	6.8E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.4E-01	1.4E-02
Total PCBs	1.6E-01	mg/kg	1.4E-02	mg/kg-d	4.0E-01	5.0E-01	mg/kg-d	3.6E-02	2.9E-02
Dieldrin	6.6E-03	mg/kg	5.7E-04	mg/kg-d	5.4E-02	1.8E-01	mg/kg-d	1.1E-02	3.2E-03
Total DDx	2.3E-02	mg/kg	2.1E-03	mg/kg-d	9.0E-03	2.7E-02	mg/kg-d	2.3E-01	7.6E-02
TCDD TEQ (D/F)	4.8E-07	mg/kg	4.2E-08	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	1.5E-02	1.5E-03
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.8E-06	2.8E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	9.1E-01	2.7E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-20.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-243.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 1.1E+01

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
HPAH		5.7E+00		7.6E-03	1.4E-01	*5.8E+00*	*54%*
Lead		3.5E+00		9.8E-03	2.3E-01	*3.8E+00*	*35%*
Mercury		2.8E-01		8.3E-02	1.9E-01	5.6E-01	5%
Total DDx		1.7E-02		3.7E-02	2.3E-01	2.8E-01	3%
Copper		1.4E-01		5.0E-02	4.9E-02	2.4E-01	2%
LPAH		6.1E-02		3.8E-04	7.6E-03	6.9E-02	1%
Total PCBs		5.9E-03		8.0E-03	3.6E-02	5.0E-02	0%
TCDD TEQ (D/F)		3.7E-03		1.5E-03	1.5E-02	2.0E-02	0%
Dieldrin		4.8E-04		1.3E-03	1.1E-02	1.2E-02	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.7E+00**	**-**	**2.0E-01**	**9.1E-01**	**1.1E+01**	
PERCENTAGE OF TOTAL RISK		**90%**		**2%**	**8%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-244.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : HERON

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: Background (visitor w/ mummichog diet)
RECEPTOR: HERON
TOTAL RISK (HI): 1.5E+00

Analyte	Exposure Medium[a]					Combined HQs[b]	Percent Contribution[c]
	Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish		
HPAH		5.7E-01		7.6E-04	1.4E-02	5.8E-01	*39%*
Lead		3.5E-01		9.8E-04	2.3E-02	3.8E-01	*25%*
Mercury		1.4E-01		4.1E-02	9.5E-02	2.8E-01	*19%*
Copper		6.9E-02		2.4E-02	2.4E-02	1.2E-01	8%
Total DDx		5.7E-03		1.2E-02	7.6E-02	9.4E-02	6%
Total PCBs		4.7E-03		6.4E-03	2.9E-02	4.0E-02	3%
LPAH		6.1E-03		3.8E-05	7.6E-04	6.9E-03	0%
Dieldrin		1.4E-04		3.9E-04	3.2E-03	3.7E-03	0%
TCDD TEQ (D/F)		3.7E-04		1.5E-04	1.5E-03	2.0E-03	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.1E+00**	**-**	**8.7E-02**	**2.7E-01**	**1.5E+00**	
PERCENTAGE OF TOTAL RISK		**76%**		**6%**	**18%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-245.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{sed}	ESTIMATED DAILY INTAKE VIA SEDIMENT INGESTION	mg/kg-d	calculated		SEDIMENT INTAKE-INGESTION
	C_{sed}	CHEMICAL CONCENTRATION IN SEDIMENT	mg/kg	chemical-specific		$EDI_{sed} = C_{sed} * IR_{sed} * SFF * EF * 1/BW$
	IR_{sed}	INGESTION RATE OF SEDIMENT	kg/day	0.0034	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-246.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surficial sediment / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: Surficial sediment
EXPOSURE POINT: Background
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	6.3E+01	mg/kg	3.8E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.1E-01	5.6E-02
Lead	1.3E+02	mg/kg	7.8E-01	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.1E+00	1.1E-01
Mercury	7.2E-01	mg/kg	4.3E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.7E-01	1.6E-01
LMW PAHs	7.9E+00	mg/kg	4.8E-02	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	9.5E-04	3.2E-04
HMW PAHs	5.3E+01	mg/kg	3.2E-01	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	5.1E-01	1.0E-01
Total PCBs	4.6E-01	mg/kg	2.8E-03	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.0E-02	3.4E-02
Dieldrin	5.0E-03	mg/kg	3.0E-05	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	2.0E-03	1.0E-03
Total DDx	3.0E-02	mg/kg	1.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-04	4.5E-05
TCDD TEQ (D/F)	2.0E-06	mg/kg	1.2E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	1.5E-01	5.4E-03
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	2.2E+00	4.7E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-24.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-247.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$ Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{sed} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	20%	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:

Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-248.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Blue crab / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: AQUATIC INVERTEBRATES
EXPOSURE MEDIUM: Blue crab
EXPOSURE POINT: Background
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	7.5E+00	mg/kg	4.5E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.3E-01	6.6E-02
Lead	1.2E-01	mg/kg	7.3E-03	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	1.0E-02	1.0E-03
Mercury	7.0E-02	mg/kg	4.2E-03	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.6E-01	1.6E-01
LMW PAHs	1.7E-02	mg/kg	1.0E-03	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	2.0E-05	6.7E-06
HMW PAHs	2.4E-02	mg/kg	1.4E-03	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	2.3E-03	4.6E-04
Total PCBs	2.1E-01	mg/kg	1.3E-02	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	1.8E-01	1.5E-01
Dieldrin	4.6E-03	mg/kg	2.8E-04	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	1.8E-02	9.2E-03
Total DDx	2.2E-02	mg/kg	1.3E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.6E-03	3.3E-04
TCDD TEQ (D/F)	2.7E-07	mg/kg	1.6E-08	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	2.0E-01	7.3E-03
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	8.1E-01	3.9E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-26.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-249.
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: Background
RECEPTOR: MINK

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{fish}	ESTIMATED DAILY INTAKE VIA FISH INGESTION	mg/kg-d	calculated		FISH INTAKE-INGESTION
	C_{fish}	CHEMICAL CONCENTRATION IN FISH	mg/kg	chemical-specific		$EDI_{fish} = C_{fish} * IR_{food} * P_{fish} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.17	USEPA, 1993	
	P_{fish}	PERCENT FISH IN DIET	unitless	80%	assumption	Where C_{fish} is estimated using site-specific tissue data or estimated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Mitchell, 1961	$C_{fish} = C_{sed} * BAF_{fish}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.57	Mitchell, 1961	

References:
Mitchell, J.L., 1961. Mink movements and populations on a Montana river; J. Wildl. Manage. 25:48-54.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

ATTACHMENT 9

TABLE 9-250.
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : White perch/American eel / MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FISH
EXPOSURE MEDIUM: White perch/American eel
EXPOSURE POINT: Background
RECEPTOR: MINK

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Copper	2.0E+00	mg/kg	4.8E-01	mg/kg-d	3.4E+00	6.8E+00	mg/kg-d	1.4E-01	7.1E-02
Lead	2.1E-01	mg/kg	5.1E-02	mg/kg-d	7.1E-01	7.0E+00	mg/kg-d	7.2E-02	7.3E-03
Mercury	1.4E-01	mg/kg	3.5E-02	mg/kg-d	1.6E-02	2.7E-02	mg/kg-d	2.2E+00	1.3E+00
LMW PAHs	1.9E-01	mg/kg	4.6E-02	mg/kg-d	5.0E+01	1.5E+02	mg/kg-d	9.1E-04	3.0E-04
HMW PAHs	1.0E-01	mg/kg	2.4E-02	mg/kg-d	6.2E-01	3.1E+00	mg/kg-d	3.9E-02	7.9E-03
Total PCBs	1.2E+00	mg/kg	2.8E-01	mg/kg-d	6.9E-02	8.2E-02	mg/kg-d	4.0E+00	3.4E+00
Dieldrin	3.4E-02	mg/kg	8.1E-03	mg/kg-d	1.5E-02	3.0E-02	mg/kg-d	5.4E-01	2.7E-01
Total DDx	3.2E-01	mg/kg	7.8E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	9.7E-02	1.9E-02
TCDD TEQ (D/F)	1.4E-06	mg/kg	3.4E-07	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	4.3E+00	1.5E-01
TCDD TEQ (PCBs)	0.0E+00	mg/kg	0.0E+00	mg/kg-d	8.0E-08	2.2E-06	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	1.1E+01	5.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table 6-28.
b. Reference Dose Values presented in Table 6-2. A dash indicates that no value is available.
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

ATTACHMENT 9

TABLE 9-251.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: Background
RECEPTOR: MINK
TOTAL RISK (HI): 1.4E+01

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
TCDD TEQ (D/F)		1.5E-01		2.0E-01	4.3E+00	*4.6E+00*	*32%*
Total PCBs		4.0E-02		1.8E-01	4.0E+00	*4.3E+00*	*30%*
Mercury		2.7E-01		2.6E-01	2.2E+00	*2.7E+00*	*19%*
Lead		1.1E+00		1.0E-02	7.2E-02	*1.2E+00*	8%
Dieldrin		2.0E-03		1.8E-02	5.4E-01	5.6E-01	4%
HPAH		5.1E-01		2.3E-03	3.9E-02	5.6E-01	4%
Copper		1.1E-01		1.3E-01	1.4E-01	3.9E-01	3%
Total DDx		2.3E-04		1.6E-03	9.7E-02	9.9E-02	1%
LPAH		9.5E-04		2.0E-05	9.1E-04	1.9E-03	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.2E+00**	**-**	**8.1E-01**	**1.1E+01**	**1.4E+01**	
PERCENTAGE OF TOTAL RISK		**15%**		**6%**	**79%**	**100%**	

Notes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

ATTACHMENT 9

TABLE 9-252.
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : MINK

Focused Feasibility Study - Baseline Ecological Risk Assessment
LOWER PASSAIC RIVER
New Jersey

SCENARIO TIMEFRAME: CURRENT/FUTURE
EXPOSURE POINT: Background
RECEPTOR: MINK
TOTAL RISK (HI): 6.1E+00

Analyte	Exposure Medium[a] Surface Water	Sediment	Aquatic Plants	Aquatic Invertebrates	Fish	Combined HQs[b]	Percent Contribution[c]
Total PCBs		3.4E-02		1.5E-01	3.4E+00	*3.6E+00*	*59%*
Mercury		1.6E-01		1.6E-01	1.3E+00	*1.6E+00*	*26%*
Dieldrin		1.0E-03		9.2E-03	2.7E-01	2.8E-01	5%
Copper		5.6E-02		6.6E-02	7.1E-02	1.9E-01	3%
TCDD TEQ (D/F)		5.4E-03		7.3E-03	1.5E-01	1.7E-01	3%
Lead		1.1E-01		1.0E-03	7.3E-03	1.2E-01	2%
HPAH		1.0E-01		4.6E-04	7.9E-03	1.1E-01	2%
Total DDx		4.5E-05		3.3E-04	1.9E-02	2.0E-02	0%
LPAH		3.2E-04		6.7E-06	3.0E-04	6.3E-04	0%
TCDD TEQ (PCBs)		-		-	-		
TOTAL MEDIUM-SPECIFIC RISK	**-**	**4.7E-01**	**-**	**3.9E-01**	**5.2E+00**	**6.1E+00**	
PERCENTAGE OF TOTAL RISK		**8%**		**6%**	**86%**	**100%**	

Notes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.