integral consulting inc.

BASELINE HUMAN HEALTH RISK ASSESSMENT

Koppers Pond Kentucky Avenue Wellfield Site, Operable Unit 4 Horseheads, New York

Prepared for
Koppers Pond RI/FS Group

Prepared by
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ACRONYMS AND ABBREVIATIONS

ADD	average daily dose
ALM	Adult Lead Model
ATSDR	Agency for Toxic Substances and Disease Registry
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical of potential concern
CSF	cancer slope factor
CSM	conceptual site model
CTE	central tendency exposure
EPC	exposure point concentration
EWB	Elmira Water Board
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure and Uptake Biokentic [Lead Model]
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LOAEL	lowest observable adverse effects level
MCL	maximum contaminant level
MESA	Memorandum on Exposure Scenarios and Assumptions
NOAEL	no observable adverse effects level
NPL	National Priorities List
NYSDOH	New York State Department of Health
PAR	Pathway Analysis Report
PCB	polychlorinated biphenyl
PPRTV	Provisional Peer Review Toxicity Value
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose
RI/FS	remedial investigation and feasibility study
RME	reasonable maximum exposure
RSLs	regional screening levels
UCL	upper confidence limit
URF	unit risk factor
USEPA	United States Environmental Protection Agency
WOE	weight of evidence

EXECUTIVE SUMMARY

This baseline human health risk assessment (BHHRA) of Koppers Pond (Operable Unit 4 of the Kentucky Avenue Wellfield Superfund Site) has been prepared by Integral Consulting Inc. on behalf of the Koppers Pond RI/FS Group, pursuant to requirements of an Administrative Settlement Agreement and Order on Consent entered with the U.S. Environmental Protection Agency (USEPA). The BHHRA was conducted as part of the remedial investigation and feasibility study (RI/FS) for this Operable Unit. The objective of the BHHRA is to assess potential risks to human health from exposure to chemicals present in surface water, sediment, and fish tissue at Koppers Pond. The results of the BHHRA will be used in evaluating whether Site-related risks are acceptable or whether remedial actions are needed to address identified unacceptable risks.

The Koppers Pond BHHRA relies on the analytical results from the 2008 Site investigations as well as Site data more recently collected in 2010. This combined data set includes samples of surface water and sediment collected from both Koppers Pond and its outlet channels and from several species of gamefish taken from Koppers Pond. The compounds of potential concern (COPCs) that were selected for evaluation in the BHHRA differ between the pond and outlet channels and among the affected media, but generally include polycyclic aromatic hydrocarbons, polychlorinated biphenyls (PCBs), and metals (*i.e.*, arsenic, cadmium, chromium, lead, and mercury).

The BHHRA follows the approach presented in the *Memorandum on Exposure Scenarios and Assumptions* (MESA) and the *Pathway Analysis Report* (PAR), both of which were prepared as interim deliverables in the Koppers Pond risk evaluation process and subsequently approved by USEPA. The BHHRA incorporates the assumptions used in the MESA and PAR in identifying exposure scenarios, estimating exposures, and applying toxicity values.

The exposure scenarios selected in the MESA and PAR and evaluated in the Koppers Pond BHHRA are the following:

- Dermal contact with and incidental ingestion of surface water from the pond during wading events related to teenage trespassing activities;
- Dermal contact with and incidental ingestion of pond sediment during wading events related to teenage trespassing activities;
- Dermal contact with and incidental ingestion of surface water from the outlet channels during wading events related to teenage trespassing activities;
- Dermal contact with and incidental ingestion of sediment in the outlet channels during wading events related to teenage trespassing activities; and

- Consumption of gamefish taken from Koppers Pond by an adult, adolescent, and young child.

The COPC concentrations and other values used as input for exposure calculations rely on multiple conservative assumptions that lead to reasonable maximum exposure (RME) scenarios.

The results of the BHHRA indicate that no adverse noncarcinogenic or carcinogenic effects are expected from direct contact with sediment and surface water for either Koppers Pond or the outlet channels. A total receptor Hazard Index (HI) across all pathways, media, and exposure points for the teenage trespasser for these scenarios is 0.03. This HI is well below USEPA's target value of 1.0, indicating there is no potential for noncarcinogenic effects. The total carcinogenic risk for the teenage trespasser was similarly determined across all pathways, media, and exposure points associated with direct contact with sediment and surface water for Koppers Pond and the outlet channels; the calculated carcinogenic risk is $9.6x10^{-7}$. This total carcinogenic risk for all exposure points is lower than the low end of USEPA's target risk range (i.e., $1x10^{-6}$ to $1x10^{-4}$), and no unacceptable carcinogenic risk is estimated.

For fish consumption, exposures evaluated using USEPA's requested default assumptions estimated noncarcinogenic HI values greater than 1 and carcinogenic risks above USEPA's $1x10^{-6}$ to $1x10^{-4}$ target risk range for the RME receptors. Total PCBs represent more than 90 percent of the calculated total risk. As explained in the BHHRA, however, when Site-specific data are used in developing potential rates of fish consumption (rather than applying the non-Site-specific default assumptions), calculated risks are much lower.

Each assumption made in the BHHRA process introduces some degree of uncertainty, and, when all of the assumptions are combined, it is likely that actual risks are overestimated. In the Koppers Pond BHHRA, the default fish consumption pathway contributes substantially to the risk levels. Indeed, it is the only pathway that led to the expression of potential risk above USEPA's target levels. To evaluate the degree of conservatism introduced by default assumptions associated with this pathway, an alternative fish consumption analysis was conducted that relied on more-realistic, Site-specific exposure parameters. While the default assessment assumes a freshwater fish consumption rate based on surveys of fish consumption by anglers who fish multiple, large bodies of water across the United States, the default rate does not represent long-term consumption from single small water bodies like Koppers Pond. More importantly, evaluation of the Site-specific characteristics of Koppers Pond indicates that the productivity of the fishery of this pond is not sufficient to sustain the default fish consumption rate over the extended period evaluated in the risk assessment. When fish consumption rates based on the likely productivity of Koppers Pond are used, calculated risks are much reduced. Further, whereas the default assessment evaluates only RME scenarios, the alternative analysis also considers central tendency exposure (CTE) scenarios that consider average (rather than maximum) COPC concentrations in the consumed fish. For the alternative RME fish consumption analysis, the total carcinogenic risk is $6.1x10^{-5}$ and the alternative CTE carcinogenic risk is 4.1×10^{-6}. These risks fall within USEPA's target range of acceptable risks (1×10^{-6} to 1×10^{-4}). For the alternative fish consumption analysis, the RME HI for the most sensitive receptor (i.e., young child) is 4.3. While this HI exceeds the target HI of 1, the CTE HI for the young child is 0.3, well below the target HI of 1.

In summary, the results of the BHHRA indicate that exposures to COPCs in the sediment and surface water for both the outlet channels and Koppers Pond do not pose a significant health concern. Under the USEPA-requested default conditions and highly conservative exposure assumptions, there is a potential risk from fish consumption; however, the use of more realistic and representative exposure point concentrations and exposure assumptions based on Site-specific conditions results in potential risks that are within acceptable risk levels.

1 INTRODUCTION

Under a Settlement Agreement entered with the U.S. Environmental Protection Agency (USEPA), the Koppers Pond RI/FS Group is conducting a remedial investigation and feasibility study (RI/FS) of Koppers Pond as Operable Unit 4 of the Kentucky Avenue Wellfield Superfund Site (herein referred to as the Koppers Pond Site or Site), which is located in the Village of Horseheads and the Town of Horseheads in Chemung County, New York (Figure 1). The Kentucky Avenue Well is a municipal water supply well owned by the Elmira Water Board (EWB) that was used as part of the EWB system to furnish potable water to local communities. The Kentucky Avenue Well was closed in 1980 when it was found that the groundwater produced from this well contained trichloroethylene. In 1983, USEPA included the Kentucky Avenue Wellfield Site on the National Priorities List (NPL) for response actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

As set forth in the Settlement Agreement and its attached Statement of Work, a Baseline Human Health Risk Assessment (BHHRA) is required as part of the Remedial Investigation/Feasibility Study (RI/FS) process under the National Contingency Plan (NCP). The BHHRA presents a human health risk assessment based on USEPA Risk Assessment Guidance for Superfund (RAGS), Part A and Part D (USEPA 1989, 2001a). It relies on the sampling and analyses conducted as part of the RI, which are presented and summarized in the *Draft Site Characterization Summary Report* (Cummings/Riter and AMEC 2008), as well as more recent sampling data collected in October 2010.

1.1 OBJECTIVE

The objective of the BHHRA is to provide a comprehensive evaluation of potential risks to human health from exposure to chemicals of potential concern (COPCs) present in or entering into environmental media at the Site (i.e., water or sediment) or bioaccumulating through the food chain. . Specifically, this BHHRA evaluates potential exposures and risks associated with chemicals in sediment, surface water, and biota (i.e., fish). The BHHRA incorporates conservative, health-protective assumptions to identify exposure scenarios, estimate potential exposure, and estimate potential toxicity. The results of the BHHRA are used in USEPA's evaluation of whether Site-related risks are unacceptable and whether remedial actions are needed to address such potential risk. If its estimated Site risks form a basis for action, then the results of the BHHRA can be used in the development of remedial action objectives and, as appropriate, Site-specific preliminary remediation goals (PRGs), qualitative objectives, or residual (post-remedial) risk evaluations.

As part of the BHHRA process and in accordance with the Settlement Agreement, both a *Memorandum on Exposure Scenarios and Assumptions* (MESA) and a *Pathway Analysis Report* (PAR) were conducted. The MESA (AMEC 2009a) outlined potential exposure scenarios, identified potentially exposed receptors, and presented exposure assumptions, while the PAR (AMEC 2009b) identified the COPCs, developed exposure point concentrations (EPCs), and presented toxicity values and other COPC-specific data. Final versions of the MESA and PAR were submitted in June 2009 and were approved by USEPA Region II. These approved exposure scenarios, receptors, assumptions, and toxicity values are used in the BHHRA. Where the BHHRA evaluation departs from the values and assumptions in the approved MESA and PAR, more detailed discussion is provided.

1.2 SITE SETTING AND HISTORY

The Koppers Pond Site is a man-made water body located within the Village of Horseheads and the Town of Horseheads in Chemung County, New York. As discussed, the Kentucky Avenue Well is a municipal water supply well owned by the EWB that was closed in 1980 when it was found that the groundwater produced from this well contained trichloroethylene. In 1983, USEPA included the Kentucky Avenue Wellfield Site on the NPL for response actions under CERCLA. By the mid-1980s, several CERCLA response actions were completed, as outlined in the *Preliminary Site Conceptual Model* (Koppers Pond RI/FS Group 2007), including initial and supplemental investigations, identification of potentially impacted wells, the installation of barrier wells and a groundwater treatment system, restoration of the Kentucky Avenue Well, and the investigation and remediation of the principal waterway that feeds Koppers Pond (i.e., the "Industrial Drainageway").

At the northern end of its western leg, Koppers Pond receives inflow from the Industrial Drainageway, the watershed for which is a largely commercial and industrial area of nearly 2000 acres. The drainageway receives much of its base flow from discharges originating at an industrial complex that was formerly occupied by Westinghouse Electric Corporation (Westinghouse) and other manufacturing entities (Figure 2). Currently, those discharges are comprised of storm water runoff and treated groundwater from the ongoing Operable Unit 2 groundwater remediation. Historically, such discharges were largely treated effluents from manufacturing operations.

The overflow from Koppers Pond discharges to two outlet streams located at the southern end of the pond, which combine downstream to form a single outlet channel. Koppers Pond is a shallow, flow-through water body with typical water depths of approximately one to two meters. Because of the relatively flat topography, the open water area of the pond is highly dependent on the surface water elevation, and open water areas of approximately seven to more than nine acres have been reported in the various studies of this pond. At a pond surface water elevation of approximately 886 feet above mean sea level, the open water area of the pond covers about 8.9 acres (3.6 hectares). Water levels declined through 2008, presumably due to the removal of beaver dams that had been constructed in the outlets from the pond. The water levels returned to historical levels in 2009, but based on observations during the October 2010 field investigation, the water levels have again increased due to the presence of beaver dams in the outlet channels.

The BHHRA has been conducted using the 2008 chemical dataset as well as data collected in October 2010 (Integral 2010). These data represent samples of sediment and surface water collected from both Koppers Pond and the outlet channel, and biological tissues (several species of fish) from Koppers Pond. The results of these sampling events, coupled with the evaluation of potential risks to human health presented in this report, provide a comprehensive evaluation of the nature and extent of chemicals detected at the Koppers Pond Site, and a comprehensive assessment of potential risks that may be posed to human receptors by such chemicals.

1.3 DOCUMENT ORGANIZATION

In accordance with USEPA (1989) guidance, the BHHRA incorporates the four steps of the baseline risk assessment process:

(1) Hazard identification, including identification of COPCs;

(2) Exposure assessment;

(3) Toxicity assessment; and

(4) Risk characterization, including an uncertainty assessment.

The exposure scenarios evaluated in the BHHRA are based on a Site-specific conceptual site model (CSM) developed for the Koppers Pond Site. The CSM is a tool used to identify sources of chemicals, chemical migration pathways, exposure media, potential exposure routes, and potential receptors. The exposure assessment quantifies the potential intake of chemicals for each receptor via the exposure pathways determined to be complete, while the toxicity assessment provides information on the potential toxicity of the COPCs. Results of these two assessments are combined in the risk characterization component to provide estimates of potential risk to receptors associated with each pathway. These estimates are presented in the context of the uncertainties inherent in the risk assessment process and variability in parameter assumptions.

Hazard identification is presented in Section 2, followed by the exposure assessment in Section 3. The toxicity assessment and risk characterization are discussed in Sections 4 and 5, respectively. Section 6 presents the summary and conclusions, with references provided in Section 7.

The BHHRA has been conducted in accordance with USEPA guidance, including the following:

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A (USEPA 1989);

- Exposure Factors Handbook (USEPA 1997);
- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments (USEPA 2001a); and
- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA 2004).

2 HAZARD IDENTIFICATION

The hazard identification consists of a data evaluation step to define appropriate environmental media and data relevant to human exposures, and a COPC selection procedure to identify those chemicals that are the focus of the BHHRA. This section presents the data that were used to evaluate potential risks to human health and the results of the selection of COPCs in sediment, water, and fish tissue.

2.1 DATA EVALUATION AND SELECTION CRITERIA

The PAR provided the rationale for relying only on the chemical data collected in 2008 as part of the Operable Unit 4 RI (AMEC 2009b). Use of these data for the RI/FS and risk assessments was accepted by USEPA Region II with the understanding that reference would be made to the prior data for historical perspective. The rationale is briefly discussed here and is more fully discussed in the *Draft Site Characterization Summary Report* (Cummings/Riter and AMEC 2008) and the PAR (AMEC 2009b).

Surface Water: Historical surface water data were collected at a time when much larger quantities of treated industrial wastewaters were being discharged from the former Westinghouse Horseheads plant site. Such discharges have now been reduced or eliminated. These data were also collected prior to the remediation of the Industrial Drainageway. Because of these changes in Site conditions, the data from prior sampling events are not representative of current conditions.

Sediment: The prior sediment sampling in Koppers Pond was conducted prior to the remediation of the Industrial Drainageway. In addition, most of these earlier sediment samples were conducted without regard to vertical intervals within the sediment, and the data from such sampling programs are not comparable to the 2008 RI data where vertical profiling was performed. In addition, the quality control of the more recent data is better understood and the data have been fully validated.

Fish Tissue: When the 2003 fish tissue sampling results were compared to the 2008 fish data, differences in concentrations were noted, especially for metals, but also, to some degree, for polychlorinated biphenyls (PCBs). Because of these differences and the greater confidence in the quality control and data validation associated with the 2008 data, the more recent data were used in the BHHRA.

In October 2010, Integral collected the following:

- Five samples of gamefish from a nearby Reference Pond.

- Three mudflat soil/sediment samples from Koppers Pond. These were collected to supplement the limited mudflat data collected during the 2008 field program.
- A composite sediment sample from the Reference Pond and five additional sediment samples from the Koppers Pond for benthic toxicity testing.

The objective of the sediment collections was to support the evaluation of benthic organisms, and therefore the Koppers Pond sediment results are not included in the BHHRA. The Koppers Pond mudflat soil/sediment and the Reference Pond gamefish sample results are included in the BHHRA.

2.1.1 Identification of Chemicals of Potential Concern

This section describes the selection of human health COPCs for surface water, sediment, and fish tissue. The purpose of the COPC selection process is to focus the BHHRA on the chemicals that drive potential human health risks at the Koppers Pond Site. The selection of a chemical as a COPC is based on evidence of its presence in an environmental medium that may be a source of exposure. As stated in the previous section, COPCs were identified based on the chemical data set from the 2008 sample collections.

The COPC selection process involves multiple steps that are outlined in USEPA guidance (USEPA 1989), and includes the evaluation of the frequency of detection for each chemical, assessing essential nutrients detected in Site media, selecting appropriate risk-based screening levels, and comparing Koppers Pond Site concentrations to the selected screening levels for each detected chemical. The data used in the COPC screening for this BHHRA are presented in Appendix A, using RAGS Part D Table 2 format (USEPA 2001a), with separate tables for each exposure medium and exposure area. Tables A-2.1 and A-2.2 summarize the occurrence, distribution and selection of COPCs in surface water from Koppers Pond and the outlet channel, respectively. Tables A-2.3 and A-2.4 summarize the occurrence, distribution, and selection of COPCs in sediment from Koppers Pond and the outlet channel, respectively. Lastly, Table A-2.5 summarizes the occurrence, distribution, and selection of COPCs in fish from Koppers Pond. The minimum and maximum concentrations, along with the detection frequency, are reported. The maximum concentration is used to screen COPCs.

2.1.2 Frequency of Detection

The first step in selecting COPCs involves assessing the frequency of detection for all chemicals (USEPA 1989). Chemicals that are not detected in any sample are not carried forward in the COPC screening process. Typically, chemicals with a low frequency of detection (e.g., less than 5 percent) in a given medium can be removed from further consideration if they are likely attributable to laboratory contamination, or are an artifact of the sampling methodology, or are not Site-related. In this BHHRA, a conservative approach was taken in that any chemical that was detected at least once in any medium is retained for COPC evaluation, as described in the PAR (AMEC, 2009b).

2.1.3 Evaluation of Essential Nutrients

Some chemicals occur naturally in the environment and are beneficial or essential to sustaining human life. These are chemicals that are essential human nutrients and are generally toxic only at very high doses. According to USEPA (1989) guidance, chemicals that are essential nutrients are not given further consideration. Calcium, magnesium, potassium, and sodium are essential nutrients that are excluded from the COPC selection process for this BHHRA.

2.1.4 Selection of Screening Values

To further define the COPCs that are carried forward for evaluation, maximum concentrations of the chemicals are compared to risk-based screening values. Sources for these screening values were stipulated in the Statement of Work appended to the Settlement Agreement and were followed in the PAR (AMEC 2009b). The following sections briefly describe the sources of these screening values by environmental medium.

2.1.4.1 Surface Water

As stipulated, USEPA Region IX PRGs for tap water (September 12, 2008 edition) were used to screen COPCs detected in surface water. Tap water PRGs represent conservative screening values and are considered sufficiently protective of human health, given that exposure to surface water at the Koppers Pond Site would be incidental to other activities (e.g., wading), and the surface water present at the Koppers Pond Site is not a drinking water source. Tap water PRGs were not available for phenanthrene, dibenzofuran, chromium, or lead. The tap water PRG for naphthalene was used as a surrogate for phenanthrene. For dibenzofuran and chromium, maximum detected concentrations of both chemicals in surface water were compared to USEPA Region VI residential water Human Health Screening Levels (March 7, 2008 edition). Lead was compared to USEPA's action level for lead in public water supplies.

2.1.4.2 Sediment

Per the request of USEPA Region II, USEPA Region IX PRGs for residential soil (September 12, 2008 edition) were used to screen COPCs detected in sediment. The PRGs developed for residential soils represent a conservative surrogate for sediment because the soil PRGs are developed for residential soils where the intensity of exposure is greater than that expected for sediments in Koppers Pond. No residential soil PRGs were available for acetophenone, benzo[g,h,i]perylene, carbazole, dibenzofuran, phenanthrene, delta-BHC, or lead. The soil PRG for benzo(b)fluoranthene was used as a surrogate for benzo[g,h,i]perylene. The soil PRG for naphthalene was used as a surrogate for phenanthrene. The soil PRG for gamma BHC (lindane) was used as a surrogate for delta-BHC. For acetophenone, carbazole and dibenzofuran, maximum concentrations detected in sediment were compared to USEPA Region VI residential Human Health Screening Levels (March 7, 2008 edition). Lead was compared to the acceptable residential lead concentration (400 milligrams per kilogram [mg/kg] or parts per million [ppm]) derived from USEPA's Integrated Exposure and Uptake Biokinetic (IEUBK) lead model. It should be noted that while the maximum lead concentration exceeds the screening level of 400 ppm, the IEUBK model is based on young children (0 to 7 years), and residential exposures. In prior discussions regarding the Koppers Pond Site, USEPA agreed that young children are not potential receptors at this Site. Further evaluation of lead in this BHHRA focuses on the adult lead model that is designed for non-residential exposures and is appropriate for older children (USEPA 2003a).

2.1.4.3 Fish

USEPA Region IX PRGs are not available to screen COPCs detected in fish tissue; however, USEPA Region III has established screening levels for fish. During discussions of the RI/FS work plan for the Koppers Pond Site, USEPA Region II recommended that the Region III values be used. Maximum concentrations of COPCs detected in fish from Koppers Pond were compared to the USEPA Region III values, except for lead, which has no Region III value. As presented in the PAR (AMEC 2009b) and accepted by USEPA Region II, lead was compared to a lead level of 500 micrograms per kilogram (μg/kg) in fish based on the IEUBK model for lead in children.

2.1.5 Chemicals Retained for the Baseline Human Health Risk Assessment

As described in Sections 2.1.2 and 2.1.3, chemicals that are not detected and those considered to be essential nutrients were removed from further consideration as COPCs. Maximum concentrations for the remaining chemicals were compared to risk-based screening levels as described in Section 2.1.4. The following sections summarize the results of the screening process for each medium and identify those chemicals that were carried forward in this assessment. These results were presented in the PAR (AMEC 2009b) and were accepted by USEPA Region II.

2.1.5.1 Surface Water

As shown in Table A-2.1 and summarized in Table 1a, benzo(b)fluoranthene, arsenic, and lead were retained as COPCs in surface water for Koppers Pond. As shown in Table A-2.2 and summarized in Table 1a, benzo(b)fluoranthene, benzo(a)anthracene, arsenic, lead, and tetrachloroethene were retained as COPCs in surface water for the outlet channel. It should be noted that although the maximum concentrations for tetrachloroethene, arsenic, benzo(a)anthracene, and benzo(b)fluoranthene exceed the USEPA Region IX tapwater values, the concentrations are less than their respective maximum contaminant levels (MCLs) under the Safe Drinking Water Act. Both the USEPA Region IX tapwater PRGs and MCLs are highly conservative for the Koppers Pond Site because the surface water is not a drinking water source.

2.1.5.2 Sediment

As shown in Table A-2.3 and summarized in Table 1b, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo[g,h,i]perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, total PCBs (Aroclor 1254), arsenic, cadmium, chromium, and lead were retained as COPCs in sediment for Koppers Pond. As shown in Table A-2.4 and summarized in Table 1b, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo[g,h,i]perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, total PCBs (Aroclor 1254), arsenic, and cadmium were retained as sediment COPCs for the outlet channel.

2.1.5.3 Fish

As shown in Table A-2.5 and summarized in Table 1c, arsenic, mercury, and total PCBs were retained as COPCs in fish.

3 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to estimate the type and magnitude of potential human exposure to COPCs identified at a site. To estimate exposure, concentrations at the point of contact are combined with assumptions regarding receptor activity patterns to estimate chemical intakes for each complete pathway. The intakes are then combined with estimates of toxicity to estimate potential risks in the risk characterization section of the BHHRA (Section 5). Potential chemical sources, release mechanisms, transport pathways, potential exposure media, and potential routes of human exposure were presented in both the CSM and the MESA (AMEC 2009a). The exposure assessment evaluates which of the potential routes of human exposure may be complete now or in the future. For an exposure pathway to be complete, all of the following elements must be present (USEPA 1989):

- A source and mechanism for release of constituents;
- A transport or retention medium;
- A point of potential human contact (exposure point) with the affected medium;, and
- An exposure route at the exposure point.

If any one of these elements is missing, the pathway is not considered complete and exposure is not assessed. For example, if human activity patterns and/or the location of potentially exposed individuals relative to the location of an affected exposure medium prevent human contact, then that exposure pathway is not complete. Similarly, if a pathway to human contact was initially considered in the CSM but no COPCs in the environmental medium at the point of contact were identified, the pathway is not complete and not evaluated further in the BHHRA.

The following section briefly describes the CSM, identifying complete exposure pathways. Sections 3.2 and 3.3 present the methods and exposure assumptions used to estimate COPC intakes for each complete pathway included in the quantitative assessment.

3.1 CONCEPTUAL SITE MODEL

The CSM provides a technical overview of the exposure assessment in a Site-specific format that indicates likely sources of COPCs, transport mechanisms, exposure pathways, and potential receptors. The CSM is based on the setting and history of the Koppers Pond Site and the analysis of the mechanisms and release pathways, as well as local land use, demographics, and regional climate. Key points from the CSM for the Koppers Pond Site are summarized below (Koppers Pond RI/FS Group 2007).

- Koppers Pond is a shallow, flow-through pond with typical water depths of approximately one to two meters and an open water area that covers approximately nine acres. The pond bottom is comprised of soft, mucky (silty) sediments.
- The origin of the pond is not well documented. It is situated in a previously low-lying, wet area that apparently began to fill with water with the onset of discharges from the former Westinghouse Horseheads plant, which began operating in 1952, and industrial development on the south side of the area that began around 1953.
- The Industrial Drainageway begins approximately 2,300 feet to the north-northwest of Koppers Pond at the outlet of the "Chemung Street Outfall" and discharges to Koppers Pond (Figure 2). This drainageway conveys surface water runoff from a nearly 2000 acre watershed comprised primarily of commercial and industrial properties as well as discharges from the former Westinghouse Horseheads plant site.
- The current base flow of the Industrial Drainageway is comprised of the discharge from the groundwater recovery and treatment system installed and operated as part of Operable Unit 2 at the Kentucky Avenue Wellfield Site. It is not known how much longer this groundwater recovery will be required.
- Two outlet streams flow from the southern end of Koppers Pond and merge about 500 feet downstream to a single outlet channel that flows past the Hardinge, Inc. (Hardinge) plant site and into Halderman Hollow Creek. From there, the creek flows through mixed industrial, commercial, and residential areas and discharges into Newtown Creek approximately three miles south of Koppers Pond.
- Metals, pesticides, PCBs, and polycyclic aromatic hydrocarbons have been detected in pond sediments. Metals and pesticides have been found in the surface water of the pond. Metals and PCBs have been detected in fish tissue.
- Historical sources of metals to the pond include industrial discharges from the former Westinghouse Horseheads plant site, as well as from urban and industrial runoff. Ongoing sources include runoff and, to some extent, industrial discharges, although these discharges have been reduced with many of the past operations no longer discharging to the Drainageway.
- The source of the PCBs found in Koppers Pond sediment has not been determined.
- The pond is situated on property owned by Hardinge, the Village of Horseheads, and the EWB. The pond is surrounded by an area of vacant and active industrial and governmental properties. To the north and northeast is the Old Horseheads Landfill, to the south is the Kentucky Avenue Well site, to the southeast is the Hardinge facility, to the east is Fairway Spring Company, and to the west is a Norfolk Southern Corporation (Norfolk Southern) railroad right-of-way with active tracks.

- The Norfolk Southern right-of-way runs to the west of the Industrial Drainageway and to the east of this drainage channel are the Chemung County Department of Public Works maintenance facility and the Old Horseheads Landfill.
- Access to Koppers Pond is impeded by the railroad tracks and by the adjacent industrial and governmental properties that are partially fenced. Nevertheless, the presence of litter and off-road vehicle tracks suggest that periodic trespassing occurs in the area. Individuals have been observed bank fishing in Koppers Pond.
- No recreational or other use of the pond is authorized by any of the property owners. "No Trespassing" signs are posted at the Hardinge property, and the Village and Town of Horseheads have periodically undertaken more aggressive efforts to discourage trespassing. Such measures include posting "No Trespassing" signs and increased police patrols.
- Because of PCB levels measured in fish in 1988, the New York State Department of Health (NYSDOH) issued a fish advisory for Koppers Pond. The NYSDOH advisory, which is still in effect, is for carp with a recommendation that the general public eats no more than one meal per month and that infants, children under the age of 15, and women of childbearing age eat no fish from Koppers Pond.

These elements of the CSM combine to develop the exposure scenarios selected for evaluation in the BHHRA.

3.1.1 Exposure Pathways

Exposure pathways define the physical ways in which chemicals may enter the human body. The CSM shown in Figure 3 designates exposure pathways as potentially complete or potentially incomplete. For a pathway to be considered potentially complete, there must be a source of the chemical, a release or transport mechanism for the chemical, an exposure point where contact with the chemical can occur, and an exposure route through which the chemical can enter the human body. Pathways considered potentially complete are quantitatively evaluated in this BHHRA. If any of the elements of a pathway is missing, the pathway is considered incomplete and exposure does not occur. Pathways considered potentially incomplete are not evaluated further in this BHHRA. Based on the understanding of the Koppers Pond Site and as presented in the MESA (AMEC 2009a) and approved by USEPA Region II, the potentially complete exposure pathways for the BHHRA are:

- Dermal contact with and incidental ingestion of surface water from the pond during wading events related to trespassing or fishing activity;
- Dermal contact with and incidental ingestion of pond sediment during wading events related to trespassing or fishing activity;

- Dermal contact with and incidental ingestion of surface water from the outlet channel during wading events related to trespassing;
- Dermal contact with and incidental ingestion of sediment in the outlet channel during wading events related to trespassing; and,
- Consumption of fish taken from Koppers Pond.

As described in the MESA (AMEC 2009a) and approved by USEPA Region II, the following exposure pathways are considered incomplete and have not been addressed in the BHHRA.

- Incidental ingestion and dermal contact with surface water while swimming; and
- Inhalation of vapors or particulates.

3.1.2 Potential Receptors

As discussed in the MESA, no recreational or other use of the Koppers Pond is authorized, access is impeded by railroad tracks and adjacent industrial/governmental properties, and efforts have been undertaken to discourage trespassing. Nevertheless, the presence of litter and off-road vehicle tracks suggest that periodic trespassing occurs. As presented in the MESA, the most likely potential receptors are teenage trespassers, who may be exposed via direct contact to both surface water and sediment. In addition, although Koppers Pond currently has restrictions to discourage trespassing and has a fish consumption advisory for carp, the Pond is used at times as a local pond for casual fishermen. While informal interviews with the local fishermen who were encountered at the Pond during the 2008 RI sampling revealed that they are generally catch-and-release anglers and, therefore, taking of fish from Koppers Pond for family meals would be uncommon, this BHHRA assumes that potential receptors for fish consumption are the young child, older child, and adult. The potentially exposed receptors by exposure medium and pathway are discussed briefly below, and are detailed in the MESA (AMEC 2009a) that has been approved by the USEPA Region II.

3.1.2.1 Incidental Ingestion of Surface Water

Teenage trespassers may be exposed to COPCs via incidental ingestion of surface water while wading in Koppers Pond or in the outlet channels. Likely receptors are limited to teenagers (12 to 18 years old) who might trespass on an infrequent basis. Because the area is not an established recreational destination and access is restricted, young children alone, adults, or adults with young children are anticipated to visit the area very rarely, if at all. Agreement was reached with the USEPA Region II that the area is considered unsuitable for young children. If adults are in the area, it would be on a less-frequent basis than the teenager trespassing events. The conservative approach is to evaluate the teenager as the more sensitive receptor for this pathway.

3.1.2.2 Dermal Contact with Surface Water

Similar to the reasons outlined in Section 3.1.2.1, potential dermal exposure to COPCs in surface water while wading in Koppers Pond or in the outlet channels is limited to teenagers (12 to 18 years old) who might trespass on an infrequent basis.

3.1.2.3 Incidental Ingestion of Sediment

Teenage trespassers may be exposed to COPCs via incidental ingestion of near-shore pond sediment or from sediment from the outlet channels. Similar to the reasons outlined in Section 3.1.2.1, receptors are limited to teenagers (12 to 18 years old) who might trespass on an infrequent basis.

3.1.2.4 Dermal Contact with Sediment

Teenage trespassers may be exposed to COPCs via dermal contact with near-shore pond sediment or from sediment from the outlet channels. Similar to the reasons outlined in Section 3.1.2.1, receptors are limited to teenagers (12 to 18 years old) who might trespass on an infrequent basis.

3.1.2.5 Fish Consumption

Koppers Pond currently has restrictions to discourage trespassing and a fish consumption advisory for carp. Nonetheless, based on observations during the 2008 field investigation, Koppers Pond is used at times as a local pond by casual fishermen. Informal interviews with the local fishermen who were encountered at the pond and other field observations revealed that they are generally catch-and-release anglers, focusing predominantly on the bass that are present in the pond. The taking of fish from Koppers Pond for preparation of family meals would seem unlikely or an infrequent event, particularly because there are a number of more desirable fisheries located nearby (e.g., trout streams, Finger Lakes). Nevertheless, potential risks from fish consumption are evaluated for the young child, older child, and adult.

3.2 EXPOSURE POINT CONCENTRATIONS

To estimate the magnitude of exposure from each exposure medium, a representative concentration of each COPC is calculated and used in the intake equations described in subsequent sections. The representative concentration is commonly called the exposure point concentration or EPC. An EPC is a conservative estimate of the average chemical concentration in a medium that a receptor is assumed to contact over time (USEPA 1989).

In accordance with the Settlement Agreement, the appropriate EPC to represent a reasonable maximum exposure (RME) is the 95-percent upper confidence limit (UCL) of the arithmetic mean, derived using the most recent version of USEPA's ProUCL software (version 4.00.05). ProUCL calculations are presented in Appendix B. When the 95-percent UCL exceeds the maximum concentration, the maximum is used as the EPC. Selection of the EPCs is summarized in RAGs Part D Table 3 format. These tables identify the arithmetic mean, 95-percent UCL, maximum concentration, the EPC and the rationale for the selection of the EPC. Specifically, Tables A-3.1 and A-3.2 summarize EPCs for the COPCs in surface water for Koppers Pond and the outlet channel, respectively. Tables A-3.3 and A-3.4 present EPCs for the COPCs in sediment for Koppers Pond and the outlet channel, respectively. Table A-3.5 summarizes the EPCs for the COPCs in fish. Tables 2a and 2b summarize the Koppers Pond and Outlet Channel EPCs for surface water and sediment, respectively. Table 2c summarizes the EPCs in fish tissue. These EPCs were identified in the PAR (AMEC 2009b) and have been approved by USEPA Region II. It should be noted that any slight differences in the EPCs reported here from those reported in the PAR are due to the use of the most recent version of ProUCL (version 4.00.05 as opposed to version 4.00.02, available at the time of the PAR).

3.3 EXPOSURE INTAKES

Human intakes resulting from potential exposures to COPCs are estimated using exposure algorithms (equations) and assumptions regarding such parameters as intake rate, exposure frequency, and exposure duration. Intake estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period. Intakes are typically expressed in milligrams of chemical per kilogram of body weight per day (mg/kg-day). The following sections provide the exposure algorithms and exposure factors for each medium that are used to estimate intakes of COPCs for each receptor in this BHHRA.

The generalized equation for calculating chemical intakes is:

$$I = \frac{EPC \times CR \times EF \times ED \times F \times Ab}{BW \times AT}$$

Where:

I	=	Intake, the amount of chemical taken in by the receptor (mg chemical per kg body weight per day)
EPC	=	Exposure point concentration, the chemical concentration contacted over the exposure period at the exposure point (e.g., mg/kg soil)
CR	=	Contact rate, the amount of affected medium contacted per unit time or event (e.g., soil ingestion rate [mg/day])
EF	=	Exposure frequency, describes how often exposure occurs (days/year)
ED	=	Exposure duration, describes how long exposure occurs (years)

F	=	Intake fraction, fraction of medium contacted that is assumed to be from the affected source (unitless)
Ab	=	Absorption factor (unitless)
BW	=	Body weight, the average body weight over the exposure period (kilograms [kg])
AT	=	Averaging time, period over which exposure is averaged (days).

The variables shown in the above equation are called exposure parameters, and they vary depending on the receptor population being evaluated. For some exposure pathways, the equation format also might vary slightly from the generalized format shown above and might include parameters that describe chemical-specific factors. Intakes for all pathways are expressed as average daily doses (ADDs) for potential noncarcinogenic hazards and lifetime average daily doses (LADDs) for potential carcinogenic risks. EPCs are derived from media- and Site-specific analytical data. The remaining parameters shown in the generalized equation describe activity patterns associated with each receptor population, such as amount and frequency of contact with potentially affected media, and frequency and duration of exposure.

For every exposure pathway, it is expected that there will be differences among individuals in the level of exposure due to differences in intake rates, body weights, exposure frequencies, and exposure durations. This results in a wide range of potential daily intakes among different members of an exposed population. Daily intake calculations must specify what part of the expected distribution of intakes is being estimated. Typically, attention focuses on intakes that are "average" or near the central portion of the range and on intakes that are near the "upper end" of the range. These two exposure estimates are referred to as central tendency exposure (CTE) and reasonable maximum exposure (RME), respectively. The RME case provides a conservative estimate of exposure that is plausible but is in the upper end of the distribution of potential exposures.

3.3.1 EXPOSURE PARAMETERS

For the direct contact pathways (incidental ingestion and dermal contact with surface water and sediment), a number of the exposure parameters are common to all of the pathways and are discussed below. Assumptions that are pathway-specific, including those for fish consumption, are discussed by pathway in subsequent sections. All pathway-specific parameter values have been submitted and approved by USEPA Region II through the MESA process (AMEC 2009a). Those parameters that are chemical-specific (e.g., permeability constants, absorption factors) were submitted and approved by USEPA Region II through the PAR process (AMEC 2009b). RAGs Part D Tables A-4.1, A-4.2, and A-4.3 summarize the exposure parameters for surface water, sediment, and fish consumption, respectively.

3.3.1.1 Common Exposure Parameters

Exposure parameters common across all direct contact exposure pathways are summarized in Table 3.

3.3.1.2 Incidental Ingestion of Surface Water

The following equation is used to estimate the intake from incidental ingestion of surface water while wading. Table 4 defines the pathway-specific exposure parameters for incidental ingestion of surface water.

$$\text{Intake (mg/kg-d)} = C_{sw} \times IgR_{sw} \times ET \times EF \times ED \times ABS_o \times (1/BW) \times (1/AT)$$

Where:

- C_{sw} = Chemical concentration in surface water (milligrams per liter [mg/L]),
- IgR_{sw} = Ingestion rate for surface water (liters/hour),
- ET = Exposure time (hours/day),
- EF = Exposure frequency (days/year),
- ED = Exposure duration (years),
- ABS_o = Chemical-specific oral absorption factor (unitless),
- BW = Body weight (kg),
- AT_c = Carcinogenic averaging time (days), and
- AT_{nc} = Noncarcinogenic averaging time (days).

3.3.1.3 Dermal Contact with Surface Water

Intake from dermal contact with surface water while wading is estimated using the following equation shown below (USEPA 2004). Table 5 defines the pathway-specific exposure parameters for dermal contact with surface water.

$$\text{Intake (mg/kg-day)} = DA_{event} \times SA \times EV \times EF \times ED \times (1/BW) \times (1/AT)$$

and

$$DA_{event\text{-}organic} = 2FA * Kp * Csw\sqrt{\frac{6\tau_{event} * t_{event}}{\pi}}$$

$$DA_{event\text{-}inorganic} = K_p * C_{sw} * t$$

Where:

- DA_{event} = Absorbed dose per event (milligrams per square centimeter per event [mg/cm^2-event]),
- FA = Fraction absorbed (unitless),

K_p	=	Chemical-specific dermal permeability coefficient (centimeters per hour [cm/hr]),
C_{sw}	=	Chemical concentration in surface water (milligrams per cubic centimeter [mg/cm³]),
τ event	=	Lag time per event (hr/event),
t	=	Event duration (hr/event),
π	=	Constant (unitless),
SA	=	Exposed skin surface area (cm²),
EV	=	Number of events per day (event/day),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
BW	=	Body weight (kg), and
AT_c	=	Carcinogenic averaging time (days),
AT_{nc}	=	Noncarcinogenic averaging time (days).

3.3.1.4 Incidental Ingestion of Sediment

Intake from incidental ingestion of sediment is estimated using the equation shown below. Table 6 defines the pathway-specific exposure parameters for incidental ingestion of sediment.

$$\text{Intake (mg/kg-d)} = C_{sed} \times IgR_{sed} \times EF \times ED \times ABS_o \times CF \times (1/BW) \times (1/AT)$$

Where:

C_{sed}	=	Chemical concentration in sediment (mg/kg),
IgR_{sed}	=	Ingestion rate of sediment (mg/day),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
ABS_o	=	Chemical-specific oral absorption factor (unitless),
BW	=	Body weight (kg),
CF	=	Conversion factor (kg/mg),
AT_c	=	Carcinogenic averaging time (days), and
AT_{nc}	=	Noncarcinogenic averaging time (days).

3.3.1.5 Dermal Contact with Sediment

Intake from dermal contact with sediment is estimated using the equation shown below. Table 7 defines the pathway-specific exposure parameters for dermal contact with sediment.

$$\text{Intake (mg/kg-d)} = C_{sed} \times SA \times AF \times ABS_d \times EF \times ED \times CF \times (1/BW) \times (1/AT)$$

Where:

C_{sed}	=	Chemical concentration in sediment (mg/kg),
SA	=	Exposed skin surface area (cm^2),
AF	=	Adherence factor (milligrams per square centimeter per day [mg/cm^2-day]),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
ABS_d	=	Chemical-specific dermal absorption factor (unitless),
BW	=	Body weight (kg),
CF	=	Conversion factor (kg/mg),
AT_c	=	Carcinogenic averaging time (days), and
AT_{nc}	=	Noncarcinogenic averaging time (days).

3.3.1.6 Fish Consumption

Intake from fish consumption is estimated using the equation shown below. Table 8 defines the pathway-specific exposure parameters for fish consumption.

$$\text{Intake (mg/kg-d)} = C_{fish} \times IgR_{fish} \times EF \times ED \times ABS_f \times CL \times CF \times (1/BW) \times (1/AT)$$

Where:

C_{fish}	=	Chemical concentration in fish (mg/kg),
IgR_{fish}	=	Fish consumption rate (g/day),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
ABS_f	=	Chemical-specific oral absorption factor (unitless),
BW	=	Body weight (kg),
CL	=	Cooking loss (unitless),
CF	=	Conversion factor (kg/g),
AT_c	=	Carcinogenic averaging time (days), and
AT_{nc}	=	Noncarcinogenic averaging time (days).

3.3.1.7 Chemical-Specific Parameters

Table 9 summarizes the chemical-specific parameters that were used in the BHHRA. These parameter values were presented in the PAR (AMEC 2009b) and have been approved by USEPA Region II.

4 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to summarize health effects that may be associated with exposure to the chemicals included in the risk assessment and to identify health protective doses that are not likely to be associated with those effects. Toxicity values are numerical expressions of chemical dose and response, and vary based on factors such as the route of exposure (e.g., oral or inhalation) and duration of exposure. Exposure to a chemical does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally occurring non-nutritive chemicals and man-made chemicals at low levels with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold.

Toxicity values for carcinogenic and noncarcinogenic health effects have been developed for many chemicals by government agencies, including USEPA, Agency for Toxic Substances and Disease Registry (ATSDR), Health Canada, and the World Health Organization. As recommended by USEPA (2003b), the primary sources consulted for toxicity values are, in order of priority, USEPA's Integrated Risk Information System (IRIS) and USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) from the National Center for Environmental Assessment/Superfund Health Risk Technical Support Center. When neither IRIS toxicity values nor PPRTVs are available, toxicity values are obtained from other documented sources, such as the California Environmental Protection Agency, ATSDR minimal risk levels, Oak Ridge National Laboratory, and USEPA's Health Effects Assessment Summary Tables. The following two sections describe the toxicity values used to assess noncarcinogenic and carcinogenic effects of chemicals.

4.1 NONCARCINOGENIC EFFECTS

The potential for noncarcinogenic health effects from long duration or chronic exposures (i.e., greater than 7 years) is evaluated by comparing the estimated daily intake with a chronic oral reference dose (RfD) for ingestion. These toxicity values represent an average daily exposure level, with a built-in margin of safety, at which no adverse effects are expected to occur with chronic exposures. Although childhood exposures are assumed to occur for 6 years, chronic RfDs are used in this BHHRA for estimating potential noncarcinogenic hazards for children, consistent with USEPA's historical practice and USEPA's stated concern with adequately protecting children as potentially sensitive receptors. RfDs reflect the underlying assumption that systemic toxicity occurs as a result of processes that have a threshold (i.e., that a safe level of exposure exists and that toxic effects will not be observed below this level).

The RfDs for many noncarcinogenic effects are generally derived on the basis of laboratory animal studies or epidemiological studies in humans. In such studies, the RfD is typically calculated by first identifying the highest concentration or dose that does not cause observable adverse effects (the no-observed-adverse-effect level, or NOAEL) in the study subject. If a NOAEL cannot be identified from the study, a lowest-observed-adverse-effect level (LOAEL) may be used. The NOAEL or LOAEL is then divided by uncertainty factors to calculate an RfD. The uncertainty factors are applied to account for limitations in the underlying data and are intended to ensure that the toxicity value calculated based on the data will not result in adverse health effects in exposed human populations. For example, an uncertainty factor of 10 might be used to account for interspecies differences (if animal studies were used as the basis for the calculation), and another factor of 10 might be used to address the potential that human subpopulations such as children or the elderly may have increased sensitivity to the chemical's adverse effects. Thus, variations in the strength of the underlying data are reflected in the uncertainty factors used to calculate the toxicity values.

Toxicity values have not been established for dermal exposure. In the absence of dermal toxicity values, USEPA (2004) recommends using the oral value, adjusted when necessary. Oral toxicity values are expressed as administered doses, whereas the exposure estimates for the dermal pathway are expressed as absorbed doses. For certain chemicals, the oral toxicity value is adjusted to represent an absorbed rather than administered dose. This adjustment accounts for the absorption efficiency in the critical study that forms the basis of the oral toxicity value (USEPA 2004). When the oral absorption in the critical study is greater than 50 percent, it is assumed that the absorbed dose is equivalent to the administered dose, and USEPA (2004) does not require an adjustment. When oral adsorption in the critical study is poor, the absorbed dose is much lower than the administered dose and toxicity factors need to be adjusted (USEPA 2004). When an adjustment is necessary, the oral RfD is multiplied by the oral absorption in the critical toxicity study. Route-to-route extrapolation assumes that once a chemical is absorbed into the bloodstream, the health effects are similar regardless of whether the route of exposure is oral or dermal. This assumption may be valid for some chemicals with pharmacokinetic characteristics that are similar regardless of route of administration; however, for many chemicals, factors such as absorption, metabolism, distribution, and elimination vary by exposure route, leading to substantial differences in toxicity. Nevertheless, adjusted oral RfDs are used to evaluate dermal exposure in this analysis.

The toxicity values used to estimate potential noncarcinogenic hazards in the BHHRA for oral and dermal exposure routes are summarized in Table 10 and in RAGs Part D Table A-5.1. These toxicity values were submitted and approved by USEPA Region II (AMEC 2009b). Inhalation exposure is considered an incomplete pathway and is not evaluated in the BHHRA;

however, for completeness and comparability with the PAR (AMEC 2009b), inhalation RfDs are summarized in RAGs Part D Table A-5.2.

4.2 CARCINOGENIC EFFECTS

To assess the potential for carcinogenic health effects, cancer slope factors (CSFs) are used for oral and dermal exposures. CSFs are upper-bound estimates of the carcinogenic potency of chemicals. They are used to estimate the incremental risk of developing cancer, corresponding to a lifetime of exposure at the levels described in the exposure assessment. In standard risk assessment procedures, estimates of carcinogenic potency reflect the conservative assumption that no threshold exists for carcinogenic effects (i.e., that any exposure to a carcinogenic chemical will contribute an incremental amount to an individual's overall risk of developing cancer).

Another component of assessing carcinogenic health effects is a qualitative evaluation of the likelihood that a chemical is a human carcinogen. For most chemicals listed in IRIS, this evaluation is conducted by USEPA using a classification system called a weight of evidence (WOE) determination. A chemical is assigned a WOE classification based on data obtained from both human and animal studies. Once a WOE is assigned to a chemical, a CSF is derived. Chemicals for which EPA considers human data adequate to categorize as "known human carcinogens" are assigned a WOE Class A. Other chemicals with various levels of supporting data are classified as "probable human carcinogens" (WOE Class B1 or B2), or "possible human carcinogens" (WOE Class C). Where USEPA considers that data are inadequate for determining potential carcinogenicity, the chemical is "not classifiable as to human carcinogenicity" (WOE Class D). When studies provide evidence of noncarcinogenicity, a chemical is assigned a WOE Class E.

As discussed in the previous section, toxicity values have not been established for dermal exposure. In the absence of dermal toxicity values, USEPA (2004) recommends using the oral value, adjusted when necessary. When an adjustment is necessary, the oral CSF is divided by the oral absorption in the critical toxicity study. The toxicity values used to estimate potential carcinogenic risks in the BHHRA are summarized in Table 11 for oral and dermal exposure routes. These toxicity values were submitted and approved by USEPA Region II (AMEC 2009b). RAGs Part D Table A-6.1 summarizes the oral and dermal CSFs and WOE classification. For completeness and comparability with the PAR (AMEC 2009b), inhalation CSFs are summarized in RAGs Part D Table A-6.2.

5 RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process. In this step, information from previous steps in the risk assessment is integrated to synthesize an overall picture of Site-related risk. The goal of risk characterization is to present and interpret the key findings of the risk assessment, along with their limitations and uncertainties, for use in risk management decision making. The risk characterization is an integral part of this decision making process and is considered, along with other information, critical to evaluating options for how to best reduce risks, if needed, and protect human health and the environment.

Risks are quantified by combining the intakes estimated in the exposure assessment (Section 3.3) with the toxicity values compiled in the toxicity assessment (Section 4) to yield numerical estimates of potential health risk. Within each exposure scenario, the risk estimates for the complete exposure pathways are combined to estimate the total potential risk for that scenario. For example, risk estimates calculated for incidental ingestion of sediment and surface water, and dermal contact with sediment and surface water for Koppers Pond are combined to estimate total risks for the teenage trespasser at Koppers Pond. Similarly, risk estimates for the direct contact pathways for the outlet channel are combined to estimate total risks for the teenage trespasser at the outlet channel. In addition to estimating risks for each scenario separately, risks across exposure pathways for multiple scenarios are combined to evaluate cumulative exposures for the teenage trespasser; thus, a single estimate of potential risk is developed for the teenage trespasser that encompasses all complete exposure pathways at both the outlet channel and Koppers Pond.

Potential risks for noncarcinogenic and carcinogenic effects are estimated separately. Sections 5.1 and 5.2 present the potential noncarcinogenic and carcinogenic risks, and the methods used to estimate those risks, respectively. The uncertainties and limitations associated with the risk estimates for the Koppers Pond Site, including an alternative fish consumption analysis, are presented in Section 5.3.

5.1 NONCARCINOGENIC HAZARDS

The potential for noncarcinogenic adverse health effects to occur due to exposure to a given chemical at a given concentration is evaluated by comparing the estimated average daily intake (or an average daily dose -ADD) over the duration of exposure to an RfD derived for a similar exposure period. As described in Section 4.1, RfDs are estimates of acceptable daily doses developed by USEPA and other agencies. USEPA defines the chronic RfD as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA 1989).

The ratio of the estimated average daily intake to the RfD is called a hazard quotient (HQ). When one or more hazard quotients are added, either for multiple exposure pathways or for multiple chemicals, the sum is called a hazard index (HI). If the HQ or HI is less than 1, no adverse health effects are expected (USEPA 1989). If the HQ or HI is greater than 1, further risk evaluation might be needed. However, HQs and HIs greater than 1 do not necessarily mean that adverse health effects will be observed. A substantial margin of safety has been incorporated into the RfDs developed for the COPCs. For these chemicals, adverse health effects may not be likely even if the HQ or HI is much larger than 1. The ratio is not a measure of probability that adverse health effects will occur. That is, the level of concern for health effects to occur does not necessarily increase linearly as the RfD is approached or exceeded (USEPA 1989).

The HQ is calculated using the following equation:

$$HQ = \frac{ADD}{RfD}$$

Where:

HQ	=	Hazard quotient associated with exposure to the COPC via the specified route of exposure (dimensionless)
ADD[1]	=	Estimated average daily dose of the COPC via the specified exposure route (mg/kg-day)
RfD	=	Reference dose for the COPC (mg/kg-day)

The HI is calculated using the following formula:

$$HI = HQ_1 + HQ_2 + \ldots + HQ_i$$

Where:

HI	=	hazard index (unitless)
HQ_i	=	the hazard quotient for the i^{th} chemical

In this BHHRA, an HI for each exposure pathway is calculated by summing the HQs for all COPCs, regardless of health effect endpoint. Once HQs for individual chemicals are added within an exposure pathway, the HI for each pathway is summed across multiple pathways to

[1] For exposure via dermal contact, the average daily dose is referred to as the dermally absorbed dose (DAD); however, for simplicity, intakes are referred to in the general equation as the ADD for all exposure routes.

yield a total HI for each exposure scenario. The assumption of additivity is generally believed to overestimate the potential for noncarcinogenic health effects due to simultaneous exposure to multiple chemicals that might impact different endpoints or target organs (USEPA 1989).

The following sections present the HIs calculated for the COPCs identified for Koppers Pond and the outlet channel. Detailed HQ and HI calculations for all direct contact exposure pathways and scenarios are provided in Appendix A, RAGs Part D Table A-7.1, while Table A-7.2 provides detailed HI calculations for fish consumption. Noncarcinogenic hazards for the teenage trespasser are summarized in Table 12. Table 13 summarizes the noncarcinogenic hazards associated with fish consumption. Noncarcinogenic hazards are presented separately for children and adults.

5.1.1 NONCARCINOGENIC HAZARDS FOR TEENAGE TRESPASSER

The HI for the teenage trespasser exposed via incidental ingestion and dermal contact with surface water for Koppers Pond is estimated at 0.00005. The HI for incidental ingestion and dermal contact with sediment for Koppers Pond is 0.03. The total HI for the teenage trespasser for direct contact with both sediment and surface water for Koppers Pond is 0.03 (Table 12). This total HI is well below the target HI of 1; therefore, no adverse noncarcinogenic effects are expected from direct contact with sediment and surface water for Koppers Pond.

The HI for the teenage trespasser exposed via incidental ingestion and dermal contact with surface water for the outlet channel is estimated at 0.00015. The HI for incidental ingestion and dermal contact with sediment for the outlet channel is 0.004. The total HI for the teenage trespasser for direct contact with both sediment and surface water for the outlet channel is 0.004 (Table 12). As is the case with Koppers Pond, this total HI is well below the target HI of 1; therefore, no adverse noncarcinogenic effects are expected from direct contact with sediment and surface water for the outlet channel.

A total receptor HI also is calculated across all pathways, media and all exposure points (i.e., HIs for Koppers Pond and the outlet channel are added). This assumes that the same teenage trespasser could be exposed to surface water and sediment from both Koppers Pond and the outlet channel. The total HI for the teenage trespasser for direct contact with sediment and surface water for Koppers Pond and the outlet channel is 0.03 (Table 12). This represents a conservative estimate of noncarcinogenic hazard, because the potential exposures to COPCs common to both the pond and the outlet channel have been summed, rather than expressed as an average of the exposures to the two locations. In essence, by summing the exposures from the pond and the outlet channel, the teenage trespasser is assumed to have double the exposure of either the pond or outlet channel alone. Because the total HI for the summed exposure is less than 1, and therefore, does not pose an unacceptable risk, the more typical and less conservative approach was not applied in this BHHRA.

As discussed in Section 2.1.4.2 and in the PAR (AMEC 2009b), evaluation of lead in sediment focuses on the USEPA's Adult Lead Model (ALM). This model is appropriate because young children are not receptors at this Koppers Pond Site and the ALM is designed to evaluate non-residential exposures. The ALM is recommended for repeated intermittent or continuous exposures over extended periods of time. However, the ALM is not ideally suited for application to situations where exposure is infrequent. Because the model is based on predicting steady-state blood lead concentrations, infrequent exposure does not allow the blood lead concentrations to reach steady state relative to the exposure source.

The ALM guidance (USEPA 2001b) recommends a minimum exposure duration of 90 days and a minimum exposure frequency of one day per week. When the ALM is run using model default values and an exposure frequency of 52 days/year and an averaging time of 90 days/year (the minimum values recommended as valid by USEPA), the resulting PRG for lead is 2,326 mg/kg. This PRG corresponds to a geometric standard deviation of 1.8 and a background lead blood level of 1.0 microgram per liter (μg/L). Both of these parameters were updated and recommended by USEPA (2009) for all applications of the ALM. Even though the frequency used to derive the lead PRG is greater than the exposure frequency used to estimate sediment exposures, the EPC for lead in sediment (761.7 mg/kg) for Koppers Pond is still well below the lead PRG. Therefore, potential exposure to lead via contact with sediment does not pose a health concern. Lead was not retained as a COPC in sediment for the outlet channel.

Lead was retained as a COPC in surface water for both Koppers Pond and the outlet channel. Maximum lead concentrations were compared to USEPA's action level for lead in tap water (15 μg/L). Due to the lack of other more appropriate benchmarks, this same benchmark is used to compare the EPCs for lead in surface water. It is important to note that USEPA's action level for lead is set as the action level in water delivered to users of public drinking water systems. The surface water for both Koppers Pond and the outlet channel is not a source of drinking water and if any ingestion occurs, it is incidental and infrequent.

For Koppers Pond surface water, the lead EPC is 19.2 μg/L, which slightly exceeds the drinking water action level. Only one surface water sample is at or exceeds the benchmark. This sample, SW08-02, is located near where the Industrial Drainageway empties into Koppers Pond. The arithmetic mean of all surface water samples from the pond (14.1 μg/L) is below the drinking water action level. For the outlet channel, the lead surface water EPC is 16.9 μg/L and represents the maximum lead concentration in the surface water. This maximum concentration slightly exceeds the 15μg/L drinking water action level. The lead concentrations for the other outlet channel surface water samples are less than the drinking water action level, as is the arithmetic mean (11.6 μg/L). In light of the fact that only one surface water sample for both Koppers Pond and the outlet channel only slightly exceeds the lead drinking water benchmark and because the benchmark is set for drinking water, it is reasonable to conclude that the lead concentrations in the surface water for both Koppers Pond and the outlet channel do not pose a health concern.

5.1.2 NONCARCINOGENIC HAZARDS ASSOCIATED WITH FISH CONSUMPTION

When considering noncarcinogenic hazards for both adults and children, the noncarcinogenic hazards are generally higher for children and typically the noncarcinogenic hazard for the young child represents the greatest noncarcinogenic hazards for the given scenario. In this analysis, the HI associated with fish consumption for the young child is 21.1 and is greater than either the HI for the older child (20.3) or adult (15.6) (Table 13). All of these HIs exceed the target HI of 1, but it should be noted that these results reflect the use of USEPA's non-Site-specific default rates of fish consumption to this scenario. When Site-specific data are used to develop potential rates of fish consumption, the calculated risks are much lower, as described in the uncertainty analysis (Section 5.3). The HQ for PCBs represents more than 90 percent of the total HI.

5.2 CARCINOGENIC RISKS

Carcinogenic health risks are estimated as the incremental probability of an individual developing cancer over a lifetime as the result of exposure to carcinogenic chemicals. Because carcinogenic risks from environmental exposures are usually very small numbers, they are typically expressed in scientific notation. The notation $1\text{x}10^{-6}$ is equivalent to 0.000001, or 1/1,000,000, or one in a million. The term incremental probability reflects the fact that the potential risk associated with Site-related exposure is in addition to the background risk of cancer experienced by all individuals in the course of daily life. The lifetime probability of a male resident of the United States developing cancer is 1 in 2, which is equivalent to $5\text{x}10^{-1}$ (i.e., 0.5 or 500,000 in one million) (ACS 2010). The lifetime probability of a female resident of the United States developing cancer is 1 in 3, or $3.3\text{x}10^{-1}$ (i.e., 0.33 or 330,000 in one million) (ACS 2010).

Both federal and state regulatory agencies define what is considered an acceptable level of carcinogenic risk associated with exposure to chemicals in environmental media. USEPA considers $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$ to be the target range for acceptable risks at sites where remediation is considered (USEPA 1990). Estimates of lifetime incremental increases in carcinogenic risks of less than $1\text{x}10^{-6}$ are considered low enough not to warrant any further investigation or analysis (USEPA 1990).

Estimated daily intakes averaged over a lifetime of exposure are multiplied by CSFs (Section 4.2) to yield incremental probabilities of carcinogenic risk, as estimated using the following equation:

$$Cancer\ Risk = Intake\left(\frac{mg}{kg \quad day}\right) \times CSF\left(\frac{mg}{kg \quad day}\right)^{-1}$$

As with HIs, the estimated incremental increase in carcinogenic risks for each chemical and exposure pathway are summed regardless of the carcinogenic endpoint to estimate the total, or cumulative, incremental increase in carcinogenic risk for the exposed individual. Given that the CSFs used to estimate risk are often upper 95 percent confidence limits of the probability of response from experimental animal data, the incremental increase in carcinogenic risks calculated are generally upper-bound estimates (USEPA 1989). It can be assumed that the true risks associated with the site do not exceed the cumulative incremental increase in carcinogenic risks estimated for an exposure scenario, and they may be well below the estimated values. In fact, the range of possible risks includes zero.

The following sections describe the lifetime incremental increase in potential carcinogenic risks calculated for the COPCs identified for Koppers Pond and the outlet channel. Detailed risk calculations for exposure pathways and scenarios associated with direct contact are provided in Appendix A, RAGs Part D Table A-7.1, while Table A-7.2 provides detailed risk calculations for fish consumption. Carcinogenic risks for the teenage trespasser are summarized in Table 12. Table 13 summarizes the carcinogenic risks associated with fish consumption. In contrast with noncarcinogenic hazards, carcinogenic risks are presented for children and adults combined to represent a lifetime risk.

5.2.1 CARCINOGENIC RISKS FOR TEENAGE TRESPASSER

The carcinogenic risk for the teenage trespasser exposed via incidental ingestion and dermal contact with surface water for Koppers Pond is estimated at 3.0×10^{-7}. The carcinogenic risk for incidental ingestion and dermal contact with sediment for Koppers Pond is 1.3×10^{-7}. The total carcinogenic risk for the teenage trespasser for direct contact with both sediment and surface water for Koppers Pond is 4.3×10^{-7} (Table 12). This total carcinogenic risk is below the target risk range of 1×10^{-6} to 1×10^{-4}; therefore, direct contact with sediment and surface water for Koppers Pond does not pose an unacceptable risk.

The carcinogenic risk for the teenage trespasser exposed via incidental ingestion and dermal contact with surface water for the outlet channel is estimated at 3.6×10^{-7}. The carcinogenic risk for incidental ingestion and dermal contact with sediment for the outlet channel is 1.7×10^{-7}. The total carcinogenic risk for the teenage trespasser for direct contact with both sediment and surface water for the outlet channel is 5.3×10^{-7} (Table 12). As is the case with Koppers Pond, this total carcinogenic risk is below the target risk range of 1×10^{-6} to 1×10^{-4}; therefore, direct contact with sediment and surface water for the outlet channel does not pose an unacceptable risk.

A total receptor carcinogenic risk also is calculated across all pathways, media and all exposure points (i.e., carcinogenic risks for Koppers Pond and the outlet channel are added). As discussed in Section 5.1.1, this assumes that the same teenage trespasser was exposed to surface water and sediment from both Koppers Pond and the outlet channel. The total carcinogenic risk for the teenage trespasser for direct contact with sediment and surface water for Koppers

Pond and the outlet channel is $9.6x10^{-7}$. This represents a conservative estimate, because the potential exposures to COPCs common to both the pond and the outlet channel have been summed, rather than expressed as an average of the exposures to the two locations. In essence, by summing the exposures from the pond and the outlet channel, the teenage trespasser is assumed to have double the exposure of either the pond or outlet channel alone. Because the total carcinogenic risk for all exposure points is less than the target risk range of $1x10^{-6}$ to $1x10^{-4}$, and therefore, does not pose an unacceptable risk, the less conservative approach was not applied in this BHHRA.

5.2.2 CARCINOGENIC RISKS ASSOCIATED WITH FISH CONSUMPTION

As discussed previously, carcinogenic risks are averaged over an entire lifetime. Therefore, the estimated carcinogenic risks for the young child, older child and adult are summed to provide a total carcinogenic risk for a lifetime resident consuming fish from the Koppers Pond Site. The total carcinogenic risk associated with fish consumption for a lifetime resident is $3.1x10^{-4}$ (Table 13), using USEPA's default rates of fish consumption, exposure duration, and cooking loss. Although the calculated risk falls outside USEPA's target range of acceptable risks ($1x10^{-6}$ to $1x10^{-4}$), it should be noted that this result reflects the use of USEPA's non-Site-specific default rates of fish consumption and other conservative values for the parameters in this scenario. When Site-specific data are used to develop potential rates of fish consumption, the calculated risks are much lower, as described in the uncertainty analysis (Section 5.3). The carcinogenic risk associated with PCBs represents more than 90 percent of the total carcinogenic risk.

5.3 UNCERTAINTY ANALYSIS

The method followed in this BHHRA to estimate potential risk is a point estimate approach, in which single fixed input values (i.e., point estimates) are used to represent exposure and toxicity parameters in the risk assessment equations. The COPC concentrations and other exposure parameters as well as the toxicity values used in the RME scenarios rely on multiple conservative assumptions. The output of this approach is a single value of risk for each exposure pathway and scenario, which is almost certainly an overestimate of actual risks. Moreover, point estimates are based on numerous assumptions and do not characterize the variability inherent in population exposures and responses or the uncertainty associated with the assumptions made (USEPA 1989; 2001a). As a result, there is a potentially high degree of uncertainty which has led to the characterization of overstated RME risks at the Koppers Pond Site. Therefore, to place risk estimates in perspective and to provide a comprehensive characterization of risk, it is necessary to examine generic and site-specific uncertainties associated with the BHHRA.

Input parameters to the BHHRA are selected by applying parameter values and methods that enhance the likelihood that potential exposures and risks are not underestimated (i.e., by applying conservative assumptions). Variability and uncertainty are evaluated using two approaches. In the first approach, the risk assessment process is evaluated qualitatively to identify assumptions introducing uncertainty into the process. Key factors are evaluated in terms of whether they over- or underestimated risks. The qualitative evaluation of uncertainty is discussed in Section 5.3.1.

In the second approach, uncertainty is characterized by conducting an alternative analysis. This is done by identifying the exposure pathway that contributes substantially to risk levels, in this case, fish consumption, and by applying alternative values for key exposure parameters. The results of the alternative fish consumption analysis, discussed in Section 5.3.2, help to identify the degree of uncertainty associated with that exposure pathway, which contributes most significantly to the total risk.

5.3.1 QUALITATIVE UNCERTAINTY ANALYSIS

Within any of the four steps of the risk assessment process (hazard identification, exposure assessment, toxicity assessment and risk characterization), assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Conservative assumptions are made throughout the risk assessment to ensure that public health is protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are overestimated rather than underestimated.

The assumptions that introduce the greatest amount of uncertainty in this risk assessment are discussed in the following sections.

5.3.1.1 Uncertainties in the Hazard Identification

During the hazard identification step, constituents are selected for inclusion in the quantitative risk assessment. Uncertainties in hazard identification include adequacy of sampling design, analytical error, and selection of COPCs. Generally, there is less uncertainty in this phase of the risk assessment process than in other phases, because these types of uncertainties are likely better understood.

The adequacy of the sampling strategies to characterize site conditions is a potential source of uncertainty in the data analysis phase. Because there are limited resources available, limited sampling is generally performed. In addition, sampling (especially in multiple sampling events) is typically not random but is designed to locate the highest constituent concentrations. Combining data biased in this manner with EPC calculation procedures that do not account for the bias, as is the case in this BHHRA, result in EPCs that are biased high and overestimate the actual concentration to which receptors might be exposed. Use of the upper 95 percent UCL of the average concentration as the EPC adds an additional conservative assumption.

Laboratory analysis is accurate relative to the qualitative nature of "professional judgment" in exposure assessments. Appropriate quality assurance/quality control measures such as the collection of duplicate samples and trip and field blanks were taken and noted. In summary, analytical uncertainty is relatively small compared to sampling uncertainty and the bias introduced by EPC estimation methods that fail to account for the biased nature of sample locations.

Often, only a portion of detected constituents is carried through the risk assessment process because, for example, there may not be USEPA-published toxicity values, or some chemicals might be below background levels. However, all detected constituents identified in Koppers Pond Site media were evaluated in this BHHRA and conservative screening criteria (i.e., residential soil and tapwater PRGs) were used to select COPCs. Therefore, it appears the selection process characterized the analytes likely to contribute to potential risks, and it is unlikely that any appreciable risks were underestimated.

5.3.1.2 Uncertainties in the Exposure Assessment

During the exposure assessment, average daily doses of COPCs to which receptors are potentially exposed are estimated. This process involves assumptions about how often exposure occurs. Such assumptions include location, accessibility, and use of an area. With this in mind, the receptor, or person who may potentially be exposed, and the location of exposure, are both defined for this risk assessment.

In the CSM, the primary uncertainty is associated with correctly identifying complete exposure pathways. If an exposure pathway is identified as complete when, in fact, it is not complete, risk will be overestimated for that receptor. Likewise, if an exposure pathway is identified as incomplete when it is complete, risk will be underestimated for that receptor. In the case of the Koppers Pond Site, it is unlikely that an exposure pathway identified as incomplete is complete, primarily due to restricted access and limited activity and use. Furthermore, while USEPA Region II has agreed that a young child is unlikely to be on site, Region II has requested that fish consumption include a young child. This assumes that the catch is brought home to share with family members. It is quite possible that this exposure pathway is incomplete because those anglers observed fishing report that they typically practice catch and release.

The potential intake/contact rates and exposure frequencies and durations assumed in the risk assessment are conservative. For example, because the Koppers Pond Site is not a recreational destination and only trespassing activity is likely, the assumption that a teenager visits the area one day every week for six months for six years, overestimates the exposure frequency and duration. Another example is the assumption that fish are consumed at rates that are based on surveys of fish consumption by anglers who fish multiple, large bodies of water. These rates are not likely representative of long-term consumption rates from single small waterbodies like Koppers Pond. Furthermore, in using these rates, it is assumed that the productivity of Koppers Pond is sufficient to sustain these rates for 30 years. As discussed in Section 5.3.2, fish productivity for Koppers Pond does not support these rates. Such assumptions almost certainly overestimate actual exposures, if any, which might occur at the Koppers Pond Site. As demonstrated in Section 5.3.2, when more realistic and reasonable exposure assumptions are used, the estimated risks are substantially lower.

5.3.1.3 Uncertainties in the Toxicity Assessment

Dose-response values are usually based on limited toxicological data. For this reason, a margin of safety is built into estimates of both noncarcinogenic hazards and carcinogenic risks, and actual hazards and risks are lower than those estimated. The two major areas of uncertainty introduced in the toxicity assessment are: (1) animal to human extrapolation; and (2) high to low dose extrapolation. These are discussed below.

Human dose-response values are often extrapolated, or estimated, using the results of animal studies. Extrapolation from animals to humans introduces a great deal of uncertainty in the risk assessment because in most instances, it is not known how differently a human may react to the constituent compared to the animal species used to test the constituent. The procedures used to extrapolate from animals to humans involve conservative assumptions and incorporate several uncertainty factors that overestimate the adverse effects associated with a specific dose. As a result, overestimation of the potential for adverse effects to humans is more likely than underestimation.

Predicting potential health effects requires the use of models to extrapolate the observed health effects from the high doses used in laboratory studies to the anticipated human health effects from low doses experienced in the environment. The models contain conservative assumptions to account for the large degree of uncertainty associated with this extrapolation (especially for potential carcinogens) and therefore, tend to overestimate than underestimate the risks.

No toxicity value is available for benzo(ghi)perylene. In this case, benzo[b]fluoranthene is used as a surrogate for benzo(ghi)perylene and the toxicity value for benzo[b]fluoranthene is used. The use of surrogate toxicity values introduces uncertainty into the risk assessment.

5.3.1.4 Uncertainties in the Risk Characterization

The major area of uncertainty in the risk characterization process is the combination of upper-bound exposure estimates with upper-bound toxicity estimates, resulting in an overestimation of risks.

5.3.2 ALTERNATIVE FISH CONSUMPTION ANALYSIS

The selection of values for exposure parameters requires professional judgment about the strengths and limitations of information available in the technical literature and about how the literature values apply to a specific site. In the case of the fish consumption pathway, a great deal of overt conservatism is introduced through the use of the USEPA default fish consumption rate that was used in the BHHRA. The adult RME consumption rate required by USEPA Region II is a default freshwater fish consumption rate that is based on surveys of fish consumption by anglers who fish multiple, large bodies of water. It has been applied by USEPA Region II in risk assessments of major waterways in the region. As discussed in detail in Appendix C, *Alternative Fish Consumption Rates to Support the Koppers Pond Human Health Risk Assessment*, (Arcadis 2011), this RME rate does not represent long-term consumption from single small waterbodies like Koppers Pond. In addition, the productivity of Koppers Pond is not sufficient to sustain the RME rate over the 30-year exposure duration. Arcadis (2011) determined the likely productivity of Koppers Pond and based on the productivity, presents alternative fish consumption rates that are used in this alternative analysis. At the direction of USEPA Region II, only RME exposures are provided in the BHHRA. This alternative analysis presents both RME and CTE exposure estimates. The alternative RME analysis follows the baseline RME fish consumption scenario in the BHHRA with the exception of alternative consumption rates and a cooking loss factor. The alternative CTE analysis relies on alternative consumption rates, EPCs based on the mean rather than the UCL, and a cooking loss factor. Table 14 summarizes the exposure parameters that vary from the baseline analysis and are used in the alternative analysis. The following sections discuss those parameters that are different from the defaults used in the BHHRA.

5.3.2.1 Alternative Fish Consumption Rates

As discussed in Appendix C (Arcadis 2011), it is highly unlikely that Koppers Pond would experience the level of fishing and consumption activity that USEPA Region II recommends. Rates of fish consumption from specific waterbodies are affected by a number of factors including the size and productivity of the fishery, the climate, accessibility, availability of edible size fish, fishing regulations, and the availability of better quality fisheries nearby. Appendix C describes the methodology used to determine the productivity for Koppers Pond. Briefly, three different methods are used to estimate the total sustainable fish yield of Koppers Pond. These methods are the following:

- Method provided by Downing and Plante (1993);
- Forage to carnivorous (F/C) ratio; and
- Estimation of harvestable-sized fish (AT value).

These estimates are based on productivity and then adjusted to reflect the amount of fish mass produced by the pond each year that could be removed from the pond by fishing, without impacting the sustainability of the fishery. The three estimates are very similar ranging from 9.8 g/day to 11.8 g/day (12 g/day is assumed for subsequent evaluation). While these rates represent the maximum rate at which fish can be removed from Koppers Pond, these rates are not equivalent to a fish consumption rate that can be sustained for all anglers who fish Koppers Pond. One individual could consume at the sustainable harvest rate (12 g/day) without affecting the pond's productivity, but no other individuals could also eat fish from the pond and have the pond retain a sustainable fishery.

To arrive at a fish consumption rate, it is necessary to divide the sustainable harvest rate by the number of fish consumers. As directed by USEPA Region II, it is assumed that an angler's catch is shared with himself, an adolescent, and a young child. Therefore, assuming the sustainable yield of 12 g/day is harvested by a single angler and that this individual shares his or her catch with one adolescent and one young child, the maximum consumption rates, without impacting the sustainability of the pond, would be 6 g/day for the adult, 4 g/day for the adolescent (2/3 of adult rate), and 2 g/day for the young child (1/3 of adult rate). To derive rates for the CTE analysis, Arcadis (2011) conservatively assumed that five individuals fish the pond and that their total combined sustainable harvest is 12 g/day. Assuming that these five individuals consume with equal frequency, a total of 2.4 g/day of total fish mass is available per person. Sharing the 2.4 g/day with an adolescent and young child, the consumption rates are 1.2 g/day, 0.8 g/day and 0.4 g/d for an adult, an adolescent and a young child, respectively.

5.3.2.2 Exposure Point Concentrations

Exposure point concentrations for the alternative RME analysis are the same as those used to estimate the potential risk associated with fish consumption in the BHHRA. As discussed in the PAR (AMEC 2009b), the EPCs for the alternative CTE analysis reflect the mean concentrations. Selection of the appropriate mean depends on the distribution of the concentration data for each COPC. As previously discussed, total PCBs, mercury, and arsenic are the COPCs in fish. The concentration data for total PCBs and mercury are best represented by gamma-normal distributions and such distributions are best approximated by the geometric mean. Therefore, the geometric means for total PCBs and mercury are selected as the EPCs in the alternative CTE analysis (Table 14). Arsenic data in the fish are neither normal nor log-normal. Therefore, per USEPA guidance, the mean derived by the Kaplan-Meier method is used as the EPC for arsenic (Table 14).

5.3.2.3 Cooking Loss Factor

Cooking loss accounts for the amount of chemical in fish tissue that is lost as a result of preparation and cooking. No cooking loss has been assumed for metals (i.e., arsenic and mercury). Heavy metals tend to bind to protein, thereby concentrating in the muscle tissue and are not impacted by cooking (USEPA 2000). PCBs and other organochlorine compounds accumulate in the fatty tissue; therefore, preparation techniques such as trimming and skin removal, and cooking methods like frying, broiling or baking can reduce the amount of chemical contaminants in the fish that is consumed (USEPA 2000). USEPA (2000) summarizes chemical contaminant reduction due to skinning, trimming, and cooking for a number of different chemicals present in a number of different fish species. The reported reduction percentage for PCBs ranges from 0 to approximately 40 percent. The midpoint of this range (20 percent) is used as the cooking loss factor in the alternative RME analysis, while the upper end of the range (40 percent) is used for the alternative CTE analysis.

5.3.3 RESULTS OF THE ALTERNATIVE FISH CONSUMPTION ANALYSIS

When considering noncarcinogenic hazards for both adults and children, the noncarcinogenic hazards are generally higher for children and typically the noncarcinogenic hazard for the young child represents the greatest noncarcinogenic hazards for the given scenario. For the alternative fish consumption analysis, the RME HI for the young child is 4.3 (Table 15). While this HI exceeds the target HI of 1, the CTE HI for the young child is 0.3, well below the target HI of 1. Similar to the baseline HI, the HQ for PCBs represents more than 90 percent of the total HI. For the alternative RME fish consumption analysis, the total carcinogenic risk is 6.1×10^{-5} and the alternative CTE carcinogenic risk is 4.1×10^{-6} (Table 15). These risks fall within USEPA's target range of acceptable risks (1×10^{-6} to 1×10^{-4}). Similar to the baseline risks, the carcinogenic risk associated with PCBs represents more than 90 percent of the total carcinogenic risk.

The results of the alternative fish consumption analysis clearly demonstrate that the baseline risks are highly conservative and overestimate exposures. Both the alternative CTE and RME carcinogenic risks fall within USEPA's acceptable range and while the alternative RME noncarcinogenic hazard exceeds 1, it is well below the baseline noncarcinogenic hazard. The alternative CTE noncarcinogenic hazard is below USEPA's target. These alternative risks rely on fish consumption rates that are more realistic and based on the productivity of Koppers Pond. Even using site-specific consumption rates, the risks, in all likelihood, are still overestimated. While fishing activity has been observed, anglers have reported that they typically practice catch and release. Therefore, the alternative CTE risks should be viewed as the most realistic upper-bound estimates of potential risk.

6 SUMMARY AND CONCLUSIONS

USEPA (1989) describes a BHHRA as a quantitative evaluation of the potential risk posed to human health by the actual or potential presence of chemicals in the environment. A risk assessment provides a conservative estimate of the likelihood of health effects in a population. The results of the risk assessment are intended to help site managers determine the need for remedial action; and ; provide a basis for comparing the health impacts of remedial alternatives, if necessary; and provide a consistent process for documenting potential risks (USEPA1989). This BHHRA was performed in accordance with USEPA guidance and incorporates numerous comments provided by USEPA Region II on the MESA and PAR (AMEC 2009a,b). Consistent with USEPA's description and stated purpose of risk assessment, this BHHRA provides an evaluation of potential risks associated with potential exposure to COPCs for teenagers who might trespass and contact surface water and sediment from the outlet channel or Koppers Pond. In addition, this BHHRA provides an evaluation of potential risks associated with consumption of fish from Koppers Pond.

Estimates of potential noncarcinogenic hazards associated with direct contact to sediment and surface water for Koppers Pond and the outlet channel are summarized in Table 12. All of the HIs for the RME teenager are below the health-based target noncarcinogenic HI of 1. Therefore, no noncarcinogenic hazards associated with direct exposure to COPCs in sediment and surface water exist at the Koppers Pond Site. Because lead, a COPC in sediment and surface water, lacks a toxicity value, a different approach was used to evaluate the potential noncarcinogenic hazards associated with lead exposure. In the case of sediment, the EPC for lead is well below the PRG based on USEPA's adult lead model. Therefore, potential exposure to lead via contact with sediment does not pose a health concern. For surface water, the lead EPCs are compared to USEPA's lead action level in water delivered to users of public drinking water systems. The EPCs slightly exceed the drinking water action level but the arithmetic means are below the action level. It is important to recognize that the surface water for both Koppers Pond and the outlet channel is not a source of drinking water and if any ingestion occurs, it is incidental and infrequent. Because surface water RME EPCs only slightly exceed the lead benchmark and because the benchmark is set for drinking water, it is reasonable to conclude that exposure to lead in the surface water does not pose a health concern.

Estimates of potential carcinogenic risks associated with direct contact to sediment and surface water for Koppers Pond and the outlet channel are summarized in Table 12. The cumulative potential RME lifetime carcinogenic risks for the teenage trespasser are below the target risk range of 1×10^{-6} to 1×10^{-4}. Both the total RME HI and the cumulative potential RME lifetime carcinogenic risk associated with fish consumption exceed USEPA's acceptable levels (Table 13), but these results are generated using USEPA's default conditions and highly conservative exposure assumptions. PCBs represent more than 90 percent of the total estimated risks.

The parameter values and risk assessment methods employed in this BHHRA rely on multiple conservative assumptions that are designed to overestimate potential exposures and risks. In combination, these conservative assumptions overstate potential risks for most receptors. For example, the fish consumption rates are default values that represent consumption by anglers who fish multiple large waterbodies. The productivity of Koppers Pond cannot sustain these rates over the default exposure duration of 30 years. In addition, there is little evidence to support that the harvested fish are even consumed and shared with family members. Another example is the use of the 95- percent UCL for the EPC. The UCL represents the upper confidence level of the mean or even the maximum concentration. A simple analysis of the concentrations of PCBs detected in fish for Koppers Pond demonstrates that the mean value better represents the data than the UCL. Figure 4 shows that most of the observed results are below the UCL, particularly for the large mouth bass.

Use of more representative EPCs and more realistic exposure assumptions results in substantially lower estimates of potential risk. Table 16 compares the baseline risks to the results of analyses where more representative EPCs and more realistic exposure assumptions are used. As shown, when EPCs that are based on the mean are combined with baseline exposure assumptions, estimated hazards and risks are substantially reduced (depicted in Table 16 as "Mean EPC – Baseline Analysis"). Similar reductions in hazards and risks are seen when baseline EPCs are combined with site-specific consumption rates (depicted in Table 16 as "RME – Alternative Analysis"). Estimated hazards and risks are further reduced and, in fact, fall below USEPA's acceptable thresholds when data that best represent the site are used (depicted in Table 16 as "CTE – Alternative Analysis").

Table 16 also presents the risks associated with background PCB concentrations. As part of the ecological assessment, sediment and fish samples were collected from a nearby reference pond. PCBs and metals were not detected in the gamefish collected from the reference pond; however, background risks are conservatively estimated using one-half the detection limit for PCBs (10 ppb) in combination with the default baseline exposure assumptions. Even the undetected PCB concentration results in a HI slightly greater than 1, underscoring the highly conservative nature of the exposure assumptions used in the BHHRA.

In summary, the results of the BHHRA indicate that exposures to COPCs in the sediment and surface water for both the outlet channel and Koppers Pond do not pose a health concern. Under baseline conditions, and conservative exposure assumptions, the potential risks from fish consumption exceed target levels. However, use of more realistic and representative EPCs and exposure assumptions based on Site-specific conditions result in potential risks that are within acceptable risk levels.

7 REFERENCES

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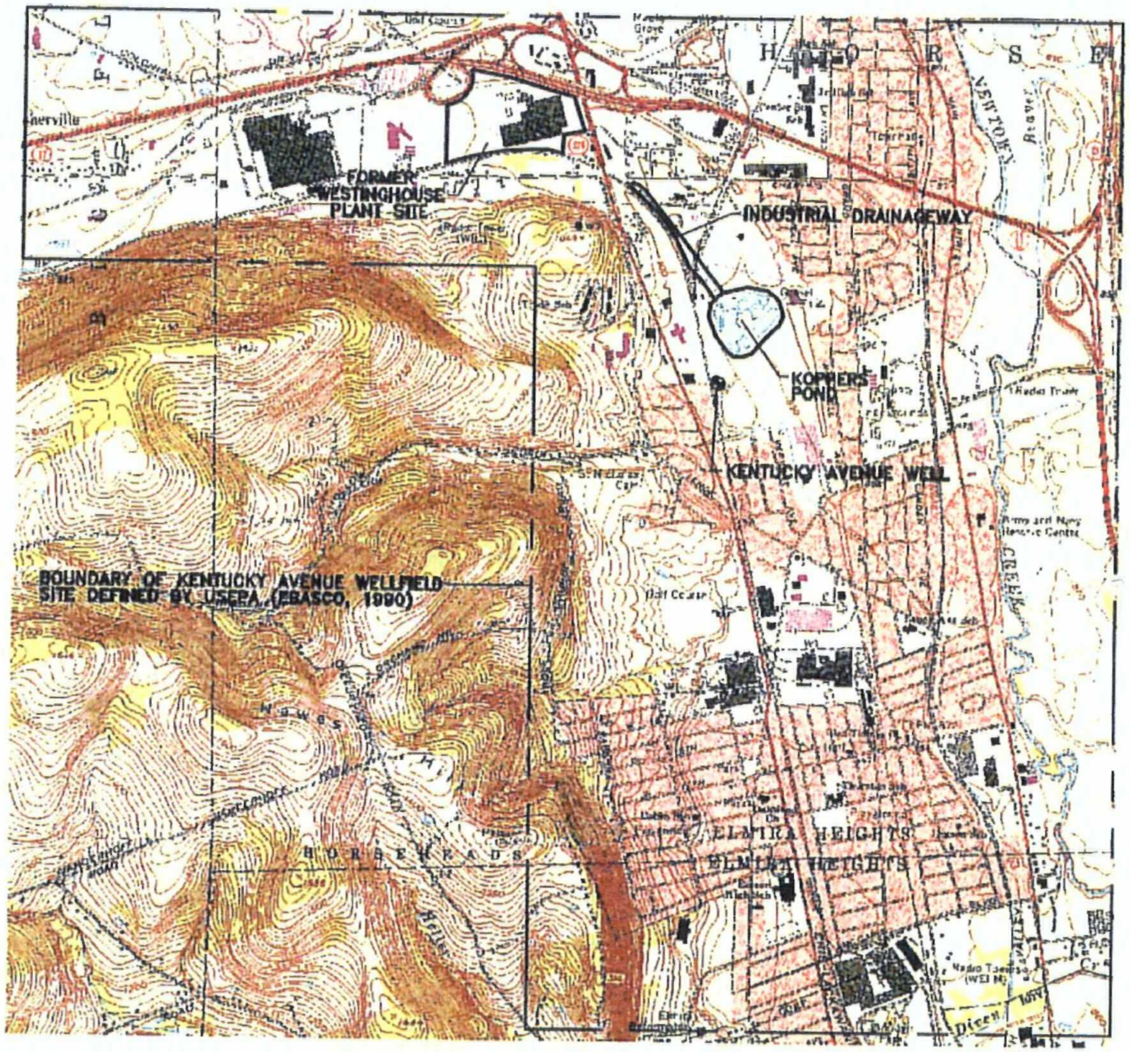
FIGURES

DRAWING NUMBER 07502B1



SCALE

0 2000 4000 FEET

QUADRANGLE LOCATION

REFERENCE:

MODIFIED FROM U.S GEOLOGICAL SURVEY HORSEHEADS, NEW YORK, AND ELMIRA, NEW YORK-PENNSYLVANIA, QUADRANGLES, PHOTOREVISED 1978.

FIGURE 1

SITE LOCATION MAP

KENTUCKY AVENUE WELLFIELD SITE – OU4
HORSEHEADS, NEW YORK

PREPARED FOR

KOPPERS POND RI/FS GROUP

CUMMINGS RITER CONSULTANTS, INC.

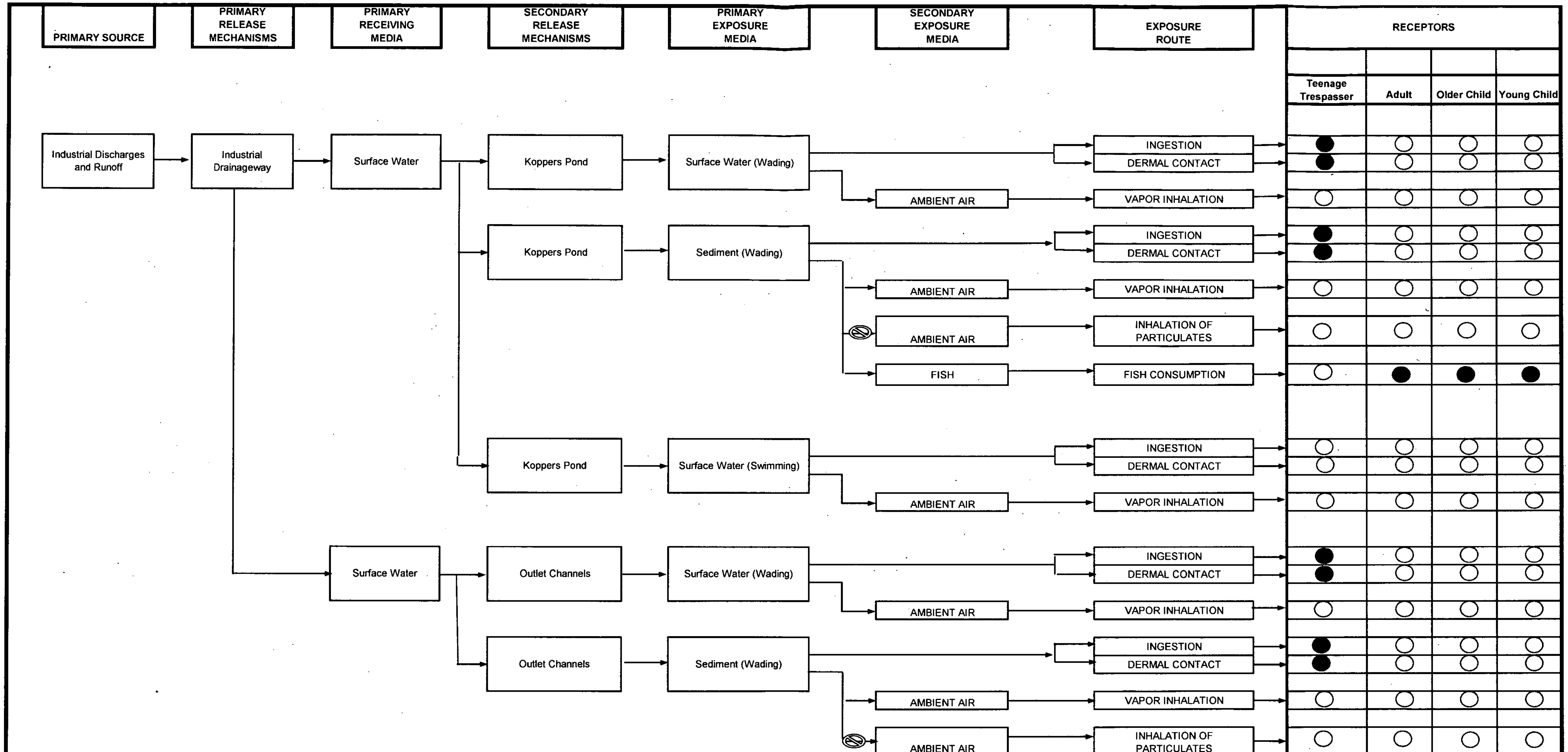
DRAWING NUMBER	07502B1
DRAWN BY: T.E. McKee	DATE: 1-31-07
CHECKED BY: W.C. Smith	DATE: 2-19-07
APPROVED BY: W.C. Smith	DATE: 2-19-07

PLOT SCALE: 1=1

FIGURE 2
SITE PLAN
KENTUCKY AVE. WELLFIELD SITE - OU4
HORSEHEADS, NEW YORK

CUMMINGS RITER CONSULTANTS, INC.

Prepared For:
KOPPERS POND RI/FS GROUP



LEGEND

- ○ Exposure Pathway Evaluated and Incomplete
- ● Exposure Pathway Evaluated and Complete
- ⊘ Transport Pathway Incomplete

integral consulting inc.

Figure 3. Conceptual Site Model
Koppers Pond Kentucky Avenue Wellfield Site, Operable Unit 4, Horseheads, New York

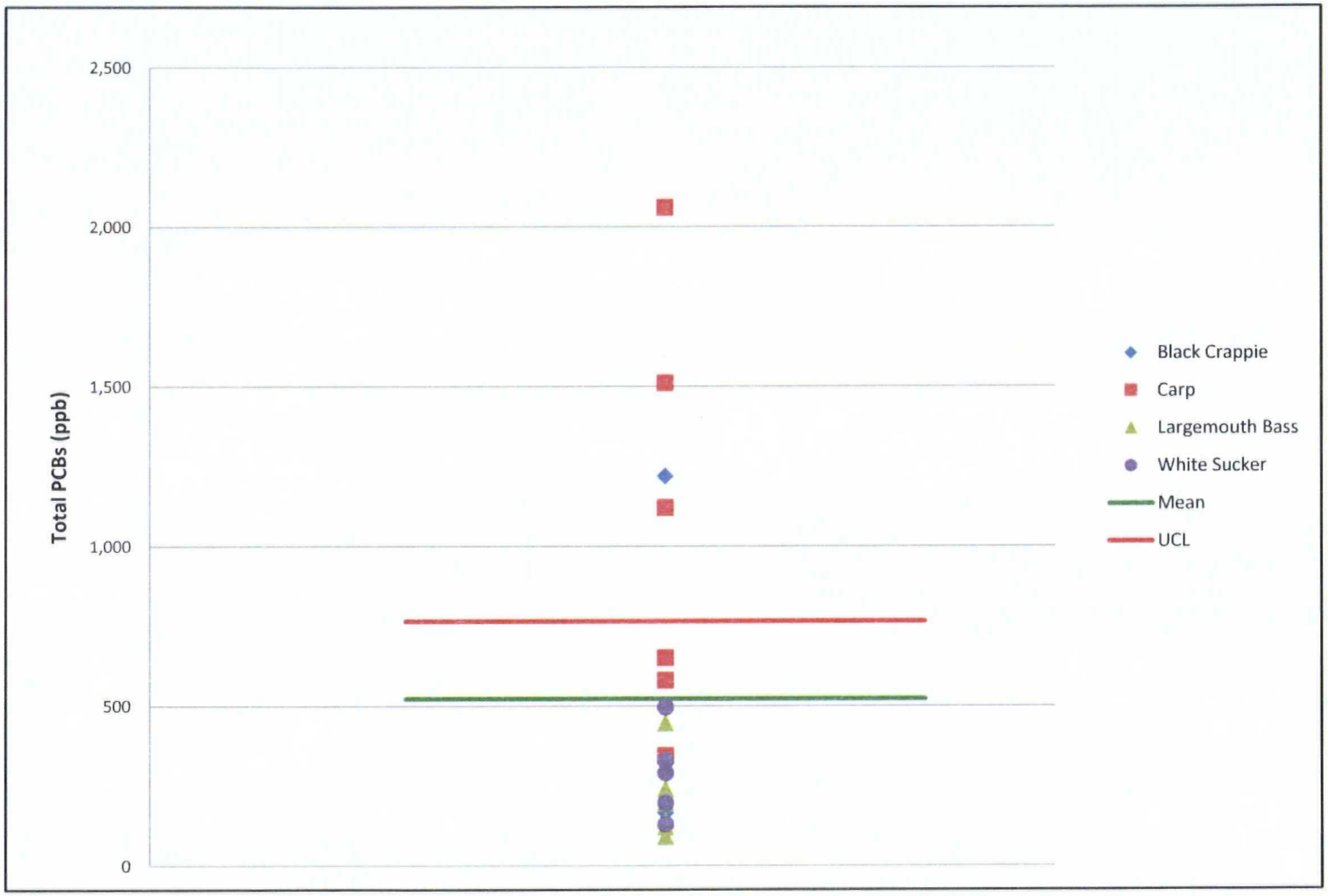


Figure 4. Comparison of Observed Total PCB Concentrations in Gamefish and EPCs

integral consulting inc.

TABLES

Table 1a. Chemicals of Potential Concern - Surface Water

Koppers Pond	Outlet Channel
Benzo(b)fluoranthene	Tetrachloroethene
Arsenic	Benzo(a)anthracene
Lead	Benzo(b)fluoranthene
	Arsenic
	Lead

Table 1b. Chemicals of Potential Concern - Sediment

Koppers Pond	Outlet Channel
Benzo(a)anthracene	Benzo(a)anthracene
Benzo(a)pyrene	Benzo(a)pyrene
Benzo(b)fluoranthene	Benzo(b)fluoranthene
Benzo(ghi)perylene	Benzo(ghi)perylene
Dibenz(a,h)anthracene	Dibenz(a,h)anthracene
Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene
Total PCBs (Aroclor 1254)[1]	Total PCBs (Aroclor 1254)[1]
Arsenic	Arsenic
Cadmium	Cadmium
Chromium	
Lead	

1. Aroclor 1254 was the only Aroclor detected in sediment; therefore, total PCBs is equivalent to Aroclor 1254 in sediment.

Table 1c. Chemicals of Potential Concern - Gamefish

Koppers Pond
Total PCBs
Arsenic
Mercury

Table 2a. Exposure Point Concentrations - Surface Water

Chemicals of Potential Concern	Exposure Point Concentrations (µg/L)	
	Koppers Pond	Outlet Channel
Tetrachloroethene	--	0.22
Benzo(a)anthracene	--	0.05
Benzo(b)fluoranthene	0.25	0.27
Arsenic	0.30	0.79
Lead	19.2	16.9

Table 2b. Exposure Point Concentrations - Sediment

	Exposure Point Concentrations			
Chemicals of Potential Concern	Koppers Pond		Outlet Channel	
Benzo(a)anthracene	867	µg/kg	2200	µg/kg
Benzo(a)pyrene	752	µg/kg	940	µg/kg
Benzo(b)fluoranthene	1099	µg/kg	2600	µg/kg
Benzo(ghi)perylene	825	µg/kg	580	µg/kg
Dibenz(a,h)anthracene	164	µg/kg	85	µg/kg
Indeno(1,2,3-cd)pyrene	695	µg/kg	580	µg/kg
Total PCBs (Aroclor 1254)[1]	1338	µg/kg	280	µg/kg
Arsenic	3.2	mg/kg	7.2	mg/kg
Cadmium	392	mg/kg	91.9	mg/kg
Chromium	275	mg/kg	--	mg/kg
Lead	762	mg/kg	--	mg/kg

1. Aroclor 1254 was the only Aroclor detected in sediment; therefore, total PCBs is equivalent to Aroclor 1254 in sediment.

Table 2c. Exposure Point Concentrations - Gamefish

Chemicals of Potential Concern	Exposure Point Concentrations	
Total PCBs	827	µg/kg
Arsenic	0.08	mg/kg
Mercury	0.2	mg/kg

Table 3. Common Exposure Parameters for Direct-Contact Pathways

Exposure Parameter	Teenage Trespasser	Source
Body weight (kg)	57.2	USEPA 1997
Exposure duration (yrs)	6	Based on age of teenager (12 – 18 years old)
Exposure frequency (days/yr)	24	4 days/month for 6 months per year (CDM 1995)
Averaging time – carcinogenic (days)	25,550	USEPA 1989
Averaging time - noncarcinogenic (days)	2,190	Equal to the exposure duration (USEPA 1989)

Table 4. Pathway-Specific Exposure Parameters for Incidental Ingestion of Surface Water

Exposure Parameter	Teenage Trespasser	Source
Incidental ingestion rate for surface water (liters/hour)	0.025	one-half the default swimming contact rate of 0.05 liters/hour (USEPA 1989)
Exposure time (hours/day)	1.6	Based on the age-specific amount of time spent outdoors for teenagers (USEPA 2008)
Chemical concentration in surface water (C_{sw})	Chemical-specific	See Table 2a
Oral absorption factor (ABS_o)	Chemical-specific	See Table 9

Table 5. Pathway-Specific Exposure Parameters for Dermal Contact with Surface Water

Exposure Parameter	Teenage Trespasser	Source
Exposed skin surface area (cm^2)	4,029	Based on the age-specific mean surface area of hands, lower legs, and feet (USEPA 2004)
Events per day (event/day)	1	Professional judgment
Event duration (hour/event)	1.6	Based on the age-specific amount of time spent outdoors for teenagers (USEPA 2008)
Chemical concentration in surface water (C_{sw})	Chemical-specific	See Table 2a
Fraction absorbed (FA), permeability coefficient (Kp), lag time (event)	Chemical-specific	See Table 9

Table 6. Pathway-Specific Exposure Parameters for Incidental Ingestion of Sediment

Exposure Parameter	Teenage Trespasser	Source
Incidental ingestion rate for sediment (mg/day)	50	USEPA 1997
Chemical concentration in sediment (C_{sed})	Chemical-specific	See Table 2b
Oral absorption factor (ABS_o)	Chemical-specific	See Table 9

Table 7. Pathway-Specific Exposure Parameters for Dermal Contact with Sediment

Exposure Parameter	Teenage Trespasser	Source
Exposed skin surface area (cm^2)	4,029	Based on the age-specific mean surface area of hands, lower legs and feet (USEPA 2004)
Skin adherence factor (mg/cm^2-day)	0.07	Based on the residential adherence factor for an adult (USEPA 2004)
Chemical concentration in sediment (C_{sed})	Chemical-specific	See Table 2b
Dermal absorption factor (ABS_d)	Chemical-specific	See Table 9

Table 8. Pathway-Specific Exposure Parameters for Fish Consumption

Exposure Parameter	Young Child	Older Child	Adult	Source
Body weight (kg)	16.6	34.5	70	USEPA 1997
Fish consumption rates (grams/day)	8	16	25	Based on discussions with USEPA Region 2
Exposure frequency (days/year)	365	365	365	Annualized consumption rate
Exposure duration (years)	6	6	18	USEPA 1989
Chemical concentration in fish (C_{fish})	Chemical-specific	Chemical-specific	Chemical-specific	See Table 2c
Oral absorption factor (ABS_f)	Chemical-specific	Chemical-specific	Chemical-specific	See Table 9

Table 9. Chemical-Specific Parameter Values [1]

Chemical of Concern	Oral Absorption Factor (ABS_o) (unitless)	Dermal Absorption Factor (ABS_d) (unitless)	Oral Absorption Factor - Fish (ABS_{fish}) [2] (unitless)	Dermal Permeability Coefficient (K_p) (cm/hour)	Fraction Absorbed (FA) unitless	Lag Time per Event (t event) (hour/event)
Tetrachloroethene	1	NA	NA	3.30E-02	1.0	0.91
Benzo(a)anthracene	1	0.13	NA	4.70E-01	1.0	2.03
Benzo(a)pyrene	1	0.13	NA	NA	NA	NA
Benzo(b)fluoranthene	1	0.13	NA	7.00E-01	1.0	2.77
Benzo(ghi)perylene [3]	1	0.13	NA	NA	NA	NA
Dibenz(a,h)anthracene	1	0.13	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1	0.13	NA	NA	NA	NA
Total PCBs (Aroclor 1254)	1	0.14	1	NA	NA	NA
Arsenic	1	0.03	1	1.00E-03	NA	NA
Cadmium	soil:0.025; water:0.05	0.001	NA	NA	NA	NA
Chromium VI	0.025	0.013 [4]	NA	NA	NA	NA
Lead	1	0.001 [5]	NA	1.00E-04	NA	NA
Mercury (methyl)	NA	NA	1	NA	NA	NA

Notes:
[1] USEPA (2004) source for all values, unless otherwise noted.
[2] ABS_{fish} assumed to be 100%
[3] benzo(b)fluoranthene surrogate for benzo(ghi)perylene
[4] Chen et al. 2001
[5] Moore et al. 1980 cited in USEPA 2001
NA = Not Applicable

Table 10. Noncarcinogenic Toxicity Data -- Oral/Dermal

Chemical of Potential Concern	Oral Reference Dose (mg/kg-day)	Absorbed Reference Dose for Dermal (mg/kg-day)
Arsenic (inorganic)	3.0E-04	3.0E-04
Benzo(a)anthracene	NA	NA
Benzo(a)pyrene	NA	NA
Benzo(b)fluoranthene	NA	NA
Benzo(ghi)perylene	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA
Cadmium	1.8E-03	4.5E-05
Chromium (VI)	3.0E-03	7.5E-05
Dibenz(a,h)anthracene	NA	NA
Lead	NA	NA
Mercury (methyl)	1.0E-04	1.0E-04
Tetrachloroethene	1.0E-02	1.0E-02
Total PCBs (Aroclor 1254)	2.0E-05	2.0E-05

Table 11. Carcinogenic Toxicity Data -- Oral/Dermal

Chemical of Potential Concern	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Absorbed Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$
Arsenic	1.5E+00	1.5E+00
Benzo(a)anthracene	7.3E-01	7.3E-01
Benzo(a)pyrene	7.3E+00	7.3E+00
Benzo(b)fluoranthene	7.3E-01	7.3E-01
Benzo(ghi)perylene	7.3E-01	7.3E-01
Indeno(1,2,3-cd)pyrene	7.3E-01	7.3E-01
Cadmium	NA	NA
Chromium (IV)	NA	NA
Dibenz(a,h)anthracene	7.3E+00	7.3E+00
Lead	NA	NA
Mercury (methyl)	NA	NA
Tetrachloroethene	5.4E-01	5.4E-01
Total PCBs (Aroclor 1254)	2.0E+00	2.0E+00

Table 12. Total RME Noncarcinogenic Hazards and Carcinogenic Risks - Teenage Trespasser

	Noncarcinogenic Hazards (Unitless)	Carcinogenic Risks (Unitless)
Koppers Pond	0.03	4.3E-07
Outlet Channel	0.004	5.3E-07
Koppers Pond and Outlet Channel	0.03	9.6E-07

Table 13. RME Noncarcinogenic Hazards and Carcinogenic Risks - Fish Consumption

	Noncarcinogenic Hazards (Unitless)			Carcinogenic Risks (Unitless)			
COPC	Child RME	Older Child RME	Adult RME	Child RME	Older Child RME	Adult RME	Total Risk
Arsenic	0.1	0.1	0.1	4.7E-06	4.5E-06	1.0E-05	2.0E-05
Mercury	1.0	1.0	0.8	NA	NA	NA	NA
Total PCBs	19.9	19.2	14.8	6.8E-05	6.6E-05	1.5E-04	2.9E-04
Total RME Noncarcinogenic Hazards	**21.1**	20.3	15.6	Total RME Carcinogenic Risk			**3.1E-04**

Table 14. Pathway-Specific Exposure Parameters for Alternative Fish Consumption Analysis[1]

Exposure Parameter	RME			CTE			Source
	Young Child	Older Child	Adult	Young Child	Older Child	Adult	
Chemical concentration in fish							
Total PCBs (µg/kg)	827	827	827	321	321	321	calculated
Arsenic (mg/kg)	0.08	0.08	0.08	0.06	0.06	0.06	calculated
Mercury (mg/kg)	0.2	0.2	0.2	0.08	0.08	0.08	calculated
Fish consumption rates (grams/day)	2	4	6	0.4	0.8	1.2	Arcadis 2011
Cooking loss (percent)	20	20	20	40	40	40	USEPA 2000

1. All other parameters were similar to those used for the baseline analysis

Table 15. RME Noncarcinogenic Hazards and Carcinogenic Risks - Alternative Fish Consumption Analysis

	Noncarcinogenic Hazards (Unitless)						Carcinogenic Risks (Unitless)							
	Central Tendency Exposures (CTE)			Reasonable Maximum Exposures (RME)			Central Tendency Exposures (CTE)			Reasonable Maximum Exposures (RME)				
COPC	Child CTE	Older Child CTE	Adult CTE	Child RME	Older Child RME	Adult RME	Child CTE	Older Child CTE	Adult CTE	Child RME	Older Child RME	Adult RME	CTE Risk	RME Risk
Arsenic	0.01	0.005	0.004	0.03	0.03	0.02	2.0E-07	1.9E-07	4.2E-07	1.2E-06	1.1E-06	2.5E-06	8.0E-07	4.8E-06
Mercury	0.02	0.02	0.01	0.3	0.2	0.2	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	0.2	0.2	0.2	4.0	3.8	2.8	8.0E-07	7.7E-07	1.7E-06	1.4E-05	1.3E-05	2.9E-05	3.3E-06	5.6E-05
Total Noncarcinogenic Hazards	**0.3**	0.2	0.2	**4.3**	4.1	3.0				Total CTE Carcinogenic Risk			**4.1E-06**	
										Total RME Carcinogenic Risk				**6.1E-05**

Table 16. Comparison of Noncarcinogenic Hazards and Carcinogenic Risks - Fish Consumption

	Noncarcinogenic Hazards	Carcinogenic Risks
RME - Baseline Analysis	21.1	3.1E-04
Mean EPC - Baseline Analysis	4.1	6.6E-05
RME - Alternative Analysis	4.3	6.1E-05
CTE - Alternative Analysis	0.3	4.1E-06
Background	1.4	2.3E-05

APPENDIX A

RAGS PART D TABLES

APPENDIX A TABLES

Table A-0. Site Risk Assessment Identification Information

Table A-1. Selection of Exposure Pathways

Table A-2.1. Occurrence, Distribution, and Selection of Chemicals of Potential Concern – Surface Water, Koppers Pond

Table A-2.2. Occurrence, Distribution, and Selection of Chemicals of Potential Concern – Surface Water, Outlet Channel

Table A-2.3. Occurrence, Distribution, and Selection of Chemicals of Potential Concern – Sediment, Koppers Pond

Table A-2.4. Occurrence, Distribution, and Selection of Chemicals of Potential Concern – Sediment, Outlet Channel

Table A-2.5. Occurrence, Distribution, and Selection of Chemicals of Potential Concern – Fish, Koppers Pond

Table A-3.1. Exposure Point Concentration Summary-Reasonable Maximum Exposure – Surface Water, Koppers Pond

Table A-3.2. Exposure Point Concentration Summary-Reasonable Maximum Exposure – Surface Water, Outlet Channel

Table A-3.3. Exposure Point Concentration Summary-Reasonable Maximum Exposure – Sediment, Koppers Pond

Table A-3.4. Exposure Point Concentration Summary-Reasonable Maximum Exposure – Sediment, Outlet Channel

Table A-3.5a. Exposure Point Concentration Summary-Reasonable Maximum Exposure – Fish, Koppers Pond

Table A-3.5b. Exposure Point Concentration Summary-Central Tendency Exposure – Fish, Koppers Pond

Table A-4.1. Values Used for Daily Intake Calculations – Surface Water – Reasonable Maximum Exposure

Table A-4.2. Values Used for Daily Intake Calculations – Sediment – Reasonable Maximum Exposure

Table A-4.3a. Values Used for Daily Intake Calculations – Fish Consumption – Reasonable Maximum Exposure, Adult

Table A-4.3b. Values Used for Daily Intake Calculations – Fish Consumption – Reasonable Maximum Exposure, Older Child

Table A-4.3c. Values Used for Daily Intake Calculations – Fish Consumption – Reasonable Maximum Exposure, Young Child

Table A-5.1	Non-Cancer Toxicity Data – Oral/Dermal
Table A-5.2	Non-Cancer Toxicity Data - Inhalation
Table A-6.1	Cancer Toxicity Data – Oral/Dermal
Table A-6.2	Cancer Toxicity Data - Inhalation
Table A-7.1	Calculation of Chemical Cancer Risks and Non-Cancer Hazards - Reasonable Maximum Exposure, Surface Water and Sediment
Table A-7-2.	Calculation of Chemical Cancer Risks and Non-Cancer Hazards - Reasonable Maximum Exposure, Fish Consumption
Table A-9.1	Summary of Receptor Risks and Hazards for COPCs - Reasonable Maximum Exposure, Surface Water and Sediment
Table A-9.2	Summary of Receptor Risks and Hazards for COPCs - Reasonable Maximum Exposure, Fish Consumption

TABLE A-0

SITE RISK ASSESSMENT IDENTIFICATION INFORMATION

KOPPER'S POND KENTUCKY AVENUE WELLFIELD SUPERFUND SITE, OPERABLE UNIT 4

Site Name/OU:	Kopper's Pond Kentucky Avenue Wellfield Superfund Site, Operable Unit 4, Horseheads, New York
Region:	II
EPA ID Number:	NYD980650667
State:	New York
Status:	
Federal Facility (Y/N):	
EPA Project Manager:	
EPA Risk Assessor:	
Prepared by (Organization):	Integral Consulting Inc.
Prepared for (Organization):	Koppers Pond RI/FS Group
Document Title:	Baseline Human Health Risk Assessment (BHHRA)
Document Date:	March 2011
Probabilistic Risk Assessment (Y/N):	No
Comments:	

TABLE A-1
SELECTION OF EXPOSURE PATHWAYS
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
CURRENT/FUTURE	Surface Water	Surface Water	Koppers Pond	Teenage Trespasser/Wader	Teen: 12 - 18 yrs	Dermal Contact	Quant	Although the area is posted 'No Trespassing' and access is limited by railroad tracks, there is evidence (e.g., litter and tracks of all-terrain vehicles) of use. It is assumed that teenage trespassers are the most likely individuals that visit the area. Because the pond is not an established recreational destination and access is restricted, young children alone, adults, or adults with young children would not typically visit the area.
			Outlet Channel			Incidental Ingestion		
CURRENT/FUTURE	Surface Water	Surface Water	Koppers Pond	Teenage Trespasser/Swimmer	Teen: 12 - 18 yrs	Dermal Contact	None	The pond is not operated as a recreational area and has limited access. It is assumed that only wading or other incidental contact with surface water occurs.
						Incidental Ingestion		
CURRENT/FUTURE	Sediment	Sediment	Koppers Pond	Teenage Trespasser/Wader	Teen: 12 - 18 yrs	Dermal Contact	Quant	Although the area is posted 'No Trespassing' and access is limited by railroad tracks, there is evidence (e.g., litter and tracks of all-terrain vehicles) of use. It is assumed that teenage trespassers are the most likely individuals that visit the area. Because the pond is not an established recreational destination and access is restricted, young children alone, adults, or adults with young children would not typically visit the area.
						Incidental Ingestion		
			Outlet Channel			Dermal Contact		
						Incidental Ingestion		
CURRENT/FUTURE	Sediment	Vapor	Koppers Pond	Teenage Trespasser/Wader	Teen: 12 - 18 yrs	Inhalation	None	Based on results of the HHRA of Operable Unit III (CDM, 1995), volatile organic compounds, if present, will likely be detected at low frequencies and at concentrations that do not pose a concern. Sediment areas are not expected to dry out; therefore, no suspended particles are anticipated. With these rationales, inhalation of vapor and particulate are considered incomplete pathways.
		Particulate						
		Vapor	Outlet Channel			Inhalation		
		Particulate						
CURRENT/FUTURE	Sediment	Fish	Fish	Young child, older child and adult	Young child: 1 - 6 yrs Older child: 7 - 13 yrs Adult: >13 yrs	Ingestion	Quant	Due to restricted access and fish advisory, recreational anglers are not likely to prefer Koppers Pond over more desirable fisheries that are nearby. Informal interviews with the local fishermen that were encountered at the pond and other field observations revealed that they are generally catch-and-release anglers, focusing predominantly on the bass that are present in the pond. Nevertheless, it is assumed that the receptors are young and older children and adults.

TABLE A-2.1

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (ug/L)	Background Value	Screening Toxicity Value (2) (N/C) (ug/L)	N/C		Potential ARAR/TBC Value (ug/L)	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (7)
Koppers Pond	71-55-6	1,1,1-Trichloroethane	0.36	0.36	ug/L	-	1/6	1 - 1	0.36	NA	9.10E+03	N		-	-	N	BSL
	67-66-3	Chloroform	0.083	0.083	ug/L	-	1/6	1 - 1	0.083	NA	1.90E-01	C		-	-	N	BSL
	108-88-3	Toluene	0.28	0.28	ug/L	-	1/6	1 - 1	0.28	NA	2.30E+03	N		-	-	N	BSL
	100-52-7	Benzaldehyde	0.057	0.057	ug/L	-	1/6	0.94 - 0.97	0.057	NA	3.70E+03	N		-	-	N	BSL
	205-99-2	Benzo(b)fluoranthene	0.25	0.25	ug/L	-	1/6	0.19 - 0.19	0.25	NA	2.90E-02	C		2.00E+00	MCL (6)	Y	ASL
	218-01-9	Chrysene	0.05	0.05	ug/L	-	1/6	0.19 - 0.19	0.05	NA	2.90E+00	C		-	-	N	BSL
	132-64-9	Dibenzofuran	0.17	0.17	ug/L	-	5/6	0.95 - 0.95	0.17	NA	1.20E+01	N	(3)	-	-	N	BSL
	84-74-2	Di-n-butyl phthalate	0.32	0.43	ug/L	-	6/6	-	0.43	NA	3.70E+03	N		-	-	N	BSL
	206-44-0	Fluoranthene	0.44	0.51	ug/L	-	3/6	0.19 - 0.19	0.51	NA	1.50E+03	N		-	-	N	BSL
	85-01-8	Phenanthrene	0.17	0.26	ug/L	-	5/6	0.19 - 0.19	0.26	NA	6.20E+00	N	(4)	-	-	N	BSL
	108-95-2	Phenol	0.1	0.1	ug/L	-	1/6	0.19 - 0.19	0.1	NA	1.10E+04	N		-	-	N	BSL
	129-00-0	Pyrene	0.067	0.067	ug/L	-	1/6	0.19 - 0.19	0.067	NA	1.10E+03	N		-	-	N	BSL
	7429-90-5	Aluminum	178	446	ug/L	-	6/6	-	446	NA	3.70E+04	N		-	-	N	BSL
	7440-36-0	Antimony	0.23	0.72	ug/L	-	6/6	-	0.72	NA	1.50E+01	N		-	-	N	BSL
	7440-38-2	Arsenic	0.17	0.33	ug/L	-	4/6	1 - 1	0.33	NA	4.50E-02	C*		1.00E+01	MCL	Y	ASL
	7440-39-3	Barium	104	123	ug/L	-	6/6	-	123	NA	7.30E+03	N		-	-	N	BSL
	7440-43-9	Cadmium	0.59	7.1	ug/L	-	6/6	-	7.1	NA	1.80E+01	N		-	-	N	BSL
	7440-70-2	Calcium	54600	68600	ug/L	-	6/6	-	68600	NA	NA	-		-	-	N	EN
	7440-47-3	Chromium	4.9	9.3	ug/L	-	6/6	-	9.3	NA	1.10E+02	N	(3)	-	-	N	BSL
	7440-48-4	Cobalt	0.25	0.38	ug/L	-	6/6	-	0.38	NA	1.10E+01	N		-	-	N	BSL
	7440-50-8	Copper	3	9.9	ug/L	-	6/6	-	9.9	NA	1.50E+03	N		-	-	N	BSL
	7439-89-6	Iron	260	550	ug/L	-	6/6	-	550	NA	2.60E+04	N		-	-	N	BSL
	7439-92-1	Lead	9.1	25.7	ug/L	-	6/6	-	25.7	NA	1.50E+01	N	(5)	1.50E+01	MCL	Y	ASL
	7439-95-4	Magnesium	10700	13700	ug/L	-	6/6	-	13700	NA	NA	-		-	-	N	EN
	7439-96-5	Manganese	8.3	10	ug/L	-	6/6	-	10	NA	8.80E+02	N		-	-	N	BSL
	7440-02-0	Nickel	1.9	2.8	ug/L	-	6/6	-	2.8	NA	7.30E+02	N		-	-	N	BSL
	7440-09-7	Potassium	893	1110	ug/L	-	6/6	-	1110	NA	NA	-		-	-	N	EN
	7782-49-2	Selenium	0.28	0.44	ug/L	-	2/6	5 - 5	0.44	NA	1.80E+02	N		-	-	N	BSL
	7440-22-4	Silver	0.087	0.72	ug/L	-	5/6	1 - 1	0.72	NA	1.80E+02	N		-	-	N	BSL
	7440-23-5	Sodium	68300	93900	ug/L	-	6/6	-	93900	NA	NA	-		-	-	N	EN
	7440-62-2	Vanadium	0.43	1.2	ug/L	-	6/6	-	1.2	NA	2.60E+02	N		-	-	N	BSL
	7440-66-6	Zinc	13.8	119	ug/L	-	6/6	-	119	NA	1.10E+04	N		-	-	N	BSL

Notes:

(1) Maximum concentration used for screening chemicals.

(2) All compounds were compared against Region IX tapwater PRGs (updated 12Sept2008), unless otherwise noted.

(3) Compound screened against Region VI residential water Human Health Screening Levels (updated 7March2008)

(4) Naphthalene used as surrogate (USEPA, Region 2)

(5) Lead screened against USEPA's TRW tap water

(6) MCL based on MCL for benzo(a)pyrene * 10

(7) Rational Codes:

BSL = Below Screening Level

ASL = Above Screening Level

EN = Essential Nutrient

Definitions: NA = Not Applicable

C = Carcinogen

C* = Known human carcinogen

N = Noncarcinogen

MCL = Maximum Contaminant Level (maximum permissible level of contaminant allowed in drinking water)

TABLE A-2.2

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (ug/L)	Background Value	Screening Toxicity Value (2) (ug/L)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (7)
Outlet Channel	71-55-6	1,1,1-Trichloroethane	0.29	0.29	ug/L	-	1/4	1 - 1	0.29	NA	9.10E+03	N		-	-	N	BSL
	67-66-3	Chloroform	0.069	0.069	ug/L	-	1/4	1 - 1	0.069	NA	1.90E-01	C		-	-	N	BSL
	127-18-4	Tetrachloroethene	0.22	0.22	ug/L	-	1/4	1 - 1	0.22	NA	1.10E-01	C		5.00E+00	MCL	Y	ASL
	108-88-3	Toluene	0.21	0.21	ug/L	-	1/4	1 - 1	0.21	NA	2.30E+03	N		-	-	N	BSL
	83-32-9	Acenaphthene	0.16	0.16	ug/L	-	1/4	0.19 - 0.19	0.16	NA	2.20E+03	N		-	-	N	BSL
	100-52-7	Benzaldehyde	0.13	0.13	ug/L	-	1/4	0.95 - 0.95	0.13	NA	3.70E+03	N		-	-	N	BSL
	56-55-3	Benzo(a)anthracene	0.05	0.05	ug/L	-	1/4	0.19 - 0.19	0.051	NA	2.90E-02	C		2.00E+00	MCL (6)	Y	ASL
	205-99-2	Benzo(b)fluoranthene	0.27	0.27	ug/L	-	1/4	0.19 - 0.19	0.27	NA	2.90E-02	C		2.00E+00	MCL (6)	Y	ASL
	218-01-9	Chrysene	0.06	0.06	ug/L	-	1/4	0.19 - 0.19	0.061	NA	2.90E+00	C		-	-	N	BSL
	132-64-9	Dibenzofuran	0.16	0.17	ug/L	-	4/4	-	0.17	NA	1.20E+01	N	(3)	-	-	N	BSL
	84-74-2	Di-n-butyl phthalate	0.37	0.61	ug/L	-	3/4	0.95 - 0.95	0.61	NA	3.70E+03	N		-	-	N	BSL
	206-44-0	Fluoranthene	0.43	0.51	ug/L	-	3/4	0.19 - 0.19	0.51	NA	1.50E+03	N		-	-	N	BSL
	86-73-7	Fluorene	0.47	0.47	ug/L	-	1/4	0.19 - 0.19	0.47	NA	1.50E+03	N		-	-	N	BSL
	85-01-8	Phenanthrene	0.17	0.23	ug/L	-	4/4	-	0.23	NA	6.20E+00	N	(4)	-	-	N	BSL
	129-00-0	Pyrene	0.07	0.07	ug/L	-	1/4	0.19 - 0.19	0.069	NA	1.10E+03	N		-	-	N	BSL
	7429-90-5	Aluminum	126	417	ug/L	-	4/4	-	417	NA	3.70E+04	N		-	-	N	BSL
	7440-36-0	Antimony	0.27	0.49	ug/L	-	4/4	-	0.49	NA	1.50E+01	N		-	-	N	BSL
	7440-38-2	Arsenic	0.21	0.79	ug/L	-	2/4	1 - 1	0.79	NA	4.50E-02	C*		1.00E+01	MCL	Y	ASL
	7440-39-3	Barium	118	129	ug/L	-	4/4	-	129	NA	7.30E+03	N		-	-	N	BSL
	7440-43-9	Cadmium	0.52	2.1	ug/L	-	3/4	1 - 1	2.1	NA	1.80E+01	N		-	-	N	BSL
	7440-70-2	Calcium	63500	70500	ug/L	-	4/4	-	70500	NA	NA	-		-	-	N	EN
	7440-47-3	Chromium	3.8	6.7	ug/L	-	4/4	-	6.7	NA	1.10E+02	N	(3)	-	-	N	BSL
	7440-48-4	Cobalt	0.24	0.41	ug/L	-	4/4	-	0.41	NA	1.10E+01	N		-	-	N	BSL
	7440-50-8	Copper	2	6.6	ug/L	-	4/4	-	6.6	NA	1.50E+03	N		-	-	N	BSL
	7439-89-6	Iron	267	559	ug/L	-	4/4	-	559	NA	2.60E+04	N		-	-	N	BSL
	7439-92-1	Lead	6.2	16.9	ug/L	-	4/4	-	16.9	NA	1.50E+01	N	(5)	1.50E+01	MCL	Y	ASL
	7439-95-4	Magnesium	13000	14200	ug/L	-	4/4	-	14200	NA	NA	-		-	-	N	EN
	7439-96-5	Manganese	11.7	28.5	ug/L	-	4/4	-	28.5	NA	8.80E+02	N		-	-	N	BSL
	7440-02-0	Nickel	1.5	2.8	ug/L	-	4/4	-	2.8	NA	7.30E+02	N		-	-	N	BSL
	7440-09-7	Potassium	1060	1400	ug/L	-	4/4	-	1400	NA	NA	-		-	-	N	EN
	7782-49-2	Selenium	0.34	0.34	ug/L	-	1/4	5 - 5	0.34	NA	1.80E+02	N		-	-	N	BSL
	7440-22-4	Silver	0.22	0.22	ug/L	-	1/4	1 - 1	0.22	NA	1.80E+02	N		-	-	N	BSL
	7440-23-5	Sodium	87900	95600	ug/L	-	4/4	-	95600	NA	NA	-		-	-	N	EN
	7440-62-2	Vanadium	0.5	0.75	ug/L	-	3/4	1 - 1	0.75	NA	2.60E+02	N		-	-	N	BSL
	7440-66-6	Zinc	13.6	49.2	ug/L	-	4/4	-	49.2	NA	1.10E+04	N		-	-	N	BSL

Notes:

(1) Maximum concentration used for screening chemicals.

(2) All compounds were compared against Region IX tapwater PRGs (updated 12Sept2008), unless otherwise noted.

(3) Compound screened against Region VI residential water Human Health Screening Levels (updated 7March2008)

(4) Naphthalene used as surrogate (USEPA, Region 2)

(5) Lead screened against USEPA's TRW tap water

(6) MCL based on MCL for benzo(a)pyrene * 10

(7) Rational Codes:

BSL = Below Screening Level

ASL = Above Screening Level

EN = Essential Nutrient

Definitions: NA = Not Applicable

C = Carcinogen

C* = Known human carcinogen

N = Noncarcinogen

MCL = Maximum Contaminant Level (maximum permissible level of contaminant allowed in drinking water)

TABLE A-2.3

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment (Koppers Pond)

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (mg/kg)	Background Value	Screening Toxicity Value (2) (mg/kg)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (8)
Koppers Pond	78-93-3	2-Butanone	14	14	ug/kg	-	1/16	6.6 - 20	0.01	NA	2.80E+04	N		-	-	N	BSL
	67-64-1	Acetone	31	73	ug/kg	-	3/16	26 - 80	0.07	NA	6.10E+04	N		-	-	N	BSL
	79-20-9	Methyl acetate	5.6	8.9	ug/kg	-	3/16	6.6 - 20	0.01	NA	7.80E+04	N		-	-	N	BSL
	91-57-6	2-Methylnaphthalene	14	24	ug/kg	-	4/19	35 - 270	0.02	NA	3.10E+02	N		-	-	N	BSL
	106-44-5	4-Methylphenol	15	53	ug/kg	-	5/19	170 - 1300	0.05	NA	3.10E+02	N		-	-	N	BSL
	83-32-9	Acenaphthene	14	230	ug/kg	-	5/19	31 - 270	0.23	NA	3.40E+03	N		-	-	N	BSL
	208-96-8	Acenaphthylene	12	600	ug/kg	-	9/19	31 - 270	0.60	NA	3.40E+03	N		-	-	N	BSL
	120-12-7	Anthracene	12	530	ug/kg	-	16/19	65 - 140	0.53	NA	1.70E+04	N		-	-	N	BSL
	100-52-7	Benzaldehyde	28	110	ug/kg	-	7/19	310 - 1300	0.11	NA	7.80E+03	N		-	-	N	BSL
	56-55-3	Benzo(a)anthracene	37	1600	ug/kg	-	19/19	-	1.60	NA	1.50E-01	C		-	-	Y	ASL
	50-32-8	Benzo(a)pyrene	58	1500	ug/kg	-	19/19	-	1.50	NA	1.50E-02	C		-	-	Y	ASL
	205-99-2	Benzo(b)fluoranthene	72	2600	ug/kg	-	19/19	-	2.60	NA	1.50E-01	C		-	-	Y	ASL
	191-24-2	Benzo(ghi)perylene	34	1200	ug/kg	-	19/19	-	1.20	NA	1.50E-01	C	(3)	-	-	Y	ASL
	207-08-9	Benzo(k)fluoranthene	21	920	ug/kg	-	10/19	31 - 140	0.92	NA	1.50E+00	C		-	-	N	BSL
	117-81-7	bis(2-Ethylhexyl) phthalate	20	1400	ug/kg	-	12/19	170 - 890	1.40	NA	3.50E+01	C		-	-	N	BSL
	85-68-7	Butyl benzyl phthalate	24	130	ug/kg	-	7/19	150 - 1300	0.13	NA	2.60E+02	C		-	-	N	BSL
	105-60-2	Caprolactam	55	120	ug/kg	-	4/19	310 - 1300	0.12	NA	3.10E+04	N		-	-	N	BSL
	86-74-8	Carbazole	9.2	490	ug/kg	-	9/19	31 - 270	0.49	NA	2.40E+01	C	(4)	-	-	N	BSL
	218-01-9	Chrysene	70	2000	ug/kg	-	19/19	-	2.00	NA	1.50E+01	C		-	-	N	BSL
	53-70-3	Dibenz(a,h)anthracene	12	370	ug/kg	-	13/19	35 - 180	0.37	NA	1.50E-02	C		-	-	Y	ASL
	132-64-9	Dibenzofuran	12	36	ug/kg	-	3/19	170 - 1300	0.04	NA	1.50E+02	N	(4)	-	-	N	BSL
	206-44-0	Fluoranthene	97	5200	ug/kg	-	19/19	-	5.20	NA	2.30E+03	N		-	-	N	BSL
	86-73-7	Fluorene	20	670	ug/kg	-	7/19	31 - 270	0.67	NA	2.30E+03	N		-	-	N	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	29	1100	ug/kg	-	19/19	-	1.10	NA	1.50E-01	C		-	-	Y	ASL
	91-20-3	Naphthalene	18	24	ug/kg	-	3/19	35 - 270	0.02	NA	3.90E+00	C		-	-	N	BSL
	85-01-8	Phenanthrene	39	1400	ug/kg	-	19/19	-	1.40	NA	3.90E+00	C	(5)	-	-	N	BSL
	129-00-0	Pyrene	45	2900	ug/kg	-	19/19	-	2.90	NA	1.70E+03	N		-	-	N	BSL
	319-86-8	delta-BHC	4.9	4.9	ug/kg	-	1/16	1.6 - 160	0.005	NA	5.20E-01	C	(6)	-	-	N	BSL
	58-89-9	gamma-BHC (Lindane)	15	15	ug/kg	-	1/16	0.93 - 160	0.02	NA	5.20E-01	C		-	-	N	BSL
	11097-69-1	Total PCBs (Aroclor 1254)	20	2700	ug/kg	-	18/19	16-16	2.70	NA	2.20E-01	C		-	-	Y	ASL
	7429-90-5	Aluminum	5910	17000	mg/kg	-	19/19	-	17,000	NA	7.70E+04	N		-	-	N	BSL
	7440-36-0	Antimony	0.28	5.2	mg/kg	-	19/19	-	5.2	NA	3.10E+01	N		-	-	N	BSL
	7440-38-2	Arsenic	1.7	4.8	mg/kg	-	19/19	-	4.8	NA	3.90E-01	C*		-	-	Y	ASL
	7440-39-3	Barium	187	596	mg/kg	-	19/19	-	596	NA	1.50E+04	N		-	-	N	BSL
	7440-41-7	Beryllium	0.26	0.88	mg/kg	-	19/19	-	0.88	NA	1.60E+02	N		-	-	N	BSL

TABLE A-2.3

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment (Koppers Pond)

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (mg/kg)	Background Value	Screening Toxicity Value (2) (mg/kg)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (8)
	7440-43-9	Cadmium	1.3	739	mg/kg	-	19/19	-	739	NA	7.00E+01	N		-	-	Y	ASL
	7440-70-2	Calcium	3630	199000	mg/kg	-	19/19	-	199,000	NA	NA	-		-	-	N	EN
	7440-47-3	Chromium	17.5	462	mg/kg	-	19/19	-	462	NA	2.80E+02	C**		-	-	Y	ASL
	7440-48-4	Cobalt	5	13.3	mg/kg	-	19/19	-	13.3	NA	2.30E+01	N		-	-	N	BSL
	7440-50-8	Copper	21.2	820	mg/kg	-	19/19	-	820	NA	3.10E+03	N		-	-	N	BSL
	57-12-5	Cyanide, Total	0.17	2.1	mg/kg	-	6/19	0.34 - 1.6	2.1	NA	1.60E+03	N		-	-	N	BSL
	7439-89-6	Iron	11800	19700	mg/kg	-	19/19	-	19,700	NA	5.50E+04	N		-	-	N	BSL
	7439-92-1	Lead	36.6	1620	mg/kg	-	19/19	-	1,620	NA	4.00E+02	N	(7)	-	-	Y	ASL
	7439-95-4	Magnesium	2290	5970	mg/kg	-	19/19	-	5,970	NA	NA	-		-	-	N	EN
	7439-96-5	Manganese	77.8	170	mg/kg	-	19/19	-	170	NA	1.80E+03	N		-	-	N	BSL
	7439-97-6	Mercury	0.072	1.4	mg/kg	-	19/19	-	1.4	NA	6.70E+00	N		-	-	N	BSL
	7440-02-0	Nickel	16.3	180	mg/kg	-	19/19	-	180	NA	1.60E+03	N		-	-	N	BSL
	7440-09-7	Potassium	475	1320	mg/kg	-	19/19	-	1,320	NA	NA	-		-	-	N	EN
	7782-49-2	Selenium	0.32	2.5	mg/kg	-	19/19	-	2.5	NA	3.90E+02	N		-	-	N	BSL
	7440-22-4	Silver	0.34	52.5	mg/kg	-	19/19	-	52.5	NA	3.90E+02	N		-	-	N	BSL
	7440-23-5	Sodium	158	733	mg/kg	-	19/19	-	733	NA	NA	-		-	-	N	EN
	7440-28-0	Thallium	0.13	0.42	mg/kg	-	18/19	0.18 - 0.18	0.42	NA	5.10E+00	N		-	-	N	BSL
	7440-62-2	Vanadium	9.8	27.5	mg/kg	-	19/19	-	27.5	NA	5.50E+02	N		-	-	N	BSL
	7440-66-6	Zinc	94.5	12500	mg/kg	-	19/19	-	12,500	NA	2.30E+04	N		-	-	N	BSL

Notes:

(1) Maximum concentration used for screening chemicals.

(2) All compounds were compared against Region IX residential PRGs (updated 12Sept2008), unless otherwise noted.

(3) Benzo(b)fluoranthene used as surrogate (USEPA, Region 2)

(4) Compound screened against Region VI residential Human Health Screening Levels (updated 7March2008)

(5) Naphthalene used as surrogate (USEPA, Region 2)

(6) Gamma BHC (lindane) used as surrogate

(7) Lead screened against USEPA's IUEBK lead model

(8) Rational Codes:

BSL = Below Screening Level

ASL = Above Screening Level

EN = Essential Nutrient

Definitions: NA = Not Applicable

C = Carcinogen

C* = Known human carcinogen

C** = Known human carcinogen by inhalation only

N = Noncarcinogen

TABLE A-2.4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment (Outlet Channel)

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (mg/kg)	Background Value	Screening Toxicity Value (2) (mg/kg)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (7)
Outlet Channel	67-64-1	Acetone	11	79	ug/kg	-	3/4	52 - 52	0.08	NA	6.10E+04	N		-	-	N	BSL
	79-20-9	Methyl acetate	23	23	ug/kg	-	1/4	10 - 16	0.02	NA	7.80E+04	N		-	-	N	BSL
	108-88-3	Toluene	160	160	ug/kg	-	1/4	10 - 30	0.16	NA	5.00E+03	N		-	-	N	BSL
	91-57-6	2-Methylnaphthalene	19	48	ug/kg	-	3/4	35 - 35	0.05	NA	3.10E+02	N		-	-	N	BSL
	106-44-5	4-Methylphenol	35	1,600	ug/kg	-	4/4	-	1.60	NA	3.10E+02	N		-	-	N	BSL
	83-32-9	Acenaphthene	19	230	ug/kg	-	3/4	35 - 35	0.23	NA	3.40E+03	N		-	-	N	BSL
	208-96-8	Acenaphthylene	24	190	ug/kg	-	3/4	35 - 35	0.19	NA	3.40E+03	N		-	-	N	BSL
	98-86-2	Acetophenone	58	66	ug/kg	-	2/4	260 - 490	0.07	NA	1.70E+03	N	(3)	-	-	N	BSL
	120-12-7	Anthracene	10	490	ug/kg	-	4/4	-	0.49	NA	1.70E+04	N		-	-	N	BSL
	100-52-7	Benzaldehyde	52	170	ug/kg	-	4/4	-	0.17	NA	7.80E+03	N		-	-	N	BSL
	56-55-3	Benzo(a)anthracene	46	2,200	ug/kg	-	4/4	-	2.20	NA	1.50E-01	C		-	-	Y	ASL
	50-32-8	Benzo(a)pyrene	48	940	ug/kg	-	4/4	-	0.94	NA	1.50E-02	C		-	-	Y	ASL
	205-99-2	Benzo(b)fluoranthene	89	2,600	ug/kg	-	4/4	-	2.60	NA	1.50E-01	C		-	-	Y	ASL
	191-24-2	Benzo(ghi)perylene	55	580	ug/kg	-	4/4	-	0.58	NA	1.50E-01	C	(4)	-	-	Y	ASL
	207-08-9	Benzo(k)fluoranthene	0	0	ug/kg	-	0/4	35 - 100	0.00	NA	1.50E+00	C		-	-	N	BSL
	117-81-7	bis(2-Ethylhexyl) phthalate	53	260	ug/kg	-	4/4	-	0.26	NA	3.50E+01	C		-	-	N	BSL
	85-68-7	Butyl benzyl phthalate	36	75	ug/kg	-	3/4	260 - 260	0.08	NA	2.60E+02	C		-	-	N	BSL
	105-60-2	Caprolactam	90	250	ug/kg	-	2/4	220 - 260	0.25	NA	3.10E+04	N		-	-	N	BSL
	86-74-8	Carbazole	13	380	ug/kg	-	3/4	52 - 52	0.38	NA	2.40E+01	C	(3)	-	-	N	BSL
	218-01-9	Chrysene	66	3,400	ug/kg	-	4/4	-	3.40	NA	1.50E+01	C		-	-	N	BSL
	53-70-3	Dibenz(a,h)anthracene	14	85	ug/kg	-	4/4	-	0.09	NA	1.50E-02	C		-	-	Y	ASL
	132-64-9	Dibenzofuran	20	180	ug/kg	-	3/4	170 - 170	0.18	NA	1.50E+02	N	(3)	-	-	N	BSL
	84-74-2	Di-n-butyl phthalate	68	68	ug/kg	-	1/4	170 - 490	0.07	NA	6.10E+03	N		-	-	N	BSL
	206-44-0	Fluoranthene	140	10,000	ug/kg	-	4/4	-	10.00	NA	2.30E+03	N		-	-	N	BSL
	86-73-7	Fluorene	24	310	ug/kg	-	3/4	35 - 35	0.31	NA	2.30E+03	N		-	-	N	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	48	580	ug/kg	-	4/4	-	0.58	NA	1.50E-01	C		-	-	Y	ASL
	91-20-3	Naphthalene	22	28	ug/kg	-	2/4	35 - 52	0.03	NA	3.90E+00	C		-	-	N	BSL
	85-01-8	Phenanthrene	46	1,600	ug/kg	-	4/4	-	1.60	NA	3.90E+00	C	(5)	-	-	N	BSL
	108-95-2	Phenol	29	29	ug/kg	-	1/4	35 - 100	0.03	NA	1.80E+04	N		-	-	N	BSL
	129-00-0	Pyrene	67	4,600	ug/kg	-	4/4	-	4.60	NA	1.70E+03	N		-	-	N	BSL
	12789-03-6	gamma-Chlordane	2	2	ug/kg	-	1/4	2.8 - 16	0.002	NA	1.60E+00	C		-	-	N	BSL
	11097-69-1	Total PCBs (Aroclor 1254)	20	280	ug/kg	-	4/4	-	0.28	NA	2.20E-01	C		-	-	Y	ASL
	7429-90-5	Aluminum	8100	16700	mg/kg	-	4/4	-	16,700	NA	7.70E+04	N		-	-	N	BSL
	7440-36-0	Antimony	0.27	6	mg/kg	-	4/4	-	6	NA	3.10E+01	N		-	-	N	BSL
	7440-38-2	Arsenic	3	7.2	mg/kg	-	4/4	-	7	NA	3.90E-01	C*		-	-	Y	ASL
	7440-39-3	Barium	198	282	mg/kg	-	4/4	-	282	NA	1.50E+04	N		-	-	N	BSL
	7440-41-7	Beryllium	0.41	0.93	mg/kg	-	4/4	-	0.93	NA	1.60E+02	N		-	-	N	BSL
	7440-43-9	Cadmium	3	91.9	mg/kg	-	4/4	-	91.9	NA	7.00E+01	N		-	-	Y	ASL
	7440-70-2	Calcium	7440	70100	mg/kg	-	4/4	-	70,100	NA	NA	-		-	-	N	EN
	7440-47-3	Chromium	24.8	149	mg/kg	-	4/4	-	149	NA	2.80E+02	C**		-	-	N	BSL
	7440-48-4	Cobalt	7.6	13.1	mg/kg	-	4/4	-	13.1	NA	2.30E+01	N		-	-	N	BSL
	7440-50-8	Copper	25.1	175	mg/kg	-	4/4	-	175	NA	3.10E+03	N		-	-	N	BSL

TABLE A-2.4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment (Outlet Channel)

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1) (mg/kg)	Background Value	Screening Toxicity Value (2) (mg/kg)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (7)
	7439-89-6	Iron	16800	37400	mg/kg	-	4/4	-	37,400	NA	5.50E+04	N		-	-	N	BSL
	7439-92-1	Lead	34.3	288	mg/kg	-	4/4	-	288	NA	4.00E+02	N	(6)	-	-	N	BSL
	7439-95-4	Magnesium	4690	6540	mg/kg	-	4/4	-	6,540	NA	NA	-		-	-	N	EN
	7439-96-5	Manganese	216	415	mg/kg	-	4/4	-	415	NA	1.80E+03	N		-	-	N	BSL
	7439-97-6	Mercury	0.044	0.25	mg/kg	-	4/4	-	0.25	NA	6.70E+00	N		-	-	N	BSL
	7440-02-0	Nickel	29.9	55.5	mg/kg	-	4/4	-	55.5	NA	1.60E+03	N		-	-	N	BSL
	7440-09-7	Potassium	932	1150	mg/kg	-	4/4	-	1,150	NA	NA	-		-	-	N	EN
	7782-49-2	Selenium	0.47	1.3	mg/kg	-	4/4	-	1.3	NA	3.90E+02	N		-	-	N	BSL
	7440-22-4	Silver	0.42	14.5	mg/kg	-	4/4	-	14.5	NA	3.90E+02	N		-	-	N	BSL
	7440-23-5	Sodium	325	875	mg/kg	-	4/4	-	875	NA	NA	-		-	-	N	EN
	7440-28-0	Thallium	0.15	0.22	mg/kg	-	3/4	0.3 - 0.3	0.22	NA	5.10E+00	N		-	-	N	BSL
	7440-62-2	Vanadium	15.7	24.7	mg/kg	-	4/4	-	24.7	NA	5.50E+02	N		-	-	N	BSL
	7440-66-6	Zinc	123	1690	mg/kg	-	4/4	-	1,690	NA	2.30E+04	N		-	-	N	BSL

Notes:

(1) Maximum concentration used for screening chemicals.

(2) All compounds were compared against Region IX residential PRGs (updated 12Sept2008), unless otherwise noted.

(3) Compound screened against Region VI residential Human Health Screening Levels (updated 7March2008)

(4) Benzo(b)fluoranthene used as surrogate (USEPA, Region 2)

(5) Naphthalene used as surrogate (USEPA, Region 2)

(6) Lead screened against USEPA's IUEBK lead model

(7) Rational Codes:

BSL = Below Screening Level

ASL = Above Screening Level

EN = Essential Nutrient

Definitions: NA = Not Applicable

C = Carcinogen

C* = Known human carcinogen

C** = Known human carcinogen by inhalation only

N = Noncarcinogen

TABLE A-2.5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish

Exposure Point	CAS Number	Chemical	Positive Range	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value	Screening Toxicity Value (2) (mg/kg)	N/C		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (6)
Koppers Pond	11097-69-1	Total PCBs	90 - 2,060	90	2,060	µg/Kg (ww)	-	17/17	—	2.06	NA	1.58E-03	C		-	-	Y	ASL
	7429-90-5	Aluminum	0.32 -1.5	0.32	1.5	mg/Kg (ww)	-	20/20	—	1.5	NA	1.35E+03	N		-	-	N	BSL
	7440-36-0	Antimony	0.0034 -0.034	0.0034	0.034	mg/Kg (ww)	-	16/20	0.1 - 0.1	0.034	NA	5.41E-01	N		-	-	N	BSL
	7440-38-2	Arsenic	0.018 -0.15	0.018	0.15	mg/Kg (ww)	-	15/20	—	0.15	NA	2.10E-03	C*		-	-	Y	ASL
	7440-39-3	Barium	0.057 -0.93	0.057	0.93	mg/Kg (ww)	-	20/20	—	0.93	NA	2.70E+02	N		-	-	N	BSL
	7440-70-2	Calcium	83.3 -2130	83.3	2,130	mg/Kg (ww)	-	20/20	—	2130	NA	NA	-		-	-	N	EN
	18540-29-9	Chromium	0.32 -1.2	0.32	1.2	mg/Kg (ww)	-	20/20	—	1.2	NA	4.06E+00	N	(3)	-	-	N	BSL
	7440-48-4	Cobalt	0.0028 -0.05	0.0028	0.05	mg/Kg (ww)	-	20/20	—	0.05	NA	4.06E-01	N		-	-	N	BSL
	7440-50-8	Copper	0.21 -1	0.21	1	mg/Kg (ww)	-	20/20	—	1	NA	5.41E+01	N		-	-	N	BSL
	7439-89-6	Iron	0.85 -15.2	0.85	15.2	mg/Kg (ww)	-	20/20	—	15.2	NA	9.46E+02	N		-	-	N	BSL
	7439-92-1	Lead	0.0065 -0.17	0.0065	0.17	mg/Kg (ww)	-	20/20	—	0.17	NA	0.5		(4)	-	-	N	BSL
	7439-95-4	Magnesium	220 -315	220	315	mg/Kg (ww)	-	20/20	—	315	NA	-			-	-	N	EN
	7439-96-5	Manganese	0.069 -0.26	0.069	0.26	mg/Kg (ww)	-	20/20	—	0.26	NA	1.89E+02	N		-	-	N	BSL
	7439-97-6	Mercury	0.011 -0.37	0.011	0.37	mg/Kg (ww)	-	20/20	—	0.37	NA	1.35E-01	N	(5)	-	-	Y	ASL
	7440-02-0	Nickel	0.012 -0.1	0.012	0.1	mg/Kg (ww)	-	20/20	—	0.1	NA	2.70E+01	N		-	-	N	BSL
	7440-09-7	Potassium	2530 -3480	2,530	3,480	mg/Kg (ww)	-	20/20	—	3480	NA	-			-	-	N	EN
	7782-49-2	Selenium	0.2 -0.44	0.2	0.44	mg/Kg (ww)	-	20/20	—	0.44	NA	6.76E+00	N		-	-	N	BSL
	7440-23-5	Sodium	355 -592	355	592	mg/Kg (ww)	-	20/20	—	592	NA	-			-	-	N	BSL
	7440-28-0	Thallium	0.0023 -0.032	0.0023	0.032	mg/Kg (ww)	-	12/20	0.1 - 0.1	0.032	NA	8.76E-02	N		-	-	N	BSL
	7440-62-2	Vanadium	0.027 -0.28	0.027	0.28	mg/Kg (ww)	-	15/20	0.1 - 0.1	0.28	NA	9.46E+00	N		-	-	N	BSL
	7440-66-6	Zinc	4.8 -26.1	4.8	26.1	mg/Kg (ww)	-	20/20	—	26.1	NA	4.06E+02	N		-	-	N	BSL

Notes:

(1) Maximum concentration used for screening chemicals.

(2) All compounds were compared against Region 3 fish ingestion PRGs (May, 2008), unless otherwise noted.

(3) Screening value for chromium VI (particulates).

(4) Lead screened against acceptable lead concentration in fish derived by USEPA Region 10, *Columbia River Basin Fish Contaminant Survey 1996-1998* (USEPA, 2002).

(5) Screening value for methyl mercury.

(6) Rational Codes:

BSL = Below Screening Level
ASL = Above Screening Level
EN = Essential Nutrient

Definitions: NA = Not Applicable/Not Available
C = Carcinogen
C* = Known human carcinogen
N = Noncarcinogen

TABLE A-3.1

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Koppers Pond	Lead	ug/L	14.1	19.2 (N)	25.7	19.2	ug/L	95% UCL - N	95% Student's-t UCL
	Benzo(b)fluoranthene	ug/L	0.25	NC	0.25	0.25	ug/L	Max	Maximum concentration
	Arsenic	ug/L	0.24	0.295 (NP)	0.33 (J)	0.295	ug/L	95% UCL - NP	95% KM (Percentile Bootstrap) UCL

Notes:

1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"

J = Estimated value

KM = Kaplan-Meier Method

N = Normal distribution

NC = Not calculated due to small sample size

NP = Nonparametric distribution

UCL = Upper confidence limit

ug/L = micrograms per liter

TABLE A-3.2

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Outlet Channel	Lead	ug/L	11.6	NC	16.9	16.9	ug/L	Max	Maximum concentration
	Tetrachloroethene	ug/L	0.22	NC	0.22 (J)	0.22	ug/L	Max	Maximum concentration
	Benzo(a)anthracene	ug/L	0.051	NC	0.051	0.051	ug/L	Max	Maximum concentration
	Benzo(b)fluoranthene	ug/L	0.27	NC	0.27	0.27	ug/L	Max	Maximum concentration
	Arsenic	ug/L	0.5	NC	0.79 (J)	0.79	ug/L	Max	Maximum concentration

Notes:

1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"

J = Estimated value

NC = Not calculated due to small sample size

UCL = Upper confidence limit

ug/L = micrograms per liter

TABLE A-3.3
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Koppers Pond	Benzo(a)anthracene	ug/kg	390.7	867.3 (NP)	1600	867.3	ug/kg	95% UCL - NP	95% Chebyshev (Mean, Sd) UCL
	Benzo(a)pyrene	ug/kg	499.9	752.2 (G)	1500	752.2	ug/kg	95% UCL - G	95% Approximate Gamma UCL
	Benzo(b)fluoranthene	ug/kg	726.2	1099 (G)	2600	1099	ug/kg	95% UCL - G	95% Approximate Gamma UCL
	Benzo(ghi)perylene	ug/kg	397	825 (NP)	1200	825	ug/kg	95% UCL - NP	95% Chebyshev (Mean, Sd) UCL
	Dibenz(a,h)anthracene	ug/kg	113.9	163.9 (NP)	370	163.9	ug/kg	95% UCL - NP	95% KM (BCA) UCL
	Indeno(1,2,3-cd)pyrene	ug/kg	335.1	694.6 (NP)	1100	694.6	ug/kg	95% UCL - NP	95% Chebyshev (Mean, Sd) UCL
	Total PCBs (Aroclor 1254)	ug/kg	604.8	1338 (NP)	2700	1338	ug/kg	95% UCL - G	95% KM (Chebyshev) UCL
	Arsenic	mg/kg	2.9	3.2 (N)	4.8	3.2	mg/kg	95% UCL - N	95% Student's-t UCL
	Cadmium	mg/kg	181	392 (G)	739	392	mg/kg	95% UCL - G	95% Adjusted Gamma UCL
	Chromium	mg/kg	184.7	275.3 (G)	462	275.3	mg/kg	95% UCL - G	95% Approximate Gamma UCL
	Lead	mg/kg	479.7	761.7 (G)	1620	761.7	mg/kg	95% UCL - G	95% Approximate Gamma UCL

Notes:

1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"

G = Gamma distribution

KM = Kaplan-Meier Method

mg/kg = milligram per kilogram

N = Normal distribution

NP = Nonparametric distribution

PCBs = polychlorinated biphenyls

UCL = Upper confidence limit

ug/kg = microgram per kilogram

TABLE A-3.4

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Outlet Channel	Benzo(a)anthracene	ug/kg	666.5	NC	2200	2200	ug/kg	Max	Maximum concentration
	Benzo(a)pyrene	ug/kg	387	NC	940	940	ug/kg	Max	Maximum concentration
	Benzo(b)fluoranthene	ug/kg	912.3	NC	2600	2600	ug/kg	Max	Maximum concentration
	Benzo(ghi)perylene	ug/kg	343.8	NC	580	580	ug/kg	Max	Maximum concentration
	Dibenz(a,h)anthracene	ug/kg	57.8	NC	85	85	ug/kg	Max	Maximum concentration
	Indeno(1,2,3-cd)pyrene	ug/kg	297	NC	580	580	ug/kg	Max	Maximum concentration
	Total PCBs (Aroclor 1254)	ug/kg	155	NC	280	280	ug/kg	Max	Maximum concentration
	Arsenic	mg/kg	4.4	NC	7.2	7.2	mg/kg	Max	Maximum concentration
	Cadmium	mg/kg	41.6	NC	91.9	91.9	mg/kg	Max	Maximum concentration

Notes:

1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"

KM = Kaplan-Meier Method

mg/kg = milligram per kilogram

NC = Not calculated due to small sample size

N = Normal distribution

NP = Nonparametric distribution

PCBs = polychlorinated biphenyls

UCL = Upper confidence limit

ug/kg = microgram per kilogram

TABLE A-3.5

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Koppers Pond	Total PCBs	µg/Kg (ww)	525.2	826.5 (G)	2060	826.5	µg/Kg (ww)	95% UCL - G	95% Approximate Gamma UCL
	Arsenic	mg/Kg (ww)	0.0631	0.0752 (NP)	0.15	0.0752	mg/Kg (ww)	95% UCL - NP	95% KM (Percentile Bootstrap) UCL
	Mercury	mg/Kg (ww)	0.138	0.211 (G)	0.37	0.211	mg/Kg (ww)	95% UCL - G	95% Approximate Gamma UCL

Notes:

1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"

G = Gamma distribution

KM = Kaplan-Meier Method

mg/kg = milligrams per kilogram

NP = Nonparametric distribution

PCBs = polychlorinated biphenyls

ug/kg = micrograms per kilogram

UCL = Upper confidence limit

ww = wet weight

TABLE A-3.5b
EXPOSURE POINT CONCENTRATION SUMMARY
CENTRAL TENDENCY EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean[1]	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration - Central Tendency Exposure[2]			
						Value	Units	Statistic	Rationale
Koppers Pond	Total PCBs	ug/kg (ww)	525.2	826.5 (G)	2060	321	ug/kg (ww)	Geometric mean - G	Geometric mean; Gamma distribution
	Arsenic	mg/Kg (ww)	0.0631	0.0752 (NP)	0.15	0.0631	mg/Kg (ww)	KM mean - NP	KM mean
	Mercury	mg/Kg (ww)	0.138	0.211 (G)	0.37	0.081	mg/Kg (ww)	Geometric mean - G	Geometric mean; Gamma distribution

Notes
1 = Arithmetic mean is the mean calculated by ProUCL under "raw statistics", except in the cases where the EPC is the KM UCL, then the arithmetic mean is the mean calculated by ProUCL under "Kaplan-Meier"
2 = CTE EPCs to be used in the uncertainty analysis
G = Gamma distribution
KM = Kaplan-Meier Method
mg/kg = milligrams per kilogram
NP = Nonparametric distribution
PCBs = polychlorinated biphenyls
ug/kg = micrograms per kilogram
UCL = Upper confidence limit
ww = wet weight

Table A-4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS - SURFACE WATER
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Teenage Trespasser	Teen: 12 - 18 years	Surface Water, Wading: Koppers Pond and Outlet Channel	C_{sw}	Chemical Concentration in Surface Water	Chem-specific	mg/L		Intake (mg/kg-day) = C_{sw} x IgR_{sw} x ET x EF x ED x ABS_o x 1/BW x 1/AT
				IgR_{sw}	Ingestion Rate - Surface Water	0.025	L/hr	Professional judgement - 1/2 default swimming contact rate (USEPA 1989)	
				ABS_o	Oral Absorption Factor	Chem-specific	unitless		
				ET	Exposure Time	1.6	hr/day	Age-specific amount of time spent outdoors for teenagers (USEPA 2008)	
				EF	Exposure Frequency	24	days/yr	Four days per month for six months per year (CDM 1995)	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				BW	Body Weight	57.2	kg	Mean body weight ages 12-18 for male/female (USEPA 1997)	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	
Dermal Contact	Teenage Trespasser	Teen: 12 - 18 years	Surface Water, Wading: Koppers Pond and Outlet Channel	C_{sw}	Chemical Concentration in Surface	Chem-specific	mg/L		Intake (mg/kg-day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT Where: $DA_{event\text{-}organic} = 2FA * Kp * Csw\sqrt{\frac{6\tau_{event} * t_{event}}{\pi}}$ $DA_{event\text{-}inorganic} = K_p \times C_{sw} \times t$
				DA_{event}	Absorbed Dose per event	calculated	mg/cm^2-event		
				FA	Fraction Absorbed	Chem-specific	unitless		
				K_p	Dermal permeability coefficient	Chem-specific	cm/hr		
				t_{event}	Lag Time per event	Chem-specific	hr/event		
				π	Constant	3.14	unitless		
				SA	Exposed Skin Surface Srea	4,029	cm^2	Age-specific mean surface area of hands, lower legs and feet (USEPA 2004)	
				EV	Number of Events per day	1	event/day	Professional judgement	
				EF	Exposure Frequency	24	days/yr	Four days per month for six months per year (CDM 1995)	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				BW	Body Weight	57.2	kg	Mean body weight ages 12-18 for male/female (USEPA 1997)	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	

TABLE A-4.2
VALUES USED FOR DAILY INTAKE CALCULATIONS - SEDIMENT
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	Teenage Trespasser	Teen: 12 - 18 years	Sediment, Wading: Koppers Pond and Outlet Channel	C_s	Chemical Concentration in Sediment	Chem-specific	mg/kg		Intake (mg/kg-day) = C_s x IgR_{sed} x EF x ED x ABS_o x 1/BW x 1/AT
				IgR_{sed}	Ingestion Rate	50	mg/day	Soil ingestion rate for older children and adults (USEPA 1997)	
				ABS_o	Oral Absorption Factor	Chem-specific	unitless		
				EF	Exposure Frequency	24	days/yr	Four days per month for six months per year (CDM 1995)	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				BW	Body Weight	57.2	kg	Mean body weight ages 12-18 for male/female (USEPA 1997)	
				CF	Conversion Factor	1.00E-06	kg/mg	Calculated	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	
Dermal Contact	Teenage Trespasser	Teen: 12 - 18 years	Sediment, Wading: Koppers Pond and Outlet Channel	C_s	Chemical Concentration in Sediment	Chem-specific	mg/kg		Intake (mg/kg-day) = C_s x SA x AF x ABS_d x EF x ED x 1/BW x 1/AT
				SA	Exposed Skin Surface Area	4,029	cm^2	Age-specific mean surface area of hands, lower legs and feet (USEPA 2004)	
				ABS_d	Dermal Absorption Factor	Chem-specific	unitless		
				AF	Adherence Factor	0.07	mg/cm^2-day	Residential adherence factor for an adult (USEPA 2004, Exhibit 3-5)	
				EF	Exposure Frequency	24	days/yr	Four days per month for six months per year (CDM 1995)	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				BW	Body Weight	57.2	kg	Mean body weight ages 12-18 for male/female (USEPA 1997)	
				CF	Conversion Factor	1.00E-06	kg/mg	Calculated	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	

TABLE A-4.3a
VALUES USED FOR DAILY INTAKE CALCULATIONS - FISH CONSUMPTION
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Fish

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Fish Ingestion	Adult	Adult: >13 yrs	Fish: Koppers Pond and Outlet Channel	C_{fish}	Chemical Concentration in Fish	Chem-specific	mg/kg		Intake (mg/kg-day) = C_{fish} x IgR_{fish} x AF x EF x ED x 1/BW x 1/AT
				IgR_{fish}	Fish Consumption Rate	0.025	kg/day	USEPA, Region 2	
				EF	Exposure Frequency	365	days/yr	Based on a daily consumption rate	
				ED	Exposure Duration	18	yrs	Age-adjusted exposure duration: 30 yrs - 12 yrs (total duration of child exposures) (USEPA 1989)	
				ABS_f	Oral Absorption Factor	Chem-specific	unitless		
				AF	Ajustment Factor				
					cooking loss	no loss	unitless	USEPA, Region 2	
					local consumption	1	unitless	Professional judgment	
				BW	Body Weight	70	kg	Default adult body weight (USEPA 1989)	
				AT_{nc}	Averaging Time (noncancer)	6570	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	

TABLE A-4.3b
VALUES USED FOR DAILY INTAKE CALCULATIONS - FISH CONSUMPTION
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Fish

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Fish Ingestion	Older child	Older child: 7 - 13 yrs	Fish: Koppers Pond and Outlet Channel	C_{fish}	Chemical Concentration in Fish	Chem-specific	mg/kg		Intake (mg/kg-day) = C_{fish} x IgR_{fish} x AF x EF x ED x 1/BW x 1/AT
				IgR_{fish}	Fish Consumption Rate	0.016	kg/day	USEPA, Region 2	
				EF	Exposure Frequency	365	days/yr	Based on a daily consumption rate	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				ABS_f	Oral Absorption Factor	Chem-specific	unitless		
				AF	Ajustment Factor				
					cooking loss	no loss	unitless	USEPA, Region 2	
					local consumption	1	unitless	Professional judgment	
				BW	Body Weight	34.5	kg	Default adult body weight (USEPA 1989)	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	

TABLE A-4.3c
VALUES USED FOR DAILY INTAKE CALCULATIONS - FISH CONSUMPTION
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Fish

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Fish Ingestion	Young child	Youngr child: 1 - 6 yrs	Fish: Koppers Pond and Outlet Channel	C_{fish}	Chemical Concentration in Fish	Chem-specific	mg/kg		Intake (mg/kg-day) = C_{fish} x IgR_{fish} x AF x EF x ED x 1/BW x 1/AT
				IgR_{fish}	Fish Consumption Rate	0.008	kg/day	USEPA, Region 2	
				EF	Exposure Frequency	365	days/yr	Based on a daily consumption rate	
				ED	Exposure Duration	6	yrs	Age-adjusted exposure duration (USEPA 1989)	
				ABS_f	Oral Absorption Factor	Chem-specific	unitless		
				AF	Ajustment Factor				
					cooking loss	no loss	unitless	USEPA, Region 2	
					local consumption	1	unitless	Professional judgment	
				BW	Body Weight	16.6	kg	Default adult body weight (USEPA 1989)	
				AT_{nc}	Averaging Time (noncancer)	2190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25550	days	365 days x 70 yrs (USEPA 1989)	

TABLE A-5.1

NON-CANCER TOXICITY DATA – ORAL/DERMAL

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Chemical of Potential Concern		Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
			Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	(3)	Chronic	3.0E-04	mg/kg-day	1	3.0E-04	mg/kg-day	hyperpigmentation; keratosis; possible vascular complications	3	IRIS	10/8/2008
Benzo(a)anthracene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Benzo(ghi)perylene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Cadmium		Chronic	1.8E-03	mg/kg-day	0.025	4.5E-05	mg/kg-day	significant proteinurea	10	IRIS	10/8/2008
Chromium	(4)	Chronic	3.0E-03	mg/kg-day	0.025	7.5E-05	mg/kg-day	none reported	300	IRIS	10/9/2008
Dibenz(a,h)anthracene		Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Lead	(5)	Chronic	NA	NA	1	NA	NA	NA	NA	NA	NA
Mercury	(6)	Chronic	1.0E-04	mg/kg-day	1	1.0E-04	mg/kg-day	developmental neurologic abnormalities in infants	10	IRIS	3/31/2009
Tetrachloroethene		Chronic	1.00E-02	mg/kg-day	1	1.0E-02	mg/kg-day	hepatotoxicity, weight gain	1000	IRIS	3/31/2009
Total PCBs (Aroclor 1254)		Chronic	2.0E-05	mg/kg-day	1	2.0E-05	mg/kg-day	ocular; immune system	300	IRIS	10/8/2008

Notes:

(1) RAGS Part E (USEPA 2004)

(2) Equation for dermal RfD: Oral RfD * Oral Absorption Efficiency (USEPA 2004)

(3) RfD is for inorganic arsenic. Arsenic present in fish tissue is primarily organic arsenic, a less-toxic form; thus, risks from arsenic via fish consumption will likely be overestimated.

(4) Toxicity values are for chromium VI.

(5) Toxicity values are not available for lead; risk-based concentrations estimated by adult lead model will be compared to lead EPCs.

(6) Mercury is identified as a COPC for fish only; therefore, the RfD is for methylmercury, the organic form that is the primary form in fish tissue.

Definitions:
NA = Not Available/Applicable
IRIS = Integrated Risk Information System

TABLE A-5.2

NON-CANCER TOXICITY DATA – INHALATION

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD (1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	1.5E-05	mg/m^3	4.3E-06	mg/kg-day	NA	NA	CalEPA	3/31/2009
Benzo(a)anthracene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(ghi)perylene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (2)	Chronic	1.0E-04	mg/m^3	2.9E-05	mg/kg-day	lung (bronchioalveolar)	300	IRIS	10/9/2008
Dibenz(a,h)anthracene	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Lead	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Mercury (methyl)	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	Chronic	6.00E-01	mg/m^3	1.7E-01	mg/kg-day	tubular cell karyomegaly	30	NCEA	cited in ORNL:03/312009
Total PCBs (Aroclor 1254)	Chronic	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

(1) Extrapolation equation: InhRfC (mg/m3) *20m3/d *1/70kg

(2) Toxicity values are for chromium VI.

Definitions:
NA = Not Available/Applicable
IRIS = Integrated Risk Information System
CalEPA = California Environmental Protection Agency
NCEA = The National Center for Environmental Assessment
ORNL = Oak Ridge National Laboratory

TABLE A-6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/8/2008
Benzo(a)anthracene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/8/2008
Benzo(a)pyrene	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/8/2008
Benzo(b)fluoranthene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/8/2008
Benzo(ghi)perylene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/8/2008
Indeno(1,2,3-cd)pyrene	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	12/15/2010
Cadmium	NA	NA	0.025	NA	NA	NA	NA	NA
Chromium (3)	NA	NA	0.025	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/8/2008
Lead	NA	NA	1	NA	NA	NA	NA	NA
Mercury (4)	NA	NA	1	NA	NA	C	IRIS	3/31/2009
Tetrachloroethene	5.40E-01	$(mg/kg\text{-}day)^{-1}$	1	5.4E-01	$(mg/kg\text{-}day)^{-1}$	NA	CalEPA	3/31/2009
Total PCBs (Aroclor 1254)	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/8/2008

Notes:

(1) RAGS Part E (USEPA 2004)

(2) Equation for dermal CSF: Oral CSF / Oral Absorption Efficiency (USEPA 2004)

(3) Toxicity values are for chromium VI.

(4) Toxicity values are for methylmercury.

Definitions:

NA = Not Available/Applicable

IRIS = Integrated Risk Information System

CalEPA = California Environmental Protection Agency

A = Human Carcinogen

B2 = Probable Human Carcinogen

C = Possible Human Carcinogen

D= Not classifiable to human carcinogenicity

TABLE A-6.2

CANCER TOXICITY DATA -- INHALATION

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor (1)		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	4.3E-03	$(\mu g/m^3)^{-1}$	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/8/2008
Benzo(a)anthracene	1.1E-04	$(\mu g/m^3)^{-1}$	3.9E-01	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	9/12/2008
Benzo(a)pyrene	1.1E-03	$(\mu g/m^3)^{-1}$	3.9E+00	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	9/12/2008
Benzo(b)fluoranthene	1.1E-04	$(\mu g/m^3)^{-1}$	3.9E-01	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	9/12/2008
Benzo(ghi)perylene	1.1E-04	$(\mu g/m^3)^{-1}$	3.9E-01	$(mg/kg\text{-}day)^{-1}$	D	CalEPA	9/12/2008
Indeno(1,2,3-cd)pyrene	1.1E-04	$(\mu g/m^3)^{-1}$	3.9E-01	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	9/12/2008
Cadmium	1.8E-03	$(\mu g/m^3)^{-1}$	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/9/2008
Chromium (2)	8.4E-02	$(\mu g/m^3)^{-1}$	2.9E+02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/9/2008
Dibenz(a,h)anthracene	1.2E-03	$(\mu g/m^3)^{-1}$	4.2E+00	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	9/12/2008
Lead	NA	NA	NA	NA	NA	NA	NA
Mercury (methyl)	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5.90E-06	$(\mu g/m^3)^{-1}$	2.1E-02	$(mg/kg\text{-}day)^{-1}$	NA	CalEPA	3/31/2009
Total PCBs	5.7E-04	$(\mu g/m^3)^{-1}$	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/9/2008

Notes:

(1) Extrapolation equation: InhUR (µg/m3) *1/20m3/d * 70kg * 1000µg/mg

(2) Toxicity values are for chromium VI.

Definitions:

NA = Not Available/Applicable

IRIS = Integrated Risk Information System

CalEPA = California Environmental Protection Agency

A = Human Carcinogen

B1 = Probable Human Carcinogen

B2 = Probable Human Carcinogen

TABLE A-7.1

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current and Future
Receptor Population: Trespasser/Wader
Receptor Age: Teenager

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water	Surface Water	Koppers Pond	Incidental Ingestion	Arsenic	0.000295	mg/l	1.2E-09	mg/kg-day	1.5E+00	1/mg/kg-day	1.7E-09	1.4E-08	mg/kg-day	3.0E-04	mg/kg/day	4.5E-05
				Benzo(b)fluoranthene	0.00025	mg/l	9.9E-10	mg/kg-day	7.3E-01	1/mg/kg-day	7.2E-10	1.1E-08	mg/kg-day	NA	mg/kg/day	NA
				Lead	0.01921	mg/l	7.6E-08	mg/kg-day	NA	1/mg/kg-day	NA	8.8E-07	mg/kg-day	NA	mg/kg/day	NA
			Exp. Route Total								2.5E-09					4.5E-05
			Dermal Contact	Arsenic	0.000000295	mg/cm^3	1.9E-10	mg/kg-day	1.5E+00	1/mg/kg-day	2.8E-10	2.2E-09	mg/kg-day	3.0E-04	mg/kg/day	7.3E-06
				Benzo(b)fluoranthene	0.00000025	mg/cm^3	4.0E-07	mg/kg-day	7.3E-01	1/mg/kg-day	3.0E-07	4.7E-06	mg/kg-day	NA	mg/kg/day	NA
				Lead	0.00001921	mg/cm^3	1.2E-09	mg/kg-day	NA	1/mg/kg-day	NA	1.4E-08	mg/kg-day	NA	mg/kg/day	NA
			Exp. Route Total								3.0E-07					7.3E-06
		Exposure Point Total									**3.0E-07**					**5.3E-05**
		Outlet Channel	Incidental Ingestion	Arsenic	0.00079	mg/l	3.1E-09	mg/kg-day	1.5E+00	1/mg/kg-day	4.7E-09	3.6E-08	mg/kg-day	3.0E-04	mg/kg/day	1.2E-04
				Benzo(a)anthracene	0.000051	mg/l	2.0E-10	mg/kg-day	7.3E-01	1/mg/kg-day	1.5E-10	2.3E-09	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	0.00027	mg/l	1.1E-09	mg/kg-day	7.3E-01	1/mg/kg-day	7.8E-10	1.2E-08	mg/kg-day	NA	mg/kg/day	NA
				Lead	0.0169	mg/l	6.7E-08	mg/kg-day	NA	1/mg/kg-day	NA	7.8E-07	mg/kg-day	NA	mg/kg/day	NA
				Tetrachloroethene	0.00022	mg/l	8.7E-10	mg/kg-day	5.4E-01	1/mg/kg-day	4.7E-10	1.0E-08	mg/kg-day	1.0E-02	mg/kg/day	1.0E-06
			Exp. Route Total								6.1E-09					1.2E-04
			Dermal Contact	Arsenic	0.00000079	mg/cm^3	5.0E-10	mg/kg-day	1.5E+00	1/mg/kg-day	7.5E-10	5.9E-09	mg/kg-day	3.0E-04	mg/kg/day	2.0E-05
				Benzo(a)anthracene	0.000000051	mg/cm^3	4.7E-08	mg/kg-day	7.3E-01	1/mg/kg-day	3.5E-08	5.5E-07	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	0.00000027	mg/cm^3	4.4E-07	mg/kg-day	7.3E-01	1/mg/kg-day	3.2E-07	5.1E-06	mg/kg-day	NA	mg/kg/day	NA
				Lead	0.0000169	mg/cm^3	1.1E-09	mg/kg-day	NA	1/mg/kg-day	NA	1.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Tetrachloroethene	0.00000022	mg/cm^3	9.6E-09	mg/kg-day	5.4E-01	1/mg/kg-day	5.2E-09	1.1E-07	mg/kg-day	1.0E-02	mg/kg/day	1.1E-05
			Exp. Route Total								3.6E-07					3.1E-05
		Exposure Point Total									**3.7E-07**					**1.5E-04**
	Exposure Medium Total										6.6E-07					2.1E-04
Surface Water Total											**6.6E-07**					**2.1E-04**
Sediment	Sediment	Koppers Pond	Incidental Ingestion	Arsenic	3.196	mg/kg	1.6E-08	mg/kg-day	1.5E+00	1/mg/kg-day	2.4E-08	1.8E-07	mg/kg-day	3.0E-04	mg/kg/day	6.1E-04
				Benzo(a)anthracene	0.8673	mg/kg	4.3E-09	mg/kg-day	7.3E-01	1/mg/kg-day	3.1E-09	5.0E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(a)pyrene	0.7522	mg/kg	3.7E-09	mg/kg-day	7.3E+00	1/mg/kg-day	2.7E-08	4.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	1.099	mg/kg	5.4E-09	mg/kg-day	7.3E-01	1/mg/kg-day	4.0E-09	6.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(ghi)perylene	0.825	mg/kg	4.1E-09	mg/kg-day	7.3E-01	1/mg/kg-day	3.0E-09	4.7E-08	mg/kg-day	NA	mg/kg/day	NA
				Cadmium	392	mg/kg	4.8E-08	mg/kg-day	NA	1/mg/kg-day	NA	5.6E-07	mg/kg-day	1.8E-03	mg/kg/day	3.1E-04
				Chromium	275.3	mg/kg	3.4E-08	mg/kg-day	NA	1/mg/kg-day	NA	4.0E-07	mg/kg-day	3.0E-03	mg/kg/day	1.3E-04
				Dibenz(a,h)anthracene	0.1639	mg/kg	8.1E-10	mg/kg-day	7.3E+00	1/mg/kg-day	5.9E-09	9.4E-09	mg/kg-day	NA	mg/kg/day	NA
				Indeno(1,2,3-cd)pyrene	0.6946	mg/kg	3.4E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.5E-09	4.0E-08	mg/kg-day	NA	mg/kg/day	NA
				Lead	761.7	mg/kg	3.8E-06	mg/kg-day	NA	1/mg/kg-day	NA	4.4E-05	mg/kg-day	NA	mg/kg/day	NA
				Total PCBs (Aroclor 1254)	1.338	mg/kg	6.6E-09	mg/kg-day	2.0E+00	1/mg/kg-day	1.3E-08	7.7E-08	mg/kg-day	2.0E-05	mg/kg/day	3.8E-03
			Exp. Route Total								8.2E-08					4.9E-03
			Dermal Contact	Arsenic	3.196	mg/kg	2.7E-09	mg/kg-day	1.5E+00	1/mg/kg-day	4.0E-09	3.1E-08	mg/kg-day	3.0E-04	mg/kg/day	1.0E-04
				Benzo(a)anthracene	0.8673	mg/kg	3.1E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.3E-09	3.7E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(a)pyrene	0.7522	mg/kg	2.7E-09	mg/kg-day	7.3E+00	1/mg/kg-day	2.0E-08	3.2E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	1.099	mg/kg	4.0E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.9E-09	4.6E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(ghi)perylene	0.825	mg/kg	3.0E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.2E-09	3.5E-08	mg/kg-day	NA	mg/kg/day	NA
				Cadmium	392	mg/kg	1.1E-08	mg/kg-day	NA	1/mg/kg-day	NA	1.3E-07	mg/kg-day	4.5E-05	mg/kg/day	2.8E-03
				Chromium	275.3	mg/kg	9.9E-08	mg/kg-day	NA	1/mg/kg-day	NA	1.2E-06	mg/kg-day	7.5E-05	mg/kg/day	1.5E-02
				Dibenz(a,h)anthracene	0.1639	mg/kg	5.9E-10	mg/kg-day	7.3E+00	1/mg/kg-day	4.3E-09	6.9E-09	mg/kg-day	NA	mg/kg/day	NA

TABLE A-7.1

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current and Future
Receptor Population: Trespasser/Wader
Receptor Age: Teenager

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
				Indeno(1,2,3-cd)pyrene	0.6946	mg/kg	2.5E-09	mg/kg-day	7.3E-01	1/mg/kg-day	1.8E-09	2.9E-08	mg/kg-day	NA	mg/kg/day	NA
				Lead	761.7	mg/kg	2.1E-08	mg/kg-day	NA	1/mg/kg-day	NA	2.5E-07	mg/kg-day	NA	mg/kg/day	NA
				Total PCBs (Aroclor 1254)	1.338	mg/kg	5.2E-09	mg/kg-day	2.0E+00	1/mg/kg-day	1.0E-08	6.1E-08	mg/kg-day	2.0E-05	mg/kg/day	3.0E-03
			Exp. Route Total								4.8E-08					2.1E-02
		Exposure Point Total									**1.3E-07**					**2.6E-02**
		Outlet Channel	Incidental Ingestion	Arsenic	7.2	mg/kg	3.5E-08	mg/kg-day	1.5E+00	1/mg/kg-day	5.3E-08	4.1E-07	mg/kg-day	3.0E-04	mg/kg/day	1.4E-03
				Cadmium	91.9	mg/kg	1.1E-08	mg/kg-day	NA	1/mg/kg-day	NA	1.3E-07	mg/kg-day	1.8E-03	mg/kg/day	7.3E-05
				Benzo(a)anthracene	2.2	mg/kg	1.1E-08	mg/kg-day	7.3E-01	1/mg/kg-day	7.9E-09	1.3E-07	mg/kg-day	NA	mg/kg/day	NA
				Benzo(a)pyrene	0.94	mg/kg	4.6E-09	mg/kg-day	7.3E+00	1/mg/kg-day	3.4E-08	5.4E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	2.6	mg/kg	1.3E-08	mg/kg-day	7.3E-01	1/mg/kg-day	9.4E-09	1.5E-07	mg/kg-day	NA	mg/kg/day	NA
				Benzo(ghi)perylene	0.58	mg/kg	2.9E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.1E-09	3.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Dibenz(a,h)anthracene	0.085	mg/kg	4.2E-10	mg/kg-day	7.3E+00	1/mg/kg-day	3.1E-09	4.9E-09	mg/kg-day	NA	mg/kg/day	NA
				Indeno(1,2,3-cd)pyrene	0.58	mg/kg	2.9E-09	mg/kg-day	7.3E-01	1/mg/kg-day	2.1E-09	3.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Total PCBs (Aroclor 1254)	0.28	mg/kg	1.4E-09	mg/kg-day	2.0E+00	1/mg/kg-day	2.8E-09	1.6E-08	mg/kg-day	2.0E-05	mg/kg/day	8.0E-04
			Exp. Route Total								1.1E-07					2.3E-03
			Dermal Contact	Arsenic	7.2	mg/kg	6.0E-09	mg/kg-day	1.5E+00	1/mg/kg-day	9.0E-09	7.0E-08	mg/kg-day	3.0E-04	mg/kg/day	2.3E-04
				Cadmium	91.9	mg/kg	2.6E-09	mg/kg-day	NA	1/mg/kg-day	NA	3.0E-08	mg/kg-day	4.5E-05	mg/kg/day	6.6E-04
				Benzo(a)anthracene	2.2	mg/kg	7.9E-09	mg/kg-day	7.3E-01	1/mg/kg-day	5.8E-09	9.3E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(a)pyrene	0.94	mg/kg	3.4E-09	mg/kg-day	7.3E+00	1/mg/kg-day	2.5E-08	4.0E-08	mg/kg-day	NA	mg/kg/day	NA
				Benzo(b)fluoranthene	2.6	mg/kg	9.4E-09	mg/kg-day	7.3E-01	1/mg/kg-day	6.9E-09	1.1E-07	mg/kg-day	NA	mg/kg/day	NA
				Benzo(ghi)perylene	0.58	mg/kg	2.1E-09	mg/kg-day	7.3E-01	1/mg/kg-day	1.5E-09	2.4E-08	mg/kg-day	NA	mg/kg/day	NA
				Dibenz(a,h)anthracene	0.085	mg/kg	3.1E-10	mg/kg-day	7.3E+00	1/mg/kg-day	2.2E-09	3.6E-09	mg/kg-day	NA	mg/kg/day	NA
				Indeno(1,2,3-cd)pyrene	0.58	mg/kg	2.1E-09	mg/kg-day	7.3E-01	1/mg/kg-day	1.5E-09	2.4E-08	mg/kg-day	NA	mg/kg/day	NA
				Total PCBs (Aroclor 1254)	0.28	mg/kg	1.1E-09	mg/kg-day	2.0E+00	1/mg/kg-day	2.2E-09	1.3E-08	mg/kg-day	2.0E-05	mg/kg/day	6.4E-04
			Exp. Route Total								5.4E-08					1.5E-03
		Exposure Point Total									**1.7E-07**					**3.8E-03**
	Exposure Medium Total										3.0E-07					3.0E-02
Sediment Total											**3.0E-07**					**3.0E-02**
							Total of Receptor Risks Across All Media - Koppers Pond				**4.3E-07**	**Total of Receptor Hazards Across All Media - Koppers Pond**				**2.6E-02**
							Total of Receptor Risks Across All Media - Outlet Channel				**5.3E-07**	**Total of Receptor Hazards Across All Media - Outlet Channel**				**3.9E-03**
							Total of Receptor Risks Across All Media, All Exposure Points				**9.6E-07**	**Total of Receptor Hazards Across All Media, All Exposure Points**				**3.0E-02**

Notes:
CSF = cancer slope factor
EPC = exposure point concentration
Exp = exposure
NA = not available
RfC = inhalation reference dose
RfD = oral reference dose

TABLE A-7.2

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current and Future
Receptor Population: Angler
Receptor Age: Child, Teenager, Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Receptor Age	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
								Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
						Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Fish Tissue	Fish Tissue	Koppers Pond	Ingestion	Child Age 1-6 years	Arsenic	0.0752	mg/kg	3.1E-06	mg/kg-day	1.5E+00	1/mg/kg-day	4.7E-06	3.6E-05	mg/kg-day	3.0E-04	mg/kg/day	1.2E-01
					Mercury	0.211	mg/kg	8.7E-06	mg/kg-day	NA	1/mg/kg-day	NA	1.0E-04	mg/kg-day	1.0E-04	mg/kg/day	1.0E+00
					Total PCBs	0.8265	mg/kg	3.4E-05	mg/kg-day	2.0E+00	1/mg/kg-day	6.8E-05	4.0E-04	mg/kg-day	2.0E-05	mg/kg/day	2.0E+01
				Receptor Total								7.3E-05					**2.1E+01**
				Teenager Age 7-13 years	Arsenic	0.0752	mg/kg	3.0E-06	mg/kg-day	1.5E+00	1/mg/kg-day	4.5E-06	3.5E-05	mg/kg-day	3.0E-04	mg/kg/day	1.2E-01
					Mercury	0.211	mg/kg	8.4E-06	mg/kg-day	NA	1/mg/kg-day	NA	9.8E-05	mg/kg-day	1.0E-04	mg/kg/day	9.8E-01
					Total PCBs	0.8265	mg/kg	3.3E-05	mg/kg-day	2.0E+00	1/mg/kg-day	6.6E-05	3.8E-04	mg/kg-day	2.0E-05	mg/kg/day	1.9E+01
				Receptor Total								7.0E-05					**2.0E+01**
				Adult >13 years	Arsenic	0.0752	mg/kg	6.9E-06	mg/kg-day	1.5E+00	1/mg/kg-day	1.0E-05	2.7E-05	mg/kg-day	3.0E-04	mg/kg/day	9.0E-02
					Mercury	0.211	mg/kg	1.9E-05	mg/kg-day	NA	1/mg/kg-day	NA	7.5E-05	mg/kg-day	1.0E-04	mg/kg/day	7.5E-01
					Total PCBs	0.8265	mg/kg	7.6E-05	mg/kg-day	2.0E+00	1/mg/kg-day	1.5E-04	3.0E-04	mg/kg-day	2.0E-05	mg/kg/day	1.5E+01
				Receptor Total								1.6E-04					**1.6E+01**
			Exposure Route Total									3.1E-04					
		Exposure Point Total										3.1E-04					
	Exposure Medium Total											3.1E-04					
Fish Tissue Total												3.1E-04					
											Total Receptor Risk	**3.1E-04**				**Receptor Hazard**	**2.1E+01**

Notes:

CSF = cancer slope factor

EPC = exposure point concentration

NA = not available

RfC = inhalation reference dose

RfD = oral reference dose

TABLE A-9.1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current and Future
Receptor Population: Trespasser/Wader
Receptor Age: Teenager

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk			Non-Carcinogenic Hazard Quotient		
				Ingestion	Dermal	Exposure Routes Total	Ingestion	Dermal	Exposure Routes Total
Surface Water	Surface Water	Koppers Pond	Arsenic	1.7E-09	2.8E-10	2.0E-09	4.5E-05	7.3E-06	5.3E-05
			Benzo(b)fluoranthene	7.2E-10	3.0E-07	3.0E-07	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA
			Chemical Total	2.5E-09	3.0E-07	3.0E-07	4.5E-05	7.3E-06	5.3E-05
		Exposure Point Total				3.0E-07			5.3E-05
	Exposure Medium Total					3.0E-07			5.3E-05
	Surface Water	Outlet Channel	Arsenic	4.7E-09	7.5E-10	5.4E-09	1.2E-04	2.0E-05	1.4E-04
			Benzo(a)anthracene	1.5E-10	3.5E-08	3.5E-08	NA	NA	NA
			Benzo(b)fluoranthene	7.8E-10	3.2E-07	3.2E-07	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA
			Tetrachloroethene	4.7E-10	5.2E-09	5.7E-09	1.0E-06	1.1E-05	1.2E-05
			Chemical Total	6.1E-09	3.6E-07	3.7E-07	1.2E-04	3.1E-05	1.5E-04
		Exposure Point Total				3.7E-07			1.5E-04
	Exposure Medium Total					3.7E-07			1.5E-04
Surface Water Total						6.6E-07			2.1E-04
Sediment	Sediment	Koppers Pond	Arsenic	2.4E-08	4.0E-09	2.8E-08	6.1E-04	1.0E-04	7.2E-04
			Benzo(a)anthracene	3.1E-09	2.3E-09	5.4E-09	NA	NA	NA
			Benzo(a)pyrene	2.7E-08	2.0E-08	4.7E-08	NA	NA	NA
			Benzo(b)fluoranthene	4.0E-09	2.9E-09	6.9E-09	NA	NA	NA
			Benzo(ghi)perylene	3.0E-09	2.2E-09	5.1E-09	NA	NA	NA
			Cadmium	NA	NA	NA	3.1E-04	2.8E-03	3.1E-03
			Chromium	NA	NA	NA	1.3E-04	1.5E-02	1.6E-02
			Dibenz(a,h)anthracene	5.9E-09	4.3E-09	1.0E-08	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	2.5E-09	1.8E-09	4.3E-09	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA
			Total PCBs (Aroclor 1254)	1.3E-08	1.0E-08	2.4E-08	3.8E-03	3.0E-03	6.9E-03
			Chemical Total	8.2E-08	4.8E-08	1.3E-07	4.9E-03	2.1E-02	2.6E-02
		Exposure Point Total				1.3E-07			2.6E-02
	Exposure Medium Total					1.3E-07			2.6E-02
	Sediment	Outlet Channel	Arsenic	5.3E-08	9.0E-09	6.2E-08	1.4E-03	2.3E-04	1.6E-03
			Cadmium	NA	NA	NA	7.3E-05	6.6E-04	7.4E-04
			Benzo(a)anthracene	7.9E-09	5.8E-09	1.4E-08	NA	NA	NA
			Benzo(a)pyrene	3.4E-08	2.5E-08	5.9E-08	NA	NA	NA
			Benzo(b)fluoranthene	9.4E-09	6.9E-09	1.6E-08	NA	NA	NA
			Benzo(ghi)perylene	2.1E-09	1.5E-09	3.6E-09	NA	NA	NA
			Dibenz(a,h)anthracene	3.1E-09	2.2E-09	5.3E-09	NA	NA	NA
			Indeno(1,2,3-cd)pyrene	2.1E-09	1.5E-09	3.6E-09	NA	NA	NA
			Total PCBs (Aroclor 1254)	2.8E-09	2.2E-09	4.9E-09	8.0E-04	6.4E-04	1.4E-03
			Chemical Total	1.1E-07	5.4E-08	1.7E-07	2.3E-03	1.5E-03	3.8E-03
		Exposure Point Total				1.7E-07			3.8E-03
	Exposure Medium Total					1.7E-07			3.8E-03
Sediment Total						3.0E-07			3.0E-02

	Carcinogenic Risk	Non-Carcinogenic Hazard
Total Risk/HI Across All Media - Koppers Pond	**4.3E-07**	**2.6E-02**
Total Risk/HI Across All Media - Outlet Channel	**5.3E-07**	**3.9E-03**
Total Risk/HI Across All Media, All Exposure Points	**9.6E-07**	**3.0E-02**

TABLE A-9.2
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS
REASONABLE MAXIMUM EXPOSURE
KOPPERS POND KENTUCKY AVENUE WELLFIELD SITE, OPERABLE UNIT 4, HORSEHEADS, NY

Scenario Timeframe: Current and Future
Receptor Population: Angler
Receptor Age: Child, Teenager, Adult

Medium	Exposure Medium	Exposure Point	Receptor Age	Chemical of Potential Concern	Carcinogenic Risk		Non-Carcinogenic Hazard Quotient	
					Ingestion	Exposure Routes Total	Ingestion	Exposure Routes Total
Fish Tissue	Fish Tissue	Koppers Pond	Child Age 1-6 years	Arsenic	4.7E-06	4.7E-06	1.2E-01	1.2E-01
				Mercury	NA	NA	1.0E+00	1.0E+00
				Total PCBs	6.8E-05	6.8E-05	2.0E+01	2.0E+01
				Chemical Total	7.3E-05	7.3E-05	2.1E+01	2.1E+01
			Receptor Total			7.3E-05		2.1E+01
			Teenager Age 7-13 years	Arsenic	4.5E-06	4.5E-06	1.2E-01	1.2E-01
				Mercury	NA	NA	9.8E-01	9.8E-01
				Total PCBs	6.6E-05	6.6E-05	1.9E+01	1.9E+01
				Chemical Total	7.0E-05	7.0E-05	2.0E+01	2.0E+01
			Receptor Total			7.0E-05		2.0E+01
			Adult >13 years	Arsenic	1.0E-05	1.0E-05	9.0E-02	9.0E-02
				Mercury	NA	NA	7.5E-01	7.5E-01
				Total PCBs	1.5E-04	1.5E-04	1.5E+01	1.5E+01
				Chemical Total	1.6E-04	1.6E-04	1.6E+01	1.6E+01
			Receptor Total			1.6E-04		1.6E+01
		Exposure Point Total				3.1E-04		
	Exposure Medium Total					3.1E-04		
Fish Tissue Total						3.1E-04		
					Total Risk	**3.1E-04**	**Hazard Index**	**2.1E+01**

APPENDIX B

PROUCL CALCULATIONS

- APPENDIX B1. PROUCL – SURFACE WATER-KOPPERS POND
- APPENDIX B2. PROUCL – SURFACE WATER-OUTLET CHANNEL
- APPENDIX B3. PROUCL – SEDIMENT-KOPPERS POND
- APPENDIX B4. PROUCL – SEDIMENT-OUTLET CHANNEL
- APPENDIX B3. PROUCL – GAMEFISH-KOPPERS POND

APPENDIX B1.

PROUCL – SURFACE WATER
KOPPERS POND

ARSENIC

BENZO(B)FLUORANTHENE

LEAD

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Data	6	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	2
		Percent Non-Detects	33.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.17	Minimum Detected	-1.772
Maximum Detected	0.33	Maximum Detected	-1.109
Mean of Detected	0.243	Mean of Detected	-1.447
SD of Detected	0.069	SD of Detected	0.285
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

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

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

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

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.995
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.328	Mean	-1.196
SD	0.143	SD	0.447
95% DL/2 (t) UCL	0.446	95% H-Stat (DL/2) UCL	0.553
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.447
		SD in Log Scale	0.245
		Mean in Original Scale	0.241
		SD in Original Scale	0.0592
		95% t UCL	0.29
		95% Percentile Bootstrap UCL	0.278
		95% BCA Bootstrap UCL	0.279

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	

k star (bias corrected)	4.329
Theta Star	0.056
nu star	34.63
A-D Test Statistic	0.203
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.394

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.17
Maximum	0.33
Mean	0.244
Median	0.235
SD	0.0595
k star	10.18
Theta star	0.0239
Nu star	122.2
AppChi2	97.68
95% Gamma Approximate UCL	0.305
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.243
SD	0.0597
SE of Mean	0.0345
95% KM (t) UCL	0.312
95% KM (z) UCL	0.299
95% KM (jackknife) UCL	0.316
95% KM (bootstrap t) UCL	0.346
95% KM (BCA) UCL	0.292
95% KM (Percentile Bootstrap) UCL	0.295
95% KM (Chebyshev) UCL	0.393
97.5% KM (Chebyshev) UCL	0.458
99% KM (Chebyshev) UCL	0.586

Potential UCLs to Use

95% KM (t) UCL	0.312
95% KM (Percentile Bootstrap) UCL	0.295

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.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(b)fluoranthene

General Statistics

Number of Valid Data	6	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	5
		Percent Non-Detects	83.33%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable BbF was not processed!

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Observations 6

Number of Distinct Observations 6

Raw Statistics

Minimum	9.1
Maximum	25.7
Mean	14.13
Median	12.05
SD	6.174
Coefficient of Variation	0.437
Skewness	1.692

Log-transformed Statistics

Minimum of Log Data	2.208
Maximum of Log Data	3.246
Mean of log Data	2.582
SD of log Data	0.382

Warning: A sample size of 'n' = 6 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.

Warning: There are only 6 Values in this data

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

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.818
Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.903
Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	19.21

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	20.14
95% Modified-t UCL (Johnson-1978)	19.5

Assuming Lognormal Distribution

95% H-UCL	21.34
95% Chebyshev (MVUE) UCL	23.58
97.5% Chebyshev (MVUE) UCL	27.71
99% Chebyshev (MVUE) UCL	35.81

Gamma Distribution Test

k star (bias corrected)	3.966
Theta Star	3.564
MLE of Mean	14.13
MLE of Standard Deviation	7.097
nu star	47.59
Approximate Chi Square Value (.05)	32.76

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Adjusted Level of Significance 0.0122	95% CLT UCL 18.28
Adjusted Chi Square Value 28.38	95% Jackknife UCL 19.21
	95% Standard Bootstrap UCL 17.93
Anderson-Darling Test Statistic 0.431	95% Bootstrap-t UCL 28.41
Anderson-Darling 5% Critical Value 0.698	95% Hall's Bootstrap UCL 40.66
Kolmogorov-Smirnov Test Statistic 0.267	95% Percentile Bootstrap UCL 18.38
Kolmogorov-Smirnov 5% Critical Value 0.333	95% BCA Bootstrap UCL 19.73
Data appear Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL 25.12
	97.5% Chebyshev(Mean, Sd) UCL 29.87
Assuming Gamma Distribution	99% Chebyshev(Mean, Sd) UCL 39.21
95% Approximate Gamma UCL 20.53	
95% Adjusted Gamma UCL 23.7	
Potential UCL to Use	Use 95% Student's-t UCL 19.21

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.

APPENDIX B2.

PROUCL – SURFACE WATER OUTLET CHANNEL

TETRACHLOROETHENE

BENZO(B)FLUORANTHENE

ARSENIC

BENZO(A)ANTHRACENE

LEAD

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Tetrachloroethene

General Statistics

Number of Valid Data	4	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	3
		Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable PCE was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(b)fluoranthene

General Statistics

Number of Valid Data	4	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	3
		Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable BbF was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Data	4	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	2
		Percent Non-Detects	50.00%

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable As was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)anthracene

General Statistics

Number of Valid Data	4	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	3
		Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable BaA was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SW_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Observations	4	Number of Distinct Observations	4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Pb was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX B3.

PROUCL – SEDIMENT
KOPPERS POND

ARSENIC

CADMIUM

CHROMIUM

LEAD

BENZO(A)ANTHRACENE

BENZO(A)PYRENE

BENZO(B)FLUORANTHENE

BENZO(GHI)PERYLENE

DIBENZ(A,H)ANTHRACENE

TOTAL PCBS (AROCLOR 1254)

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	14

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.7	Minimum of Log Data	0.531
Maximum	4.8	Maximum of Log Data	1.569
Mean	2.868	Mean of log Data	1.017
Median	2.6	SD of log Data	0.276
SD	0.823		
Coefficient of Variation	0.287		
Skewness	0.848		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Test Statistic	0.979
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	3.196	95% H-UCL	3.236
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.668
95% Adjusted-CLT UCL (Chen-1995)	3.218	97.5% Chebyshev (MVUE) UCL	4.014
95% Modified-t UCL (Johnson-1978)	3.202	99% Chebyshev (MVUE) UCL	4.695

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	11.6	Data appear Normal at 5% Significance Level	
Theta Star	0.247		
MLE of Mean	2.868		
MLE of Standard Deviation	0.842		
nu star	440.8		
Approximate Chi Square Value (.05)	393.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	3.179
Adjusted Chi Square Value	389.2	95% Jackknife UCL	3.196
		95% Standard Bootstrap UCL	3.172
Anderson-Darling Test Statistic	0.271	95% Bootstrap-t UCL	3.223
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	3.233
Kolmogorov-Smirnov Test Statistic	0.132	95% Percentile Bootstrap UCL	3.174
Kolmogorov-Smirnov 5% Critical Value	0.198	95% BCA Bootstrap UCL	3.216
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	3.691
		97.5% Chebyshev(Mean, Sd) UCL	4.047
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	4.746
95% Approximate Gamma UCL	3.216		
95% Adjusted Gamma UCL	3.249		

Potential UCL to Use		Use 95% Student's-t UCL	3.196

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.3	Minimum of Log Data	0.262
Maximum	739	Maximum of Log Data	6.605
Mean	181	Mean of log Data	3.751
Median	57.1	SD of log Data	2.118
SD	241.5		
Coefficient of Variation	1.334		
Skewness	1.213		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.747	Shapiro Wilk Test Statistic	0.919
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	277.1	95% H-UCL	3723
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1066
95% Adjusted-CLT UCL (Chen-1995)	288.6	97.5% Chebyshev (MVUE) UCL	1398
95% Modified-t UCL (Johnson-1978)	279.7	99% Chebyshev (MVUE) UCL	2051

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.411	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	440.2		
MLE of Mean	181		
MLE of Standard Deviation	282.3		
nu star	15.63		
Approximate Chi Square Value (.05)	7.699	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	272.2
Adjusted Chi Square Value	7.216	95% Jackknife UCL	277.1
		95% Standard Bootstrap UCL	274.4
Anderson-Darling Test Statistic	0.616	95% Bootstrap-t UCL	306.4
Anderson-Darling 5% Critical Value	0.813	95% Hall's Bootstrap UCL	272.8
Kolmogorov-Smirnov Test Statistic	0.156	95% Percentile Bootstrap UCL	274.7
Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	289.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	422.5
		97.5% Chebyshev(Mean, Sd) UCL	527.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	732.3
95% Approximate Gamma UCL	367.4		
95% Adjusted Gamma UCL	392		

Potential UCL to Use	Use 95% Adjusted Gamma UCL 392

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	17.5	Minimum of Log Data	2.862
Maximum	462	Maximum of Log Data	6.136
Mean	184.7	Mean of log Data	4.78
Median	154	SD of log Data	1.083
SD	148.9		
Coefficient of Variation	0.806		
Skewness	0.632		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Test Statistic	0.914
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	244	95% H-UCL	430
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	454.7
95% Adjusted-CLT UCL (Chen-1995)	246.2	97.5% Chebyshev (MVUE) UCL	562.9
95% Modified-t UCL (Johnson-1978)	244.8	99% Chebyshev (MVUE) UCL	775.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.112	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	166.1		
MLE of Mean	184.7		
MLE of Standard Deviation	175.2		
nu star	42.27		
Approximate Chi Square Value (.05)	28.36	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	240.9
Adjusted Chi Square Value	27.37	95% Jackknife UCL	244
		95% Standard Bootstrap UCL	236.8
Anderson-Darling Test Statistic	0.392	95% Bootstrap-t UCL	251.4
Anderson-Darling 5% Critical Value	0.762	95% Hall's Bootstrap UCL	244.3
Kolmogorov-Smirnov Test Statistic	0.126	95% Percentile Bootstrap UCL	239.7
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL	243.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	333.7
		97.5% Chebyshev(Mean, Sd) UCL	398.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	524.7
95% Approximate Gamma UCL	275.3		
95% Adjusted Gamma UCL	285.3		

Potential UCL to Use	Use 95% Approximate Gamma UCL 275.3

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	19
Raw Statistics		**Log-transformed Statistics**	
Minimum	36.6	Minimum of Log Data	3.6
Maximum	1620	Maximum of Log Data	7.39
Mean	479.7	Mean of log Data	5.579
Median	267	SD of log Data	1.147
SD	537.9		
Coefficient of Variation	1.121		
Skewness	1.386		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.75	Shapiro Wilk Test Statistic	0.955
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	693.7	95% H-UCL	1097
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1118
95% Adjusted-CLT UCL (Chen-1995)	724.7	97.5% Chebyshev (MVUE) UCL	1392
95% Modified-t UCL (Johnson-1978)	700.3	99% Chebyshev (MVUE) UCL	1930
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.855	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	560.9		
MLE of Mean	479.7		
MLE of Standard Deviation	518.8		
nu star	32.5		
Approximate Chi Square Value (.05)	20.47	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	682.7
Adjusted Chi Square Value	19.64	95% Jackknife UCL	693.7
		95% Standard Bootstrap UCL	677
Anderson-Darling Test Statistic	0.683	95% Bootstrap-t UCL	771.4
Anderson-Darling 5% Critical Value	0.77	95% Hall's Bootstrap UCL	675.3
Kolmogorov-Smirnov Test Statistic	0.165	95% Percentile Bootstrap UCL	691.8
Kolmogorov-Smirnov 5% Critical Value	0.205	95% BCA Bootstrap UCL	722.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1018
		97.5% Chebyshev(Mean, Sd) UCL	1250
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1708
95% Approximate Gamma UCL	761.7		
95% Adjusted Gamma UCL	794.1		
Potential UCL to Use		Use 95% Approximate Gamma UCL	761.7

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)anthracene

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	37	Minimum of Log Data	3.611
Maximum	1600	Maximum of Log Data	7.378
Mean	390.7	Mean of log Data	5.346
Median	200	SD of log Data	1.126
SD	476.6		
Coefficient of Variation	1.22		
Skewness	1.596		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.708	Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	580.3	95% H-UCL	831
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	857.3
95% Adjusted-CLT UCL (Chen-1995)	613.3	97.5% Chebyshev (MVUE) UCL	1066
95% Modified-t UCL (Johnson-1978)	587	99% Chebyshev (MVUE) UCL	1474

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.823	Data appear Lognormal at 5% Significance Level	
Theta Star	474.7		
MLE of Mean	390.7		
MLE of Standard Deviation	430.7		
nu star	31.27		
Approximate Chi Square Value (.05)	19.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	570.5
Adjusted Chi Square Value	18.68	95% Jackknife UCL	580.3
		95% Standard Bootstrap UCL	565.3
Anderson-Darling Test Statistic	1.047	95% Bootstrap-t UCL	654.5
Anderson-Darling 5% Critical Value	0.772	95% Hall's Bootstrap UCL	558.9
Kolmogorov-Smirnov Test Statistic	0.215	95% Percentile Bootstrap UCL	579.6
Kolmogorov-Smirnov 5% Critical Value	0.205	95% BCA Bootstrap UCL	610.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	867.3
		97.5% Chebyshev(Mean, Sd) UCL	1074
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1479
95% Approximate Gamma UCL	626.7		
95% Adjusted Gamma UCL	653.9		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	867.3

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)pyrene

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17
Raw Statistics		**Log-transformed Statistics**	
Minimum	58	Minimum of Log Data	4.06
Maximum	1500	Maximum of Log Data	7.313
Mean	499.9	Mean of log Data	5.753
Median	230	SD of log Data	0.993
SD	496.2		
Coefficient of Variation	0.993		
Skewness	1.179		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.768	Shapiro Wilk Test Statistic	0.936
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	697.3	95% H-UCL	948.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1048
95% Adjusted-CLT UCL (Chen-1995)	720	97.5% Chebyshev (MVUE) UCL	1286
95% Modified-t UCL (Johnson-1978)	702.4	99% Chebyshev (MVUE) UCL	1754
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.065	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	469.3		
MLE of Mean	499.9		
MLE of Standard Deviation	484.3		
nu star	40.48		
Approximate Chi Square Value (.05)	26.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	687.1
Adjusted Chi Square Value	25.93	95% Jackknife UCL	697.3
		95% Standard Bootstrap UCL	683.4
Anderson-Darling Test Statistic	0.853	95% Bootstrap-t UCL	756.6
Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	678.6
Kolmogorov-Smirnov Test Statistic	0.197	95% Percentile Bootstrap UCL	684
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL	715.3
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	996.1
		97.5% Chebyshev(Mean, Sd) UCL	1211
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1633
95% Approximate Gamma UCL	752.2		
95% Adjusted Gamma UCL	780.3		
Potential UCL to Use		Use 95% Approximate Gamma UCL	752.2

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.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	72	Minimum of Log Data	4.277
Maximum	2600	Maximum of Log Data	7.863
Mean	726.2	Mean of log Data	6.114
Median	370	SD of log Data	1.017
SD	743.9		
Coefficient of Variation	1.024		
Skewness	1.429		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.783	Shapiro Wilk Test Statistic	0.966
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	1022	95% H-UCL	1427
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1559
95% Adjusted-CLT UCL (Chen-1995)	1067	97.5% Chebyshev (MVUE) UCL	1918
95% Modified-t UCL (Johnson-1978)	1031	99% Chebyshev (MVUE) UCL	2623

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.04	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	698		
MLE of Mean	726.2		
MLE of Standard Deviation	712		
nu star	39.53		
Approximate Chi Square Value (.05)	26.13	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	1007
Adjusted Chi Square Value	25.18	95% Jackknife UCL	1022
		95% Standard Bootstrap UCL	995.9
Anderson-Darling Test Statistic	0.611	95% Bootstrap-t UCL	1133
Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	1042
Kolmogorov-Smirnov Test Statistic	0.182	95% Percentile Bootstrap UCL	1007
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL	1044
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1470
		97.5% Chebyshev(Mean, Sd) UCL	1792
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2424
95% Approximate Gamma UCL	1099		
95% Adjusted Gamma UCL	1140		

Potential UCL to Use		Use 95% Approximate Gamma UCL	1099

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(ghi)perylene

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	34	Minimum of Log Data	3.526
Maximum	1200	Maximum of Log Data	7.09
Mean	397	Mean of log Data	5.41
Median	180	SD of log Data	1.122
SD	428		
Coefficient of Variation	1.078		
Skewness	1.166		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.746	Shapiro Wilk Test Statistic	0.93
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	567.3	95% H-UCL	877.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	908
95% Adjusted-CLT UCL (Chen-1995)	586.6	97.5% Chebyshev (MVUE) UCL	1128
95% Modified-t UCL (Johnson-1978)	571.6	99% Chebyshev (MVUE) UCL	1560

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.882	Data appear Lognormal at 5% Significance Level	
Theta Star	450.2		
MLE of Mean	397		
MLE of Standard Deviation	422.8		
nu star	33.51		
Approximate Chi Square Value (.05)	21.27	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	558.5
Adjusted Chi Square Value	20.42	95% Jackknife UCL	567.3
		95% Standard Bootstrap UCL	555.5
Anderson-Darling Test Statistic	0.911	95% Bootstrap-t UCL	611.7
Anderson-Darling 5% Critical Value	0.769	95% Hall's Bootstrap UCL	546.2
Kolmogorov-Smirnov Test Statistic	0.222	95% Percentile Bootstrap UCL	556.7
Kolmogorov-Smirnov 5% Critical Value	0.204	95% BCA Bootstrap UCL	564.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	825
		97.5% Chebyshev(Mean, Sd) UCL	1010
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1374
95% Approximate Gamma UCL	625.4		
95% Adjusted Gamma UCL	651.4		

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 825

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 Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	19	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	6
		Percent Non-Detects	31.58%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	12	Minimum Detected	2.485
Maximum Detected	370	Maximum Detected	5.914
Mean of Detected	150.5	Mean of Detected	4.484
SD of Detected	135.6	SD of Detected	1.182
Minimum Non-Detect	35	Minimum Non-Detect	3.555
Maximum Non-Detect	180	Maximum Non-Detect	5.193

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	15
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	78.95%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.843	Shapiro Wilk Test Statistic	0.919
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
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	118.6	Mean	4.258
SD	121.6	SD	1.072
95% DL/2 (t) UCL	167	95% H-Stat (DL/2) UCL	249.1
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	191.9	Mean in Log Scale	4.16
SD	148.7	SD in Log Scale	1.092
95% MLE (t) UCL	251	Mean in Original Scale	113.3
95% MLE (Tiku) UCL	304	SD in Original Scale	124.3
		95% t UCL	162.7
		95% Percentile Bootstrap UCL	157.6
		95% BCA Bootstrap UCL	167.9

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.883	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	170.5		
nu star	22.95		
A-D Test Statistic	0.487	**Nonparametric Statistics**	
5% A-D Critical Value	0.756	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.756	Mean	113.9
5% K-S Critical Value	0.243	SD	121.5
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	29.27
		95% KM (t) UCL	164.6
Assuming Gamma Distribution		95% KM (z) UCL	162
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	164.1
Minimum	12	95% KM (bootstrap t) UCL	180
Maximum	370	95% KM (BCA) UCL	163.9

Mean	141.3
Median	122
SD	112.7
k star	1.274
Theta star	110.9
Nu star	48.42
AppChi2	33.45
95% Gamma Approximate UCL	204.6
95% Adjusted Gamma UCL	211.4

Note: DL/2 is not a recommended method.

95% KM (Percentile Bootstrap) UCL	162.8
95% KM (Chebyshev) UCL	241.4
97.5% KM (Chebyshev) UCL	296.6
99% KM (Chebyshev) UCL	405.1

Potential UCLs to Use

95% KM (BCA) UCL	163.9

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.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	29	Minimum of Log Data	3.367
Maximum	1100	Maximum of Log Data	7.003
Mean	335.1	Mean of log Data	5.271
Median	160	SD of log Data	1.087
SD	359.5		
Coefficient of Variation	1.073		
Skewness	1.263		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.755	Shapiro Wilk Test Statistic	0.946
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
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	478.1	95% H-UCL	708
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	747.2
95% Adjusted-CLT UCL (Chen-1995)	496.3	97.5% Chebyshev (MVUE) UCL	925.3
95% Modified-t UCL (Johnson-1978)	482.1	99% Chebyshev (MVUE) UCL	1275
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.924	Data appear Lognormal at 5% Significance Level	
Theta Star	362.7		
MLE of Mean	335.1		
MLE of Standard Deviation	348.6		
nu star	35.11		
Approximate Chi Square Value (.05)	22.55	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0369	95% CLT UCL	470.8
Adjusted Chi Square Value	21.68	95% Jackknife UCL	478.1
		95% Standard Bootstrap UCL	467.8
Anderson-Darling Test Statistic	0.835	95% Bootstrap-t UCL	527.9
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL	461.8
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL	468.7
Kolmogorov-Smirnov 5% Critical Value	0.204	95% BCA Bootstrap UCL	480.7
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	694.6
		97.5% Chebyshev(Mean, Sd) UCL	850.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1156
95% Approximate Gamma UCL	521.7		
95% Adjusted Gamma UCL	542.8		

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL 694.6

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.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_KoppersPond.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Total PCBs (Aroclor 1254)

General Statistics

Number of Valid Data	19	Number of Detected Data	18
Number of Distinct Detected Data	15	Number of Non-Detect Data	1
		Percent Non-Detects	5.26%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	20	Minimum Detected	2.996
Maximum Detected	2700	Maximum Detected	7.901
Mean of Detected	637.3	Mean of Detected	5.495
SD of Detected	739.5	SD of Detected	1.698
Minimum Non-Detect	16	Minimum Non-Detect	2.773
Maximum Non-Detect	16	Maximum Non-Detect	2.773

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.807	Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	604.2	Mean	5.315
SD	733	SD	1.827
95% DL/2 (t) UCL	895.8	95% H-Stat (DL/2) UCL	5899
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	582.1	Mean in Log Scale	5.28
SD	742.1	SD in Log Scale	1.898
95% MLE (t) UCL	877.4	Mean in Original Scale	604
95% MLE (Tiku) UCL	859.5	SD in Original Scale	733.2
		95% t UCL	895.7
		95% Percentile Bootstrap UCL	876.1
		95% BCA Bootstrap UCL	938.2

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.567	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	1123		
nu star	20.43		
A-D Test Statistic	0.474	**Nonparametric Statistics**	
5% A-D Critical Value	0.788	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.788	Mean	604.8
5% K-S Critical Value	0.213	SD	712.9
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	168.3
		95% KM (t) UCL	896.7
Assuming Gamma Distribution		95% KM (z) UCL	881.7
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	896.2
Minimum	1E-12	95% KM (bootstrap t) UCL	1000
Maximum	2700	95% KM (BCA) UCL	899.1
Mean	603.8	95% KM (Percentile Bootstrap) UCL	888.1
Median	410	95% KM (Chebyshev) UCL	1338
SD	733.4	97.5% KM (Chebyshev) UCL	1656

k star	0.258	99% KM (Chebyshev) UCL	2279
Theta star	2336		
Nu star	9.823	**Potential UCLs to Use**	
AppChi2	3.831	95% KM (Chebyshev) UCL	1338
95% Gamma Approximate UCL	1548		
95% Adjusted Gamma UCL	1690		

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.

APPENDIX B4.

PROUCL – SEDIMENT
OUTLET CHANNEL

ARSENIC

CADMIUM

BENZO(A)ANTHRACENE

BENZO(A)PYRENE

BENZO(B)FLUORANTHENE

BENZO(GHI)PERYLENE

DIBENZ(A,H)ANTHRACENE

INDENO(1,2,3-CD)PYRENE

TOTAL PCBS (AROCLOR 1254)

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable As was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Number of Valid Observations 4 | Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Cd was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)anthracene

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable BaA was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)pyrene

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable BaP was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	4	Number of Distinct Observations	4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable BbF was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(ghi)perylene

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable BenzPer was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Dibenz(a,h)anthracene

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable DibAn was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable IndPy was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\SD_OutletChannel.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Total PCBs (Aroclor 1254)

General Statistics

Number of Valid Observations 4

Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable PCB was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX B5.

PROUCL – GAMEFISH
KOPPERS POND

ARSENIC

MERCURY

TOTAL PCBS

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\Gamefish.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Data	20	Number of Detected Data	16
Number of Distinct Detected Data	13	Number of Non-Detect Data	4
		Percent Non-Detects	20.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.018	Minimum Detected	-4.017
Maximum Detected	0.15	Maximum Detected	-1.897
Mean of Detected	0.0648	Mean of Detected	-2.866
SD of Detected	0.0328	SD of Detected	0.549
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0619	Mean	-2.892
SD	0.0298	SD	0.49
95% DL/2 (t) UCL	0.0734	95% H-Stat (DL/2) UCL	0.0785
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.889
		SD in Log Scale	0.51
		Mean in Original Scale	0.0625
		SD in Original Scale	0.0304
		95% t UCL	0.0742
		95% Percentile Bootstrap UCL	0.0736
		95% BCA Bootstrap UCL	0.0757
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	3.313	Data appear Normal at 5% Significance Level	
Theta Star	0.0196		
nu star	106		
A-D Test Statistic	0.462	**Nonparametric Statistics**	
5% A-D Critical Value	0.742	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.742	Mean	0.0631
5% K-S Critical Value	0.216	SD	0.0302
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.00742
		95% KM (t) UCL	0.0759
Assuming Gamma Distribution		95% KM (z) UCL	0.0753
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.076
Minimum	0.018	95% KM (bootstrap t) UCL	0.0766
Maximum	0.15	95% KM (BCA) UCL	0.0763
Mean	0.0653	95% KM (Percentile Bootstrap) UCL	0.0752
Median	0.068	95% KM (Chebyshev) UCL	0.0955
SD	0.0297	97.5% KM (Chebyshev) UCL	0.109

k star	4.131		99% KM (Chebyshev) UCL	0.137
Theta star	0.0158			
Nu star	165.2		Potential UCLs to Use	
AppChi2	136.5		95% KM (t) UCL	0.0759
95% Gamma Approximate UCL	0.079		95% KM (Percentile Bootstrap) UCL	0.0752
95% Adjusted Gamma UCL	0.0802			

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.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\Gamefish.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Mercury

General Statistics

Number of Valid Observations 20

Number of Distinct Observations 18

Raw Statistics

Minimum	0.011
Maximum	0.37
Mean	0.138
Median	0.094
SD	0.12
Coefficient of Variation	0.871
Skewness	0.555

Log-transformed Statistics

Minimum of Log Data	-4.51
Maximum of Log Data	-0.994
Mean of log Data	-2.511
SD of log Data	1.184

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.876
Shapiro Wilk Critical Value	0.905

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.185

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.186
95% Modified-t UCL (Johnson-1978)	0.185

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.911
Shapiro Wilk Critical Value	0.905

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	0.361
95% Chebyshev (MVUE) UCL	0.361
97.5% Chebyshev (MVUE) UCL	0.45
99% Chebyshev (MVUE) UCL	0.625

Gamma Distribution Test

k star (bias corrected)	0.947
Theta Star	0.146
MLE of Mean	0.138
MLE of Standard Deviation	0.142
nu star	37.89
Approximate Chi Square Value (.05)	24.8
Adjusted Level of Significance	0.038
Adjusted Chi Square Value	23.96
Anderson-Darling Test Statistic	0.595
Anderson-Darling 5% Critical Value	0.766
Kolmogorov-Smirnov Test Statistic	0.149
Kolmogorov-Smirnov 5% Critical Value	0.199

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.211
95% Adjusted Gamma UCL	0.219

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.183
95% Jackknife UCL	0.185
95% Standard Bootstrap UCL	0.181
95% Bootstrap-t UCL	0.19
95% Hall's Bootstrap UCL	0.182
95% Percentile Bootstrap UCL	0.184
95% BCA Bootstrap UCL	0.185
95% Chebyshev(Mean, Sd) UCL	0.256
97.5% Chebyshev(Mean, Sd) UCL	0.306
99% Chebyshev(Mean, Sd) UCL	0.406

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.211

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 Data Sets with Non-Detects

User Selected Options	
From File	L:\C666_KoppersPR_KoppersPond\Data\HHRA_ProUCLCalcs\ProUCL_Files\Gamefish.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Total PCBs

General Statistics

Number of Valid Observations	17	Number of Distinct Observations	16
Raw Statistics		**Log-transformed Statistics**	
Minimum	90	Minimum of Log Data	4.5
Maximum	2060	Maximum of Log Data	7.63
Mean	525.2	Mean of log Data	5.772
Median	239	SD of log Data	0.982
SD	585.4		
Coefficient of Variation	1.115		
Skewness	1.634		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.735	Shapiro Wilk Test Statistic	0.908
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	773.1	95% H-UCL	995.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1072
95% Adjusted-CLT UCL (Chen-1995)	818.9	97.5% Chebyshev (MVUE) UCL	1319
95% Modified-t UCL (Johnson-1978)	782.5	99% Chebyshev (MVUE) UCL	1806
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.989	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	530.8		
MLE of Mean	525.2		
MLE of Standard Deviation	528		
nu star	33.64		
Approximate Chi Square Value (.05)	21.38	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0346	95% CLT UCL	758.8
Adjusted Chi Square Value	20.36	95% Jackknife UCL	773.1
		95% Standard Bootstrap UCL	750.3
Anderson-Darling Test Statistic	1.025	95% Bootstrap-t UCL	893.3
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	773.1
Kolmogorov-Smirnov Test Statistic	0.192	95% Percentile Bootstrap UCL	771.2
Kolmogorov-Smirnov 5% Critical Value	0.214	95% BCA Bootstrap UCL	795.1
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1144
		97.5% Chebyshev(Mean, Sd) UCL	1412
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1938
95% Approximate Gamma UCL	826.5		
95% Adjusted Gamma UCL	868		
Potential UCL to Use		Use 95% Approximate Gamma UCL	826.5

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.

APPENDIX C

ALTERNATIVE FISH CONSUMPTION RATES TO SUPPORT THE KOPPERS POND HUMAN HEALTH RISK ASSESSMENT

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Alternative Fish Consumption Rates to Support the Koppers Pond Human Health Risk Assessment

February 2011

ARCADIS

Alternative Fish Consumption Rates to Support the Koppers Pond Human Health Risk Assessment

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Date:
February 2011

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Executive Summary

This White Paper examines site-specific data and scientific literature to evaluate the potential productivity of Koppers Pond and the rates at which fish taken from this pond could be consumed, on a sustainable basis, by one or more individuals. More specifically, this study focuses on the question of whether the pond productivity is sufficient to justify or support the default fish consumption rates recommended by the U.S. Environmental Protection Agency (USEPA) for use in the baseline Human Health Risk Assessment (HHRA) for Koppers Pond (Table ES-1).

Table ES-1. USEPA Recommended Default Fish Consumption Rates

Age Group	Fish Consumption Rate (grams per day [g/day])	
	Reasonable Maximum Exposure (RME) Case	Central Tendency Exposure (CTE) Case
Adults	25	16
Adolescents	16	11
Young children	8	5

This study examines multiple lines of evidence to identify appropriate fish consumption rates for Koppers Pond. It includes an analysis of the potential productivity of the pond, based on site-specific characteristics, and considers and discusses those findings in consideration of the likely behaviors of recreational anglers who may harvest fish from Koppers Pond for the purpose of consumption.

To estimate risks associated with fish consumption from a small waterbody like Koppers Pond, it is first necessary to determine whether the pond can produce enough fish to provide a long-term dietary source. The physical characteristics and productivity of the pond must be considered in defining how much fish harvest, for the purpose of consumption, the pond can sustain over time without adversely affecting its long-term sustainability as a fishery.

In this analysis, fishery productivity is first evaluated using site-specific characteristics of Koppers Pond (*e.g.*, total dissolved solids, areal extent, and depth). Three estimates of the total sustainable fish yield for Koppers Pond have been derived using the following approaches:

- The method provided by Downing and Plante (1993) to estimate sustainable yield from a pond;
- Calculation of the morphoedaphic index (MEI) developed by Ryder (1965) to estimate the total mass of fish tissue produced by a waterbody, based on its

physical characteristics and subsequent adjustment of that estimate by the forage/carnivorous (F/C) ratio to estimate the sustainable yield of edible fish tissue; and,

- Calculation of the MEI and subsequent adjustment of that estimate by the Total Availability value (A_T; API 1950) to derive an estimate of harvestable-sized fish from the pond.

These three alternative approaches result in maximum daily sustainable harvest rates for edible fish tissue ranging from 9.8 to 11.8 g/day. These are the maximum rates at which fish tissue (from edible sized fish) can be harvested from the pond without adversely affecting the long-term sustainability of the fishery. The highest calculated rate, 12 g/day, has been selected as the basis for deriving the proposed RME and CTE fish consumption rates for Koppers Pond.

The sustainable harvest rate for edible tissue must be divided by the number of individuals who consume that tissue to derive the sustainable, long-term average daily fish consumption rate per person. If only one individual is assumed to harvest all of the edible fish mass from Koppers Pond, the sustainable harvested rate would be the same as the sustainable fish consumption rate (12 g/day). If more than one individual is assumed to harvest or consume fish from the pond, however, the sum of the consumption rates of all consumers cannot exceed the maximum sustainable harvest rate. At a maximum harvest rate of 12 grams of edible fish tissue per day, a single individual could only provide fish to other family members (adults, adolescents, or young children) at lower rates.

USEPA has suggested that it is appropriate to evaluate potential risks to an individual assuming consumption starts as a young child and continues as an adolescent into adulthood. Thus, for the RME analysis in the HHRA, it will be assumed that the long-term daily average of 12 g/day is harvested by a single angler and that this individual shares his or her catch with one adolescent and one young child. Using the approach recommended by USEPA (*i.e.*, the adolescent consumes at 2/3 the adult rate and the young child consumes at 1/3 the adult rate), consumption rates of 6 g/day, 4 g/day, and 2 g/day, respectively, will be used to estimate potential exposures to the RME individuals in the HHRA (Table ES-2). For the CTE analysis, it will be conservatively assumed that five individuals fish the pond, that their total combined sustainable harvest of edible fish tissue is 12 g/day, and that they each feed themselves, an adolescent, and a young child. Assuming that they all consume with equal frequency, this will mean that there is a total of 2.4 g/day of total edible fish mass available to each angler on an average daily basis. Using the same USEPA factors to derive rates for the adult, adolescent, and young child will result in a fish consumption rate of 1.2 g/day for the CTE adult, 0.8 g/day for the CTE adolescent, and 0.4 g/day for the CTE child.

Table ES-2. Alternate Fish Consumption Rates Based on the Site-Specific Productivity of Koppers Pond

Age Group	Fish Consumption Rate (g/day)	
	RME Case	CTE Case
Adults	6	1.2
Adolescents	4	0.8
Young children	2	0.4

These alternate fish consumption rates, which are based on site-specific productivity estimates, have been evaluated in comparison with information from surveys of the consumption habits of freshwater recreational anglers from other northeastern fisheries. The results of this evaluation support the alternative fish consumption rates calculated from the developed productivity estimates and shown above in Table ES-2. Rates of consumption of fish from small waterbodies like Koppers Pond tend to be lower than rates of consumption from larger, more productive fisheries. This occurs because larger fisheries often provide better access and greater availability of larger fish of desirable species. In addition, individual anglers rarely obtain all of their sport-caught fish from a single, small pond like Koppers Pond. A review of the fish consumption literature indicates that this effect appears to be especially true when there are multiple, alternative, and higher quality fishing resources available nearby. Such is the case for Koppers Pond, which is located in the southern tier of New York, and is not far from the larger and higher quality Finger Lakes and Great Lakes fisheries.

1. Introduction

Based on discussions with the U.S. Environmental Protection Agency (USEPA), the Koppers Pond RI/FS Group (the Group) has been directed to use the following fish consumption rates in evaluating the reasonable maximum exposed (RME) individual in the Koppers Pond Human Health Risk Assessment (HHRA):

- Adults – 25 grams per day (g/day);
- Adolescents – 16 g/day; and
- Young child – 8 g/day.

In addition, USEPA has indicated that the Group may evaluate the central tendency exposed (CTE) adult, adolescent, and young child using consumption rates of 16, 11, and 5 g/day, respectively.

The adult RME rate required by USEPA for the HHRA is a default freshwater fish consumption rate that is based on surveys of fish consumption by anglers who fish multiple, large bodies of water (USEPA 1997). The rates for adolescents and young children are not based on age-specific consumption data but are instead based on adjustments to the adult rate. These RME fish consumption rates are not likely to be representative of long-term consumption rates from single small waterbodies like Koppers Pond (Ebert et al. 1993; 1994). Furthermore, such consumption rates incorrectly assume that the productivity of Koppers Pond is sufficient to provide enough fish mass to sustain these rates over the RME exposure period of 30 years that will be evaluated in the HHRA.

This white paper presents an analysis of the likely productivity of Koppers Pond and its ability to support the fish consumption rates required by USEPA over a 30-year exposure period. In addition, it discusses the basis of the default fish consumption rates that USEPA has directed the Group to use and the applicability of such rates to Koppers Pond. Finally, based on these two analyses, this white paper presents alternative fish consumption rates that are more appropriate for Koppers Pond. These alternative fish consumption rates will be used in an alternative risk analysis that will be conducted as part of the HHRA. Ultimately, the risk estimates based on these alternative rates will be discussed and compared with the potential risks estimated based on the USEPA-required default rates as part of the HHRA for the site.

2. Koppers Pond Fish Productivity

In order to determine realistic risk estimates associated with consumption of fish from a small waterbody like Koppers Pond, it is essential to determine whether the pond can support enough fish to represent a long-term source of exposure to hypothetical anglers who may consume fish from the pond. Thus, in addition to considering the potential consumption behaviors of individuals who may fish the pond, it is important to consider how much fish harvest, for the purpose of consumption, the pond can sustain over time. The physical characteristics and productivity of the pond must be considered in selecting sustainable fish consumption rates on a site-specific basis.

Koppers Pond has an open water area of 8.9 acres (3.6 hectares) with an average depth of one to two meters (Figure 1). The pond is 'V'-shaped, with a small feeder creek that enters at the northern end of the western leg of the pond. The feeder creek is an industrial drainageway that historically received treated wastewater discharges from the various manufacturing operations and entities that have been located at the former Westinghouse Electric Corporation (Westinghouse) plant site. The base (non-storm) flow of the industrial drainageway is now almost entirely comprised of the treated discharge from a groundwater treatment system operating at the former Westinghouse plant.

There are two discharge outlets from the pond. One is at the southern end of the pond (West Outlet) and the other is near the base of the eastern leg of the pond (East Outlet). The West Outlet and East Outlet converge approximately 100 meters downstream of the pond and continue as a single channel.

The peninsula in the central part of the pond is heavily vegetated with scrub/shrub and trees. The peninsula is formed by the Old Horseheads Landfill. The eastern shore of the pond is mostly covered by a grassy meadow with isolated scrub/shrub. The southern end of the pond is dominated by cattail and weeds. The areas to the east and south are primarily industrial property owned by Hardinge, Inc. with a smaller parcel to the southwest owned by the Elmira Water Board. The western shore of the pond abuts an active Norfolk-Southern Corporation railroad right-of-way. Residential neighborhoods are located further to the east, northeast, and south with either active industrial areas (northeast and south) or undeveloped industrial property (east) between. The pond is partially fenced and posted with 'No Trespassing' signs. There is evidence (e.g., empty bait cups along the bank, fishing line in branches) that some fishing occurs at the pond, and anglers have been observed at the Pond from time-to-time.

2.1 Approaches for Calculating Fish Yield

In its comments on the Pathway Analysis Report (PAR) for this site, USEPA (2009) presented a "productivity analysis" that was intended to support the required fish consumption rates by demonstrating that if an individual obtained the daily creel limit of different species of fish that have been collected from Koppers Pond, it would be possible to collect sufficient biomass to support that consumption rate. USEPA's analysis indicated that, based on the average weight of fish caught from the pond by electroshocking during the most-recent sampling event, and assuming that anglers are able to harvest at a rate consistent with the daily creel limit for each species, between 1.3 and 11.5 days of fishing would be required to obtain enough fish to support that rate. USEPA concluded, therefore, that these required default rates were reasonable and supportable for Koppers Pond.

USEPA's conclusion, however, is based on a theoretical limit and does not reflect conditions at Koppers Pond and typical fishing behavior. While it may be possible for an angler to harvest the creel limit for numbers of fish during a single trip, this does not mean that this level of success regularly occurs or that the pond could sustain such a level of effort over an extended period of time. In fact, the rate of fishing success can vary substantially among fisheries as it depends on the availability of target species, the size classes present for those species, the climate and habitat available, the length of the fishing season, and the skill of the angler (Bennett 1970; Ebert et al. 1994; 1996). Thus, it may be difficult, given the productivity of the fishery in terms of fish mass and the available size classes produced, to achieve the daily creel limit on a single day, and highly unlikely, that this limit would be achieved on every day of fishing. Consequently, statewide creel limits do not indicate the amount of harvest that actually occurs, particularly for a small fishery like Koppers Pond, but rather the maximum number of fish that may be legally harvested on a single day, without regard for the capacity of the fishery.

The critical issue is not whether there is enough standing biomass to support such a rate in the short-term but rather whether there is enough long-term productivity to support such a rate over an extended period of time, as is being evaluated in the HHRA. This evaluation of pond productivity needs to be based, instead, on the mass of fish tissue that the Pond can produce each year that is of harvestable size and can be removed from the pond without adversely affecting the fish population, thereby impacting its long-term sustainability as a fishery. The HHRA for the RME individual will assume that exposure via this pathway occurs for a period of 30 years. Thus, it is critical to ensure that the level of exposure that is evaluated during that time period could actually occur at Koppers Pond.

To estimate how much fish consumption Koppers Pond can support, it is necessary to estimate the mass of harvestable fish that is produced in the Pond on an annual basis (productivity) and then to estimate what fraction of those fish can be removed from the Pond each year without adversely affecting its productivity in subsequent years. There are a number of factors that affect the productivity of a pond. These factors include the amount of dissolved oxygen present during the year, the primary productivity of the waterbody, its depth, the length of the growing season for food sources, and the natural mortality that may occur. All of these factors are inter-related and, depending on their combination at a particular waterbody, can have a substantial impact on the amount of fish mass that can be produced on an annual and sustainable basis.

The amount of dissolved oxygen is a limiting factor in fish survival. When oxygen content is low, the waterbody cannot sustain a large population of fish. Oxygen is provided either from the atmosphere above the pond or by the photosynthetic activity of the plant material within it (Bennett 1970). The higher the dissolved oxygen in the water column, the larger the size of the fish population that can be sustained there (Bennett 1970).

Dissolved oxygen content can, however, be substantially impacted by climate. In cooler climates, such as that experienced in western New York State where there is an extended period of cold and snow cover, dissolved oxygen may be very low at certain times of the year. Icing of a pond removes the potential atmospheric input to the water column, making the level of dissolved oxygen within the water column totally dependent on photosynthetic activities within the pond. Photosynthesis can still occur under a clear ice layer, as long as the lake is shallow enough for sunlight to reach the vegetative layer. However, when there is snow covering the ice, the sun cannot penetrate that layer so that photosynthesis stops and available dissolved oxygen is quickly depleted. If this snow cover period is extensive, it can result in winter kill that will reduce the size of the fish population and affect the potential growth rate of the surviving fish (Bennett 1970). Shallow lakes with large amounts of vegetation and mucky bottoms are particularly susceptible to this problem (WDNR 1996). Fish that die during winter kill are often not observed due to the fact that they decompose or are eaten by scavengers (WDNR 1996).

Such winter kill is likely to occur with some frequency at Koppers Pond as the pond is shallow and narrow and so likely to freeze over early in the fall and remain frozen until spring. In addition, the period of potential snow fall in this area is from late October until early May. For example, in nearby Elmira, the annual average snowfall is 41.8 inches[1] with some snowfall occurring eight months of the year, and average monthly snowfalls ranging from 0.2 inches in October to 10 inches in January[2]. While snow cover may not remain on the ice throughout the late fall, winter and early spring, due to intermittent warming and drought during those periods, it is reasonable to conclude that the pond will be frozen and snow-covered for most of this time so that there may be some winter kill in Koppers Pond during most years.

Primary productivity is the amount of plant material (including periphyton, planktonic algae, or macrophytes) that is synthesized. Some of this material cycles through the food chain until it produces fish tissue. Thus, if there is high productivity within a waterbody, the amount of fish tissue produced is likely to be high (Bennett 1970).

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[1] (http://www.currentresults.com/weather/NewYork/annual-snowfall.php)

[2] (http://www.intellicast.com/Local/History.aspx?location=USNY0463)

However, in northern waters, where the growing season is shorter due to lower temperatures and prevalent snow cover, primary productivity is likely to be lower so that the amount of fish mass produced is also likely to be reduced.

All of the above factors affect the levels of natural mortality that will occur within a fishery, and impact the growth rate of the remaining fish, thereby affecting the availability of harvestable-sized fish in that fishery. Thus, it is important to attempt to estimate the amount of productivity of a fishery on a site-specific basis, if possible, in order to understand how much fishing pressure it is likely to be able to withstand.

The most accurate methods used for determining how much fish tissue is available within a pond include draining the pond to count the fish, measuring standing crop at a moment of time, or conducting long-term mark/recapture studies. Employing any of these methods at Koppers Pond, however, is not practical for the reasons discussed below.

- Pond draining is primarily a method of harvest that is commonly used in aquaculture but is not generally used in fisheries management. Aquaculture ponds are designed with the capability to be filled and drained on a schedule appropriate to harvest needs. Fish are then restocked for the next growing season to replace the fish that have been removed. Such an approach is not feasible for Koppers Pond and would destroy the existing fish population as well as severely impact the remainder of the aquatic community.

- Standing crop data are typically collected after the application of a piscicide (e.g., rotenone) to either coves or open water areas that are enclosed by nets (Aggus et al. 1979; Jenkins 1982). The fish data from that subarea are then extrapolated to estimate the fish mass in the entire lake. This approach is a destructive and expensive method that requires intensive field work and would also severely impact a portion of the fish community at Koppers Pond, assuming the effects could be limited to only a portion of the pond.

- Mark and recapture studies are useful long-term fisheries techniques that identify both the species present and their growth rates over time (Gresswell et al. 1997; Lockwood and Schneider 2000). Samples of fish are captured, metrics are recorded (e.g., species, length, weight, sex), the fish are marked (e.g., by attaching tags or clipping fins) and then released. The study is repeated at various intervals over the course of years. Such studies are resource-intensive and require several seasons of repeated effort to derive satisfactory estimates.

If reliable data were available on age and species distributions within the pond, it would likely be possible to derive very accurate direct estimates of the amount of fish produced by the pond each year, its balance in terms of age classes, the mix of forage and game fish, and the availability of target species and sizes for consumption. However, in the absence of those data, it is still possible to develop reliable estimates of productivity using other site-specific characteristics, such as pond size, total dissolved solids, and regional climatic factors).

Over the last 60 years, fisheries managers have correlated fish productivity with a number of physical and chemical parameters including lake area, depth, total dissolved solids (TDS), nitrogen, phosphorus, alkalinity, chlorophyll *a*, primary productivity, benthic invertebrate abundance, air temperature and fishing effort (Downing and Plante 1993). Most of the scientific literature regarding calculation of production in natural ponds and lakes, which are unfertilized and unstocked, is over 25 years old. Limited new information about natural ponds and lakes has been published since then due to a shift in fisheries sciences to the more commercial concern of maximizing aquaculture productivity. There are methods outlined in the older literature, however, that allow the quality of the fishery to be evaluated using the physical and chemical parameters listed above, without using the intensive field work-based approaches outlined above. These include methods for estimating proportional stock density, primary productivity, and calculation of the morphoedaphic index. Each of these approaches is discussed below.

Proportional Stock Density

Proportional stock density (PSD) can be used to evaluate the population structure within a specific waterbody. In order to assess fish populations in waterbodies that are destined to be stocked with fish for recreational angling purposes, the New York State Department of Environmental Conservation (NYSDEC) Bureau of Fisheries uses empirical fish data to determine the PSD (Woltmann, 2009 personal communication). Representative fish of different species are caught and their lengths are recorded for later comparison to a published table of PSD sizes (Neilsen and Johnson 1983). The PSD indicates whether the fish population is comprised of an acceptable mix (for anglers) of five different fish sizes (minimum stock, quality, preferred, memorable and trophy). Minimum stock size is defined as some length within 20 to 26 percent of the angling world record for that species (a size that corresponds to the minimum size at which anglers will consider the fish desirable). NYSDEC uses the PSD to indicate whether the populations of target species (e.g., largemouth bass, bluegill, crappie) are balanced, based on sustainable harvest of sizes preferred by anglers (Neilsen and Johnson 1983). While PSD is an important fisheries management tool, and provides insight into the presence of desirable fish species and sizes within a waterbody, it is not used to estimate the mass of fish that is available for consumption.

Primary Productivity

Estimates of fish production have been developed based on the primary productivity in a waterbody. While primary productivity is typically estimated by performing measurements[3] of oxygen produced as a result of phytoplankton and macrophyte photosynthesis, the method of measurement can greatly influence the estimate produced. Measurements made on calm, sunny days in open water generally produce higher estimates of photosynthesis than light and dark bottle measurements (McConnell et al. 1977). Because photosynthesis measurements are estimates of primary productivity and not absolute measurements, there is no single "correct" value. In addition, if increased productivity results in inedible nuisance species (such as bluegreen algae) dominating algal productivity, fish yield may actually decrease rather than increase (Kling et al. 2003). McConnell et al. (1977) reported that more study was needed to make this a useful fishery tool and this approach should be developed only on fisheries that are known to have high fishing pressure as the goal is to obtain potential optimum yield rather than existing yield.

Some correlation exists between primary productivity of a waterbody and its fish yield, but this is not always the case (Bennett 1970). Some of the plant material produced cycles through the food chain until it produces fish tissue. However, a large portion of the plant material that is produced is not consumed at all and, while some of the food energy that is consumed by fish is used to support growth of the fish, a substantial portion is used as an energy source. In addition, a portion is used by other organisms that are not part of the food chain for fish. Because only a small proportion of the plant material ultimately results in fish tissue production, one cannot reliably use estimates of primary productivity as the basis for estimating fish yield for Koppers Pond.

Morphoedaphic Index

One of the simplest methods of estimating fish production is the morphoedaphic index (MEI) developed by Ryder (1965). This method was derived using fish productivity data collected from north-temperate lakes, and calculates a productivity estimate based on the measured TDS for a waterbody and its mean depth. Ryder (1965) developed this method using data for 34 north-temperate lakes that had catch records for several years of fishing. The use of TDS is a general measure that assumes that increased dissolved solids reflect increased nutrient content due to increased contact of precipitation with the soil prior to entering the waterbody as runoff.

The MEI was developed to reflect the empirical relationships of fish yield with abiotic factors and to provide fisheries managers with an easily applied technique for approximating annual fish yield for a particular waterbody (Ryder 1965; 1982). This habitat-yield model is a preferred method of estimating lake productivity while not requiring a costly field effort (Jones, 2009 personal communication). It has been used

[3] Measurements taken over a 24-hour period usually, but not always, encompassing daylight hours and the subsequent night hours.

by fisheries managers around the world to quickly and economically produce estimates of productivity (Jenkins 1982; Ryder 1982; Kerr and Ryder 1988; Downing et al. 1990).

The MEI is calculated using the following equation:

$$MEI = \frac{TDS}{Mean\ depth}$$

According to Ryder (1965), productivity of the fishery can then be estimated based on the MEI using the following equation:

$$Fish\ Production\left(\frac{pounds}{acre - year}\right) = 2\sqrt{MEI}$$

When converted to metric units, this results in the following equation (Hubartt and Bingham 1988)

$$Fish\ Production\left(\frac{kg}{hectare - year}\right) = 0.966\sqrt{MEI}$$

This rate of production is the weight of all fish produced per unit area per unit time. The MEI makes no distinction between forage fish and edible-sized fish. Therefore, it overestimates the mass of the harvestable-sized fish that are available for recreational anglers.

In developing the MEI methodology, Ryder (1965) limited his study range to north temperate lakes (such as Koppers Pond), in order to reduce the variability associated with temperature and altitude. When comparing freshwater systems from different geographical areas, temperature is a significant variable.[4] In warmer latitudes, the growing season is longer, producing greater amounts of food during the year, while in north temperate lakes, the growing season is shorter so that food production is more limited. In colder climates, eggs and larvae spawned early in the season are vulnerable to influxes of cold water, and fish spawned later risk not growing to the minimum size required to survive their first winter (Kerr and Ryder 1988). It is likely

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[4] This is clearly demonstrated if one looks at state size records for a single species if fish, such as largemouth bass, which is found in both northern and southern fisheries. Those records demonstrate that record fish sizes are larger in southern fisheries (see for example http://assets.espn.go.com/winnercomm/outdoors/bassmaster/pdf/bb_state_Large_20100107.pdf

these types of external climatic factors that led Downing et al. (1990) to conclude that the MEI was not a good predictor of fish production based on an evaluation of the published literature concerning productivity of lakes over a wide geographic and climatic range. However, McConnell et al. (1977) reported that a number of studies have demonstrated highly significant degrees of association between fish productivity and the MEI. In addition, Youngs and Heimbugh (1982) stated that the MEI (with TDS data included) accounted for 95 percent of the variation they observed in fish yield (Youngs and Heimbugh 1982).

Thus, in the absence of site-specific information on the availability of biomass, trophic levels, and age classes present in a pond, the MEI provides a reasonable screening level tool for estimating the potential productivity of northern temperate zone ponds and lakes such as Koppers Pond.

2.2 Estimating Fishing Yield

The MEI approach can be used to estimate the mass of *all* fish produced per unit area per unit time. It makes no distinction among sizes of fish or between forage fish and game fish that are present and might be harvested by anglers for consumption. Given that recreational anglers generally harvest and consume larger fish sizes and target certain species of fish for consumption, the estimated production based on the MEI for a specific waterbody overestimates the mass of fish of desirable species and edible sizes that are available and likely to be harvested for consumption by the recreational anglers who use that fishery. In addition, it does not provide any indication of the amount of fish that can be harvested from the pond on a sustainable basis.

Fishing yield can be defined as the mass of harvestable-sized fish that can be harvested from the lake per unit time. Fishing yield cannot be maintained at the level of production of the population without causing a decline in biomass and recruitment failure. Therefore, the rate of production is the extreme upper limit of the rate at which a fish population can be exploited (Downing and Plante 1993). Harvest approaching the rate of production will cause the population to quickly decline.

A large-scale study of production data for 100 fish populations from 38 lakes and reservoirs in geographically diverse locations, including lakes that ranged from oligotrophic (poor in nutrients) to hypereutrophic (rich in nutrients), was used to determine fish population dynamics (Downing and Plante 1993). These authors reported that only small fractions of the standing fish biomass can be removed on a sustainable basis. The data evaluated indicated that more than 85 percent of the lakes had sustainable yields of less than 15 percent of the total mass of fish in the lake, that the majority of sustainable fish population yields in lakes were less than 1 kilogram per hectare per year (kg/ha-year), and more than 90 percent were less than 4 kg/ha-year. These authors reported that fish yields are lower for larger fish species and under acid conditions, and should be higher in lakes with higher temperatures and/or under more eutrophic conditions. They concluded that sustainable yield generally appears to be approximately 10 percent of the fish production of a lake.

There are additional population metrics that can be used to help estimate potential fishing yield. These include the F/C Ratio, which is the ratio of forage fish to carnivorous fish; and the Total Availability (A_T) value, which is an estimate of the percentage of harvestable-sized fish within a population. These metrics are discussed below.

F/C Ratio

Fish production per unit area is based on fish mass, and includes fish of *all* sizes. Separating fish into forage fish (F) and carnivorous fish (C), the F/C ratio (the total mass of forage fish to the total mass of carnivorous fish) can be estimated using research on balanced and unbalanced pond fish populations (API 1950). The C species include game fish and those considered "desirable" and large enough for consumption by recreational anglers.[5]

The NYSDEC Bureau of Fisheries notes that it is extremely difficult to decimate a fish population by removing fish, especially for prolific species like bluegill. However, fish populations can be reduced to a point where they no longer produce fish of the size desired by anglers (Woltmann, 2009 personal communication). Thus, it is important for a sustainable fishery to maintain the correct balance of forage and carnivorous fish.

Research in Alabama (API 1950) showed that in 89 ponds studied (55 balanced, 34 unbalanced)[6], various relationships between species could be developed. Balanced fish populations allow crops of harvestable-sized fish year after year, appropriate for the basic fertility of the water. Unbalanced fish populations are unable to produce succeeding annual crops of equivalent magnitude because removing too many

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[5] In developing this approach, fish were grouped based on a combination of their diets and their sizes because competition for food was a critical consideration. For example, crappie were segregated by size so that those under four ounces, which feed largely on insects, were included in the forage fish category and those that were greater than 4 ounces were considered carnivorous fish due to the fact that they eat small fish. Catfish were considered forage fish, regardless of their sizes, because they compete with bluegills for food. Conversely, all pickerel and largemouth bass were classed as carnivorous species without regard for their sizes.

[6] A 'balanced" fishery is in equilibrium, i.e., the species, age distributions, and overall populations are stable over time. An "unbalanced" fishery is where these parameters are not in equilibrium or stable over time.

carnivores yields unchecked population growth of forage fish, which then compete for limited resources resulting in fewer fish reaching harvestable sizes (API 1950). When larger fish are over-exploited, the biomass of smaller species will likely be maximized only to be reduced as fishing pressure continues (Regier and Henderson 1973).

In 94 percent of the Alabama farm ponds with balanced fish populations capable of producing annual crops, the F/C ratio ranged between 1.4 and 6.8. The weight of F species appears to be a function of the fertility of the pond, and the weight of the C species appears to depend on the weight of the F species on which it is dependent for food (API 1950). According to API, the most desirable balance range for the F/C ratio is 3.0 to 6.0.

A_T Value

The A_T value is the approximate percentage of the total mass of a fish population composed of fish of harvestable size (based not on legal sizes, but on the smallest sizes the public is likely to utilize) and is used in aquaculture to assess balance within a system. API (1950) reported a range of A_T values from 33 to 90 percent for balanced populations in 89 Alabama farming ponds that had been drained and the fish collected. While this balance might be optimal for southern fish farming ponds that are regularly stocked and fertilized, it may not provide a reliable prediction of sustainable yield from an unfertilized, unstocked, natural pond in New York State.

2.3 Estimation of Productivity for Koppers Pond

Two different approaches were used to estimate the productivity of Koppers Pond. First, productivity was estimated using productivity data presented by Downing and Plante (1993) from their study of 100 fish populations from 38 lakes and reservoirs. Second, productivity was estimated using the MEI method, as discussed in Section 2.1 (Table 1). Downing and Plante (1993) reported that the majority of lakes studied had sustainable fish population yields that were less than 1 kg/ha-year while 90 percent had yields that were less than 4 kg/ha-year. An upper-bound yield of 4 kg/ha-year was used to estimate yield from Koppers Pond. The Pond has a surface area of approximately 9 acres (3.6 ha). Based on this, it was estimated that Koppers Pond may sustainably yield an upper bound of 14.4 kg/year (Table 1).

For calculation of the MEI, two approaches were considered. First, TDS concentration was measured multiple times during the 2009 field season at Koppers Pond, as shown in Table 2 of Integral 2010. The measured TDS ranged from 0.401 to 1.09 grams per liter (g/L) with an arithmetic mean of 0.623 g/L (623 milligrams per liter [mg/L]). In addition, TDS can be estimated using the specific conductivity measurements that were collected from various locations and depths in Koppers Pond during field surveys conducted in 1998, 2003 and 2008 (CDM 1999; CEC 2003, Cummings/Riter and AMEC 2008. Over all sampling events from 1998 to 2008, the conductivity values ranged from 804 to 1,112 microSeimens per cm (µS/cm), with an arithmetic mean of 927 • S/cm. These conductivity measurements can be converted to TDS using a conversion factor from Myron (2008). In the absence of a site-specific conversion factor based on measuring both TDS and specific conductivity over the course of multiple sampling trips, the average of the conductivity measurements for Koppers Pond (927 µS/cm) was converted to TDS using a factor of 0.7, based on the information provided by Myron (2008). This resulted in an estimated TDS concentration of 649 mg/L, which is similar but slightly higher than the mean of the TDS measurements (623 mg/L) collected during the September 2009 field survey for the slender pondweed at Koppers Pond. The similarity of these two estimates provides support for their reliability.

The depth of the pond is reported to be one to two meters. To calculate the MEI, it was assumed that the average depth was 1.5 meters. The TDS was calculated using the higher of the mean measured and calculated TDS values (649 mg/L) and the average depth of 1.5 meters, along with the equations in Section 2.1, to yield the following productivity estimate.

$$Koppers\ Pond\ MEI = \frac{TDS}{mean\ depth} = \frac{649\ mg\ per\ liter}{1.5\ meters} = 432.7$$

$$Koppers\ Pond\ Fish\ Productivity = 0.966\sqrt{MEI} = 0.966\sqrt{432.7} = 20\ \text{kg/ha-year}$$

Koppers Pond is 3.6 ha in size; therefore, the total annual fish yield estimated using the MEI approach is 72 kg/year. The MEI-based value of 72 kg/year is not an estimate of the mass of fish currently in the pond (standing crop), but is instead an estimate of the yield of total fish mass produced by the pond in one year.

This estimate of productivity (20 kg/ha-year) for Koppers Pond is reasonable when one considers other studies of productivity but likely overestimates actual production there. Field studies conducted by Boyd (2009) indicated that a yield of 20 to 30 kg/ha-year is appropriate for unfertilized ponds in Alabama. Boyd stated, however, that higher temperatures in Alabama would result in higher productivity than could be expected to occur in cooler climates, such as that experienced in western New York State. Thus, the fish production rate of 20 kg/ha-year calculated for Koppers Pond, which is at the low end of the range provided by Boyd for Alabama, is still likely to overestimate actual production there.

The Maryland Sea Grant Extension published a rough estimate of standing stock for fertilized versus non-fertilized aquaculture ponds (Harrell and Webster 2004). The report stated that while a fertilized farm pond can yield 400 pounds of fish per acre (448 kg/ha) on complete harvest, unfertilized ponds usually produce only 100 pounds per acre (112 kg/ha). Downing and Plante (1993) reported that sustainable yield for lakes was estimated to be approximately 10 percent of standing biomass and that 85 percent of the lakes studied had sustainable yields of less than 15 percent. Application of the higher factor of 15 percent to the estimated Maryland standing stock of 112 kg/ha for an unfertilized pond results in an estimated productivity of 16.8 kg/ha-year. Because climate is more moderate in Maryland than in western New York, one would expect higher levels of productivity in Maryland. However, the production estimate for Maryland ponds is lower than the rate of production that has been calculated for Koppers Pond using the MEI method, indicating that the productivity estimate for Koppers Pond developed using the MEI approach is likely to be overestimated.

It appears, based on multiple lines of evidence, that the value of 20 kg/ha-year calculated for Koppers Pond using the MEI approach is generally supportable but likely to overestimate actual productivity in Koppers Pond. This estimate is based on an estimated total annual fish yield (72 kg/year) that is substantially higher than the estimated fish yield (14 kg/year) that was developed using the approach based on Downing and Plante (1993). Thus, it provides a conservative starting point for evaluating the amount of fish that can be harvested from Koppers Pond on a sustainable basis over time.

2.4 Sustainable Fish Yield

As discussed in Section 2.2, Downing and Plante (1993) reported on sustainable fish yield in Alabama lakes and reservoirs. These data can be used to provide one estimate of potential annual, sustainable fish yield from Koppers Pond. In addition, the F/C Ratio and A_T approach can be used to estimate the sustainable harvestable mass of fish from the pond, based on the productivity calculated using the MEI approach. Each of these approaches is discussed below.

2.4.1 Sustainable Yield Based on Downing and Plante (1993)

As discussed previously, Downing and Plante (1993) evaluated data for 100 fish populations from 38 lakes and reservoirs in geographically diverse areas and with variable nutrient levels. Their data indicated that 90 percent of the populations studied had sustainable total fish yields that were less than 4 kg/ha-year (Table 1). As shown in Table 1 and discussed above, combining this fish yield with the size of Koppers Pond results in an estimated sustainable fish yield of 14.4 kg/year using this approach.

It is important to note, however, that this is the mass of whole fish that can be harvested and is not equivalent to the amount of fish that can actually be consumed. USEPA (1989) guidance indicates that the edible portion of most fish is approximately 30 percent of the whole fish mass. If this fraction is applied to the total mass of fish that can be sustainably harvested from Koppers Pond, the result is 4.3 kg/year. On an annualized average daily basis, which is the metric that is used for fish consumption rates in the HHRA, this equates to 0.0118 kg/day or 11.8 g/day of edible fish tissue that can be harvested from the pond and consumed without affecting its sustainability, as shown below:

$$\frac{4.3\frac{kg}{year}}{365\frac{days}{year}} * 1000\frac{g}{kg} = 11.8\frac{g}{day}$$

2.4.2 Use of the F/C Ratio

As discussed in Section 2.2, API (1950) reported that the optimal range of F/C ratios of for balanced populations in Alabama farm ponds is 3 to 6. Because Koppers Pond is not heavily fished, it is likely to sustain a balanced population. Thus, the midpoint of that range, an F/C ratio of 4.5, was used in this analysis.

In Section 2.3, a total fish yield of 72 kg/year was estimated for Koppers Pond based on the MEI method. To make it comparable to the sustainable fish yield estimate derived from Downing and Plante (1993), it is necessary to estimate the amount of the total fish yield that is sustainable.

When it is assumed that the fish population in Koppers Pond is balanced and the midpoint of the F/C ratio range for balanced populations is applied to the estimated total fish yield for Koppers Pond, the yields for forage (F) and carnivorous (C) fish are as follows:

- Forage fish yield = 59 kg/year
- Carnivorous fish yield = 13 kg/year

In other words, if Koppers Pond has a balanced fish population, it may produce 59 kg of forage fish per year, and 13 kg of carnivorous fish per year. Using this ratio and assuming that recreational anglers would be most likely to target and harvest larger carnivorous fish, Koppers Pond might potentially produce 13 kg/year of such fish.

As discussed previously, only approximately 30 percent of total fish mass is edible. Applying this factor results in 3.9 kg/year of edible fish mass or 0.0108 kg/day (10.8 g/day) of edible fish tissue, on an annualized daily basis, that can be taken from Koppers Pond without affecting the long-term sustainability and quality of the fishery (Table 1).

2.4.3 A_T Value Calculation for Koppers Pond

As discussed in Section 2.2, the A_T value is the approximate percentage of the total weight of a fish population composed of fish of harvestable size. API (1950) reported a range of A_T values for balanced populations of 33 to 90 percent for stocked and fertilized farm ponds. Given the lack of stocking and fertilization (provision of non-natural food sources) at Koppers Pond, it is likely that this fraction would not exceed the low end of this range (33 percent). Based on the Koppers Pond fish productivity of 72 kg/year using the MEI method, the pond's harvestable fish production rate using this approach would be 24 kg/year.

It is not reasonable to assume that anglers could sustainably harvest 100 percent of all harvestable-size fish without affecting the sustainability of the fishery from year to year. Conservatively using the factor of 50 percent to estimate sustainable harvest of the larger fish, results in a sustainable yield of whole harvestable fish mass of 12 kg/year[7]. Adjusting this by edible portion would result in a rate of production of edible fish tissue of 3.6 kg/year or 0.0098 kg/day (9.8 g/day) on an annualized average daily basis (Table 1).

2.4.4 Summary of Results of the Productivity Analysis and Discussion of Its Uncertainties

Three estimates of the total sustainable fish yield for Koppers Pond were derived based on productivity estimates and then adjusted to reflect the amount of fish mass produced by the pond each year that could be removed from the pond, via fishing, without affecting the sustainability of the fishery. Because the HHRA for the Site will be considering 30-year exposures via the consumption of fish, this approach is appropriate for determining a supportable long-term fish consumption rate for Koppers Pond.

While three different methods were used to estimate the potential upper bound sustainable yield of edible fish from the pond, the resulting harvest rate estimates were very similar. Using the upper-bound sustainable yield estimated provided by Downing and Plante (1993) resulted in an average daily sustainable harvest rate for edible fish tissue of 11.8 g/day. Using the F/C ratio, the estimated sustainable harvest rate for edible fish tissue was 10.8 g/day, while the A_T approach resulted in a sustainable rate of 9.8 g/day. These are the rates at which edible size fish tissue can be harvested from the pond without adversely affecting the long-term sustainability of the fishery. While these rates are representative of the maximum rate at which fish can be removed from the pond, it is important to note that these are not equivalent to a fish

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[7] While Downing and Plante (1993) have reported that the majority of lakes studied had sustainable yields of 15 percent or less of the total fish mass, it is not appropriate to apply this same factor to the estimated population of fish of harvestable size, because a very large proportion of the total annual fish mass discussed by Downing and Plante would be smaller fish that would provide food for larger fish. Thus, a higher percentage of 50 percent was selected to be conservative.

consumption rate that can be sustained for all anglers who use the pond. The sustainable harvest rates must be divided by the number of consumers to derive the sustainable fish consumption rate. If only one individual is assumed to harvest all of the fish mass from Koppers Pond, the sustainable harvested rate would be the same as the sustainable fish consumption rate. However, if more than one individual is assumed to harvest or consume fish from the pond, then the sum of the consumption rates of each consumer cannot exceed the sustainable harvest rate without affecting the sustainability of the fishery.

3. Selection of Alternative Fish Consumption Rates for Koppers Pond

USEPA is requiring that an RME adult fish consumption rate of 25 g/day be used to evaluate potential exposures to adult anglers who may fish Koppers Pond. In addition, USEPA has stated that 2/3 of that rate (16 g/day) should be applied to adolescents and that 1/3 of that rate (8 g/day) should be applied to young children evaluated in the RME scenario. These rates are not appropriate for Koppers Pond for a number of reasons, not the least of which, as discussed above, is that the productivity of Koppers Pond cannot sustainably produce enough edible-sized fish to support even a single adult, never mind a population of anglers consuming fish at the default RME consumption rate. Other reasons are described below.

3.1 Evaluation of the Applicability of Default Rates

The RME rate of 25 g/day is the generic, default upper-bound rate recommended in USEPA's (1997) *Exposure Factors Handbook* (EFH) for sport-caught freshwater fish consumption. It is reported to be the average of the upper-bound fish consumption rates from three "key" studies of freshwater fish consumption that were conducted in Maine (13 g/day from McLaren/Hart 1992), New York (18 g/day from Connelly et al. 1996), and Michigan (39 g/day from West et al. 1989).

The basis for recommended CTE rate of 18 g/day for adults, as discussed in USEPA's comments on the PAR (USEPA 2009), is not known. The central tendency recommendation presented in the EFH is 8 g/day for adults. Based on this value and using the approach that USEPA (2009) is requiring to estimate consumption rates for other age groups in the RME scenario, the CTE rates would be 5.3 g/day for adolescents and 2.7 g/day for young children.

As shown in the analysis of productivity of Koppers Pond (Table 1), the RME rates that are being required by USEPA are not sustainable on a long-term basis for even a single adult angler. Using the approach discussed in Section 2.4.4 that yields the highest amount of sustainable, harvestable-sized fish indicates that no more than 11.8 g/day, on average, can be removed from Koppers Pond without adversely affecting the fishery. Thus, a single individual cannot eat fish from the pond at the RME rate of 25 g/day on average over the long-term. Because the HHRA is focused on long-term exposure to constituents that may be in the fish, this is an important consideration. While an individual might be able to consume fish at the RME rate for a limited period of time, there would not be sufficient fish available to maintain that rate over the 30-year exposure period that will be assumed in the HHRA.

It is not surprising that the RME rate is not sustainable for a small fishery like Koppers Pond. A review of the available fish consumption studies indicate that these consumption rates are not likely to be representative of the level of fish consumption that occurs in small waterbodies like Koppers Pond. While USEPA (2009) has indicated that it does not adjust consumption rates based on the size of a waterbody, there is substantial evidence to indicate that sizes of waterbodies have substantial impacts on the amount of fish that are consumed from them. Thus, this issue should be considered in selecting site-specific consumption rates to be used in an HHRA.

As shown in Table 3, adult fish consumption rates, in both the mid-range and the high end, decrease when the types and numbers of waterbodies studied are narrowed. For example, the Ebert et al. (1993) state-wide survey of Maine anglers estimated long-term 50th percentile and 95th percentile consumption rates of 2 and 26 g/day, respectively, when all types of waterbodies were considered. When looking at fishing from multiple lakes and ponds, these rates dropped to 1.7 and 15 g/day, respectively, and when evaluating fish consumed from multiple rivers and streams statewide, the rates dropped to 0.99 and 12 g/day, respectively. All of these estimates, however, were based on consumption from all waterbodies from which fish were obtained. Very few individuals indicated that they only fished one waterbody during the survey year.

When one considers available data for single waterbodies, the rates are reduced further. Two surveys of single waterbodies in Maine with ponded areas, including a renowned land-locked salmon destination fishery in Maine, indicated median rates ranging from 0.17 to 0.49 g/day and 95th percentile rates ranging from 11 to 12 g/day (McLaren/Hart 1991a; Ebert et al. 1996). Mean rates of consumption from these two studies ranged from 2.6 to 3 g/day. A third study of a fishery in Massachusetts, from which only one angler reported harvesting fish for consumption, reported that individuals' consumption rate was 1.2 g/day (McLaren/Hart 1994). These data clearly indicate that the size of the fishery and the number of locations fished during the fishing season can substantially impact the rates of consumption from them.

In addition, the survey methods used to collect fish consumption information can substantially bias the estimated consumption rates, particularly the upper bound rates (USEPA 1997); thus, not all consumption rate estimates are equivalent. All of these factors need to be considered on a site-specific basis when selecting a fish consumption rate.

The three studies that provide the basis for USEPA's default upper-bound value of 25 g/day vary considerably in their estimates of upper bound consumption. This is largely due to the survey methods used. Both the Ebert et al. (1993)[8] and Connelly et al. (1996) surveys were designed to collect consumption information from individuals over a one-year recall period. Their upper bound estimates of 13 and 18 g/day were very similar. The West et al. study (1989), which reported a much higher upper-bound consumption rate of 39 g/day, was based on a short-term recall survey (one-week) period.[9]

Short-term recall periods generally result in an overestimate of consumption behavior, particularly for foods that are not eaten on a daily basis. This is because these surveys have a tendency to over-sample more frequent consumers (those individuals who ate sport-caught fish within the single one-week period about which they were asked), and under-sample those individuals who consume sport-caught fish on a less frequent basis. This is because individuals who consume some sport-caught fish but may not have consumed it during the specific one-week recall period about which they were asked, are incorrectly assumed to be non-consumers in the survey analysis. While this does not appear to greatly affect central tendency values (USEPA 1997), the inverse relationship between upper-bound fish consumption rates and the length of survey recall period has been clearly demonstrated (Ebert et al. 1994). USEPA (1997) acknowledged this problem in its analysis of the West et al. (1989) data and used additional data collected in that study in an attempt to adjust the short-term rates and correct for this bias. It should be noted, however, that the additional data used to make that adjustment pertained to seasonal estimates of total fish meals consumed (including restaurant and store-bought fish) and were not specific to, and may not have been representative of, seasonal variations in the consumption of sport-caught fish. Thus, while USEPA used those data to make a correction, their confidence in that adjustment was limited. Because similar adjustments could not be made to the short-term results from the West et al. (1993) study, USEPA (1997) did not support the upper-bound, short-term results from that study.

Data provided by Mertz and Kelsay (1984) clearly demonstrate this bias in high-end consumption rate estimates. These authors reported on a US Department of Agriculture (USDA) survey in which 29 people tracked the types and amounts of food they ate daily for a one-year period. Because the daily dietary records kept by the

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[8] USEPA's *Exposure Factors Handbook* references this survey as ChemRisk 1992. However, the original study report was released in 1991 (McLaren/Hart 1991b) and a peer-reviewed paper discussing the study was published in 1993 (Ebert et al., 1993)

[9] A second study was conducted by West et al. (1993) using the same methodology as the 1989 study by those authors. While this study was also considered a "key" study for determining default central tendency values by USEPA (1997), USEPA did not use the upper bound estimate due to its high level of uncertainty.

study subjects could be condensed into 52 discrete one-week periods, it was possible to investigate the relationship between annual and weekly average fish consumption rates for these individuals. The mean year-long fish consumption rate from the Mertz and Kelsey (1984) survey data was estimated by summing the entire quantity of fish consumed by each survey respondent during the year and dividing by 365 days. The mean per capita "365-day" fish consumption rate developed using this approach was 26 g/day. In addition, the mean daily fish consumption rate averaged over a one-week period, the "7-day" fish consumption rate, was also estimated to be 26 g/day. Thus, the mean per capita consumption rate was not affected substantially by the recall period. It must be noted that these fish consumption rates are based on total fish consumption, including sport-caught, store-purchased, and commercially harvested freshwater, estuarine, and marine fish and shellfish. They are not relevant estimates of fish consumption from small freshwater ponds where only sport-caught fish would be harvested.

The same cannot be said, however, of the upper percentiles of the fish consumption rate distribution. When comparing the 7-day intake rates collected by Mertz and Kelsay (1984) with the 365-day intake rates, the upper percentiles were very different. When looking at the 7-day intake rates, the maximum value reported was 228 g/day. However, when the 365-day values were developed, by combining all of the 7-day periods for each individual throughout the year, the maximum consumption rate was 78 g/day. Thus, the short-term estimate overstated the actual long-term maximum by a factor of three. Similarly, when comparing the 95th percentiles reported for these two periods, the 7-day daily average (87.71 g/day) overestimated the 365-day daily average (51.13 g/day) by 72 percent, again demonstrating that the 7-day recall period did not provide a reliable estimate of long-term consumption behavior at the upper end of the distribution.

It is likely that the substantial difference in reported fish consumption rate between the West et al. (1989) study and the Ebert et al. (1993) and Connelly et al. (1996) studies is primarily due to the differences in the recall periods evaluated. While USEPA (1997) has averaged these studies without regard for differences in survey methods, it has also acknowledged (USEPA 1997; 1998, p. 108) that short-term dietary records are problematic when attempting to estimate long-term rates of consumption. In its review of fish consumption studies for the EFH (USEPA 1997, p. 10-13) stated, "The distribution of average daily intake reflective of long-term consumption patterns cannot in general be estimated using short-term (e.g., one week) data." As discussed previously, this problem resulted in USEPA discounting the upper-bound estimates from the West et al. (1993) study as reliable estimates of upper bound consumption for that population.

It is likely that the rates reported by Ebert et al. (1993) and Connelly et al. (1996) are more reliable estimates of long-term consumption as they are based on long-term data. In addition, while the Connelly et al. (1996) survey targeted anglers who fished Lake

Ontario, it is reasonable to assume that the ingestion rates from this study provide a more appropriate starting place for estimating consumption for Koppers Pond because they reflect both the New York sport-fishing population and the state's climatic characteristics. The upper-bound consumption rate from this study was 18 g/day while the central tendency value was 5 g/day. These values are still highly conservative, however, as they include fishing from multiple waterbodies, including Lake Ontario, in their respective states and, thus, likely overestimate fish consumption from a single small waterbody. In fact, data collected in 2007 by Connelly and Brown (2009) indicated that only 17 percent of all anglers included in the study only fished a single waterbody and, on average, anglers indicated that they fished an average of 3.4 waterbodies for their preferred species. Thus, it is likely that the fish consumption rates from a single small waterbody are substantially lower than the rates reported in that study.

Because of its small size, and limited productivity, the upper bound rates required by USEPA are not appropriate for Koppers Pond. As indicated in the analysis of productivity, Koppers Pond does not produce enough fish of edible sizes to support this upper-bound rate for even a single adult over a 30-year period. It is important to note, however, that the central tendency estimate of 5 g/day provided in the Ebert et al. (1993) and Connelly et al (1996) studies, as reported by USEPA (1997), is supportable at Koppers Pond over the long-term for at least a single individual.

The default rate of 25 g/day may be a reasonable generic value when evaluating the general U.S. population or populations that may obtain fish from multiple sources and from substantially larger waterbodies like the Great Lakes. This rate is not appropriate, however, for a single small waterbody like Koppers Pond. It is likely that only a small fraction of total consumption would come from a single small waterbody like Koppers Pond, particularly when there are higher quality fishing resources available nearby.

USEPA has recognized these important factors in other areas besides site-specific risk assessment. For example, USEPA's (2000a) methodology for the development of ambient water quality criteria (AWQC) recommends that, when available, consumption rates for populations of concern should be drawn from local or regional survey data. In addition, USEPA risk assessment guidance makes it clear that risk assessors should take into consideration site-specific conditions whenever possible (USEPA 1989; 1997).

USEPA has acknowledged the importance of considering differing characteristics of waterbodies when selecting fish consumption rates. For example, in its *Technical Background Document for the National Sludge Rule* (USEPA 2003), USEPA considered fish ingestion by recreational anglers who catch and eat fish from affected waterbodies. While USEPA considered selection of ingestion data from all four "Key" studies presented in the 1997 EFH, it concluded that, because three of the studies (West et al. 1989; West et al. 1993; Connelly et al. 1996) included large numbers of individuals who fished the Great Lakes, the Maine data collected by Ebert et al. (1993) provided a more relevant and appropriate basis for evaluating the streams, rivers and ponds under consideration in developing the sludge rule. Thus, the Ebert et al. (1993) data were used as the basis for that national regulation, which was promulgated in 2003.

This study provided fish consumption rates from different types of waterbodies. While these rates still represented consumption from multiple waterbodies of each type, and 80 percent of the survey respondents reported that they fished more than one waterbody during the year, the 50th percentile, arithmetic mean and 95th percentile values for anglers who consumed fish from lakes and ponds (including fish obtained through ice fishing) were 1.7, 4.2, and 15 g/day. If at least a portion of those fish were obtained from more than one waterbody, it is reasonable to conclude that consumption from a single, small waterbody would be lower. For example, if an angler fished just two waterbodies of equal size and productivity during the year, it is likely that this estimate would be reduced by half when considering consumption from just one of the fisheries.

In its 2000 draft document entitled *Estimating Exposures to Dioxin-Like Compounds* (USEPA 2000b), USEPA acknowledged that smaller waterbodies are likely to have limited rates of consumption. In that document, USEPA suggested that an alternative approach, which estimated the number of meals that might be consumed from a single small waterbody, might be used to estimate consumption from that waterbody. In that approach, it was suggested that 3 meals/year might be consumed on average and that a high-end consumer might eat 10 meals/year. Using an estimated meal size of 150 g, USEPA (2000b) derived a central estimate consumption rate of 1.2 g/day and a high-end estimate of 4.1 g/day for single, small waterbodies.

3.2 Site Specific Considerations for Koppers Pond

The amount of fishing effort necessary to obtain 25 g/day from a small pond is substantial. Harvest per unit effort (HPUE), which is generally expressed as either fish harvested per hour or mass of fish harvested per hour, varies based on the quality of the fishery, the species being harvested, and the skill of the angler. Crone and Malvestuto (1991) reported that HPUE for bass taken from three large reservoirs in Alabama ranged from 0.11 to 0.29 fish/hour with a mean of 0.2 fish/hour, while the HPUE for crappie ranged from 0.36 to 0.77 with a mean of 0.65 fish/hour. Weithman and Haverland (1991) studied fishing effort on five Missouri reservoirs and reported mean HPUE rates of 0.048 fish/hour for black bass, 0.9 fish/hour for crappie, 0.25 fish/hour for catfish, and 0.73 fish/hour for white bass. Weithman (1991) evaluated harvest rates from different types of waterbodies in Missouri, including ponds. The species-specific HPUE rates reported for ponds that were less than 2 hectares in size were 0.32 fish/hour for black bass, 1.36 fish/hour for crappie, 0.34 fish/hour for catfish, and 1.74 fish/hour for sunfish. For larger ponds/lakes, ranging in size from 2 to 400 hectares, the reported harvest rates were 0.21 fish/hour for bass, 1.22 fish/hour for crappie, and 1.59 fish/hour for sunfish (Table 3).

These HPUE estimates, while very conservative for Koppers Pond given the much higher productivity that is likely in both Alabama and Missouri waterbodies, can provide insight into the amount of fishing effort necessary to support the default RME rate of 25 g/day, required by USEPA. This level of fishing effort is in Table 4.

As shown in Table 4, the fish species that are known to be present in Koppers Pond and for which there are both HPUE estimates available and site-specific mass estimates, include bass, crappie and sunfish. While carp are also known to be present in Koppers Pond, there is very little information on sport-fishing HPUE for carp because they are generally not targeted by sport anglers and, if caught, are often released rather than consumed (West et al. 1989; Ebert et al. 1993; Connelly et al. 1996). Generally the HPUE estimates that are reported for carp by fisheries scientists are based on harvest by seining or electroshocking and thus are not representative of harvest rates of sport anglers. The limited sport harvest of carp is demonstrated by a study conducted by Brofka and Dettmers (2003). These authors evaluated fishing activity in the Illinois portion of Lake Michigan and reported that, between April and September of 2002, a total of 144,300 yellow perch were harvested from this portion of the lake but only 480 carp were harvested during the same period. These data demonstrate the low desirability of carp as a target species.

Using the average HPUE estimates (fish/hour) for each species, and combining that with the average mass of whole fish of each species, as provided in USEPA's response to the PAR (USEPA 2009), results in the mean mass of fish that might be harvested by an angler per hour. After adjusting the total mass of fish for the edible portion of 30 percent, it is estimated that anglers could harvest edible fish tissue masses of 44 g of bass, 62 g of crappie, and 19 g of sunfish/hour. While none of the fish consumption studies reviewed that were conducted in the northeastern US provide estimates of the number of hours of fishing spent per day of fishing, there are data from a recently completed survey of a fishery in Alabama that indicate that the range of hours spent fishing by those anglers was <1 to 10 hours/day, with an arithmetic mean of 4 hours per day (ARCADIS 2009). A study of another fishery that included several ponds indicated that the anglers who fished there spent, on average, 3 hours per fishing day (McLaren/Hart 1994). Using the higher of the two rates as the average length of a fishing day (4 hours/day), it can be estimated that in order to achieve an annualized fish consumption rate of 25 g/day, as required by USEPA, an angler would have to spend 51 days/year fishing for bass, 37 days/year fishing for crappie, and 117 days/year fishing for sunfish[10].

This is a substantial level of effort that does not regularly occur, particularly for less avid anglers. According to the 2006 U.S. Fish and Wildlife Service (USFWS) survey for the state of New York, the average number of total fishing trips taken to lakes, ponds, and reservoirs (excluding the Great Lakes) in New York State by resident anglers was 15 trips per year (USFWS 2008). This level of fishing activity is typical for the northeast region of the US. The survey conducted by NYSDEC (1990) reported an average of 7.4 trips/year by anglers who fished Seneca Lake. A survey conducted of anglers who fished Lake Champlain indicated that anglers fished there an average of 20 days/year (Connelly and Knuth 1995). The Maine angler survey conducted by Ebert et al. (1993) reported that Maine anglers fished lakes and ponds in the state at an average rate of 15 days/year. This rate included fishing during the open water fishing season as well as during the ice fishing season. In a creel survey conducted in Alabama, anglers took between 1 and 52 trips per year but the average frequency of fishing trips was 7 trips per year (ARCADIS 2009).

It is highly unlikely that the number of fishing trips required to harvest enough fish to supply the USEPA-required RME rate of 25 g/day would occur on a single fishery of the size and quality of Koppers Pond. While fishing may occur there on an intermittent basis, anglers interested in engaging in this level of fishing activity would likely turn to other, larger, and more productive nearby fisheries in order to sustain these rates of consumption.

There are numerous alternative fishing locations that are very close to Koppers Pond and provide easy access. Koppers Pond is approximately one mile from the center of Horseheads and is only accessible by walking down undeveloped trails or the adjacent railroad tracks. There are other fisheries that are approximately the same distance from the center of town that have substantially better access. These include Beaver Brook (which is just of one mile from the center of Horseheads) and Latta Brook, which is 1.6 miles from the center of town. In addition, there are many fisheries available within five miles of the center of the town. These include Eldridge Lake, Heller Creek, Weyer Pond, and Elmira Reservoir. As shown in Figure 2, these are all recognized fishing destinations. In addition, Seneca Lake, which is much larger, is only 11 miles

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[10] Example: If edible bass tissue is harvested at a rate of 44 g/hour and the average fishing trip is 4 hours per day, a total of 176 g will be harvested per trip. If the average daily fish consumption rate is 25 g/day, it will be necessary to harvest 9,125 grams of edible bass per year (25 g/day * 365 days/year). In order to achieve that mass, it would be necessary to complete 51 fishing trips (9,125 g/year /176 g/trip = 51 trips/year).

from the Horseheads. Most of these fisheries are substantially more accessible and attractive fisheries. Both Eldridge Lake and Weyer Pond are adjacent to park land and are within easy walking distance of residential neighborhoods. Conversely Koppers Pond is surrounded on three sides by industrial areas and is largely overgrown. While there is a residential area to the east, it would require walking nearly a half mile along undeveloped trails to reach the pond from those neighborhoods. Given the limited attractiveness of Koppers Pond as a destination fishery, its limited accessibility, and the availability of many, more attractive and accessible fisheries nearby, it is highly unlikely that avid anglers would spend a major portion of their fishing effort at Koppers Pond.

3.3 Alternative Fish Consumption Rates for Koppers Pond

These analyses are focused on the questions of whether the pond productivity could support the default USEPA consumption rates, and also whether a more appropriate consumption rate can be selected for Koppers Pond based on site-specific considerations. As demonstrated in the previous section (2.4), fish productivity for Koppers Pond does not support USEPA's default fish consumption rate of 25 g/day. Instead, this analysis concludes that the maximum amount of edible fish that could be harvested from Koppers Pond without adversely affecting the sustainability of the fishery, would be approximately 12 g/day. Because this rate represents the amount of edible fish tissue that can be harvested, it also represents the maximum consumption rate, on an annualized daily basis, that can be sustainably supported by the pond for an extended period of time. It is important to note, however, that because this is the maximum amount of edible fish tissue that can be removed from the fishery, only one individual can consume fish from the pond at this rate without affecting its productivity.

Consequently, at this rate, it cannot be assumed that this individual is providing fish to other family members (adults, adolescents, or young children) at a similar rate. For example, if an individual harvests an average of 12 g/day from the pond but is feeding himself, an adolescent and a young child, the maximum rates of consumption that would be possible, without impacting the sustainability of the fishery, would be 6 g/day for the adult, 4 g/day for an adolescent, and 2 g/day for a young child. Similarly, if two adults are fishing Koppers Pond, harvesting a sustainable total of 12 g/day of edible tissue between them, and sharing those with the same number and ages of individuals, all of those rates would have to be half of the rates proposed above.

For the alternative analysis that will be presented in the HHRA, it will be assumed that a total of 12 g/day, on average, are harvested by a single angler and that this individual shares his or her catch with one adolescent and one young child. Thus, consumption rates of 6 g/day, 4 g/day, and 2 g/day will be used to estimate potential exposures to the RME individuals in the HHRA.

For the CTE analysis, it will be assumed that there may be five individuals who consume fish from the pond and that their total sustainable harvest of edible fish tissue is 12 g/day. Assuming that they all consume with equal frequency, this will mean that there is a total of 2.4 g/day of total edible fish mass available per person on an average daily basis. Using the same factors for the adult, adolescent and young child will result in a fish consumption rate of 1.2 g/day for the adult, 0.8 g/day for an adolescent, and 0.4 g/day for a young child.

These rates are consistent with long-term fish consumption rates that have been reported by Ebert et al. (1993) and Connelly et al. (1996). They are also consistent with the rates for individual waterbodies that are presented in Table 3, as reported by Ebert et al. (1996) and McLaren/Hart (1991a and 1994).

4. Summary and Discussion

While individuals occasionally fish Koppers Pond, it is highly unlikely, given its characteristics and the availability of superior fisheries nearby, that Koppers Pond will experience the level of fishing and consumption activity that is being required by USEPA. Even if Koppers Pond is fished with some regularity, the fish consumption rates recommended by EPA are not supported by either site-specific characteristics or the body of literature on fish consumption habits.

Rates of fish consumption from specific waterbodies are substantially affected by a number of factors including the size and productivity of the fishery, the climate, accessibility, availability of edible size fish of target species, fishing regulations, aesthetics, and the availability of better quality fisheries nearby. In addition, as discussed previously, survey-based fish consumption rates are strongly affected by the survey method used, the length of the recall period, and the population targeted (Ebert et al. 1994). As a result, not all surveys that provide fish consumption rate estimates are equivalent and selection of a "one size fits all" consumption rate for all fisheries, as recommended by USEPA, is not appropriate. Instead, the applicability of each study and consumption estimate and the water body being evaluated needs to be considered carefully before selecting a fish consumption rate.

These analyses are focused on the question of whether the pond productivity could support the default USEPA consumption rates, and also whether a more appropriate consumption rate can be selected for Koppers Pond based on site-specific considerations. As demonstrated, fish productivity for Koppers Pond does not support USEPA's recommended fish consumption rate of 25 g/day. Instead, this analysis concludes that the upper bound amount of edible fish that could be harvested from Koppers Pond, without adversely affecting the sustainability of the fishery, would be 12 g/day. This rate could be sustained by only one individual, however. Thus, if more than one person is being provided with fish from the pond, their long-term sustainable consumption rates would need to be lower.

At a maximum harvest rate of 12 g of edible fish tissue per day, it cannot be assumed that even a single individual is providing fish to other family members (adults, adolescents, or young children) at a similar rate. For example, if an individual harvests an average of 12 g/day from the pond but is feeding himself, an adolescent and a young child, the maximum rates of consumption that would be possible, without impacting the sustainability of the fishery, would be 6 g/day for the adult, 4 g/day for an adolescent, and 2 g/day for a young child. Thus, for the HHRA, it will be assumed that that the total of 12 g/day, on average, is harvested by a single angler and that this individual shares his or her catch with one adolescent and one young child. Thus, consumption rates of 6 g/day, 4 g/day, and 2 g/day will be used to estimate potential exposures to the RME individuals in the HHRA.

For the CTE analysis, it will be conservatively assumed that five individuals fish the pond, that their total combined sustainable harvest of edible fish tissue is 12 g/day, and that they each feed themselves, an adolescent, and a young child. Assuming that they all consume with equal frequency, this will mean that there is a total of 2.4 g/day of total fish mass available per angler on an average daily basis. Using the same factors for the adult, adolescent, and young child will result in a fish consumption rate of 1.2 g/day for the adult, 0.8 g/day for an adolescent, and 0.4 g/day for a young child.

These sustainable yields are reported in terms of daily average harvest throughout the year. It is important to note that an angler could catch and keep substantially more fish mass during a fishing trip as long as the frequency of fishing trips is not great enough to exceed this daily average.

For example, using the highest of the three rates calculated here (12 g/day), an angler could harvest 1 kg of whole fish (0.3 kg of edible fish tissue) every 25 days without exceeding this average daily rate. Thus, he or she could take approximately 15 fishing trips per year and harvest 1 kg of whole fish during each trip without adversely affecting the fishery. As discussed previously, this is consistent with the average rate reported by USFWS (2008) for New York anglers and with the frequency of trips to lakes and ponds reported by Maine anglers (McLaren/Hart 1991b).

However, if the angler kept more fish per trip, fished with greater frequency, or if there was more than one angler fishing with the same frequency, the fish population would become unbalanced, slowing the rate at which large fish could be produced by introducing excessive competition among the forage fish, resulting in the fishery not being sustainable over the period of time being evaluated in the HHRA.

The F/C and A_T estimates are likely to be conservative due to the fact that they are based on an estimated productivity rate of 20 kg/ha-year. This rate was likely overestimated, given available information on productivity. It is at the low end of the range reported for unfertilized Alabama farm ponds, which would be expected to be more productive than northern ponds (API 1950). However, it is higher than the productivity rate of 16.8 kg/ha-year reported for Maryland ponds (Harrell and Webster 2004). Finally, Downing and Plante (1993) reported that the majority of sustainable fish population yields in lakes were less than 1 kg/ha-year and that 90 percent of fish populations had sustainable yields of less than 4 kg/ha-year.

At the same time, the F/C approach may not accurately reflect sustainable yield at Koppers Pond if individuals are opportunistically harvesting species or sizes of fish that API (1950) categorized as forage fish (such as bluegill, catfish and carp) rather than the larger game fish that are typically harvested by sport anglers. As discussed by API (1950), when a waterbody is not fished, as much as 25 percent or more of the fishes in it will die each year. These dead fish may form a considerable portion of the diets of benthivorous fish, such as carp and catfish. Because of this greater food source in an unfished pond, the F/C ratio range developed by API may not reflect the ratio of consumed fish from Koppers Pond.

This analysis uses an edible portion assumption of 30 percent based on USEPA (1989) guidance for estimating the fraction of muscle meat in the fish. While there is some variability in this factor based on the species, size, and quality of habitat, this percentage is generally used in consumption studies to convert the mass of whole fish to the mass of edible fish tissue.

In the productivity analysis that was conducted as part of the comments on the Pathways Analysis Report, USEPA (2009) used a factor of 70 percent to represent the edible portion of whole fish. This factor is not supported in the fish consumption literature and the basis for this factor was not provided. However, it is likely that this factor was derived as the percent of whole fish mass that is represented by a gutted fish (with head, bones, skin and tail still intact). This factor is supported by data concerning the relative dress-out percentages of whole fish mass after certain cleaning methods are used, provided in a survey conducted in Alabama (FIMS and FAA 1994). While it may be representative of the fraction of the total mass that is present on the fish when it is cooked, it is not representative of the mass of fish that is consumed. Nearly all surveys of fish consumption habits indicate that while individuals may only eviscerate their fish before cooking, they generally only consume the muscle meat after it is cooked (ARCADIS 2009; Ebert et al. 1993). Thus an edible portion factor of 30 percent representing the remaining fish tissue after the head, viscera and bones have been removed, is most appropriate.

Fish productivity methods have been widely accepted staples of fisheries management for many years. While it is true that ratios are being supplanted by data-intensive regression calculations, these more recent fisheries models have been developed for use in intensive aquaculture and require a significant amount of field data. Even though this analysis presents a relatively simple estimate of fish production, it agrees well with empirical findings from the literature.

While the highest harvest rate calculated (11.8 g of edible fish tissue per day) may not appear to be a substantial amount of fish when considered on an average daily basis, support of that rate for even a single individual requires removal of a substantial mass of fish from the pond. A rate of 11.8 g/day, as calculated above, indicates the amount of fish that is actually consumed. In order to achieve that rate, one must harvest 39 g/day of whole fish to have 11.8 g/day of edible fish. When annualized, this results in 14,357 grams of fish per person or 32 pounds of fish person per year. When considered over the 30-year exposure period being evaluated for the RME scenario in the HHRA, this results in the total removal of 947 pounds of fish/person during that period. In addition, if an individual were providing fish to a family of four for 30 years, it would be necessary to remove nearly 3,800 pounds of fish from the pond during that 30-year span. This represents a significant level of fishing effort and harvest; one that is very conservative for Koppers Pond and likely represents a substantial overestimate of any actual fish harvest that is likely to occur there.

While there is some indication that fishing may occasionally occur at the pond, there is no indication that there is regular usage of the pond as a fishery or that individuals are using the pond as a source of fish to be consumed. The level of fishing effort necessary to support that rate would be high and has not been observed at Koppers Pond. Instead, an analysis of the likely productivity within the pond indicates that the pond could not sustainably support USEPA's recommended RME ingestion rate of 25 g/day for even a single individual. Rather, a single individual may be able to consume fish at a rate of approximately 12 g/day without adversely affecting the sustainability of the pond's fishery. However, if the HHRA assumes that more than one individual is fishing the pond, lower rates of ingestion will need to be incorporated into the HHRA.

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Table 1. Calculation of Edible Fish Yields for Koppers Pond Based on the Sustainable Yield, F/C and A_T Approaches

ALTERNATE APPROACH BASED ON SUSTAINABLE YIELD (DOWNING AND PLANTE 1993)		
Upper-Bound Estimate of Sustainable Fish Yield (kg/ha-year)	4	
Size of Koppers Pond (hectares)	3.6	
Annual yield of whole fish mass from Koppers Pond (kg/year)	14.4	
Edible fraction of whole fish (USEPA, 1989)	0.3	
Total sustainable edible fish yield on a daily basis (g edible/day)	**11.8**	

ALTERNATE APPROACHES BASED ON MEI	TDS Estimated from Specific Conductance (see equations 1 and 2)	Measured TDS Values Based on 2009 Field Study
Depth of Koppers Pond (m)	1.5	
Size of Koppers Pond (ha)	3.6	
Specific conductance (µS/cm)	927	
Conversion factor	0.7	
Total Dissolved Solids (TDS) (mg/L)	649	623
MEI METHOD FOR ESTIMATING PRODUCTIVITY		
MEI = TDS/depth	432	415
Fish productivity (kg/ha-yr) = 0.966 * sqrt MEI	20	20
Total annual fish yield (kg/yr)	72	71
F/C APPROACH		
Total annual fish yield (kg/yr) based on MEI	72	71
Fish yield at F/C ratio 4.5 (kg/yr)		
F=	59	59
C=	13	13
Desirable whole fish yield for carnivorous (C) fish (kg/yr)	13	13
Desirable whole fish yield on a daily basis (kg/day) based on the F/C approach	0.036	0.036
Edible fraction of whole fish (USEPA, 1989)	0.3	0.3
Total sustainable edible fish yield on a daily basis (g edible/day) based on the F/C Ratio	**10.8**	**10.7**
A_T APPROACH		
Fish yield on a daily basis (kg/year) based on the MEI	72	71
Total harvestable-size fish yield on a annual basis (kg/year) based on A_T = 33%	24	23
Fraction of harvestable-sized fish that can be sustainably removed	0.5	0.5
Sustainable whole fish yield on a daily basis (kg/day)	0.033	0.032
Edible fraction of whole fish (USEPA, 1989)	0.3	0.3
Total sustainable edible fish yield on a daily basis (g edible/day) based on the A_T approach	**9.8**	**9.6**
SUMMARY OF EDIBLE FISH YIELD		
Fish Yield on a Daily Basis (g/day) - Sustainable Yield Approach	**11.8**	
Fish Yield on a Daily Basis (g/day) - F/C Approach	**10.8**	**10.7**
Fish Yield on a Daily Basis (g/day) - A_T Approach	**9.8**	**9.6**

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Table 2. Summary of Select Water Quality Parameter Results for Koppers Pond

Sample ID	Date Collected	Total Dissolved Solids (g/L)	Conductivity (µSi/cm)[1]	Data Source
SD-5 surface	8/18/1998	NR	804	CDM (1999)
SD-5 bottom	8/18/1998	NR	908	CDM (1999)
SD-6 surface	8/19/1998	NR	847	CDM (1999)
SD-6 bottom	8/19/1998	NR	855	CDM (1999)
SD-7 surface	8/19/1998	NR	875	CDM (1999)
SD-7 bottom	8/19/1998	NR	917	CDM (1999)
SD-8 surface	8/20/1998	NR	930	CDM (1999)
SD-8 bottom	8/20/1998	NR	1040	CDM (1999)
SD-9 surface	8/20/1998	NR	930	CDM (1999)
SD-9 bottom	8/20/1998	NR	930	CDM (1999)
SD-10	8/19/1998	NR	910	CDM (1999)
SD-11 surface	8/20/1998	NR	940	CDM (1999)
SD-11 bottom	8/20/1998	NR	980	CDM (1999)
SD-12 surface	8/19/1998	NR	990	CDM (1999)
SD-12 bottom	8/19/1998	NR	980	CDM (1999)
SD-13	8/19/1998	NR	Entry error	CDM (1999)
SD-14	8/19/1998	NR	1040	CDM (1999)
WQ-1	6/5/2003	NR	1112	CEC (2003)
WQ-2	6/6/2003	NR	958	CEC (2003)
WQ-3	6/7/2003	NR	519	CEC (2003)
WQ-4	6/8/2003	NR	1069	CEC (2003)
SW08-02	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SW08-04	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SW08-05	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SW08-08	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SW08-10	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SW08-13	5/12/2008	NR	NR	Cummings/Riter and AMEC (2008)
SP09-005	9/16/2009	0.587	NR	Integral 2009
SP09-006	9/16/2009	0.581	NR	Integral 2009
SP09-007	9/16/2009	1.09	NR	Integral 2009
SP09-009	9/16/2009	0.606	NR	Integral 2009
SP09-010	9/16/2009	0.579	NR	Integral 2009
SP09-011	9/16/2009	0.566	NR	Integral 2009
SP09-012	9/16/2009	0.575	NR	Integral 2009
SP09-013	9/16/2009	0.401	NR	Integral 2009
	AVERAGE	**0.623**	**927**	

Notes:

NR = Not reported

Entry error = data entry error resulting in unuseable data point

[1]Data collected in 1998, which were reported in mSi/cm, have been converted to µSi/cm.

Specific conductance is the measured conductivity of water adjusted to the equivalent of 25°C

CDM collected surface water samples at their sediment (SD) stations, but did not adjust the sample ID. They also collected samples from the surface and near the bottom of the water column at most of these locations.

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Table 3. Comparison of Consumption Rates from Several Northeastern Angler Surveys by Waterbody Types and Numbers

Author	Location	Type of Waterbodies	Adult Fish Consumption Rates (g/day)		
			Median	Mean	95th Percentile
Multiple Waterbodies					
Ebert et al., 1993	Maine	All Types of Waterbodies Combined Statewide	2	6.4	26
Connelly et al., 1996[a]	New York	Multiple Waterbodies Statewide Including Great Lakes	-	5	18
McLaren/Hart 1991b	Maine	Multiple Lakes and Ponds Statewide	1.7	4.2	15
Ebert et al., 1993	Maine	Multiple Rivers and Streams Statewide	0.99	3.7	12
Single Waterbodies					
McLaren/Hart, 1994	Massachusetts	Single River with Small Impoundments	-	1.2[b]	-
Ebert et al. 1996	Connecticut	Single River with Larger Impoundsments	0.17	2.6	12
McLaren/Hart 1991a	Maine	Single Destination River Fishery for Landlocked Salmon	0.49	3	11
Proposed Alternative Adult Rates	New York	Koppers Pond		1.2[c]	6[d]

[a] Analysis of the Connelly et al. data as provided in USEPA's 1997 *Exposure Factors Handbook*

[b] Only a single individual interviewed had kept fish for consumption at the time of the interview

[c] Based on maximum sustainable level of harvest of edible fish tissue per year and assuming consumption by a five adults, five adolescents and five children (See Section 3.3)

[d] Based on maximum sustainable level of harvest of edible fish tissue per year and assuming consumption by a one adult, one adolescent and one child (See Section 3.3)

Table 4. Estimation of Angler Hours and Days Necessary to Achieve Annualized Average Consumption Rates of 25 g/day and 10 g/day

Study	Location	Mean Harvest Per Unit Effort (fish/hour)		
		Bass	Crappie	Sunfish
Crone and Malvestuto (1990)	Three Alabama Reservoirs	0.20	0.65	-
Weithman and Haverland (1990)	Five Missouri Reservoirs	0.048	0.9	-
Weithman (1990)	Missouri Ponds (<2 hectares)	0.32	1.36	1.74
Weithman (1990)	Missouri Ponds/Lakes (2-400 hectares)	0.21	1.22	1.59
	Mean	**0.19**	**1.0**	**1.7**

Estimate of Necessary Fishing Effort (days of fishing per year)			
	Bass	Crappie	Sunfish
Average mass (g) of fish collected from Koppers Pond (USEPA, 2009)	760	199	39
Mean harvest in mass per hour (g/hour) = Mean HPUE*Average Mass	148	205	65
Edible portion of total mass (USEPA, 1989, 1997)	0.3	0.3	0.3
Mean edible harvest in mass per hour (g/hour) = Mean harvest in mass per hour*Edible portion	44	62	19
Total grams to be harvested at 25 g/day (g/year) = 25 g/day*365 days/year	9125	9125	9125
Number of hours necessary to achieve 25 g/day = Total grams to be harvested/Mean edible grams per hour	206	148	468
Number of 4-hour days of fishing to achieve 25 g/day (days/year) = Number of hours necessary/4 hours per day	**51**	**37**	**117**
Total grams to be harvested at maximum sustainable rate of 10 g/day (g/year)	3650	3650	3650
Number of hours necessary to achieve 10 g/day (hours)	82	59	187
Number of 4-hour days of fishing to achieve 25 g/day (days/year) = Number of hours necessary/4 hours per day	**21**	**15**	**47**

Figure 1
Koppers Pond and Local Setting
Kentucky Avenue Wellfield OU4 –
Koppers Pond, Horseheads, NY

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KOPPERS POND RI/FS GROUP

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Figure 2. Available Fishing Locations Near Horseheads, New York