

**EVALUATION OF POTENTIAL HUMAN HEALTH RISKS
ASSOCIATED WITH CONTAMINATION IDENTIFIED IN BUILDING MATERIALS
AT THE FORMER ANACORTES WATER TREATMENT PLANT**

Prepared for:

*THE CITY OF ANACORTES
14549 RIVER BEND ROAD
MOUNT VERNON, WASHINGTON 98273*

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Prepared by:

*INTERTOx, INC.
600 Stewart Street
Suite 1101
Seattle, WA 98101*

206.443.2115 phone
206.443.2117 facsimile

EXECUTIVE SUMMARY

This Risk Assessment presents the results of a toxicological evaluation to estimate the possible human health risks associated with exposure to polychlorinated biphenyls (PCBs) and other chemicals from building materials at the former Anacortes Water Treatment Plant (WTP) in Mt. Vernon, Washington. Where information is unavailable, we made cautious assumptions related to exposure. Based on the results of this Risk Assessment, no adverse health effects are likely to have occurred to customers, workers, or trespassers as a result of exposures at the former WTP.

The overall objective of the health Risk Assessment is to understand the likelihood of adverse health effects resulting from exposures to these chemicals. Whether or not a health effect can occur is dependent upon the characteristics of the chemical and the dose to which a person is exposed. The exposures considered in this Risk Assessment are related to a person contacting building materials (e.g., concrete structures) as well as dust, soil, and sediment at the former WTP (Site). We also reviewed water sampling data provided to us by the Anacortes WTP that were obtained over the history of the facility. These samples are regularly collected by the WTP in accordance with the federal Safe Drinking Water Act. None of the samples of drinking water contained detectable concentrations of PCBs, and therefore, there is no risk to users of the City's regional water system.

The former WTP was constructed in 1969-1970 and came online officially in February 1970. In 2013, the facility was replaced with a new plant adjacent to the same site on the Skagit River. The WTP considered demolishing the old facility, and sampled building materials from unused structures at the out-of-service portion of the WTP (the Site) in 2015 and 2016. The results of the sampling identified some building materials and soil containing PCBs in excess of applicable regulatory levels.

PCBs were commonly used in buildings built or renovated between about 1950 and 1979, because of PCBs' properties as insulators, plasticizers, and fire-retardant agents. Uses included in caulking, paints, and other adhesives; in fireproofing materials; and in the manufacture of some ceiling tiles and acoustic boards. PCBs were generally banned for use in the U.S. in 1979 because of the discovery that they are persistent in the environment and have the potential to cause adverse effects on humans and the environment at certain doses and exposures.

Although the Site was generally unused after 2013, this Risk Assessment assumes that past workers or trespassers at the Site could have contacted chemicals that were detected during the sampling. The Risk Assessment considers three possibly exposed populations: (1) adult workers in the Administration Building, (2) adult facility or maintenance workers (including contractors), and (3) trespassers (primarily adolescents) at the Site. Indoor workers are assumed to have been exposed to PCBs that were detected in dust on window sills and other surfaces in the Administration Building. Outdoor workers are assumed to have been exposed to PCBs in surface soils and in sediment inside the Sedimentation Basin, Clearwell, and Wastewell. Trespassers are assumed to have been exposed to PCBs in surface soils. Because chemicals (primarily PCBs) detected in concrete, paint, and coating materials are tightly bound within the structure of the materials, and were only detectable by forcible removal of samples (e.g., by drilling sample cores, scraping off coating, or cutting or scraping off

sealants and cork) followed by crushing the samples to enable the chemicals to be extracted using solvents, no pathways of exposure of persons at the Site to chemicals in these materials were assumed to have existed. This includes lead and arsenic, which were detected infrequently but at concentrations that were either below cleanup levels or below naturally-occurring background concentrations and so were not evaluated further.

For a health risk to occur to a person(s), a pathway of exposure must exist. Possible pathways of exposure considered in this assessment are incidental ingestion (e.g., contacting dust and then, without washing one's hands, eating a meal with one's hands), dermal (skin) contact, and inhalation (breathing) of dust or chemical vapors. For these exposure pathways, potential exposures were estimated and cancer risks and noncancer health hazards were evaluated.

Actual exposures are highly unlikely to have occurred at the levels that were assumed in this Risk Assessment, since the Risk Assessment uses conservative assumptions about how much people could have been exposed so that risks are not underestimated. For example, the Risk Assessment assumes people were exposed to concentrations of PCBs at or near the maximum-detected concentrations repeatedly over a working lifetime. We are not aware of any instances in which workers or any other people were actually exposed to the degree we assumed. Furthermore, we are not aware of any complaints of negative health effects or conditions as a result of exposure to these chemicals while at the Site.

Cancer risk is characterized as the probability of cancer occurring as the result of an exposure. To calculate cancer risk, the estimated lifetime average daily dose of a chemical is multiplied by a toxicity value, developed by U.S. EPA, that is specific to that chemical. The toxicity values are based on studies in laboratory animals or data from humans, and are used to assess lifetime cancer risks associated with specific doses. The average U.S. citizen has an approximately 40% chance (0.400000) of being diagnosed with cancer at some point in his or her lifetime. If the result of a cancer risk assessment estimates an increased lifetime excess cancer risk of 1 in a million (0.000001, also written as 1E-06 or 1×10^{-6}) due to an exposure, the total lifetime cancer risk to an exposed individual would be 0.400001. Although there is no universally accepted acceptable risk standard, the U.S. EPA generally considers risks above 1×10^{-6} (1 in 1,000,000) (i.e., *de minimis* risks) to be acceptable in nearly all circumstances, and risks within the range of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000) to be acceptable depending on site and exposure characteristics.

The Table below summarizes the cancer risks estimated in this Risk Assessment. These risks are within U.S. EPA's acceptable risk range.

Cancer Risk Summary

Population	Medium	Lifetime Excess Cancer Risk
Indoor office worker	Dust	4.5×10^{-5}
Outdoor worker	Soil	3.6×10^{-7}
	Sedimentation Basin sediment	2.5×10^{-5}
	Clearwell sediment	1.2×10^{-7}
	Wastewell sediment	4.5×10^{-8}
	Total	2.6×10^{-5}
Trespasser	Soil	1.9×10^{-7}

Noncancer risk is calculated as the ratio of the estimated dose for a specific chemical and pathway to the chemical-specific acceptable daily intake for noncancer effects. Acceptable daily intakes for noncancer effects (known as Reference Doses) are developed by U.S. EPA based on data collected from studies of laboratory animals or data from exposure in humans, and incorporate safety factors so as not to underestimate noncancer risks. The ratios for each exposure pathway are then summed to calculate a Hazard Index (HI) for each exposure population. An HI of one (1) is the reference level established by U.S. EPA above which concerns about noncancer health effects should be evaluated further to ensure that there is no unacceptable health risk. However, because of the multiple conservative assumptions used in calculating exposure and in deriving toxicity values, an HI greater than 1 does not mean that adverse effects are expected or will occur.

The Table below summarizes the noncancer hazards estimated in this Risk Assessment.

Noncancer Hazard Summary

Population	Medium	Noncancer Hazard
Indoor office worker	Dust	3.1
Outdoor worker	Soil	0.027
	Sedimentation Basin sediment	1.9
	Clearwell sediment	0.0089
	Wastewell sediment	<u>0.0034</u>
	Total	1.9
Trespasser	Soil	0.034

Estimates of potential exposure to indoor office workers and outdoor workers who contacted Sedimentation Basin sediment resulted in the highest estimates of noncancer health hazards, and are above 1. However, both of these estimates likely substantially overestimate actual noncancer health hazards.

Estimates for the indoor worker are based on PCB concentrations measured in samples of dust that were collected from visibly dusty surfaces in the Administration Building in 2016, years after the facility had ceased operation. During active operation, regular housekeeping measures would have prevented dust accumulation to this degree. Further, the Risk Assessment cautiously assumes workers directly contacted this dust several times per day, every working day over a working lifetime. These assumptions likely overestimate risks. For the outdoor worker, the estimated risk is

based largely on two samples with high PCB concentrations measured in sediment at the bottom of one of the basins. Other samples had much lower concentrations, such that concentrations averaged over an area or over time would likely have been much lower. Further, the locations from which these samples were collected were largely inaccessible. Some sampling locations were in basins that were usually filled with water, or were below the surface of the soil. For exposure to these locations to have occurred, the basins would have needed to be drained (e.g., as during cleaning) or a hole dug to reach the subsurface location. Further, these estimates assume repeated exposure for 25 years. As indicated, PCBs were not detected in any of the drinking water samples, and so no exposure to PCBs in water is assumed to have occurred.

The following example illustrates how the assumptions used to estimate exposures and risks impact the estimates of cancer and noncancer health risks. For the indoor office worker, we assumed that a worker contacted the contaminated dusty surfaces 3 times per day for 250 days per year for a working lifetime (25 years). However, if one assumes that a worker contacted these surfaces 1 time per day for 3 days per week (150 days per year) for a 9 year working exposure duration, the estimated cancer risk to the indoor worker is 3.2×10^{-6} and the noncancer hazard (0.23) is less than 1.0. If one assumes that regular housekeeping occurred and that the average PCB concentration on the surfaces was 10 times lower, the estimated cancer risk is 4.5×10^{-6} and the noncancer hazard is 0.31. If both a contact time of 1 time per day, 3 days per week, for 9 years and a 10 times lower PCB concentration are incorporated, the estimated cancer risk is 3.2×10^{-7} and the noncancer hazard is 0.023.

Uncertainties are inherent in the risk assessment process. For example, uncertainties exist about the chemical concentrations people could have been exposed to, how much and how often they could have been exposed, and the toxicity of the chemicals. However, the risk assessment process, which follows U.S. EPA protocol, makes conservative assumptions so that risks are likely to be overestimated, rather than underestimated.

This risk assessment does not consider potential exposures to future site workers who could be involved in demolition and disposal of the Site features, as it is assumed that health and safety measures as well as institutional controls will be implemented to minimize exposures during this work.

In summary, based on the results of this health Risk Assessment, no adverse health effects are likely to have occurred to customers, workers or trespassers at the former Anacortes WTP from exposure to PCBs or other chemicals present in building materials.

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ACRONYMS

ADD	Average Daily Dose
AF	Adherence Factor
AT	Averaging Time
B _{oral}	Bioavailability Factor (Oral)
BW	Body Weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Conversion Factor
COPC	Chemical of Potential Concern
CT	Central Tendency
DAF	Dermal Absorption Factor
ED	Exposure Duration
EF	Exposure Frequency
EPC	Exposure Point Concentration
ET	Exposure Time
GAF	Gastrointestinal Absorption Factor
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
InhR	Inhalation Rate
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
LOAEL	Lowest Observed Adverse Effect Level
MTCA	Model Toxics Control Act
NA	Not Analyzed
ND	Not Detected
NOAEL	No Observed Adverse Effect Level
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
QAPP	Quality Assurance Project Plan
RAF	Relative Absorption Factor
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource, Conservation, and Recovery Act
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SA	Surface Area
SDWA	Safe Drinking Water Act
SF	Slope Factor
SVOC	Semi-volatile Organic Compound
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
UR	Unit Risk
U.S. EPA	United States Environmental Protection Agency
UCL	Upper Confidence Limit
VOC	Volatile Organic Compound
WDOE	Washington Department of Ecology
WTP	Water Treatment Plant

1.0 INTRODUCTION

The defined site (Site) is located in Mount Vernon, Skagit County, Washington and consists of unused structures in the out-of-service portion of the City of Anacortes Water Treatment Plant (WTP). The WTP is located on Skagit County Parcel #21669, and is owned and operated by the City of Anacortes. The out-of-service features have been replaced with new infrastructure and are being considered for deconstruction.

In 2015 and 2016, sampling activities were conducted at the Site, to characterize chemical contamination in building materials prior to demolition of unused buildings and structures. Several types of materials were sampled, including concrete structures, concrete and metal coatings, sediment within settling basins, joint sealants and cork, filter media and gravel, and window caulk/glazing. Materials were analyzed for chemicals that included polychlorinated biphenyls (PCBs) and metals. In addition, drinking water samples were historically collected by the Anacortes WTP in accordance with the federal Safe Drinking Water Act (SDWA).

To assess whether detected concentrations pose or could have posed unacceptable human health risks under possible exposure scenarios, Intertox, Inc. conducted an evaluation of the potential human health risks. This human health risk assessment (the Risk Assessment) focuses on characterizing potential risks to past indoor and outdoor workers at the Site, as well as Site trespassers, from exposures to contaminants present in building materials, WTP filter media, soil, sediment, and groundwater at the Site. This Risk Assessment concludes that no adverse human health effects are likely to have occurred from exposure to materials at the Site. The methods and results of this evaluation are described below.

1.1 Objectives of the Risk Assessment

The goals of this health Risk Assessment are:

- To evaluate human health risks associated with potential past or current exposure to contaminants in or released from building materials at the Site;
- To identify the materials, contaminants, and pathways that are likely to contribute most significantly to risks, if any, and identify any populations that could have been significantly exposed;
- To provide information to support the evaluation of remedial alternatives and setting of remediation priorities; and
- To provide information on factors that contribute most significantly to uncertainties in risk estimates, to focus potential future investigations if necessary.

This evaluation provides a conservative evaluation of risks based on detected concentrations and assumptions about possible exposure scenarios. In some cases, potential exposure pathways were only evaluated qualitatively due to lack of applicable media concentrations or reasonable quantitative estimates of exposure. Overall, the resulting risk estimates are intended to overestimate risks for most scenarios.

This health Risk Assessment was conducted in accordance with current regional and national U.S. EPA and State of Washington risk assessment guidance and policy (e.g., U.S. EPA, 1989a, 1991a, 1996, 2001, 2004, 2007a, 2009, 2011, 2014, 2016; U.S. EPA Region IV, 2014; Washington State Chapter 70.105D).

1.2 Background

The Site is located in Mount Vernon, Skagit County, Washington and consists of unused structures in the out-of-service portion of the City of Anacortes Water Treatment Plant (WTP). The WTP is located on Skagit County Parcel #21669, and is owned and operated by the City of Anacortes. In 2013, the now out-of-service WTP—which was constructed in 1969-1970 and brought online officially in February 1970— was replaced with a new water treatment facility adjacent to the former WTP (MWH Americas, 2015). The out-of-service features have been replaced with new infrastructure and are being considered for demolition and deconstruction (City of Anacortes, 2015).

The out-of-service WTP treated raw water from the Skagit River prior to its transfer to the City of Anacortes municipal water storage and distribution network (MWH Americas, 2016). The out-of-service WTP had an average daily production capacity of 21 MGD of water. Raw water was pumped through traveling screens into an intake across the river from the Treatment Plant, on the west side of the river. The water was then pumped into a common 42” pipe that crosses the river into the treatment plant. Water first passed into the Sedimentation Basin, followed by the Filtration Basin, and finally the Clearwell. The Wastewell is located adjacent to the Clearwell, and is where sediment filtered out of the river water was collected prior to pumping it into one of three settling lagoons for drying. The settling lagoons were rotated for filling, drying, and removal of sediment.

The Anacortes WTP operates under the following water treatment plant general permit (MWH Americas, 2016):

Permit number: WAG643002 – Washington State Department of Ecology Water Treatment Plan General Permit.

Facility Name: Anacortes WTP

Dates of Coverage: September 1, 2014 – August 31, 2019

The City of Anacortes conducted regular sampling of drinking water produced by the WTP. This sampling has included analyses for PCBs. For the now out-of-service WTP, water sampling data for PCBs are available for July 2000, November 2001, February 2002, July 2003, July 2006, August 2007, August 2012, and August 2013. None of the drinking water samples contained detectable concentrations of PCBs. Detection limits for PCB Aroclors were consistent with state reporting levels and ranged from 0.0 to 0.5 µg/L for Aroclors 1016, 1232, 1242, 1248, 1254, and 1260, and 0.5 to 20 µg/L for Aroclor 1221.

On January 12 and 16, 2015, limited sampling at the Site as part of a hazardous materials assessment reported concentrations of the following contaminants in excess of cleanup levels under the Model Toxics Control Act, Chapter 70.105D RCW: (1) arsenic and PCBs in concrete wall samples (collected from the Filtration Basin, Sedimentation Basin, and Administration Building); (2) PCBs and PAHs in a single composite soil sample (collected along an exterior wall of the Sedimentation Basin); and (3) lead in Administration Building paint samples (DLH Environmental Consulting, 2015). Subsequently, additional sampling was conducted in July 2015 and in May and June 2016 to assess the presence of PCBs and other contaminants in building materials at the Site, and provide information to support selection of appropriate waste disposal options.

Historically, PCBs were used widely in buildings built or renovated between about 1950 and 1979 (U.S. EPA, 2015a,b). PCBs were used in caulking around windows, door frames, building joints, and masonry columns; in paints (particularly in industrial or military applications), mastics, and other adhesives; in fireproofing materials; and in the manufacture of some ceiling tiles and acoustic boards; and were present in fluorescent light ballasts. In many of these applications, PCBs were used because of their properties as plasticizers, and because they are able to endure thermal stress, vibration, or corrosivity (U.S. EPA, 2015a,b). PCBs can off-gas into the air from these sources, or PCB-containing dust and residues from these materials can contaminate surfaces. In addition, PCBs in coatings or other manufactured materials can move into adjacent porous materials, or leach into surrounding building materials and soil from precipitation and deterioration of the coating, or from disturbances during renovations or construction (U.S. EPA, 2015a,b).

PCBs comprise a group of 209 structurally similar chlorinated biphenyl compounds (known as congeners). Commercially, PCBs were available in the U.S. as mixtures known by their trade name, Aroclors. The names of specific Aroclor mixtures indicate the number of carbon atoms (the first two numbers of the Aroclor name) and the approximate percent chlorine by weight (the second two numbers). For example, Aroclor 1254 is a mixture comprised of PCB congeners with 12 carbon atoms, and is comprised of approximately 54% chlorine by weight (U.S. EPA, 1996). PCBs were generally banned for use in the U.S. in 1979 because of the discovery that they are persistent in the environment and have the potential to cause adverse effects on humans and the environment in certain doses and exposure conditions.

1.3 Report Structure

The subsequent sections of this document are organized as follows:

- **Data Evaluation and Hazard Characterization (Section 2.0).** This section describes the data considered in the evaluation and describes the chemicals of potential concern (COPCs) selected for purposes of this health Risk Assessment.
- **Exposure Assessment (Section 3.0).** This section identifies populations that could have potentially been exposed to the COPCs, describes potential exposure pathways,

and, for the exposure pathways that could have been complete, describes the development of contaminant-specific exposure estimates. It also provides the rationale for excluding pathways judged to be incomplete.

- **Toxicity Assessment (Section 4.0).** This section characterizes the toxicity of the COPCs and identifies quantitative toxicity criteria for each chemical for use in evaluating the significance of estimated exposures.
- **Risk Characterization (Section 5.0).** This section integrates the results of the toxicity and exposure assessments to develop quantitative measures of the potential for adverse health effects for those exposure pathways characterized as potentially complete.
- **Conclusions and Recommendations (Section 6.0).** This section summarizes the results of this Risk Assessment and provides recommendations for further evaluation.
- **References (Section 7.0).** This section provides the references used to conduct this evaluation.
- **Appendix A: Report Tables.** This appendix provides tables with additional detail on inputs and results of this Risk Assessment.
- **Appendix B: Exposure Equations.** This appendix provides the exposure equations used in this Risk Assessment.
- **Appendix C: Risk Calculations.** This appendix provides the detailed risk calculations and results.

1.4 Report Methodology

Because information about how much a person could have contacted a chemical in the past is imperfect, toxicologists assess risks by making assumptions. Typically, these assumptions deliberately overestimate how much exposure could have occurred, so as not to underestimate risks for anyone who could reasonably have been assumed to come in contact with the materials. To estimate past risks to workers who could have entered the facility, this risk assessment uses assumptions recommended by U.S. EPA that describe how much and how long people could have been exposed. These estimates are based on studies of average adults and children and their behaviors and, in general, provide upperbound estimates of the rate at which exposure could have occurred. For example, this Risk Assessment assumes that workers worked year round at the facility and could have been exposed for 25 years. Office workers were assumed to be exposed for 5 days per week for 50 weeks per year, and outdoor workers for 4 days per week for 50 weeks per year.

The Risk Assessment likely overestimates exposure and risk for a number of other reasons. First, the sampling data used in this Risk Assessment were collected in 2015 and 2016, after the now out-of-service WTP had been shut down and replaced by the new WTP. Because routine housekeeping was not conducted in the Administration Building during this time, dust and dirt accumulated on surfaces. As such, concentrations measured in the dust samples used to estimate exposure for the indoor worker scenario likely reflect higher contaminant concentrations than would reasonably have been expected when the facility was active and in

regular use. Second, this Risk Assessment assumes that an outdoor worker routinely (4 times per year) came in direct contact with sediment in the Sedimentation Basin, Clearwell, or Wastewell, for example while cleaning or maintaining these facilities. Since these structures generally were filled with water when in active use, it is likely that direct contact with sediment in these structures was minimal. Third, this Risk Assessment assumes that the detected chemicals in these media enter the body. Whether this actually occurred would have depended on a number of factors including how tightly the chemicals were bound to their carrier (for example, to soil or a building material) and the behaviors of individuals who could have contacted these materials.

The Risk Assessment evaluates both cancer and noncancer health endpoints. Cancer risks are based on estimates of the lifetime excess risk of developing cancer due to exposure to the chemicals being evaluated. Noncancer hazards consider such effects as the potential for reproductive impairment, developmental disorders, and disruption of specific organ functions. A cancer risk is the estimated probability of developing a particular cancer during a person's life, whereas the noncancer hazard is expressed as the ratio of the chemical intake (dose) to a Reference Dose, or RfD, which represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of daily exposure at a dose for the human population that includes sensitive populations (*e.g.*, children), that is likely to be without an appreciable risk of deleterious effects during a lifetime. The toxicity values used in this assessment to estimate cancer risks and noncancer hazards are established by the U.S. EPA. These toxicity estimates incorporate assumptions to account for uncertainties in their derivation, and thus are conservative.

Cancer risks are reported using a number of different conventions. A cancer risk of 1 in 100,000, for example, can also be noted as 1×10^{-5} , 1E-05, or 10^{-5} which is short hand for the decimal 0.00001. U.S. EPA (under federal Superfund law) considers lifetime excess cancer risks to a reasonable maximally exposed individual of 10^{-6} to 10^{-4} (1 in 1,000,000 to 1 in 10,000) to be acceptable. Risks less than 1 in a 1,000,000 are nearly always considered to be *de minimis*, or acceptable, whereas risks greater than 1 in 10,000 are typically considered unacceptable. To elaborate on the meaning of these risk designations, the average U.S. citizen has an approximately 40% chance (0.400000) of being diagnosed with cancer at some point in his or her lifetime. If the result of this cancer risk analysis estimated a 1 in a million (0.000001) excess cancer risk as a result of an exposure, the total lifetime cancer risk to an exposed individual would be 0.400001. Or, conversely, if the estimated excess cancer risk is 1 in a million, then in an exposed population of one million people, an upperbound of one additional cancer due to the exposure would be expected.

2.0 DATA EVALUATION AND HAZARD CHARACTERIZATION

The objective of the data evaluation and hazard characterization step is to identify and describe data considered in the health Risk Assessment and to identify chemicals of potential concern (COPCs). This section of the health Risk Assessment addresses the following:

- Describes environmental investigations at the Site that collected data considered in the health Risk Assessment;
- Describes sampled media and summarizes data collected to characterize chemical concentrations in those media;
- Evaluates the appropriateness of the data for purposes of conducting a health Risk Assessment; and
- If appropriate, identifies COPCs in each medium, based on detected concentrations and comparison to risk-based screening benchmarks.

Results of this step are discussed below.

2.1 Environmental Investigations

Several environmental investigations at the Site collected data that were considered in the Risk Assessment. These investigations and the data collected are described below.

2.1.1 2010 Shannon & Wilson, Inc. Geotechnical Data Report

A geotechnical investigation was conducted in 2010 during the design phase of the new WTP by Shannon & Wilson, Inc. and reported in the Geotechnical Data Report, Anacortes Water Treatment Plan, Mount Vernon, Washington (Shannon & Wilson, 2010). The objective was to characterize subsurface conditions prior to construction of the new WTP.

Sampled materials included eight soil borings; in addition, seven previously collected soil borings were reviewed. Soil tests included visual classification, natural water content, grain size analyses, resistivity tests, and Atterberg limit. The report concluded, in part, “Based on the soils encountered in the subsurface explorations, the site is primarily underlain by loose to dense alluvial sand, silt, and gravel... The explorations encountered groundwater between Elevation 12 and 15 feet (depths of 17 to 20 feet) in February 2009 and April 1965, as shown in Subsurface Profiles A-A’ and B-B’. The groundwater elevation likely fluctuates seasonally and is expected to be coincident with the water level in the Skagit River adjacent to the project site.”

No sampling data to characterize chemical contaminants were collected during the geotechnical investigation.

2.1.2 January 2015 DLH Hazardous Materials Assessment

An environmental assessment of the out-of-service WTP was conducted by DLH Environmental Consulting in January, 2015 and reported in the City of Anacortes Water

Treatment Plant Hazardous Materials Assessment (DLH Environmental Consulting, 2015). The objective was to collect samples of concrete, paint, and soil, and analyze them for metals, semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), and PCBs. In addition, samples of building materials in the Administration Building were also collected and analyzed for asbestos.

Sampled materials included the following:

- **Concrete wall samples** (n = 4; from the interior walls of the Sedimentation Basin, interior and exterior walls of the Filtration Basin, and the interior of the Clearwell)
- **Composite soil sample** (n = 1; from the exterior of the Sedimentation Basin)
- **Paint samples for lead** (n = 9; from the concrete walls in the Sedimentation Basin and Filtration Basin, and from interior and exterior walls and equipment inside of the Administration Building)
- **Building material samples for asbestos** (n = 15; from flooring material, roofing material, acoustical ceiling tiles, and interior brick walls in the Administration Building)

Data were not collected in accordance with a formalized Sampling Plan or Quality Assurance Project Plan (QAPP), and concrete sample collection was not conducted in accordance with the U.S. EPA Draft Standard Operating Procedure for Sampling Concentrate in the Field, U.S. EPA Region 1, 1997 (MWH Americas Inc., 2015). Further, data from the single soil sample were not considered representative of site conditions (MWH Americas Inc., 2015).

Sampling results are summarized in Table A-1. Briefly, the 2015 Hazardous Materials Assessment reported the following results:

- PCBs were detected in concrete wall samples associated with the Sedimentation and Filtration Basins and the Clearwell. Total PCB concentrations in the four samples ranged from 1.4 to 3900 mg/kg, which is above the Washington Department of Ecology (WDOE) Model Toxics Control Act (MTCA) Method A cleanup level for PCB mixtures of 1 mg/kg. These results suggested that permitted disposal was required. Arsenic was also detected in three of four concrete wall samples at concentrations above the MTCA Method A cleanup level for arsenic (20 mg/kg).
- PCBs were detected in the soil sample, which was collected on the exterior of the east side of the Sedimentation Basin, at a level (total PCB = 33 mg/kg) above the MTCA Method A cleanup level, suggesting that permitted disposal is required.
- Elevated PAHs (i.e., at a toxicity equivalency methodology (TEM) level of 0.8299 mg/kg, which is above the MTCA Method B TEM cleanup level of 0.137 mg/kg) were confirmed in the soil sample.
- Lead was detected in six of eight Administration Building paint samples (detected levels ranged from 41.8 to 21,800 mg/kg), and in four of the samples, levels exceeded the lead WDOE MTCA Method A Cleanup Level (for unrestricted land uses) of 250 mg/kg. Lead was not detected in the Filtration Basin paint sample (<10 mg/kg).

- Asbestos was confirmed in the flooring materials of second floor storage room in the Administration Building, but was not detected in other samples including other flooring and ceiling tile samples from the main entry, stairs, office, lab, and lunch room, or from the roofing.

2.1.3 2015 MWH Remedial Investigation Initial Investigation and 2016 Data Gap Investigation

A site characterization was undertaken in 2015 based upon the initial hazardous materials assessment by MWH Americas, Inc. (MWH Americas Inc., 2016). The objective was to define the nature of the PCB contamination in coatings and provide data for use in determining appropriate means and methods for demolition, deconstruction and subsequent disposal. A Sampling Plan and QAPP were prepared (MWH Americas Inc., 2016).

Data collected during the 2015 Remedial Investigation are summarized in Table A-2.

Sampled materials included the following:

- **Sediment within the Sedimentation Basin, Clearwell, and Wastewell (n = 18).** Samples were collected from the Sedimentation Basin (n = 10), Clearwell (n = 6), and Wastewell (n = 2) and analyzed for PCB Aroclors. Some samples were analyzed for total lead, Toxicity Characteristic Leaching Procedure (TCLP) volatile organic compounds (VOCs), TCLP SVOCs, and TCLP metals. Samples were collected using disposable spoons or trowels in locations where sediments were less than six inches in depth to underlying substrate. Samples collected from within standing water were collected as sediment laden water to be settled, decanted, and analyzed as solid.
- **Filter and anthracite media (n = 12).** Samples were collected from the Filtration Basin and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected using disposable spoons or trowels in locations where sediments were less than six inches in depth to underlying substrate.
- **Gravel bed (n = 6).** Samples were collected from the Filtration Basin and analyzed for PCB Aroclors.
- **Coatings on concrete and metal structures (n = 20).** Samples were collected from the Sedimentation Basin (n = 10) and the Filtration Basin (n = 10) and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected by scraping coated concrete surfaces to separate coating materials from the concrete substrate, and collecting the coating chips or flakes.
- **Concrete (n = 64).** Samples were collected from the Sedimentation Basin (n = 40), Filtration Basin (n = 6), Filtration Basin pipe gallery (n = 2), Clearwell (n = 10), and Wastewell (n = 6) and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected from locations without surface coating materials by drilling holes using a hammer drill with a 1" carbide-tipped bit, to a depth of less than 3". Dust generated during drilling was collected by hand using disposable spoons or scoops and placed into sealed sample jars for transport to the laboratory and analysis.

- **Expansion joint sealant** (n = 10). Samples were collected from the Sedimentation Basin and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected by cutting or scraping the material into sample jars using paint scrapers, chisels, hammers, and/or razor blades.
- **Expansion joint cork** (n = 4). Samples were collected from the Sedimentation Basin and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected by cutting or scraping the material into sample jars using paint scrapers, chisels, hammers, and/or razor blades.
- **Joint Caulk** (n = 3). Samples were collected from the Sedimentation Basin and analyzed for PCB Aroclors. Samples were collected by cutting or scraping the material into sample jars using paint scrapers, chisels, hammers, and/or razor blades.
- **Redwood baffles** (n = 3). Samples were collected from the Clearwell and analyzed for PCB Aroclors. Samples were collected from locations without surface coating materials by drilling holes using a hammer drill with a 1” carbide-tipped bit, to a depth of less than 3”. Dust generated during drilling was collected by hand using disposable spoons or scoops and placed into sealed sample jars for transport to the laboratory and analysis.
- **Window caulk/glazing** (n = 10). Samples were collected from the Administration Building and analyzed for PCB Aroclors. Some samples were analyzed for total lead, TCLP VOCs, TCLP SVOCs, and TCLP metals. Samples were collected by cutting or scraping the material into sample jars using paint scrapers, chisels, hammers, and/or razor blades.
- **Surface wipe samples** (n = 13). Samples were collected from the fiberglass collector boards in the Sedimentation Basin (n = 2), steel agitator blades in the Sedimentation Basin (n = 2), fiberglass troughs in the Filtration Basin (n = 6), and window sills in the Administration Building (n = 3), and analyzed for PCB Aroclors. Wipe samples were collected in accordance with the definition of Standard Wipe Test outlined in 40 CFR 761.123. Individual disposable templates measuring 10 cm × 10 cm were used to isolate sample areas. A new, clean template was used for each separate wipe sampling location, and hexane was employed as the solvent for PCB wipe samples.
- **Paint chips** (n = 5). Samples were collected in the Administration Building. One sample was analyzed for PCB Aroclors and the remaining four were analyzed for total metals and TCLP metals.

A second phase of the Remedial Investigation, known as the Data Gap Investigation, was undertaken by MWH Americas, Inc. in May and June 2016 (MWH Americas Inc., 2016). The objective was to fill data gaps for media not addressed in the first phase, or collect additional data to provide insight into material characterization. A Sampling Plan and QAPP were prepared (MWH Americas Inc., 2016).

Data collected during the 2016 Data Gap Investigation are summarized in Table A-2. Sampled materials included the following:

- **Soil** (n = 32). Samples were collected from locations where groundwater monitoring wells were subsequently planned to be installed by taking geoprobe soil borings from the 0-12” and 12-36” intervals from just outside the Sedimentation Basin (10 borings) and the Filtration Basin (six borings). Samples from each interval were composited and analyzed for PCB Aroclors. For the Sedimentation Basin, two borings were collected from each of the north, west, and south sides and four were collected from the east side towards the lagoon. For the Filtration Basin, three borings were collected from the south side and two from the east side. No borings were collected from the north and west sides since the concrete top of the Clearwell and the Administration Building, respectively, are located in these directions.
- **Clearwell sediment** (n = 6). To further understand PCB concentrations in sediment in the Clearwell, additional samples were collected during the Gap Investigation—four samples from accumulated dry sediment and two from the pump well which contained standing water. The two aqueous samples were collected by vigorously agitating standing water within the pump well and collecting the sample in 2-L water containers. Samples were then settled, decanted, and analyzed as solid. The four dry samples were collected using disposable spoons and placed into sealed sample jars for transport to the laboratory.
- **Settling lagoon sediment** (n = 4). Two samples each were collected from Lagoon 1 and Lagoon 2 and analyzed for PCB Aroclors. Samples were collected by removing an existing layer of settled sediment by hand and using a hand auger to collect a sample of sandy soils from the 0”-12” interval below the surface. Samples were collected using disposable scoops and placed into sealed sample jars for transport to the laboratory.
- **Subgrade mastic coatings** (n = 4). Samples were collected from the Sedimentation Basin (n = 2), Filtration Basin (n = 1), and Clearwell (1) and analyzed for PCB Aroclors. Samples were collected by cutting or scraping the material into sample jars using paint scrapers, chisels, hammers, and/or razor blades.
- **Groundwater** (n = 14). Samples were collected near the Sedimentation Basin (n = 9) and the Filtration Basin (n = 4) and downgradient towards the river (n = 1), and analyzed for PCB Aroclors. Samples were collected using piezometers installed into geoprobe soil borings; samples were collected at least 24 hours following well development.
- **Surface wipe samples** (n = 12). Samples were collected from the walls, floor, and pump room equipment in the Administration Building and analyzed for PCB Aroclors. Wipe samples were collected in accordance with the Standard Wipe Test procedures outlined in 40 CFR 761.123. Individual disposable templates measuring 10 cm × 10 cm were used to isolate sample areas. A new, clean template was used for each wipe sampling location, and hexane was employed as the solvent for PCB wipe samples.

The materials were analyzed for PCBs, VOCs, SVOCs, or metals as follows:

- Samples were analyzed for PCB Aroclors by U.S. EPA Method SW-846 8082A (U.S. EPA, 2007), and results were compared with the Toxic Substances Control Act (TSCA) limit of 50 mg/kg to assess whether the material should be managed as TSCA or non-TSCA material with regard to disposal options.

- Select samples were analyzed for Resource, Conservation, and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) VOCs, SVOCs, and metals by U.S. EPA Method SW-846 1311 to determine whether hazardous waste limits have been exceeded (U.S. EPA, 1992c). The method involves agitation of the size-reduced samples of the waste material with an extraction fluid (buffered acetic acid 2.88 or 4.93) equal to 20 times the weight of the solid phase (i.e., 20:1). Prior to extraction, particle size reduction is required unless the solid has a surface area equal to or greater than 3.1 cm per gram of material, or is smaller than 1 cm in its two narrowest dimensions. Particle size reduction is achieved by crushing, cutting, or grinding (WDOE, 2003).
- Some select samples were also analyzed for Total Metals by U.S. EPA 200.8 for health and safety purposes.

Detected concentrations of PCBs and metals reported for samples collected from the various media and sampling locations are summarized in Tables A-3 and A-4 respectively. For PCBs (Table A-3), the following results were reported:

- **Soil:** PCBs were detected in 14 of 32 soil samples (≥ 0.2 mg/kg total Aroclors). Seven of these were at total Aroclor concentrations above 1.0 mg/kg, the proposed MTCA Method A Soil Cleanup Level for unrestricted land use, and all of the detections above 1.0 mg/kg were in the shallow (0-12”) layer. The maximum detected total Aroclor concentration was 15.6 mg/kg in a sample from the 0-12” interval collected just outside and to the east of the Filtration Basin. All detected concentrations in soil were below the TSCA 50 mg/kg threshold.
- **Sediment within the Sedimentation Basin, Clearwell, and Wastewell:** PCBs were detected in 15 of 20 sediment samples collected from the interior of the Sedimentation Basin, Filtration Basin, Clearwell, or Wastewell during the Initial Investigation. The highest concentrations were detected in troughs in the Sedimentation Basin (2 of 2 samples, with total Aroclor concentrations of 1800 and 1900 mg/kg). PCBs were also detected in four of eight other sediment samples collected from the Sedimentation Basin (maximum total Aroclor concentration of 6.1 mg/kg) and in six of six samples from the Clearwell (maximum total Aroclor concentration of 11.0 mg/kg). PCBs were detected in three of four samples from the Wastewell (maximum total Aroclor concentration of 3.4 mg/kg).

PCBs were detected in all four of the additional dry sediment samples collected from the Clearwell during the Gap Investigation—the maximum total Aroclor concentration was 2.8 mg/kg. PCBs were also detected in the two aqueous samples from the Clearwell. Reported total Aroclor concentrations were 0.0010 mg/L and 0.00156 mg/L.

- **Settling Lagoon Sediment:** No PCBs were detected in the four settling lagoon sediment samples (detection limit 0.2 mg/kg).
- **Filter Media:** PCBs were only detected in one of 18 samples from the Filtration Basin filter media. PCBs were not detected in samples of anthracite or sand (six samples each), but were detected in 1/6 gravel samples at a concentration slightly above the detection limit of 0.2 mg/kg (total Aroclor concentration of 0.22 mg/kg).
- **Above-Grade Basin Coatings:** PCBs were detected in all of the above-grade coating samples collected from the interior and exterior of the Sedimentation Basin (10

samples) and Filtration Basin (10 samples). Total Aroclor concentrations ranged from 1,600-20,000 mg/kg and 10,400-34,000 mg/kg in the Sedimentation Basin interior and exterior, respectively, and from 0.26-4,070 mg/kg and 25,000-35,000 mg/kg in the Filtration Basin interior and exterior, respectively.

- **Below-Grade Basin Mastic Coatings:** PCBs were detected in two of the four below-grade mastic coating samples. Both detects were in the two samples collected from outside of the Sedimentation Basin: total Aroclor concentrations ranged from 4.7-4.9 mg/kg. No PCBs were detected in the mastic from the Filtration Basin or the Clearwell (detection limit 0.1 mg/kg).
- **Concrete:** PCBs were detected in concrete samples from the Sedimentation Basin (8/40 samples) and Filtration Basin (8/8 samples) but not from the Clearwell (0/10 samples) or Wastewell (0/6 samples). Maximum total Aroclor concentrations were 260 mg/kg and 233 mg/kg in samples from the Sedimentation Basin and Filtration Basin, respectively.
- **Other Basin Building Materials:** PCBs were detected in all samples of expansion joint sealant (10 samples) and caulk (three samples) and two of four samples of expansion joint cork from the Sedimentation Basin. Maximum total Aroclor concentrations were 38,000 mg/kg, 3,000 mg/kg, and 1,100 mg/kg for sealant, caulk, and cork, respectively. PCBs were not detected in redwood baffles from the Clearwell, or in wipe samples taken from the surface of fiberglass collector boards or steel agitator blades in the Sedimentation Basin or from fiberglass troughs in the Filtration Basin.
- **Groundwater:** PCBs were not detected in any groundwater sample at a concentration above the reporting limit of 0.01 µg/L.
- **Administration Building Samples:** PCBs were detected in all 10 window caulk/glaze samples collected from the administration building (total Aroclor concentration range from 6.6-640 mg/kg) and in 4/15 window sill wipe samples (maximum total Aroclor concentration 43 mg/kg). PCBs were not detected in one paint chip sample collected from along a window (detection limit 1 mg/kg).

For metals (Table A-4), the following results were reported:

- **Sediment within the Sedimentation Basin, Clearwell, and Wastewell.** Lead analyzed by the Total Metals method was detected in two of four sediment samples collected from the interior of the Sedimentation Basin, Clearwell, or Wastewell during the Initial Investigation. The highest concentration was detected in the Sedimentation Basin (40.8 mg/kg).
- **Filter Media:** Arsenic, barium, chromium, and lead analyzed by the Total Metals method were detected in single samples of anthracite, sand, or gravel bed media collected from the Filtration Basin. No mercury was detected.
- **Above-Grade Basin Coatings:** Lead was detected in most of the above-grade coating and paint samples (6/7 samples) collected from the interior and exterior of the Sedimentation Basin and Filtration Basin. One paint sample from the Sedimentation Basin had a very high level of lead (23,300 mg/kg); all other concentrations were much lower (maximum 112 mg/kg in Filtration Basin paint). Barium, chromium, and mercury were also detected in some coating samples.

- **Concrete:** Lead was detected in most of the concrete samples (5/6 samples) at low levels, with a maximum concentration of 16.2 mg/kg. Arsenic, barium, and chromium were each also detected at low levels in the Filtration Basin concrete sample.
- **Other Basin Building Materials:** Lead was detected in one Sedimentation Basin expansion joint sealant sample at low levels (9.57 mg/kg).
- **Administration Building Paint Chips:** Barium, chromium, and lead analyzed by the Total Metals method were detected in paint chip samples. Lead was detected in four of four samples with a maximum concentration of 421 mg/kg. Lead analyzed by the TCLP method was also detected in one of one sample, at a concentration of 3.29 mg/L.

2.2 Drinking Water Samples for PCBs

As described in Section 1.2, samples of drinking water produced by the Anacortes WTP are regularly collected by the WTP in accordance with the federal SDWA of 1976, amended in 1996, and reported in an annual drinking water quality report. Sampling data for PCBs are summarized in Table A-5. None of the drinking water samples contained detectable concentrations of PCBs.

2.3 Identification of Chemicals of Potential Concern

The term “chemicals of potential concern” (COPCs) refers to those chemicals detected in sampled media that are potentially site-related, have data of sufficient quality to quantify risk, and are identified as of potential toxicological concern based on comparison to toxicity screening values (U.S. EPA, 1989a; U.S. EPA, 2001). The following sections describe the data considered in selecting COPCs and the selection process.

2.3.1 Data Considered in Selecting COPCs

In this evaluation, all valid sample data (see Section 2.1) were included in the screening process for identifying COPCs, specifically sampling data collected by MWH Americas, Inc., during the Remedial Investigation in July 2015 and during the Data Gap Investigation in 2016 to characterize building materials in the Site. Data collected during the January 2015 DLH Hazardous Materials Assessment were not considered further in the Risk Assessment because data were not collected in accordance with a formalized Sampling Plan or Quality Assurance Project Plan (QAPP), and concrete sample collection was not conducted in accordance with the U.S. EPA Draft Standard Operating Procedure for Sampling Concentrate in the Field, U.S. EPA Region 1, 1997 (MWH Americas Inc., 2016).

Data collected during the 2015-2016 Remedial Investigation and Data Gap Investigation considered in the health Risk Assessment are summarized in Table A-2, differentiated by general location of collection, media type, and analyte groups.

2.3.2 Data Qualifiers

Data validation results were reviewed to identify qualifiers that indicate data would not be appropriate for use in the Risk Assessment. Data were treated based on reported qualifiers as follows (U.S. EPA, 1992a):

- “J” qualifier, indicating an estimated value. These compound or analytes were analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to nonconformances discovered during data validation. These data and the reported concentrations were used in the risk assessment.
- “UJ” qualifier, indicating non-detected samples with the reported detection limit estimated. The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation. These data were used in the risk assessment and, if selected as a COPC, the analyte was assumed to be present at one-half of the reported estimated detection limit.

2.3.3 Sample Analytes

As described in Section 2.1, samples were analyzed for PCB Aroclors, VOCs, SVOCs, and metals (total and TCLP metals). The following chemicals were detected in at least one valid sample:

- PCB Aroclor 1016
- PCB Aroclor 1232
- PCB Aroclor 1242
- PCB Aroclor 1248
- PCB Aroclor 1254
- PCB Aroclor 1260
- Arsenic
- Barium
- Chromium
- Lead
- Mercury

These chemicals were considered further as potential COPCs.

2.3.4 Comparison to Risk-Based Concentrations and Selection of COPCs

Chemicals present in several of the sampled solid matrices such as concrete, coatings, and other building materials are typically bound or sequestered within the matrices, which limits the potential for human exposure to these chemicals. Nonetheless, to provide some perspective on analyte concentrations, detected concentrations were compared to health risk-based concentrations published by U.S. EPA, including Regional Screening Levels (RSLs) (U.S. EPA, 2016b).

The U.S. EPA has developed RSLs for a large number of metals and organic compounds as tools for evaluating and cleaning up contaminated sites. Chemical concentrations above these levels do not automatically designate a site as “dirty” or trigger a response of action. However, exceeding a screening level suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate (U.S. EPA, 2016b). These values combine current U.S. EPA toxicity values with “standard” exposure factors to estimate contaminant concentrations in environmental media (soil, sediment, air, water) that are considered protective of humans, including sensitive groups, over a lifetime.

For application to this assessment, detected chemical concentrations in solid media (including soil, sediment, concrete, filter media, and coatings) were compared to RSLs for “industrial exposure” to soil. These values are calculated assuming exposure of adult workers to these levels in soil through ingestion, dermal contact, and inhalation of dust. For noncarcinogens, the risk-based concentrations are based on a hazard quotient (HQ), while for carcinogens, the risk-based concentrations are based on an assumed *de minimis* cancer risk level of 1×10^{-6} (i.e., 1 in 1,000,000) (see Section 5.1 and 5.2 for further discussion of these risk thresholds). Consistent with U.S. EPA risk assessment guidance (U.S. EPA Region IV, 2014), if the maximum-detected concentration of a contaminant in a given medium exceeded its RSL, the chemical was retained as a COPC.

TCLP results for VOCs, SVOCs, and metals that are reported as liquid concentrations (in units of mg/L) were screened based on U.S. EPA’s recommended approach for interpreting TCLP results from solid waste in terms of potential human health risks. Specifically, U.S. EPA recommends assuming a contaminant attenuation factor of 100 for leachate; that is, that the concentration of a contaminant in test leachate from solid waste measured using the TCLP will be reduced by a factor of 100 within the disposal area system prior to accessing surface or groundwaters (Lee and Jones, 1981; U.S. EPA Region II, 1994). Consequently, if the concentration in the test leachate is more than 100 times the U.S. EPA drinking water standard, then the waste is considered hazardous. However, each disposal site has its own set of characteristics that determine the potential for contaminants released from hazardous wastes to impair beneficial uses of surface and groundwaters. In some instances a factor of 100 attenuation would be too liberal an estimate; in others, it would be far too strict. Some chemicals show attenuation factors approaching infinity, while others show little attenuation. Further, attenuation properties exhibited by a chemical or mixture of chemicals at one location could be substantially different at another location, depending on such factors as the geology and hydrology of the area. Nonetheless, for purposes of identifying potential COPCs based on the TCLP results for metals, detected concentrations were compared to the RSL for tap water (U.S. EPA, 2016b) multiplied by a factor of 100 (Lee and Jones, 1981; U.S. EPA Region II, 1994).

Regulatory agencies have not established a standardized approach for estimating human health risks based on the results of surface wipe sample concentrations. However, several

approaches have been proposed by relevant regulatory agencies. For this screening step, the potential significance of surface wipe sample results was assessed consistent with the U.S. Occupational Safety and Health Administration (OSHA, 2016) screening approach for surface wipe samples by assuming that 100% of a contaminant measured in a surface wipe sample can be ingested and comparing that value to the maximum allowable dose derived from the RSL for industrial soil (e.g., the industrial soil RSL for Aroclor 1254 is 0.97 mg/kg soil corresponding to a daily soil ingestion rate of 0.0001 kg (100 mg/d), suggesting an acceptable daily dose of Aroclor 1254 of 0.000097 mg, or 0.097 $\mu\text{g/d}$). This maximum allowable dose is then divided by the approximate area of a worker's hand that is assumed to contact the surface (equal to 100 cm^2 , which is also the area of the surface wipe) to yield an acceptable surface limit (e.g., 0.097 $\mu\text{g}/100 \text{ cm}^2$ for Aroclor 1254).

Comparisons of detected concentrations to risk-based levels are shown in the following tables:

- Table A-6 compares RSLs for PCB Aroclors for industrial soil for specific media and locations to maximum detected PCB concentrations for solid matrices. Media/locations with concentrations that exceed the RSL are highlighted. In some cases, PCBs were not detected in at a given medium/location but limits of detection significantly exceeded the RSL; in these cases, these media/locations were also highlighted for further consideration since the detection limits were too high to conclude that PCB concentrations in those samples did not exceed the RSL.
- Table A-7 compares RSLs for metals for industrial soil to maximum detected concentrations of metals reported for analyses by the Total Metals and TCLP methods for solid matrices. Media/locations with concentrations that exceed the RSL are highlighted.
- Table A-8 compares PCB Aroclors detected in other matrices or using other methods (Clearwell water, Sedimentation Basin below grade mastic coating TCLP samples, and Administration Building window wipe samples) to other risk-based values. For Clearwell water, detected values are compared to RSLs for tap water. For TCLP method results for Sedimentation Basin below grade mastic coating, results are compared to RSLs for tap water $\times 100$. For surface wipe samples, results are compared to risk-based concentrations calculated as follows: RSL for industrial soil (in $\mu\text{g/kg}$) \times a daily soil ingestion rate of (0.0001 kg)/100 cm^2 . Media/locations with concentrations that exceed the risk-based concentrations are highlighted.

As shown in Tables A-6, A-7, and A-8, no COPCs were identified for the following media/locations because no chemicals were detected or detected concentrations (or detection limits) were below the risk-based screening levels:

- Sedimentation Basin soil 12''-36''
- Filtration Basin soil 12''-36''
- Wastewell sediment
- Filtration Basin filter media sand
- Filtration Basin gravel (or brick/block) bed

- Settling Lagoon sediment
- Filtration Basin below grade mastic coating
- Clearwell below grade mastic coating
- Clearwell concrete
- Wastewell concrete
- Sedimentation Basin caulk
- Clearwell redwood baffles
- Sedimentation Basin fiberglass collector board wipes
- Sedimentation Basin steel agitator blades wipes
- Filtration Basin fiberglass troughs wipes
- Sedimentation Basin groundwater
- Sedimentation Basin downgradient well groundwater
- Filtration Basin groundwater

Table A-9 summarizes the media/locations for which COPCs were identified, and the COPCs identified for those media/locations. The selected COPCs for specific media/locations were evaluated further for presence of complete exposure pathways in Section 3.0.

2.4 Uncertainties in Chemicals of Potential Concern Selection

As discussed above, a point of significant human contact with most of the analytes detected in various media in the Remedial Investigation is unlikely, due to sequestration of these chemicals within their respective matrices and lack of a human contact point with the medium. Nonetheless, for screening purposes, any detected compound that was detected at least once at a concentration in excess of its risk-based concentration was identified as a COPC for that medium and general location. For most of the COPCs/media/ locations, this screening evaluation significantly overestimates potential exposures and health risks. The likelihood of potential exposure to these compounds is evaluated further in Section 3.0.

3.0 EXPOSURE ASSESSMENT

The goals of the Exposure Assessment are: (1) to identify and characterize the populations and scenarios for which exposures will be evaluated; (2) identify potentially complete exposure pathways; and (3) develop contaminant-specific estimates of exposures for potentially exposed populations and complete pathways. The populations and pathways that were considered in the health Risk Assessment and the exposure parameters that were used to estimate exposures and risks are described below.

3.1 Exposure Populations and Scenarios

This Risk Assessment focuses on characterizing potential past or present exposures to contaminants in features at the Site, including building materials and filter media as well as residual contamination that may have been measured in soil, sediment, and groundwater.

All sampled features at the Site that were included in this Risk Assessment have restricted access. No detections of chemicals above risk-based screening levels were reported in groundwater that has the potential to be transported offsite, nor were PCBs detected in samples of finished drinking water produced by the WTP. Thus it is assumed that any exposures that could have occurred or continue to occur are within the boundaries of the facility. No off-site exposure scenarios (i.e., outside of the facility fence line) were evaluated. Further, this assessment does not evaluate potential exposures to workers involved in demolition and disposal of features at Site, as it is assumed that institutional controls will be implemented and that workers will wear appropriate personal protective equipment for this activity that will minimize any exposures to site-related contaminants. It is assumed that past or present facility workers were only exposed to facility features in place (e.g., not undergoing demolition or otherwise disturbed).

Based on these assumptions, the following populations were identified as having the potential to be exposed to COPCs associated with the site:

- Adult indoor workers in the Administration Building (assumed to do largely indoor office work),
- Adult facility or maintenance workers, including contractors (assumed to do largely outdoor facility or maintenance work), and
- Adolescent trespassers (age 7-16, consistent with the U.S. EPA Region IV (2014) trespasser scenario) at the Site.

Section 3.2 describes the potentially complete exposure pathways identified for these populations.

For each of these populations, an upperbound estimate of exposures was calculated. These estimates are assumed to represent the highest level of exposures that could reasonably have been expected to occur for a given exposure pathway at the Site, and account for both uncertainty in the contaminant concentration and variability in the exposure parameters.

3.2 Exposure Pathways

An exposure pathway describes the course a chemical takes from its source to an exposed individual. In order for an exposure pathway to be complete, it must have four elements (U.S. EPA, 1989a):

- A source and mechanism of chemical release,
- A retention or transport medium,
- A point of potential human contact with the contaminated medium, and
- An exposure route (*e.g.*, ingestion) at the contact point.

Typically assumed potential routes of exposure considered in environmental risk assessments include:

- Incidental ingestion of soil, sediment, dust, water, or other material,
- Dermal contact with soil, sediment, dust, water, or other material, and
- Inhalation of volatilized substance or wind-blown dust.

As described in Section 2.0 and summarized in Table A-9, COPCs at the Site were identified for the following media, based on detection in at least one sample at a concentration in excess of a risk-based screening level:

- Soil (0-12" below ground surface) (PCB Aroclors)
- Sedimentation Basin, Clearwell, and Wastewell sediment (PCB Aroclors)
- Filtration Basin anthracite media (arsenic)
- Sedimentation Basin and Filtration Basin interior and exterior coatings (PCB Aroclors)
- Sedimentation Basin below grade mastic coating (PCB Aroclors)
- Sedimentation Basin paint (lead)
- Sedimentation Basin and Filtration Basin concrete (PCB Aroclors and arsenic (Filtration Basin only))
- Sedimentation Basin expansion joint sealant and cork (PCB Aroclors)
- Administration Building window caulk and glaze (PCB Aroclors)
- Administration Building window wipes (PCB Aroclors)

As described in Section 2.3.4, the risk-based screening levels used to provide perspective to detected concentrations are extremely conservative for application to the Site and these media (*i.e.*, the risk-based screening levels assume the chemicals are present in media in a form to which people could actually be exposed, and they assume repeated, daily direct exposure to the designated concentration every working day for a working lifetime, assumed to be 25 years).

However, it is extremely unlikely that anyone would have contacted the identified COPCs in most of the sampled media at the Site at rates even approaching these levels. For example, chemicals present in building materials, including concrete, coatings, paints, sealant, cork, caulk, and glaze, are typically bound or sequestered within the matrices. As described in Section 2.1, to obtain sufficient samples of concrete and other building materials for chemical analysis, the materials were aggressively drilled, scraped, cut, or chiseled. Then, after delivery to the laboratory, the materials were further processed to reduce the particle size and increase the surface area to enable extraction of chemicals from the matrix using appropriate solvents. For example, when analyzing solid materials using U.S. EPA SW-846 8082A for PCBs, solid samples are extracted using hexane-acetone (1:1) or methylene-acetone (1:1) solvents (U.S. EPA, 2007b), and when using TCLP SW-846 Method 1311 (USEPA, 1996a), organic compounds and metals are extracted from size-reduced samples of waste material with an extraction fluid (sodium acetate buffer solution with a pH of 4.93, or pH 2.9 for highly alkaline wastes), present at a volume equal to 20 times the weight of the solid phase (i.e., a 20:1 liquid to solid ratio (m/m)) (U.S. EPA, 1992c). These sample manipulation/extraction procedures do not reflect how humans would interact with the material while in place (e.g., transient dermal contact with an intact concrete wall or other building material), but are intended to provide a very conservative assessment of the potential for leaching of chemicals from the material in a waste disposal situation. Thus, the potential for human exposure to any of these substances at doses that could cause adverse health conditions is extremely unlikely.

TCLP in particular is designed to provide an estimate of the potential for leaching of materials from waste if it is co-disposed with municipal solid waste in a sanitary landfill. Prior to extraction, particle size reduction is usually required to increase the surface area available to the extraction fluid. If the surface area is smaller than 3.1 cm per gram of material or the particle size is larger than 1 cm in its two narrowest dimensions (i.e., is capable of passing through a 9.5 mm (0.375 inch) standard sieve), the sample must be prepared for extraction by crushing, cutting, or grinding the waste. This TCLP co-disposal scenario is designed to reflect the most reasonable “worst-case mismanagement scenario” for industrial wastes, and assumes that infiltrating precipitation will combine with water-soluble products of municipal solid waste biodegradation to act as the leaching fluid. The TCLP leaching fluid is intended to approximate concentrations of volatile fatty acids likely to occur in actual landfill leachates during the acid generation phase of landfill decomposition (see 45 FR 33112, May 19, 1980). The TCLP methodology further assumes a 3-meter landfill depth, 100 cm annual rainfall, 5 percent co-disposal with municipal waste, 100 percent rain percolation through the landfill, 1 g/cm³ waste density, and three years of leaching. Thus, while the TCLP may predict worst-case leaching potential in a municipal solid waste landfill, it will substantially overpredict leaching potential for contaminants left in place (U.S. EPA, 1992c; U.S. EPA, 2012; WDOE, 2003).

For most of the media and COPCs listed above, the necessary elements of a complete exposure pathway do not exist. Specifically, it is unlikely that complete pathways of exposure to detected contaminants in these media would have existed because there was:

- **No source or mechanism of chemical release.** For most of the materials sampled, contaminants are tightly bound within the materials and were only detectable after forcible removal of sufficient sample (e.g., by drilling sample cores of concrete or wood; scraping coating off of concrete surfaces; or cutting or scraping sealants and cork using scrapers, chisels, hammers, or razor blades) and alteration of sample size to increase surface area (e.g., crushing the material), followed by extraction of contaminants from the matrices using solvents. Thus it is extremely unlikely that a worker or trespasser at the Site would be exposed to these substances.
- **No transport medium.** Most sampled matrices (e.g., cement, wood, coatings, sealant, cork in Sedimentation or Filtration Basins, the Clearwell, or the Wastewell) are solid materials, and there is no evidence of a transport mechanism by which these materials or their breakdown products could have been transported to a point of significant contact with humans, e.g., in water or through air.
- **No point of human contact with the contaminated material or a transport medium.** Workers likely had minimal or no contact with several of the sampled materials in which COPCs were identified, because the materials were below the water surface or within basin enclosures (e.g., concrete, coatings, sealants, cork, or filter media in the Sedimentation or Filtration Basins), or were otherwise inaccessible (e.g., below grade mastic coating on the Sedimentation Basin).
- **No exposure route at a contact point.** Without other elements of an exposure pathway being complete, no route of exposure (e.g., inhalation of volatilized substance or wind-blown dust, or ingestion of or dermal contact with contaminants) can exist.

Based on the lack of all of the elements for a complete exposure pathway as described above, no exposure was assumed for detected chemicals in the following media:

- Sedimentation Basin and Filtration Basin interior and exterior coatings (PCB Aroclors)
- Sedimentation Basin below grade mastic coating (PCB Aroclors)
- Sedimentation Basin paint (lead)
- Sedimentation Basin concrete (PCB Aroclors)
- Filtration Basin concrete (PCB Aroclors and arsenic)
- Sedimentation Basin expansion joint sealant and cork (PCB Aroclors)

The potential for workers to have been exposed to some of the other sampled materials in which COPCs were detected was also limited (e.g., because they were below the ground surface, as for soils in the 0-12” interval near the Sedimentation Basin or Filtration Basin; or they were predominantly below the water surface, as for sediments in the Sedimentation Basin, Clearwell, or Wastewell). However, for purposes of this Risk Assessment, it was assumed that people could have infrequently come in contact with these media while working on or travelling across the site (e.g., exposure of workers or trespassers to soils at the ground

surface) or when cleaning out sediment from basins or the Clearwell or Wastewell (e.g., exposure of workers to sediment). Therefore, these media were retained for evaluation in this health Risk Assessment.

In the Filtration Basin, arsenic was detected in a single sample of anthracite media at a concentration of 4.37 mg/kg. This concentration slightly exceeds the U.S. EPA RSL for arsenic in industrial soil of 3 mg/kg (U.S. EPA, 2016b). However, anthracite (i.e., coal) is a natural material that naturally contains arsenic as well as certain other elements (Trent et al., 1982). While the risk-based screening level for arsenic is 3 mg/kg, arsenic occurs naturally in soils at higher levels. In the State of Washington, the “background” level of arsenic in soil is considered to be 20 mg/kg (WDOE, 2016). Typically, cleanup levels for arsenic in soil in Washington are not set below this level (WDOE, 2016). Since the maximum detected concentration of arsenic in anthracite is below this level, and since contact of workers with anthracite media is expected to be minimal, arsenic was not retained as a COPC for evaluation in this health Risk Assessment.

In the Administration Building, PCBs were detected above screening levels in at least one sample of window caulk and glaze and in a single paint chip sample. Surface wipe samples along window sills were also collected in the Administration Building. Since caulk and glaze samples were collected by cutting or scraping the surface, and only a single paint chip sample was collected, PCB concentrations detected in the wipe samples were assumed to be more representative of potential PCB exposure levels to office workers. Therefore, only wipe samples were used to estimate potential exposures of workers to PCBs in the Administration Building.

In addition, in the Administration Building, lead was detected in a single paint sample using the TCLP method at a concentration (3,290 µg/L) more than 100 × the U.S. EPA RSL for tap water (150 µg/L) (Table A-8). However, lead in Administration paint samples was also analyzed using the total metals method, and the maximum detected concentration (421 mg/kg) was below the RSL for lead in soil (800 mg/kg), a medium that is expected to be associated with greater availability of lead for absorption than lead in paint chips and therefore considered to reflect a conservative measure of potential risk from exposure to lead in a paint chip. As a result, lead in Administration Building paint was not retained as a COPC/medium of concern for purposes of this health Risk Assessment.

For the following media and COPCs, potentially complete pathways of exposure were assumed to have existed in order to complete this health Risk Assessment for the identified exposure populations.

Indoor office workers:

- *Administration Building window wipes (PCB Aroclors).* Assumed potential pathways of exposure were incidental ingestion resulting from hand-to-mouth contact, dermal contact followed by absorption through the skin, and inhalation of dust from surfaces.

Outdoor maintenance workers:

- *Soil (0-12" below ground surface) (PCB Aroclors)*. Assumed potential pathways of exposure were incidental ingestion, dermal contact followed by absorption through the skin, and inhalation of dust or vapor.
- *Sedimentation Basin, Clearwell, and Wastewell sediment (PCB Aroclors)*. Assumed potential pathways of exposure were incidental ingestion, dermal contact followed by absorption through the skin, and inhalation of dust or vapor.

Outdoor trespassers:

- *Soil (0-12" below ground surface) (PCB Aroclors)*. Assumed potential pathways of exposure were incidental ingestion, dermal contact followed by absorption through the skin, and inhalation of dust or vapor.

3.3 Quantification of Exposure

The following sections present the equations used to calculate estimated doses of COPCs for potentially complete exposure pathways, and the parameters applied to the equations to estimate dose.

3.3.1 Exposure Equations

The equations used to estimate intake (dose) for each pathway evaluated in this health Risk Assessment are provided in Appendix B.

In general, wipe samples are collected to provide information on surface contamination levels that may lead to human exposures and the effectiveness of housekeeping measures (OSHA, 2016). Regulatory agencies have not established a standardized approach for estimating human health risks based on the results of surface wipe sample concentrations (at the Site, samples were collected by wiping a 100 cm² surface area—the approximate area of a human palm—with a filter and analyzing the filter for PCB Aroclors). May et al. (2002) proposed a screening-level method to assess potential risks to workers associated with wipe sample concentrations by estimating uptake from incidental ingestion due to hand-to-mouth contact, dermal contact, and inhalation of dust or vapor from the surface. The equations given below for quantifying exposure associated with measured concentrations in surface wipe samples are based on this approach.

Equations for contact with soil or sediment through incidental ingestion, dermal contact, and inhalation are consistent with standard U.S. EPA risk assessment methodologies (e.g., U.S. EPA, 1989a).

3.3.2 Exposure Point Concentrations

Exposure point concentrations (EPCs) of PCB Aroclors were calculated for the media/locations with potentially complete exposure pathways.

PCB Aroclor exposures were evaluated as total PCB Aroclors. For each sample, the total PCB Aroclor concentration was calculated as the sum of the concentrations of all detected Aroclors, consistent with Washington Department of Ecology guidelines for Aroclor summation (WDOE, 2007). If all Aroclors were undetected in a given sample, the highest detection limit was used as representative of that sample.

Per U.S. EPA risk assessment guidance (U.S. EPA, 1989a; 1992b; 2002a), the 95 percent upper confidence limit (95% UCL) of the arithmetic mean was used as an estimate of the arithmetic average PCB concentration in each medium. Use of the 95% UCL provides reasonable confidence that the true average concentration in the medium will not be underestimated. 95% UCLs were calculated using U.S. EPA's ProUCL software, version 5.1.002 (U.S. EPA, 2016c). For PCBs, the 95% UCL concentration in a given medium was calculated using the total Aroclor concentrations measured in all of the samples collected in that medium; if Aroclors were not detected in a given sample, one-half of the highest detection limit for all of the Aroclors in that sample was used in the 95% UCL calculation.

Consistent with U.S. EPA guidance, if the calculated 95% UCL exceeded the maximum-detected concentration in a given medium, the maximum-detected concentration was used (U.S. EPA, 1989a; 1992b; 2002a). In addition, the maximum-detected concentration was used if fewer than five samples were collected in a given medium.

EPCs applied in this health Risk Assessment are summarized in Table A-10.

3.3.3 Exposure Parameters

Quantification of exposure requires information on the behaviors of the population of interest (e.g., how frequently the population engages in an activity, how many years the population is exposed). Where appropriate, assumptions about site-specific behavior were used to quantify potential exposures. In the absence of site-specific information, information on average rates of exposures in U.S. populations, such as quantified in U.S. EPA's *Exposure Factors Handbook* (U.S. EPA, 2011) or U.S. EPA standardized default exposure parameters, were used.

Consistent with U.S. EPA guidance, exposure parameters were selected to represent reasonable upper-bound estimates of exposure (U.S. EPA, 1989a). Where available and appropriate, parameter values were consistent with recommended U.S. EPA reasonable maximum exposure (RME) values for assessing risks to workers, such that risks would not be underestimated.

Exposure parameters for the indoor office worker, outdoor maintenance worker, and trespasser are presented in Tables A-11, A-12, and A-13, respectively. Considerations for selection of specific exposure parameters are discussed below.

- *Exposure frequency (EF)* describes the numbers of days per year that a person contacts a contaminated medium. For the indoor office worker, EF is assumed to be five days per week for 50 weeks per year, or 250 days per year; this is consistent with the default recommended by U.S. EPA for the reasonable maximum exposure (RME) scenario for indoor workers (U.S. EPA, 2016b). For outdoor workers, EF to soil is assumed to be 5 days per week for 45 weeks per year, or 225 days per year; this value is consistent with the default recommended by U.S. EPA for the RME scenario for outdoor workers (U.S. EPA, 2016b). For outdoor workers, EF for contact with sediment in the basins and wells is assumed to be once per quarter, or 4 times per year (i.e., 4 days/year), based on professional judgment, assuming a worker cleans sediment from the basins on a quarterly basis. For trespassers, EF is assumed to be 10 days/year based on professional judgment.
- *Exposure duration (ED)* describes the number of years that a person has the opportunity to contact a contaminated medium. For the indoor office worker and outdoor worker, ED is assumed to be equal to 25 years; this is consistent with the default recommended by U.S. EPA for the RME scenarios for the duration spent at a single job for indoor and outdoor workers (U.S. EPA, 2016b). For trespassers, ED is assumed to be 10 years (U.S. EPA Region IV, 2014).
- *Averaging time (AT)* describes the number of days over which the estimated exposure is averaged. For evaluation of noncarcinogenic hazard, exposures are averaged over the duration of exposure, and so AT is equal to 365 days multiplied by the ED (i.e., 9,125 days for the indoor and outdoor worker and 3,650 days for the trespasser). For evaluation of cancer risk, exposures are averaged over a lifetime, and so AT is equal to 365 days per year multiplied by the assumed average length of a lifetime, or 70 years (i.e., 25,550 days).
- *Body weight (BW)* describes the assumed average body weight of the exposed population. For indoor office workers and outdoor maintenance workers, the BW is assumed to be 80 kg, the average adult body weight; this is equal to the U.S. EPA default for adults (U.S. EPA, 2016b). For trespassers, the assumed BW is 45 kg, the U.S. EPA default for the trespasser scenario for children ages 7-16 (U.S. EPA Region IV, 2014).
- *Skin surface area available for contact (SA)* describes the total area of skin that could come in contact with the contaminated surface. For indoor workers, this is assumed to be 2,848 cm²/contact event, equal to the 95% UCL of the mean of surface areas of the hands and forearms for an adult (U.S. EPA, 2011). For the outdoor worker, an SA of 3,535 cm²/contact event is assumed; this is equal to the 95% UCL of the mean of surface areas of the face, lower arms, and hands for male and female adults (U.S. EPA, 2011). For the trespasser, an SA of 2,533 cm²/contact event is assumed; this is equal to the 95% UCL of the mean of surface areas of the face, lower arms, and hands for children age 6-16 (U.S. EPA, 2011).
- *Fraction of available skin surface area that contacts a surface during an event (fa)* describes the fraction of the exposed skin surface area that actually contacts the contaminated surface. For indoor workers, this is assumed to be 25%, which would be equal to approximately two palms contacting the surface during each event (U.S. EPA, 1997a as cited in May et al., 2002).

- *Fraction of the skin surface area that contacted a surface that then contacts the mouth (f_{d-m})* describes the assumed area of the hand surface that contacts the mouth in a hand-to-mouth event. For indoor workers, this is assumed to be 10%, or approximately one finger; this is equal to the U.S. EPA Region III recommended default value for this scenario (U.S. EPA, 1997a as cited in May et al., 2002).
- *Contact frequency with surface (EV)* describes the number of times that an exposed person contacts the contaminated surface per exposure day. For indoor workers, this is assumed to be 3 events per 8 hour workday, equal to the default proposed by May et al. (2002) in the absence of site-specific data (U.S. EPA, 1997a as cited in May et al., 2002). For outdoor workers in contact with soil or sediment, this is assumed to be 1 event per day in which exposure occurs.
- *Relative fraction of surface concentration transferred from surface to skin ($FT_{surf-sk}$)* describes the fraction of the contamination measured in the wipe sample that is assumed to actually be transferred from the surface onto the skin when contact with the surface occurs. For indoor workers, this is assumed to be 10%, equal to the default proposed by May et al. (2002) in the absence of site-specific data (U.S. EPA, 1997a as cited in May et al., 2002).
- *Fraction of surface concentration transferred from skin to mouth (FT_{sk-m})* describes the fraction of the contamination that has been transferred to skin that is then transferred to the mouth in a hand-to-mouth contact scenario. For indoor workers, this is assumed to be 30%, equal to the default proposed by May et al. (2002) in the absence of site-specific data (U.S. EPA, 1997a as cited in May et al., 2002).
- *Inhalation rate ($InhR$)* describes the volume of air inhaled per hour. For the outdoor worker, this is assumed to be 1.6 m³/hr based on the average value for adults ages 21-51 engaged in moderate activity (U.S. EPA, 2011). For the adolescent trespasser, this is assumed to be 2.0 m³/hr, based on the average value for children ages 6-16 engaged in moderate to high activity (U.S. EPA, 2011).
- *Resuspension factor (K)* is a measure of the amount of dust expected to be resuspended into the air after a disturbance of a surface covered with contaminated dust, and is characterized as the ratio of the concentration in air (e.g., mg/m³) to the amount of contaminant per m² of surface (mg/m²), and so has units of m⁻¹. Many variables can affect this factor including whether particles were freshly deposited on the surface, the extent to which the particles are bound to the surface, the size of the particles, the type and intensity of resuspension forces, the height of measurement of the air concentration, the area over which the resuspended particulate is distributed (e.g., room size), and room ventilation (Abu-Eid et al., 2002). This value is based on the mean of measured values for resuspension factors in indoor air in five buildings undergoing decommissioning of $4.7 \times 10^{-7} \text{ m}^{-1}$ (Abu-Eid et al., 2002). Since this K value was assumed to represent resuspension from all surfaces in a building, including floors, whereas the PCB wipe samples are assumed to represent contamination originating from PCBs in glazing and caulking around windows only, this factor was divided by an additional factor of 10 to result in a value of $5 \times 10^{-8} \text{ m}^{-1}$. This value is consistent with the default K value for light industrial activity recommended by May et al. (2002) based on data from Sansone (1987).
- *Ingestion rate of soil or sediment (IR)* describes the amount of soil or sediment assumed to be incidentally ingested per day during outdoor activities. For the outdoor

worker, a soil ingestion rate of 0.00010 kg/d (100 mg/d) is assumed; this is equal to the U.S. EPA default for outdoor workers for the RME scenario (U.S. EPA, 2016b). For the trespasser, a soil ingestion rate of 0.00020 (200 mg/d) is assumed; this is equal to the U.S. EPA default for child recreators for the RME scenario (U.S. EPA, 2016b).

- *Fraction of soil contacted from a contaminated source (f_s)* describes the fraction of soil contacted that is assumed to be contaminated. For the outdoor worker, this is equal to 10% since only a small portion of the entire soil area at the Site was sampled and, based on the two sets of two samples collected outside the east wall of the Sedimentation Basin, concentrations of PCBs in soils appear to decrease with distance from the Basin wall. Soils even further from the Basins are assumed to have even lower concentrations.
- *Medium to skin adherence factor (AF)* describes how much soil or sediment is assumed to adhere to contacted skin. For the outdoor worker, this is equal to 0.060 mg/cm² based on the average of skin adherence values recorded for adults engaged in “activities with soil” including gardeners, farmers, landscapers, groundskeepers, and archeologists (U.S. EPA, 2011). For the trespasser, this is equal to 0.080 mg/cm² based on the average of skin adherence values recorded for children engaged in “activities with soil” including children playing soccer (U.S. EPA, 2011).
- *Volatilization factor (VF)* describes the emission rate of a volatile substance from a contaminated surface into air, and is chemical-specific. For PCBs, the value is equal to the VF for Aroclor 1254 of 8.43×10^5 m³/kg (U.S. EPA 2016b).
- *Particulate emission factor (PEF)* describes the emission rate of particulates from soil into the air. A PEF of 1.40×10^9 m³/kg is assumed, equal to the U.S. EPA default value for particulate emissions from soil (U.S. EPA, 2016b).

3.3.4 Chemical-Specific Uptake Factors

Chemical-specific uptake factors are used to estimate absorption of chemicals into tissue. For this health Risk Assessment, uptake factors were identified from U.S. EPA guidance documents and the scientific literature, as appropriate. Uptake factors used in the health Risk Assessment include:

- *Relative gastrointestinal absorption factor (GAF)* describes the amount of a chemical that is assumed to be absorbed following ingestion of a contaminated medium, relative to the rate of absorption associated with the toxicity study upon which the toxicity criterion for a chemical is based. For PCBs, the cancer toxicity criteria used in this assessment are based on studies in rats in which PCBs were administered in the diet (i.e., Aroclor 1260 mixed with corn oil, added to ground chow diet; Norback and Weltman, 1985; U.S. EPA, 1989b). The noncancer toxicity criteria are based on studies in which monkeys were delivered Aroclor 1254 by gelatin capsule. In the absence of other data, the bioavailability of PCBs in soil or sediment is assumed to be similar to what it was in the toxicity studies, and so a value for GAF of 100% is assumed in this assessment.
- *Dermal absorption factor (DAF)* describes the amount of a chemical that is assumed to be absorbed across the skin following dermal contact with a contaminated medium. For PCBs, a value of 14% is assumed based on dermal

absorption observed in rhesus monkeys exposed to soil containing 44 ppm Aroclor 1242 or 23 ppm Aroclor 1254 for 24 hours (Wester et al., 1993 as cited in U.S. EPA, 1996).

Chemical-specific uptake factors used in this health Risk Assessment are summarized in Table A-14.

3.4 Derivation of Dose Estimates and Exposure Concentrations

For each exposure population, doses or exposure concentrations were estimated for each pathway. For all ingestion and dermal contact pathways, and for evaluation of noncancer hazards associated with inhalation, doses are presented in units of milligrams per kilogram body weight per day (mg/kg-d). Noncarcinogenic effects are evaluated by averaging doses over one year to yield average daily doses (ADDs). Cancer risk is evaluated by averaging doses over a lifetime (assumed to be 70 years) to yield lifetime average daily doses (LADDs). These dose estimates are compared to reference doses for noncarcinogens and cancer slope factors for carcinogens as described in Section 4.0.

For evaluation of carcinogenic risks associated with inhalation, lifetime average daily exposure concentrations in air are calculated (in units of $\mu\text{g}/\text{m}^3$). Cancer risks are then estimated by multiplying these concentrations by unit risk values for PCBs in air (in units of $(\mu\text{g}/\text{m}^3)^{-1}$) as described in Section 4.0.

3.5 Exposure Assessment Uncertainties

Exposure parameters used in this health Risk Assessment are based primarily on default values compiled by U.S. EPA or other estimates that represent upperbound estimates of exposure for a given population. When these parameters are multiplied together, the resulting doses are expected to overestimate actual exposures to individuals who were or are exposed to contaminants at the Site. This is particularly true since the potential for contact with most of the media evaluated in this assessment is extremely limited.

This Risk Assessment assumes that PCBs in ingested soil or sediment are as likely to be absorbed into the systemic circulation following ingestion in soil or sediment as they are in the studies upon which the toxicity criteria for these chemicals are based. The toxicity criteria for PCBs are based on PCBs that were administered to laboratory animals in diet; compared to PCBs in the diet, it is likely that PCBs present in soil or sediment will be less bioavailable as they will likely be more tightly bound to particles such that a smaller fraction of the total ingested dose is absorbed into the circulation. Thus, assuming 100% bioavailability likely overestimates exposures for ingestion pathways.

4.0 TOXICITY ASSESSMENT

The goal of the Toxicity Assessment step is to characterize the toxicity of the COPCs and identify quantitative toxicity criteria for each chemical, for use in evaluating the likelihood of adverse health effects from estimated exposures.

4.1 Types of Toxicity Criteria

Availability of the following types of toxicity criteria was determined for each of the COPCs:

- U.S. EPA reference doses (RfDs) or reference concentrations (RfCs) for evaluation of noncarcinogenic effects; and
- U.S. EPA slope factors (SFs) or unit risks (URs) for evaluation of cancer risks.

The approach used by the U.S. EPA and other regulatory agencies to assess risks associated with noncarcinogenic effects is to identify an exposure threshold below which adverse effects are not observed. The first adverse effect that occurs as the dose or concentration increases beyond the threshold is called the “critical effect” (U.S. EPA, 2002b). Selection of regulatory levels for noncarcinogenic effects is based on the assumption that if the critical effect is prevented, then all toxic effects are prevented. For evaluation of noncarcinogenic effects from ingestion or dermal contact, U.S. EPA has established RfDs, which are estimates (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (U.S. EPA, 2002b; U.S. EPA, 2016e). For evaluation of noncarcinogenic effects from inhalation, U.S. EPA establishes RfCs, which are estimates (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (U.S. EPA, 2002b; U.S. EPA, 2016e).

U.S. EPA typically derives RfDs and RfCs from threshold doses based on No Observed Adverse Effect Levels (NOAELs), Lowest Observed Adverse Effect Levels (LOAELs), or benchmark doses, for noncarcinogenic endpoints such as effects on reproduction, developmental effects, learning deficits, or immunological effects. A NOAEL is the highest dose in a given study at which no statistically or biologically significant indication of the toxic effect of concern has been identified, while a LOAEL is the lowest dose at which the toxic dose has been identified. NOAELs and LOAELs are typically established from studies in animals or from worker exposure studies. Since there are limitations inherent in these data for determining risks associated with exposure to diverse human populations, these threshold doses are divided by uncertainty factors to develop RfDs.

U.S. EPA evaluates cancer risks based on extrapolations from estimates of the increase in cancer incidence associated with exposure to specific doses or concentrations of the substance in animal or worker exposure studies. To evaluate cancer risk from ingestion or

dermal contact, U.S. EPA has developed cancer slope factors (SFs), which are upperbounds, approximating 95% confidence limits, on the increased cancer risk from a lifetime exposure to a unit dose of an agent. (U.S. EPA, 2016f). SFs are usually expressed in units of proportion (of a population) assumed to be affected per mg/kg-day $((\text{mg}/\text{kg}\cdot\text{d})^{-1})$. To evaluate cancer risk from inhalation, U.S. EPA has developed unit risk (UR) values, which are upperbound estimates of the excess lifetime cancer risk resulting from continuous exposure to an agent over a lifetime at a concentration of $1 \mu\text{g}/\text{m}^3$ in air. URs are usually expressed in units of proportion (of a population) assumed to be affected per $\mu\text{g}/\text{m}^3$ (i.e., $(\mu\text{g}/\text{m}^3)^{-1}$). Both SFs and URs are generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100 (U.S. EPA, 2002b).

4.2 Sources of Toxicity Criteria

For purposes of this Risk Assessment, toxicity criteria were identified according to the following hierarchy of sources:

- *U.S. EPA's Integrated Risk Information System (IRIS) database* (U.S. EPA, 2016d). This database was the primary source of toxicity criteria for this health Risk Assessment. The IRIS database includes verified RfDs and SFs developed by the U.S. EPA, as well as information on the derivation of these values, and is regularly reviewed and updated. Consistent with U.S. EPA risk assessment guidance (U.S. EPA, 1989a), information in IRIS was assumed to supersede all other sources. The oral RfD, inhalation UR, and oral SF for PCBs were taken from IRIS.
- *U.S. EPA's Regional Screening Levels (RSL) Tables*. This table (U.S. EPA, 2016b) provides risk-based screening levels that are based largely on U.S. EPA RfDs and SFs compiled from the IRIS database. Since toxicity criteria are often withdrawn from the IRIS database for review, these tables also include withdrawn U.S. EPA toxicity values published in earlier versions of IRIS or in U.S. EPA's Health Effects Assessment Summary Table (HEAST), in order to avoid exclusion of chemicals due to a lack of toxicity criteria. In the event that a toxicity criterion was not listed in IRIS for a COPC but was listed in the RSL tables, the criterion listed in the RSL tables would be used in this Risk Assessment. However, no values from this source were used in this assessment.

Toxicity criteria used in this Risk Assessment are presented in Table A-15.

4.3 Evaluation of PCB Toxicity

PCB concentrations can be presented either as specific congeners or as Aroclor mixtures. The term “congener” refers to specific PCB compounds distinguished by the number and arrangement of chlorine atoms bound to the molecule's 10 carbon atoms, while “Aroclor” is the tradename for commercial mixtures of congeners that were manufactured in the United States. Aroclors (Aroclors 1016, 1232, 1242, 1248, 1254, and 1260) have been detected in one or more sampled media at the Site; no sampling for specific congeners was conducted.

U.S. EPA has published noncancer RfDs for two Aroclors, Aroclor 1016 and Aroclor 1254, based on reproductive effects (reduced birth weight) in monkeys administered Aroclor 1016 (in feed) and immunologic effects in monkeys administered Aroclor 1254 (in gelatin capsules). The value for Aroclor 1254 (0.00002 mg/kg-d) (U.S. EPA, 1994) is lower than the value for Aroclor 1016 (0.00007 mg/kg-d) (U.S. EPA, 1993) and hence is more conservative. Also, Aroclor 1254 was detected more frequently in the media of interest and typically at greater concentrations (see Tables 6 and 9). Consequently, the RfD for Aroclor 1254 was used in this assessment to evaluate potential noncancer hazards from exposure to Total Aroclor. The U.S. EPA has not established any inhalation RfCs for PCBs or individual Aroclors. Therefore, for evaluation of noncancer hazards for the inhalation route, exposure was calculated as the total inhaled dose in mg/kg-d, and compared to the oral RfD (the rate of absorption from inhaled particles was assumed to be the same as the exposure that is the basis for the RfD).

Overall, human studies provide inadequate to limited evidence of carcinogenicity of PCBs, but studies in animals have been interpreted as providing sufficient evidence of carcinogenicity. Based on these findings, some commercial PCB mixtures have been characterized as probably carcinogenic to humans, although U.S. EPA has stated, “there has been some controversy about how this conclusion applies to PCB mixtures found in the environment” (U.S. EPA, 1996).

Studies have demonstrated that the range of cancer potency for different PCB mixtures is influenced by the chlorine content, with congeners with higher chlorine content having higher toxicity. In addition, congeners with higher chlorine content tend to be more persistent. Congeners present in soil and sediment or that have bioaccumulated (*e.g.*, in fish) tend to be highest in chlorine content and persistence (U.S. EPA, 1996). In addition, certain population groups including children may be more susceptible to health effects from exposure to PCB mixtures. Since the actual composition of PCB mixtures in the environment is uncertain and the toxicity of mixtures can vary, U.S. EPA recommends using a tiered approach to evaluate the cancer potency of PCB mixtures in the environment (U.S. EPA, 1996, 2016d). According to this approach, cancer slope factors for application to a particular exposure scenario are selected based on information about exposed populations, potential pathways of exposure, and the likely environmental persistence of the particular PCB mixture.

In their tiered approach for evaluation of PCB mixtures, U.S. EPA (1996) recommends the following:

- To evaluate food chain, sediment or soil, dermal, dust or aerosol inhalation, and early life exposures, or exposures to dioxin-like, tumor-promoting, or persistent congeners (*i.e.*, “high risk and persistence” exposures), use an upperbound SF of 2.0 (mg/kg-d)⁻¹ and a central-estimate SF of 1.0 (mg/kg-d)⁻¹ (U.S. EPA, 1996);

- To evaluate adult ingestion of water-soluble congeners or inhalation of evaporated (volatile) congeners (*i.e.*, “low risk and persistence” exposure), use an upperbound SF of $0.4 \text{ (mg/kg-d)}^{-1}$ and a central estimate SF of $0.3 \text{ (mg/kg-d)}^{-1}$, or an upperbound unit risk value (for inhalation) of $1 \times 10^{-4} \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ (U.S. EPA, 1996).

These estimates of toxicity are based on a study in which PCBs were administered to female Sprague-Dawley rats in the diet (specifically, Aroclor 1260 mixed with corn oil and added to ground chow diet) and increases in liver hepatocellular adenomas, carcinomas, cholangiomas, or cholangiocarcinomas were seen (Norback and Weltman, 1985; U.S. EPA, 1989b). Because of human variability and uncertainty in the environmental mixture composition, the upperbound SFs are recommended in most cases to ensure risk estimates are conservative. The central estimate SFs may be an appropriate when site characteristics are known in great enough detail.

Based on these recommendations, the upperbound SF for “high risk and persistence” exposure to PCBs (U.S. EPA, 2016d) was used in this Risk Assessment to evaluate exposures via ingestion, dermal contact, and inhalation of dust. The upperbound UR for “low risk and persistence” was used to evaluate exposures via inhalation of volatilized PCBs.

4.4 Route-to-Route Extrapolation of Reference Doses and Slope Factors

Because the U.S. EPA has not promulgated dermal toxicity values for most chemicals, oral RfDs and SFs were modified using gastrointestinal absorption data to evaluate exposures to chemicals via the dermal route. Since the intake equations for the dermal routes presented in Section 3.2 generate estimates of absorbed dose, and oral toxicity criteria are generally based on administered dose, dermally absorbed doses were calculated by adjusting the oral toxicity criteria based on the oral absorption rate (represented by the gastrointestinal absorption factor or GAF).

To adjust an administered dose RfD to an absorbed dose (dermal) RfD, the following equation is used:

$$RfD_{adm} \times \text{Oral absorption rate (GAF)} = RfD_{abs}$$

To adjust an administered dose slope factor to an absorbed dose (dermal) slope factor, the following equation is used:

$$\frac{SF_{adm}}{\text{Oral absorption rate (GAF)}} = SF_{abs}$$

GAFs used in this Risk Assessment are presented in Table A-14.

4.5 Toxicity Assessment Uncertainties

A number of uncertainties are evident in the toxicity criteria used in this Risk Assessment to evaluate the likelihood of adverse health effects from exposure to chemical contaminants. In particular, the toxicity criteria are based on observations of adverse health effects in animals exposed to very high concentrations of chemicals in the diet or water. Because of differences between the exposures that are the basis for these criteria and exposures evaluated in this Risk Assessment, these criteria may under- or overestimate, but most likely overestimate, actual risks to people from exposure to lower concentrations in environmental media.

In this assessment, risks from exposure to PCBs are evaluated based on concentrations of Aroclor mixtures measured in soil, sediment, or wipe samples. However, Aroclors are commercial mixtures of PCB congeners and, once released to the environment, the composition of these mixtures can change due to differences in partitioning, chemical transformation, and bioaccumulation of the different congeners in the mixture (U.S. EPA, 1996). Thus, concentrations of PCBs estimated based on Aroclor mixtures can be imprecise, and estimated concentrations may over- or underestimate actual concentrations of total PCBs that are present. Further, congeners vary in toxicity, and since data on Aroclor toxicity are based on the commercial mixtures rather than the mixtures that are present in the environment, toxicity estimates based on commercial Aroclors may under- or over-estimate risks for the mixture of PCB congeners present in the environment. However, U.S. EPA's tiered approach for evaluating the toxicity of PCBs in the environment based on the assumed pathways of exposure to PCBs and the relative persistence of PCBs likely to be present in different environmental media is intended to provide a conservative estimate of the potential toxicity of PCB mixtures in the environment.

5.0 RISK CHARACTERIZATION

In the Risk Characterization section, the results of the toxicity and exposure assessments are integrated to develop quantitative measures of the potential for adverse health effects. Specifically, dose estimates are compared to quantitative toxicity criteria to provide a quantitative measure of the likelihood of noncarcinogenic effects or lifetime excess cancer risk.

5.1 Noncarcinogenic Effects

The potential for noncarcinogenic effects was evaluated using the Hazard Index (HI) approach. This approach assumes that simultaneous subthreshold exposures to several chemicals could result in an adverse health effect, and that the magnitude of the adverse effect is proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures (U.S. EPA, 1989a).

The HI is equal to the sum of Hazard Quotients (HQs) calculated for each chemical- and pathway-specific dose. HQs are calculated by dividing the estimated ADD for each chemical and pathway by the appropriate RfD for that chemical and pathway, using the following equation:

$$HQ = \frac{ADD \text{ (mg / kg - d)}}{RfD \text{ (mg / kg - d)}}$$

Then, HQs for each pathway are summed to obtain an HI for each pathway. Pathway-specific HIs are summed to obtain an HI for each population and scenario. However, since only one chemical (PCBs) was evaluated in this assessment, summing HQs for multiple chemicals for each pathway was not necessary.

According to U.S. EPA (1989a) guidance, if the resulting HI is below unity (1), then adverse health effects are not expected. However, because of the multiple conservative assumptions incorporated into the evaluation, if an HI is equal to or exceeds 1, it does not mean that adverse health effects are expected or will occur.

5.2 Cancer Risks

Pathway-specific excess cancer risks for exposure to COPCs are calculated by multiplying each LADD estimate by the chemical- and pathway-specific SF, using the following equation:

$$\text{Excess Cancer Risk} = LADD \text{ (mg / kg - d)} \times SF \text{ (mg / kg - d)}^{-1}$$

For evaluation of lifetime average concentrations in air, excess cancer risks are calculated as follows:

$$\text{Excess Cancer Risk} = \text{Lifetime Average Air Concentration} (\mu\text{g}/\text{m}^3) \times \text{UR} (\mu\text{g}/\text{m}^3)^{-1}$$

Similar to the HQ calculation, the chemical-specific excess cancer risks are summed to obtain a total lifetime excess cancer risk value for each pathway, and these pathway-specific cancer risks are summed to estimate lifetime excess cancer risks for each population and scenario.

Cancer risk is presented as the probability of cancer occurring as the result of an exposure. Lifetime excess cancer risk is defined as the additional or extra cancer risk incurred over the lifetime of an individual as a result of exposure to a toxic substance (U.S. EPA, 1989a). To elaborate, the average U.S. citizen has an approximately 40% chance (0.400000) of being diagnosed with cancer at some point in his or her lifetime (NIH-NCI, 2015). If the result of a cancer risk analysis estimates a 1 in a million (0.000001, also written as 1E-06 or 1×10^{-6}) excess cancer risk, the total cancer risk to an exposed individual over a lifetime would be 0.400001. Or, conversely, if the estimated excess cancer risk is 1 in a million, then in an exposed population of one million people, an upperbound of one additional cancer due to the exposure would be expected.

Although there is no universally accepted acceptable risk standard, the U.S. EPA Superfund program established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) generally considers risks above 1×10^{-6} (1 in 1,000,000) (i.e., *de minimis* risks) to be acceptable in nearly all circumstances and risks within the range of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000) to be acceptable depending on specific site and exposure characteristics (U.S. EPA, 1989a; U.S. EPA, 1991b). The National Contingency Plan (U.S. EPA, 1990), which provides the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants under CERCLA, defines the 1×10^{-6} (1 in a million) risk level as the “point of departure” for establishing remediation goals at contaminated sites. Risks above 1×10^{-4} are nearly always considered to be unacceptable. More specific acceptable risk levels have been identified for certain circumstances. For example, under U.S. EPA’s Great Lakes Initiative (U.S. EPA, 1995), a 1×10^{-5} (1 in 100,000) risk level is defined as acceptable for use in deriving criteria and limit values for individual carcinogens in Great Lakes surface water and fish.

5.3 Results

The results of this Risk Assessment are presented in Tables A-16 and A-17 for noncancer hazard and cancer risk, respectively. Appendix C provides the detailed risk calculations and results. Results for each scenario are summarized below.

5.3.1 Indoor Worker Results

As shown in Table A-16, the estimated noncancer hazard quotient for the indoor worker scenario, assuming contact with PCBs in dust on window sills or other surfaces, is 3.1.

Approximately 82% of this estimated hazard is associated with dermal contact, while 18% is associated with incidental ingestion. Estimated hazards from inhalation are lower. The hazard quotient exceeds 1.0, indicating that noncancer hazards for the indoor worker scenario could be significant based on the highly conservative assumptions used in this Risk Assessment.

As shown in Table A-17, the total estimated lifetime excess cancer risk for the indoor worker scenario is 4.5×10^{-5} . Like the noncancer estimates, approximately 82% of this risk is associated with dermal absorption following contact, while 18% is associated with incidental ingestion. Estimated risks from inhalation are lower. These risks are within U.S. EPA's acceptable risk range (i.e., 10^{-4} to 10^{-6}) (U.S. EPA, 1991b).

These estimates of health risks for the indoor worker scenario are likely overestimated since they assume a person could have come in direct contact with PCB-contaminated dust on surfaces three times per day every working day (250 days per year) for a working lifetime (25 years), and that the person engaged in hand-to-mouth contact behaviors each of these times. If instead one assumes that a worker contacted these surfaces 1 time per day on three days per week (150 days per year) for a 9 year working exposure duration, the estimated risk to the indoor worker is 3.2×10^{-6} and the noncancer hazard (0.23) is less than 1.0. Further, the total PCB Aroclor wipe sample concentration used in the calculations is the 95% UCL of the mean of all samples collected in the Administration Building ($20.2 \mu\text{g}/100 \text{ cm}^2$). These samples were collected from visibly dusty surfaces long after regular occupation of the building by WTP staff was discontinued. During active operation of the Administration Building, normal housekeeping (e.g., dusting, wiping down surfaces, vacuuming) would have resulted in significantly less dust accumulation and consequently significantly lower concentrations of PCBs on surfaces and correspondingly lower risks. For example, if it is assumed that the average PCB concentrations on the surfaces was 10 times lower, the estimated cancer risk is 4.5×10^{-6} and the noncancer hazard is 0.31. If the above alternative assumptions about less frequent exposure are also incorporated, the cancer risk estimate is 3.2×10^{-7} and the noncancer hazard is 0.023.

5.3.2 Outdoor Worker Results

As shown in Table A-16, the estimated noncancer hazard quotient for the outdoor worker scenario, assuming contact with PCBs in soil and infrequent (quarterly) contact with sediments in the Sedimentation Basin, Clearwell, and Wastewell, is 1.9. Nearly all of this estimated hazard is contributed by assumed contact with sediments in the Sedimentation Basin—the estimated hazard associated with contact with this medium is 1.9. The hazard quotient exceeds 1.0 indicating that noncancer hazards for the outdoor worker scenario could be significant based on the highly conservative assumptions used in this Risk Assessment.

As shown in Table A-17, the total estimated lifetime excess cancer risk for the outdoor worker scenario is 2.6×10^{-5} . The majority of this risk (98%) is contributed by assumed contact with sediments in the Sedimentation Basin—the estimated risk associated with

contact with this medium is 2.5×10^{-5} . This risk is within U.S. EPA's acceptable risk range (i.e., 10^{-4} to 10^{-6}) (U.S. EPA, 1991b). Estimated risks for the outdoor worker scenario associated with contact with all other media considered in this assessment, including contact with soil and contact with sediment from other sources, are below 10^{-6} .

These estimates of health risks are likely overestimated since they assume a person could have come in direct contact with PCB-containing sediment from the Sedimentation Basin quarterly (four times per year) for a working lifetime (25 years). Further, because the variability in sample concentrations resulted in a skewed estimate of the upperbound sediment concentration (i.e., the calculated 95% UCL concentration exceeded the maximum measured concentration), the estimated total PCB Aroclor concentration used in the risk calculations is the maximum concentration measured in all samples from this medium (1,900 mg/kg). Of the 10 collected samples, one other sample had a concentration of 1,800 mg/kg, but the other concentrations were much lower (four samples had total PCB Aroclor concentrations ranging from 0.25 to 6.1 mg/kg, and four samples had nondetectable levels (<0.2 mg/kg)). Thus it is likely that if sediment in the Sedimentation Basin was contacted, average concentrations would have been much lower. Further, it is likely that during active operation of the facility, the potential for contact with these sediments would have been limited as they would have been submerged most of the time. As indicated, PCBs were not detected in any of the drinking water samples, and so no exposure to PCBs in water is assumed to have occurred.

5.3.3 Trespasser Results

As shown in Table A-16, the estimated noncancer hazard quotient for the adolescent trespasser scenario, assuming contact with PCBs in soil, is 0.034. The hazard quotient is below 1.0 and thus estimated noncancer hazards are for this scenario are not significant.

As shown in Table A-17, the estimated lifetime excess cancer risk for this scenario is 1.9×10^{-7} . This risk estimate is below U.S. EPA's *de minimis* risk level of 10^{-6} , indicating no significant risk for this scenario. This scenario is highly conservative as it assumes an adolescent could have trespassed on the site 10 times per year for 10 years.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this Risk Assessment for the out-of-service Anacortes WTP address possible exposure risks to individuals who could have come in contact with contaminants in building materials and other features associated with the Site. Based on the methods and assumptions described in this report, the following observations were made:

- Based on detected concentrations of PCBs in wipe samples collected from window sills in the Administration Building after the building had been vacated by workers, the estimated upperbound lifetime excess cancer risk to an office worker assumed to have repeatedly contacted dusty surfaces daily through their working lifetime is 4.5×10^{-5} , and the estimated noncancer hazard quotient (3.1) exceeds 1.0. However, cancer risks and noncancer hazards to individuals who contacted these surfaces less frequently would have been lower.

For example, this assessment assumes that a person contacted the contaminated surfaces 3 times per day for 250 days per year for a working lifetime (25 years). If instead one assumes that a worker contacted these surfaces 1 time per day on three days per week (150 days per year) for a 9 year working exposure duration, the estimated risk to the indoor worker is 3.2×10^{-6} and the noncancer hazard (0.23) is less than 1.0.

Further, these risks are based on samples that were collected from visibly dusty surfaces in the Administration Building long after regular occupation by WTP staff ceased. During active operation, it is likely that normal housekeeping (e.g., dusting, wiping surfaces, vacuuming) would have resulted in significantly lower concentrations and correspondingly lower risks. For example, if it is assumed that the average PCB concentrations on the surfaces was 10 times lower, the estimated cancer risk is 4.5×10^{-6} and the noncancer hazard is 0.31. If the above alternative exposure assumptions are also incorporated, the cancer risk estimate is 3.2×10^{-7} and the noncancer hazard is 0.023.

- Based on detected concentrations of PCBs in soil near the basins and in sediments inside the Sedimentation Basin, Clearwell, and Wastewell, the estimated upperbound lifetime excess cancer risks to an outdoor maintenance worker or contractor who contacted the soil and intermittently contacted sediment from the basins throughout their working lifetime is 2.6×10^{-5} , and the estimated noncancer hazard quotient (1.9) exceeds 1.0. However, cancer risks and noncancer hazards to individuals who contacted these materials less frequently would have been lower, and these risks estimates are largely based on high concentrations detected in two samples of sediment from the Sedimentation Basin. More typical concentrations would likely be lower. Further, the potential for workers to have contacted these sediments would have been limited since the sediments were likely submerged most of the time. In addition, as described previously, routine water sampling conducted in accordance with the SDWA did not detect PCBs.
- Based on detected concentrations of PCBs in soil, estimated upperbound lifetime excess cancer risks to adolescent trespassers who contacted the soil are below U.S. EPA's *de minimis* risk level of 10^{-6} , and the estimated noncancer hazard quotient is below 1.0. Thus, estimated risks for this population are insignificant.

In conclusion, it is our opinion that no adverse health effects are likely to have occurred to customers, workers, or trespassers at the WTP based on exposure to COPCs. Future demolition or deconstruction activities will need to be performed according to health and safety protocols to ensure no health risks to workers and to ensure proper disposal in accordance with regulatory requirements. No additional protective measures are required at this time in advance of future demolition and deconstruction activities.

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APPENDIX A
REPORT TABLES

Table A-1. Summary of Detections in the January 2015 DLH Hazardous Materials Assessment^a

Type	Location	PCBs ^b	PAHs ^c	Lead and arsenic
Concrete	Filtration Basin, interior wall (n = 1)	Aroclor 1254 = 130 mg/kg All others, ND at <20 mg/kg Total PCBs = 130 mg/kg	Phenanthrene = 0.023 mg/kg All others, ND at <0.01 mg/kg	Pb: 20.3 mg/kg As: 30.9 mg/kg
Concrete	Filtration Basin, exterior wall (n = 1)	Aroclor 1254 = 1,300 mg/kg Aroclor 1260 = 1,200 mg/kg Aroclor 1262 = 1,400 mg/kg All others, ND at <60 mg/kg Total PCBs = 3,900 mg/kg	Benzo(b)fluoranthene = 0.68 mg/kg All others, ND at <0.5 mg/kg	Pb: 8.43 mg/kg As: 11.6 mg/kg
Concrete	Sedimentation Basin, interior wall (n = 1)	Aroclor 1254 = 540 mg/kg All others, ND at <20 mg/kg Total PCBs = 540 mg/kg	All, ND at <0.1 mg/kg	Pb: 23.2 mg/kg As: 40.5 mg/kg
Concrete	Clearwell, interior wall (n = 1)	Aroclor 1254 = 1.4 mg/kg All others, ND at <0.2 mg/kg Total PCBs = 1.4 mg/kg	All, ND at <0.01 mg/kg	Pb: 18.7 mg/kg As: 56.9 mg/kg
Soil	Exterior of Sedimentation Basin (n = 1)	Aroclor 1254 = 11 mg/kg Aroclor 1260 = 10 mg/kg Aroclor 1262 = 12 mg/kg All others, ND at <0.2 mg/kg Total PCBs = 33 mg/kg	Acenaphthylene = 0.40 mg/kg Fluorene = 0.15 mg/kg Phenanthrene = 1.0 mg/kg Anthracene = 0.26 mg/kg Fluoranthene = 1.2 mg/kg Pyrene = 1.1 mg/kg Benz(a)anthracene = 0.62 mg/kg Chrysene = 0.61 mg/kg Benzo(a)pyrene = 0.60 mg/kg Benzo(b)fluoranthene = 0.74 mg/kg Benzo(k)fluoranthene = 0.19 mg/kg Indeno(1,2,3-cd)pyrene = 0.34 mg/kg Dibenz(a,h)anthracene = 0.087 mg/kg Benzo(g,h,i)perylene = 0.30 mg/kg PAH TEM level = 0.8299 mg/kg	NA
Paint	Administration Building (n = 8)	NA	NA	Freq. of Det. = 6/8 (Range: <10- 21,800 mg/kg)
Paint	Filtration Basin (exterior wall) (n = 1)	NA	NA	Freq. of Det. = 0/1 (<10 mg/kg)

As – Arsenic; NA – Not analyzed; ND – Not detected; PAH – Polycyclic aromatic hydrocarbon; Pb – Lead; PCB – Polychlorinated biphenyl; TEM – Toxicity equivalency methodology

a Analytes and concentrations in excess of MTCA Method A cleanup levels for unrestricted land use are bolded.

b Analyzed compounds included: Aroclor 1221, Aroclor 1232, Aroclor 1016, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262

c Analyzed compounds included: naphthalene, acenaphthylene, acenaphthene, fluorine, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene

Table A-2. Summary of Data Collected During the 2015-2016 Remedial Investigation of the Former Anacortes WTP

Medium and Location	Description	Number of Samples				
		PCBs	Total Metals	TCLP Metals	VOCs	SVOCs
2015 Remedial Investigation						
Interior Basin Sediment and Filter Media						
Sedimentation Basin Sediment/ Trough	20 bays	10	2	2	2	2
Clearwell Sediment	~5 chambers	6	1	1	1	1
Wastewell Sediment	100' long; 20' wide	2	1	1	1	1
Filtration Basin Anthracite Media	6 bays	6	1	0	1	1
Filtration Basin Filter Media Sand	6 bays	6	1	0	1	1
Filtration Basin Gravel (or brick/block) Bed	6 bays	6	1	0	1	1
Coatings						
Sedimentation Basin Coating - Exterior	240' × 82'; 2 layers coating	8	2	2	2	2
Sedimentation Basin Coating - Interior	Coating only on troughs; thin coat	2	0	0	0	0
Sedimentation Basin Paint	---	0	1	0	0	0
Filtration Basin Coating - Exterior	100' × 92'; 2 layers coating	4	1	0	1	1
Filtration Basin Coating - Interior	6 bays; no access to bottom of bays	6	1	0	1	1
Filtration Basin Paint	---	0	2	0	0	0
Concrete						
Sedimentation Basin Concrete	20 bays	40	2	2	2	2
Filtration Basin Concrete	6 bays	6	1	0	1	1
Filtration Basin Pipe Gallery Concrete	100' long; 20' wide	2	1	1	1	1
Clearwell Concrete	~5 chambers	10	1	1	1	1
Wastewell Concrete	100' long; 20' wide	6	1	1	1	1
Other Basin Building Materials						
Sedimentation Basin Expansion Joint Sealant	1 joint full width	10	1	1	1	1
Sedimentation Basin Expansion Joint Cork	1 joint full width	4	1	1	1	1
Sedimentation Basin Joint Caulk	Caulk applied at joints	3	0	0	0	0
Clearwell Redwood Baffles	6 baffles	3	1	1	1	1
Sedimentation Basin Fiberglass Collector Boards	Non-porous; wipe samples	2	0	0	0	0
Sedimentation Basin Steel Agitator Blades	Non-porous; wipe samples	2	0	0	0	0
Filtration Basin Fiberglass Troughs	Non-porous; wipe samples	6	0	0	0	0

Medium and Location	Description	Number of Samples				
		PCBs	Total Metals	TCLP Metals	VOCs	SVOCs
Administration Building Samples						
Admin Bldg Window Wipes	Walls/Floor & pump room	3	0	0	0	0
Admin Bldg Window Caulk/Glaze	27 windows	10	0	0	0	0
Admin Bldg Paint Chips	Chip samples	1	1	4	0	0
2016 Data Gap Investigation						
Soil						
Sedimentation Basin Soil 0"-12"	Geoprobe sample	10	0	0	0	0
Sedimentation Basin Soil 12"-36"	Geoprobe sample	10	0	0	0	0
Filtration Basin Soil 0"-12"	Geoprobe sample	6	0	0	0	0
Filtration Basin Soil 12"-36"	Geoprobe sample	6	0	0	0	0
Sediment						
Clearwell Sediment-Wet from Pump well	High TSS water	2	0	0	0	0
Clearwell Sediment-Dry	Above water, semi-solid	4	0	0	0	0
Settling Lagoon Sediment	Grab sample from 2 inactive lagoons	4	0	0	0	0
Subgrade Mastic Coatings						
Sedimentation Basin Below Grade Mastic Coating	Grab sample below grade	2	0	0	0	0
Filtration Basin Below Grade Mastic Coating	Grab sample below grade	1	0	0	0	0
Clearwell Below Grade Mastic Coating	Grab sample below grade	1	0	0	0	0
Groundwater						
Sedimentation Basin Groundwater	Geoprobe sample during low flow	9	0	0	0	0
Sedimentation Basin Downgradient Well	Geoprobe sample toward river	1	0	0	0	0
Filtration Basin Groundwater	Geoprobe sample during low flow	4	0	0	0	0
Administration Building Samples						
Admin Bldg Window Wipes	Walls/Floor & pump room	12	0	0	0	0
Total # of samples		236	24	18	20	20

PCBs – Polychlorinated biphenyls; SVOCs – Semi-volatile organic compounds; TCLP – Toxicity characteristic leaching procedure; TSS – Total suspended solids; VOCs – Volatile organic compounds

Table A-3. Summary of Sampling Results for PCBs: Frequency of Detection and Range of Concentrations (mg/kg, unless otherwise noted)*

Medium and Location	Aroclor 1221	Aroclor 1232	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
Soil								
Sedimentation Basin Soil 0"-12"	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	5/10 (<0.2-3.3)	5/10 (<0.2-3.5)	5/10 (<0.2-6.8)
Sedimentation Basin Soil 12"-36"	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	2/10 (<0.2-0.28)	1/10 (<0.2-0.29)	2/10 (<0.2-0.57)
Filtration Basin Soil 0"-12"	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	5/6 (<0.2-6.9)	5/6 (<0.2-8.7)	5/6 (<0.2-15.6)
Filtration Basin Soil 12"-36"	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	2/6 (<0.2-0.33)	1/6 (<0.2-0.24)	2/6 (<0.2-0.57)
Interior Basin Sediment and Filter Media								
Sedimentation Basin Sediment	0/8 (<0.2)	0/8 (<0.2)	0/8 (<0.2)	0/8 (<0.2)	0/8 (<0.2)	4/8 (<0.2-6.1)	0/8 (<0.2)	4/8 (<0.2-6.1)
Sedimentation Basin Sediment-Trough	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	2/2 (1,800-1,900)	0/2 (<10-<200)	2/2 (1,800-1,900)
Clearwell Sediment (Initial Investigation)	0/6 (<0.2)	0/6 (<0.2)	6/6 (0.38-7.3)	0/6 (<0.2)	0/6 (<0.2)	5/6 (<0.2-5.6)	0/6 (<0.2)	6/6 (5.1-11.0)
Clearwell Sediment-Dry (Gap Investigation)	0/4 (<0.4)	0/4 (<0.4)	0/4 (<0.4)	0/4 (<0.4)	0/4 (<0.4)	4/4 (0.67-2.8)	0/4 (<0.4)	4/4 (0.67-2.8)
Clearwell Sediment-Wet from Pump well (mg/L) (Gap Investigation)	0/2 (<0.00001)	0/2 (<0.00001)	0/2 (<0.00001)	0/2 (<0.00001)	2/2 (0.00071-0.00085)	2/2 (0.00032-0.00068)	0/2 (<0.00001)	2/2 (0.00100-0.00156)
Wastewell Sediment	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	3/4 (<0.2-3.4)	0/4 (<0.2)	3/4 (<0.2-3.4)
Filtration Basin Filter Media Anthracite	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)
Filtration Basin Filter Media Sand	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)
Filtration Basin Gravel (or brick/block) Bed	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	1/6 (<0.2-0.22)	0/6 (<0.2)	1/6 (<0.2-0.22)
Settling Lagoon Sediment								
Settling Lagoon Sediment	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)
Coatings								
Sedimentation Basin Coating - Exterior	0/8 (<100-<500)	0/8 (<100-<500)	0/8 (<100-<500)	0/8 (<100-<500)	0/8 (<100-<500)	8/8 (6,000-18,000)	8/8 (4,400-16,000)	8/8 (10,400-34,000)
Sedimentation Basin Coating - Interior	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	2/2 (1,600-20,000)	0/2 (<10-<200)	2/2 (1,600-20,000)
Filtration Basin Coating - Exterior	0/4 (<100-<1,000)	0/4 (<100-<1,000)	0/4 (<100-<1,000)	0/4 (<100-<1,000)	0/4 (<100-<1,000)	4/4 (14,000-20,000)	4/4 (11,000-15,000)	4/4 (25,000-35,000)
Filtration Basin Coating - Interior	0/6 (<0.2-<100)	0/6 (<0.2-<100)	4/6 (<0.2-770)	0/6 (<0.2-<100)	0/6 (<0.2-<100)	6/6 (0.26-3300)	0/6 (<0.2-<100)	6/6 (0.26-4,070)
Sedimentation Basin Below Grade Mastic Coating (µg/L)	0/2 (<0.1)	0/2 (<0.1)	0/2 (<0.1)	0/2 (<0.1)	0/2 (<0.1)	2/2 (3.1-3.2)	2/2 (1.6-1.7)	2/2 (4.7-4.9)

Medium and Location	Aroclor 1221	Aroclor 1232	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
Filtration Basin Below Grade Mastic Coating (µg/L)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)
Clearwell Below Grade Mastic Coating (µg/L)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)	0/1 (<0.1)
Concrete								
Sedimentation Basin Concrete	0/40 (<0.2-<20)	0/40 (<0.2-<20)	0/40 (<0.2-<20)	0/40 (<0.2-<20)	0/40 (<0.2-<20)	8/40 (<0.2-260)	0/40 (<0.2-<20)	8/40 (<0.2-260)
Filtration Basin Concrete	0/6 (<4-<20)	0/6 (<4-<20)	4/6 (<20-43)	0/6 (<4-<20)	0/6 (<4-<20)	6/6 (54-190)	0/6 (<4-<20)	6/6 (64-233)
Filtration Basin Pipe Gallery Concrete	0/2 (<0.2-<2)	0/2 (<0.2-<2)	0/2 (<0.2-<2)	0/2 (<0.2-<2)	0/2 (<0.2-<2)	2/2 (0.52-180)	0/2 (<0.2-<2)	2/2 (0.52-180)
Clearwell Concrete	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)
Wastewell Concrete	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)
Other Basin Building Materials								
Sedimentation Basin Expansion Joint Sealant	0/10 (<1-<1,000)	1/10 (<1-2,700)	1/10 (<1-9700)	4/10 (<1-38,000)	6/10 (<1-13,000)	1/10 (<1-850)	0/10 (<1-<1,000)	10/10 (8.7-38,000)
Sedimentation Basin Expansion Joint Cork	0/4 (<1-<500)	0/4 (<1-<500)	0/4 (<1-<500)	1/4 (<1-1)	1/4 (<1-1,100)	0/4 (<1-<500)	0/4 (<1-<500)	2/4 (<1-1,100)
Sedimentation Basin Caulk	0/3 (<1-<100)	0/3 (<1-<100)	2/3 (<10-430)	0/3 (<1-<100)	0/3 (<1-<100)	2/3 (<1-3,000)	1/3 (<1-1,800)	3/3 (3.6-3,000)
Clearwell Redwood Baffles	0/3 (<1)	0/3 (<1)	0/3 (<1)	0/3 (<1)	0/3 (<1)	0/3 (<1)	0/3 (<1)	0/3 (<1)
Sedimentation Basin Fiberglass Collector Boards (Wipe) (µg/100 cm ²)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)
Sedimentation Basin Steel Agitator Blades (Wipe) (µg/100 cm ²)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)	0/2 (<10)
Filtration Basin Fiberglass Troughs (Wipe) (µg/100 cm ²)	0/6 (<10)	0/6 (<10)	0/6 (<10)	0/6 (<10)	0/6 (<10)	0/6 (<10)	0/6 (<10)	0/6 (<10)
Groundwater								
Sedimentation Basin Groundwater (µg/L)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)	0/9 (<0.01)
Sedimentation Basin Downgradient Well (µg/L)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)	0/1 (<0.01)
Filtration Basin Groundwater (µg/L)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)	0/4 (<0.01)
Administration Building Samples								
Admin Bldg Window Caulk/Glaze	0/10 (<1-<20)	0/10 (<1-<20)	1/10 (<1-2.8)	0/10 (<1-<20)	0/10 (<1-<20)	9/10 (<1-500)	3/10 (<1-250)	10/10 (6.6-640)
Admin Bldg Window Paint Chip	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)
Admin Bldg Window Wipes (µg/100 cm ²)	0/15 (<10)	0/15 (<10)	0/15 (<10)	0/15 (<10)	0/15 (<10)	4/15 (<10-43)	0/15 (<10)	4/15 (<10-43)

*Sample results with detected concentrations of the analyte are bolded

Table A-4. Summary of Sampling Results for Metals: Frequency of Detection and Range of Concentrations (mg/kg)*

Medium and Location	Total Metals (mg/kg)					TCLP Metals (mg/L)				
	Arsenic	Barium	Chromium	Lead	Mercury	Arsenic	Barium	Chromium	Lead	Mercury
Interior Basin Sediment and Filter Media										
Sedimentation Basin Sediment	--	--	--	2/2 (4.83-40.8)	--	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<0.1)
Clearwell Sediment	--	--	--	1/1 (20.5)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Wastewell Sediment	--	--	--	1/1 (9.41)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Filtration Basin Anthracite Media	1/1 (4.37)	1/1 (41.6)	1/1 (2.9)	1/1 (5.18)	0/1 (<1)	--	--	--	--	--
Filtration Basin Filter Media	1/1 (1.98)	1/1 (20)	1/1 (4.35)	1/1 (2.09)	0/1 (<1)	--	--	--	--	--
Filtration Basin Gravel (or brick/block) Bed	1/1 (2)	1/1 (19.3)	1/1 (4.74)	1/1 (1.9)	0/1 (<1)	--	--	--	--	--
Coatings										
Sedimentation Basin Coating - Exterior	--	--	--	2/2 (35.7-44.7)	--	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<0.1)
Sedimentation Basin Paint	0/1 (<10)	1/1 (2,060)	1/1 (1,300)	1/1 (23,300)	0/1 (<10)	--	--	--	--	--
Filtration Basin Coating - Exterior	0/1 (<10)	1/1 (161)	0/1 (<10)	1/1 (30.2)	1/1 (52.8)	--	--	--	--	--
Filtration Basin Coating - Interior	0/1 (<10)	1/1 (21.8)	0/1 (<10)	0/1 (<10)	0/1 (<10)	--	--	--	--	--
Filtration Basin Paint	0/2 (<10)	2/2 (17.1-973)	2/2 (13.9-400)	2/2 (87.8-112)	0/2 (<10)	--	--	--	--	--
Concrete										
Sedimentation Basin Concrete	--	--	--	2/2 (13.1-13.8)	--	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<1)	0/2 (<0.1)
Filtration Basin Concrete	1/1 (10.9)	1/1 (94.4)	1/1 (16.3)	1/1 (6.18)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Filtration Basin Pipe Gallery Concrete	--	--	--	0/1 (<1)	--	--	--	--	--	--
Clearwell Concrete	--	--	--	1/1 (12.4)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Wastewell Concrete	--	--	--	1/1 (16.2)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Other Basin Building Materials										
Sedimentation Basin Expansion Joint Sealant	--	--	--	1/1 (9.57)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Sedimentation Basin Expansion Joint Cork	--	--	--	0/1 (<2)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Clearwell Redwood Baffles	--	--	--	0/1 (<2)	--	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<1)	0/1 (<0.1)
Administration Building Paint										
Administration Building Paint Chips	0/3 (<10)	3/3 (17.1-3,300)	2/3 (<10-20)	4/4 (26.7-421)	0/3 (<10)	0/1 (<1)	0/1 (<1)	0/1 (<1)	1/1 (3.29)	0/1 (<1)

Table A-5. PCB Concentrations Reported in Drinking Water Samples from the Anacortes WTP

Analyte	Date							
	7/13/2000	11/19/2001	2/27/2002	7/22/2003	7/17/2006	8/22/2007	8/13/2012	8/12/2013
Detected Levels								
Aroclor 1016	ND	<i>Not reported</i>	ND	ND	ND	ND	ND	ND
Aroclor 1221	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1232	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1242	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1248	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1254	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1260	ND	ND	ND	ND	ND	ND	ND	ND
PCBs (Total Aroclors)	<i>Not reported</i>	<i>Not reported</i>	<i>Not reported</i>	<i>Not reported</i>	ND	ND	ND	ND
State Reporting Level (SRL) ($\mu\text{g/L}$)								
Aroclor 1016	0.1		0.1	0.1	0.1	0.1	0.08	0.08
Aroclor 1221	0.5	20	20	0.5	20	20	20	20
Aroclor 1232	0.1	0.5	0.5	0.1	0.5	0.5	0.5	0.5
Aroclor 1242	0.1	0.3	0.3	0.1	0.5	0.5	0.3	0.3
Aroclor 1248	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Aroclor 1254	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Aroclor 1260	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2
PCBs (Total Aroclors)					0.2	0.2	0.2	0.2

ND – Not detected

Table A-6. Comparison of Maximum-Detected PCB Concentrations in Solid Matrices to Risk-Based Screening Levels for Soil ^a

Medium and Location	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
Soil						
Sedimentation Basin Soil 0"-12"	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	5/10 (<0.2-3.3)	5/10 (<0.2-3.5)	5/10 (<0.2-6.8)
Sedimentation Basin Soil 12"-36"	0/10 (<0.2)	0/10 (<0.2)	0/10 (<0.2)	2/10 (<0.2-0.28)	1/10 (<0.2-0.29)	2/10 (<0.2-0.57)
Filtration Basin Soil 0"-12"	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	5/6 (<0.2-6.9)	5/6 (<0.2-8.7)	5/6 (<0.2-15.6)
Filtration Basin Soil 12"-36"	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	2/6 (<0.2-0.33)	1/6 (<0.2-0.24)	2/6 (<0.2-0.57)
Interior Basin Sediment and Filter Media						
Sedimentation Basin Sediment	0/8 (<0.2)	0/8 (<0.2)	0/8 (<0.2)	4/8 (<0.2-6.1)	0/8 (<0.2)	4/8 (<0.2-6.1)
Sedimentation Basin Sediment-Trough	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	2/2 (1,800-1,900)	0/2 (<10-<200)	2/2 (1,800-1,900)
Clearwell Sediment (Initial Investigation)	6/6 (0.38-7.3)	0/6 (<0.2)	0/6 (<0.2)	5/6 (<0.2-5.6)	0/6 (<0.2)	6/6 (0.38-11.0)
Clearwell Sediment-Dry (Gap Investigation)	0/4 (<0.4)	0/4 (<0.4)	0/4 (<0.4)	4/4 (0.67-2.8)	0/4 (<0.4)	4/4 (0.67-2.8)
Wastewell Sediment	0/4 (<0.2)	0/4 (<0.2)	0/4 (<0.2)	3/4 (<0.2-3.4)	0/4 (<0.2)	3/4 (<0.2-3.4)
Filtration Basin Gravel (or brick/block) Bed	0/6 (<0.2)	0/6 (<0.2)	0/6 (<0.2)	1/6 (<0.2-0.22)	0/6 (<0.2)	1/6 (<0.2-0.22)
Coatings						
Sedimentation Basin Coating - Exterior	0/8 (<100-<500)	0/8 (<100-<500)	0/8 (<100-<500)	8/8 (6,000-18,000)	8/8 (4,400-16,000)	8/8 (10,400-34,000)
Sedimentation Basin Coating - Interior	0/2 (<10-<200)	0/2 (<10-<200)	0/2 (<10-<200)	2/2 (1,600-20,000)	0/2 (<10-<200)	2/2 (1,600-20,000)
Filtration Basin Coating - Exterior	0/4 (<100-<1,000)	0/4 (<100-<1,000)	0/4 (<100-<1,000)	4/4 (14,000-20,000)	4/4 (11,000-15,000)	4/4 (25,000-35,000)
Filtration Basin Coating - Interior	4/6 (<0.2-770)	0/6 (<0.2-<100)	0/6 (<0.2-<100)	6/6 (0.26-3,300)	0/6 (<0.2-<100)	6/6 (0.26-4,070)
Concrete						
Sedimentation Basin Concrete	0/40 (<0.2-<20)	0/40 (<0.2-<20)	0/40 (<0.2-<20)	8/40 (<0.2-260)	0/40 (<0.2-<20)	8/40 (<0.2-260)
Filtration Basin Concrete	4/6 (<20-43)	0/6 (<4-<20)	0/6 (<4-<20)	6/6 (54-190)	0/6 (<4-<20)	6/6 (64-233)
Filtration Basin Pipe Gallery Concrete	0/2 (<0.2-<2)	0/2 (<0.2-<2)	0/2 (<0.2-<2)	2/2 (0.52-180)	0/2 (<0.2-<2)	2/2 (0.52-180)
Other Basin Building Materials						
Sedimentation Basin Expansion Joint Sealant	1/10 (<1-9,700)	4/10 (<1-38,000)	6/10 (<1-13,000)	1/10 (<1-850)	0/10 (<1-<1,000)	10/10 (8.7-38,000)
Sedimentation Basin Expansion Joint Cork	0/4 (<1-<500)	1/4 (<1-1)	1/4 (<1-1,100)	0/4 (<1-<500)	0/4 (<1-<500)	2/4 (<1-1,100)
Administration Building Samples						
Admin Bldg Window Caulk/Glaze	1/10 (<1-2.8)	0/10 (<1-<20)	0/10 (<1-<20)	9/10 (<1-500)	3/10 (<1-250)	10/10 (6.6-640)
Admin Bldg Paint Chip	0/1 (<1)	0/1 (<1)	0/1 (<1)	1/1 (1.7)	0/1 (<1)	1/1 (1.7)
Risk-based screening level for worker soil	27	0.95	0.95	0.97	0.99	NA

^a A Sample results with detected concentrations of the analyte are bolded. Media/Locations with a maximum concentration greater than the risk-based screening level are highlighted.
NA – Not available

Table A-7. Comparison of Maximum-Detected Metals Concentrations in Solid Matrices to Risk-Based Screening Levels for Soil ^a

Medium and Location	Total Metals (mg/kg)				
	Arsenic	Barium	Chromium ^b	Lead	Mercury
Interior Basin Sediment and Filter Media					
Sedimentation Basin Sediment	--	--	--	2/2 (4.83-40.8)	--
Clearwell Sediment	--	--	--	1/1 (20.5)	--
Wastewell Sediment	--	--	--	1/1 (9.41)	--
Filtration Basin Anthracite Media	1/1 (4.37)	1/1 (41.6)	1/1 (2.9)	1/1 (5.18)	0/1 (<1)
Filtration Basin Filter Media	1/1 (1.98)	1/1 (20)	1/1 (4.35)	1/1 (2.09)	0/1 (<1)
Filtration Basin Gravel (or brick/block) Bed	1/1 (2)	1/1 (19.3)	1/1 (4.74)	1/1 (1.9)	0/1 (<1)
Coatings					
Sedimentation Basin Coating - Exterior	--	--	--	2/2 (35.7-44.7)	--
Sedimentation Basin Paint	0/1 (<10)	1/1 (2,060)	1/1 (1,300)	1/1 (23,300)	0/1 (<10)
Filtration Basin Coating - Exterior	0/1 (<10)	1/1 (161)	0/1 (<10)	1/1 (30.2)	1/1 (52.8)
Filtration Basin Coating - Interior	0/1 (<10)	1/1 (21.8)	0/1 (<10)	0/1 (<10)	0/1 (<10)
Filtration Basin Paint	0/2 (<10)	2/2 (17.1-973)	2/2 (13.9-400)	2/2 (87.8-112)	0/2 (<10)
Concrete					
Sedimentation Basin Concrete	--	--	--	2/2 (13.1-13.8)	--
Filtration Basin Concrete	1/1 (10.9)	1/1 (94.4)	1/1 (16.3)	1/1 (6.18)	0/1 (<1)
Filtration Basin Pipe Gallery Concrete	--	--	--	0/1 (<1)	--
Clearwell Concrete	--	--	--	1/1 (12.4)	--
Wastewell Concrete	--	--	--	1/1 (16.2)	--
Other Building Materials					
Sedimentation Basin Expansion Joint Sealant	--	--	--	1/1 (9.57)	--
Sedimentation Basin Expansion Joint Cork	--	--	--	0/1 (<2)	--
Clearwell Redwood Baffles	--	--	--	0/1 (<2)	--
Administration Building Samples					
Administration Building Paint Chips	0/3 (<10)	3/3 (17.1-3,300)	2/3 (<10-20)	4/4 (26.7-421)	0/3 (<10)
Risk-based screening level for worker soil (mg/kg)	3	220,000	1,800,000 (CrIII), 6.3 (CrVI)	800	350 (Inorganic mercury salts)

^a Sample results with detected concentrations of the analyte are bolded. Media/Locations with a maximum concentration greater than the risk-based screening level are highlighted.

^b Assumed to be trivalent chromium (CrIII)

Table A-8. Comparison of Maximum-Detected PCB and Lead Concentrations in Liquid Matrices, TCLP Samples, or Wipe Samples to Risk-Based Screening Levels^a

Medium and Location	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors	Lead
Sediment Water							
Clearwell Sediment-Wet from Pump well (µg/L)	0/2 (<0.01)	0/2 (<0.01)	2/2 (0.71-0.85)	2/2 (0.32-0.68)	0/2 (<0.01)	2/2 (1.0-1.56)	---
Risk-based screening level for tap water (µg/L)	0.22	0.0078	0.0078	0.0078	0.0078	---	---
Coatings							
Sedimentation Basin Below Grade Mastic Coating (µg/L) (TCLP)	0/2 (<0.1)	0/2 (<0.1)	0/2 (<0.1)	2/2 (3.1-3.2)	2/2 (1.6-1.7)	2/2 (4.7-4.9)	---
Admin Bldg Paint Chip (µg/L) (TCLP)	---	---	---	---	---	---	(1/1) 3,290^b
Risk-based screening level for tap water × 100 (for comparison to TCLP results) (µg/L)	22	0.78	0.78	0.78	0.78	---	150
Administration Building Samples							
Admin Bldg Window Wipes (µg/100 cm ²)	0/15 (<10)	0/15 (<10)	0/15 (<10)	4/15 (<10-43)	0/15 (<10)	4/15 (<10-43)	---
Risk-based screening level for surface wipe (equal to industrial soil RSL × daily soil ingestion rate of 0.0001 kg/100 cm ²) (µg/100 cm ²)	2.7	0.095	0.095	0.097	0.099	---	---

^a Sample results with detected concentrations of the analyte are bolded. Media/Locations with a maximum concentration greater than the risk-based screening level are highlighted.

^b The lead concentration in the paint chip exceeded the risk based screening level for tap water × 100. However, since lead was also analyzed in the same paint chip using the Total Metals method with results reported in mg/kg, and the maximum-detected concentration was below the risk-based screening level for industrial soil, lead in Administration Building paint chips was not identified as a COPC.

RSL – Risk-based screening level; TCLP – Toxicity Characteristic Leaching Procedures

Table A-9. Chemicals of Potential Concern (COPCs) Considered Further in the Anacortes WTP Risk Assessment by Medium/Location

Medium and Location	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Arsenic	Lead
Soil							
Sedimentation Basin Soil 0"-12"				X	X		
Filtration Basin Soil 0"-12"				X	X		
Interior Basin Sediment and Filter Media							
Sedimentation Basin Sediment				X			
Sedimentation Basin Sediment-Trough	X	X	X	X	X		
Clearwell Sediment (Initial Investigation)			X	X			
Clearwell Sediment-Dry (Gap Investigation)				X			
Clearwell Sediment-Wet from Pump well (µg/L)			X	X			
Wastewell Sediment				X			
Filtration Basin Anthracite Media						X	
Coatings							
Sedimentation Basin Coating - Exterior	X	X	X	X	X		
Sedimentation Basin Coating - Interior	X	X	X	X	X		
Sedimentation Basin Paint							X
Sedimentation Basin Below Grade Mastic Coating (µg/L) (TCLP)				X	X		
Filtration Basin Coating - Exterior	X	X	X	X	X		
Filtration Basin Coating - Interior	X	X	X	X	X		
Concrete							
Sedimentation Basin Concrete		X	X	X			
Filtration Basin Concrete	X	X	X	X		X	
Filtration Basin Pipe Gallery Concrete				X			
Other Basin Building Materials							
Sedimentation Basin Expansion Joint Sealant	X	X	X	X	X		
Sedimentation Basin Expansion Joint Cork	X	X	X	X	X		
Administration Building Samples							
Admin Bldg Window Caulk/Glaze				X			
Admin Bldg Paint Chip				X			
Admin Bldg Window Wipes				X			

TCLP – Toxicity Characteristic Leaching Procedure

Table A-10. Exposure Point Concentration Summary, Anacortes WTP Risk Assessment

Chemical	Medium	Range	Estimated 95% UCL	Exposure Point Concentration
Total Aroclors	Soil (0-12" below ground surface) (n = 16)	<0.2-15.6 mg/kg	4.87 mg/kg	4.87 mg/kg
Total Aroclors	Sedimentation Basin sediment (n = 10)	<0.2-1,900 mg/kg	2,855 mg/kg	1,900 mg/kg
Total Aroclors	Clearwell sediment (n = 6)	0.38-11 mg/kg	8.98 mg/kg	8.98 mg/kg
Total Aroclors	Wastewell sediment (n = 4)	<0.2-3.4 mg/kg	NA	3.4 mg/kg
Total Aroclors	Administration Building window sill wipe (n=15)	<10-43 µg/100 cm ²	20.2 µg/100 cm ² (0.202 µg/cm ²)	20.2 µg/100 cm ² (0.202 µg/cm ²)

NA – Not applicable

Table A-11. Exposure Parameters for Indoor Office Worker, Anacortes WTP Risk Assessment

Parameter	Definition	Units	Value	Rationale	Reference
SA _i	Skin surface area available for contact	m ² /contact event	0.2848	Approximate 95% upper confidence limit of the mean of surface areas for the hands and forearms for an adult	U.S. EPA 2011
f _d	Fraction of available skin surface area that contacts surface during an event	unitless	0.25	Assumes that the equivalent of approximately 2 palms contact the surface during an event	U.S. EPA 1997a as cited in May et al., 2002
f _{d-m}	Fraction of skin surface area that contacted a surface that then contacts mouth	unitless	0.1	Assumes approximately one finger contacts the mouth	U.S. EPA 1997a as cited in May et al., 2002
FT _{surf-sk}	Fraction of surface concentration transferred from surface to skin	unitless	0.1	Default value in the absence of site-specific data for an industrial worker	U.S. EPA 1997a as cited in May et al., 2002
FT _{sk-m}	Fraction of skin concentration transferred from skin to mouth	unitless	0.3	Default value in the absence of site-specific data for an industrial worker	Schneider 1993 as cited in May et al., 2002
EV	Contact frequency with surface	events/d	3	Assumed number of contacts in an 8 hour day	U.S. EPA 1997a as cited in May et al., 2002
InhR	Inhalation rate	m ³ /hr	1.2	Average value for light and moderate activity for ages 21-51	U.S. EPA 2011
K	Resuspension factor	m ⁻¹	5 × 10 ⁻⁸	Based on measured values for resuspension of particles into indoor air in five buildings undergoing decommissioning	Abu-Eid et al., 2002
ET _i	Exposure time for indoor worker	hr/d	8	Default value for an indoor worker	U.S. EPA 2016b
EF _i	Exposure frequency to indoor surfaces	d/yr	250	Default value for an indoor worker	U.S. EPA 2016b
ED	Exposure duration	year	25	Industrial worker default	U.S. EPA 2016b
BW	Body weight	kg	80	Industrial worker default	U.S. EPA 2016b
AT	Averaging time	d	365 d/yr × ED for non-carcinogen, or × 70 yr for carcinogen	Risk assessment default	U.S. EPA 2016b

Table A-12. Exposure Parameters for Outdoor Maintenance Worker, Anacortes WTP Risk Assessment

Parameter	Definition	Units	Value	Rationale	Reference
IR	Solid matrix incidental ingestion rate	kg/d	0.00010	Average adult soil ingestion rate, outdoor worker default	U.S. EPA 2016b
f_s	Fraction of soil contacted from a contaminated source	unitless	0.1	Assume 10% since only a small portion of the entire soil area was sampled and soils further from the Basins are assumed to have even lower concentrations.	Professional judgment
f_{sed}	Fraction of sediment contacted from a contaminated source	unitless	1	Assume 100% since only 12 days of contact with sediment per year assumed.	Professional judgment
SA	Skin surface area available for contact with medium	cm ² /event	3,535	Equal to the approximate 95% upper confidence limit of the mean of surface areas for the face, lower arms, and hands for male and female adults	U.S. EPA 2011
AF	Medium to skin adherence factor	mg/cm ²	0.060	Average of skin adherence values for recorded for adults engaged in “activities with soil” including gardeners, farmers, landscapers, groundskeepers, and archeologists	U.S. EPA 2011
InhR	Inhalation rate	m ³ /hr	1.6	Average value for moderate activity for ages 21-51	U.S. EPA 2011
VF	Medium to air volatilization factor	m ³ /kg	8.43×10^5	Chemical-specific, for PCB 1254	U.S. EPA 2016b
PEF	Particulate emission factor	m ³ /kg	1.40×10^9	Default	U.S. EPA 2016b
ET _o	Exposure time for outdoor worker	hr/d	8	Outdoor worker default	U.S. EPA 2016b
EF _s	Exposure frequency to soil	d/yr	225	Outdoor worker default, equal to 5 days per week for 45 weeks per year	U.S. EPA 2016b
EF _{sed}	Exposure frequency to sediment	d/yr	4	Once per quarter	Professional judgment
ED	Exposure duration	year	25	Outdoor worker default	U.S. EPA 2016b
BW	Body weight	kg	80	Outdoor worker default	U.S. EPA 2016b
AT	Averaging time	d	365 d/yr × ED for non-carcinogen, or × 70 yr for carcinogen	Outdoor worker default	EPA 2016b

Table A-13. Exposure Parameters for Adolescent Trespasser, Anacortes WTP Risk Assessment

Parameter	Definition	Units	Value	Rationale	Reference
IR	Soil incidental ingestion rate	kg/d	0.00020	Average soil ingestion rate, child recreator default	U.S. EPA 2016b
f_i	Fraction of soil contacted from a contaminated source	unitless	1	Assume 100%	Professional judgment
SA	Skin surface area available for contact with medium	cm ² /event	2,533	Equal to the approximate 95% upper confidence limit of the mean of surface areas for the face, lower arms, and hands for children age 6-16	U.S. EPA 2016b
AF	Medium to skin adherence factor	mg/cm ²	0.080	Average of skin adherence values for recorded for children engaged in “activities with soil” which included children playing soccer	U.S. EPA 2011
InhR	Inhalation rate	m ³ /hr	2.0	Average value for moderate and high activity for ages 6-16	U.S. EPA 2011
VF	Medium to air volatilization factor	m ³ /kg	8.43×10^5	Chemical-specific, for PCB 1254	U.S. EPA 2016b
PEF	Particulate emission factor	m ³ /kg	1.40×10^9	Default	U.S. EPA 2016b
ET _t	Exposure time for inhalation	hr/d	1	Professional judgment, consistent with U.S. EPA guidance for trespasser scenario	U.S. EPA 2009
EF _t	Exposure frequency for trespasser	d/yr	10	Professional judgment	Professional judgment
ED	Exposure duration	year	10	Trespasser default	U.S. EPA Region IV 2014
BW	Body weight	kg	45	Trespasser default, age 7-16	U.S. EPA Region IV 2014
AT	Averaging time	d	365 d/yr × ED for non-carcinogen, or × 70 yr for carcinogen	Outdoor worker default	U.S. EPA 2016b

Table A-14. Chemical-Specific Uptake Factors for PCBs Used in the Anacortes WTP Risk Assessment

Criterion	Value	Reference
GI Absorption Factor (GAF)	1	U.S. EPA, 2016b
Dermal Absorption Factor (DAF)	0.14	U.S. EPA, 2016b

Table A-15. Toxicity Criteria Used in the Anacortes WTP Risk Assessment for PCBs

Criterion	Value	Reference
Noncancer Criteria		
Oral RfD (mg/kg-d)	0.00002	RfD for Arcolor 1254 (lowest RfD for any Aroclor); U.S. EPA, 1994, 2016b
Dermal RfD (mg/kg-d)	0.000018	Equivalent “absorbed dose” RfD, equal to Oral RfD × GAF; U.S. EPA, 1994, 2016b
Cancer Criteria		
U.S. EPA Cancer Classification	B2	U.S. EPA, 2016d
Oral SF (mg/kg-d) ⁻¹	2	Value for high risk and persistence; U.S. EPA, 2016d
Dermal SF (mg/kg-d) ⁻¹	2.2	Equivalent “absorbed dose” SF, equal to the Oral SF / GAF; U.S. EPA, 2016d
Inhalation Unit Risk (µg/m ³)	0.0001	U.S. EPA, 2016d

GAF – Gastrointestinal absorption factor; RfD – Reference dose; SF – Slope factor

a Absorbed Dermal RfD = Oral RfD × GAF

b Absorbed Dermal SF = Oral SF/GAF

c U.S. EPA Cancer Classification: A, Human carcinogen; B1, Probable human carcinogen; B2, Probable human carcinogen; C, Possible human carcinogen; D, Not classifiable as to human carcinogenicity

Table A-16. Summary of Noncancer Hazard Estimates for PCBs at the Site

Receptor Population	Medium	Pathway	Noncancer Hazard
Indoor Worker	Window Sill Dust	Ingestion of Dust	0.55
		Dermal Contact with Dust	2.59
		Inhalation of Dust	0.00042
		Medium Total	3.1
Receptor Total			3.1
Outdoor Worker	Soil	Ingestion	0.019
		Dermal Contact	0.0056
		Inhalation	0.0029
		Medium Total	0.027
	Sedimentation Basin Sediment	Ingestion	1.30
		Dermal Contact	0.39
		Inhalation	0.20
		Medium Total	1.9
	Clearwell Sediment	Ingestion	0.0062
		Dermal Contact	0.0018
		Inhalation	0.00093
		Medium Total	0.0089
	Wastewell Sediment	Ingestion	0.0023
Dermal Contact		0.00069	
Inhalation		0.00035	
Medium Total		0.0034	
Receptor Total			1.9
Trespasser	Soil	Ingestion	0.030
		Dermal Contact	0.0039
		Inhalation	0.00035
		Medium Total	0.034
		Receptor Total	

Table A-17. Summary of Cancer Risk Estimates for PCBs at the Site

Receptor Population	Medium	Pathway	Lifetime Excess Cancer Risk
Indoor Worker	Window Sill Dust	Ingestion of Dust	7.9E-06
		Dermal Contact with Dust	3.7E-05
		Inhalation of Dust	1.4E-08
		Medium Total	4.5E-05
	Receptor Total	4.5E-05	
Outdoor Worker	Soil	Ingestion	2.7E-07
		Dermal Contact	7.9E-08
		Inhalation	1.3E-08
		Medium Total	3.6E-07
	Sedimentation Basin Sediment	Ingestion	1.9E-05
		Dermal Contact	5.5E-06
		Inhalation	8.8E-07
		Medium Total	2.5E-05
	Clearwell Sediment	Ingestion	8.8E-08
		Dermal Contact	2.6E-08
		Inhalation	4.2E-09
		Medium Total	1.2E-07
	Wastewell Sediment	Ingestion	3.3E-08
		Dermal Contact	9.9E-09
		Inhalation	1.6E-09
		Medium Total	4.5E-08
Receptor Total	2.6E-05		
Trespasser	Soil	Ingestion	1.7E-07
		Dermal Contact	2.3E-08
		Inhalation	2.3E-09
		Medium Total	1.9E-07
	Receptor Total	1.9E-07	

APPENDIX B
EXPOSURE EQUATIONS

Exposure Equations for Contact with Surfaces (e.g., using concentrations in surface wipe samples)

Incidental Ingestion from Contact with Surfaces

$$Dose_{ing-surf} (mg / kg - d) = \frac{C_{surf} \times SA_i \times f_d \times f_{d-m} \times EV \times FT_{surf-sk} \times FT_{sk-m} \times EF_i \times ED}{BW \times AT_{n\ or\ c}}$$

Where:

C_{surf}	=	Concentration of contaminant on surface, mg/cm ²
SA_i	=	Skin surface area available for contact, cm ² /hand-to-mouth event
f_d	=	Fraction of available skin surface area that contacts surface during an event, unitless
f_{d-m}	=	Fraction of skin surface area that contacted a surface that then contacts mouth, unitless
EV	=	Contact frequency with surface, event/d
$FT_{surf-sk}$	=	Fraction of surface concentration transferred from surface to skin, unitless
FT_{sk-m}	=	Fraction of surface concentration transferred from skin to mouth, unitless
EF_{iw}	=	Exposure frequency to indoor surfaces, d/yr
ED_{iw}	=	Exposure duration, yr
BW	=	Body weight, kg
$AT_{n\ or\ c}$	=	Averaging time for noncarcinogens or carcinogens, d

Dermal Uptake from Contact with Surfaces

$$Dose_{derm-surf} (mg / kg - d) = \frac{C_{surf} \times SA_d \times f_d \times EV \times FT_{surf-sk} \times DAF \times EF_i \times ED}{BW \times AT_{n\ or\ c}}$$

Where:

C_{surf}	=	Concentration of contaminant on surface, mg/cm ²
SA_d	=	Dermal surface area available for absorption, cm ² /contact event
f_d	=	Fraction of available dermal area that contacts surface, unitless
EV	=	Contact frequency with surface, contact event/d
$FT_{surf-sk}$	=	Fraction of surface concentration transferred from surface to skin, unitless
DAF	=	Dermal absorption factor (chemical-specific), unitless
EF_i	=	Exposure frequency to indoor surfaces, d/yr
ED	=	Exposure duration, yr
BW	=	Body weight, kg

$AT_{n\ or\ c}$ = Averaging time for noncarcinogens or carcinogens, d

Inhalation of Dust from Surface

Noncancer evaluation (for comparison to a noncancer RfD in units of mg/kg-d)

$$Dose_{inh-surf} (mg / kg - d) = \frac{C_{surf} \times CF \times InhR \times K \times ET_i \times EF_i \times ED}{BW \times AT_n}$$

Where:

C_{surf}	=	Concentration of contaminant on surface, mg/cm ²
CF	=	Conversion factor, 10000 cm ² /m ²
$InhR$	=	Inhalation rate, m ³ /hr
K	=	Resuspension factor, m ⁻¹
ET_i	=	Exposure time for indoor worker, hr/d
EF_i	=	Exposure frequency to indoor surfaces, d/yr
ED	=	Exposure duration, yr
BW	=	Body weight, kg
AT_n	=	Averaging time for noncarcinogens, d

Cancer Evaluation (for comparison to a cancer UR value in units of (μg/m³)⁻¹)

$$C_{inh-surf} (\mu g / m^3) = \frac{C_{surf} \times CF \times K \times EF_i \times ED \times 1000 \mu g / mg}{AT_c}$$

Where:

C_{surf}	=	Concentration of contaminant on surface, mg/cm ²
CF	=	Conversion factor, 10000 cm ² /m ²
K	=	Resuspension factor, m ⁻¹
EF_i	=	Exposure frequency, dermal contact with indoor surfaces, d/yr
ED	=	Exposure duration, yr
BW	=	Body weight, kg
AT_c	=	Averaging time for carcinogens, d

Exposure Equations for Contact with Solid Matrices (e.g., using concentrations in soil or sediment)

Incidental Ingestion of Soil or Sediment

$$Dose_{ing} (mg / kg - d) = \frac{C \times IR \times f_s \times GAF \times EF_o \times ED}{BW \times AT_{n\ or\ c}}$$

Where:

C	=	Concentration of contaminant in medium, mg/kg
IR	=	Ingestion rate, kg/d

f_s	=	Fraction contacted from a contaminated source, unitless
GAF	=	Relative gastrointestinal absorption factor (chemical-specific), unitless
EF_o	=	Exposure frequency to outdoor solid matrices, d/yr
ED	=	Exposure duration, yr
BW	=	Body weight, kg
$AT_{n\ or\ c}$	=	Averaging time for noncarcinogens or carcinogens, d

Dermal Contact with Soil or Sediment

$$Dose_{derm} (mg / kg - d) = \frac{C \times SA \times f_s \times AF \times DAF \times CF \times EV_o \times EF_o \times ED}{BW \times AT_{n\ or\ c}}$$

Where:

C	=	Concentration of contaminant in medium, mg/kg
SA	=	Skin surface area available for contact with medium, cm ² /event
f_s	=	Fraction contacted from a contaminated source, unitless
AF	=	Medium to skin adherence factor, mg/cm ²
DAF	=	Dermal absorption factor (chemical-specific), unitless
CF	=	Conversion factor, kg/mg
EV_o	=	Contact frequency with surface, event/d
EF_o	=	Exposure frequency to outdoor solid matrices, d/yr
ED	=	Exposure duration, yr
BW	=	Body weight, kg
$AT_{n\ or\ c}$	=	Averaging time for noncarcinogens or carcinogens, d

Inhalation of Particulate or Vapor from Soil or Sediment

Noncancer evaluation (for comparison to a noncancer RfD in units of mg/kg-d)

$$Dose_{inh} (mg / kg - d) = \frac{C \times InhR \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \times f_s \times ET_o \times EF_o \times ED}{BW \times AT_n}$$

Where:

C	=	Concentration of contaminant in medium, mg/kg
$InhR$	=	Inhalation rate, m ³ /hr
VF	=	Volatilization factor, m ³ /kg
PEF	=	Particulate emission factor, m ³ /kg
f_s	=	Fraction contacted from a contaminated source, unitless
ET_o	=	Exposure time for outdoor worker, hr/d
EF_o	=	Exposure frequency to outdoor solid matrices, d/yr
ED	=	Exposure duration, yr

BW = Body weight, kg
 AT_n = Averaging time for noncarcinogens, d

Cancer Evaluation (for comparison to a cancer UR value in units of $(\mu\text{g}/\text{m}^3)^{-1}$)

$$\text{Concentration}_{inh} (\mu\text{g}/\text{m}^3) = \frac{C \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \times f_s \times EF_o \times ED \times 1000 \mu\text{g}/\text{mg}}{AT_c}$$

Where:

C = Concentration of contaminant in medium, mg/kg
 VF = Volatilization factor, m^3/kg
 PEF = Particulate emission factor, m^3/kg
 f_s = Fraction contacted from a contaminated source, unitless
 EF_o = Exposure frequency to outdoor solid matrices, d/yr
 ED = Exposure duration, yr
 BW = Body weight, kg
 AT_c = Averaging time for carcinogens, d

APPENDIX C
RISK CALCULATIONS

Risk Calculations for Indoor Worker Scenario

Indoor Worker- Evaluation of Cancer Risk

Ingestion of Dust

Chemical	C (mg/cm ²)	x	SA _{iw} (cm ² /contact event)	x	f _d (unitless)	x	f _{d-m} (unitless)	x	EV (event/d)	x	FT _{surf-sk} (unitless)	x	FT _{sk-m} (unitless)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	/	BW _{iw} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	2.02E-04		2848		0.25		0.1		3		0.1		0.3		250		25		80		25550		4.0E-06		2.0E+00		7.9E-06

Dermal Contact with Dust

Chemical	C (mg/cm ²)	x	SA _{iw} (cm ² /contact event)	x	f _d (unitless)	x	EV (event/d)	x	FT _{surf-sk} (unitless)	x	DAF (unitless)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	/	BW _{iw} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	2.02E-04		2848		0.25		3		0.1		0.14		250		25		80		25550		1.8E-05		2.0E+00		3.7E-05

Inhalation of Dust

Chemical	C (mg/cm ²)	x	CF (cm ² /m ²)	x	K (1/m)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	x	CF (μg/mg)	/	AT (d)	=	LADC (μg/m ³)	x	Inhalation UR (μg/m ³) ⁻¹	=	Cancer Risk
PCB Aroclors	2.02E-04		1.00E+04		5.00E-08		250		25		1.0E+03		25550		2.5E-05		5.7E-04		1.4E-08

Indoor Worker- Evaluation of Noncancer Hazard

Ingestion of Dust

Chemical	C (mg/cm ²)	x	SA _{iw} (cm ² /contact event)	x	f _d (unitless)	x	f _{d-m} (unitless)	x	EV (event/d)	x	FT _{surf-sk} (unitless)	x	FT _{sk-m} (unitless)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	/	BW _{iw} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	2.02E-04		2848		0.25		0.1		3		0.1		0.3		250		25		80		9125		1.1E-05		2.0E-05		0.55

Dermal Contact with Dust

Chemical	C (mg/cm ²)	x	SA _{iw} (cm ² /contact event)	x	f _d (unitless)	x	EV (event/d)	x	FT _{surf-sk} (unitless)	x	DAF (unitless)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	/	BW _{iw} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	2.02E-04		2848		0.25		3		0.1		1.4E-01		250		25		80		9125		5.2E-05		2.0E-05		2.59

Inhalation of Dust

Chemical	C (mg/cm ²)	x	CF (cm ² /m ²)	x	InhR (m ³ /hr)	x	K (1/m)	x	ET _i (hr/d)	x	EF _{iw} (d/yr)	x	ED _{iw} (yr)	/	BW _{iw} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	2.02E-04		1.00E+04		1.2		5.00E-08		8		250		25		80		9125		8.3E-09		2.0E-05		0.00042

Risk Calculations for Outdoor Worker Scenario

Outdoor Worker- Evaluation of Cancer Risk

Soil																											
Ingestion of Soil																											
Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _s (unitless)	x	GAF (unitless)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk						
PCB Aroclors	4.87		0.0001		1.0E-01		1		225		25		80		25550		1.3E-07		2.0E+00		2.7E-07						
Dermal Contact with Soil																											
Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _s (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	4.87		3527		1.0E-01		0.06		0.14		0.000001		1		225		25		80		25550		4.0E-08		2.0E+00		7.9E-08
Inhalation of Vapor/Dust from Soil																											
Chemical	C (mg/kg)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _s (unitless)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	x	CF (µg/mg)	/	AT (d)	=	LADC (µg/m ³)	x	Inhalation UR (µg/m ³) ⁻¹	=	Cancer Risk						
PCB Aroclors	4.87		1.19E-06		7.14286E-10		1.0E-01		225		25		1.0E+03		25550		1.3E-04		1.0E-04		1.3E-08						
Sedimentation Basin Sediment																											
Ingestion of Sediment																											
Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk						
PCB Aroclors	1900.00		0.0001		1.0E+00		1		4		25		80		25550		9.3E-06		2.0E+00		1.9E-05						
Dermal Contact with Sediment																											
Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	1900.00		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		25550		2.8E-06		2.0E+00		5.5E-06
Inhalation of Vapor/Dust from Sediment																											
Chemical	C (mg/kg)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _{sed} (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	x	CF (µg/mg)	/	AT (d)	=	LADC (µg/m ³)	x	Inhalation UR (µg/m ³) ⁻¹	=	Cancer Risk						
PCB Aroclors	1900.00		1.19E-06		7.14286E-10		1.0E+00		4		25		1.0E+03		25550		8.8E-03		1.0E-04		8.8E-07						
Clearwell Sediment																											
Ingestion of Sediment																											
Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk						
PCB Aroclors	8.98		0.0001		1.0E+00		1		4		25		80		25550		4.4E-08		2.0E+00		8.8E-08						
Dermal Contact with Sediment																											
Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	8.98		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		25550		1.3E-08		2.0E+00		2.6E-08
Inhalation of Vapor/Dust from Sediment																											
Chemical	C (mg/kg)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _{sed} (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	x	CF (µg/mg)	/	AT (d)	=	LADC (µg/m ³)	x	Inhalation UR (µg/m ³) ⁻¹	=	Cancer Risk						
PCB Aroclors	8.98		1.19E-06		7.14286E-10		1.0E+00		4		25		1.0E+03		25550		4.2E-05		1.0E-04		4.2E-09						

Risk Calculations for Outdoor Worker Scenario

Wastewell Sediment

Ingestion of Sediment

Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	3.40		0.0001		1.0E+00		1		4		25		80		25550		1.7E-08		2.0E+00		3.3E-08

Dermal Contact with Sediment

Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	3.40		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		25550		4.9E-09		2.0E+00		9.9E-09

Inhalation of Vapor/Dust from Sediment

Chemical	C (mg/kg)	x	[1/VF (kg/m ³)	+	1/PEF (kg/m ³)	x	f _{sed} (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	x	CF (µg/mg)	/	AT (d)	=	LADC (µg/m ³)	x	Inhalation UR (µg/m ³) ⁻¹	=	Cancer Risk
PCB Aroclors	3.40		1.19E-06		7.14286E-10		1.0E+00		4		25		1.0E+03		25550		1.6E-05		1.0E-04		1.6E-09

Risk Calculations for Outdoor Worker Scenario

Outdoor Worker- Evaluation of Noncancer Hazard

Soil

Ingestion of Soil

Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _s (unitless)	x	GAF (unitless)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		0.0001		1.0E-01		1		225		25		80		9125		3.8E-07		2.0E-05		0.019

Dermal Contact with Soil

Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _s (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		3527		1.0E-01		0.06		0.14		0.000001		1		225		25		80		9125		1.1E-07		2.0E-05		0.0056

Inhalation of Vapor/Dust from Soil

Chemical	C (mg/kg)	x	InhR (m ³ /hr)	x	[1/VF (kg/m ³)	+	1/PEF (kg/m ³)	x	f _s (unitless)	x	ET _{ow} (hr/d)	x	EF _{soil_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		1.6		1.19E-06		7.14E-10		1.0E-01		8		225		25		80		9125		5.7E-08		2.0E-05		0.0029

Sedimentation Basin Sediment

Ingestion of Sediment

Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	1900.00		0.0001		1.0E+00		1		4		25		80		9125		2.6E-05		2.0E-05		1.3

Dermal Contact with Sediment

Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	1900.00		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		9125		7.7E-06		2.0E-05		0.39

Inhalation of Vapor/Dust from Sediment

Chemical	C (mg/kg)	x	InhR (m ³ /hr)	x	[1/VF (kg/m ³)	+	1/PEF (kg/m ³)	x	f _{sed} (unitless)	x	ET _{ow} (hr/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	1900.00		1.6		1.19E-06		7.14E-10		1		8		4		25		80		9125		4.0E-06		2.0E-05		0.20

Clearwell Sediment

Ingestion of Sediment

Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	8.98		0.0001		1.0E+00		1		4		25		80		9125		1.2E-07		2.0E-05		0.0062

Dermal Contact with Sediment

Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	8.98		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		9125		3.6E-08		2.0E-05		0.0018

Inhalation of Vapor/Dust from Sediment

Chemical	C (mg/kg)	x	InhR (m ³ /hr)	x	[1/VF (kg/m ³)	+	1/PEF (kg/m ³)	x	f _{sed} (unitless)	x	ET _{ow} (hr/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	8.98		1.6		1.19E-06		7.14E-10		1		8		4		25		80		9125		1.9E-08		2.0E-05		0.00093

Risk Calculations for Outdoor Worker Scenario

Wastewell Sediment

Ingestion of Sediment

Chemical	C (mg/kg)	x	IR _{ow} (kg/d)	x	f _{sed} (unitless)	x	GAF (unitless)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	3.40		0.0001		1.0E+00		1		4		25		80		9125		4.7E-08		2.0E-05		0.0023

Dermal Contact with Sediment

Chemical	C (mg/kg)	x	SA _{ow} (cm ² /event)	x	f _{sed} (unitless)	x	AF (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _o (event/d)	x	EF _{sed_ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	3.40		3527		1.0E+00		0.06		0.14		0.000001		1		4		25		80		9125		1.4E-08		2.0E-05		0.00069

Inhalation of Vapor/Dust from Sediment

Chemical	C (mg/kg)	x	InhR (m ³ /hr)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _{sed} (unitless)	x	ET _{ow} (hr/d)	x	EF _{sed-ow} (d/yr)	x	ED _{ow} (yr)	/	BW _{ow} (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	3.40		1.6		1.19E-06		7.14E-10		1		8		4		25		80		9125		7.1E-09		2.0E-05		0.00035

Risk Calculations for Trespasser Scenario

Trespasser- Evaluation of Cancer Risk

Ingestion of Soil

Chemical	C (mg/kg)	x	IR _t (kg/d)	x	f _s (unitless)	x	GAF (unitless)	x	EF _t (d/yr)	x	ED _t (yr)	/	BW _t (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Oral SF (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	4.87		0.0002		1.0E+00		1		10		10		45		25550		8.5E-08		2.0E+00		1.7E-07

Dermal Contact with Soil

Chemical	C (mg/kg)	x	SA _t (cm ² /event)	x	f _s (unitless)	x	AF _t (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _t (event/d)	x	EF _t (d/yr)	x	ED _t (yr)	/	BW _t (kg)	x	AT (d)	=	LADD (mg/kg-d)	x	Dermal SF (adj to absorbed value) (mg/kg-d) ⁻¹	=	Cancer Risk
PCB Aroclors	4.87		2373		1.0E+00		0.08		0.14		0.000001		1		10		10		45		25550		1.1E-08		2.0E+00		2.3E-08

Inhalation of Vapor/Dust from Soil

Chemical	C (mg/kg)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _s (unitless)	x	EF _t (d/yr)	x	ED _t (yr)	x	CF (µg/mg)	/	AT (d)	=	LADC (µg/m ³)	x	Inhalation UR (µg/m ³) ⁻¹	=	Cancer Risk
PCB Aroclors	4.87		1.19E-06		7.14286E-10		1.0E+00		10		10		1.0E+03		25550		2.3E-05		1.0E-04		2.3E-09

Trespasser- Evaluation of Noncancer Hazard

Ingestion of Soil

Chemical	C (mg/kg)	x	IR _t (kg/d)	x	f _s (unitless)	x	GAF (unitless)	x	EF _t (d/yr)	x	ED _t (yr)	/	BW _t (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Oral RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		0.0002		1.0E+00		1		10		10		45		3650		5.9E-07		2.0E-05		0.030

Dermal Contact with Soil

Chemical	C (mg/kg)	x	SA _t (cm ² /event)	x	f _{sed} (unitless)	x	AF _t (mg/cm ²)	x	DAF (unitless)	x	CF (kg/mg)	x	EV _t (event/d)	x	EF _t (d/yr)	x	ED _t (yr)	/	BW _t (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Dermal RfD (adj to abs value) (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		2373		1		0.08		0.14		0.000001		1		10		10		45		3650		7.9E-08		2.0E-05		0.0039

Inhalation of Vapor/Dust from Soil

Chemical	C (mg/kg)	x	InhR (m ³ /hr)	x	[1/VF (kg/m ³)	+	1/PEF] (kg/m ³)	x	f _{sed} (unitless)	x	ET _t (hr/d)	x	EF _t (d/yr)	x	ED _t (yr)	/	BW _t (kg)	x	AT (d)	=	ADD (mg/kg-d)	/	Inhalation RfD (mg/kg-d)	=	Noncancer Hazard
PCB Aroclors	4.87		2		1.19E-06		7.14E-10		1		1		10		10		45		3650		7.0E-09		2.0E-05		0.00035