Former Municipal Solid Waste Incinerator

Human Health and Ecological Risk Assessment

Prepared for

City of Sitka
Sitka, Alaska

Former Municipal Solid Waste Incinerator

Human Health and Ecological Risk Assessment

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Acronyms and Abbreviations

AWQC	ambient water quality criteria
CCC	criterion continuous concentration
City	City and Borough of Sitka
College	Sheldon Jackson College
CoPC	chemical of potential concern
CSF	carcinogenic slope factor
CSM	conceptual site model
CTE	central tendency exposure
DEC	Alaska Department of Environmental Conservation
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
former facility	municipal waste-to-energy facility
FWS	U.S. Fish and Wildlife Service
HHRA	human health risk assessment
IEUBK	integrated exposure uptake/biokinetic
ISQG	interim sediment quality guideline
LOAEL	lowest-observed-adverse-effect level
MCL	maximum contaminant level
NCP	National Contingency Plan
NEC	no-effect concentration
NOAEL	no-observed-adverse-effect level
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbon
PCDD/F	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
PEC	probable effect concentration
PEL	probable effects level
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RBA	relative bioavailability adjustment
RBC	risk-based concentration
RfD	reference dose
RME	reasonable maximum exposure
RRO	residual-range organics
SLERA	screening-level ecological risk assessment
SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzo-*p*-dioxin
TEC	threshold effect concentration
TEQ	toxicity equivalent quotient
TRV	toxicity reference value
UCL	upper confidence limit
VOC	volatile organic compound
WTE	waste-to-energy facility

Executive Summary

The City and Borough of Sitka (the City) operated a municipal waste-to-energy facility (the former facility) from 1985 through 2000, under a cooperative agreement with Sheldon Jackson College (the College). Operation of the former facility and past waste handling practices have been linked to the detection of metals and polychlorinated dibenzo-*p*-dioxins and polychlorinated furans (PCDD/Fs) at concentrations greater than the Alaska Department of Environmental Conservation (DEC) residential cleanup levels within onsite and offsite soils and an adjacent wetland area. In addition to the former facility, a separate boiler (the Cleaver-Brooks boiler, hereafter termed the College heating boiler) and associated fuel tanks operated by the College may also have contributed many of the same chemicals to onsite and offsite media.

A human health risk assessment (HHRA) and screening-level ecological risk assessment (SLERA) were conducted to assess whether adverse impacts to human health or the environment could occur now or under reasonably likely future use, as a result of direct or indirect exposure to site-related chemicals. The risk assessment was focused on evaluating the incremental risk related to operations of the former facility and was developed in consideration of comments received from DEC, the College, and the Sitka Tribe on the April 2003 *Draft Conceptual Site Model and Risk Assessment Work Plan* for the site. A draft risk assessment was provided in August 2003. This final version incorporates comments provided by DEC and by the Sitka Tribe on that draft, and incorporates findings from additional sediment samples collected from the flume. The results of the risk assessment are intended to help risk managers determine what actions, if any, are necessary to reduce those impacts. Any additional site characterization or future remedial measures will also take into consideration the possibility of sites of cultural significance (e.g., grave sites) within the affected areas.

Conceptual Site Model

Past operation of the former facility has resulted in concentrations of metals, PCDD/Fs, polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbon residuals. Ash from the incinerator operation is a likely source of metals, PCDD/Fs, and PAHs. Ash was primarily deposited into the adjacent area by runoff and washing of site surfaces. The petroleum hydrocarbons (and possibly some of the PAHs) are likely related to the College heating boiler, although past operation of the former facility may also have contributed some petroleum hydrocarbons and PAHs. Site history indicates that ash from former operations of the facility is likely present under the former facility paving. There are no current plans to disturb this covering and institutional controls will be developed together with DEC to maintain the covering and to assure nonresidential site use. These constituents are present on the hillside next to the former facility and in the wetland sediments adjacent to the site at concentrations greater than DEC screening levels.

Some apparent migration of PCDD/Fs and metals to the flume sediments immediately adjacent to the site was also detected in one sample taken in 2003. The City and DEC then worked with Exponent staff and James Clare, PE, LLC, to agree upon three additional locations including

one upgradient and two downgradient locations, which were sampled in March 2004 (Clare 2004) and analyzed for PCDD/Fs and metals. Analytical results from these locations did not identify an increase over background concentrations of metals or PCDD/Fs in sediments at these locations. These findings suggested that any migration from the site is limited to the flume sediments immediately adjacent to the wetland.

Juvenile salmon were present in this area in the spring of 2003. Two composite fish samples (one composed of 15 smolts and a second composed of 27 smolts) were analyzed for the site chemicals of potential concern (CoPCs): one from the wetland and one from the flume upgradient of the culvert. The composite fish sample from the wetland had the same PCDD/F toxicity equivalent concentration as the composite sample from the upgradient flume location. Thus, although the data are limited and there may be some uncertainty related to movement of fish, there does not appear to be an elevation of PCDD/F concentrations.

Metals concentrations that were higher in fishes from the wetland areas included cadmium, lead, and mercury, but mercury concentrations appeared to be consistent with general background. Fish tissue samples were also compared with risk-based concentrations (RBCs) derived based on human health criteria and only cadmium exceeded both its upstream concentration and RBC (no RBC was available for lead). Given the limited exceedances of the conservative risk-based screening value, there does not appear to be a human health hazard related to the food chain pathway for people, and therefore that pathway was not included in the HHRA. Although the data for salmon smolts provide useful information for evaluating bioaccumulation, they do not represent concentrations in adult fishes as they would be consumed by people. Instead, any site-related influence on adult fish tissue would be reduced by more than 100-fold as the fish increases its body size during time in the saltwater environment (e.g., in a 15 gram smolt versus a 1.5 kg adult). In addition, sediment samples taken from the flume in 2004 do not indicate a site-related increase in metals or PCDD/F concentrations in the flume. However, because juvenile salmon may serve as a food source for ecological receptors, fish tissue concentrations were evaluated in the SLERA.

Human Health Risk Assessment

The HHRA evaluated risk to human populations posed by current or future exposure to metals in soil, water, sediments, and biota in areas surrounding the site. The assessment was conducted consistent with guidance from DEC and the U.S. Environmental Protection Agency (EPA) and included the following four steps: identification of CoPCs, exposure assessment, toxicity assessment, and risk characterization. An uncertainty assessment was also included in the risk characterization to place potential site risks in context by discussing HHRA assumptions that may over- or underestimate potential site risks. Site CoPCs included metals (cadmium, chromium, lead, mercury), PAHs (benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene), and PCDD/Fs. Petroleum residuals (diesel-range organics and residual-range organics) also were present at concentrations greater than DEC cleanup levels and were evaluated in the uncertainty assessment.

Exposure Estimates for People Using the Site—The paved area of the former facility is currently used for the College boiler. However, this use does not involve activities in the

subsurface and therefore there are no current exposure pathways in this paved area. The most likely use of the nearby areas is recreational use by occasional visitors or by those who may visit grave sites adjacent to the facility. However, because the facility area is zoned for residential use, a hypothetical residential scenario was also evaluated. Potential exposures for the following receptors and exposure pathways are quantified in the HHRA:

- **Visitors to Grave Sites—**Adults or children who visit the grave sites could be exposed to chemicals in soils through ingestion and dermal contact. Visits were assumed to be infrequent (3–6 visits per year), but to occur over a long time period (30 years, including 24 years for adults and 6 years for a young child). (For example, the reasonable maximum exposure (RME) risk estimate for adults assumed 6 visits per year for 30 years.)

- **Occasional Visitors—**Visitors passing through the area during recreation or on their way to work or school might come into contact with chemicals in soil, sediment, and surface water in the wetland area and with soils in the forested areas. Potential exposures resulting from ingestion and dermal contact were estimated in a scenario assuming 12 to 24 visits per year over a 30-year period.

- **Receptors in Planned Daycare Center Area—**Potential exposures for adult workers and children in the daycare facility area were evaluated. Potential exposures resulting from ingestion and dermal contact were estimated in a scenario assuming exposures on 250 days per year over 6 years for a child and 25 years for an adult worker.

- **Hypothetical Future Residents—**A hypothetical residential scenario was evaluated here, in which adults or children come into contact with soils within the site area through ingestion or dermal contact using conservative residential exposure assumptions provided by EPA and DEC including exposure for 330 days per year over a 30-year period.

Both RME estimates and central tendency exposure (CTE) estimates were calculated, with the CTE estimates presented in the uncertainty assessment. Exposure point concentrations were derived using the lower of either a maximum concentration or an upper confidence limit on the mean concentration. This approach may overestimate site risks.

Findings and Conclusions of the HHRA—Risk estimates for all CoPCs were based on use of toxicity values, including carcinogenic slope factors to assess potential carcinogenic effects and reference doses to assess potential noncancer effects, derived by EPA and intended to provide a health protective means to evaluate potential human health risks.

The determination of an acceptable risk level is ultimately a decision to be made by risk managers. DEC has adopted risk management standards for evaluation of the incremental risk associated with a site. These standards were set to ensure the same level of protection of human health for all land uses. Consistent with these standards, the findings of the HHRA were compared with the cumulative carcinogenic risk level of 1×10^{-5} and a hazard index of 1.

Two potential exposure scenarios in the RME scenarios resulted in risk estimates greater than the cumulative carcinogenic risk level of 1×10^{-5} identified in the DEC regulations. These included the occasional visitor scenario, where the cumulative carcinogenic risk estimates were 2×10^{-5} for the adult and 3×10^{-5} for the child; and the adult and child in the hypothetical future residential scenarios, which had risk estimates of 3×10^{-4} and 5×10^{-4}, respectively. In each of these risk estimates, the majority of site risks were associated with PCDD/Fs. The highest hazard index was a cumulative hazard index of 1.2 for children in the hypothetical future residential scenario associated with exposure to cadmium and chromium. All other hazard indices were below 1, suggesting that no adverse effects would be expected under the exposure conditions evaluated.

Risk estimates for the daycare center and for grave site visitors were well within the acceptable level identified by DEC. Calculations presented in Section 3.4.4 suggested that even if more frequent visits were assumed for these exposure scenarios, risks for site visitors would be within acceptable levels.

Although DEC has identified a cumulative carcinogenic risk level of 1×10^{-5} as a starting point, DEC regulations also identify a number of considerations in evaluating risk estimates including potential future site use. The slight elevation over the 1×10^{-5} risk level in the occasional visitor scenario can be considered in light of the potential for overestimation of risk associated with the exposure assumptions (i.e., 24 visits per year for 6 years for a young child). In addition, the future residential use of the area is highly unlikely given the small size, the location, and the steep slopes adjacent to the facility. Moreover, the CTE estimates for the future residential scenario had risk estimates of 1×10^{-5} and 6×10^{-5}, resulting largely from the application of an average concentration for PCDD/F instead of the maximum PCDD/F concentration, which was used in the RME estimates. Nevertheless, this assessment would suggest that residential uses should be prevented through some means that can be agreed upon by all parties. In addition, future uses of the former facility pad that would require removing the pavement should be restricted and should require proper health and safety practices to prevent unacceptable human exposures.

Ecological Risk Assessment

The SLERA evaluated the likelihood of adverse effects to ecological receptors occurring in habitats adjacent to the former facility that may be associated with any releases of hazardous waste and/or hazardous constituents. The results of the SLERA can be used to eliminate exposure pathways or contaminants from further consideration of ecological risk. The assessment was conducted consistent with guidance from DEC and EPA and included selection of assessment and measurement endpoints, receptor species, screening benchmarks, and food-web exposure models. An uncertainty assessment was also included to place exceedances of screening values in an ecological context by discussing screening assumptions that may over- or underestimate the risk of adverse effects to ecological receptors. Site CoPCs included metals (cadmium, chromium, lead, mercury), PAHs, and PCDD/Fs.

The maximum concentrations of CoPCs in soil, sediment, and surface water in the study area were compared against screening benchmarks to evaluate risk to terrestrial plants, soil fauna,

and freshwater aquatic life. Screening benchmarks represent ambient media concentrations of a chemical that, if exceeded, could indicate the occurrence of adverse effects to ecological receptors. Exceedance of screening values may indicate the need for further evaluation of the risk associated with a chemical.

The presence of incinerator-related CoPCs in sediments, soils, surface water, and fish tissue indicates that exposure pathways to wildlife exist through contact with sediment, soil, surface water, and food consumption. Risk to avian and mammalian receptors was evaluated using a simple food-web exposure model. Conservative assumptions were made throughout the modeling exercise to minimize the possibility of a false negative finding at the screening stage. These assumptions included using the maximum CoPC concentrations in food, sediment, soil, and water to evaluate exposure, maximizing the time spent by receptors at the former facility, and no-adverse effect level toxicity thresholds. Risk was evaluated for aquatic piscivorous birds and mammals (represented by the great blue heron and mink), terrestrial vermivorous birds and mammals (represented by the American robin and masked shrew) and terrestrial herbivorous mammals (represented by the Sitka mouse). Conservative food-web models indicated a very low likelihood of adverse effects to piscivorous wildlife. Risk of adverse effects to terrestrial wildlife could not be shown to be insignificant, but considerable uncertainty was associated with this conclusion, largely associated with the accuracy of assumptions made regarding dietary exposures to CoPCs. However, even in these cases, adverse ecological impacts, should they occur, would affect only a few individuals of the receptor species, and would be highly unlikely to be reflected in effects at the population level.

The screening evaluation has considered the likelihood of adverse effects to ecological receptors occurring in habitats adjacent to the former facility that may be associated with any releases of hazardous constituents from that facility. The conclusions of the SLERA are:

- Metals (cadmium, chromium, lead, and mercury) in wetland surface water exceed EPA's ambient water quality criteria indicating a potential for unacceptable adverse effects to aquatic organisms in that area.
- Metals (cadmium, chromium, lead, and mercury) and PCDD/Fs exceed screening criteria in wetland sediments and sediments at the location where the wetland empties into the flume. However the lack of criteria exceedances in the three flume sediment samples collected upstream or downstream of the outlet indicates that the area where adverse effects to benthic organisms could occur appears to be spatially limited to within the wetland area and does not expand into the flume. Metals and PCDD/Fs in flume samples did not identify concentrations greater than background levels, further suggesting that migration from the site is limited to the flume sediments immediately adjacent to the wetland.
- Food web modeling did not identify adverse effects to piscivorous wildlife that forage in the wetland or the flume.
- Metals (cadmium, chromium, lead, and mercury) in soils adjacent to the former facility exceed screening benchmarks, indicating a potential for unacceptable adverse effects to plants and soil fauna in that area.

Although the screening-level calculations identified risks to vermivorous and herbivorous wildlife species associated with the terrestrial ecosystem, more representative consideration of the degree of intake from the affected area suggests that the likelihood of adverse risk is low and would affect only a few individuals of the receptor species. Population-level risks are highly unlikely given the size and nature of the site.

Overall Conclusions

The HHRA did not identify any risks above levels identified as acceptable by DEC for current uses of the site or the planned daycare area. The hypothetical residential scenario risk estimates for the RME scenario were greater than acceptable risk levels. However, the future residential use of the area is highly unlikely given the small size, the location, and the steep slopes adjacent to the facility. Moreover, the CTE estimates for the future residential scenario had risk estimates of 1×10^{-5} and 6×10^{-5}, resulting largely from the application of an average concentration for PCDD/F instead of the maximum PCDD/F concentration. Nevertheless, this assessment would suggest that residential uses should be prevented through some means that can be agreed upon by all parties. In addition, future uses of the former facility pad that would require removing the pavement should be restricted and should require proper health and safety practices to prevent unacceptable human exposures.

Ecological risk estimates were conducted using highly conservative screening-level assumptions and could not rule out risks to aquatic organisms, benthic invertebrates, terrestrial plants, soil fauna, and terrestrial wildlife. The area where risks to aquatic organisms or benthic invertebrates could occur is restricted to the wetland area, and does not expand into the adjacent flume. Consideration of more representative exposure and toxicity assumptions regarding intake from the affected area suggests risks to terrestrial wildlife would be limited to a few individuals, at most, of each receptor species, and would not translate into population-level effects.

Sampling conducted in the spring of 2003 indicated that PCDD/Fs were detected in flume sediments directly adjacent to the site. However, following this finding two additional downgradient samples and one upgradient sample were taken in March of 2004. These sediments had PCDD/Fs and metals concentrations consistent with background concentrations, suggesting that migration from the wetland area is limited to the flume sediments immediately adjacent to the wetland.

1 Introduction

The City and Borough of Sitka (the City) operated a municipal waste-to-energy (WTE) facility (the former facility) from 1985 though 2000, under a cooperative agreement with Sheldon Jackson College (the College). Operation of the former facility and past waste handling practices have been linked to the detection of metals and polychlorinated dibenzo-*p*-dioxins and polychlorinated furans (PCDD/Fs) at concentrations greater than the Alaska Department of Environmental Conservation (DEC) residential cleanup standards within onsite and offsite soils and an adjacent wetland area. In addition to the former facility, a separate boiler (the Cleaver-Brooks boiler, hereafter termed the College heating boiler) and associated fuel tanks operated by the College may also have contributed many of the same chemicals to onsite and offsite media.

In April 2003, Exponent submitted a draft conceptual site model (CSM) and risk assessment work plan for the former municipal solid waste incinerator facility and downgradient areas (the site) on behalf of the City (Exponent 2003). The CSM identified chemical sources, complete exposure pathways, and potential receptors to be evaluated in the human health and ecological risk assessments and the work plan identified the approach to be applied in the risk assessment to meet relevant requirements set out by DEC and the U.S. Environmental Protection Agency (EPA). The CSM also identified additional data needed to complete characterization of exposure pathways at the site. Comments on the CSM from DEC, the College, and the Sitka Tribe resulted in additional sampling beyond that initially proposed in the draft CSM (Appendix A).

This document presents the results of the human health risk assessment (HHRA) and the screening-level ecological risk assessment (SLERA). This document replaces the draft HHRA and SLERA provided in August 2003, and incorporates comments on the draft received from the Sitka Tribe, the City, the College, and DEC. Comments and responses from the Sitka Tribe are provided in Appendix A. The purpose of the site risk assessment is to determine whether adverse impacts to human health or the environment could occur now or under reasonably likely future use, as a result of direct or indirect exposure to site-related chemicals. The risk assessment was focused on evaluating the incremental risk related to operations of the former facility. The results of the risk assessment are intended to help risk managers determine what actions, if any, are necessary to reduce those impacts. Any future remedial measures must take into consideration the possibility of sites of cultural significance (e.g., grave sites) within the affected areas.

The exposure pathways identified in the CSM and in subsequent comments are the focus of the risk assessments. The risk assessment provides estimates of the magnitude and probability of risks to human and ecological receptors posed by current or hypothetical future exposure to site-related contaminants in any affected media. Media evaluated include soil, water, sediments, and biota at the site. This risk assessment focuses on elements described in Section 3.0 and Section 4.0 of DEC's *Risk Assessment Procedures Manual* (DEC 2000b).

1.1 Organization

This document begins with a brief summary of site background information that includes site history, physical characteristics, climate, land use, and demographics. This is followed by a summary of the site data, the CSM and then the human health and ecological risk assessments. Appendix A provides the comments received on the draft HHRA and the responses to those comments, and Appendix B provides detailed risk assessment spreadsheets.

1.2 Site History, Description, and Cultural Resources

1.2.1 Site History

The areas to be considered in the risk assessments include the former facility and any affected downgradient areas (see Figures 1 and 2). The former facility was located off Sawmill Creek Road on land owned by the College. The City built the former facility in 1985 in cooperation with the College and operated it through 2000. Incineration of municipal waste was used to generate steam heat, which was provided to the College in exchange for use of the land. The College also operated an oil-fired boiler during much of the same period; this oil-fired boiler continues to operate and generate heat for the college. From 1985 through 1997 most of the former facility area was not paved. Approximately 2,000 tons per year of flyash and bottom ash were generated in the incineration process. Flyash, which was later determined to contain metals and PCDD/Fs, was inadvertently released at the former facility and was also washed offsite into the nearby marshy area. In 1994, concerns raised by Sitka citizens led to an EPA investigation of the facility, which concluded that heavy metals had likely migrated to nearby soils as a result of poor ash handling. The former facility property was paved as a result of the EPA investigation. The City gave a one-year notice of closure in 1999 and the facility ceased operations in August 2000 (Bevan 2001, pers. comm.).

1.2.2 Site Description

At present, the site includes the paved footprint of the former incineration facility, and the immediately surrounding areas (see Figures 1 and 2). Adjacent to the former facility there is a steep slope covered with rock fill. It ends in a marsh area running approximately 120 ft along the south edge of the facility. The marsh area is approximately 40 to 60 ft wide and is bordered to the south by a footpath between the facility and the back of the Hames P.E. Center. On the downward slope of the southeast corner of the former facility there is a visible deposit that appears to be ash, which may have originated from a storm drain outfall from the former facility. Adjacent to the site to the east is a forested area, which slopes downward approximately 60 to 80 ft to a pathway through the campus.

Downgradient from the forested area and the marshy area is a flume, which originates from Indian River, flows south past the site then in an easterly direction, ultimately rejoining with the Indian River (Figures 1 and 2). Some of the water from the flume is diverted by pipe to the salmon hatchery on the campus. The water from the flume is used to feed the penstock that runs to the fish holding pens next to the hatchery. This water serves to imprint fish, and release to

the channel allows fish to home into the "stream" and the holding pens. A separate flow of Indian River water, carried by a high-density polyethylene pipe, supplies water to flush the incubators within the hatchery. Thus, the water from the flume is not the entire water supply for the hatchery.

1.2.3 Cultural Resources

Within this forested area to the east of the former facility, there are grave sites with at least 24 graves dating from the late 1900s to the present (Mobley 2000; Clare 2001c). The burial grounds were primarily a final resting place for deceased students during the time-period that the College was a boarding school for primary and secondary students. However, other burials occurred there as well. Further discussion of these cultural resources is provided in Attachment B to this report, which includes *Cultural Resource Investigations for the Proposed Sitka Fire Station, Baranof Island, Alaska* (Mobley 2000), and a summary of grave sites prepared by Jim Clare (Clare 2001c). The area with known graves and surroundings was considered in the risk assessment to evaluate potential for visitors to contact chemicals from the former facility. No actions are planned that may disturb these areas. However, any future measures that might affect cultural resources will be considered together with the College, the Sitka Tribe, and interested members of the public.

1.3 Summary of Existing Data

The CSM and risk assessments draw on data and analyses from existing reports. The CSM and risk assessments also draw from a meeting and site walk on February 11, 2003, conducted by Hugh Bevan for the City and attended by Jessica Brown for the Sitka Tribe; Stuart Denslow for the College; James Clare, PE, as the City's consultant on sampling; Lisa Yost and Nicholas Gard from Exponent as the City's consultants on human health and ecological risk assessment, respectively. As described above, an initial investigation was conducted in 1994 and indicated that past handing of ash from the former facility likely resulted in offsite migration of metals (Bevan 2001, pers. comm.). Subsequently, three investigations were conducted for the City by their consultant, James Clare, PE, LLC, with oversight from DEC. Targeted analytes were selected inorganic chemicals, petroleum hydrocarbons, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), and PCDD/Fs. The first investigation, entitled *Soil Characterization Report and Sample Results* (Clare 2001a), reported analytical results for selected metals, polycyclic aromatic hydrocarbons (PAHs), VOCs, Aroclor® 1260, petroleum hydrocarbons and PCDD/Fs in soil samples collected at the perimeter of the former facility. Metals targeted were cadmium, chromium, lead, and mercury.[1] An apparent ash deposit was noted near the former facility storm drain outfall and signs of recent trash dumping were also observed in the vicinity of samples taken at locations 2S04, 2S05, 2S06, 2ESE07, and 2SE08.

[1] Although this was a limited list of metals, these are the most likely to have been associated with the incineration of residential trash from Sitka. No arsenic-treated wood was burned at this facility and thus, this potential arsenic source does not appear to be present. Uncertainties related to this approach are discussed in the *Risk Characterization* section.

These findings were supplemented by a second report entitled *Expanded Site and Off-site Migration Characterization Report and Sample Results* (Clare 2001b), which provided additional sampling results for the metals (cadmium, chromium, lead, and mercury) and petroleum hydrocarbon residuals (diesel-range organics [DRO] and residual-range organics [RRO]) in three soil samples, plus five sediment and four water samples. PCDD/F data were also obtained for four soil samples and one sediment sample.

In March and April 2003, additional sampling was conducted to address identified data gaps related to the potential for past or ongoing migration into the flume and paste aerial deposition onto the proposed daycare site location. Results were reported in the *Expanded Off-site Characterization – NE, SJC Daycare Site, Hatchery Intake (Phase 4) Final Report* (Clare 2003). This sampling of soil, sediment, water, and fish focused on previous contaminants of concern and PAHs in sediment. Two soil samples were collected from the northeast and east boundaries of the former WTE site in an area associated with grave sites. Two additional soil samples were collected from the site for a proposed daycare center. These soil samples were analyzed for metals and PCDD/Fs. Two sediment samples were also collected. One was taken within the wetland area adjacent to the culvert that flows to the flume (2SE08-04) and the other (3SE03) was collected within the flume near the culvert outlet. The sediment samples were analyzed for PAHs; the flume sample was also analyzed for metals and PCDD/Fs. A water sample was collected at the sediment location in the flume and analyzed for petroleum hydrocarbons. In March 2004 three additional flume samples, including two downgradient samples (4SE06 at the intake to the hatchery and 4SE05, midway between the former facility and the hatchery sample) and one upgradient sample (4NE04), were collected and analyzed for PCDD/Fs, cadmium, chromium, lead, and mercury. This sampling effort and these results are

reported in *Flume Sediment Sampling (Phase 5) Portion of USS 407, Tract B, Sheldon Jackson College 802 Sawmill Creek Road, Sitka, Alaska* (Clare 2004). The analytical results of soil, sediment, and water samples reported in these four investigations are provided in Tables 1-1 through 1-6.

Four fish traps were set for minnow in the large "upper" pond (Figure 2, Sample 41903JCP01). Two traps in the lower pond produced no fish. Three additional minnow traps were set in the flume upstream of the culvert (Figure 2, Sample 41903JCC02) for comparison purposes. The two composite fish samples were analyzed for metals, PAHs and PCDD/Fs. The composite from the wetland area (Sample 41903JCC02) consisted of 15 salmon smolts, mostly Coho salmon, and the composite from the upstream area (Sample 41903JCP01) consisted of 27 salmon smolts, mostly Coho salmon with at least one king. Thus, although there were two fish samples, the compositing produced more representative information about the overall concentrations of chemicals of potential concern (CoPCs). The fish tissue analytical results are reported in Tables 1-7 and 1-8.

Sample results further defined soil, sediment substrate, and surface water contamination surrounding the former facility. The highest concentrations of detected chemicals were in soil and sediment to the south and southeast of the former facility area and the active College heating boiler (Figure 2). The report noted that greater heavy metal and petroleum hydrocarbon concentrations were detected along storm water runoff routes and in the vicinity of fuel and

flyash handling or transport. In addition, the highest PCDD/F concentration (as toxic equivalencies)[2] was identified with soil (Sample S7) to the south of the site.

[2] PCDD/Fs are evaluated within risk assessments through consideration of the congeners that are substituted at the 2,3,7,8 positions on the molecule. These congeners are assigned a toxic equivalence relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, which is considered to be the most toxic congener and has been the most studied. The congener concentrations are adjusted to reflect an equivalent toxicity relative to TCDD and the then all congeners are summed to derive a TEQ.

2 Conceptual Site Model

A CSM is a planning tool used for identifying chemical sources, complete exposure pathways, and potential receptors on which to focus the risk assessment. The CSM describes the network of relationships between chemicals released from a site and the receptors that may be exposed to the chemicals through pathways such as ingestion of food or water. The CSM examines the range of potential exposure pathways and identifies those that are present and may be important for human and ecological receptors; it eliminates those pathways that are incomplete and therefore do not pose a risk.

The following sections identify sources of chemicals and transport mechanisms as well as potential exposure pathways to be considered in the human health and ecological risk assessment. Following this CSM, the HHRA and SLERA identify exposure pathways and CoPCs that are quantitatively evaluated in the risk assessments. Flow chart illustrations of the human health and ecological CSMs are shown in Figures 3 and 4, respectively, and are also discussed in further detail in later sections.

2.1 Sources and Transport Mechanisms

2.1.1 Chemical Sources

Chemicals identified in site media include metals, PCDD/Fs, PAHs, and petroleum hydrocarbon residuals. Ash from the incinerator operation is a likely source of metals, PCDD/Fs, and PAHs. The petroleum hydrocarbons (and possibly some of the PAHs) are likely related to the College heating boiler, although past operation of the former facility may also have contributed some petroleum hydrocarbons and PAHs. Metals and PCDD/Fs, and possibly PAHs, could have been released from the site through stack emissions and subsequent aerial deposition. Ash was washed from site surfaces during some years of operation and, thus, direct washing and surface water runoff is another source of site-related chemicals in adjacent areas. This was a site maintenance procedure practiced prior to knowledge of the chemical concentrations present in ash. During site visits, what appeared to be an ash deposit was observed at the southeast corner of the former incinerator site (Clare 2001a).

Although no data on PCDD/F or metals concentrations in ash from the former facility were available for consideration in preparation of this assessment, EPA has compiled data on PCDD/Fs in bottom ash and flyash sampled at other municipal solid waste incinerators (U.S. EPA 1998b). Flyash was reported to have higher PCDD/F concentrations and to comprise 5 to 15 percent of the total ash. EPA reported PCDD/F toxicity equivalent quotient (TEQ) concentrations in ash from five state-of-the-art facilities in the United States as ranging from 106 to 466 ng/kg in mixed flyash and bottom ash. EPA also reported data indicating concentrations up to 13,000 ng/kg TEQ in flyash. The actual concentrations of PCDD/Fs in ash from the former facility is uncertain; however, the maximum concentration of PCDD/Fs of 4.13 μg/kg present in offsite sediments adjacent to the former facility is within the range of concentrations reported by EPA for municipal incinerators. The concentration in adjacent

wetland areas appears to be consistent with past releases of ash from the former facility during the time of operation. Releases of ash from washdown during site maintenance and through surface runoff during rainfall were likely more significant transport mechanisms than aerial transport and deposition.

2.1.2 Past and Ongoing Transport Mechanisms

Elevated concentrations of PCDD/Fs, metals, and PAHs detected in soil and sediments within adjacent areas are likely the result of past releases from the former facility. Airborne deposition of ash and direct deposition of ash (through washdown and surface runoff) were the likely past transport mechanisms. (Transport and exposure mechanisms are depicted schematically in Figures 3 and 4.) Past airborne deposition could have reached a radius surrounding the site including areas where graves are present (see Figures 1 and 2) and the campus area adjacent to the site where a daycare facility is planned. However, based on available data, the effect of past airborne deposition appears to be small relative to direct deposition. Petroleum hydrocarbons are likely attributable to the former facility, the ongoing College heating boiler operation, and additional unknown sources. Site-related petroleum hydrocarbon releases are likely the result of cumulative small releases during operations (e.g., related to vehicles and facility operation), as no significant spills have been reported.

Ongoing releases from the former facility footprint area are not expected because this area was paved in 1994 and the incinerator was shut down in August 2000. There is some potential for continued migration of chemicals from affected media. Possible offsite migration pathways include airborne migration or surface water runoff of contaminants in soil, sediments, or water to offsite areas including the flume adjacent to this area. Ongoing airborne migration could occur through volatilization or resuspension of particulates from site environmental media. However, the chemicals detected in the site media have low volatilities, therefore, transport volatilization is expected to be relatively insignificant. Airborne migration of particulates from the wetland area, where the majority of elevated concentrations were observed is expected to be minimal. Airborne migration from soils is also expected to be minimal because the high level of precipitation that occurs in the area (>85 in. per year) keeps soils moist a large part of the year (www.alaska.com/akcom/southeast/visit_travel/story/737603p-785361c.html).

Offsite migration through surface water runoff is also possible. Chemicals from the site may be carried in surface water through the wetland to the flume in a dissolved or particulate form. Migration is likely reduced by retention of contaminants in the organic fraction of the soils in downgradient areas. Available data indicate that concentrations decrease with distance from the former facility. However, there is some evidence that migration into the flume has occurred.

2.1.3 Non-site Sources of Chemicals

The main chemicals detected at the site all have multiple sources and thus, evaluation of downgradient migration may be complicated by sources other than former facility operations. Metals occur naturally in soils and sediments as a result of their presence in native rock. Petroleum residual may be found offsite resulting from multiple sources. PCDD/Fs can be generated from a wide variety of combustion sources; any detection in downgradient samples

must be considered in light of potential local and regional combustion sources. Relevant sources of background PCDD/Fs include combustion of wood and other biomass (either in residential wood combustion, vegetation burning, or in forest fires), automotive exhausts (both diesel and non-diesel), and backyard barrel burning of rubbish. EPA has reported national average background PCDD/F soil concentrations of 7.6 ng/kg TEQ in urban areas and 3.1 ng/kg TEQ in rural areas (U.S. EPA 2000a). Residential and forest soil samples in the Ketchikan area, that were not thought to be related to operation of that facility, had average concentrations of 6.85 and 5.1 ng/kg TEQ, respectively (Exponent 1998).

2.2 Considerations for Human Health

The potential for human contact with chemicals in site soils is highly dependent on assumed site use and the resulting potential exposure pathways. This section describes current and anticipated future site use including land ownership and use and groundwater use. Potential current and future human exposure pathways are illustrated in Figure 3, and discussed in more detail within the HHRA in Section 3.0.

2.2.1 Land Ownership and Use

The College owns the site area including the adjacent areas. The City has joint responsibility for the site related to former operations of the facility. The current use of the former facility footprint is for ongoing operation of an oil-fueled boiler that provides heat for the College. However, the surface of the former facility is paved and there are no plans that would require removal of paving material.

There is no residential use of this area, nor is any expected in the future. The College owns the land and future land use plans are to continue operation of the College heating boiler and campus maintenance facility. This clearly shows there is no intent to change site use to residential. There are adjacent residential properties within a half mile of the site. There is no specific land use within the small wetland areas adjacent to the site, although because this area is adjacent to a footpath, there may be site visitors. Visitors come to the grave sites located in the wooded areas to the east of the site. There is also some occasional use of the general area. The flume, adjacent to the wetland area, has a footpath and visitors may also walk along this area. These land uses are expected to remain in place in the future. The College has plans to place a daycare facility to the southwest of the Hames P.E. Center (Figure 2). The plans call for most of the soil surfaces at the daycare facility to be covered by crushed rock, clean fill, or paving. Chemical concentrations in samples collected at the daycare and grave site areas were lower levels, consistent with aerial deposition.

2.2.2 Groundwater Considerations

Drinking water for the areas under consideration comes from remote and pristine surface water resources. Specifically, the City and surrounding area get drinking water from Blue Lake, which is approximately 5 miles from the site and would not have been affected by former

facility operation. For this reason, groundwater and the protection of groundwater are not considered to be complete exposure pathways at this site.

2.3 Potential Exposure Pathways for Ecological Receptors

As described above, an exposure pathway is the course a CoPC takes from a source to an exposed receptor. As with human exposure, only those exposure pathways judged to be potentially complete are of concern for ecological receptors. The exposure pathways and receptors are illustrated in Figure 4.

Pathways by which ecological receptors may be exposed to CoPCs may exist for both terrestrial and aquatic communities in the vicinity of the former facility. Primary exposure pathways for terrestrial receptors include the consumption of water and food (plant material or prey) and the incidental ingestion of soil or sediment. Primary exposure pathways for aquatic receptors include the ingestion or uptake of surface water, consumption of prey, incidental ingestion of sediment, and direct contact with surface water. For most avian and mammalian receptors, dermal contact with affected sediment or soil and ingestion of surface water would be minor exposure pathways compared with the ingestion pathway. CoPCs could accumulate in the tissues of small mammals, and consumption of this prey by carnivorous predators could represent a potential exposure pathway to higher trophic levels that may occur in the habitat adjacent to the facility.

Runoff from the facility has resulted in deposition of CoPCs in the marshy area immediately downgradient of the facility, and to a much lesser degree, to the adjacent flume. Metals may be present either dissolved in the water column or bound to sediments; organic CoPCs will typically be bound to sediment. The limited extent and depth of the water in this marshy area suggests that use of the area by aquatic organisms would be limited. However, small fish (including salmonids) have been observed in the marshy area. It is unlikely that fish would reside permanently within this marshy area (most of the fish observed were juvenile salmonid species, which would spend a limited amount of time in this area before migrating). Benthic invertebrates may also be present in the sediment of the marshy area. About 5–10 small brown trout (approximately 3–5 in.) were seen in the flume during the February 11, 2003, site visit. If CoPCs have migrated into the flume, benthic invertebrates and fish could be exposed to CoPCs via uptake from or direct contact with sediment or water, and fish may also be exposed via ingestion of prey items, such as aquatic invertebrates. Higher trophic-level species that feed on aquatic invertebrates and fish, such as piscivorous birds and mammals, could be exposed to CoPCs via consumption of these prey items or via incidental ingestion of sediment while foraging. Contact with sediments and surface water and ingestion of surface water represent minor exposure pathways for piscivorous birds and mammals.

Aside from the fish in the wetland, the most significant of the possible downgradient receptors is the fish hatchery within the Sage Building (approximately 1,000 ft via the flume and underground piping) operated by the College, which is across the campus a considerable distance from the site. If site-related chemicals, particularly PCDD/Fs, reached the hatchery, there is potential for bioaccumulation in juvenile salmon. This potential is limited by the migratory nature of salmon, which limits the time they spend in a given feeding area.

3 Human Health Risk Assessment

This section describes the methodology used to evaluate risk to human health posed by current or future exposure to metals in soil, water, sediments, and biota in areas surrounding the site. This section then presents results of the four steps recommended in EPA guidance for risk assessment: identification of CoPCs, exposure assessment, toxicity assessment, and risk characterization (Figure 1). An uncertainty assessment is included in the risk characterization to place potential site risks in context. The uncertainty assessment discusses HHRA assumptions that may over- or underestimate potential site risks. The HHRA was conducted in accordance with risk assessment guidance provided by DEC (2000a,b, 2001a,b, 2002) and EPA (U.S. EPA 1989, 1991, 1992, 1996a, 1997a, 2001a, 2003a,b, 2004). These risk assessment elements are described in the following sections.

3.1 Identification of CoPCs for Human Health

All available concentration data were reviewed to identify a preliminary list of CoPCs for human health. CoPCs were identified in the soil, sediment and water collected from the site operations area perimeter. The data used are from three investigations reported by Clare (2001a,b, 2003). Additional data evaluated in the assessment included fish tissue samples collected in 2003 and sediment data collected in 2004. These data and the human health screening values are presented in Tables 1-1 through 1-8. Table 3-1 presents a summary of the CoPCs identified for the HHRA.

Water data were collected in July 2001 from four locations in the pond and analyzed for metals (cadmium, chromium, lead, and mercury), DRO, and RRO. One sample from near the culvert to the flume was also analyzed for petroleum hydrocarbons. In March 2003, a water sample was collected from the flume near the culvert outlet; it was also analyzed for petroleum hydrocarbons. Water data were compared to EPA maximum contaminant levels (MCLs), where available, from the *2002 Edition of the Drinking Water and Standards and Health Advisories* (U.S. EPA 2002b) and DEC groundwater cleanup levels (18 AAC 75.345, Table C [DEC 2003a]).[3] In screening, MCLs were not divided by 10, consistent with DEC guidance. Samples exceeded the screening criteria for some of the metals and for DRO/RRO (Table 1-1; Figure 2).

As described above, any subsurface water that may be present at the site is not considered a drinking water source. Consequently, sediment and soil data were compared with DEC soil cleanup levels (18 AAC 75.341, Table B1 [DEC 2003b]) based on direct contact (i.e., either through ingestion of soil or inhalation of particulates) rather than the DEC screening levels derived based on protection of groundwater. Because DEC does not provide a soil cleanup level for dioxins, the PCDD/F TEQs were compared to the Region 9 residential soil ingestion preliminary remediation goal (PRG) for dioxin as listed in the Region 9 PRG table 2002 update (U.S. EPA 2003a). In each case, the maximum concentration in each medium was compared to the human health risk-based concentration (RBC) using one-tenth of the soil and groundwater

[3] The MCL was used in this screening based on guidance in DEC (2001b).

cleanup levels as prescribed in Technical Memorandum 01-003–*Screening Procedure for CoPCs under Method Four* (DEC 2001b). Compounds were identified as CoPCs where the maximum concentration exceeded the respective RBC at either an excess cancer risk level of 1×10^{-6} or a noncancer hazard quotient of 0.1.[4]

Sediment data were collected in July 2001 from five locations in and near the wetland. Two additional sediment samples were collected in the flume and pond near the culvert in March 2003 (Tables 1-1, 1-2, and 1-3). One of these samples was analyzed for metals (3SE03). One 2001 sample and one 2003 sample were also analyzed for PCDD/Fs. Both 2003 samples were analyzed for PAHs. Three additional samples were collected from the flume, at one upgradient location and two downgradient locations, in March 2004 and analyzed for metals (cadmium, chromium, lead, and mercury) as well as PCDD/Fs. Results were compared to one-tenth of the DEC Method 2 soil cleanup levels for ingestion in the over 40-in. zone. PCDD/F TEQ results were compared to the Region 9 residential soil PRG, which accounts for ingestion, dermal contact, and inhalation. This value divided by ten is 0.39 ng/kg. Cadmium, chromium, lead, and mercury plus petroleum hydrocarbon residuals (DRO and RRO) exceeded their respective RBCs in sediment or soil. PCDD/F TEQ results for the two onsite sediment samples exceeded the Region 9 RBC for dioxin.

Sediment samples from downstream locations within the flume indicated little or no migration beyond the sample taken adjacent to the site (i.e., sample 3SE03). Additional sample results for cadmium, lead, and mercury were below screening levels. Chromium concentrations were higher than the RBC of 25 mg/kg, which represents one tenth of the derived concentration for residential soils. The highest chromium concentration of 56.3 mg/kg was detected at the sample location furthest downgradient (4SE06) and was not substantially different from the upgradient sample (4NE04), which had a concentration of 47.4 mg/kg (based on the average of two field duplicates), or the mid-way station which had a concentration of 41.1 mg/kg (4SE05) (Table 1-2). Similarly, PCDD/F concentrations in the three supplemental sampling locations ranged from 0.41 ng/kg to 3.2 ng/kg (as TEQ), which are all below typical background concentrations for sediments (Table 1-6). Specifically, U.S. EPA (2000a) dioxin reassessment identified 5.3 ng/kg TEQ as a "typical" background concentration of PCDD/Fs in sediments.

Soil data were collected in January 2001 at six locations and in July 2001 at the same locations. Additional soil data were collected in March 2003 at two locations near grave sites and at two depths at the site of the proposed daycare center. Soil data were compared to one-tenth of the DEC Method 2 soil cleanup levels for ingestion in the over 40-in. zone. Cadmium, chromium, lead, mercury, and PCDD/Fs exceeded their respective screening values for soil in samples near the pond south of the facility. Chromium also exceeded its screening value for soil ingestion in samples west and north of the former facility. Mercury in the grave site soil sample east of the facility was also above screening (Table 1-2). PAHs were elevated in one sample near the separator discharge plume (Table 1-3). All soil PCDD/F results exceeded the adjusted Region 9 RBC for dioxin (Table 1-6; Figure 2). Three of the undetected VOCs had reporting limits greater than their respective RBCs. They were bis[2-chloroethyl]ether, hexachlorobenzene, and

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[4] DEC risk-based concentrations are based on a cancer risk of 1×10^{-5} and a hazard index of 1. Consistent with DEC guidance, in screening these values were adjusted to represent a 1×10^{-6} cancer risk, or a hazard quotient of 0.1.

n-nitrosodi-*n*-propylamine (Table 1-5). Given the site use, these chemicals are not considered likely to be present.

The risk-based cleanup level for lead used by DEC (400 mg/kg) is based on output from the integrated exposure uptake/biokinetic (IEUBK) model developed by U.S. EPA (1994). Because the IEUBK model calls for average, rather than reasonable maximum exposure (RME) input assumptions, the lead screening level of 400 mg/kg should be compared with average site concentrations, not the maximum concentrations. The average site concentrations for lead were as follows: site-wide soil and sediments (except grave site and daycare samples) 559 mg/kg; site-wide soils (except grave site and daycare samples) 506; grave site area soils 240 mg/kg; and daycare samples 90 mg/kg. Thus, the site-wide samples evaluated with soils only or with soils and sediments were higher than the 400 mg/kg residential screening value. Lead is evaluated further within the risk characterization section.

In order to evaluate whether the inhalation pathway would be a substantial contributor to site risks, soil and sediment analytical results were compared to the DEC Method 2 soil cleanup levels for inhalation in the over 40-in. zone. The inhalation screening values are based on residential use and were also adjusted to one-tenth the cleanup level. Only lead, mercury, and the petroleum hydrocarbon residuals exceeded this screening comparison for the air pathway. Two of the undetected VOCs (bis[2-chloroethyl]ether and hexachlorobenzene) also had reporting limits greater than the screening levels, but they are not considered to be CoPCs. The mercury cleanup number identified by DEC is 13 mg/kg and the screening value used in this evaluation was 1.3 mg/kg (i.e., the residential RBC divided by 10). The maximum site concentration was 4.4 mg/kg, which is lower than the actual RBC, but about 3.3 times higher than the residential RBC/10. Given the fact that the screening value is based on residential use and that the value is divided by 10, the inhalation pathway is not expected to contribute substantially to site risks. Based on these comparisons, the inhalation pathway is not quantified in the risk assessment. The risk assessment discussions for petroleum hydrocarbons and lead include further qualitative consideration of this pathway.

As described above, two composite fish samples were collected from the wetland area adjacent to the site and in the flume upstream from the culvert and analyzed for metals, PAHs, and PCDD/Fs. Although the fish samples collected in April 2003 consisted of juvenile salmon that would not be part of the human diet, these results were evaluated to determine whether wetland fishes had concentrations greater than fishes collected in the flume. Cadmium, lead, and mercury were present at concentrations higher than those in upstream juvenile samples (Table 1-7). For PCDD/Fs, only heptachlorodibenzo-*p*-dioxin, heptachlorodibenzofuran, and octachlorodibenzofuran congeners were detected and the TEQs for upstream and wetland locations were both 3.4 ng/kg. This suggests that there was no PCDD/F elevation in fishes related to the wetland (Table 1-8). Mercury concentrations in salmon collected at the wetland and upstream location were also compared to available background data for salmon in Alaska. Specifically, mercury in both samples was lower than the background concentration for Alaskan salmon of 0.2 mg/kg reported by USGS (1994).

A number of PAHs were reported as detected ‘J’ flagged values in the wetland composite fish sample, at concentrations lower than the reported detection limits in the reference composite (Table 1-7). Thus, there is some uncertainty about the PAH concentrations. However, although

juvenile salmon sampled in composites are not representative of fish consumed, for comparison purposes the fish tissue concentrations were also compared with RBCs derived by EPA Region 3 based on consumption of 54 g/day of fish (U.S. EPA 2003b). The RBCs were adjusted to reflect a 10^{-6} cancer risk or a hazard index of 0.1. None of the PAH concentrations exceeded these RBCs, but both wetland and upstream composites of cadmium, mercury, and PCDD/Fs exceeded the RBCs. However, because mercury concentrations appear to be consistent with general background and the PCDD/F concentrations are equivalent with the upstream samples, these do not appear to be elevated.

Thus, although the data are limited and there may be some uncertainty related to movement of fish, there does not appear to be an elevation of PCDD/F concentrations. There is an apparent elevation in cadmium and lead concentrations in fishes from the wetland relative to that in upstream areas. Comparisons with RBCs identified only cadmium as exceeding both the RBC and the upstream concentration (no RBC was available for lead). Given the limited exceedances of the conservative risk-based screening value, there does not appear to be a human health hazard related to the food chain pathway for people, and therefore that pathway was not included in the HHRA. The data for salmon smolts provide useful information for evaluating bioaccumulation, but do not represent concentrations in adult fish that would be consumed by people. Instead, any site-related influence on adult fish tissue would be reduced by more than 100-fold (e.g., in a 15 gram smolt versus a 1.5 kg adult). Moreover, sediment samples taken from the flume in 2004 do not indicate a site-related increase in metals or PCDD/F concentrations in the flume (Tables 1-2 and 1-6). Although observed tissue concentrations do not appear to be site-related, the juvenile salmon do serve as a food source for ecological receptors. Therefore, fish tissue samples are further evaluated in the SLERA.

3.2 Exposure Assessment

Exposure assessment is the process of identifying human populations that could potentially contact site-related CoPCs and estimating the magnitude, frequency, duration, and route(s) of potential exposures. Land ownership and use and groundwater considerations were described above (see Section 2.2). This section begins with a discussion of potential human exposure pathways and then provides sections describing the basis for assumptions used in quantifying each of the complete pathways.

3.2.1 Potential Human Receptors and Exposure Pathways

An exposure pathway is the course a chemical takes from a source to an exposed receptor. Exposure pathways consist of the following four elements: 1) a source; 2) a mechanism of release, retention, or transport of a chemical to a given medium (e.g., air, water, soil); 3) a point of human contact with the medium (i.e., exposure point); and 4) a route of exposure at the point of contact (e.g., incidental ingestion, dermal contact). If any of these elements is missing, the pathway is considered incomplete (i.e., it does not present a means of exposure). Only those exposure pathways judged to be potentially complete are of concern for human exposure.

3.2.1.1 Human Receptors

Potential receptor groups typically considered in risk assessments include residents, visitors, and workers, depending on the land use. Current use and planned future uses for the area are for commercial or light industrial purposes. Given these site uses (i.e., nonresidential), three main receptor groups were identified: workers at the current facility, visitors to the grave sites, and people who may occasionally visit the area or who pass by on the footpath. Although future residential use of the area is unlikely, it is hypothetically possible and consistent with the current zoning of R-2 multifamily residential. Therefore, to provide information for risk managers and interested parties, a hypothetical future residential scenario was also considered in the risk assessment.

Workers—The College heating boiler, which is oil-fueled, is currently in use in the area occupied by the former facility. Thus, there are current workers who use this area and this occupational use is likely to continue. The former facility footprint is currently paved, however, and there are no current plans that would require removing paving. Operation of the current boiler does not require workers to access adjacent areas. Development of adjacent areas for workplace use is not feasible without substantial modification, given the steep slope of the area directly adjacent and the standing water in the wetland. Thus there is no current potential for workers to contact CoPCs in this area.

The College has considered developing a maintenance plant on the paved area of the former facility. If this work required removal of paving, there would be potential for construction workers to contact chemicals in soils under the pavement. These soils have not been characterized, but likely contain elevated concentrations of PCDD/Fs, petroleum residuals, and metals. This pathway is not considered complete at this time. However, any future plans for construction should incorporate appropriate measures to reduce or eliminate direct contact with soils.

Visitors—There are several groups of people who might visit the area and have the potential for contact with chemicals in site media. Those who visit the graves in the area could contact affected media in the forested area where the graves are located. Students, faculty, and other personnel from the College pass by this area on the footpaths. In addition to students, the trainees at the Alaska State Trooper facility across Sawmill Creek Road regularly use the College facilities for dining and for training at the Hames P.E. center. Thus, these individuals pass by affected areas often. Use of the footpaths, however, would not likely lead to direct contact with chemicals in affected media.

There is also some evidence of people occasionally visiting the area. Because this is a small area, with many other areas within walking distance of similar or greater interest, such recreational use would be expected to be limited. However, the area is not restricted and is near a footpath that is frequently used. Therefore, an occasional visitor exposure scenario is proposed as a means to evaluate hypothetical current or future uses of the area. The areas under consideration are within the College property, so adults would be the most likely visitors. However, there are residences nearby. Therefore, the risk assessment evaluated both adults and young children who might visit the area. Potential visitor scenarios for adults or children evaluated include:

- Exposures for adults and children who visit the grave sites and contact soil in those areas
- Exposures for adults and children who pass through or occasionally visit the area and might contact sediment, soil, and water in site areas (Figure 3). Assessments for visitors are expected to be protective of occasional exposures experienced by people who use the footpath regularly (e.g., Alaska State Troopers and students).

Daycare Workers and Children—As described above, two soil samples were analyzed for PCDD/Fs at the building site of the future daycare center for the College. One sample had a concentration of 4.2 ng/kg TEQ, which was higher than the EPA Region 9 risk-based screening value of 3.9 ng/kg TEQ (adjusted to 0.39 ng/kg TEQ to reflect a 10^{-7} risk), but is similar to background concentrations identified by EPA. For example, EPA has reported national average background PCDD/F soil concentrations of 7.6 ng/kg TEQ in urban areas and 3.1 ng/kg TEQ in rural areas (U.S. EPA 2000a). In addition, background residential and forest soil samples in the Ketchikan area had average concentrations of 6.85 and 5.1 ng/kg TEQ, respectively (Exponent 1998). The second sample had a concentration of 25.6 ng/kg TEQ, which was higher than background and the screening concentration. Therefore, soil data for PCDD/Fs was used to derive risk estimates for children and adults who might contact these soils. It should also be noted that both of these samples were well below the cleanup level identified by EPA for residential soils of 1,000 ng/kg (U.S. EPA 1998a).

Food Chain Issues—As indicated in the work plan, potential for food chain pathways were evaluated. There do not appear to be any berries or other consumable foods on or near the site. However, there are fish in the flume adjacent to the site and juvenile salmon were also observed within the wetland area. As described above, one composite fish sample from the wetland and one from the flume upgradient of the culvert were analyzed for site CoPCs. The composite fish sample from the wetland had the same TEQ concentration as the composite from the upgradient flume location. Metals concentrations in fishes that were higher in wetland areas included cadmium, lead, and mercury, but mercury concentrations appeared to be consistent with general background. Fish tissue samples were also compared with RBCs derived based on human health criteria and only cadmium exceeded both the RBCs and upstream concentration (lead did not have an RBC and PCDD/F concentrations were equivalent in the two samples).

The data for salmon smolts provide useful information for evaluating bioaccumulation, but do not represent concentrations in adult fish that would be consumed by people. Instead, any site-related influence on adult fish tissue would be reduced by more than 100-fold (e.g., in a 15 gram smolt versus a 1.5 kg adult). Given the limited exceedances of this conservative screening value, there does not appear to be a human health hazard related to the food chain pathway. In addition, sediment samples taken from the flume in 2004 do not indicate a site-related increase in metals or PCDD/F concentrations in the flume (Tables 1-2 and 1-6).

Hypothetical Future Residents—As described above, although future residential use is considered to be unlikely, a hypothetical residential scenario was evaluated in the risk assessment, in which adults or children come into contact with soils during residential use.

Sediment contact was evaluated through the recreational scenario. In addition, any building for residential purposes would require covering of sediments currently present at the site.

3.2.1.2 Potential Exposure Routes and Exposure Pathways

Potential exposure routes include ingestion and dermal contact with chemicals in soil, sediment, and surface water. Inhalation exposure routes related to soil and sediment are also hypothetically possible, but are expected to be minimal as a result of site conditions and the nature of the chemicals as described above. In addition, screening described above indicated that evaluation of ingestion and dermal exposures would be protective for inhalation exposures. Therefore, inhalation pathways will not be evaluated further here. Potential exposures for the following receptors and exposure pathways are quantified in the risk assessment:

- **Visitors to Grave Sites—**Adults or children who visit the grave sites could be exposed to chemicals in soils through ingestion and dermal contact.
- **Occasional Visitors**—Visitors passing through the area during recreation or on their way to work or school might come into contact with chemicals in soil, sediment, and surface water in the wetland area and with soils in the forested areas. Potential exposures resulting from ingestion and dermal contact were estimated.
- **Receptors in Planned Daycare Center Area—**Potential exposures for adult workers and children in the daycare facility area were evaluated. Potential exposures resulting from ingestion and dermal contact were estimated.
- **Hypothetical Future Residents—**A hypothetical residential scenario was evaluated here, in which adults or children come into contact with soils within the site area through ingestion or dermal contact.

3.2.2 Quantification of Exposure

This section describes the methodology to evaluate exposure for the complete exposure pathways identified above. Consistent with guidance from both DEC and EPA, RME estimates will be derived for all complete exposure pathways. Consistent with the DEC *Risk Assessment Procedures Manual* (DEC 2000b) an RME scenario was evaluated. The RME scenario is intended to provide an estimate based on the highest exposure that is reasonably expected to occur at a site. In addition, a central tendency exposure (CTE) estimate is presented in Section 3.4.4. The CTE estimate is intended to estimate the more typical exposure situation and is based primarily on average or central tendency values

Exposure estimates were based on site-specific information as well as exposure assessment guidance provided by EPA (U.S. EPA 1989, 1991, 1997a, 2001a) and DEC (DEC 2000a,b, 2001a,b, 2002). Estimates were derived using deterministic methodology and are intended to be both health-protective and reasonable. The rationale for all assumptions applied here is described in this section. Exposure estimates provided in DEC's *Cleanup Level Guidance* (DEC 2002) were a primary basis used in calculations. However, DEC guidance does not

specify exposure variables for dermal exposure or for non-residential settings. In these exposure scenarios and pathways, appropriate variables identified by EPA were applied.

Exposure assessment for all CoPCs except lead were conducted by combining estimates of media (soil, sediment, and surface water) intake with estimates of the CoPC concentration in those media as described above. The daily exposure to each CoPC was estimated using the following general algorithm:

$$\text{Dose } (\text{mg/kg-day}) = \frac{C \times CF \times CR_m \times ED \times EF \times AB}{BW \times AT}$$

where:

C	=	chemical concentration in soil, sediment, or surface water
CF	=	conversion factor as needed to correct units in soil or water
CR_m	=	contact rate for soil, sediment, or water
ED	=	exposure duration (years)
EF	=	exposure frequency (days/year)
AB	=	absorption fraction from site media (unitless)
BW	=	body weight (kg)
AT	=	averaging time

- noncarcinogens – exposure duration × 365 days
- carcinogens – 70 year lifetime × 365 days

This exposure assessment first describes the grouping of site data and the derivation of exposure point concentrations for CoPCs in site media (e.g., soil, sediment, surface water). Subsequent sections provide the methodology for calculating each of the exposure pathways and the rationale for exposure assumptions applied in those estimates. Tables 3-2 and 3-3 provide exposure algorithms unique to each pathway and the exposure assumptions applied. Because exposure assessment for lead differs from that of other CoPCs to be evaluated, the lead evaluation is described separately.

3.2.2.1 Grouping of Site Data and Exposure Frequency and Duration Assumptions

As described above, the possible current and future site uses were evaluated and four potential current or future exposure scenarios were identified for quantification in the HHRA. This section describes what site data were used to derive exposure point concentrations used in quantifying each of the potential exposure scenarios. In addition, it describes the assumptions used in estimating the frequency and magnitude of exposure. Exposure estimates for each of the potential scenarios were derived using conservative assumptions about the potential for contact with site media. The following table summarizes how site data were grouped to derive exposure point concentrations and the assumed frequency and magnitude of exposures:

Exposure Scenarios (Adults and Children)	Site Data Included in Exposure Estimates	Frequency of Exposure (Rationale)[a]
Occasional visitor to facility or grave sites	All site soil and sediment combined; all water samples combined. Flume station 3SE03 included.	12 visits in CTE and 24 visits in RME (best professional judgment)
Hypothetical future resident	All soil samples except daycare center area soils	330 days per year for adults and children (DEC 2002)
Grave site visitor	Grave site soil samples (3NE01S, 3NE02S)	3 visits in CTE and 6 visits in RME (best professional judgment)
Daycare worker and child	Daycare soil samples (3SW0SS, 3SW05-06S)	250 days per year for adult workers and children (DEC 2002)

[a] Exposure durations for each scenario are 6 years for children (ages 1-6) and 30 years for adult visitors or residents (DEC 2002), 25 years for adult workers (U.S. EPA 2001a and DEC 2002).

As described above, sediment samples taken from flume stations beyond the station immediately adjacent to the site (i.e., 3SE03) were not elevated above RBCs or background concentrations. Therefore, the flume sediment sample results from downgradient stations (4SE05 and 4SE06) or the upgradient station (4NE04) were not included in exposure point concentrations. Inclusion of these stations would reduce the exposure point concentrations and risk estimates. Tables 1-1 through 1-8 provide the exposure point concentrations for CoPCs derived following grouping these data and Figure 2 provides sample locations and concentrations of the CoPCs. Tables 3-2 and 3-3 show the exposure assumptions used in the risk estimates.

Estimation of Exposure Frequency and Duration—Exposure frequency is used in the HHRA as the assumed number of days an individual is in contact with site media per year and exposure duration is the assumed number of years of exposure to site media. Exposure duration estimates were based on the assumption that site visitors were people who live in the area. Therefore, the exposure durations of 30 years for adults and 6 years for young children were applied to recreational exposures as well as to the hypothetical future residential scenario. This assumed exposure duration is consistent with residential exposure assumptions provided by DEC (2002) and U.S. EPA (1989, 2001a). This 30-year adult exposure duration is based on the 90th percentile of time that individuals live in one residence. The CTE exposure duration estimate applied was 9 years, based on the median number of years that U.S. residence stay at one home (U.S. EPA 1989). The exposure frequency for hypothetical future residents was 330 days, consistent with the DEC (2002) guidance for areas with over 40 in. of rainfall per year.

Exposure frequencies for visitors to the site area were 24 days per year in the RME scenario and 12 days per year in the CTE scenario, based on an assumed visit per month in the CTE or two visits per month in the RME scenario. Given the nature of the area, which has no uniquely attractive characteristics, and the availability of many other recreational areas nearby in the Sitka community, this assumption is likely to represent an overestimate of exposure and risk. Visits to the grave sites were expected to be limited and were assumed to be 3 visits per year in the CTE and 6 visits per year in the RME scenario. Both of the visitor scenarios were assumed to occur over a 30-year duration (i.e., 30 years for adults). Both adults and young children are assumed to visit site areas in these scenarios. The assumption that young children would visit

the area up to 24 days per year is also likely to be an overestimate of exposure (and risks), because of higher supervision typically given to young children. However, consistent with comments received on the work plan and CSM, young children were evaluated here as part of a hypothetical estimate.

Exposure estimates for future daycare workers and daycare children in RME and CTE estimates were based on an exposure frequency of 250 days, which was estimated by EPA based on 5 weekdays for 50 weeks per year (U.S. EPA 1991, 2001a). Future daycare workers' exposure durations were assumed to be 25 years in the RME and 9 years in the CTE estimate, consistent with U.S. EPA (1991, 2001a), and daycare children's exposure duration was assumed to be 6 years consistent with DEC (2002).

Derivation of Exposure Point Concentrations—Consistent with guidance from U.S. EPA (1989), exposure point concentrations applied in the RME calculations were the lower of either the upper confidence limit (UCL) on the mean concentration or the maximum concentration. Central tendency estimates were based on average concentrations. Where a chemical was detected at least once in a media, one-half the detection limits for remaining samples were included in the calculation.

As recommended by EPA's *Risk Assessment Guidance for Superfund* (RAGS) (U.S. EPA 1989), the 95 percent UCL of the mean was used in estimating exposure concentrations for the RME scenarios because of the uncertainty associated with estimating the mean exposure concentration. Consistent with supplemental guidance to RAGS (U.S. EPA 1992), the UCL on mean concentrations was calculated for lognormal and unknown distributions as follows:

$$UCL = \exp\left(\bar{y} + \frac{S_y^2}{2} + \frac{S_y \times H}{\sqrt{n-1}}\right)$$

where:

n	=	number of observations
H	=	H statistic for a given confidence level, n, and Sy
exp	=	exponential function
$\bar{y}$	=	average of the log-transformed data (y = ln(x))
S_y	=	standard deviation of the log-transformed data.

The UCLs for normally distributed data sets were calculated using the *t*-statistic for a one-tailed distribution (U.S. EPA 1992).

3.2.3 Incidental Ingestion of Surface Soil or Sediments

Exposure estimates for incidental ingestion of surface soil or sediments were quantified for each of the exposure scenarios evaluated using the soil or sediment data groups described above (Table 3-2). Adults and children may contact soils or sediments during outdoor activities and

some proportion of that soil may be ingested. In addition, a portion of particles inhaled are ultimately swallowed and thus, ingested. Soil ingestion rates have been estimated from studies evaluating the excretion of certain minerals present in soils, and include both the soil that is directly ingested and the portion that is swallowed following inhalation. For the childhood exposure scenarios (i.e., child visitors and hypothetical future residents) an ingestion rate of 200 mg/day was applied consistent with the parameters used in DEC's *Cleanup Levels Guidance* (DEC 2002) and with EPA guidance (U.S. EPA 1991). EPA's *Exposure Factors Handbook* (U.S. EPA 1997a) and *Child-Specific Exposure Factors Handbook* (U.S. EPA 2000c) recommend 100 mg/day as the best estimate of the mean long-term soil ingestion for children and state that 200 mg/day may be used as a conservative estimate of the mean. Specifically, in U.S. EPA (2000c), EPA reaches these conclusions after presenting the mean values from the soil ingestion studies that were reviewed. Presumably because most of the values displayed were below the 200-mg/day value that was used by EPA in the past, EPA states that the values are consistent with using 200 mg/day as a conservative estimate of the mean. Furthermore, EPA took into consideration that the mean soil ingestion rate across all of the reviewed studies was calculated to be 138 mg/day, that the highest values were seen when titanium was used as a marker of soil ingestion (which tends to exhibit great variability), and that one study included a pica child. They concluded that 100 mg/day was the best estimate of mean soil ingestion.

No data exist in the literature for sediment ingestion rates and consequently soil ingestion rates were applied. U.S. EPA (1997a) does not provide an upper-bound value for adults. However, U.S. EPA (1991) has identified 100 mg/day as an upper-bound intake rate and this intake rate is also applied for adults by DEC (2002). Therefore, this value was used as the intake rate for adults in all RME scenarios. Consistent with EPA guidance, the mean value for adults of 50 mg/day was used in the CTE scenarios (U.S. EPA 1997a). This 50 mg/day soil ingestion rate was also applied in the RME and CTE scenarios for workers based on guidance in DEC (2002) and U.S. EPA (1991), which indicates that half of an adult's soil ingestion rate of 100 mg/day might occur at work. Although it is reasonable to assume that incidental ingestion of soil and sediments from the site areas would be a fraction of the total daily soil ingested, the HHRA conservatively assumes that 100 percent of the total soil ingested on days of exposure comes from the contaminated source (i.e., fraction intake = 1) for both the RME and CTE scenarios.

Chemical-specific relative bioavailability adjustments (RBAs) account for reduced absorption of chemicals from soil in comparison with absorption in the studies used to derive the toxicity values. In this HHRA, an RBA was applied to risk estimates for ingestion of PCDD/F in soil based on evidence of reduced absorption from ingested soil. Oral absorption of chemicals (i.e., oral bioavailability) in soil is generally less than that of chemicals in water or food. An RBA can be applied to exposure estimates to account for observed differences in bioavailability. For chemicals other than lead, EPA does not provide default assumptions for gastrointestinal absorption from soil. Instead, bioavailability from soil of chemicals such as arsenic and PCDD/Fs is often assumed to equal absorption of these chemicals in the studies used by EPA to derive their respective toxicity values. However, the studies used to derive the toxicity factors are not based on exposure to chemicals in soil. EPA's carcinogenic slope factor (CSF) used to evaluate PCDD/Fs is based on absorption of PCDD/Fs dissolved in acetone that was mixed with food. The following paragraphs provide the basis for RBAs used in exposure estimates for arsenic and PCDD/Fs in soil. Evidence suggests that PAHs are also incompletely absorbed

from soil. However, RBAs were not developed for these CoPCs because these chemicals had less influence on risk estimates.

Oral absorption of PCDD/Fs varies with the medium in which the compounds are administered. In studies where PCDD/Fs were administered to rats by gavage (stomach tube) in an acetone-corn oil mixture, absorption from the gastrointestinal tract ranged from 70 to 83 percent (Rose et al. 1976; Piper et al. 1973). Oral absorption of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) administered to rats in the diet was reported to be 50–60 percent (Fries and Marrow 1975). In the study that was used as the basis for EPA's CSF, 2,3,7,8-TCDD was administered to rats mixed in their food (Kociba et al. 1978).

Absorption of ingested PCDD/Fs from soil is dependent on conditions and physical characteristics of the soil. The Agency for Toxic Substances and Disease Registry (DeRosa et al. 1997) identifies bioavailability of PCDD/Fs in soil as critical to calculating the exposure to PCDD/Fs through soil ingestion, noting that "If assumed that 100% of TCDD is bioavailable, risk may be overestimated." Absorption from soil has been measured at levels varying from 0.5 to 50 percent (DeRosa et al. 1997; Paustenbach et al. 1992). Some authors have reported that the bioavailability of PCDD/Fs adhering to material with low organic content appeared to be on the low end of the range (i.e., 1 to 10 percent [van den Berg et al. 1985]). A study conducted by Shu et al. (1988) examined the bioavailability of 2,3,7,8-TCDD from Times Beach soil relative to its bioavailability when administered in corn oil. The relative bioavailability estimates ranged from 37 to 49 percent with a mean value of 43 percent.

Using the results from the Shu et al. (1988) study and the range of bioavailability estimates for 2,3,7,8-TCDD in corn oil discussed above (70–83 percent), the absolute bioavailability of 2,3,7,8-TCDD from the test soil can be estimated as 30–36 percent (e.g., 43 percent multiplied by 70 percent equals 30 percent). Then, using the range of bioavailability estimates for 2,3,7,8-TCDD in the diet discussed above (50–60 percent), the bioavailability of 2,3,7,8-TCDD in soil relative to that from the diet can be estimated as 50–70 percent (e.g., 30 percent divided by 50 percent equals 60 percent). For the risk calculations presented in this report, the midpoint of this range (i.e., 60 percent) was selected as a conservative estimate of the RBA for PCDD/Fs ingested in soil.

3.2.4 Dermal Contact with Surface Soil or Sediment

Dermal exposure was expressed as an absorbed dose by incorporating a contaminant-specific dermal absorption factor into the exposure equation using guidance provided in the EPA *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA dermal guidance document) (U.S. EPA 2001a). Dermal absorption factors reflect desorption of the contaminant from soil and the absorption of the contaminant across the skin and into the bloodstream (U.S. EPA 2001a). Dermal absorption factors used in the HHRA are reported in Table 3-4 and are based on U.S. EPA (2001a). In the case of DRO and RRO, no guidance is provided on dermal absorption. For calculations provided in Section 3.4.4, an absorption factor of 0.13 is applied for dermal absorption of these petroleum mixtures based on dermal absorption recommended for benzo[a]pyrene.

Dermal exposures result in an estimate of absorbed dose, not the amount of contaminant that comes in contact with the skin (i.e., intake). Because oral toxicity values (i.e., CSFs and reference doses [RfDs]) are usually expressed as intakes, they must be adjusted with oral absorption factors to obtain reference toxicity values expressed as an absorbed dose. To calculate an adjusted toxicity value, a CSF is divided by the oral absorption factor, and an RfD is multiplied by the oral absorption factor (U.S. EPA 1989). Table 3-5 provides the oral absorption factors used for relevant CoPCs in this HHRA as well as the adjusted toxicity values applied in dermal exposure estimates.

A skin surface area term is used in dermal exposure estimates to reflect the amount of skin in cm^2 that is in contact with a contaminant in the exposure scenario. For adult dermal contact with outdoor soil, U.S. EPA (2001a) recommends using 5,700 cm^2 for both CTE and RME estimates. This value represents the average of the 50th percentile of surface area for males and females older than 18 years of age and was used in dermal exposure estimates in the adult visitor and hypothetical resident scenarios (Table 3-2). Similarly, for evaluating a child's dermal contact with outdoor soil, U.S. EPA (2001a) recommends using 2,800 cm^2 for both CTE and RME estimates, based on the 50th percentile of surface area for males and females ages 1–6 years. This surface area estimate was applied in the child visitor, daycare, and hypothetical resident scenarios. For daycare workers, the skin surface area recommended by U.S. EPA (2001a) for workers, of 3300 cm^2, which is representative of the 50th percentile skin surface area for the head, hands, and forearms of males and females greater than 18 years old, was applied in both the CTE and RME scenarios.

A soil-to-skin adherence factor is also applied in dermal exposure estimates to estimate the amount of soil that remains deposited on the skin after contact (Table 3-2). Adherence factors vary by soil type, (e.g., moisture content, particle size), by the body part contacting the soil, and by the activity being conducted while in contact with the soil. U.S. EPA (2001a) has recommended application of assumed dermal absorption factors of 0.07 for adults and 0.2 for children in residential scenarios for both RME and CTE estimates and these were applied in scenario estimates for visitors and hypothetical future residents. EPA derived these adherence factors based on adherence measurements for various activities, time-weighted to reflect residential activity patterns for adults and children. The adherence factor of 0.2 recommended by U.S. EPA (2001a) for workers was applied in CTE and RME exposure estimates for adult daycare workers. This adherence factor was based on data for utility workers and was identified by EPA as a health protective means to evaluate workplace exposures.

3.2.5 Incidental Ingestion and Dermal Contact with Surface Water

Visitors to the wetland area might come into contact with chemicals in surface water during visits either by dermal contact or incidental ingestion. Table 3-3 shows the exposure algorithm used to derive exposure estimates for these pathways. These exposure pathways were evaluated using the exposure frequency and duration described above (i.e., 24 days per year for adults and children in the RME scenario and 12 days per year in the CTE scenario). For the recreational scenario, wading was assumed to represent the greatest exposure potential because the area is relatively unappealing for swimming and is possibly also too small and shallow (i.e., less than 3 ft deep). RAGS (U.S. EPA 1989) recommends a value of 50 mL/hour as the amount of water

ingested while swimming. Based on professional judgment, the HHRA assumes that 25 percent of EPA's assumed water consumption rate for swimming, or 12 mL/hour, will be consumed while wading in the wetland. For the RME and CTE scenarios, it is assumed that wading might occur 1 hour/day, based on best professional judgment.

Occasional visitors, including children or adults wading in the wetland, are assumed to submerse the surface areas of their hands, forearms, feet, and lower legs, or approximately 25 percent of their total body surface area. Application of the 25 percent assumed surface area to total body surface areas provided by U.S. EPA (2001a) resulted in an exposure assumption of 4,500 cm^2 for an adult (i.e., 18,000 cm^2 adult total body surface area × 0.25) and 1,650 cm^2 for a child (i.e., 6,600 cm^2 child total body surface area × 0.25). The exposure estimates for dermal contact with water incorporate a permeability constant, which reflects the rate of movement of the chemical across the skin. The permeability constants applied in the assessment are taken from Appendix B, Tables B-3 and B-4, of U.S. EPA (2001a) and are shown in Table 3-5.

3.2.5.1 Lead Evaluation

Unlike other constituents, lead exposure is evaluated by estimating its effect on increasing blood lead levels rather than by calculating a daily dose per body weight. EPA has developed two models for assessing lead exposure: the IEUBK model (U.S. EPA 1994) for assessing lead exposure in young children, and a simplified linear model for assessing exposure to older children and adults (EPA adult lead model; U.S. EPA 1996a). Both models predict steady-state chronic blood lead levels and incorporate health-protective assumptions about behavior. DEC's risk-based cleanup level for lead of 400 mg/kg is derived based on the IEUBK model. The IEUBK model integrates exposures from soil, air, and dietary sources. EPA guidance (U.S. EPA 1994) indicates that the CTE assumptions should be used in the IEUBK model. Therefore, the cleanup level derived using the IEUBK model should be compared with average site concentrations. The average site concentrations for lead were as follows: site-wide soil and sediments (except grave site and daycare samples) 559 mg/kg; site-wide soils (except daycare samples) 506; grave site area soils 240 mg/kg; and daycare samples 90 mg/kg. Thus, the site-wide samples evaluated with soils only, or with soils and sediments, were higher than the 400 mg/kg residential screening value.

The DEC guidance at 18 AAC 75.341 indicates that:

> Lead cleanup levels must be determined on a site-specific basis, based on land use; for residential land use, the soil cleanup level is 400 mg/kg, and for commercial or industrial land use, that level is 1,000 mg/kg; through an approved site-specific risk assessment, conducted according to the Risk Assessment Procedures Manual, adopted by reference at 18 AAC 75.340, approved exposure models may be used to evaluate exposure to a child resident or an adult worker; a responsible person may also propose an alternative cleanup level, through a site-specific risk assessment conducted according to the Manual, and based on a chemical speciation of the lead present at the site.

Thus, DEC guidance indicates that while 1,000 mg/kg is an identified cleanup level for nonresidential soils (commercial, industrial), higher cleanup levels may also be derived using

appropriate methods. The 1,000 mg/kg cleanup value is identified as applicable for commercial and industrial soils, but it has also been widely applied for nonresidential soils in areas where children may occasionally visit (i.e., recreational areas). The most likely current site use is limited recreational (i.e., occasional visits). Because this is a nonresidential use, the 1,000 mg/kg lead level would be protective of site visitors. Hypothetical future residential exposures would have a somewhat elevated hazard. However, because the average concentration for this scenario was 506 mg/kg compared with the 400 mg/kg default value, any increase would be minimal.

3.3 Toxicity Assessment

In the toxicity assessment, the hazards associated with chemicals of concern at the site are evaluated. For noncarcinogenic chemicals, EPA has developed a specific toxicity value called an RfD. An RfD is an estimate of the level of daily exposure that is likely to avoid appreciable risk of health effects over a lifetime, even in sensitive populations. Potential carcinogenic effects are evaluated through application of a CSF. The first resource for these toxicity values is EPA's Integrated Risk Information System, which is available online (U.S. EPA 2004). In addition, EPA provides toxicity values within the Health Effects Summary Tables and in documentation provided by the EPA National Center for Environmental Assessment, which are available as hard copy and are also compiled and kept up to date within the EPA Region 9 RBC tables at www.epa.gov/region09/waste/sfund/prg/ whatsnew.htm (U.S. EPA 2003a). All toxicity values used in this assessment are described Tables 3-4 and 3-6.

EPA has not developed an RfD for lead, but rather evaluates lead toxicity in reference to blood lead levels, with a blood lead level of 10 μg/dL identified by EPA as the target level to be met by 95 percent of an exposed population of children. The evaluation conducted for lead was a qualitative assessment based on comparison with lead cleanup levels derived for residential and non-residential soils. Toxicity values for petroleum hydrocarbon ranges are described in Section 3.4.4.

3.4 Risk Characterization

In risk characterization, quantitative exposure estimates and toxicity factors are combined to calculate numerical estimates of potential health risk. In this section, potential cancer and noncancer health risks will be estimated assuming long-term exposure to contaminants detected in site media. The risk characterization methods described in DEC and EPA guidance will be applied to calculate potential RME and typical excess lifetime cancer risks for carcinogens and hazard indices for contaminants with noncancer health effects. These methods and the results of the risk characterization are described below.

3.4.1 Carcinogens

Quantifying total excess cancer risk requires calculating risks associated with exposure to individual carcinogens and aggregating risks associated with simultaneous exposure to multiple

carcinogenic contaminants. A cancer risk estimate for a single carcinogen is calculated by multiplying the carcinogenic chronic daily intake of the contaminant by its slope factor. A 1×10^{-6} cancer risk represents a one-in-one-million additional probability that an individual may develop cancer over a 70-year lifetime as a result of the exposure conditions evaluated. Because cancer risks are assumed to be additive, risks associated with simultaneous exposure to more than one carcinogen in a given medium will be aggregated to determine a total cancer risk for each exposure pathway. Total cancer risks for each pathway are then summed for reasonable combinations of exposure pathways to determine the total cancer risk for the population of concern.

The likelihood that actual risks are greater than estimated risks is very low because of the conservative assumptions used to develop cancer risk estimates; in fact, actual risks may be significantly less than predicted values. EPA's *Guidelines for Cancer Risk Assessment* state ". . . the linearized multistage procedure (typically used to calculate CSFs) leads to a plausible upper limit to the risk that is consistent with proposed mechanisms of carcinogenesis . . . . The true value of the risk is unknown, and may be as low as zero" (51 Fed. Reg. 185:33992, 33998).

3.4.1.1 Risk Estimates for Carcinogens

Carcinogenic risk estimates were calculated for children and adults in the RME scenarios as the probability of additional cancers associated with the exposure pathways was evaluated. Table 3-7 provides an overview of RME cancer risk estimates for all complete ingestion and dermal exposure pathways. The risk estimates for adults and children in the hypothetical future resident scenarios were the highest estimates (i.e., 3×10^{-4} and 5×10^{-4}, respectively). Risk estimates for occasional visitor scenarios were 2×10^{-5} and 3×10^{-5} for adults and children, respectively. The highest risk estimates for the daycare and the grave site visitor scenarios were each 2×10^{-6}, which is only slightly higher than the 10^{-6} risk threshold often applied by EPA, and lower than the 1×10^{-5} level identified by DEC (See Section 3.4.3). Remaining risk estimates were lower than or equal to 1×10^{-6} (Table 3-7). The risk estimates in all of these scenarios were almost entirely the result of exposure to PCDD/Fs.

3.4.2 Evaluation of Noncancer Effects

Unlike carcinogenic effects, other potential adverse health effects are not expressed as a probability. Instead, these effects are expressed as the ratio of the estimated exposure over a specified period to the RfD derived for a similar exposure period. This ratio is termed a hazard quotient and is calculated through application of this general algorithm:

$$\text{Hazard Quotient} = \frac{\text{Intake}}{\text{RfD}}$$

A hazard quotient less than 1 implies that exposure is below the level that is expected to result in a significant health risk. A hazard quotient greater than 1 does not necessarily mean that an effect would occur, rather that exposure may exceed a general level of concern for potential health effects in sensitive populations. Exposures resulting in a hazard quotient less than or equal to 1 are very unlikely to result in noncancer adverse health effects. EPA states that the

range of possible values around RfDs is "perhaps an order of magnitude" (U.S. EPA 2004). Therefore, the significance of intakes exceeding the RfD by one-half an order of magnitude or less (i.e., hazard indices less than 5) must be carefully considered. Uncertainties in data supporting RfDs may cause their use to underestimate risk. However, because RfDs include uncertainty factors used to ensure protectiveness for sensitive human populations, they may also overestimate risks for many individuals.

In initial risk calculations, hazard quotients for individual CoPCs are summed for each exposure pathway to derive a hazard index. Hazard indices for each exposure pathway are then summed to determine the total hazard index for each population of concern.

3.4.2.1 Noncarcinogenic Risk Estimates

Noncarcinogenic risks were calculated as RME estimates of the probability of adverse health effects other than cancer. The only pathway in the RME scenarios that resulted in a hazard index greater than 1 was the hypothetical future resident child's ingestion of surface soil. The hazard index for this pathway of 1.2 was contributed to primarily by cadmium (58 percent) and chromium (26 percent). No other hazard index for a pathway was greater than 0.19. Because only PCDD/Fs were identified as CoPCs in the future daycare area, and PCDD/Fs do not have a currently approved RfD, no noncancer risks were calculated for this area. Noncancer risks calculated for grave site area visitors were very low (Table 3-8). These risk estimates indicate that no adverse effects related to noncancer endpoints would be expected to result from exposure to CoPCs under the assumed exposure conditions.

3.4.3 Risk Levels for Carcinogens and Noncarcinogens

The determination of an acceptable risk level is ultimately a decision to be made by risk managers. DEC has adopted risk management standards for evaluation of the incremental risk associated with a site. These standards were set to ensure the same level of protection of human health for all land uses. Consistent with these standards, the findings of the HHRA will be compared with the cumulative carcinogenic risk level range of 1×10^{-5} and a hazard index of 1. In addition, the broader range of acceptable risk levels (i.e., risks up to 1×10^{-4}) cited in EPA's National Contingency Plan (NCP) (40 CFR 300) may be applied at DEC's discretion. Considerations in applying this range include the following criteria:

- Site-specific conditions
- Land use
- Contaminant characteristics
- Statutory compliance
- Protection of health and the environment
- Implementability of cleanup

- Long and short term effectiveness
- Public comment
- Cost.

This range is identified in the NCP, which states that risk levels in the range of 10^{-4} to 10^{-6} and lower are considered to be within the range of acceptable risks. Once target risk levels are agreed upon with DEC, these levels will also be applied in deriving risk-based cleanup levels.

3.4.4 Uncertainty Assessment

Because risk characterization serves as a bridge between risk assessment and risk management, it is important that major assumptions, scientific judgments, and estimates of uncertainties be described in the assessment. Risk assessment methods are designed to be conservative to address the uncertainties associated with each step in the risk assessment process. Thus, "true" site risks are likely to be less than risks estimated using standard risk assessment methods.

Risk assessment is subject to a number of uncertainties. General sources of uncertainty include the site characterization (adequacy of the sampling plan and quality of the analytical data), the exposure assumptions, and estimation of chemical toxicity, background concentrations, and the present state of the science involved. In this section several key sources of uncertainty related to this site are evaluated including the following: summary of central tendency risk estimates, estimation of exposure frequencies and durations for site visitors, and the risk estimates for petroleum hydrocarbons.

3.4.4.1 Evaluation of Additional Metals

As described above, site media were analyzed for the set of metals expected to be associated with a municipal incinerator (i.e., cadmium, chromium, lead, and mercury). It is possible that there are additional metals present at the site related to past burning of municipal wastes (e.g., arsenic). However, the contribution of these additional metals, if any, to offsite soils is not expected to be substantial. For example, in flyash from a hog fuel boiler evaluated in the Ketchikan Pulp Company remedial investigation and feasibility study, arsenic concentrations ranged from background to 31 mg/kg (Exponent 1998). This source would be expected to be a minimal contribution to arsenic in soil at background concentrations. Moreover, the municipal incinerator did not burn wood, which was instead sent offsite to a landfill and thus no arsenic input from treated wood would be expected.

3.4.4.2 Summary of Central Tendency Estimates of Risk

Appendix B provides detailed tables presenting risk estimates derived based on central tendency estimates. As indicated there, the only cancer risk estimates that exceed the 1×10^{-5} risk level are the estimates for the hypothetical future resident child scenario (6×10^{-5}) and adult scenario (1×10^{-5}). The next highest cancer risk estimate is 2×10^{-6} for the child in the occasional visitor or the daycare scenarios. No hazard indices were greater than 1. These risk estimates suggest

that site risks are within acceptable levels for all scenarios except the hypothetical future residential scenario.

3.4.4.3 Estimation of Exposure Frequency and Duration for Site Visitors

Exposure estimates for occasional visitors included the assumed exposure frequencies of 12–24 days per year over a 30-year exposure duration. These exposure assumptions are expected to represent an overestimate for most users, but may represent an underestimate for individuals visiting more often. For example, if a child visited 48 times per year for 6 years their risk estimate would be increased from 3×10^{-5} to 6×10^{-5}. This assumed exposure frequency may over-estimate risks for many individuals who only visit infrequently. Similarly, the risk estimates for the visitors to grave sites assuming 3–6 visits per year may also underestimate risks for some individuals. For example, the HHRA assumed a child might visit the grave area six times a year, resulting in a risk estimate of 2×10^{-6} (Table 3-7). If the child visited 60 times per year, the risk estimate would be increased to 2×10^{-5}. Thus, although there is some uncertainty in the exposure frequencies related to these pathways, because the risk estimates for these pathways are relatively low, visits could be more frequent without incurring risks greater than the risk range typically identified as acceptable by risk managers.

3.4.4.4 Risk Estimates for Petroleum Hydrocarbons

Petroleum hydrocarbon fractions were detected at the site at concentrations greater than screening levels. These fractions are representative of a range of carbon-based compounds and as such, are imprecise values. Because data were available for toxic constituents of petroleum hydrocarbons in site media, risk estimates for DRO and RRO fraction calculations were described in Section 3.4.4. The risk estimates provided in Section 3.4.4 are based on toxicity values identified by DEC as follows:

	Aromatic		Aliphatic	
Carbon Range	Assumed Percentage	RfD (mg/kg-day)	Assumed Percentage	RfD (mg/kg-day)
DRO (C_{10}–C_{25})	40	0.04	80	0.1
RRO (C_{25}–C_{36})	30	0.03	90	2.0

Source: Tables 6 and 8 of DEC (2000a).

The only hazard index that exceeded 1 was a hazard index of 3.2 for the child in the occasional visitor scenario and a hazard index of 1.3 in the residential scenario. However, there is considerable uncertainty associated with the risk calculations and they are likely to overestimate risks. In particular, the assumed percentages that fall within aromatic or aliphatic ranges are likely to overestimate the potency of the mixture because they total more than 100 percent. In addition, risk estimates based on the measured toxic constituents of TPH were much lower (Table 3-9).

3.5 Conclusions of HHRA

Health protective means were applied to estimate potential human health risks related to past operation of the facility. Two potential exposure scenarios resulted in risk estimates greater than the cumulative carcinogenic risk level of 1×10^{-5} identified in the DEC regulations. These receptors were the adult and the child in the occasional visitor scenario, which had cumulative cancer risk estimates of 2×10^{-5} and 3×10^{-5}, respectively, and the adult and child in the hypothetical future residential scenarios, which had risk estimates of 3×10^{-4} and 5×10^{-4}, respectively, with the majority of site risks associated with PCDD/Fs. The highest hazard index was a cumulative hazard index of 1.2 for children in the hypothetical future residential scenario associated with exposure to cadmium and chromium. All other hazard indices were below 1 suggesting that no adverse effects would be expected under the exposure conditions evaluated.

Risk estimates for the daycare center and for grave site visitors were well below the acceptable level identified by DEC. Calculations presented in Section 3.4.4 suggested that even if more frequent visits were assumed for these exposure scenarios, risks for site visitors would be within acceptable levels.

Although DEC has identified a cumulative carcinogenic risk level of 1×10^{-5} as a starting point, DEC regulations also identify a number of considerations in evaluating risk estimates including potential future site use. The future residential use of the area is highly unlikely given the small size, the location, and the steep slopes adjacent to the facility. Moreover, the central tendency estimates for the future residential scenario had risk estimates of 1×10^{-5} and 6×10^{-5} for the adult and child scenarios, respectively, resulting largely from the application of an average concentration for PCDD/Fs instead of the maximum PCDD/F concentration. Nevertheless, this assessment would suggest that residential uses should be prevented through some means that can be agreed upon by all parties. In addition, future uses of the former facility pad that would require removing the pavement should be restricted and should require proper health and safety practices to prevent unacceptable human exposures.

4 Screening Ecological Risk Assessment

This SLERA was conducted to evaluate the likelihood of adverse effects to ecological receptors occurring in habitats adjacent to the former facility associated with any releases of hazardous waste and/or hazardous constituents. The results of the SLERA can be used to eliminate exposure pathways or contaminants from further consideration of ecological risk. This SLERA is consistent with the most recent guidance from EPA and DEC for conducting SLERAs (U.S. EPA 1996b, 1997b, 1999a,b, 2000b, 2001b,c, DEC 2002).

4.1 Environmental Setting

The history and description of the site are included in Sections 1.1.1 and 1.1.2. This section provides information on the environmental setting, including sensitive populations and sensitive environments.

4.1.1 Sensitive Populations

There have been biological assessments to determine the presence of threatened or endangered species on the areas immediately adjacent to the former facility. The U.S. Fish and Wildlife Service (FWS) lists nine threatened and endangered wildlife species for Alaska, including:

- Short-tailed albatross (*Phoebastria albatrus*, endangered)
- Eskimo curlew (*Numenius borealis*, endangered)
- Spectacled eider (*Somateria fischeri*, threatened)
- Steller's eider (*Polysticta stelleri*, threatened)
- Leatherback sea turtle (*Dermochelys coriacea*, endangered)
- Steller's sea-lion (*Eumetopias jubatus*, western population endangered, eastern population threatened)
- Bowhead whale (*Balaena mysticetus*, endangered)
- Finback whale (*Balaenoptera physalus*, endangered)
- Humpback whale (*Megaptera novaeangliae*, endangered).

All of these species except the Eskimo curlew occur exclusively or primarily in the marine environment and would not occur at the area surrounding the facility. The Eskimo curlew occurs in terrestrial environments, but not the temperate coniferous rainforest habitat prevalent around the former facility. The only plant species listed by FWS, the Aleutian fern (*Polystichum aleuticum*), does not occur in the Sitka area. The State of Alaska lists five endangered species. Three of these species, the short-tailed albatross, Eskimo curlew, and

humpback whale are also on the FWS list. The other two species are marine mammals (right whale, *Eubalaena glacialis*, and blue whale, *Balaenoptera musculus*) and would not occur at the former facility. There are several bird species on the State of Alaska list of Species of Special Concern that could use forest habitats such as those surrounding the former facility. These species include northern goshawk (*Accipiter gentilis*), gray-cheeked thrush (*Catharus minimus*), olive-sided flycatcher (*Contopus cooperi*), Townsend's warbler (*Dendroica townsendi*), and Blackpoll warbler (*Dendroica striata*).

4.1.2 Sensitive Environments

The Alaska Administrative Code (18 AAC 75.990) defines an "environmentally sensitive area" as a geographic area that is particularly susceptible to change or alteration, including rare or vulnerable natural habitats, areas of high natural productivity or essential habitat for wildlife, unique geologic or topographic features that are susceptible to a discharge, floodplains or other areas that protect, maintain, or replenish land or resources, and state and federal protected areas, such as wilderness areas, parks, and wildlife refuges. The Sitka National Historic Park is the most notable area within the vicinity of the former facility that meets this definition of a sensitive environment. Freshwater wetlands and land "with continuous natural terrestrial vegetation cover" (AAC 75.630) are other sensitive environments that occur in the study area.

4.2 Potential Ecological Receptors

Ecological receptors that occur in the forest and marsh habitats adjacent to the former facility may be exposed to CoPCs in surface soil, sediment, water, and food items. If downgradient migration of CoPCs has occurred from the marsh area into the flume, then aquatic receptors in the flume or downstream areas could also be exposed to CoPCs in sediment, water, and food items. Categories of ecological receptors that are potentially affected include terrestrial and wetland plants, soil fauna, birds, mammals, benthic invertebrates, and fish.

4.3 Assessment Endpoints and Measurement Endpoints

This section defines preliminary assessment and measurement endpoints and presents the rationale for selection of representative receptors. Based on the ecological setting, habitat characteristics, and the transport, fate, and toxicity of the CoPCs, the preliminary assessment endpoints selected for the screening assessment include the protection of plant and animal communities from adverse ecological effects resulting from exposure to CoPCs in surface water, soil, sediment, and diet. The preliminary assessment endpoints for this SLERA are:

- The protection of terrestrial and wetland plant and soil invertebrate communities from adverse ecological effects resulting from exposure to CoPCs in soil
- The protection of freshwater aquatic life (e.g., benthic invertebrates and fish) from adverse ecological effects resulting from exposure to CoPCs in sediment or surface water

- The protection of terrestrial mammalian herbivore communities from adverse ecological effects resulting from exposure to CoPCs in water, soil, and diet
- The protection of terrestrial avian and mammalian vermivore communities from adverse ecological effects resulting from exposure to CoPCs in water, soil, and diet
- The protection of freshwater avian and mammalian piscivore communities from adverse ecological effects resulting from exposure to CoPCs in water, sediment, and diet.

The measurement endpoints used to evaluate assessment endpoints such as the protection of plant communities and soil fauna, benthic invertebrate communities, and aquatic life will be the maximum concentrations of CoPCs measured in soil, sediment, and surface water at the site, respectively. For assessment endpoints such as the protection of various bird and mammal communities, indicator species that are representative of broader communities will be used to evaluate ecological risk to those communities.

4.3.1 Aquatic Receptors

CoPCs have been identified in sediment and surface water collected from the marsh area downgradient of the former facility and in the flume, which receives water from the marsh. There are resident populations of juvenile salmonids, and likely benthic invertebrates, in these aquatic habitats, and therefore risk of adverse ecological effects from sediment and surface water to freshwater aquatic life will be assessed.

Mammalian and avian piscivores (fish-eating wildlife) could potentially forage on fish inhabiting the marsh area downgradient of the former facility or in the flume. Therefore, risk of adverse effects to avian and mammalian piscivores will be assessed using simplified food web models to estimate total dietary exposure to CoPCs from prey, water, and incidental sediment ingestion. The mink (*Mustela vison*) and the great blue heron (*Ardea herodias*) have been selected as the freshwater mammalian and avian receptors, respectively. Both species are known to occur in the Sitka area (Foster Wheeler 1998).

4.3.2 Terrestrial Receptors

In terrestrial portions of the habitat adjacent to the former facility, CoPCs have been identified in soil, and therefore risk of adverse effects to terrestrial plants and soil invertebrates from soil exposure will be assessed. Risk of adverse ecological effects to mammals that may feed on plants, and birds and mammals that may feed on soil fauna (i.e., worms) will be evaluated using simplified food web models to estimate total dietary exposure to CoPCs. The Sitka mouse (*Peromyscus sitkensis*) has been selected as the preliminary receptor representing mammalian herbivores in the food web model. The common shrew (*Sorex cinereus*) and the American robin (*Turdus migratorius*) have been selected as representatives of mammalian and avian vermivores (worm-eating wildlife), respectively. These three species are known to occur in the Sitka area (Foster Wheeler 1998) and may be exposed to CoPCs in surface water, soil, and their

diet. These three species have home range sizes sufficiently small that they could obtain most or all of their food from habitats adjacent to the former facility. Due to the small size of the area adjacent to the former facility relative to home range sizes, larger mammals, such as Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) and brown bears (*Ursus arctos*) are expected to occur only as transients across the site, if at all.

4.4 Screening Assessment

The following sections present the results of the screening assessment. The initial step screens CoPC concentrations in media against ecological benchmarks to identify important exposure pathways and CoPCs and eliminate those chemicals and exposure pathways that pose negligible risks (U.S. EPA 1997b). The screening-level estimates ensure that the appropriate and relevant CoPCs are selected for further evaluation, if necessary, and that data gaps are identified for any following phases of the ecological risk assessment (ERA). The SLERA also serves to focus any subsequent risk evaluation on the ecosystems that are potentially at risk. Additionally, CoPC concentrations in media are used to model risk to higher trophic level ecological receptors. The following sections discuss the selection of screening benchmarks and toxicity reference values (TRVs) and present summary tables of these criteria and comparisons of site-specific media data with these criteria.

4.4.1 Ecological Screening Overview

The maximum concentrations of CoPCs in soil, sediment, and surface water in the study area are compared against screening benchmarks to evaluate potential for adverse risk to terrestrial plants, soil fauna, and freshwater aquatic life. Screening benchmarks represent ambient media concentrations of a chemical that, if exceeded, could indicate the occurrence of adverse effects to ecological receptors. The screening assessment does not result in a quantitative risk characterization. However, exceedance of screening values may indicate the need for further evaluation of the risk associated with a chemical. CoPC concentrations in media samples will also be compared with appropriate regional background levels, if available. Chemicals are retained for further evaluation if their maximum concentrations exceed the ecological screening benchmarks. When possible, media concentrations will also be compared to screening benchmarks for risk to wildlife. However, in cases where such benchmarks do not exist or where they are exceeded, conservative food web models are used to model dietary exposure for birds and mammals from media concentrations.

4.4.2 Surface Water Screening

CoPC concentrations in surface water are compared to EPA's national ambient water quality criteria (AWQC) criterion continuous concentration (CCC) values for protection of aquatic life, such as aquatic invertebrates and fish (U.S. EPA 2002b). The CCC is the highest water concentration of a given chemical to which an aquatic community can be exposed indefinitely without adverse effect (U.S. EPA 2002b). The CCC for lead, zinc, and cadmium are hardness-dependent and comparisons between site concentrations and criteria are made using a default hardness of 100 mg/L as $CaCO_3$ (U.S. EPA 2002b). Results of surface water screening for

metals are summarized in Table 4-1. Cadmium and lead concentrations exceeded their CCC at all four sampling locations, whereas chromium and mercury concentrations only exceeded their respective criteria at Station 2ESE07. The implications of these results are discussed in more detail in *Discussion and Interpretation of Ecological Screening Results*.

4.4.3 Sediment Screening

Sediment CoPC concentrations are compared to screening benchmarks to evaluate the potential for adverse effects to freshwater benthic invertebrates and aquatic life. The maximum concentrations of metals and PAHs in sediment are compared to consensus-based threshold effect concentrations (TECs) and probable effect concentrations (PECs) developed by MacDonald et al. (2000). The TEC is the sediment concentration below which adverse effects to benthic organisms are not expected; the PEC is the sediment concentration above which adverse effects to benthic organisms are expected to occur frequently (MacDonald et al. 2000). Sediment metal and PAH concentrations are also compared to no-effect concentrations (NECs) derived by Ingersoll et al. (1996) from toxicity tests of *Hyalella azteca* and *Chironomus riparius*, two sensitive and representative freshwater benthic organisms. The NEC is the sediment concentration of a given chemical above which a statistically significant effect is always observed.

Dioxin and furan concentrations are expressed on a TEQ basis and compared with Canadian sediment quality guidelines for the protection of aquatic life (CCME 2001b) and screening values developed by U.S. EPA (1993a) for the protection of fish, birds, and mammals. Canadian guidelines report two screening values, one interim sediment quality guideline (ISQG), and a probable effects level (PEL). The ISQG is comparable to a TEC, whereas a PEL is comparable to a PEC. U.S. EPA (1993a) developed two sets of screening values, the lower of which equates to the highest concentration that is unlikely to cause significant effects in sensitive organisms, and the higher set represents concentrations that will likely cause severe effects in sensitive organisms.

Sediment screening values are summarized in Table 4-2. Screening results are presented for metals in Table 4-3, for PAHs in Table 4-4, and for PCDDs/Fs in Table 4-5. Sediment metals concentrations were measured at nine stations. All metals exceeded their benchmarks at one or more stations. The greatest frequency of exceedance of screening benchmarks was observed at Stations 2S06 within the wetland and 3SE03 in the flume at the culvert outlet that drains the wetland. Supplemental sediment sampling within the flume, conducted in March 2004, indicated no exceedance of screening benchmarks for cadmium, lead, or mercury. Chromium exceeded the TEC benchmark at 4NE04, located upstream of the wetland and at 4SE06 near the hatchery intake, but not at 4SE05, which is in between the wetland and the hatchery intake. PAHs were measured in sediments at two locations, at Station 2SE08-04 in the wetland at the location where it discharges to the flume and at Station 3SE03 in the adjacent section of the flume. Most PAHs exceeded screening benchmarks at each location; however, in many cases PAHs were undetected and exceedances result from detection limits being greater than the corresponding benchmark. Only benzo[b]fluoranthene and benzo[k]fluoranthene concentrations were less than their benchmarks at both locations. No ecological screening benchmarks were available for comparison with measured concentrations of 2-methylnaphthalene, acenaphthene,

and acenaphthylene. PCDDs/Fs were examined at five locations. All five screening benchmarks were exceeded at the wetland station (2SE08) and at the culvert draining the wetland (3SE03). Limited benchmark exceedances were seen at the next downstream flume station (4SE05), but there were no benchmark exceedances at the upstream flume station (4NE04) or the farthest downstream flume location (4SE06). The implications of these results are discussed in more detail in *Discussion and Interpretation of Ecological Screening Results*.

4.4.4 Terrestrial Plant and Soil Fauna Assessment

Soil data are compared to screening benchmarks to evaluate the potential for adverse effects to terrestrial plants and soil fauna from site-related CoPCs in soils. The maximum metals concentrations in soil are compared to Oak Ridge National Laboratory (ORNL) toxicological benchmarks for effects on terrestrial plants (Efroymson et al. 1997a) and earthworms and microbial heterotrophs (Efroymson et al. 1997b), and to Canadian soil quality guidelines (CCME 2001a). The ORNL screening benchmarks approximate the 10th percentile of lowest-observed-effect concentrations reported in studies that examined the effects of chemicals on vascular plant growth or production (yield) (Efroymson et al. 1997a), earthworm survival, or soil microflora community functioning, including carbon mineralization, nitrogen transformation, and enzyme activities (Efroymson et al. 1997b). Canadian soil quality guidelines are derived both for the protection of ecological receptors and human health. Where available, metals concentrations in soil will also be compared to EPA ecological soil screening levels developed for the protection of terrestrial plants, soil invertebrates, and wildlife (U.S. EPA 2000b). Soil screening values are summarized in Table 4-6. No appropriate soil screening values exist for PAHs, so for screening purposes, the sediment screening values listed in Table 4-2 are used for this class of CoPCs. PCDD/F concentrations, expressed on a TEQ basis are screened against Canadian soil quality guidelines listed in Table 4-6.

All four metals exceeded at least one screening value at one or more sampling stations (Table 4-7). Chromium had the greatest frequency of screening value exceedance followed by mercury and lead. Cadmium exceedances of screening values were largely restricted to stations SE5 and S7. Three PAHs exceeded screening values: benzo[a]anthracene, benzo[a]pyrene and naphthalene at stations SE4 and/or SE5 (Table 4-8). No PAHs exceeded screening values at the other two sampling stations. PCDDs/Fs exceeded the screening value only at Station S7 (Table 4-9). The implications of these results are discussed in more detail in *Discussion and Interpretation of Ecological Screening Results*.

4.5 Wildlife Exposure Assessment

The presence of incinerator-related CoPCs in sediments, soils, surface water, and fish indicates that exposure pathways to wildlife exist through ingestion of sediment, soil, surface water, and food. The ingestion pathway is the primary route of exposure and the dermal and inhalation pathways are usually minor exposure pathways in comparison.

Preliminary evaluation of potential for unacceptable risk to wildlife receptors was done by comparing media concentrations to wildlife screening benchmarks, as discussed above. The

results of this comparison indicate that the only case where media concentrations screen out is for chromium in soils, where the maximum concentration is less than the mammalian screening benchmark. Therefore, no further evaluation of risk from chromium to terrestrial mammals is required. For all other cases where media concentrations exceed their benchmarks, or if benchmarks are unavailable for specific CoPC/media combinations, then risk for avian and mammalian receptors is evaluated using simple food-web exposure models. Conservative assumptions are made throughout the modeling exercise to minimize the possibility of a false negative finding at the screening stage. These exposure estimates should, therefore, be considered highly conservative. Food-web model input parameters are described below for the representative receptors (Sitka mouse, common shrew, American robin, mink, and great blue heron).

A standard food-web modeling approach that is consistent with EPA's wildlife exposure guidance (U.S. EPA 1993b; 61 Fed. Reg. 47552) is used to calculate exposure. The food-web model estimates dietary exposure as a body-weight-normalized total daily dose for each receptor species. The general structure of the food-web exposure model is described by the following equation:

$$IR_{chemical} = \frac{\sum_i \left(C_i \times M_i \times A_i \times F_i\right)}{W}$$

where:

$IR_{chemical}$	=	total ingestion rate of chemical from all dietary components (mg/kg body weight/day)
C_i	=	concentration of the chemical in a given dietary component or inert medium (mg/kg)
M_i	=	rate of ingestion of dietary component or inert medium (kg/day)
A_i	=	relative gastrointestinal absorption efficiency for the chemical in a given dietary component or inert medium (fraction)
F_i	=	fraction of the daily intake of a given dietary component or inert medium derived from the site (unitless area-use factor)
W	=	body weight of receptor species (kg).

The term $IR_{chemical}$ can be expanded to specify each ingestion medium, which includes one or more primary food items, drinking water, and incidentally ingested sediment or soil:

$$IR_{chemical} = [\Sigma\ (C_{food} \times M_{food} \times A_{food} \times F_{food}) + (C_{water} \times M_{water} \times A_{water} \times F_{water}) + (C_{sediment/soil} \times M_{sediment/soil} \times A_{sediment/soil} \times F_{sediment/soil})]/W$$

This model provides an estimated total dietary exposure to CoPCs resulting from consumption of food, water, and the incidental ingestion of sediment or soil on a mg/kg body weight-day basis. For all receptors modeled, the screening-level exposure calculation assumes that the entire diet for all receptors comes from the site ($F_i = 1$), and that 100 percent of the chemical in ingested food is absorbed ($A_i = 1$). Although receptors are more likely to be exposed to lower

concentrations, for purposes of the screening assessment, the maximum CoPC concentrations in food, sediment, soil, and water are to evaluate exposure. Uncertainties associated with use of these conservative exposure parameters are discussed below in the uncertainty analysis.

Metal and PCDD/F concentrations were measured in fish (juvenile salmonids) collected from the marshy area adjacent to the former facility. These site-specific data will be used in evaluation of potential for unacceptable risk to piscivorous wildlife. Metals data are presented in Table 4-10, and PCDD/F data are presented in Table 4-11. No site-specific data are available for CoPC concentrations in terrestrial prey that are potentially consumed by mammalian herbivores or avian and mammalian herbivores. For purposes of this screening assessment, CoPC concentrations in prey (plants and earthworms) are extrapolated from soil concentrations using empirical models developed by Bechtel (1998) and Sample et al. (1998). Model regression equations are presented in Table 4-12.

4.5.1 Wildlife Toxicity Assessment

To evaluate the potential for adverse effects to avian and mammalian ecological receptors, exposure estimates must be calculated and compared to TRVs. A TRV is a body-weight-normalized daily intake rate of a chemical that, if exceeded, could potentially result in adverse effects to the ecological receptor. The selection of TRVs requires the use of professional judgment in combination with guidelines provided in EPA's ERA guidance documents. Consistent with U.S. EPA (1997b) guidance, the lowest available no-observed-adverse-effect levels (NOAELs) selected from the toxicology literature are used as TRVs in this screening assessment. Because the intent of an ERA is to assess risk to wildlife populations (U.S. EPA 1997b), preference was given to exposure studies that evaluated endpoints that directly affect receptors on a population level: development, reproduction, and survival. TRVs are expressed in body-weight-normalized units of mg/kg-day, which enables application of the TRV to various species consuming diets of variable moisture content. TRVs for metals are presented in Table 4-13.

To evaluate potential risk of adverse effects from exposure to PCDDs/Fs, the PCDD/F concentrations measured in fish are compared with threshold effects levels proposed by U.S. EPA (1993a). Fish concentrations are shown in Table 4-11. Since isomer-specific toxic potencies vary for fish, birds, and mammals, separate TEQ concentrations are presented for each of these groups. EPA threshold concentrations are shown in Table 4-14. U.S. EPA (1993a) developed two sets of screening values, the lower of which equates to the highest concentration that is unlikely to cause significant effects in sensitive organisms, and the higher set represents concentrations that will likely cause severe effects in sensitive organisms.

4.5.2 Species-Specific Exposure Parameters

4.5.2.1 Exposure Parameters for Great Blue Heron

The exposure parameters for the great blue heron are presented in Table 4-15. Fish typically are 85 percent of the great blue heron's diet; crustaceans, insects, amphibians, reptiles, birds, and small mammals comprise the remainder of the diet (Alexander 1977; Hoffman 1978; Peifer

1979). For the purpose of this screening assessment, however, it is assumed that 100 percent of the great blue heron's diet is fish and all the fish are obtained from habitats adjacent to the former facility. The female adult body weight is assumed to be 2.2 kg (Hoffman 1978). Using the allometric equation for birds developed by Nagy (1987), the total daily food ingestion rate for the great blue heron on a dry-weight basis is 97 g. The food ingestion rate is presented on a dry-weight basis because exposure from sediment ingestion, which is based on dry-weight concentrations, is dependent on the food ingestion rate (i.e., the sediment ingestion rate is expressed as a percent of total food ingestion).

Allometric estimation methods for drinking water intake rates have been developed for birds (Calder and Braun 1983) (L water/day = $0.059 \times$ kg body weight$^{0.67}$). Assuming a body weight of 2.2 kg for the great blue heron, the daily water ingestion rate is estimated to be 0.1 L/day.

Incidental sediment ingestion rates have not been reported for the great blue heron; therefore, a sediment ingestion rate has been estimated, based on the analysis of acid-insoluble ash in waterfowl scat by Beyer et al. (1994). Piscivorous wading birds were not included in the study by Beyer et al. (1994), but can be expected to have lower incidental sediment ingestion rates than the species that were studied. Beyer et al. (1994) reported that aquatic birds that derive all or most of their diet through bottom-feeding, such as sandpipers and wood ducks, have sediment ingestion rates ranging from 7.3 to 30 percent of their total dietary intake, based on ash-insoluble scat analysis. The mallard, which dabbles in submerged aquatic vegetation, has a sediment ingestion rate of only 3.3 percent of the total dietary intake. Other duck species, such as the blue-winged teal and ring-necked duck, have sediment ingestion rates less than 2 percent of total dietary intake (the resolution limit of the Beyer et al. [1994] study). All of these species feed heavily on benthic infauna living in the sediment and/or rooted aquatic vegetation that is likely to have attached sediment; their feeding behavior should therefore be expected to result in higher incidental sediment ingestion than wading piscivores. The great blue heron and similar species feed in the water column on fish. The incidental sediment ingestion rate for the great blue heron is therefore conservatively estimated to be 2 percent of total daily food consumption (on a dry-weight basis). The incidental sediment ingestion rate is estimated to be 2 percent of 97 g, or 1.9 g of sediment per day on a dry-weight basis.

In summary, the screening-level exposure model for great blue heron is based on the following assumptions:

- The diet is composed of 100 percent fish
- All food, incidental sediment, and water consumed are from habitats adjacent to the former facility (area-use factor of 1.0)
- All fish, sediment, and water consumed contain the maximum concentration reported for each CoPC
- The entire CoPC load in fish, sediment, and water is 100 percent bioavailable (absorption factor of 1.0)
- Birds are residents at the Site for the entire year

- Body weight is 2.2 kg
- Daily fish consumption is 97 g (dry weight)
- Daily incidental sediment ingestion is 1.9 g (dry weight)
- Daily water ingestion is 0.1 L.

4.5.2.2 Exposure Parameters for Mink

The exposure parameters for the mink are presented in Table 4-15. Mink consume a varied diet including fish, amphibians, small mammals, and birds. Typically, fish comprise less than 50 percent of the diet (Arnold and Frizzell 1987; Alexander 1977; Sealander 1943; Korschgen 1958). However, for the purpose of this screening assessment, it is assumed that 100 percent of the mink's diet is fish and all the fish are obtained from the habitats adjacent to the former facility.

Adult female body weights for wild (not farm-raised) mink are reported to range from 0.50 to 0.65 kg (Mitchell 1961). As a conservative estimate, the minimum body weight from this range, 0.55 kg, is used in this model. Bleavins and Aulerich (1981) measured food ingestion rates for mink and reported that consumption by 12 adults fed *ad libitum* averaged 0.052 kg/kg body weight/day (dry weight). Assuming a body weight of 0.55 kg, the daily food ingestion rate would be 0.029 kg/day (dry weight). The drinking water ingestion rate is assumed to be 0.058 L/day, using the allometric equation of Calder and Braun (1983) (i.e., L water/day = $0.099 \times$ kg body weight$^{0.9}$). Incidental sediment ingestion rates for mink have not been well researched. Hamilton (1940) indicated that mineral matter constitutes no more than a trace of the total intake. However, for purposes of this screening assessment, it is assumed that mink ingest sediment at a rate equal to 2 percent of their food ingestion rate, or 0.00058 kg/day (dry weight).

In summary, the screening-level exposure model for mink is based on the following assumptions:

- The diet is composed of 100 percent fish
- All food, incidental soil, and water consumed are from habitats adjacent to the former facility (area-use factor of 1.0)
- All prey, sediment, and water consumed contain the maximum concentration of CoPCs
- CoPCs in prey, sediment, and water are 100 percent bioavailable (absorption factor of 1.0)
- The receptor is a resident at the Site for the entire year
- Body weight is 0.55 kg
- Daily food consumption is 0.029 kg of fish (dry weight)

- Daily soil ingestion is 0.00058 kg (dry weight)
- Daily water consumption is 0.058 L.

4.5.2.3 Exposure Parameters for the American Robin

The exposure parameters for the American robin are presented in Table 4-15. Terrestrial invertebrates are a major component of the robin's diet. Other food items include fruit, seeds, and plants. For the purposes of this screening assessment, however, it is assumed that the robin's diet is 100 percent soil invertebrates (i.e., earthworms). Of all the prey items of the American robin, soil invertebrates have the highest exposure to CoPCs because they are in direct contact with soil particles. It is also assumed that all the invertebrates consumed by robins are from terrestrial habitats adjacent to the former facility, and all invertebrates contain the maximum CoPC concentration. The adult body weight is assumed to be 77 g (Clench and Leberman 1978, as cited by Dunning 1984). Using the allometric equation for birds developed by Nagy (1987), the total food ingestion rate is estimated to be 16.0 g dry weight.

Allometric estimation methods for drinking water intake rates have been developed for birds (Calder and Braun 1983) (i.e., L water/day = $0.059 \times$ kg body weight$^{0.67}$). Assuming a body weight of 0.077 kg for the American robin, the daily water ingestion rate is estimated to be 0.011 L/day.

Incidental soil ingestion rates have not been reported for the American robin; therefore, a soil ingestion rate has been estimated, based on the analysis of acid-insoluble ash in scat by Beyer et al. (1994). A vermivorous bird, the American woodcock, was included in the study by Beyer et al. (1994), and had a reported soil ingestion rate of 10.4 percent of the diet. The diet of the American woodcock is primarily earthworms, while the American robin consumes a wide variety of animal and plant material, including earthworms. Thus, the American robin can be expected to have lower incidental soil ingestion rates than the woodcock. However, for the purposes of this ERA, the conservative incidental soil ingestion of the American robin is assumed to be 10.4 percent of the diet of 16.0 g, or 1.7 g of soil per day on a dry-weight basis.

In summary, the screening-level exposure model for American robin is based on the following assumptions:

- The diet is composed of 100 percent earthworms
- All food, incidental soil, and water consumed are from habitats adjacent to the former facility (area-use factor of 1.0)
- All prey, soil, and water consumed contain the maximum concentration of CoPCs
- CoPCs in prey, soil, and water are 100 percent bioavailable (absorption factor of 1.0)
- The receptor is a resident at the Site for the entire year

- Body weight is 77 g
- Daily food consumption is 16 g of earthworms (dry weight)
- Daily soil ingestion is 1.7 g (dry weight)
- Daily water consumption is 0.011 L.

4.5.2.4 Exposure Parameters for Common Shrew

The exposure parameters for the common shrew are presented in Table 4-15. The shrew diet consists primarily of a variety of invertebrates, and for the purpose of this screening assessment it is assumed that 100 percent of the shrew's diet is earthworms and all the earthworms are obtained from the Site.

The average weight of adult common shrews is reported to range from 3.2 to 5.1 g (Silva and Downing 1995). As a conservative estimate, the minimum body weight from this range, 3.2 g, is used in this model. The food ingestion rate is assumed to be 0.86 g/day (dry weight) using the allometric equation of Nagy et al. (1999) for insectivorous mammals and assuming a body weight of 3.2 g. The drinking water ingestion rate is assumed to be 0.00056 L/day, using the allometric equation of Calder and Braun (1983) (i.e., L water/day = $0.099 \times$ kg body weight$^{0.9}$). Incidental soil/sediment ingestion rates for shrews have not been well researched. For purposes of this screening assessment, it is assumed that common shrews ingest sediment at a rate equal to 9.4 percent of their food ingestion rate, or 0.081 g/day (dry weight), estimated from values reported for other species by Beyer et al. (1994).

In summary, the screening-level exposure model for common shrew is based on the following assumptions:

- The diet is composed of 100 percent earthworms
- All food, incidental soil, and water consumed are from habitats adjacent to the former facility (area-use factor of 1.0)
- All prey, soil, and water consumed contain the maximum concentration of CoPCs
- CoPCs in prey, soil, and water are 100 percent bioavailable (absorption factor of 1.0)
- The receptor is a resident at the Site for the entire year
- Body weight is 3.2 g
- Daily food consumption is 0.86 g of earthworms (dry weight)
- Daily soil ingestion is 0.081 g (dry weight)
- Daily water consumption is 0.00056 L.

4.5.2.5 Exposure Parameters for Sitka Mouse

The exposure parameters for the Sitka mouse are presented in Table 4-15. Sitka mice are omnivorous and opportunistic and their diet can contain a variety of plant species and terrestrial arthropods. However, for the purpose of this screening assessment it is assumed that 100 percent of the Sitka mouse diet is plant material and all the plants are obtained from habitats adjacent to the former facility.

The average weight of an adult Sitka mouse is reported as 28.3 g (Silva and Downing 1995). The food ingestion rate is assumed to be 6.88 g/day (dry weight) using the allometric equation of Nagy et al. (1999) for herbivorous mammals and assuming a body weight of 28.3 g. The drinking water ingestion rate is assumed to be 0.0054 L/day, using the allometric equation of Calder and Braun (1983) (i.e., L water/day = 0.099 × kg body weight$^{0.9}$). Beyer et al. (1994) report the incidental soil ingestion rate for the congeneric white-footed mouse (*Peromyscus leucopus*) to be equivalent to 2.0 percent of their food ingestion rate, and this value will be used in the screening assessment for Sitka mice. Therefore, the soil ingestion rate is 0.14 g/day (dry weight).

In summary, the screening-level exposure model for Sitka mouse is based on the following assumptions:

- The diet is composed of 100 percent plant material
- All food, incidental soil, and water consumed are from habitats adjacent to the former facility (area-use factor of 1.0)
- All prey, soil, and water consumed contain the maximum concentration of CoPCs
- CoPCs in prey, soil, and water are 100 percent bioavailable (absorption factor of 1.0)
- The receptor is a resident at the Site for the entire year
- Body weight is 28.3 g
- Daily food consumption is 6.88 g of plant material (dry weight)
- Daily soil ingestion is 0.14 g (dry weight)
- Daily water consumption is 0.0054 L.

4.5.3 Risk Calculations

Risk of adverse ecological effects from metals to bird and mammal communities will be estimated using the hazard quotient approach:

$$HQ = \frac{IR_{chemical}}{TRV}$$

where:

HQ	=	hazard quotient (unitless)
$IR_{chemical}$	=	total ingestion rate of the chemical (mg/kg body weight-day)
TRV	=	toxicity reference value (mg/kg body weight-day).

In a screening assessment, hazard quotients below 1.0 indicate that the CoPC is unlikely to cause adverse ecological effects. Hazard quotients above 1.0 do not necessarily imply unacceptable risk, only that further evaluation may be required (U.S. EPA 1997b). Other pieces of information, such as sources of uncertainty and site-specific exposure information, also need to be weighted in the evaluation and interpretation of screening-level hazard quotients exceeding 1.0.

The calculations of total daily exposure and hazard quotients for all receptors are presented in Tables 4-16 through 4-20. For the great blue heron (Table 4-16) and mink (Table 4-17), hazard quotients only exceeded 1.0 for mercury. For terrestrial species, hazard quotients exceeded 1.0 for all metals evaluated (Tables 4-18 through 4-20), with the highest estimates calculated for the American Robin.

PCDD/F concentrations in fish (Table 4-11) were compared with TECs proposed by U.S. EPA (1993a). Measured concentrations were below all thresholds except the threshold for low risk to mammalian wildlife. The implications of results for wildlife exposure modeling are discussed in detail in *Discussion and Interpretation of Ecological Screening Results*.

4.6 Sources of Uncertainty

This SLERA has many sources of uncertainty that are associated with the conservative assumptions characteristic of any screening assessment. There is uncertainty associated with the screening criteria, assumptions made in the selection of exposure parameters, accumulation factors, and TRVs, as well as with data gaps; these are discussed below.

The surface water, sediment, and soil benchmarks used in the screening evaluation are generic values developed using a variety of test species and experimental conditions that may not be representative of the receptors and site-specific environmental conditions. Therefore, application of these generic values adds uncertainty to the risk assessment because these values may not be directly relevant to environmental conditions at the former facility (e.g., acclimation of ecological receptors over time to site-specific factors, differences in bioavailability of CoPCs, heterogeneous sediment or soil matrices, etc.) that could potentially reduce the likelihood of adverse ecological effects even when CoPC concentrations in media exceed benchmark values.

Uncertainties inherent in the exposure assumptions for higher trophic level species (birds and mammals) specifically include the variability and/or lack of information regarding food and sediment ingestion rates, the dietary composition of receptors, the contaminant concentrations ingested by the receptors, the portion of the receptors' diet obtained from the habitats adjacent to the facility, and the portion of ingested contaminants that is absorbed. The magnitude of each

uncertainty differs and can vary with CoPC and receptor. Significant sources of uncertainty are discussed below.

This SLERA was conducted using diet assumptions that maximized exposure to the receptors. For example, the American robin has a varied diet that includes a high proportion of aerial invertebrates, such as Lepidoptera, and fruits that receive lower exposure than earthworms to CoPCs in soil. The proportions of invertebrates and fruit in their diet vary seasonally, with fruit dominating in the fall and winter months (Sallabanks and James 1999). Therefore, considering the complete diet composition of the American robin, this SLERA overestimates total exposure to CoPCs from food ingestion. However, risk estimates based on a diet of 100 percent earthworms would be protective of risk to other vermivorous birds potentially present at the site and that may have higher proportions of worms in their diet than robins.

Exposure modeling for avian and mammalian receptors conservatively assumed that animals consume only prey with the maximum CoPC concentrations and incidentally ingest sediment or soil with the maximum CoPC concentrations. Although appropriate for screening purposes, this approach does not reflect the exposure for a typical receptor that forages at multiple locations across the site. Additionally, to calculate hazard quotients, exposure estimates were compared to NOAEL-based TRVs, which although conservative, do not represent dietary exposure concentrations at which adverse effects potentially first occur. Jointly, use of these exposure and effects parameters maximize exposure and sensitivity to determine a worst-case upper bound risk estimate. Under this scenario, if a hazard quotient for a CoPC is less than 1.0, it can be concluded that the chemical in question is highly unlikely to constitute a risk to ecological receptors under more representative exposure and effects conditions. However, even for those CoPCs with a hazard quotient exceeding 1.0 under these worst-case conditions, the level of risk may not be unacceptable under more ecologically representative exposure scenarios.

Area-use and temporal-use factors are sources of uncertainty that vary with receptor but not CoPC. Screening models conservatively assume that receptors forage exclusively within the footprint of the site. However, for some larger-bodied receptors, such as herons and mink, this assumption is overly conservative. For example, great blue herons breed in heronries and nest in hardwood trees and they may forage over 10 km from their breeding colony. Thus, great blue herons, even if nesting at the former facility, are likely to spend a considerable portion of their time foraging elsewhere. Similarly, the mink has a home range of 7.8 to 380 ha depending on the type of habitat (U.S. EPA 1993b). For receptors such as these with home ranges larger than the site, some proportion of their prey is obtained from local background areas, and thus actual exposure to CoPCs is over-predicted under the conservative assumption that foraging is restricted to the former facility area.

Bioaccumulation factors were used to estimate concentrations of metals in earthworms as prey of American robin and common shrews and in plants as food of Sitka mice. These factors are generated for most metals from empirical data to which a regression relationship is fitted. The accuracy of the relationship is dependent on the quality of the database. For example, the width of the distribution of soil concentrations in the database is an important factor. The database available to produce the mathematical relationship is sometimes sparse and does not capture a wide range of concentrations. Because the accumulation of contaminants from soil to earthworms or plants is not usually a linear relationship, it is important to include a wide range

of soil concentrations to be able to accurately describe the accumulation relationship. Also, bioaccumulation rates commonly reach a saturation point above which the concentration of a contaminant can no longer increase in the tissues. If bioaccumulation factors are applied to soil concentrations that are above or below the range used to develop the regression relationship, the result may be over- or under-estimation of bioaccumulation.

TRVs are significant sources of uncertainty for the following reasons:

- Test conditions may not accurately mimic natural exposure
- Relative sensitivity of the receptors compared to the test species may be unknown
- Identification of the no-effect threshold is imprecise and dependent on selected dose intervals
- Uncertainty factors applied in calculating TRVs are generalized and ignore species-specific sensitivities
- Chronic no-effect thresholds have not been measured for all CoPCs and may need to be estimated from low-effect thresholds or acute exposure studies.

Data gaps that exist in this ERA include lack of available toxicity benchmarks and TRVs for some CoPCs. Toxicity benchmarks have been developed for the contaminants that are relatively toxic to wildlife, bioaccumulate, and are typically detected in the environment. Therefore, the CoPCs that could not be assessed because of a data gap are less likely to pose significant risk to wildlife than those for which adequate toxicity data exist.

For example, food-chain exposure modeling did not evaluate the potential for adverse effects of VOCs and SVOCs to avian and mammalian receptors. However, this data gap is considered insignificant, as these compounds tend not to be persistent or to bioaccumulate in prey items. Therefore, any potential for ecological impact from these compounds will most likely be limited to lower trophic organisms such as zooplankton benthic macroinvertebrates, and soil fauna, and these potential effects are assessed by comparison of sediment or soil concentrations to screening benchmarks. For example, as noted by Kaputska (2004), there is no evidence that PAHs in soils at hazardous waste sites result in adverse effects to wildlife. Therefore, it is highly unlikely that any of these CoPCs would represent a potentially unacceptable incremental risk for the higher trophic receptors considered in this risk assessment.

4.7 Discussion and Interpretation of Ecological Screening Results

In the following sections, the results of the screening assessment are summarized for each of the media and the ecological relevance of exceedance of toxicological benchmarks is discussed.

4.7.1 Surface Water

All four metals analyzed in surface water exceed their AWQC for chronic effects to aquatic organisms, thus potential for adverse risk to aquatic organisms exposed to metals in surface water cannot be eliminated. Cadmium and lead exhibit the greatest spatial extent of criteria exceedance, as concentrations at all four stations sampled are above the AWQC, whereas chromium and mercury concentrations only exceed the AWQC at one location in the marsh area.

4.7.2 Sediment

Metals concentrations in sediments exceed screening values at most locations throughout the marsh area and also at the location in the flume adjacent to the outfall of the wetland area. However, in flume sediments upstream and downstream of the outfall, metals are generally present at concentrations below screening thresholds. The PEC and NEC benchmarks represent chemical concentrations above which adverse effects on benthic organisms are expected to occur. As all metals exceed one or both of their PEC and NEC at multiple locations within the wetland, the potential for adverse risk to benthic organisms in sediment cannot be eliminated. However, there are no exceedances of PEC or NEC benchmarks in the flume sediments, indicating that effects, if they do occur, are likely to be spatially restricted to within the wetland area.

Twelve PAHs exceed screening benchmarks in wetland sediment and flume sediment. However, in half these cases, exceedances occurred when chemicals were undetected but had detection limits greater than the benchmarks. In all other cases, reported PAH concentrations were estimated values because the analyte concentration was less than the method reporting limit. Together, these results suggest that the potential for adverse risk to benthic organisms from PAHs in sediment is likely to be low despite exceedance of screening values.

PCDD/F concentrations in the wetland sediment sample and flume sediment sample collected adjacent to the wetland outlet exceed the PEL screening value, which represents a concentration above which adverse effects to benthic organisms are expected to occur. No exceedance of the PEL is seen in any of the three flume sediment samples collected upstream or downstream of the outlet. Thus, while the potential for adverse risk to benthic organisms in sediment cannot be eliminated, the area where such effects could occur appears to be spatially limited to within the wetland area and does not expand into the flume. Concentrations also exceed EPA screening benchmarks for effects to fish, mammals, and birds, although these exceedances are not likely to be ecologically relevant as discussed below in the review of results for wildlife exposure modeling.

4.7.3 Soil

Metal concentrations in soils exceed screening values at numerous locations throughout the habitat adjacent to the former facility, although only chromium exceeds its screening benchmarks at all sampling locations. Despite exceedance of screening benchmarks, however, metal concentrations may not always be excessively elevated across the entire habitat.

Background metal concentrations were developed for forest soils in the Ketchikan region as part of the remedial investigation for the Ketchikan Pulp Company site (Exponent 1998). Background concentrations at that location were 0.5 mg/kg for cadmium, 21 mg/kg for chromium, 32.6 mg/kg for lead, and 0.14 mg/kg for mercury. Assuming that these values reflect background concentrations at Sitka, then concentrations in measured in soils at the former facility (Table 4-7) are not uniformly elevated. For example, 6 of 17 sampling stations have chromium concentrations less than this background value and another 7 stations have concentrations less than two-fold greater than background. In addition, the conservative nature of the screening values is illustrated by the fact that the Ketchikan background chromium concentration is greater than or equal to 5 of 7 benchmark values. In conclusion, soil metal concentrations exceed screening benchmarks, thus the potential for adverse risk to plants and soil fauna cannot be eliminated. However, comparison of metals data to background concentrations suggests that screening benchmarks over-predict the spatial extent of potential for adverse effects.

Soil PAH and PCDD/F concentrations are generally below screening levels. There are limited exceedances of PAH screening benchmarks at two locations (SE4 and SE5), and for PCDD/Fs at only one of ten locations (S7). Therefore, the likelihood of adverse effects to plants and soil fauna from these CoPCs appears to be low.

4.7.4 Wildlife Receptors

Risk to wildlife receptors was modeled using conservative exposure and effects scenarios. Even with these assumptions, the only chemical where the hazard quotient exceeded 1.0 for piscivorous wildlife was mercury, and for both modeled receptors the calculated value was only slightly greater than this value (1.1 for great blue heron, and 1.3 for mink). Given that these scenarios represent an upper-bound, worst case example, the likelihood of unacceptable risk from metals to piscivorous wildlife appears to be very low. PCDD/F concentrations in salmon smolts were less than screening benchmarks for effects to fish, birds, and mammals, with the exception of the benchmark representing low risk to mammalian wildlife. However, PCDD/F concentrations in fish collected from the wetland were lower than or equal to concentrations in fish collected at an upstream reference location, indicating that the likelihood of incremental risk at the site is very low. These results indicate that there is very low likelihood of unacceptable risk to piscivorous wildlife at the former facility, and no further evaluation of pathways to these receptors is required.

In the terrestrial habitats, hazard quotients exceed 1.0 for all metals for vermivorous birds and mammals and herbivorous mammals under conservative worst-case scenarios. Considerable uncertainty exists with regard to the ecological relevance of these model results, however, because it is not clear how reliable it is to estimate CoPC concentrations in prey (worms or plants) through extrapolation from soil concentrations. The food-web model results represent worst-case scenarios.

For comparative purposes, a second set of analyses was performed using mean soil concentrations (averaged from values in Table 4-7, excluding soils collected at the proposed daycare site), to reflect a more typical exposure scenario for a receptor foraging across the

habitat. Conservative assumptions were retained for site use by assuming that the receptor forages exclusively at the site and for bioavailability by assuming that metals in soils are completely bioavailable. Exposure estimates were compared with TRVs based on lowest-observed-adverse-effect levels (LOAELs), which represent the threshold concentration at which adverse effects are first known to occur. The LOAEL TRVs are listed in Table 4-21, and food-web model results are shown in Tables 4-22 through 4-24. Under this scenario, hazard quotients decline substantially, but still exceed 1.0 in most cases for vermivorous robins (Table 4-22) and common shrews (Table 4-23). However, hazard quotients are less than 1.0 for all metals when modeling exposure to Sitka mice (Table 4-24).

The high hazard quotients for robins and shrews are largely driven by the elevated soil metals concentrations in the downgradient area between the former WTE facility and the wetland, as represented by sampling stations SE5, SE6, and S7. Excluding these three locations, the hazard quotients for robin exposure to cadmium, chromium, lead, and mercury would be 0.23, 4.0, 3.7, and 4.0, respectively. For shrews, the hazard quotients for cadmium, lead, and mercury would be 0.59, 0.20, and 2.1, respectively. Even these hazard quotients likely reflect a substantial overestimation of risk, as they do not incorporate area use factors, variability in diet, or bioavailability of metals in soils, and are based on modeled predictions of metals concentrations in earthworms. Furthermore, even if there are adverse risks to wildlife receptors, these risks would probably only occur to individuals and would be very unlikely to be reflected at the population level. The upland area around the former WTE where soil sampling has been conducted is approximately 1 acre. The home range of robins ranges from 0.3 to 2 acres (Pitts 1984), and the average home range of a masked shrew is 1.5 acres (Nagorsen 1996). Thus, at most a few individuals of either species would be likely to occupy this area, and given the abundance of comparable habitat elsewhere in the vicinity of the site, adverse effects to these few individuals, if any, would be highly unlikely to be reflected at the local or regional population levels.

In conclusion, screening-level food-web model evaluations are not able to eliminate the possibility that exposure pathways to terrestrial vermivorous and herbivorous wildlife species constitute an unacceptable risk under the conservative assumptions inherent in such models. Models that are more ecologically representative suggest that the likelihood of adverse risks to herbivorous wildlife is low, but adverse risk may remain for vermivores. However, even in these cases, adverse ecological impacts, should they occur, would affect only a few individuals of the receptor species, and would be highly unlikely to be reflected in effects at the population level. The major source of uncertainty in these risk conclusions relates to the accuracy of dietary exposures estimated on the basis of extrapolation from soil data.

4.8 Conclusions of the SLERA

The screening evaluation has evaluated the likelihood of adverse effects to ecological receptors occurring in habitats adjacent to the former facility that may be associated with any releases of hazardous constituents from that facility. The conclusions of the SLERA are:

- Metals (cadmium, chromium, lead, and mercury) in wetland surface water exceed AWQC, indicating a potential for unacceptable adverse effects to aquatic organisms in that area

- Metals (cadmium, chromium, lead, and mercury) and PCDD/Fs, exceed screening criteria in wetland sediments and sediments at the location where the wetland empties into the flume. However, the lack of criteria exceedances in the three flume sediment samples collected upstream or downstream of the outlet indicates that the area where adverse effects to benthic organisms could occur appears to be spatially limited to within the wetland area and does not expand into the flume. Metals and PCDD/Fs in flume samples did not occur in concentrations greater than background levels, further suggesting that migration from the site is limited to the flume sediments immediately adjacent to the wetland.

- Food web modeling did not identify adverse effects to piscivorous wildlife that forage in the wetland or the flume.

- Metals (cadmium, chromium, lead, and mercury) in soils adjacent to the former facility exceed screening benchmarks, indicating a potential for unacceptable adverse effects to plants and soil fauna in that area.

- Although the screening-level calculations identified risks to vermivorous and herbivorous wildlife species associated with the terrestrial ecosystem, more representative consideration of the degree of intake from the affected area suggests that the likelihood of adverse risk is low and would only affect a few individuals of the receptor species. Population-level risks are highly unlikely given the size and nature of the site.

5 Overall Conclusions

The HHRA did not identify any risks above levels identified as acceptable by DEC for current uses of the site or the planned daycare area. The slight elevation over the 1×10^{-5} risk level in the recreational scenario can be considered in light of the potential for overestimation of risk associated with the exposure assumptions (i.e., 24 visits per year for 6 years for a young child). The hypothetical residential scenario risk estimates were greater than acceptable risk levels. However, the future residential use of the area is highly unlikely given the small size, the location, and the steep slopes adjacent to the facility. Moreover, the central tendency estimates for the future residential scenario had risk estimates of 1×10^{-5} and 6×10^{-5}, resulting largely from the application of an average concentration for PCDD/F instead of the maximum PCDD/F concentration. Nevertheless, this assessment would suggest that residential uses should be prevented through some means that can be agreed upon by all parties. In addition, future uses of the former facility pad that would require removing the pavement should be restricted and should require proper health and safety practices to prevent unacceptable human exposures.

Ecological risk estimates were conducted using highly conservative screening-level assumptions and could not rule out risks to aquatic organisms, benthic invertebrates, terrestrial plants, soil fauna, and terrestrial wildlife. The area where risks to aquatic organisms or benthic invertebrates could occur is restricted to the wetland area and does not expand into the adjacent flume. Consideration of more representative exposure and toxicity assumptions regarding intake from the affected area suggests that risks to terrestrial wildlife would be limited to a few individuals, at most, of each receptor species, and would not translate into population-level effects.

Sampling conducted in spring of 2003 indicated that PCDD/Fs were detected in flume sediments directly adjacent to the site. The draft HHRA identified potential downgradient sampling locations to address the extent, if any, of migration of site-related contaminants. Subsequent to the draft report in March 2004, three additional samples were collected in the flume (Clare 2004) and analyzed for metals and PCDD/Fs. Sample results from these locations did not identify an increase over background concentrations of metals or PCDD/Fs in sediments at these locations. These findings suggest that any migration from the site is limited to the flume sediments immediately adjacent to the wetland.

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Figures

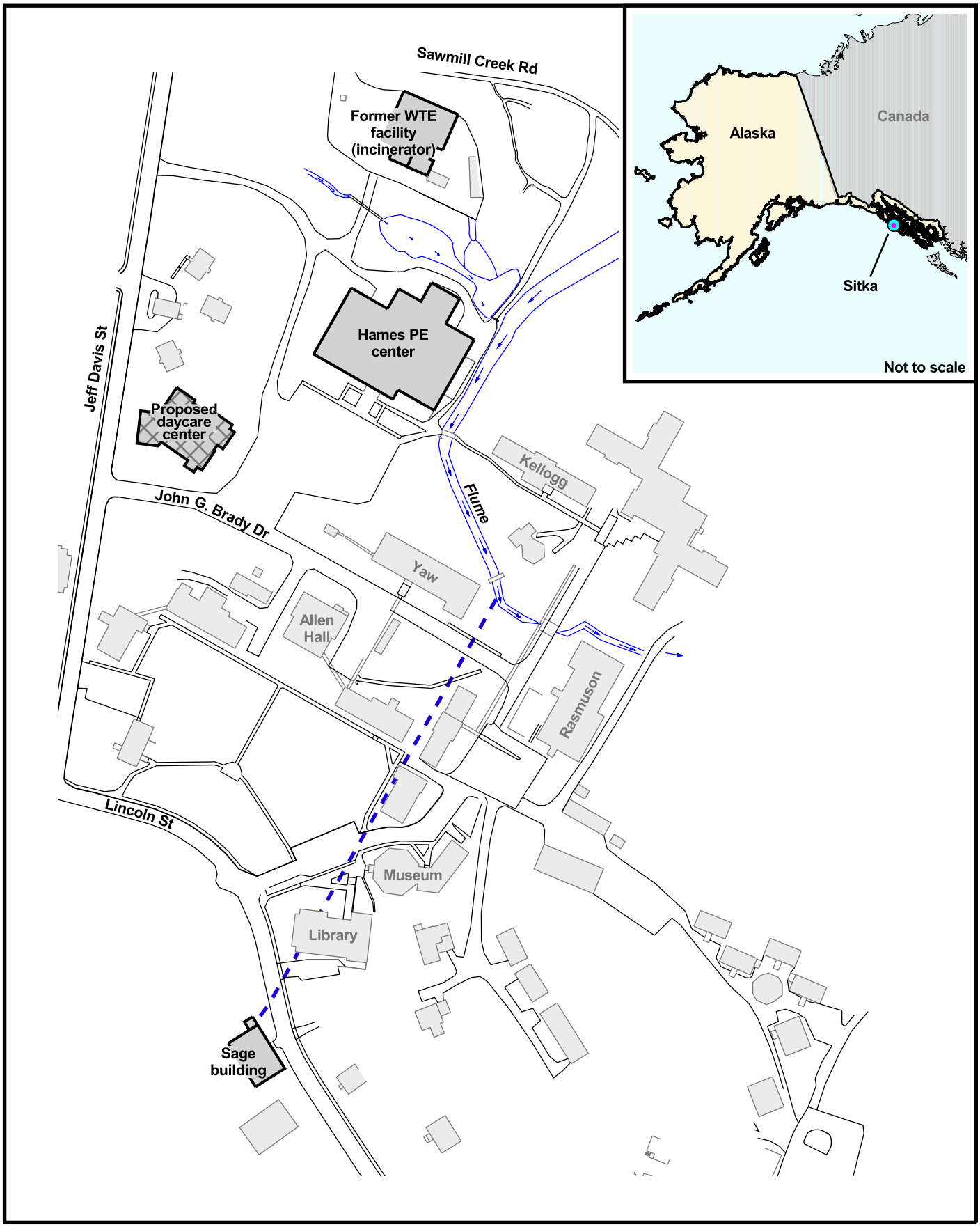

Figure 1. Site location and vicinity map

Exponent®

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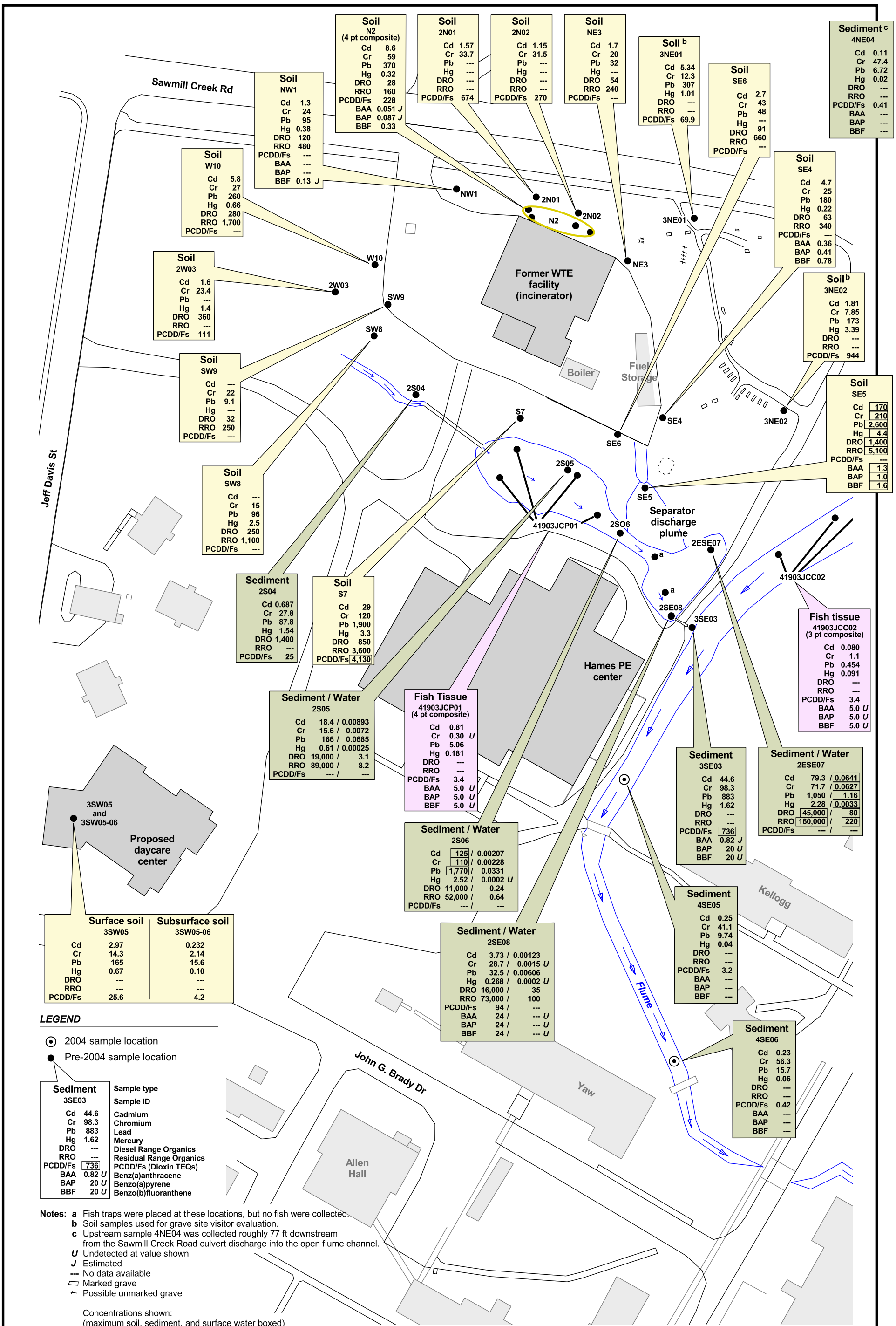

Figure 2. Concentrations of site CoPCs (metals, petroleum hydrocarbons, PAHs, and PCDD/Fs) in soil, sediment, and water samples, and concentrations of analytes in fish tissue

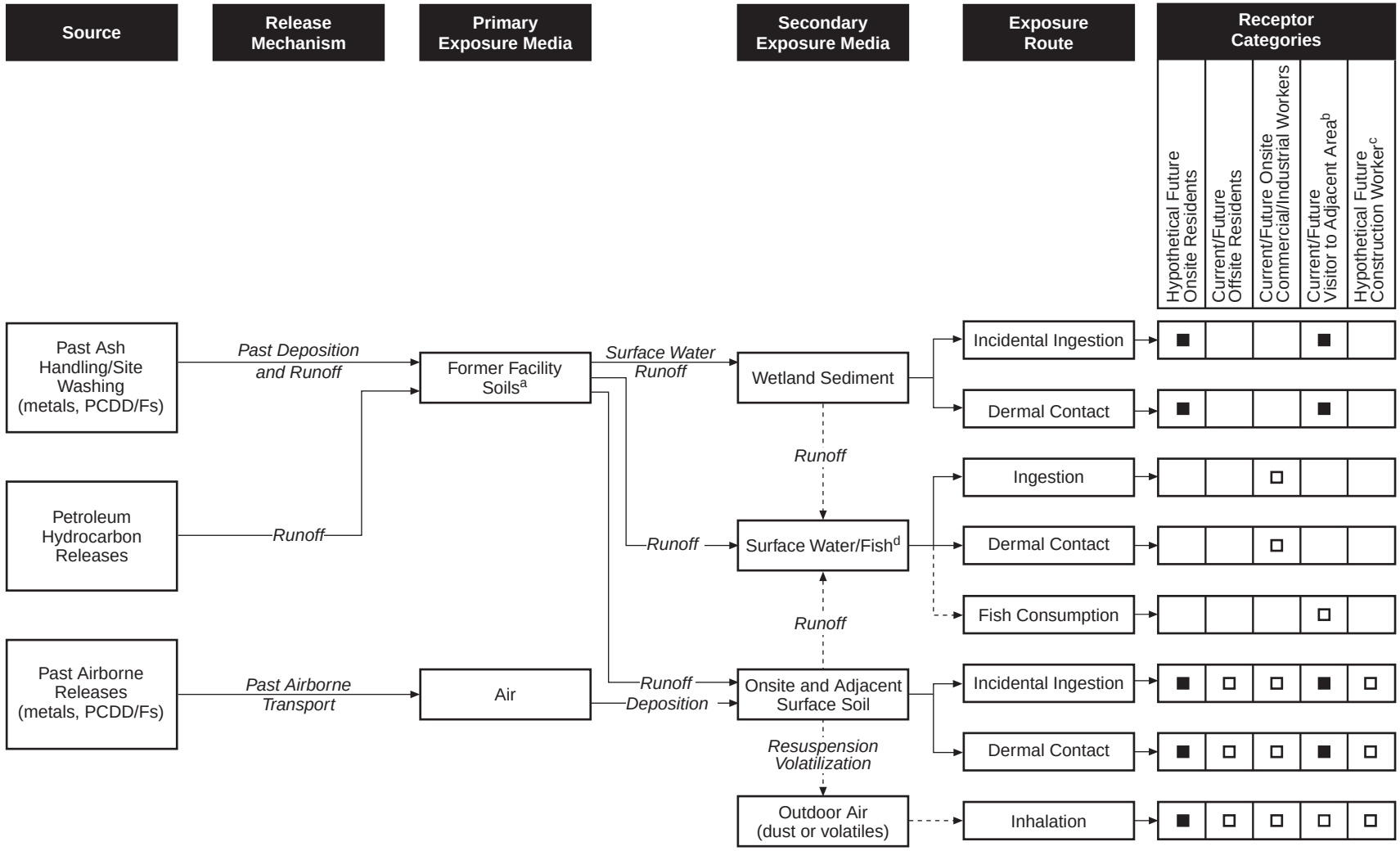

Figure 3. Human health conceptual site exposure model

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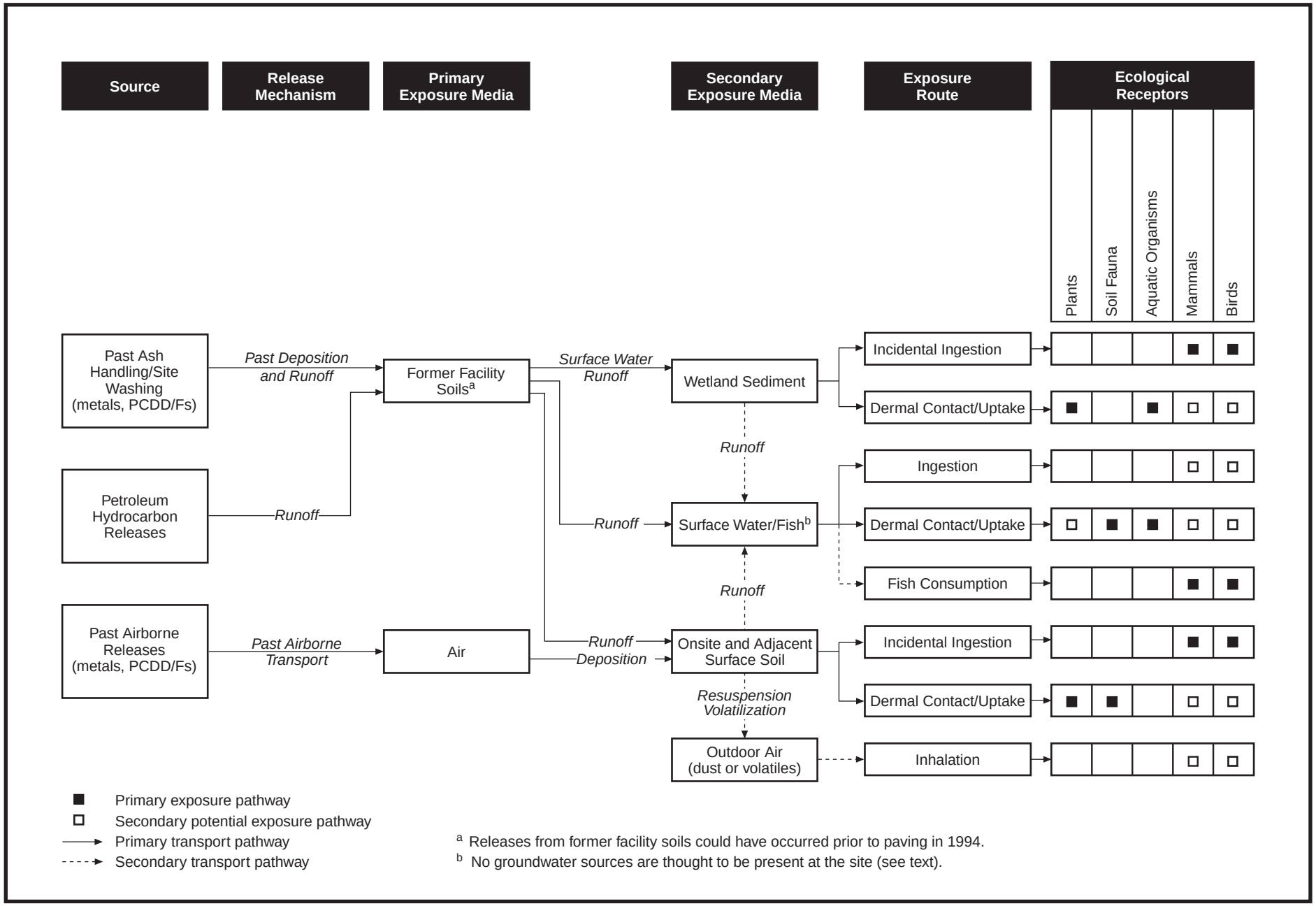

Figure 4. Ecological conceptual site exposure model

Tables

Table 1-1. Human health screening of detected inorganic and petroleum hydrocarbons in water at the former municipal solid waste incinerator site—Sitka, Alaska

Location		Dup.	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	DRO (mg/L)	RRO (mg/L)	Total Aromatic Hydrocarbons (mg/L)	Total Hydrocarbons (mg/L)
2ESE07	Jul-01	A	0.0641	0.0627	1.16	0.0064	80	220		
2ESE07	Jul-01	B				0.0002 *U*				
2S05	Jul-01	A	0.00893	0.0072	0.0685	0.0004	3.1	8.2		
2S05	Jul-01	B				0.0002 *U*				
2S06	Jul-01	A	0.00207	0.00228	0.0331	0.0002 *U*	0.24	0.64		
2S06	Jul-01	B				0.0002 *U*				
2SE08	Jul-01	A	0.00123	0.0015 *U*	0.00606	0.0002 *U*	35	100	0.0032 *U*	0.000074
2SE08	Jul-01	B				0.0002 *U*				
3SE03	Mar-03								0.001 *U*	0.0007432
Data with Field Duplicates Averaged										
2ESE07	Jul-01		0.0641	0.0627	1.16	0.0033	80	220		
2S05	Jul-01		0.00893	0.0072	0.0685	0.00025	3.1	8.2		
2S06	Jul-01		0.00207	0.00228	0.0331	0.0002 *U*	0.24	0.64		
2SE08	Jul-01		0.00123	0.0015 *U*	0.00606	0.0002 *U*	35	100	0.0032 *U*	0.000074
3SE03	Mar-03								0.001 *U*	0.0007432
Mean			0.019	0.018	0.32	0.00093	30	82	0.0011	0.00041
Maximum detected value			0.064	0.063	1.2	0.0033	80	220	na	0.00074
EPA CCC WQC [a]			0.00025	0.011	0.0025	0.00077	--	--	--	--
GW cleanup levels [b]			0.005	0.1	0.015	0.002	1.5	1.1	--	--
EPA MCL [c]			0.005	0.1	0.015	0.002	--	--	--	--
RBC/10			0.005 [d]	0.1 [d]	0.015 [d]	0.002 [d]	0.15	0.11	--	--

Note: Boxed values indicate exceedance of criteria.
Water screening values are DEC groundwater cleanup levels or EPA MCLs. EPA freshwater aquatic life criteria (CCC) are included for comparison purposes.

-- - no screening value available
AAC - Alaska Administrative Code
CCC - criterion continuous concentration
DEC - Alaska Department of Environmental Conservation
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
GW - groundwater
MCL - maximum contaminant level
RBC - risk-based concentration
RRO - residual range organics
U - compound analyzed for but not detected
WQC - water quality criteria

[a] U.S. EPA (2002b).

[b] DEC (2003a).

[c] U.S. EPA (2002c).

[d] MCLs are not divided by 10.

Table 1-2. Human health screening of detected inorganics and petroleum hydrocarbons in soil and sediment at the former municipal solid waste incinerator site—Sitka, Alaska

Location		Dup.	Cadmium (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	DRO (mg/kg)	GRO (mg/kg)	RRO (mg/kg)
Soil Data									
N2	Jan-01		8.6	59	370	0.32	28	2.9	160
NE3	Jan-01		1.7	20	32		54		240
NW1	Jan-01		1.3	24	95	0.38	120		480
SE4	Jan-01		4.7	25	180	0.22	63		340
SE5	Jan-01		170	210	2,600	4.4	1,400		5,100
SE6	Jan-01		2.7	43	48		91		660
S7	Jan-01		29	120	1,900	3.3	850		3,600
SW8	Jan-01			15	96	2.5	250		1,100
SW9	Jan-01			22	9.1		32	3.5	250
W10	Jan-01		5.8	27	260	0.66	280		1,700
2N01	Jul-01		1.57	33.7					
2N02	Jul-01		1.15	31.5					
2W03	Jul-01	A	1.6	23.4		2.5	360		
2W03	Jul-01	B				0.221			
Grave site									
3NE01	Mar-03		5.34	12.3	307	1.01			
3NE02	Mar-03		1.81	7.85	173	3.39			
Proposed daycare									
3SW05	Mar-03		2.97	14.3	165	0.67			
3SW05-06	Mar-03		0.232	2.14	15.6	0.10			
Sediment									
Onsite Sediment									
2S04	Jul-01	A	0.687	27.8	87.8	1.8	1,400		
2S04	Jul-01	B				1.27			
2S05	Jul-01	A	18.4	15.6	166	1.6 *U*	19,000		89,000
2S05	Jul-01	B				0.413			
2S06	Jul-01	A	125	110	1,770	3.3	11,000		52,000
2S06	Jul-01	B				1.74			
2ESE07	Jul-01	A	79.3	71.7	1050	2.2	45,000		160,000
2ESE07	Jul-01	B				2.35			
2SE08	Jul-01	A	3.73	28.7	32.5	0.67 *U*	16,000		73,000
2SE08	Jul-01	B				0.2			
3SE03	Mar-03		44.6	98.3	883	1.62			
Supplemental Flume Sediment									
4SE06	Mar-04	A	0.23	56.3	15.7	0.06			
4SE06	Mar-04	B				0.06			
4SE05	Mar-04		0.25	41.1	9.74	0.04			
4NE04	Mar-04	A	0.11	46.3	6.52	0.02			
4NE04	Mar-04	B	0.11	48.4	6.92				
Soil Data with Field Duplicates Averaged									
N2	Jan-01		8.6	59	370	0.32	28	2.9	160
NE3	Jan-01		1.7	20	32		54		240
NW1	Jan-01		1.3	24	95	0.38	120		480
SE4	Jan-01		4.7	25	180	0.22	63		340
SE5	Jan-01		170	210	2,600	4.4	1,400		5,100
SE6	Jan-01		2.7	43	48		91		660

Table 1-2. (cont.)

Location	Dup.	Cadmium (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	DRO (mg/kg)	GRO (mg/kg)	RRO (mg/kg)
Soil Data with Field Duplicates Averaged (cont.)								
S7	Jan-01	29	120	1,900	3.3	850		3,600
SW8	Jan-01		15	96	2.5	250		1,100
SW9	Jan-01		22	9.1		32	3.5	250
W10	Jan-01	5.8	27	260	0.66	280		1,700
2N01	Jul-01	1.57	33.7					
2N02	Jul-01	1.15	31.5					
2W03	Jul-01	1.6	23.4		1.4	360		
Grave site								
3NE01	Mar-03	5.34	12.3	307	1.01			
3NE02	Mar-03	1.81	7.85	173	3.39			
Proposed daycare								
3SW05	Mar-03	2.97	14.3	165	0.67			
3SW05-06	Mar-03	0.232	2.14	15.6	0.10			
Sediment Data with Field Duplicates Averaged								
Onsite Sediment								
2S04	Jul-01	0.687	27.8	87.8	1.54	1,400		
2S05	Jul-01	18.4	15.6	166	0.61	19,000		89,000
2S06	Jul-01	125	110	1,770	2.52	11,000		52,000
2ESE07	Jul-01	79.3	71.7	1,050	2.28	45,000		160,000
2SE08	Jul-01	3.73	28.7	32.5	0.268	16,000		73,000
3SE03	Mar-03	44.6	98.3	883	1.62			
Supplemental Flume Sediment [a]								
4NE04	Mar-04	0.11	47.4	6.72	0.02			
4SE05	Mar-04	0.25	41.1	9.74	0.04			
4SE06	Mar-04	0.23	56.3	15.7	0.06			
Mean facility/grave site value		26.7	48.9	**559**	**1.6**	**5,996**	3.2	**27,688**
Maximum facility/grave site detected value		170	210	**2,600**	**4.4**	**45,000**	3.5	**160,000**
Facility/grave site value UCL		136	74.3	NA	3.6	NA	NA	NA
Facility/grave site (CTE EPC)		26.7	48.9	559	1.6	5,996	3.2	27,688
Facility/grave site (RME EPC)		136 UCL	74.3 UCL	559 mean	3.6 UCL	45,000 max	3.5 max	160,000 max
Mean residential mean site value		18.1	44.9	**506**	**1.8**	321	3.2	1,363
Maximum residential site detected value		170	210	**2,600**	**4.4**	**1,400**	3.5	**5,100**
Residential site UCL		55.8	75.1	NA	6.6	1,518	NA	5,798
Residential site CTE EPC		18.1	44.9	506	1.8	321	3.2	1,363
Residential site RME EPC		55.8 UCL	75.1 UCL	506 mean	4.4 max	1,400 max	3.5 max	5,100 max
Mean grave site value (CTE EPC)		3.6	10.1	240	**2.2**			
Maximum grave site detected value (RME EPC)		5.3 max	12.3 max	240 mean	**3.4** max			
Mean daycare value (CTE EPC)		1.6	8.2	90.3	0.39			
Maximum daycare detected value (RME EPC)		3.0 max	14.3 max	90.3 mean	0.67 max			
DEC 2003 Method 2 (over 40 in.) Ingestion [b]		83	250	400	13 [d]	8,250	1,400	8,300
RBC/10		8.3	25	400 [c]	1.3	825	140	830
DEC 2003 Method 2 (over 40 in.) Inhalation [b]		--	--	400	13	12,500	1,400	22,000
RBC/10		--	--	400 [c]	1.3	1,250	140	2,200

Table 1-2. (cont.)

Note: Boxed values indicate exceedance of ingestion criteria. Bolded values indicate exceedance of inhalation criteria.

Sediment screening values are the DEC soil cleanup levels for protection of exposure from ingestion or inhalation in the over 40 in. zone. They are taken either from Table B1 or Table B2 of DEC (2003b).

--	-	no screening value available	RRO	-	residual range organics
AAC	-	Alaska Administrative Code	RME	-	reasonable maximum exposure
CTE	-	central tendency exposure	NA	-	no UCL calculated because of small sample set.
DEC	-	Alaska Department of Environmental Conservation	*U*	-	compound anaylzed for but not detected
DRO	-	diesel range organics	UCL	-	upper confidence level
EPC	-	exposure point concentration			

[a] Supplemental flume sediment samples (Clare 2004) were not included in risk calculations (see text). Station 4NE04 is the upgradient flume location and stations 4SE05 and 4SE06 are downgradient locations.

[b] DEC (2003b).

[c] Not divided by ten because analyses for lead are based on a modeling approach that differs from that applied for other chemicals. This value represents an average, so the screening of lead in soil and sediment is based on the average concentration not the maximum or UCL.

[d] This is the inhalation value provided by DEC; no ingestion value is presented.

Table 1-3. Human health screening of PAHs (mg/kg) in soil and sediment at the former municipal solid waste incinerator site—Sitka, Alaska

	Onsite Soil N2 Jan-01	Onsite Soil NW1 Jan-01	Onsite Soil SE4 Jan-01	Onsite Soil SE5 Jan-01	Flume Sediment 3SE03 Mar-03	Wetland Sediment 2SE08-04 Mar-03	Mean (nd @ half dl)	Maximum detected	DEC 2003 Method 2 (over 40 in.)[a] Ingestion	RBC/10	Inhalation	RBC/10	Exceeds RBC?	CTE EPC	RME EPC
PAH (mg/kg)															
2-Methylnaphthalene					0.28 *J*	0.41 *J*	0.35	0.41	--	--	--	--	--	--	--
Acenaphthene					0.57 *J*	0.87 *J*	0.72	0.87	5,000	500	--	--	N	--	--
Acenaphthylene					4.0 *U*	4.7 *U*	2.2	nd	--	--	--	--	nd	--	--
Anthracene					4.0 *U*	4.7 *U*	2.2	nd	24,900	2,490	--	--	nd	--	--
Benz[a]anthracene	0.051 *J*		0.36	1.3	0.82 *J*	24 *U*	2.9	1.3	9.0	0.90	--	--	Y	1.3	1.3
Benzo[a]pyrene	0.087 *J*		0.41	1.0	20 *U*	24 *U*	4.7	1.0	0.90	0.090	--	--	Y	1.0	1.0
Benzo[b]fluoranthene	0.33	0.13 *J*	0.78	1.6	20 *U*	24 *U*	4.1	1.6	9.0	0.90	--	--	Y	1.6	1.6
Benzo[g,h,i]perylene					20 *U*	24 *U*	11	nd	--	--	--	--	nd	--	--
Benzo[k]fluoranthene	0.1 *J*	0.055 *J*	0.35	0.77	20 *U*	24 *U*	3.9	0.77	93	9.3	--	--	N	--	--
Chrysene					0.90 *J*	24 *U*	6.5	0.90	930	93	--	--	N	--	--
Dibenzo[a,h]anthracene					20 *U*	24 *U*	11	nd	0.90	0.090	--	--	nd	--	--
Fluoranthene					2.2 *J*	3.9 *J*	3.1	3.9	3,300	330	--	--	N	--	--
Fluorene					0.43 *J*	0.71 *J*	0.57	0.71	3,300	330	--	--	N	--	--
Indeno[1,2,3-cd]pyrene					20 *U*	24 *U*	11	nd	9.0	0.90	--	--	nd	--	--
Naphthalene				0.26 *J*	0.31 *J*	0.43 *J*	0.33	0.43	1,700	170	92	9.2	N	--	--
Phenanthrene					1.7 *J*	2.6 *J*	2.2	2.6	--	--	--	--	--	--	--
Pyrene					2.7 *J*	5.6 *J*	4.2	5.6	2,500	250	--	--	N	--	--

Note: Boxed values indicate exceedance of criteria.

Sediment screening values are the DEC soil cleanup levels for protection of exposure from ingestion or inhalation in the over 40 in. zone. They are taken from Table B2 of DEC (2003b).

-- - no screening value available
AAC - Alaska Administrative Code
CTE - central tendency exposure
DEC - Alaska Department of Environmental Conservation
EPC - exposure point concentration
J - estimated value
nd - not detected
RBC - risk-based concentration
RME - reasonable maximum exposure
U - compound analyzed for but not detected

[a] DEC (2003b).

Table 1-4. Human health screening of detected organic compounds in soil at the former municipal solid waste incinerator site—Sitka, Alaska

Location		Chloroform (mg/kg)	Dibenzofuran (mg/kg)	Methylene Chloride (mg/kg)	1,1,1-Trichloro-ethane (mg/kg)	Aroclor® 1260 (mg/kg)
N2	Jan-01			0.010 *J*		
NE3	Jan-01			0.011 *J*		
NW1	Jan-01	0.0024 *J*		0.013 *J*	0.0035	0.035
SE4	Jan-01			0.009 *J*	0.0044	
SW8	Jan-01				0.015	
SW9	Jan-01			0.0077 *J*		
W10	Jan-01			0.0093 *J*	0.0095	
3SE03	Mar-03		0.41 *J*			
2SE08-04	Mar-03		0.58 *J*			
	Mean (nd @ half dl)	0.0024	0.50	0.010	0.0081	0.035
	Maximum detected value	0.0024	0.58	0.013	0.015	0.035
DEC 2003 Method 2 (over 40 in.) Ingestion[a]		830	--	900	--	1.0
	RBC/10	83	--	90	--	0.10
DEC 2003 Method 2 (over 40 in.) Inhalation[a]		2.4	--	135	460	1.0
	RBC/10	0.24	--	13.5	46	0.10

Note: Soil screening values are the DEC soil cleanup levels for protection of exposure from ingestion or inhalation in the over 40 in. zone. They are taken either from Table B1 or Table B2 of DEC (2003b).

-- - no screening value available
AAC - Alaska Administrative Code
CTE - central tendency exposure
DEC - Alaska Department of Environmental Conservation
J - estimated value
RBC - risk-based concentration

[a] DEC (2003b).

Table 1-5. Human health screening of target analytes that were not detected but had detection limits greater than screening levels in soil at the former municipal solid waste incinerator site—Sitka, Alaska

Location		α-Hexachloro-cyclohexane (mg/kg)	β-Hexachloro-cyclohexane (mg/kg)	γ-Hexachloro-cyclohexane (mg/kg)	*cis* -1,3 Dichloro-propene (mg/kg)	Methylene Chloride (mg/kg)	Vinyl Chloride (mg/kg)	Bis[2-chloro-ethyl] ether (mg/kg)	4-Chloro-aniline (mg/kg)	1,4-Dichloro-benzene (mg/kg)
NW1	Jan-01	0.0036 *U*		0.0094 *U*				0.290 *U*		
N2	Jan-01	0.0029 *U*		0.0075 *U*				0.230 *U*		
NE3	Jan-01	0.005 *U*	0.010 *U*	0.013 *U*				0.400 *U*	0.540 *U*	
SE4	Jan-01	0.0031 *U*		0.008 *U*				0.250 *U*		
SE5	Jan-01	0.0059 *U*	0.012 *U*	0.015 *U*		0.024 *U*		0.470 *U*	0.640 *U*	
SE6	Jan-01	0.003 *U*		0.0079 *U*				0.24 *U*		
S7	Jan-01	0.012 *U*	0.023 *U*	0.030 *U*	0.0092 *U*	0.046 *U*	0.0092 *U*	0.920 *U*	1.200 *U*	0.920 *U*
SW8	Jan-01	0.011 *U*	0.023 *U*	0.030 *U*	0.0092 *U*	0.046 *U*	0.0092 *U*	0.920 *U*	1.200 *U*	0.920 *U*
SW9	Jan-01	0.0026 *U*		0.0069 *U*				0.210 *U*		
W10	Jan-01	0.006 *U*	0.012 *U*	0.016 *U*				0.480 *U*	0.640 *U*	
Maximum detection limit		0.012 *U*	0.023 *U*	0.03 *U*	0.0092 *U*	0.046 *U*	0.0092 *U*	**0.92** *U*	1.2 *U*	0.92 *U*
DEC 2003 Method 2 (over 40 in.) Ingestion[a]		1.0	4.0	5.0	68	900	5.0	6.0	330	280
	RBC/10	0.1	0.4	0.5	6.8	90	0.5	0.6	33	28
DEC 2003 Method 2 (over 40 in.) Inhalation[a]		4.0	32	--	11	135	3.0	2.4	--	6000
	RBC/10	0.4	3.2	--	1.1	13.5	0.3	0.24	--	600

Table 1-5. (cont.)

Location		3,3-Dichloro-benzidine (mg/kg)	2,4-Dichloro-phenol (mg/kg)	2,4-Dinitro-phenol (mg/kg)	2,4-Dinitro-toluene (mg/kg)	2,6-Dinitro-toluene (mg/kg)	Hexachloro-benzene (mg/kg)	Nitro-benzene (mg/kg)	*n*-Nitrosodi-*n*-propyl-amine (mg/kg)	Penta-chloro-phenol (mg/kg)	2,4,6-Trichloro-phenol (mg/kg)
NW1	Jan-01	0.240 *U*		1.600 *U*	0.240 *U*	0.240 *U*		0.240 *U*	0.240 *U*	0.240 *U*	
N2	Jan-01	0.190 *U*		1.300 *U*	0.190 *U*	0.190 *U*		0.190 *U*	0.190 *U*	0.190 *U*	
NE3	Jan-01	0.330 *U*		2.200 *U*	0.330 *U*	0.330 *U*		0.330 *U*	0.330 *U*	0.330 *U*	
SE4	Jan-01	0.210 *U*		1.300 *U*	0.210 *U*	0.210 *U*		0.210 *U*	0.210 *U*	0.210 *U*	
SE5	Jan-01	0.390 *U*		2.600 *U*	0.390 *U*	0.390 *U*		0.390 *U*	0.390 *U*	0.390 *U*	
SE6	Jan-01	0.200 *U*		1.300 *U*	0.200 *U*	0.200 *U*		0.200 *U*	0.200 *U*	0.200 *U*	
S7	Jan-01	0.770 *U*	0.770 *U*	5.000 *U*	0.770 *U*	0.770 *U*	0.770 *U*	0.770 *U*	0.770 *U*	0.770 *U*	0.770 *U*
SW8	Jan-01	0.760 *U*	0.760 *U*	5.000 *U*	0.760 *U*	0.760 *U*	0.760 *U*	0.760 *U*	0.760 *U*	0.760 *U*	0.760 *U*
SW9	Jan-01	0.180 *U*		1.200 *U*	0.180 *U*	0.180 *U*		0.180 *U*	0.180 *U*	0.180 *U*	
W10	Jan-01	0.400 *U*		2.600 *U*	0.400 *U*	0.400 *U*		0.400 *U*	0.400 *U*	0.400 *U*	
Maximum detection limit		0.77 *U*	0.77 *U*	5.0 *U*	0.77 *U*	0.77 *U*	**0.77** *U*	0.77 *U*	0.77 *U*	0.77 *U*	0.77 *U*
DEC 2003 Method 2 (over 40 in.)											
Ingestion[a]		15	250	170	10	10	4.0	42	1.0	28	620
	RBC/10	1.5	25	17	1	1	0.4	4.2	0.1	2.8	62
DEC 2003 Method 2 (over 40 in.)											
Inhalation[a]		--	--	--	--	--	5.0	67	--	--	1,100
	RBC/10	--	--	--	--	--	0.5	6.7	--	--	110

Note: Boxed values indicate exceedance of criteria.

Bolded values indicate exceedance of inhalation criteria.

Soil screening values are the DEC soil cleanup levels for protection of exposure from ingestion or inhalation in the over 40 in. zone. They are taken either from Table B1 or Table B2 of DEC (2003b).

-- - no screening value available
AAC - Alaska Administrative Code
DEC - Alaska Department of Environmental Conservation
RBC - risk-based concentration
U - compound analyzed for but not detected

[a] DEC (2003b).

Table 1-6. Human health screening of detected PCDD/Fs in soil and sediment at the former municipal solid waste incinerator site—Sitka, Alaska

		Facility Soil and Sediment						Grave Site Soil		Proposed Daycare Facility Soil		Wetland Sediment	Flume Sediment	Supplemental Flume Sediment[a]		
Sample No.		N2[b]	S7[b]	2N01[b]	2N02[b]	2W03[b]	2S04[c]	3NE01S[b]	3NE02S[b]	3SW05S[b]	3SW05-06S[b]	2SE08[b]	3SE03[b]	4NE04	4SE05	4SE06
Sampling Date		Jan-01	Jan-01	Jul-01	Jul-01	Jul-01	Jul-01	Mar-03	Mar-03	Mar-03	Mar-03	Jul-01	Mar-03	Mar-04	Mar-04	Mar-04
Analytes		(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)
Isomers	WHO TEFs															
2,3,7,8-TCDD	1	6.9	180	27.1	13.6	1.6 *J*	1.2 *J*	2.759	34.805	1.229 *JK*	1.0 *U*	3.1	18.86	0.071 *U*	0.063 *U*	0.113 *U*
1,2,3,7,8-PeCDD	1	33	746	83.2	43.7	5.4 *J*	3.4 *J*	10.098	142.515	3.536 *J*	2.5 *U*	12.4 *J*	85.69	0.147 *U*	0.378 *J*	0.177 *U*
1,2,3,4,7,8-HxCDD	0.1	47.7	1,090	96.2	50.8	8.7 *J*	4.2 *JK*	11.205	163.452	5.078 *J*	2.5 *U*	17.9	139.26	0.154 *U*	0.809 *J*	0.237 *U*
1,2,3,6,7,8-HxCDD	0.1	124	2,870 *E*	242	128	13.5 *J*	13.7 *JB*	35.49	384.921	11.581	2.5 *U*	57.5	448.21	0.57 *J*	2.297	0.211 *U*
1,2,3,7,8,9-HxCDD	0.1	140	3,050 *E*	256	154	13.7 *J*	11.4 *JB*	33.274	426.383	11.086	2.5 *U*	47.4	401.73	0.143 *U*	2.007	0.22 *U*
1,2,3,4,6,7,8-HpCDD	0.01	1,690	19,280 *SE*	2,550	1,390	117	152	524.625	4195.307 *E*	175.531	14.371 *JK*	535	5,834.58 *E*	7.281	26.139	3.717
OCDD	0.0001	4,550 *E*	39,910 *SE*	6,760	3,730	314	468	1,778.036 *B*	8,382.52 *BE*	439.339 *B*	110.664 *J*	1,500	12,083.62 *BE*	30.728	88.602	14.356
2,3,7,8-TCDF	0.1	142	1,770 *E*	328	182	55.4 *JK*	15.8	70.255 *C*	781.924 *CE*	18.263 *C*	1.0 *U*	66.4	557.325 *CE*	0.275 *UC*	0.622 *C*	0.335 *UC*
1,2,3,7,8-PeCDF	0.05	43.6	794	151	66.3	230	9.6 *J*	14.355 *K*	224.47 *K*	5.685	2.5 *U*	25.6	154.71 *K*	0.094 *U*	0.784 *J*	0.098 *U*
2,3,4,7,8-PeCDF	0.5	89.9	1,330	279	129	27.5 *J*	10.9 *JB*	25.97 *K*	438.846 *K*	10.318	2.5 *U*	47.6	276.93	0.096 *U*	1.407 *J*	0.1 *U*
1,2,3,4,7,8-HxCDF	0.1	261	5,080 *E*	550	257	291	24.7 *JB*	77.983	1,092.25	29.122	4.691 *J*	103	968.82 *K*	0.273 *J*	3.786	0.662 *J*
1,2,3,6,7,8-HxCDF	0.1	126	2,430 *E*	317	148	139	15.0 *J*	35.285	533.567	14.402	2.5 *U*	58	467.71	0.121 *U*	2.197	0.145 *U*
2,3,4,6,7,8-HxCDF	0.1	284	5,140 *SE*	482	273	57.9	31.2	78.456	1,221.89 *K*	34.748	3.878	88.6	885.23 *K*	0.592	4.102	0.592 *J*
1,2,3,7,8,9-HxCDF	0.1	13.1	237	24.9	12.9	93.4	3.1 *J*	2.643 *J*	26.783	1.011 *J*	2.5 *U*	6.1 *J*	30.35	0.124 *U*	0.097 *U*	0.148 *U*
1,2,3,4,6,7,8-HpCDF	0.01	877	11,020 *SE*	15,870	878	577	80.7 *B*	300.528	2,679.26	96.351	9.505 *J*	311	3,148.38 *E*	0.82 *JK*	13.141	2.02 *J*
1,2,3,4,7,8,9-HpCDF	0.01	140	2,460 *E*	189	113	434	17.0 *J*	38.003	316.97 *E*	13.956	2.5 *U*	39.7	392.38	0.25 *U*	1.74	0.635 *U*
OCDF	0.0001	724	11,850 *E*	1,120	633	6,350	155 *B*	286.379	1,542.71	73.309	5.0 *U*	171	1,803.95	1.217 *J*	11.016	1.356 *U*
Totals																
Total TCDD		267	6,140 *E*	906	429	19.5	34.9	123.231	1,226.44	24.250	1.956	115	808.117	0.071 *U*	1.941	0.113 *U*
Total PeCDD		501	12,420 *E*	1,180	632	53.0	42.4	216.295	3,249.09	62.0212	2.5 *U*	233	2,290.488	0.147 *U*	7.486	0.177 *U*
Total HxCDD		1,490	29,210 *SE*	2,770	1,490	130	123	459.847	5,654.54	135.367	13.175	615	5,917.014	2.861	23.738	2.521
Total HpCDD		3,080	36,880 *SE*	5,140	2,720	206	272	1,735.609	9,193.85	348.778	24.145	1,240	12,496.301	12.845	49.939	7.064
Total TCDF		731	9,330 *E*	1,790	920	291	84.2	415.508	4,009.93	69.352	14.453	327	2,576.485	0.343	11.389	1.202
Total PeCDF		936	14,750 *E*	3,280	1,420	718	118	304.442	5,065.45	124.948	3.770	536	2,957.931	1.168	15.456	0.1 *U*
Total HxCDF		1,260	23,480 *SE*	2,730	1,290	863	141	409.529	5,888.33	161.636	14.224	551	4,894.412	1.289	20.408	2.457
Total HpCDF		1,450	21,640 *SE*	2,580	1,380	1,240	150	533.675	4,223.76	174.995	9.505	485	5,059.731	1.186	22.197	2.961
WHO TEQs[d]																
TEQ with detection limit at 1/2		228	4,130	674	270	111	25	69.9	944	25.6	4.2	94	736	0.41	3.2	0.42
TEQ excluding detection limit		228	4,130	674	270	111	25	69.9	944	25.6	1.1	94	736	0.23	3.1	0.18
TEQ with full detection limit		228	4,130	674	270	111	25	69.9	944	25.6	7.4	94	736	0.58	3.2	0.67

Mean facility/grave site TEQ (CTE EPC)	728
Maximum facility/grave site TEQ (RME EPC)	4,130
Mean site soil TEQ (for residential) (CTE EPC)	918
Maximum site soil TEQ (for residential) (RME EPC)	4,130
Mean grave site TEQ (CTE EPC)	507
Maximum grave site TEQ (RME EPC)	944
Mean daycare TEQ (CTE EPC)	15
Maximum daycare TEQ (RME EPC)	26
Region 9 PRG[e]	0.39

Note: Boxed values indicate exceedance of criteria.

Method 8290 PCDD/PCDF Analysis (b), MIT3 (DB-5).

Detection limit as specified in Table 1A (Clare 2003).

The soil screening value used for PCDD/Fs is the Region 9 residential PRG for soil. The inhalation soil screening value is 59,000 ng/kg.

B - used when analyte detected in laboratory method blank as well as in associated sample
C - TCDD value determined using DB-225 confirmation column
D - reported result from dilution
E - estimate used when analyte concentration exceeds upper linear calibration range
HpCDD - heptachlorodibenzo-*p*-dioxin

Table 1-6. (cont.)

HpCDF	-	heptachlorodibenzofuran
HxCDD	-	hexachlorodibenzo-*p*-dioxin
HxCDF	-	hexachlorodibenzofuran
J	-	estimated value
K	-	estimated maximum possible concentration
OCDD	-	octachlorodibenzo-*p*-dioxin
OCDF	-	octachlorodibenzofuran
PCDD/F	-	polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran
PeCDD	-	pentachlorodibenzo-*p*-dioxin
PeCDF	-	pentachlorodibenzofuran
PRG	-	preliminary remediation goal
S	-	minimum estimate from saturated signal
TCDD	-	tetrachlorodibenzodioxin
TCDF	-	tetrachlorodibenzofuran
TEF	-	toxicity equivalence factor
TEQ	-	toxicity equivalent quotient
U	-	compound analyzed for but not detected
WHO	-	World Health Organization

[a] Supplemental flume sediment samples (Clare 2004) were not included in risk calculations (see text). Station 4NE04 is the upgradient flume location and stations 4SE05 and 4SE06 are downgradient locations.

[b] Soil samples.

[c] Sediment sample.

[d] TEQ calculations based on TEFs for mammals recommended by the World Health Organization (Van den Berg et al. 1998).

[e] U.S. EPA (2002a).

Table 1-7. Human health screening of detected inorganics and PAHs in fish tissue at the former municipal solid waste incinerator site—Sitka, Alaska

	41903JCC02 Mar-03 Upstream	41903JCP01 Mar-03 Wetland	Greater than upstream?	Ratio Wetland / Upstream	Mean (nd @ half dl)	Maximum detected	Alaskan background concentration	Region 3 RBC[a]	Adjusted RBC/10	Exceeds background/ RBC
Metals (mg/kg)										
Cadmium	0.080	0.81	Y	10	0.81	0.81		0.14	0.014	Y
Chromium	1.1	0.30 *U*	N	0.27	0.15	nd		0.41	0.041	nd
Lead	0.454	5.06	Y	11	5.1	5.1		--	--	--
Mercury	0.091	0.181	Y	2.0	0.18	0.18	0.2 [b]	0.014	0.0014	N
PAH (μg/kg)										
2-Methylnaphthalene	5.0 *U*	0.76 *J*	Y	0.15	0.76	0.76		27,037	2,704 N	N
Acenaphthene	0.36 *J*	0.41 *J*	Y	1.1	0.41	0.41		81,111	8,111 N	N
Acenaphthylene	5.0 *U*	0.13 *J*	Y	0.026	0.13	0.13		--	--	--
Anthracene	5.0 *U*	0.27 *J*	Y	0.05	0.27	0.27		405,556	40,556 N	N
Benz[a]anthracene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		4.3	0.43 C	nd
Benzo[a]pyrene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		0.43	0.043 C	nd
Benzo[b]fluoranthene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		4.3	0.43 C	nd
Benzo[g,h,i]perylene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		--	--	nd
Benzo[k]fluoranthene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		43	4.3 C	nd
Chrysene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		432	43 C	nd
Dibenzo[a,h]anthracene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		0.43	0.043 C	nd
Dibenzofuran	0.32 *J*	0.41 *J*	Y	1.3	0.41	0.41		541	54	N
Fluoranthene	0.41 *J*	0.44 *J*	Y	1.1	0.44	0.44		54,074	5,407 N	N
Fluorene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		54,074	5,407 N	nd
Indeno[1,2,3-cd]pyrene	5.0 *U*	5.0 *U*	N	1.0	2.5	nd		4.3	0.43 C	nd
Naphthalene	5.0 *U*	1.1 *J*	Y	0.22	1.1	1.1		27,037	2,704 N	N
Phenanthrene	0.45 *J*	0.73 *J*	Y	1.6	0.73	0.73		--	--	--
Pyrene	5.0 *U*	0.59 *J*	Y	0.12	0.59	0.59		40,556	4,056 N	N

Note: Sample 41903JCC02 consists of 15 salmon smolts, mostly coho salmon, from 3 minnow traps placed in the flume upstream of the culvert.

Sample 41903JCP01 consists of 27 salmon smolts, mostly coho salmon with at least one king salmon, from 4 minnow traps placed in the large "upper" pond. Traps (2) in the lower pond produced no fish large enough for capture by the trap screens.

DEC - Alaska Department of Environmental Conservation
J - estimated value
N - not elevated over upstream location
nd - not detected
U - compound analyzed for but not detected
Y - elevated over upstream location

[a] U.S. EPA (2003a), divided by ten.

[b] USGS (1994, 1996).

Table 1-8. Human health screening of detected PCDD/Fs in fish tissue at the former municipal solid waste incinerator site—Sitka, Alaska

	Sample No. Sampling Date Location	41903JCC02 Mar-03 Upstream (ng/kg)	41903JCP01 Mar-03 Wetland (ng/kg)	Greater than upstream?	Ratio Wetland / Upstream
Isomers	WHO TEFs				
2,3,7,8-TCDD	1	1.0 *U*	1.0 *U*		
1,2,3,7,8-PeCDD	1	2.5 *U*	2.5 *U*		
1,2,3,4,7,8-HxCDD	0.1	2.5 *U*	2.5 *U*		
1,2,3,6,7,8-HxCDD	0.1	2.5 *U*	2.5 *U*		
1,2,3,7,8,9-HxCDD	0.1	2.5 *U*	2.5 *U*		
1,2,3,4,6,7,8-HpCDD	0.01	0.891	0.689		
OCDD	0.0001	3.036	1.516		
2,3,7,8-TCDF	0.1	1.0 *U*	1.0 *U*		
1,2,3,7,8-PeCDF	0.05	2.5 *U*	2.5 *U*		
2,3,4,7,8-PeCDF	0.5	2.5 *U*	2.5 *U*		
1,2,3,4,7,8-HxCDF	0.1	2.5 *U*	2.5 *U*		
1,2,3,6,7,8-HxCDF	0.1	2.5 *U*	2.5 *U*		
2,3,4,6,7,8-HxCDF	0.1	2.5 *U*	2.5 *U*		
1,2,3,7,8,9-HxCDF	0.1	2.5 *U*	2.5 *U*		
1,2,3,4,6,7,8-HpCDF	0.01	2.5 *U*	0.288		
1,2,3,4,7,8,9-HpCDF	0.01	2.5 *U*	2.5 *U*		
OCDF	0.0001	5.0 *U*	5.0 *U*		
Totals					
Total TCDD		1.0 *U*	1.0 *U*		
Total PeCDD		0.204	2.5 *U*		
Total HxCDD		0.497	2.5 *U*		
Total HpCDD		2.303	1.202		
Total TCDF		1.0 *U*	1.0 *U*		
Total PeCDF		0.373	2.5 *U*		
Total HxCDF		0.100	2.5 *U*		
Total HpCDF		2.5 *U*	0.288		
WHO TEQs[a]					
TEQ with detection limit at 1/2		3.4	3.4	N	1.0
TEQ excluding detection limit		0.0092	0.0099	Y	1.1
TEQ with full detection limit		6.8	6.8	N	1.0
Region 3 RBC[b]	0.0021				

Note: Sample 41903JCC02 consists of 15 salmon smolts, mostly coho salmon, from 3 minnow traps placed in the flume upstream of the culvert.

Sample 41903JCP01 consists of 27 salmon smolts, mostly coho salmon with at least one king salmon, from 4 minnow traps placed in the large "upper" pond. Traps (2) in the lower pond produced no fish large enough for capture by the trap screens.

Method 8290 PCDD/PCDF Analysis (b), MIT3 (DB-5).

Detection limit as specified in Table 1A (Clare 2003).

HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran

Table 1-8. (cont.)

OCDD	-	octachlorodibenzo-*p*-dioxin
OCDF	-	octachlorodibenzofuran
PCDD/F	-	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
PeCDD	-	pentachlorodibenzo-*p*-dioxin
PeCDF	-	pentachlorodibenzofuran
TCDD	-	tetrachlorodibenzodioxin
TCDF	-	tetrachlorodibenzofuran
TEF	-	toxicity equivalence factor
TEQ	-	toxicity equivalent quotient
U	-	compound analyzed for but not detected
WHO	-	World Health Organization

[a] TEQ calculations based on TEFs for human protection recommended by the World Health Organization (Van den Berg et al. 1998).

[b] U.S. EPA (2003a), divided by ten.

Table 3-1. Summary of chemicals detected at concentrations greater than human health screening levels at the former solid waste incinerator site—Sitka, Alaska

Analyte	Facility/ Grave Site Soil/ Sediment	Grave Site Soil	Daycare Soil	Facility Wetlands/ Flume Surface Water
Inorganics				
Cadmium	X			X
Chromium	X			
Lead	X			
Mercury (total)	X	X		X
Organics				
DRO	X			X
RRP	X			X
PAHs				
Benz[a]anthracene	X			
Benzo[a]pyrene	X			
Benzo[b]fluoranthene	X			
PCDD/Fs	X	X	X	

Note: DRO - diesel range organics
PAH - polycyclic aromatic hydrocarbon
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
RRO - residual range organics
WTE - waste to energy

Table 3-2. Values used for daily intake calculations for soil/sediment ingestion and dermal exposure

Soil/sediment ingestion

Chronic daily intake (CDI)

CDI= (CS*RBA*CF*IR*EF*ED)/(BW*AT)

			Adult visitor / resident		Adult daycare worker		Child visitor, resident, daycare	
			CTE	RME	CTE	RME	CTE	RME
Exposure assumptions that are constant[a]:								
Chemical concentration in soil/sediment	CS	mg/kg	*	*	*	*	*	*
Relative bioavailability adjustment[b]	RBA	--						
Conversion factor	CF	kg/mg	1E-6	1E-6	1E-6	1E-6	1E-6	1E-6
Fraction ingested	FI	--	1	1	1	1	1	1
Exposure duration[d]	ED	yrs	9	30	9	25	6	6
Body weight	BW	kg	70	70	70	70	15	15
Averaging time - carc	AT.c	days	25,550	25,550	25,550	25,550	25,550	25,550
Averaging time - nonc	AT.n	days	3,285	10,950	3,285	9,125	2,190	2,190

Exposure assumptions for different scenarios:			Facility/Grave Site Visitor				Grave Site Visitor				Facility/Grave Site Hypothetical future resident				Daycare Center Future worker and child			
			Adult		Child		Adult		Child		Adult		Child		Adult		Child	
			CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Ingestion rate[c]	IR	mg soil/day	50	100	100	200	50	100	100	200	50	100	100	200	50	50	100	200
Exposure frequency[d]	EF	days/yr	12	24	12	24	3	6	3	6	330	330	330	330	250	250	250	250

Soil/sediment dermal

CDI (as absorbed dose) =

CDI = (CS*CF*SA*AF*EF*ED)/(BW*AT)

			Adult visitor / resident		Adult daycare worker		Child visitor, resident, daycare	
			CTE	RME	CTE	RME	CTE	RME
Exposure assumptions that are constant[a]:								
Chemical concentration in soil/sediment	CS	mg/kg	*	*	*	*	*	*
Conversion factor	CF	kg/mg	1E-6	1E-6	1E-6	1E-6	1E-6	1E-6
Skin surface area available for contact[a]	SA	cm^2/event	5700	5700	3300	3300	2800	2800
Dermal absorption factor*	ABS	--	*	*	*	*	*	*
Soil or sediment-to-skin adherence factor[d]	AF	mg/cm^2	0.07	0.07	0.2	0.2	0.2	0.2
Exposure duration[d]	ED	yrs	9	30	9	25	6	6
Body weight	BW	kg	70	70	70	70	15	15
Averaging time - carc	AT.c	days	25,550	25,550	25,550	25,550	25,550	25,550
Averaging time - nonc	AT.n	days	3,285	10,950	3,285	9,125	2,190	2,190

Exposure assumptions for different scenarios:			Facility/Grave Site Visitor				Grave Site Visitor				Facility/Grave Site Hypothetical future resident				Daycare Center Future worker and child			
			Adult		Child		Adult		Child		Adult		Child		Adult		Child	
			CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure frequency[d]	EF	days/yr	12	24	12	24	3	6	3	6	330	330	330	330	250	250	250	250

Note: * - chemical-specific
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
PCDD/F - polychlorinated dibenzo-*p*-dioxin and dibenzofuran
RME - reasonable maximum exposure

[a] General methodology based on guidance in U.S. EPA (1989) and DEC (2002). Exposure assumptions for residential and occupational soil ingestion based on DEC (2002), which is consistent with EPA references.

[b] Relative bioavailability adjustment for PCDD/F based on investigations of absorption in study used to derive toxicity value and of PCDD/F in soil. See text.

[c] Soil ingestion rates for RME residents and visitors consistent with DEC (2002) resident. CTE estimate for adult and child based on U.S. EPA (1997a).

[d] Exposure frequency and duration for residents consistent with DEC (2002) and other EPA references. Visitor exposure frequency based on professional judgment.

[e] Dermal surface area and adherence factors based on U.S. EPA (2001a).

Table 3-3. Values used for daily intake calculations for surface water ingestion and dermal contact

Surface water ingestion						
Absorbed dose = CS * CDI * PC			Facility Visitor			
[(CF*IR*EF*ED*ET)/(BW*AT)]			Adult		Child	
			CTE	RME	CTE	RME
Exposure assumptions[a]:						
Chemical concentration in water	CS	mg/L	*	*	*	*
Conversion factor	CF	L/cm^3	1E-3	1E-3	1E-3	1E-3
Fraction ingested	FI	--	--	--	--	--
Ingestion rate[b]	IR	mL/hr	12	12	12	12
Exposure time[b]	ET	hr/event	1	1	1	1
Exposure frequency[c]	EF	events/yr	12	24	12	24
Exposure duration[c]	ED	yrs	9	30	6	6
Body weight	BW	kg	70	70	15	15
Averaging time - carc	AT.c	days	25,550	25,550	25,550	25,550
Averaging time - nonc	AT.n	days	3,285	8,760	2,190	2,190

Surface water dermal						
Absorbed dose = CS * CDI *PC			Facility Visitor			
[(CF*PC*SA*EF*ED*ET)/(BW*AT)]			Adult		Child	
			CTE	RME	CTE	RME
Exposure assumptions[a]:						
Chemical concentration in water	CS	mg/L	*	*	*	*
Conversion factor	CF	L/cm^3	1E-03	1E-03	1E-03	1E-03
Skin surface area available for contact	SA	cm^2/event	4,500	4,500	1,650	1,650
Absorption factor	ABS	--	--	--	--	--
Dermal permeability constant*	PC	cm/hr	*	*	*	*
Exposure time[b]	ET	hr/event	1	1	1	1
Exposure frequency[c]	EF	events/yr	12	24	12	24
Exposure duration[c]	ED	yrs	9	30	6	6
Body weight	BW	kg	70	70	15	15
Averaging time - carc	AT.c	days	25,550	25,550	25,550	25,550
Averaging time - nonc	AT.n	days	3,285	10,950	2,190	2,190

Note: * - chemical-specific
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
RME - reasonable maximum exposure

[a] General methodology based on guidance in U.S. EPA (1989) and DEC (2002).

[b] Surface water ingestion rate for visitors based on 25 percent of the ingestion rate of water 50 mL/hour during swimming identified by U.S. EPA (1989). Swimming time of one hour based on U.S. EPA (1989).

[c] Exposure duration for visitors based on residential exposure duration identified in DEC (2002) and other EPA references. Visitor exposure frequency based on professional judgment.

[d] Dermal surface area represents 25 percent of the whole body surface area identified in U.S. EPA (2001a) (i.e., 18,000 cm^2 for an adult and 6,600 cm^2 for a child $\times$ 0.25).

Table 3-4. Noncancer toxicity data—oral/dermal reference doses

Chemical of Concern	Oral Chronic RfD (mg/kg-day)	Oral-to-Dermal Adjustment Factor[a]	Adjusted Dermal RfD[b] (mg/kg-day)	Primary Target Organ or System	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ[c]
Inorganics							
Cadmium - food	0.001	0.05	0.00005	Kidney	10/1	IRIS	7/19/2004
Cadmium - water	0.0005	0.05	0.000025	Kidney	10/1	IRIS	7/19/2004
Chromium (as chromium[VI])	0.003 [d]	0.025	0.000075	None reported	300/3	IRIS	7/19/2004
Lead	NA	NA	NA	NA	NA	NA	NA
Mercury	0.0003	0.07	0.000021	Immunologic	1,000/1	IRIS	7/19/2004
Organics							
DRO (aliphatic)	0.10		0.10	Liver / hematologic		ADEC	
DRO (aromatic)	0.04		0.04	Body weight		ADEC	
RRO (aliphatic)	2.0		2.0	Liver		ADEC	
RRO (aromatic)	0.03		0.03	Kidney		ADEC	

Note:
-- - not available
ATSDR - Agency for Toxic Substances and Disease Registry
DRO - diesel-range organics
EPA - U.S. Environmental Protection Agency
IRIS - Integrated Risk Information System
NA - not applicable
PAH - polycyclic aromatic hydrocarbon
RfD - reference dose
RRO - residual-range organics

[a] See Table 3-5 for references for dermal adjustment factors.

[b] Consistent with U.S. EPA (2001a), where oral absorption is less than 50 percent, oral RfDs are adjusted by multiplying by the oral-to-dermal adjustment factor.

[c] Date when IRIS was searched.

[d] Because the chemical forms of chromium present are not known, the human health risk assessment conservatively assumes that all chromium is present as chromium(VI).

Table 3-5. Summary of absorption factors used to assess dermal exposures via soil/sediment and surface water

Contaminant of Concern	Dermal Absorption Factors[a] (unitless)	Oral to Dermal Adjustment Factor (unitless)	Dermal Permeability Constants[a] (cm/hour)
Inorganics			
Cadmium	0.001	0.05	0.001
Chromium (as chromiun	--	0.025	0.001
Lead	NA	NA	NA
Mercury	--	0.07	0.001
Organics			
DRO	0.13	1	--
RRO	0.13	1	--
PAHs			
Benz[a]anthracene	0.13	1	0.47
Benzo[a]pyrene	0.13	1	0.70
Benzo[b]fluoranthene	0.13	1	0.70
PCDD/F TEQs	0.03	1	0.81

Note: -- - no data available for these chemicals
DRO - diesel-range organics
NA - not applicable
PAH - polycyclic aromatic hydrocarbon
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
RRO - residual-range organics
TEQ - toxicity equivalent quotient

[a] Dermal absorption factors, oral-to-dermal adjustment factors, and permeability constants from U.S. EPA (2001a) unless otherwise noted. Consistent with guidance from U.S. EPA (2001a), where data for absorption from soil are not available, dermal exposure is evaluated qualitatively.

Table 3-6. Oral toxicity values for estimating excess cancer risks associated with contaminants of concern

Contaminant of Concern	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	EPA Weight-of-Evidence Classification	Oral-to-Dermal Adjustment Factor[a]	Adjusted Dermal CSF[a] (mg/kg-day)	Type of Cancer	Basis of Cancer Slope Factor	Source of CSF	Date of CSF Source[b]
PAH Compounds[c]								
Benz[a]anthracene	0.73	B2	1	0.73	Based on potency relative to benzo[a]pyrene	Mouse diet	IRIS	07/19/04
Benzo[a]pyrene	7.3	B2	1	7.3	Forestomach, squamous cell papillomas and carcinomas	Mouse diet	IRIS	07/19/04
Benzo[b]fluoranthene	0.73	B2	1	0.73	Based on potency relative to benzo[a]pyrene	Mouse diet	IRIS	07/19/04
PCDD/F TEQs[d]	1.5E+5		1	1.5E+5			EPA Region 9	

Note: Toxicity values obtained from U.S. EPA (2000a), unless otherwise specified.

B2 - probable human carcinogen; sufficient evidence in animals and inadequate or no evidence in humans
CSF - carcinogenic slope factor
IRIS - Integrated Risk Information System
EPA - U.S. Environmental Protection Agency
PAH - polycyclic aromatic hydrocarbon

[a] Consistent with U.S. EPA (2001a), where oral absorption is less than 50 percent, oral reference doses are adjusted by multiplying by the oral-to-dermal adjustment factor. See Table 3-5 for dermal adjustment factor.

[b] Date when IRIS was searched.

[c] Carcinogenic slope factors for PAH compounds are based on potency relative to benzo[a]pyrene per EPA guidance (U.S. EPA 1998b).

[d] Carcinogenic slope factor as cited by U.S. EPA Region 9 (U.S. EPA 2003a).

Table 3-7. Summary of total excess lifetime cancer risks for reasonable maximum exposure scenarios

Receptor/Exposure Pathway	Adult Cancer Risk	Adult Percent Contribution by Pathway	Child Cancer Risk	Child Percent Contribution by Pathway	Chemicals Accounting for 90 percent of Cancer Risk for each Pathway
Facility/grave site area					
Occasional visitor scenario					
Ingestion of Surface Soil/sediment	2E-5	83	3E-5	87	PCDD/Fs
Dermal Contact with Surface Soil/sediment	3E-6	17	4E-6	13	PCDD/Fs
Ingestion of Surface Water	--	--	--	--	No carcinogenic CoPCs
Dermal Contact with Surface Water	--	--	--	--	No carcinogenic CoPCs
Total Cancer Risk	**2E-5**	100	**3E-5**	100	
Hypothetical future resident					
Ingestion of Surface Soil	2E-4	83	4E-4	87	PCDD/Fs
Dermal Contact with Surface Soil	4E-5	17	6E-5	13	PCDD/Fs
Total Cancer Risk	**3E-4**	100	**5E-4**	100	
Grave site area					
Visitor					
Ingestion of Surface Soil	9E-7	83	2E-6	88	PCDD/Fs
Dermal Contact with Surface Soil	2E-7	17	2E-7	12	PCDD/Fs
Total Cancer Risk	**1E-6**	100	**2E-6**	100	
Daycare area					
Worker and child					
Ingestion of Surface Soil	4E-7	60	2E-6	88	PCDD/Fs
Dermal Contact with Surface Soil	3E-7	40	3E-7	12	PCDD/Fs
Total Cancer Risk	**7E-7**	100	**2E-6**	100	

Note: CoPC - chemical of potential concern
PCDD/F - polychlorinated dibenzo-*p*-dioxin and dibenzofuran

Table 3-8. Summary of total noncancer hazard indices for reasonable maximum exposure scenarios

Receptor/Exposure Pathway	Adult Hazard Index	Adult Percent Contribution by Pathway	Child Hazard Index	Child Percent Contribution by Pathway	Chemicals Accounting for 90 percent of the Total Hazard Quotient for each Pathway
Facility/grave site area					
Occasional visitor scenario					
Ingestion of Surface Soil/sediment	0.016	48	0.15	82	Cadmium, chromium
Dermal Contact with Surface Soil/sediment	0.0010	3	0.0067	4	Cadmium
Ingestion of Surface Water	0.0016	5	0.0073	4	Cadmium
Dermal Contact with Surface Water	0.011	38	0.020	11	Cadmium
Total Noncancer Risk	**0.030**	100	**0.19**	100	
Hypothetical future resident					
Ingestion of Surface Soil	0.12	96	1.2	97	Cadmium, chromium
Dermal Contact with Surface Soil	0.006	4	0.04	3	Cadmium
Total Noncancer Risk	**0.13**	100	**1.2**	100	
Grave site area					
Visitor					
Ingestion of Surface Soil	0.00027	100	0.0025	100	Mercury, cadmium, chromium
Dermal Contact with Surface Soil	0	0	0	0	No noncarcinogenic CoPCs
Total Noncancer Risk	**0.00027**	100	**0.0025**	100	
Daycare area					
Ingestion of Surface Soil	0	0	0	0	No noncarcinogenic CoPCs
Dermal Contact with Surface Soil	0	0	0	0	No noncarcinogenic CoPCs
Total Noncancer Risk	**0**	0	**0**	0	

Note: CoPC - chemical of potential concern

Table 3-9. Summary of total noncancer hazard indices from TPH for reasonable maximum exposure scenarios

Receptor/Exposure Pathway	Adult Hazard Index	Adult Percent Contribution by Pathway	Child Hazard Index	Child Percent Contribution by Pathway
Facility/grave site area				
Occasional visitor scenario				
Ingestion of Surface Soil/sediment	0.23	59	2.2	69
Dermal Contact with Surface Soil/sediment	0.12	31	0.79	25
Ingestion of Surface Water	0.042	11	0.20	6
Dermal Contact with Surface Water	0	0	0	0
Total Noncancer Risk	**0.40**	100	**3.2**	100
Hypothetical future resident				
Ingestion of Surface Soil	0.10	66	0.95	73
Dermal Contact with Surface Soil	0.05	34	0.34	27
Total Noncancer Risk	**0.15**	100	**1.3**	100

Note: TPH - total petroleum hydrocarbons

Table 4-1. Ecological screening of detected metals in water at the former municipal solid waste incinerator site—Sitka, Alaska

Location		Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)
Data with Field Duplicates Averaged					
2ESE07	Jul-01	0.064	0.0627	1.16	0.0033
2S05	Jul-01	0.0089	0.0072	0.069	0.00025
2S06	Jul-01	0.0021	0.0023	0.033	0.0002 *U*
2SE08	Jul-01	0.0012	0.0015 *U*	0.006	0.0002 *U*
3SE03	Mar-03				
	Mean	0.019	0.018	0.32	0.00093
	Maximum detected value	0.064	0.063	1.2	0.0033
	EPA CCC WQC[a]	0.00025	0.011	0.0025	0.00077

Note: Boxed values indicate exceedance of criteria.

CCC - criterion continuous concentration
EPA - U.S. Environmental Protection Agency
U - compound analyzed for but not detected
WQC - water quality criteria

[a] U.S. EPA (2002b).

Table 4-2. Ecological screening benchmarks for sediment

Chemical	Measurement Basis	Sediment Quality Guidelines					EPA Screening Benchmarks		
					CCME				
		TEC	PEC	NEC	ISQG	PEL	Fish	Mammals	Birds
Total Metals									
Cadmium	mg/kg dw	0.99	4.98	8			--	--	--
Chromium	mg/kg dw	43.4	111	95			--	--	--
Lead	mg/kg dw	35.8	128	130			--	--	--
Mercury (inorganic)	mg/kg dw	0.18	1.06	--			--	--	--
Semivolatile Organic Compounds									
Anthracene	mg/kg dw	0.057	0.85	2.0			--	--	--
Benz[a]anthracene	mg/kg dw	0.11	1.1	3.0			--	--	--
Benzo[a]pyrene	mg/kg dw	0.15	1.5	1.0			--	--	--
Benzo[b]fluoranthene	mg/kg dw	--	--	4.0			--	--	--
Benzo[g,h,i]perylene	mg/kg dw	--	--	1.2			--	--	--
Benzo[k]fluoranthene	mg/kg dw	--	--	4.0			--	--	--
Chrysene	mg/kg dw	0.17	1.3	3.0			--	--	--
Dibenz[a,h]anthracene	mg/kg dw	0.033	--	0.87			--	--	--
Fluoranthene	mg/kg dw	0.42	2.2	10			--	--	--
Fluorene	mg/kg dw	0.077	0.54	3.0			--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg dw			0.77			--	--	--
Naphthalene	mg/kg dw	0.18	0.56	1.4			--	--	--
Phenanthrene	mg/kg dw	0.20	1.2	20			--	--	--
Pyrene	mg/kg dw	0.20	1.5	9.0			--	--	--
PCDDs/PCDFs									
PCDD/Fs[a]	ng TEQ/kg dw	--	--	--	0.85	21.5	60 100	2.5 25	21 210

Note:
-- - no screening value
CCME - Canadian Council of Ministers of the Environment
dw - dry weight
EPA - U.S. Environmental Protection Agency
ISQG - interim sediment quality guideline
NEC - no-effect concentration
PCDD/F - polychlorinated dibenzo-*p*-dioxin and dibenzofuran
PEC - probable effect concentration
PEL - probable effect level
TEC - threshold effect concentration
TEQ - toxicity equivalent quotient

[a] Upper value associated with low risk, lower value associated with high risk to sensitive species.

Table 4-3. Ecological screening of detected metals in sediment at the former municipal solid waste incinerator site—Sitka, Alaska

		Cadmium		Chromium		Lead		Mercury	
Location	Date	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded
Sediment Data with Field Duplicates Averaged									
2S04	Jul-01	0.69	0/3	27.8	0/3	87.8	1/3	1.54	2/2
2S05	Jul-01	18.4	3/3	15.6	0/3	166	3/3	0.61	1/2
2S06	Jul-01	125	3/3	110	2/3	1,770	3/3	2.52	2/2
2ESE07	Jul-01	79.3	3/3	71.7	1/3	1,050	3/3	2.28	2/2
2SE08	Jul-01	3.73	1/3	28.7	0/3	32.5	0/3	0.268	1/2
3SE03	Mar-03	44.6	3/3	98.3	2/3	883	3/3	1.62	2/2
4SE05	Mar-04	0.25	0/3	41.1	0/3	9.7	0/3	0.04	0/2
4SE06	Mar-04	0.23	0/3	56.3	1/3	15.7	0/3	0.06	0/2
4NE04	Mar-04	0.11	0/3	47.4	1/3	6.7	0/3	0.02	0/2

Note: *U* - compound analyzed for but not detected

Table 4-4. Ecological screening of PAHs in sediment at the former municipal solid waste incinerator site—Sitka, Alaska

	Flume sediment 3SE03		Wetland sediment 2SE08-04	
	Mar-03	Benchmarks exceeded	Mar-03	Benchmarks exceeded
PAH (mg/kg)				
2-Methylnaphthalene	0.28 *J*	--	0.41 *J*	--
Acenaphthene	0.57 *J*	--	0.87 *J*	--
Acenaphthylene	4 *U*	--	4.7 *U*	--
Anthracene	4 *U*	3/3	4.7 *U*	3/3
Benz[a]anthracene	0.82 *J*	1/3	24 *U*	3/3
Benzo[a]pyrene	20 *U*	3/3	24 *U*	3/3
Benzo[b]fluoranthene	20 *U*	1/1	24 *U*	1/1
Benzo[g,h,i]perylene	20 *U*	1/1	24 *U*	1/1
Benzo[k]fluoranthene	20 *U*	1/1	24 *U*	1/1
Chrysene	0.90 *J*	1/3	24 *U*	3/3
Dibenzo[a,h]anthracene	20 *U*	2/2	24 *U*	2/2
Fluoranthene	2.2 *J*	1/3	3.9 *J*	2/3
Fluorene	0.43 *J*	1/3	0.71 *J*	2/3
Indeno[1,2,3-cd]pyrene	20 *U*	1/1	24 *U*	1/1
Naphthalene	0.31 *J*	1/3	0.43 *J*	1/3
Phenanthrene	1.7 *J*	2/3	2.6 *J*	2/3
Pyrene	2.7 *J*	2/3	5.6 *J*	2/3

Note: -- - no screening value
J - estimated value
nd - not detected
U - compound analyzed for but not detected

Table 4-5. Ecological screening of detected PCDD/Fs in sediment at the former municipal solid waste incinerator site—Sitka, Alaska

	Wetland sediment (ng/kg)	Flume sediment (ng/kg)	Supplemental Flume sediment (ng/kg)		
Sample No.	2SE08	3SE03	4NE04	4SE05	4SE06
Analyte / Sampling Date	Jul-01	Mar-03	Mar-04	Mar-04	Mar-04
Isomers					
2,3,7,8-TCDD	3.1	18.86	0.071 *U*	0.063 *U*	0.113 *U*
1,2,3,7,8-PeCDD	12.4 *J*	85.69	0.147 *U*	0.378 *J*	0.177 *U*
1,2,3,4,7,8-HxCDD	17.9	139.26	0.154 *U*	0.809 *J*	0.237 *U*
1,2,3,6,7,8-HxCDD	57.5	448.21	0.57 *J*	2.297	0.211 *U*
1,2,3,7,8,9-HxCDD	47.4	401.73	0.143 *U*	2.007	0.22 *U*
1,2,3,4,6,7,8-HpCDD	535	5,834.58 *E*	7.281	26.139	3.717
OCDD	1,500	12,083.62 *BE*	30.728	88.602	14.356
2,3,7,8-TCDF	66.4	557.325 *CE*	0.275 *UC*	0.622 *C*	0.335 *UC*
1,2,3,7,8-PeCDF	25.6	154.71 *K*	0.094 *U*	0.784 *J*	0.098 *U*
2,3,4,7,8-PeCDF	47.6	276.93	0.096 *U*	1.407 *J*	0.1 *U*
1,2,3,4,7,8-HxCDF	103	968.82 *K*	0.273 *J*	3.786	0.662 *J*
1,2,3,6,7,8-HxCDF	58	467.71	0.121 *U*	2.197	0.145 *U*
2,3,4,6,7,8-HxCDF	88.6	885.23 *K*	0.592	4.102	0.592 *J*
1,2,3,7,8,9-HxCDF	6.1 *J*	30.35	0.124 *U*	0.097 *U*	0.148 *U*
1,2,3,4,6,7,8-HpCDF	311	3,148.38 *E*	0.82 *JK*	13.141	2.02 *J*
1,2,3,4,7,8,9-HpCDF	39.7	392.38	0.25 *U*	1.74	0.635 *U*
OCDF	171	1,803.95	1.217 *J*	11.016	1.356 *U*
Totals					
Total TCDD	115	808.117	0.071 *U*	1.941	0.113 *U*
Total PeCDD	233	2,290.488	0.147 *U*	7.486	0.177 *U*
Total HxCDD	615	5,917.014	2.861	23.738	2.521
Total HpCDD	1,240	12,496.301	12.845	49.939	7.064
Total TCDF	327	2,576.485	0.343	11.389	1.202
Total PeCDF	536	2,957.931	1.168	15.456	0.1 *U*
Total HxCDF	551	4,894.412	1.289	20.408	2.457
Total HpCDF	485	5,059.731	1.186	22.197	2.961
WHO TEQs[a]					
TEQ with detection limit at 1/2	94	736	0.41	3.2	0.42
Benchmarks exceeded	5/5	5/5	0/5	2/5	0/5

Table 4-5. (cont.)

Note: Method 8290 PCDD/F Analysis (b), MIT3 (DB-5).

Detection limit as specified in Table 1A (Clare 2003)

B	-	detected in laboratory method blank as well as in associated sample
C	-	TCDD value determined using DB-225 confirmation column
E	-	estimated; concentration exceeds upper linear calibration range
HpCDD	-	heptachlorodibenzo-*p*-dioxin
HpCDF	-	heptachlorodibenzofuran
HxCDD	-	hexachlorodibenzo-*p*-dioxin
HxCDF	-	hexachlorodibenzofuran
J	-	estimated value
K	-	estimated maximum possible concentration
OCDD	-	octachlorodibenzo-*p*-dioxin
OCDF	-	octachlorodibenzofuran
PCDD/F	-	polychlorinated dibenzo-*p*-dioxin and dibenzofuran
PeCDD	-	pentachlorodibenzo-*p*-dioxin
PeCDF	-	pentachlorodibenzofuran
TCDD	-	tetrachlorodibenzodioxin
TCDF	-	tetrachlorodibenzofuran
TEQ	-	toxicity equivalent quotient
WHO	-	World Health Organization

[a] TEQ calculations based on TEFs for mammal protection recommended by WHO (Van den Berg et al. 1998).

Table 4-6. Ecological screening benchmarks for soil

Chemical	Measurement Basis	ORNL Benchmark			CCME	Eco-SSLs			
		Earth-worms	Soil fauna	Phyto-toxicity		Plants	Invertebrates	Avian Wildlife	Mammalian Wildlife
Cadmium	mg/kg dw	20	20	4	10	29	110	--	--
Chromium	mg/kg dw	0.4	10	1	64	5		21 (as Cr^{3+})	360 (as Cr^{3+}) 330 (as Cr^{6+})
Lead	mg/kg dw	500	900	50	140	--	--	--	--
Mercury (inorganic)	mg/kg dw	0.1	30	0.3	6.6	--	--	--	--
PCDD/Fs[a]	ng/kg dw	--	--	--	1,000	--	--	--	--

Note:
-- - no screening value
2,3,7,8-TCDD - 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
CCME - Canadian Council of Ministers of the Environment
dw - dry weight
Eco-SSL - ecological soil screening levels
ORNL - Oak Ridge National Laboratory
PCDD/F - polychlorinated dibenzo-*p*-dioxin and dibenzofuran

[a] PCDD/Fs expressed as 2,3,7,8-TCDD equivalents.

Table 4-7. Ecological screening of detected metals in soil at the former municipal solid waste incinerator site—Sitka, Alaska

		Cadmium		Chromium		Lead		Mercury	
Location	Date	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded	mg/kg	Benchmarks exceeded
Soil Data with Field Duplicates Averaged									
N2	Jan-01	8.6	1/6	59	5/7	370	2/4	0.32	2/4
NE3	Jan-01	1.7	0/6	20	4/7	32	0/4		
NW1	Jan-01	1.3	0/6	24	5/7	95	1/4	0.38	2/4
SE4	Jan-01	4.7	1/6	25	5/7	180	2/4	0.22	1/4
SE5	Jan-01	170	6/6	210	6/7	2600	4/4	4.4	2/4
SE6	Jan-01	2.7	0/6	43	5/7	48	0/4		
S7	Jan-01	29	4/6	120	6/7	1900	4/4	3.3	2/4
SW8	Jan-01			15	4/7	96	1/4	2.5	2/4
SW9	Jan-01			22	5/7	9.1	0/4		
W10	Jan-01	5.8	1/6	27	5/7	260	2/4	0.66	2/4
2N01	Jul-01	1.57	0/6	33.7	5/7				
2N02	Jul-01	1.15	0/6	31.5	5/7				
2W03	Jul-01	1.6	0/6	23.4	5/7			0.32	2/4
Grave site									
3NE01	Mar-03	5.34	1/6	12.3	4/7	307	2/4	1.01	2/4
3NE02	Mar-03	1.81	0/6	7.85	3/7	173	2/4	3.39	2/4
Proposed daycare									
3SW05	Mar-03	2.97	0/6	14.3	4/7	165	2/4	0.67	2/4
3SW05-06	Mar-03	0.232	0/6	2.14	2/7	15.6	0/4	0.10	0/4

Note: *U* - compound analyzed for but not detected

Table 4-8. Ecological screening of PAHs (mg/kg) in soil at the former municipal solid waste incinerator site—Sitka, Alaska

	N2		NW1		SE4		SE5	
	Jan-01	Benchmarks exceeded	Jan-01	Benchmarks exceeded	Jan-01	Benchmarks exceeded	Jan-01	Benchmarks exceeded
PAH (mg/kg)								
Benz[a]anthracene	0.051 *J*	0/3			0.36	1/3	1.3	2/3
Benzo[a]pyrene	0.087 *J*	0/3			0.41	1/3	1.0	1/3
Benzo[b]fluoranthene	0.33	0/1	0.13 *J*	0/1	0.78	0/1	1.6	0/1
Benzo[k]fluoranthene	0.1 *J*	0/1	0.055 *J*	0/1	0.35	0/1	0.77	0/1
Naphthalene							0.26 *J*	1/3

Note: *J* - estimated value
PAH - polycyclic aromatic hydrocarbon

Table 4-9. Ecological screening of detected PCDD/Fs in soil at the former municipal solid waste incinerator site—Sitka, Alaska

									Grave site soil		Proposed daycare facility soil	
		Sample No.	N2	S7	2N01	2N02	2W03	2S04	3NE01S	3NE02S	3SW05S	3SW05-06S
Analytes	WHO TEFs	Sampling Date	Jan-01	Jan-01	Jul-01	Jul-01	Jul-01	Jul-01	Mar-03	Mar-03	Mar-03	Mar-03
Isomers												
2378-TCDD	1		6.9	180	27.1	13.6	1.6 *J*	1.2 *J*	2.759	34.805	1.229 *JK*	1.0 *U*
12378-PeCDD	1		33	746	83.2	43.7	5.4 *J*	3.4 *J*	10.098	142.515	3.536 *J*	2.5 *U*
123478-HxCDD	0.1		47.7	1,090	96.2	50.8	8.7 *J*	4.2 *K*	11.205	163.452	5.078 *J*	2.5 *U*
123678-HxCDD	0.1		124	2,870 *E*	242	128	13.5 *J*	13.7 *JB*	35.49	384.921	11.581	2.5 *U*
123789-HxCDD	0.1		140	3,050 *E*	256	154	13.7 *J*	11.4 *JB*	33.274	426.383	11.086	2.5 *U*
1234678-HpCDD	0.01		1,690	19,280 *SE*	2,550	1,390	117	152	524.625	4,195.31 *E*	175.531	14.371 *JK*
OCDD	0.0001		4,550 *E*	39,910 *SE*	6,760	3,730	314	468	1,778.036 *B*	8,382.52 *BE*	439.339 *B*	110.664 *J*
2378-TCDF	0.1		142	1,770 *E*	328	182	55.4 *K*	15.8	70.255 *C*	781.924 *CE*	18.263 *C*	1.0 *U*
12378-PeCDF	0.05		43.6	794	151	66.3	230	9.6 *J*	14.355 *K*	224.47 *K*	5.685	2.5 *U*
23478-PeCDF	0.5		89.9	1,330	279	129	27.5 *J*	10.9 *JB*	25.97 *K*	438.846 *K*	10.318	2.5 *U*
123478-HxCDF	0.1		261	5,080 *E*	550	257	291	24.7 *JB*	77.983	1,092.25	29.122	4.691 *J*
123678-HxCDF	0.1		126	2,430 *E*	317	148	139	15.0 *J*	35.285	533.567	14.402	2.5 *U*
234678-HxCDF	0.1		284	5,140 *SE*	482	273	57.9	31.2	78.456	1,221.89 *K*	34.748	3.878
123789-HxCDF	0.1		13.1	237	24.9	12.9	93.4	3.1 *J*	2.643 *J*	26.783	1.011 *J*	2.5 *U*
1234678-HpCDF	0.01		877	11,020 *SE*	15,870	878	577	80.7 *B*	300.528	2,679.26	96.351	9.505 *J*
1234789-HpCDF	0.01		140	2,460 *E*	189	113	434	17.0 *J*	38.003	316.97 *E*	13.956	2.5 *U*
OCDF	0.0001		724	11,850 *E*	1,120	633	6,350	155 *B*	286.379	1542.708	73.309	5.0 *U*
Totals												
Total TCDD			267	6,140 *E*	906	429	19.5	34.9	123.231	1,226.44	24.250	1.956
Total PeCDD			501	12,420 *E*	1,180	632	53.0	42.4	216.295	3,249.09	62.0212	2.5 *U*
Total HxCDD			1,490	29,210 *SE*	2,770	1,490	130	123	459.847	5,654.54	135.367	13.175
Total HpCDD			3,080	36,880 *SE*	5,140	2,720	206	272	1,735.609	9,193.85	348.778	24.145
Total TCDF			731	9,330 *E*	1,790	920	291	84.2	415.508	4,009.93	69.352	14.453
Total PeCDF			936	14,750 *E*	3,280	1,420	718	118	304.442	5,065.45	124.948	3.770
Total HxCDF			1,260	23,480 *SE*	2,730	1,290	863	141	409.529	5,888.33	161.636	14.224
Total HpCDF			1,450	21,640 *SE*	2,580	1,380	1,240	150	533.675	4,223.76	174.995	9.505
WHO TEQs[a]												
TEQ with detection limit at 1/2			228	4,130	674	270	111	25	69.9	944	25.6	4.2
Benchmarks exceeded			0/1	1/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Note: Method 8290 PCDD/PCDF Analysis (b), MIT3 (DB-5).
Detection limit as specified in Table 1A (Clare 2003).
All measurements in ng/kg.

B - detected in laboratory method blank as well as in associated sample
C - determined using DB-225 confirmation column
E - estimated; analyte concentration exceeds upper linear calibration range
HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran
J - estimated value
K - estimated maximum possible concentration
OCDD - octachlorodibenzo-*p*-dioxin
OCDF - octachlorodibenzofuran
PCDD/F - polychlorinated dibenzo-p-dioxin and dibenzofuran
PeCDD - pentachlorodibenzo-*p*-dioxin
PeCDF - pentachlorodibenzofuran
S - minimum estimate from saturated signal
TCDD - tetrachlorodibenzodioxin
TCDF - tetrachlorodibenzofuran
TEF - toxicity equivalence factor
TEQ - toxicity equivalent quotient
U - compound analyzed for but not detected
WHO - World Health Organization

[a] TEQ calculations based on TEFs for mammal protection recommended by the World Health Organization (Van den Berg et al. 1998).

Table 4-10. Metal concentrations in fish tissue used in food web models at the former municipal solid waste incinerator site—Sitka, Alaska

	41903JCC02 Mar-03 Upstream	41903JCP01 Mar-03 Wetland
Metals (mg/kg)		
Cadmium	0.080	0.81
Chromium	1.1	0.30 *U*
Lead	0.454	5.06
Mercury	0.091	0.181

Note: Sample 41903JCC02 consists of 15 salmon smolts, mostly coho salmon, from 3 minnow traps placed in the flume upstream of the culvert.

Sample 41903JCP01 consists of 27 salmon smolts, mostly coho salmon with at least one king salmon, from 4 minnow traps placed in the large "upper" pond. Traps (2) in the lower pond produced no fish large enough for capture by the trap screens.

U - compound analyzed for but not detected

Table 4-11. Concentration of detected PCDD/Fs in fish tissue at the former municipal solid waste incinerator site—Sitka, Alaska

	WHO TEFs			Sample No.	41903JCC02	41903JCP01
				Sampling Date	Mar-03	Mar-03
				Location	Upstream	Wetland
	Mammal	Fish	Birds		(ng/kg)	(ng/kg)
Isomers						
2,3,7,8-TCDD	1	1	1		1.0 *U*	1.0 *U*
1,2,3,7,8-PeCDD	1	1	1		2.5 *U*	2.5 *U*
1,2,3,4,7,8-HxCDD	0.1	0.5	0.05		2.5 *U*	2.5 *U*
1,2,3,6,7,8-HxCDD	0.1	0.01	0.01		2.5 *U*	2.5 *U*
1,2,3,7,8,9-HxCDD	0.1	0.01	0.1		2.5 *U*	2.5 *U*
1,2,3,4,6,7,8-HpCDD	0.01	0.001	0.001		0.891	0.689
OCDD	0.0001	0.0001	0.0001		3.036	1.516
2,3,7,8-TCDF	0.1	0.05	1		1.0 *U*	1.0 *U*
1,2,3,7,8-PeCDF	0.05	0.05	0.1		2.5 *U*	2.5 *U*
2,3,4,7,8-PeCDF	0.5	0.5	1		2.5 *U*	2.5 *U*
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1		2.5 *U*	2.5 *U*
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1		2.5 *U*	2.5 *U*
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1		2.5 *U*	2.5 *U*
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1		2.5 *U*	2.5 *U*
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.01		2.5 *U*	0.288
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.01		2.5 *U*	2.5 *U*
OCDF	0.0001	0.0001	0.0001		5.0 *U*	5.0 *U*
Totals						
Total TCDD					1.0 *U*	1.0 *U*
Total PeCDD					0.204	2.5 *U*
Total HxCDD					0.497	2.5 *U*
Total HpCDD					2.303	1.202
Total TCDF					1.0 *U*	1.0 *U*
Total PeCDF					0.373	2.5 *U*
Total HxCDF					0.100	2.5 *U*
Total HpCDF					2.5 *U*	0.288
WHO TEQs[a]						
Mammals					3.4	3.4
Fish					3.6	3.6
Birds					4.4	4.3

Note: Sample 41903JCC02 consists of 15 salmon smolts, mostly coho salmon, from 3 minnow traps placed in the flume upstream of the culvert.

Sample 41903JCP01 consists of 27 salmon smolts, mostly coho salmon with at least one king salmon, from 4 minnow traps placed in the large "upper" pond. Traps (2) in the lower pond produced no fish large enough for capture by the trap screens.

Method 8290 PCDD/PCDF Analysis (b), MIT3 (DB-5).

Detection limit as specified in Table 1A (Clare 2003).

HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran
OCDD - octachlorodibenzo-*p*-dioxin

Table 4-11. (cont.)

OCDF	-	octachlorodibenzofuran
PCDD/F	-	polychlorinated dibenzo-p-dioxin and dibenzofuran
PeCDD	-	pentachlorodibenzo-*p*-dioxin
PeCDF	-	pentachlorodibenzofuran
TCDD	-	tetrachlorodibenzodioxin
TCDF	-	tetrachlorodibenzofuran
TEF	-	toxicity equivalence factor
TEQ	-	toxicity equivalent quotient
U	-	compound analyzed for but not detected
WHO	-	World Health Organization

[a] TEQ calculations based on TEFs recommended by the World Health Organization (Van den Berg et al. 1998), and using one-half the detection limit for undetected isomers.

Table 4-12. Uptake factors used to estimate concentrations of CoPCs in plants and earthworms

Analyte	Earthworm Uptake Factors[a]	Plant Uptake Factors[b]
Metals		
Cadmium	ln(earthworm) = 2.114 + 0.795*(ln[soil])	ln(plant) = –0.476 + 0.546*(ln[soil])
Chromium	3.162	--[c]
Lead	ln(earthworm) = –0.218 + 0.807*(ln[soil])	ln(plant) = –1.328 + 0.561*(ln[soil])
Mercury/methylmercury	ln(earthworm) = 0.0781 + 0.3369*(ln[soil])	ln(plant) = –0.996 + 0.544*(ln[soil])

Note: CoPC - contaminant of potential concern

[a] Sample et al. (1998).

[b] Bechtel (1998).

[c] No uptake factor is available.

Table 4-13. TRVs used in ecological screening assessment at the former municipal solid waste incinerator site—Sitka, Alaska

CoPC	NOAEL TRV	Reference	Mammalian NOAEL TRV	Reference
Metals				
Cadmium	1.45	White and Finley (1978)	1.0	Sutou et al. (1980)
Chromium	0.86	Haseltine et al. (unpublished), as cited in Sample et al. (1996)	3.3	Mackenzie et al. (1958)
Lead	3.9	Pattee (1984)	11	Azar et al. (1973)
Mercury	0.032	Heinz (1974, 1976a,b, 1979)	0.032	Verschuuren et al. (1976)

Note: CoPC - chemical of potential concern
NOAEL - no observed adverse effect level
TRV - toxicity reference value

Table 4-14. Ecological screening benchmarks for PCDD/F concentrations in fish[a]

	Fish Concentration (pg/g)	
Organism	Low Risk	High Risk
Fish	50	80
Mammalian wildlife	0.7	7
Avian wildlife	6	60

Note: PCDD/F - polychlorinated dibenzo-*p*-dioxin and dibenzofuran
TCDD - tetrachlorodibenzodioxin

[a] PCDD/Fs expressed as 2,3,7,8-TCDD equivalents.

Table 4-15. Receptor exposure parameters for ecological screening assessment at the former municipal solid waste incinerator site—Sitka, Alaska

Parameters	Units	Great Blue Heron	American Robin	Mink	Common Shrew	Sitka Mouse
Body weight	kg	2.2 [a]	0.077 [b]	0.55 [c]	0.0032 [d]	0.0283 [d]
Food ingestion rate (dw basis)	kg/day	0.097 [e]	0.016 [e]	0.029 [f]	0.00086 [g]	0.00688 [g]
Water ingestion rate	L/day	0.1 [h]	0.011 [h]	0.058 [h]	0.00056 [h]	0.00540 [h]
Sediment ingestion rate (dw basis)	kg/day	0.0019 [i]	NA	0.00058 [j]	NA	NA
Soil ingestion rate (dw basis)	kg/day	NA	0.0017 [k]	NA	0.000081 [l]	0.000140 [i]

[a] Hoffman (1978).

[b] Clench and Leberman (1978), as cited in Dunning (1984).

[c] Mitchell (1961).

[d] Silva and Downing (1995).

[e] Nagy (1987) estimation.

[f] Bleavins and Aulerich (1981).

[g] Nagy (1999) estimation.

[h] Calder and Braun (1983) estimation.

[i] Two percent of food ingestion rate, estimated from Beyer et al. (1994).

[j] Based on Hamilton (1940).

[k] 10.4 percent of food ingestion rate, estimated from Beyer et al. (1994).

[l] 9.4 percent of food ingestion rate, from Beyer et al. (1994).

Table 4-16. Exposure estimation and hazard quotient calculation for great blue heron at the former municipal solid waste incinerator site—Sitka, Alaska

	Maximum Concentration			Daily Exposure			Total	Body Weight	TRV	
Analyte	Water (μg/L)	Sediment (mg/kg dw)	Fish (mg/kg dw)[a]	Water (mg/day)	Sediment (mg/day)	Prey (mg/day)	Daily Intake	Normalized Exposure	(mg/kg-day)	Hazard Quotient
Cadmium	64.10	125.00	3.24	6.41E-03	0.24	0.31	0.56	0.25	1.45	0.17
Chromium	62.70	110.00	1.20	6.27E-03	0.21	0.12	0.33	0.15	0.86	0.17
Lead	1,160.00	1,770.00	20.24	1.16E-01	3.36	1.96	5.44	2.47	3.90	0.63
Mercury	3.30	2.52	0.72	3.30E-04	0.00	0.07	0.08	0.03	0.03	1.07

Note: NA - not available
PCB - polychlorinated biphenyl
TRV - toxicity reference value

[a] Fish concentrations are in dry weight and are converted from reported wet weight values assuming a moisture content of 75 percent.

Table 4-17. Exposure estimation and hazard quotient calculation for mink at the former municipal solid waste incinerator site—Sitka, Alaska

	Maximum Concentration			Daily Exposure						
Analyte	Water (μg/L)	Sediment (mg/kg dw)	Fish (mg/kg dw)[a]	Water (mg/day)	Sediment (mg/day)	Prey (mg/day)	Total Daily Intake	Body Weight Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	125.00	3.24	3.72E-03	0.07	0.09	0.17	0.31	1.00	0.31
Chromium	62.70	110.00	1.20	3.64E-03	0.06	0.03	0.10	0.19	3.30	0.06
Lead	1,160.00	1,770.00	20.24	6.73E-02	1.03	0.59	1.68	3.06	11.00	0.28
Mercury	3.30	2.52	0.72	1.91E-04	0.00	0.02	0.02	0.04	0.03	1.29

Note: TRV - toxicity reference value

[a] Fish concentrations are in dry weight and are converted from reported wet weight values assuming a moisture content of 75 percent.

Table 4-18. Exposure estimation and hazard quotient calculation for American robin at the former municipal solid waste incinerator site—Sitka, Alaska

	Maximum Concentration			Daily Exposure						
Analyte	Water (μg/L)	Soil (mg/kg dw)	Worm (mg/kg dw)[a]	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Total Daily Intake	Body Weight Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	170.00	491.25	7.05E-04	0.29	7.86	8.15	105.84	1.45	72.99
Chromium	62.70	210.00	664.02	6.90E-04	0.36	10.62	10.98	142.62	0.86	165.07
Lead	1,160.00	2,600.00	458.36	1.28E-02	4.42	7.33	11.77	152.81	3.90	39.18
Mercury	3.30	4.40	1.78	3.63E-05	0.01	0.03	0.04	0.47	0.03	14.62

Note: TRV - toxicity reference value

Table 4-19. Exposure estimation and hazard quotient calculation for common shrew at the former municipal solid waste incinerator site—Sitka, Alaska

	Maximum Concentration			Daily Exposure						
Analyte	Water (μg/L)	Soil (mg/kg dw)	Worm (mg/kg dw)[a]	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Total Daily Intake	Body Weight Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	170.00	491.25	3.59E-05	0.01	0.42	0.44	136.34	1.00	136.34
Lead	1,160.00	2,600.00	458.36	6.50E-04	0.21	0.39	0.61	189.20	11.00	17.20
Mercury	3.30	4.40	1.78	1.85E-06	0.00	0.00	0.00	0.59	0.03	18.46

Note: TRV - toxicity reference value

Table 4-20. Exposure estimation and hazard quotient calculation for Sitka mouse at the former municipal solid waste incinerator site—Sitka, Alaska

	Maximum Concentration			Daily Exposure						
Analyte	Water (μg/L)	Soil (mg/kg dw)	Plant (mg/kg dw)[a]	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Total Daily Intake	Body Weight Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	170.00	10.26	3.46E-04	0.02	0.07	0.09	3.35	1.00	3.35
Lead	1,160.00	2,600.00	21.83	6.26E-03	0.36	0.15	0.52	18.39	11.00	1.67
Mercury	3.30	4.40	0.83	1.78E-05	0.00	0.01	0.01	0.22	0.03	6.98

Note: TRV - toxicity reference value

Table 4-21. LOAEL TRVs used in re-evaluation of ecological screening results at the former municipal solid waste incinerator site—Sitka, Alaska

CoPC	Avian LOAEL TRV	Reference	Mammalian LOAEL TRV	Reference
Metals				
Cadmium	20	White and Finley (1978)	10	Sutou et al. (1980)
Chromium	4.30	Haseltine et al. (unpublished), as cited in Sample et al. (1996)		
Lead	3.9 [a]	Pattee (1984)	90	Azar et al. (1973)
Mercury	0.064	Heinz (1974, 1976a,b, 1979)	0.16	Verschuuren et al. (1976)

Note: CoPC - chemical of potential concern
LOAEL - lowest observed adverse effect level
NOAEL - no observed adverse effect level
TRV - toxicity reference value

[a] No LOAEL-based TRV available, NOAEL-based TRV retained.

Table 4-22. Re-evaluation of exposure estimates and hazard quotients for American robin at the former municipal solid waste incinerator site—Sitka, Alaska, under ecologically representative exposure and effects conditions

	Mean Concentration			Daily Exposure			Total	Body Weight		
Analyte	Water (μg/L)	Soil (mg/kg dw)	Worm (mg/kg dw)	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Daily Intake	Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	18.10	82.79	7.05E-04	0.03	1.32	1.36	17.61	20.00	0.88
Chromium	62.70	44.92	142.04	6.90E-04	0.08	2.27	2.35	30.51	4.30	7.10
Lead	1,160.00	505.84	122.31	1.28E-02	0.86	1.96	2.83	36.75	3.90	9.42
Mercury	3.30	1.65	1.28	3.63E-05	0.00	0.02	0.02	0.30	0.06	4.73

Note: TRV - toxicity reference value

Table 4-23. Re-evaluation of exposure estimates and hazard quotients for common shrew at the former municipal solid waste incinerator site—Sitka, Alaska, under ecologically representative exposure and effects conditions

	Mean Concentration			Daily Exposure			Total	Body Weight		
Analyte	Water (μg/L)	Soil (mg/kg dw)	Worm (mg/kg dw)	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Daily Intake	Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	18.10	82.79	3.59E-05	0.00	0.07	0.07	22.72	10.00	2.27
Lead	1,160.00	505.84	122.31	6.50E-04	0.04	0.11	0.15	45.88	90.00	0.51
Mercury	3.30	1.65	1.28	1.85E-06	0.00	0.00	0.00	0.39	0.16	2.41

Note: TRV - toxicity reference value

Table 4-24. Re-evaluation of exposure estimates and hazard quotients for Sitka mouse at the former municipal solid waste incinerator site—Sitka, Alaska, under ecologically representative exposure and effects conditions

	Mean Concentration			Daily Exposure				Body Weight		
Analyte	Water (μg/L)	Soil (mg/kg dw)	Plant (mg/kg dw)	Water (mg/day)	Soil (mg/day)	Prey (mg/day)	Total Daily Intake	Normalized Exposure	TRV (mg/kg-day)	Hazard Quotient
Cadmium	64.10	18.10	3.02	3.46E-04	0.00	0.02	0.02	0.84	10.00	0.08
Lead	1,160.00	505.84	8.71	6.26E-03	0.07	0.06	0.14	4.84	90.00	0.05
Mercury	3.30	1.65	0.49	1.78E-05	0.00	0.00	0.00	0.13	0.16	0.79

Note: TRV - toxicity reference value

Appendix A

Comments and Responses to Comments on the Draft HHRA

September 8, 2003

VIA FACSIMILE and Electronic Mail
Bill Janes
Project Manager
Alaska Department of Environmental Conservation
(907) 465- 5262
bill_janes@dec.state.ak.us

Dear Mr. Janes,

I write on behalf of the staff of Sitka Tribe of Alaska to provide comments on the Draft Former Municipal Solid Waste Incinerator Human Health and Ecological Risk Assessment. Sitka Tribe shares the following comments on the draft risk assessment. Additionally, Sitka Tribe looks forward to further dialogue with the City and Borough of Sitka, Sheldon Jackson College and other stakeholders in this project to ensure that the human health and ecological impacts of the Former Waste to Energy Plant are addressed adequately.

Initially, Sitka Tribe is concerned about the lack of public awareness regarding the environmental impacts of the Former Waste to Energy Plant. It seems the public was told repeatedly throughout the years of the incinerator's operation that there was no risk of toxic pollution associated with the facility's operation. We ask that future undertakings of this sort, with possible human health and environmental impacts, be more thoroughly researched and investigated before beginning such endeavors. Careful planning, research and siting of such a facility could prevent pollution of human residential and animal/fish habitat. To protect human health, the environment and all life, these type of operations and issues need to be dealt with the highest standards and ethics, and with consideration and regard for public input and inquiries. Sitka Tribe believes this continues to be integral throughout the life of this project and encourages the City and DEC to conduct further public outreach regarding this project.

Human Health Risk Assessment
Under 3.5 Conclusions of Human Health Risk Assessment, it is noted that, "this assessment would suggest that residential uses should be prevented through some means that can be agreed upon by all parties." Concrete plans or regulations need to be immediately set in place to prevent use as residential areas.

Response: Comment noted.

Also under HHRA 3.5 Conclusions of Human Health Risk Assessment, it is noted that, "future uses of the former facility pad that would require removing the pavement should be restricted and should require proper health and safety practices to prevent unacceptable human exposures." However, the HHRA does not address the anticipated decay rate for the paved area that covers the former incinerator site. It is likely that this material will be mobilized at some future date, and that the date of such event should be calculated. Additionally, continued ongoing sampling of seepages from this area should be conducted.

> **Response:** Decay rate calculations are unnecessary because pavement decay is easy to determine visually. Ongoing monitoring should be discussed as part of the institutional controls.

Screening Ecological Risk Assessment

Sitka Tribe is primarily concerned with the amount of uncertainty and potential for concern regarding the risk to ecological resources surrounding the Former Waste to Energy Site, and thus encourages DEC and the City and Borough of Sitka to create an aggressive ongoing sampling plan to determine what actual risks the Former Waste to Energy Site poses. Sitka Tribe also looks forward to working with the City and Borough of Sitka and the DEC to determine what sort of remediation, if any, can be done to clean up these rather scattered chemicals and heavy metals.

> **Response:** The screening level ecological risk assessment was based on very conservative exposure scenarios. Additional sampling conducted this spring did not identify significant offsite migration.

The Screening Ecological Risk Assessment notes that there are several chemicals of potential concern to the ecological environment surrounding the Former Waste to Energy Site. Because these chemicals are carcinogenic and the heavy metals bioaccumulate (increase in concentration over time) and biomagnify (accumulate in an organism at higher levels than are found in its food) in living organisms as they move up the food chain, there needs to be continuous, regular monitoring of the micro- and macroorganisms in these areas of contamination. The CoPCs may also be leaching through to other areas that weren't originally contaminated.

> **Response:** Continuous biota monitoring is probably unjustified based on the scale of this problem.

Contaminants and pollutants in the Sheldon Jackson flume is no small issue due to the large numbers of fish that rear in those waters. Though pinks and chums usually go to sea directly after hatching, cohos may live a year or two in the waters in which they hatch. This amount of time gives these fish ample opportunity to consume large numbers of smaller contaminated organisms

leading to the biomagification of the CoPCs. These fish have, and will most likely be caught by fishermen, not just Alaskan but possibly throughout the Pacific Ocean. Many have probably already grown, been harvested by fishermen and have been sold (to people) on the salmon market. For these reasons, Sitka Tribe believes that continued public outreach must be conducted in connection with this project.

> **Response:** Because salmon range over large distances, the contaminants from the former incinerator are likely just a fraction of what migrating salmon may be exposed to during several years in the ocean.

Past and Ongoing Transport Mechanisms. Sitka Tribe is concerned by the lack of real discussion regarding fuel contamination in sediments to the south and southeast of the site. Under past and ongoing transport mechanisms, there is some discussion of some migration of contaminants. However, there does not seem to be any resolution in the text as to why there is so much petroleum in the soil and whether or not this pathway continues to exist (i.e. can this be attributed to past use as a WTE facility or its continued use as an oil burning facility?).

> **Response:** The assumption is that petroleum in down-gradient soil came from various spills and leaks during the operation of the facility. Best management practices have been improved over the years.

In conclusion, Sitka Tribal staff believes that the conclusions to the Risk Assessment should be expressed in a clear and concise manner to members of the public. Sitka Tribe is concerned about the conclusions listed in the Ecological Risk Section of the document. Thus, Sitka Tribe looks forward to an on-going dialogue regarding continued sampling and actual clean-up at this site. Additionally, Sitka Tribe would like further assurances that the risks to human health are minimized from now until well into the future. If you have any questions about these comments, please do not hesitate to contact Jessica Perkins, Resources Protection Director.

Sincerely,

Robi Craig
Deputy General Manager

cc: Hugh Bevan (via fax: 747- 7403); Lisa Yost (via fax: (425) 643-9827)

Appendix B

Detailed Risk Assessment Spreadsheets

Appendix B-1

Reasonable Maximum Exposure Estimate Tables

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-1-RME
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	136	mg/kg	--	136	mg/kg	M	1.3E-5	mg/kg-day	1E-3	mg/kg-day	--	--	0.013
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	7.0E-6	mg/kg-day	3E-3	mg/kg-day	--	--	0.0023
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	3.4E-7	mg/kg-day	3E-4	mg/kg-day	--	--	0.0011
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.016
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	136	mg/kg	0.001	136	mg/kg	M	5.1E-8	mg/kg-day	5E-5	mg/kg-day	--	--	0.0010
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0010
													Total Hazard Index Across All Exposure Routes/Pathways:	0.017

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-1-2-RME
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	136	mg/kg	--	136	mg/kg	M	1.2E-4	mg/kg-day	1E-3	mg/kg-day	--	--	0.12
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	6.5E-5	mg/kg-day	3E-3	mg/kg-day	--	--	0.022
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	3.2E-6	mg/kg-day	3E-4	mg/kg-day	--	--	0.011
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.15
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	136	mg/kg	0.001	136	mg/kg	M	3.3E-7	mg/kg-day	5E-5	mg/kg-day	--	--	0.0067
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0067
													Total Hazard Index Across All Exposure Routes/Pathways:	0.16

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

Table B-1-3-RME
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	56	mg/kg	--	56	mg/kg	M	7E-5	mg/kg-day	1E-3	mg/kg-day	--	--	0.072
	Chromium	75	mg/kg	--	75	mg/kg	M	1E-4	mg/kg-day	3E-3	mg/kg-day	--	--	0.032
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	6E-6	mg/kg-day	3E-4	mg/kg-day	--	--	0.019
	PAHs													
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.12
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	56	mg/kg	0.001	56	mg/kg	M	2.9E-7	mg/kg-day	5E-5	mg/kg-day	--	--	0.0057
	Chromium	75	mg/kg	--	75	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0057
													Total Hazard Index Across All Exposure Routes/Pathways:	0.13

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Future Hypothetical Resident
Receptor Age: Child

Table B-1-4-RME
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	56	mg/kg	--	56	mg/kg	M	6.7E-4	mg/kg-day	1E-3	mg/kg-day	--	--	0.67
	Chromium	75	mg/kg	--	75	mg/kg	M	9.1E-4	mg/kg-day	3E-3	mg/kg-day	--	--	0.30
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	5.3E-5	mg/kg-day	3E-4	mg/kg-day	--	--	0.18
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	1.2
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	56	mg/kg	0.001	56	mg/kg	M	1.9E-6	mg/kg-day	5E-5	mg/kg-day	--	--	0.038
	Chromium	75	mg/kg	--	75	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.038
													Total Hazard Index Across All Exposure Routes/Pathways:	1.2

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-5-RME
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	8.0E-8	mg/kg-day	3E-4	mg/kg-day	--	--	0.00027
	PCDD/F TEQ[d]	0.00094	mg/kg	0.6	0.00094	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.00027
Dermal	**Metals and Organometallic Compounds**													
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PCDD/F TEQ	0.00094	mg/kg	0.03	0.00094	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0.00027

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-1-6-RME
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

2.2E-7
6.1E-7

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	7.4E-7	mg/kg-day	3E-4	mg/kg-day	--	--	0.0025
	PCDD/F TEQ[d]	0.00094	mg/kg	0.6	0.00094	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0025
Dermal	**Metals and Organometallic Compounds**													
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PCDD/F TEQ	0.00094	mg/kg	0.03	0.00094	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0.0025

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Worker
Receptor Age: Adult

Table B-1-7-RME
Calculation of Noncancer Hazards
Adult Soil Exposure: Reasonable Maximum Worker
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion														
	PCDD/F TEQ[d]	0.000026	mg/kg	0.6	0.000026	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
Dermal														
	PCDD/F TEQ	0.000026	mg/kg	0.03	0.000026	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Child
Receptor Age: Child

Table B-1-8-RME
Calculation of Noncancer Hazards
Child Soil Exposure: Reasonable Maximum Daycare
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion														
	PCDD/F TEQ[d]	0.000026	mg/kg	0.6	0.000026	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
Dermal														
	PCDD/F TEQ	0.000026	mg/kg	0.03	0.000026	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-9-RME
Calculation of Noncancer Hazards
Adult Water Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	0.064	mg/L	--	0.064	mg/L	M	7.2E-7	mg/kg-day	5E-4	mg/kg-day	--	--	0.0014
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.0033	mg/L	--	0.0033	mg/L	M	3.7E-8	mg/kg-day	3E-4	mg/kg-day	--	--	0.00012
													Hazard Index:	0.0016
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	0.064	mg/L	0.001	0.064	mg/L	M	2.7E-7	mg/kg-day	3E-5	mg/kg-day	--	--	0.011
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.0033	mg/L	0.001	0.0033	mg/L	M	1.4E-8	mg/kg-day	2E-5	mg/kg-day	--	--	0.00065
	Total Cancer Risk:												Hazard Index:	0.011
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.013

Note:

--	-	not applicable
EPA	-	U.S. Environmental Protection Agency
EPC	-	exposure point concentration
M	-	medium-specific
ND	-	not determined by EPA or not considered to be a carcinogen
RME	-	reasonable maximum exposure
WTE	-	waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-1-10-RME
Calculation of Noncancer Hazards
Child Water Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	0.064	mg/L	--	0.064	mg/L	M	3.4E-6	mg/kg-day	5E-4	mg/kg-day	--	--	0.0067
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.0033	mg/L	--	0.0033	mg/L	M	1.7E-7	mg/kg-day	3E-4	mg/kg-day	--	--	0.00057
													Hazard Index:	0.0073
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	0.064	mg/L	0.001	0.064	mg/L	M	4.6E-7	mg/kg-day	2.5E-5	mg/kg-day	--	--	0.019
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.0033	mg/L	0.001	0.00325	mg/L	M	2.4E-8	mg/kg-day	2.1E-5	mg/kg-day	--	--	0.0011
	Total Cancer Risk:												Hazard Index:	0.020
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.027

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined by EPA or not considered to be a carcinogen
RME - reasonable maximum exposure
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-11-RME
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	136	mg/kg	--	136	mg/kg	M	--	--	ND	--	--
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	5.2E-8	mg/kg-day	0.73	(mg/kg-day)-1	4E-8
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	4.0E-8	mg/kg-day	7.3	(mg/kg-day)-1	3E-7
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	6.4E-8	mg/kg-day	0.73	(mg/kg-day)-1	5E-8
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	1.0E-10	mg/kg-day	150,000	(mg/kg-day)-1	1E-5
											Total Risk:	2E-5
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	136	mg/kg	0.001	136	mg/kg	M	--	--	ND	--	--
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	2.7E-8	mg/kg-day	0.73	(mg/kg-day)-1	2E-8
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	2.1E-8	mg/kg-day	7.3	(mg/kg-day)-1	2E-7
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	3.3E-8	mg/kg-day	0.73	(mg/kg-day)-1	2E-8
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	2.0E-11	mg/kg-day	150,000	(mg/kg-day)-1	3E-6
											Total Risk:	3E-6
											Total Risk Across all Exposure Pathways:	2E-5

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

TableB-1-12-RME
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	136	mg/kg	--	136	mg/kg	M	--	--	ND	--	--
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	9.8E-8	mg/kg-day	0.73	(mg/kg-day)-1	7E-8
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	7.5E-8	mg/kg-day	7.3	(mg/kg-day)-1	5E-7
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	1.2E-7	mg/kg-day	0.73	(mg/kg-day)-1	9E-8
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	1.9E-10	mg/kg-day	150,000	(mg/kg-day)-1	3E-5
											Total Risk:	3E-5
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	136	mg/kg	0.001	136	mg/kg	M	--	--	ND	--	--
	Chromium	74.3	mg/kg	--	74.3	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	3.6	mg/kg	--	3.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	3.6E-8	mg/kg-day	0.73	(mg/kg-day)-1	3E-8
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	2.7E-8	mg/kg-day	7.3	(mg/kg-day)-1	2E-7
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	4.4E-8	mg/kg-day	0.73	(mg/kg-day)-1	3E-8
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	3E-11	mg/kg-day	150,000	(mg/kg-day)-1	4E-6
											Total Risk:	4E-6
											Total Risk Across all Exposure Pathways:	3E-5

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

Table B-1-13-RME
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	56	mg/kg	--	56	mg/kg	M	--	--	ND	--	--
	Chromium	75	mg/kg	--	75	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	7.2E-7	mg/kg-day	0.73	(mg/kg-day)-1	5E-7
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	5.5E-7	mg/kg-day	7.3	(mg/kg-day)-1	4E-6
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	8.9E-7	mg/kg-day	0.73	(mg/kg-day)-1	6E-7
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	1E-9	mg/kg-day	150,000	(mg/kg-day)-1	2E-4
											Total Risk:	2E-4
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	56	mg/kg	0.001	56	mg/kg	M	--	--	ND	--	--
	Chromium	75	mg/kg	--	75	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	3.7E-7	mg/kg-day	0.73	(mg/kg-day)-1	3E-7
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	2.9E-7	mg/kg-day	7.30	(mg/kg-day)-1	2E-6
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	4.6E-7	mg/kg-day	0.73	(mg/kg-day)-1	3E-7
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	3E-10	mg/kg-day	150,000	(mg/kg-day)-1	4E-5
											Total Risk:	4E-5
											Total Risk Across all Exposure Pathways:	3E-4

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Future Hypothetical Resident
Receptor Age: Child

Table B-1-14-RME
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	56	mg/kg	--	56	mg/kg	M	--	--	ND	--	--
	Chromium	75	mg/kg	--	75	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	1.3E-6	mg/kg-day	0.73	(mg/kg-day)-1	1E-6
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	1.0E-6	mg/kg-day	7.3	(mg/kg-day)-1	8E-6
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	1.7E-6	mg/kg-day	0.73	(mg/kg-day)-1	1E-6
	PCDD/F TEQ[d]	0.0041	mg/kg	0.6	0.0041	mg/kg	M	2.6E-9	mg/kg-day	150,000	(mg/kg-day)-1	4E-4
											Total Risk:	4E-4
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	56	mg/kg	0.001	56	mg/kg	M	--	--	ND	--	--
	Chromium	75	mg/kg	--	75	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	4.4	mg/kg	--	4.4	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	4.9E-7	mg/kg-day	0.73	(mg/kg-day)-1	4E-7
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	3.8E-7	mg/kg-day	7.30	(mg/kg-day)-1	3E-6
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	6.0E-7	mg/kg-day	0.73	(mg/kg-day)-1	4E-7
	PCDD/F TEQ	0.0041	mg/kg	0.03	0.0041	mg/kg	M	3.6E-10	mg/kg-day	150,000	(mg/kg-day)-1	5E-5
											Total Risk:	6E-5
											Total Risk Across all Exposure Pathways:	5E-4

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-15-RME
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ[d]	0.00094	mg/kg	0.6	0.00094	mg/kg	M	5.7E-12	mg/kg-day	150,000	(mg/kg-day)-1	9E-7
											Total Risk:	9E-7
Dermal	**Metals and Organometallic Compounds**											
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ	0.00094	mg/kg	0.03	0.00094	mg/kg	M	1.1E-12	mg/kg-day	150,000	(mg/kg-day)-1	2E-7
											Total Risk:	2E-7
											Total Risk Across all Exposure Pathways:	1E-6

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-1-16-RME
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ[d]	0.00094	mg/kg	0.6	0.00094	mg/kg	M	1.1E-11	mg/kg-day	150,000	(mg/kg-day)-1	2E-6
											Total Risk:	2E-6
Dermal	**Metals and Organometallic Compounds**											
	Mercury	3.4	mg/kg	--	3.4	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ	0.00094	mg/kg	0.03	0.00094	mg/kg	M	1.5E-12	mg/kg-day	150,000	(mg/kg-day)-1	2E-7
											Total Risk:	2E-7
											Total Risk Across all Exposure Pathways:	2E-6

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Worker
Receptor Age: Adult

Table B-1-17-RME
Calculation of Cancer Risks
Adult Soil Exposure: Reasonable Maximum Worker
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion												
	PCDD/F TEQ[d]	0.000026	mg/kg	0.6	0.000026	mg/kg	M	2.7E-12	mg/kg-day	150,000	(mg/kg-day)-1	4E-7
											Total Risk:	4E-7
Dermal												
	PCDD/F TEQ	0.000026	mg/kg	0.03	0.000026	mg/kg	M	1.8E-12	mg/kg-day	150,000	(mg/kg-day)-1	3E-7
											Total Risk:	3E-7
											Total Risk Across all Exposure Pathways:	7E-7

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Child
Receptor Age: Child

Table B-1-18-RME
Calculation of Cancer Risks
Child Soil Exposure: Reasonable Maximum Daycare
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion												
	PCDD/F TEQ[d]	0.000026	mg/kg	0.6	0.000026	mg/kg	M	1.2E-11	mg/kg-day	150,000	(mg/kg-day)-1	2E-6
											Total Risk:	2E-6
Dermal												
	PCDD/F TEQ	0.000026	mg/kg	0.03	0.000026	mg/kg	M	1.7E-12	mg/kg-day	150,000	(mg/kg-day)-1	3E-7
											Total Risk:	3E-7
											Total Risk Across all Exposure Pathways:	2E-6

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
RME - reasonable maximum exposure
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-1-19-RME
Calculation of Cancer Risks
Adult Water Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	0.064	mg/L	--	0.064	mg/L	M	--	--	ND	--	--
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0033	mg/L	--	0.0033	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	0.064	mg/L	0.001	0.064	mg/L	M	--	--	ND	--	--
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0033	mg/L	0.001	0.0033	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
											Total Risk Across all Exposure Pathways:	0E+0

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined by EPA or not considered to be a carcinogen
RME - reasonable maximum exposure
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-1-20-RME
Calculation of Cancer Risks
Child Water Exposure: Reasonable Maximum Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	0.064	mg/L	--	0.064	mg/L	M	--	--	ND	--	--
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0033	mg/L	--	0.0033	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	0.064	mg/L	0.001	0.064	mg/L	M	--	--	ND	--	--
	Lead	1.2	mg/L	--	1.2	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0033	mg/L	0.001	0.0033	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
											Total Risk Across all Exposure Pathways:	0E+0

Note:

-- - not applicable
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined by EPA or not considered to be a carcinogen
RME - reasonable maximum exposure
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Appendix B-2

Central Tendency Estimate Tables

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-1-CTE
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	26.7	mg/kg	--	26.7	mg/kg	M	6.3E-7	mg/kg-day	1E-3	mg/kg-day	--	--	0.0006
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	1.1E-6	mg/kg-day	3E-3	mg/kg-day	--	--	0.00038
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	3.7E-8	mg/kg-day	3E-4	mg/kg-day	--	--	0.00012
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.00073	mg/kg	0.6	0.00073	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0011
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	26.7	mg/kg	0.001	26.7	mg/kg	M	5.0E-9	mg/kg-day	5E-5	mg/kg-day	--	--	0.00010
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.00073	mg/kg	0.03	0.00073	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.00010
													Total Hazard Index Across All Exposure Routes/Pathways:	0.0012

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-2-CTE
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	26.7	mg/kg	--	26.7	mg/kg	M	5.8E-6	mg/kg-day	1E-3	mg/kg-day	--	--	0.0058
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	1.1E-5	mg/kg-day	3E-3	mg/kg-day	--	--	0.0036
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	3.5E-7	mg/kg-day	3E-4	mg/kg-day	--	--	0.0012
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.00073	mg/kg	0.6	0.00073	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.011
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	26.7	mg/kg	0.001	26.7	mg/kg	M	3.3E-8	mg/kg-day	5E-5	mg/kg-day	--	--	0.00066
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.00073	mg/kg	0.03	0.00073	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.00066
													Total Hazard Index Across All Exposure Routes/Pathways:	0.011

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

Table B-2-3-CTE
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Central Tendency Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	18.1	mg/kg	--	18.1	mg/kg	M	1.2E-5	mg/kg-day	1E-3	mg/kg-day	--	--	0.012
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	2.9E-5	mg/kg-day	3E-3	mg/kg-day	--	--	0.010
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	1.1E-6	mg/kg-day	3E-4	mg/kg-day	--	--	0.0038
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.00092	mg/kg	0.6	0.00092	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.025
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	18.1	mg/kg	0.001	18.1	mg/kg	M	9.3E-8	mg/kg-day	5E-5	mg/kg-day	--	--	0.0019
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.00092	mg/kg	0.03	0.00092	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0019
													Total Hazard Index Across All Exposure Routes/Pathways:	0.027

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Child

Table B-2-4-CTE
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Central Tendency Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	18.1	mg/kg	--	18.1	mg/kg	M	1.1E-4	mg/kg-day	1E-3	mg/kg-day	--	--	0.11
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	2.7E-4	mg/kg-day	3E-3	mg/kg-day	--	--	0.09
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	1.1E-5	mg/kg-day	3E-4	mg/kg-day	--	--	0.035
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ[d]	0.00092	mg/kg	0.6	0.00092	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.23
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	18	mg/kg	0.001	18	mg/kg	M	6.1E-7	mg/kg-day	5E-5	mg/kg-day	--	--	0.012
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	mg/kg-day	8E-5	mg/kg-day	--	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PAHs												--	
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	--	--	ND	--	--	--	--
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	--	--	ND	--	--	--	--
	PCDD/F TEQ	0.00092	mg/kg	0.03	0.00092	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.012
													Total Hazard Index Across All Exposure Routes/Pathways:	0.25

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-5-CTE
Calculation of Noncancer Hazards
Adult Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	1.3E-8	mg/kg-day	3E-4	mg/kg-day	--	--	0.000043
	PCDD/F TEQ[d]	0.00051	mg/kg	0.6	0.00051	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.000043
Dermal	**Metals and Organometallic Compounds**													
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	mg/kg-day	2E-5	mg/kg-day	--	--	--
	PCDD/F TEQ	0.00051	mg/kg	0.03	0.00051	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0.000043

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-6-CTE
Calculation of Noncancer Hazards
Child Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	1.2E-7	mg/kg-day	3E-4	mg/kg-day	--	--	0.0004
	PCDD/F TEQ[d]	0.00051	mg/kg	0.6	0.00051	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0.0004
Dermal	**Metals and Organometallic Compounds**													
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	--	2E-5	mg/kg-day	--	--	--
	PCDD/F TEQ	0.00051	mg/kg	0.03	0.00051	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0.0004

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Worker
Receptor Age: Adult

Table B-2-7-CTE
Calculation of Noncancer Hazards
Adult Soil Exposure: Central Tendency Worker
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion														
	PCDD/F TEQ[d]	0.000015	mg/kg	0.6	0.000015	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
Dermal														
	PCDD/F TEQ	0.000015	mg/kg	0.03	0.000015	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Child
Receptor Age: Child

Table B-2-8-CTE
Calculation of Noncancer Hazards
Child Soil Exposure: Central Tendency Daycare
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion														
	PCDD/F TEQ[d]	0.000015	mg/kg	0.6	0.000015	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
Dermal														
	PCDD/F TEQ	0.000015	mg/kg	0.03	0.000015	mg/kg	M	--	--	ND	--	--	--	--
													Hazard Index:	0
													Total Hazard Index Across All Exposure Routes/Pathways:	0

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-9-CTE
Calculation of Noncancer Hazards
Adult Water Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	0.019	mg/L	--	0.019	mg/L	M	1.1E-7	mg/kg-day	5E-4	mg/kg-day	--	--	0.00022
	Lead	0.32	mg/L	--	0.3	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.00093	mg/L	--	0.0009	mg/L	M	5.2E-9	mg/kg-day	3E-4	mg/kg-day	--	--	0.000017
													Hazard Index:	0.00023
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	0.019	mg/L	0.001	0.019	mg/L	M	4.0E-8	mg/kg-day	3E-5	mg/kg-day	--	--	0.0016
	Lead	0.32	mg/L	--	0.3	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.00093	mg/L	0.001	0.0009	mg/L	M	2.0E-9	mg/kg-day	2E-5	mg/kg-day	--	--	0.00009
	Total Cancer Risk:												Hazard Index:	0.0017
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.0019

Note:

--	-	not applicable
CTE	-	central tendency exposure
EPA	-	U.S. Environmental Protection Agency
EPC	-	exposure point concentration
M	-	medium-specific
ND	-	not determined (EPA)/not considered a carcinogen
WTE	-	waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-10-CTE
Calculation of Noncancer Hazards
Child Water Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	Cadmium	0.019	mg/L	--	0.019	mg/L	M	5.0E-7	mg/kg-day	5E-4	mg/kg-day	--	--	0.0010
	Lead	0.32	mg/L	--	0.3	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.00093	mg/L	--	0.0009	mg/L	M	2.4E-8	mg/kg-day	3E-4	mg/kg-day	--	--	0.00008
													Hazard Index:	0.0011
Dermal	**Metals and Organometallic Compounds**													
	Cadmium	0.019	mg/L	0.001	0.019	mg/L	M	6.9E-8	mg/kg-day	3E-5	mg/kg-day	--	--	0.0028
	Lead	0.32	mg/L	--	0.3	mg/L	M	--	--	ND	--	--	--	--
	Mercury (total)	0.00093	mg/L	0.001	0.0009	mg/L	M	3.3E-9	mg/kg-day	2E-5	mg/kg-day	--	--	0.00016
	Total Cancer Risk:												Hazard Index:	0.003
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.004

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-11-CTE
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	26.7	mg/kg	--	26.7	mg/kg	M	--	--	ND	--	--
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	3.9E-9	mg/kg-day	0.73	(mg/kg-day)-1	3E-9
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	3.0E-9	mg/kg-day	7.3	(mg/kg-day)-1	2E-8
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	4.8E-9	mg/kg-day	0.73	(mg/kg-day)-1	4E-9
	PCDD/F TEQ[d]	0.00073	mg/kg	0.6	0.00073	mg/kg	M	1.3E-12	mg/kg-day	150,000	(mg/kg-day)-1	2E-7
											Total Risk:	2E-7
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	26.7	mg/kg	0.001	26.7	mg/kg	M	--	--	ND	--	--
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	4.1E-9	mg/kg-day	0.73	(mg/kg-day)-1	3E-9
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	3.1E-9	mg/kg-day	7.3	(mg/kg-day)-1	2E-8
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	5.0E-9	mg/kg-day	0.73	(mg/kg-day)-1	4E-9
	PCDD/F TEQ	0.00073	mg/kg	0.03	0.00073	mg/kg	M	5.3E-13	mg/kg-day	150,000	(mg/kg-day)-1	8E-8
											Total Risk:	1E-7
											Total Risk Across all Exposure Pathways:	3E-7

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-12-CTE
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	26.7	mg/kg	--	26.7	mg/kg	M	--	--	ND	--	--
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	2.4E-8	mg/kg-day	0.73	(mg/kg-day)-1	2E-8
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	1.9E-8	mg/kg-day	7.3	(mg/kg-day)-1	1E-7
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	3.0E-8	mg/kg-day	0.73	(mg/kg-day)-1	2E-8
	PCDD/F TEQ[d]	0.00073	mg/kg	0.6	0.00073	mg/kg	M	8.2E-12	mg/kg-day	150,000	(mg/kg-day)-1	1E-6
											Total Risk:	1E-6
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	26.7	mg/kg	0.001	26.7	mg/kg	M	--	--	ND	--	--
	Chromium	48.9	mg/kg	--	48.9	mg/kg	M	--	--	ND	--	--
	Lead	559	mg/kg	--	559	mg/kg	M	--	--	ND	--	--
	Mercury	1.6	mg/kg	--	1.6	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	1.8E-8	mg/kg-day	0.73	(mg/kg-day)-1	1E-8
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	1.4E-8	mg/kg-day	7.3	(mg/kg-day)-1	1E-7
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	2.2E-8	mg/kg-day	0.73	(mg/kg-day)-1	2E-8
	PCDD/F TEQ	0.00073	mg/kg	0.03	0.00073	mg/kg	M	2E-12	mg/kg-day	150,000	(mg/kg-day)-1	3E-7
											Total Risk:	5E-7
											Total Risk Across all Exposure Pathways:	2E-6

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

Table B-2-13-CTE
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Central Tendency Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	18.1	mg/kg	--	18.1	mg/kg	M	--	--	ND	--	--
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	1.1E-7	mg/kg-day	0.73	(mg/kg-day)-1	8E-8
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	8.3E-8	mg/kg-day	7.3	(mg/kg-day)-1	6E-7
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	1.3E-7	mg/kg-day	0.73	(mg/kg-day)-1	1E-7
	PCDD/F TEQ[d]	0.00092	mg/kg	0.6	0.00092	mg/kg	M	5E-11	mg/kg-day	150,000	(mg/kg-day)-1	7E-6
											Total Risk:	8E-6
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	18.1	mg/kg	0.001	18.1	mg/kg	M	--	--	ND	--	--
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	1.1E-7	mg/kg-day	0.73	(mg/kg-day)-1	8E-8
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	8.6E-8	mg/kg-day	7.30	(mg/kg-day)-1	6E-7
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	1.4E-7	mg/kg-day	0.73	(mg/kg-day)-1	1E-7
	PCDD/F TEQ	0.00092	mg/kg	0.03	0.00092	mg/kg	M	2E-11	mg/kg-day	150,000	(mg/kg-day)-1	3E-6
											Total Risk:	4E-6
											Total Risk Across all Exposure Pathways:	1E-5

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Child

Table B-2-14-CTE
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Central Tendency Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	18.1	mg/kg	--	18.1	mg/kg	M	--	--	ND	--	--
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	--	1.3	mg/kg	M	6.7E-7	mg/kg-day	0.73	(mg/kg-day)-1	5E-7
	Benzo[a]pyrene	1.0	mg/kg	--	1.0	mg/kg	M	5.2E-7	mg/kg-day	7.3	(mg/kg-day)-1	4E-6
	Benzo[b]fluoranthene	1.6	mg/kg	--	1.6	mg/kg	M	8.3E-7	mg/kg-day	0.73	(mg/kg-day)-1	6E-7
	PCDD/F TEQ[d]	0.00092	mg/kg	0.6	0.00092	mg/kg	M	2.8E-10	mg/kg-day	150,000	(mg/kg-day)-1	4E-5
											Total Risk:	5E-5
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	18.1	mg/kg	0.001	18.1	mg/kg	M	--	--	ND	--	--
	Chromium	44.9	mg/kg	--	44.9	mg/kg	M	--	--	ND	--	--
	Lead	506	mg/kg	--	506	mg/kg	M	--	--	ND	--	--
	Mercury	1.8	mg/kg	--	1.8	mg/kg	M	--	--	ND	--	--
	PAHs											
	Benz[a]anthracene	1.3	mg/kg	0.13	1.3	mg/kg	M	4.9E-7	mg/kg-day	0.73	(mg/kg-day)-1	4E-7
	Benzo[a]pyrene	1.0	mg/kg	0.13	1.0	mg/kg	M	3.8E-7	mg/kg-day	7.30	(mg/kg-day)-1	3E-6
	Benzo[b]fluoranthene	1.6	mg/kg	0.13	1.6	mg/kg	M	6.0E-7	mg/kg-day	0.73	(mg/kg-day)-1	4E-7
	PCDD/F TEQ	0.00092	mg/kg	0.03	0.00092	mg/kg	M	8.0E-11	mg/kg-day	150,000	(mg/kg-day)-1	1E-5
											Total Risk:	2E-5
											Total Risk Across all Exposure Pathways:	6E-5

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PAHs - Polycyclic aromatic hydrocarbons
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-15-CTE
Calculation of Cancer Risks
Adult Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ[d]	0.00051	mg/kg	0.6	0.00051	mg/kg	M	2.3E-13	mg/kg-day	150,000	(mg/kg-day)-1	3E-8
											Total Risk:	3E-8
Dermal	**Metals and Organometallic Compounds**											
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ	0.00051	mg/kg	0.03	0.00051	mg/kg	M	9.2E-14	mg/kg-day	150,000	(mg/kg-day)-1	1E-8
											Total Risk:	1E-8
											Total Risk Across all Exposure Pathways:	5E-8

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-16-CTE
Calculation of Cancer Risks
Child Soil and Sediment Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ[d]	0.00051	mg/kg	0.6	0.00051	mg/kg	M	1.4E-12	mg/kg-day	150,000	(mg/kg-day)-1	2E-7
											Total Risk:	2E-7
Dermal	**Metals and Organometallic Compounds**											
	Mercury	2.2	mg/kg	--	2.2	mg/kg	M	--	--	ND	--	--
	PCDD/F TEQ	0.00051	mg/kg	0.03	0.00051	mg/kg	M	4.0E-13	mg/kg-day	150,000	(mg/kg-day)-1	6E-8
											Total Risk:	6E-8
											Total Risk Across all Exposure Pathways:	3E-7

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Worker
Receptor Age: Adult

Table B-2-17-CTE
Calculation of Cancer Risks
Adult Soil Exposure: Central Tendency Worker
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion												
	PCDD/F TEQ[d]	0.000015	mg/kg	0.6	0.000015	mg/kg	M	5.6E-13	mg/kg-day	150,000	(mg/kg-day)-1	8E-8
											Total Risk:	8E-8
Dermal												
	PCDD/F TEQ	0.000015	mg/kg	0.03	0.000015	mg/kg	M	3.7E-13	mg/kg-day	150,000	(mg/kg-day)-1	6E-8
											Total Risk:	6E-8
											Total Risk Across all Exposure Pathways:	1E-7

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Daycare Area
Receptor Population: Daycare Child
Receptor Age: Child

Table B-2-18-CTE
Calculation of Cancer Risks
Child Soil Exposure: Central Tendency Daycare
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Oral or Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion												
	PCDD/F TEQ[d]	0.000015	mg/kg	0.6	0.000015	mg/kg	M	3.5E-12	mg/kg-day	150,000	(mg/kg-day)-1	5E-7
											Total Risk:	5E-7
Dermal												
	PCDD/F TEQ	0.000015	mg/kg	0.03	0.000015	mg/kg	M	9.8E-13	mg/kg-day	150,000	(mg/kg-day)-1	1E-7
											Total Risk:	1E-7
											Total Risk Across all Exposure Pathways:	7E-7

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
PCDD/Fs - Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
TEQ - Toxicity equivalents
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a).
[d] Relative bioavailaiblity estimate applied to TEQ to account for reduced absorption from soils relative to study media.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-2-19-CTE
Calculation of Cancer Risks
Adult Water Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	0.019	mg/L	--	0.019	mg/L	M	--	--	ND	--	--
	Lead	0.3	mg/L	--	0.3	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0009	mg/L	--	0.0009	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	0.019	mg/L	0.001	0.019	mg/L	M	--	--	ND	--	--
	Lead	0.3	mg/L	--	0.3	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0009	mg/L	0.001	0.0009	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
											Total Risk Across all Exposure Pathways:	0E+0

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-2-20-CTE
Calculation of Cancer Risks
Child Water Exposure: Central Tendency Visitor
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor[c]	Cancer Slope Factor Units	Cancer Risk
Ingestion	**Metals and Organometallic Compounds**											
	Cadmium	0.019	mg/L	--	0.019	mg/L	M	--	--	ND	--	--
	Lead	0.3	mg/L	--	0.3	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0009	mg/L	--	0.0009	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
Dermal	**Metals and Organometallic Compounds**											
	Cadmium	0.019	mg/L	0.001	0.019	mg/L	M	--	--	ND	--	--
	Lead	0.3	mg/L	--	0.3	mg/L	M	--	--	ND	--	--
	Mercury (total)	0.0009	mg/L	0.001	0.0009	mg/L	M	--	--	ND	--	--
											Total Risk:	0E+0
											Total Risk Across all Exposure Pathways:	0E+0

Note:

-- - not applicable
CTE - central tendency exposure
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from either EPA Integrated Risk Information System (IRIS) July (2004) or from EPA Region 9 (2003a). Toxicity values for cadmium, chromium, and mercury were adjusted to account for oral absorption in order to calculate risks for dermal exposure on the basis of absorbed doses.

Table B-2-21-CTE. Summary of total excess lifetime cancer risks for central tendency exposure scenarios

Receptor/Exposure Pathway	Cancer Risk	Percent Contribution by Pathway	Cancer Risk	Percent Contribution by Pathway	Chemicals Accounting for 90 percent of Cancer Risk for each Pathway
	Adult		**Child**		
Facility/gravesite area					
Occasional visitor scenario					
Ingestion of Surface Soil/sediment	2E-7	68%	1E-6	75%	PCDDs/PCDFs, BaP
Dermal Contact with Surface Soil/sediment	1E-7	32%	5E-7	25%	PCDDs/PCDFs
Ingestion of Surface Water	--	--	--	--	No carcinogenic CoPCs
Dermal Contact with Surface Water	--	--	--	--	No carcinogenic CoPCs
Total Cancer Risk	**3E-7**	100%	**2E-6**	100%	
Hypothetical future resident					
Ingestion of Surface Soil	8E-6	68%	5E-5	75%	PCDDs/PCDFs
Dermal Contact with Surface Soil	4E-6	32%	2E-5	25%	PCDDs/PCDFs
Total Cancer Risk	**1E-5**	100%	**6E-5**	100%	
Gravesite area					
Visitor					
Ingestion of Surface Soil	3E-8	71%	2E-7	78%	PCDDs/PCDFs
Dermal Contact with Surface Soil	1E-8	29%	6E-8	22%	PCDDs/PCDFs
Total Cancer Risk	**5E-8**	100%	**3E-7**	100%	
Daycare area					
Worker and child					
Ingestion of Surface Soil	8E-8	60%	5E-7	78%	PCDDs/PCDFs
Dermal Contact with Surface Soil	6E-8	40%	1E-7	22%	PCDDs/PCDFs
Total Cancer Risk	**1E-7**	100%	**7E-7**	100%	

Note:

CoPC - chemical of potential concern
PCDD - Polychlorinated dibenzo-*p*-dioxins
PCDF - Polychlorinated dibenzofurans

Table B-2-22-CTE. Summary of total noncancer hazard indices for central tendency scenarios

Receptor/Exposure Pathway	Hazard Index	Percent Contribution by Pathway	Hazard Index	Percent Contribution by Pathway	Chemicals Accounting for 90 percent of the Total Hazard Quotient for each Pathway
	Adult		**Child**		
Facility/gravesite area					
Occasional visitor scenario					
Ingestion of Surface Soil/sediment	0.0011	36%	0.011	69%	Cadmium, chromium
Dermal Contact with Surface Soil/sediment	0.00010	3%	0.00066	4%	Cadmium
Ingestion of Surface Water	0.00023	7%	0.0011	7%	Cadmium, chromium
Dermal Contact with Surface Water	0.0017	54%	0.0029	19%	Cadmium, chromium
Total Noncancer Risk	**0.0032**	100%	**0.015**	100%	
Hypothetical future resident					
Ingestion of Surface Soil	0.025	93%	0.23	95%	Cadmium, chromium
Dermal Contact with Surface Soil	0.0019	7%	0.012	5%	Cadmium
Total Noncancer Risk	**0.027**	100%	**0.25**	100%	
Gravesite area					
Visitor					
Ingestion of Surface Soil	0.000043	100%	0.00040	100%	Mercury, cadmium, chromium
Dermal Contact with Surface Soil	0	0%	0	0%	No noncarcinogenic CoPCs
Total Noncancer Risk	**0.000043**	100%	**0.00040**	100%	
Daycare area					
Ingestion of Surface Soil	0	0%	0	0%	No noncarcinogenic CoPCs
Dermal Contact with Surface Soil	0	0%	0	0%	No noncarcinogenic CoPCs
Total Noncancer Risk	**0**	0%	**0**	0%	

Note:
CoPC - chemical of potential concern

Appendix B-3

Uncertainty Assessment Tables

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-3-1-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Adult Soil and Sediment Exposure: Reasonable Maximum Recreational
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion														
	DRO	45000	mg/kg											
	Assumed 80% aliphatic	36000	mg/kg	--	36000	mg/kg	M	3.4E-3	mg/kg-day	1E-1	mg/kg-day	--	--	0.034
	Assumed 40% aromatic	18000	mg/kg	--	18000	mg/kg	M	1.7E-3	mg/kg-day	4E-2	mg/kg-day	--	--	0.042
	RRO	160000	mg/kg											
	Assumed 90% aliphatic	144000	mg/kg	--	144000	mg/kg	M	1.4E-2	mg/kg-day	2E+0	mg/kg-day	--	--	0.0068
	Assumed 30% aromatic	48000	mg/kg	--	48000	mg/kg	M	4.5E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.15
													Hazard Index:	0.23
Dermal	**Metals and Organometallic Compounds**													
	DRO	45000	mg/kg											
	Assumed 80% aliphatic	36000	mg/kg	0.13	36000	mg/kg	M	1.8E-3	mg/kg-day	1E-1	mg/kg-day	--	--	0.018
	Assumed 40% aromatic	18000	mg/kg	0.13	18000	mg/kg	M	8.8E-4	mg/kg-day	4E-2	mg/kg-day	--	--	0.022
	RRO	160000	mg/kg											
	Assumed 90% aliphatic	144000	mg/kg	0.13	144000	mg/kg	M	7.0E-3	mg/kg-day	2E+0	mg/kg-day	--	--	0.0035
	Assumed 30% aromatic	48000	mg/kg	0.13	48000	mg/kg	M	2.3E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.078
													Hazard Index:	0.12
													Total Hazard Index Across All Exposure Routes/Pathways:	0.35

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
RME - reasonable maximum exposure
RRO - residual range organics
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.

Scenario Timeframe: Current/Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-3-2-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Child Soil and Sediment Exposure: Reasonable Maximum Recreational
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	DRO	45000	mg/kg											
	Assumed 80% aliphatic	36000	mg/kg	--	36000	mg/kg	M	3.2E-2	mg/kg-day	1E-1	mg/kg-day	--	--	0.32
	Assumed 40% aromatic	18000	mg/kg	--	18000	mg/kg	M	1.6E-2	mg/kg-day	4E-2	mg/kg-day	--	--	0.39
	RRO	160000	mg/kg											
	Assumed 90% aliphatic	144000	mg/kg	--	144000	mg/kg	M	1.3E-1	mg/kg-day	2E+0	mg/kg-day	--	--	0.063
	Assumed 30% aromatic	48000	mg/kg	--	48000	mg/kg	M	4.2E-2	mg/kg-day	3E-2	mg/kg-day	--	--	1.4
													Hazard Index:	2.2
Dermal	**Metals and Organometallic Compounds**													
	DRO	45000	mg/kg											
	Assumed 80% aliphatic	36000	mg/kg	0.13	36000	mg/kg	M	1.1E-2	mg/kg-day	1E-1	mg/kg-day	--	--	0.11
	Assumed 40% aromatic	18000	mg/kg	0.13	18000	mg/kg	M	5.7E-3	mg/kg-day	4E-2	mg/kg-day	--	--	0.14
	RRO	160000	mg/kg											
	Assumed 90% aliphatic	144000	mg/kg	0.13	144000	mg/kg	M	4.6E-2	mg/kg-day	2E+0	mg/kg-day	--	--	0.023
	Assumed 30% aromatic	48000	mg/kg	0.13	48000	mg/kg	M	1.5E-2	mg/kg-day	3E-2	mg/kg-day	--	--	0.51
													Hazard Index:	0.79
													Total Hazard Index Across All Exposure Routes/Pathways:	3.0

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
RME - reasonable maximum exposure
RRO - residual range organics
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil
Exposure Point: Facility / Gravesite Area
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

Table B-3-3-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Adult Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	DRO	1400	mg/kg											
	Assumed 80% aliphatic	1120	mg/kg	--	1120	mg/kg	M	1.4E-3	mg/kg-day	1E-1	mg/kg-day	--	--	0.014
	Assumed 40% aromatic	560	mg/kg	--	560	mg/kg	M	7.2E-4	mg/kg-day	4E-2	mg/kg-day	--	--	0.018
	RRO	5100	mg/kg											
	Assumed 90% aliphatic	4590	mg/kg	--	4590	mg/kg	M	5.9E-3	mg/kg-day	2E+0	mg/kg-day	--	--	0.0030
	Assumed 30% aromatic	1530	mg/kg	--	1530	mg/kg	M	2.0E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.066
													Hazard Index:	0.10
Dermal	**Metals and Organometallic Compounds**													
	DRO	1400	mg/kg											
	Assumed 80% aliphatic	1120	mg/kg	0.13	1120	mg/kg	M	7.5E-4	mg/kg-day	1E-1	mg/kg-day	--	--	0.0075
	Assumed 40% aromatic	560	mg/kg	0.13	560	mg/kg	M	3.8E-4	mg/kg-day	4E-2	mg/kg-day	--	--	0.0094
	RRO	5100	mg/kg											
	Assumed 90% aliphatic	4590	mg/kg	0.13	4590	mg/kg	M	3.1E-3	mg/kg-day	2E+0	mg/kg-day	--	--	0.0015
	Assumed 30% aromatic	1530	mg/kg	0.13	1530	mg/kg	M	1.0E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.034
													Hazard Index:	0.053
													Total Hazard Index Across All Exposure Routes/Pathways:	0.15

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
RME - reasonable maximum exposure
RRO - residual range organics
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.

Scenario Timeframe: Future
Medium: Soil / Sediment
Exposure Medium: Soil / Sediment
Exposure Point: Facility / Gravesite Area
Receptor Population: Future Hypothetical Resident
Receptor Age: Child

Table B-3-4-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Child Soil and Sediment Exposure: Reasonable Maximum Hypothetical Residential
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Absorption Factor[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	**Metals and Organometallic Compounds**													
	DRO	1400	mg/kg											
	Assumed 80% aliphatic	1120	mg/kg	--	1120	mg/kg	M	1.4E-2	mg/kg-day	1E-1	mg/kg-day	--	--	0.14
	Assumed 40% aromatic	560	mg/kg	--	560	mg/kg	M	6.8E-3	mg/kg-day	4E-2	mg/kg-day	--	--	0.17
	RRO	5100	mg/kg											
	Assumed 90% aliphatic	4590	mg/kg	--	4590	mg/kg	M	5.5E-2	mg/kg-day	2E+0	mg/kg-day	--	--	0.028
	Assumed 30% aromatic	1530	mg/kg	--	1530	mg/kg	M	1.8E-2	mg/kg-day	3E-2	mg/kg-day	--	--	0.61
													Hazard Index:	0.95
Dermal	**Metals and Organometallic Compounds**													
	DRO	1400	mg/kg											
	Assumed 80% aliphatic	1120	mg/kg	0.13	1120	mg/kg	M	4.9E-3	mg/kg-day	1E-1	mg/kg-day	--	--	0.049
	Assumed 40% aromatic	560	mg/kg	0.13	560	mg/kg	M	2.5E-3	mg/kg-day	4E-2	mg/kg-day	--	--	0.061
	RRO	5100	mg/kg											
	Assumed 90% aliphatic	4590	mg/kg	0.13	4590	mg/kg	M	2.0E-2	mg/kg-day	2E+0	mg/kg-day	--	--	0.010
	Assumed 30% aromatic	1530	mg/kg	0.13	1530	mg/kg	M	6.7E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.22
													Hazard Index:	0.34
													Total Hazard Index Across All Exposure Routes/Pathways:	1.3

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
RME - reasonable maximum exposure
RRO - residual range organics
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Adult

Table B-3-5-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Adult Water Exposure: Reasonable Maximum Recreational
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
	DRO	80	mg/L											
	Assumed 80% aliphatic	64	mg/L	--	64	mg/L	M	7.2E-4	mg/kg-day	1E-1	mg/kg-day	--	--	0.0072
	Assumed 40% aromatic	32	mg/L	--	32	mg/L	M	3.6E-4	mg/kg-day	4E-2	mg/kg-day	--	--	0.0090
	RRO	220	mg/L											
	Assumed 90% aliphatic	198	mg/L	--	198	mg/L	M	2.2E-3	mg/kg-day	2E+0	mg/kg-day	--	--	0.0011
	Assumed 30% aromatic	66	mg/L	--	66	mg/L	M	7.4E-4	mg/kg-day	3E-2	mg/kg-day	--	--	0.025
													Hazard Index:	0.042
Dermal														
	DRO	80	mg/L										--	
	Assumed 80% aliphatic	64	mg/L	--	64	mg/L	M	--	--	1E-1	mg/kg-day	--	--	--
	Assumed 40% aromatic	32	mg/L	--	32	mg/L	M	--	--	4E-2	mg/kg-day	--	--	--
	RRO	220	mg/L											
	Assumed 90% aliphatic	198	mg/L	--	198	mg/L	M	--	--	2E+0	mg/kg-day	--	--	--
	Assumed 30% aromatic	66	mg/L	--	66	mg/L	M	--	--	3E-2	mg/kg-day	--	--	--
	Total Cancer Risk:												Hazard Index:	0
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.042

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
RME - reasonable maximum exposure
RRO - residual range organics
WTE - waste to energy

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Facility Wetlands / Flume
Receptor Population: Occasional Visitor
Receptor Age: Child

Table B-3-6-RME
Calculation of Noncancer Hazards for Petroleum Fractions
Child Water Exposure: Reasonable Maximum Recreational
Former WTE Facility

Exposure Route	Chemical of Concern	Medium EPC Value[a]	Medium Units	Dermal Permeability Constant[b]	Route EPC	Route EPC Units	EPC Applied	Intake (Non-cancer)	Intake (Non-cancer) Units	Reference Dose[c]	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	DRO	80	mg/L											
	Assumed 80% aliphatic	64	mg/L	--	64	mg/L	M	3.4E-3	mg/kg-day	1E-1	mg/kg-day	--	--	0.034
	Assumed 40% aromatic	32	mg/L	--	32	mg/L	M	1.7E-3	mg/kg-day	4E-2	mg/kg-day	--	--	0.042
	RRO	220	mg/L											
	Assumed 90% aliphatic	198	mg/L	--	198	mg/L	M	1.0E-2	mg/kg-day	2E+0	mg/kg-day	--	--	0.0052
	Assumed 30% aromatic	66	mg/L	--	66	mg/L	M	3.5E-3	mg/kg-day	3E-2	mg/kg-day	--	--	0.12
													Hazard Index:	0.20
Dermal	DRO	80	mg/L											
	Assumed 80% aliphatic	64	mg/L	--	64	mg/L	M	--	--	1E-1	mg/kg-day	--	--	--
	Assumed 40% aromatic	32	mg/L	--	32	mg/L	M	--	--	4E-2	mg/kg-day	--	--	--
	RRO	220	mg/L											
	Assumed 90% aliphatic	198	mg/L	--	198	mg/L	M	--	--	2E+0	mg/kg-day	--	--	--
	Assumed 30% aromatic	66	mg/L	--	66	mg/L	M	--	--	3E-2	mg/kg-day	--	--	--
	Total Cancer Risk:												Hazard Index:	0
	Total Hazard Index:								Total Hazard Index Across All Exposure Routes/Pathways:					0.20

Note:

-- - not applicable
DRO - diesel range organics
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
M - medium-specific
ND - not determined (EPA)/not considered a carcinogen
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[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.
[b] Sources for dermal absorption values are provided in Table 3-5.
[c] Toxicity values obtained from ADEC.