Response to ADEC September 2005 Comments on the April 2005 Draft Fugitive Dust Human Health Risk Assessment

Comment No	Page	Section	Topic/ Importance	ADEC Comment	Response	DEC Remarks
HH-1	General	General Comment	General/High	We verbally requested that the implications of the findings of the Hasselbach et al. (2004) study be included in this risk assessment. Hasselbach et al. (2004) had evidence that dust from the transport system was traveling as far 25 km north of the road. Lead levels in moss were still elevated over background at this distance. It is important that this risk assessment integrate these findings. It should discuss whether animals eat the moss, especially during the winter or other times when food sources are scarce, and what the implications are for both human and ecological health. This study also has implications for the reference sample locations selected for the Phase II field sampling plan. It appears that the marine sediment samples taken during the Phase II field sampling event may possibly be impacted from fugitive dust based on the contaminant prediction maps presented in Hasselbach *et al.* (2004). The reference area for terrestrial assessment is located on the south side of the road. This reference location may still be appropriate but should be verified.	Moss data from the Hasselbach studies are already used in the ERA food web modeling as part of the diet for wildlife receptors. Additional discussion of the Hasselbach data has also been added in Section 1 describing nature and extent of fugitive dust deposition, and in Section 5 discussing the implications of the moss data on assumptions about exposure concentrations over the site area for the HHRA. Wildlife subsistence foods data (e.g., caribou) already integrate exposures from all sources, including the portion of moss in their diet. Implications for the reference areas used in the risk assessment are added to the uncertainty discussions in Sections 5 and 6. For text changes and additions to Sections 1, 5, and 6 pertaining to this comment, please refer to the response to comment NPS-1 in the previously submitted response to National Park Service comments.	Response is acceptable.
HH-2	xx	Executive summary	General/ Moderate	In the executive summary it notes that NANA Regional Corporation (NANA) and Alaska Industrial Development and Export Authority (AIDEA) commented on the January 2003 workplan. DEC is unaware of comments by these two organizations. Please provide their comments on the workplan.	NANA and AIDEA reviewed the document, but did not provide any written comments. The executive summary text was intended to reflect their involvement in the process. The text has been clarified.	Response is acceptable.
HH-3	2-4 to 2-5	2.2	Policy/ Moderate	It should be clarified in this section that dust coming directly from trucks or port loading facilities has a larger percentage of particles smaller than 1 micron than does dirt sampled near the road. Air pollution that occurs as part of ongoing mine operations is not regulated by the Contaminated Sites program. However it would be useful to include a discussion of current levels of dust detected in air monitors to address public health concerns.	Additional text was added to Section 2.1.1 further describing the concentrates. Additional text was also added to Section 2.2 broadly describing differences in concentrate presence in various dust sources, and text was added to Section 2.3.3.1.2 describing the relevance of this information to exposures. Teck Cominco has monitored air concentrations of lead in the villages, and these results are discussed in Section 2.3.2.3. Demonstration of compliance with national ambient air quality standards (NAAQS) through both modeling and monitoring of air concentrations relative to the ambient air boundaries are also discussed in Section 2.3.2.3.	Response is acceptable.
HH-4	2-7	2.2.4	Policy/ Moderate	This section generally describes control implemented by Teck Cominco to reduce fugitive dust and thereby risk to human health and the environment. To assist the reader in understanding the specific controls implemented this should describe in greater detail the specific controls that have been implemented. Although this section refers the reader to the background document, Teck Cominco has implemented more controls since the background document was written. DEC suggests detailed information about engineering and other controls be included as part of this section or as an appendix to the report.	Appendix L has been added, providing detailed lists of dust control improvements made in the port and road operations.	Response is acceptable.

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HH-5	2-12	2.3.2.3	Technical/ Moderate	The draft report states that surface water will be evaluated for streams that flow into the Wulik river that provide drinking water for the Kivalina residents. Please modify this section and other later sections in the report, such as Section 3.2.2. to address comments raised by resident in Kivalina during the April 20, 2005 meetings that other surface water bodies near the port, such as Umayutsiak Creek, are used for drinking water by humans or terrestrial animals. The report should also address other creeks that are potentially impacted by fugitive dust and could be used for drinking water by subsistence users or terrestrial animals that cross the DMTS such as those in Cape Krusenstren National Monument. Figures provided in the report generally detail the Wulik drainage and creeks immediately to the north of the port area. No detailed figure is provided that shows the creeks with names to the south of the port. This would give the reader a better perspective on the area that is potentially affected.	The language in this section, and related language in Section 2.3.3.2, has been modified. Water data used in the human health risk assessment were from creeks that cross the haul road. These data are expected to reflect surface water that is potentially the most affected by dust or runoff from the DMTS. As a result, use of these data in the assessment is also expected to be protective of subsistence use of other water sources elsewhere in the surrounding area, including water from the Umayutsiak Creek south of the port. Additional creeks and place names south of the port have been added to Figure 1-2.	Response is acceptable.
HH-6	2-19	2.4.1	Technical/ Moderate	Please rephrase this section. It states that with the exception of Evaingiknuk Creek drainage basin, all the streams crossed by the DMTS road drain to the Wulik River. New Heart Creek and the Omikviorok River and its tributaries flow either directly into the Chukchi Sea or coastal lagoons. This section should include a discussion of river systems that discharge directly to the Chukchi Sea and may be impacted by fugitive dust.	Section 2.4.1 has been modified to clarify the language in question.	Response is acceptable.
HH-7	5-1	5.1 and Figure 5-1	Technical/ Medium	The revised conceptual site model (CSM), Figure 5-1, is the same CSM provided in the RAWP prior to incorporating the comments on compounds of potential concern (COPC) screening protocol. Figure 5-1 should be updated to include quantitative evaluation of freshwater environments, as stated in Section 5.1. Specifically, surface water ingestion by residents and biota ingestion by subsistence users and the combined worker/ subsistence user scenarios should be primary exposure pathways. These pathways were quantitatively evaluated in the risk assessment.	The errors in Figure 5-1 have been corrected.	Response is acceptable.
HH-8	5-3	5.2.1.1	Technical/ High	ADEC would prefer to also see the soil EPC presented without weighting, because it assumes that the time spent near the port is determined by surface area relative to the area along the road. There is no known evidence to support this assumption. Concern over berry harvesting in the port area remains an important issue to the residents of Kivalina. It is feasible that the time they spend near the port is comparable to the time they spend near the haul road. To allow comparison, a simpler non-weighted EPC should also be presented in the main text.	As agreed upon in recent discussions with DEC, two sets of risk estimates are now presented in the main text and tables of the HHRA: 1) Based on area weighting of soil concentrations, as was previously done, and 2) Based on an average of the port EPCs and the road EPCs, without area weighting.	Response is acceptable.

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HH-9	5-4	5.2.1.2.3	Technical/ Medium	Please explain why the data from ptarmigan collected in the reference area is not used in the risk assessment. This data appears to be used when determining COPCs in ptarmigan and caribou. Specifically, thallium in ptarmigan and caribou were eliminated as COPCs based on comparison of ptarmigan site samples to reference samples.	As with berries and sourdock (the other subsistence foods collected at both site and reference locations), only the site data were used to calculate risks. This is a more conservative approach. Thallium was eliminated because it was only rarely detected in site ptarmigan tissue (0 of 5 muscle, 1 of 5 liver, and 2 of 5 kidney samples) and the few detected values were at concentrations near or below reference concentrations. Data from ptarmigan were not used to calculate risks in the risk assessment, and therefore the following revisions were made to Section 5.2.1.2.3: *Five ptarmigan were collected from near the DMTS road in summer 2004, as described in the Summary of Phase II Sampling Program for the DMTS Fugitive Dust Risk Assessment (Appendix E) and shown in Figure 5-2. Muscle, liver, and kidney tissue were analyzed for antimony, barium, cadmium, lead, thallium, and zinc concentrations. Data from the three ptarmigan collected in the reference area were not used to calculate risks in the risk assessment. More detailed information on sampling locations and data analysis is presented in Assessment of Metals in Ptarmigan Collected near the DMTS (Exponent 2005), which is included in Appendix H. Ptarmigan tissue analytical data used in the risk assessment are presented in Appendix G, Table G-27. Reference area ptarmigan data are presented in Appendix G, Table G-28.*	Response is acceptable.
HH-10	5-4	5.2.1.2.4	Policy/ High	The executive summary states that the area within the port is included in the risk assessment. This is not consistent with eliminating berry samples taken at the port facility. Additional rationale should be provided in the risk assessment for eliminating some berry samples. The statement in section 8.1.3 that "…risks are not elevated even when data from restricted areas are included…" is an overstatement if data from the port area is excluded. Moreover the restriction of berry gathering in this area does not mean it never occurs. Since the intention of the risk assessment is to include the port area, all samples taken near the port should be included in the assessment.	To be conservative, berry samples from offsite stations were not included in the assessment. Appendix tables presenting berry and sourdock data have been clarified with respect to onsite (included) versus offsite (excluded) data. All site-related berry samples were included in the assessment, with the exception of samples collected at a station directly next to the fuel storage tanks. These samples were originally excluded because they were collected next to a facility unit, rather than in harvestable tundra areas. However, for the sake of clarity, the berries collected next to the fuel storage tanks are now included in the assessment along with all of the other site-related berry samples. The text in Section 5.2.1.2.4 has been revised to reflect this change, and Figure 5-2 and Table G-25 have also been revised accordingly.	Response is acceptable.

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HH-11	5-5	5.2.1.2.6.1 and Table 5-3	Technical/ High	Because data on thallium in fish was not available, it was agreed upon in the response to the RAWP comments that thallium will be estimated in fish based on the relationship between thallium and lead concentrations in surface water. This assumes uptake and bioaccumulation of both compounds occurs at the same rate. Data supporting this assumption should be provided in the main text of the risk assessment. Some supporting data is provided in the uncertainty section. Please provide a rationale for why the ratio of thallium to lead was determined based on the mean concentrations versus the upper confidence limit (UCL) or the maximum concentration. If the ratio were determined based on the UCL the thallium concentration in fish would be estimated as 0.004 mg/kg-wet versus 0.0027 mg/kg-wet based on the mean comparison.	Additional supporting information has been added to the main text. There is no specific rationale for selecting the mean or the UCL concentrations to calculate the thallium to lead ratio, and neither is inherently superior. However, a consistent approach should be applied for all similar estimates. Mean concentrations were also used to calculate barium concentrations in caribou based on the ratio of barium to other metals in ptarmigan. For ptarmigan metals there were too few samples (n=5) to determine a distribution and calculate a UCL, based on U.S. EPA (2002b) guidance. Thus, mean concentrations were the best, and only, choice. To maintain consistency in approach, mean concentrations were also used to calculate the thallium to lead ratio for water. In this particular case, use of UCLs would provide a slightly more conservative estimate, but the impact on risk estimates would be negligible.	Response is acceptable.
HH-12	5-5	5.2.1.2.6.2 and Table 5-4	Technical/ High	Barium concentrations in caribou tissue were estimated similar to the method described in the comment above. This general approach was agreed upon in the response to the RAWP comments. Please address the comments above regarding bioaccumulation, uptake, and mean comparisons for the estimation of caribou tissue concentrations. These issues are especially of concern since tissue concentrations are being estimated between species. Some discussion is provided in the uncertainty section but this should be expanded and provided in the main text of the risk assessment. Section 5.2.1.2.3 indicates that the ptarmigan samples taken from the reference area are not used in this risk assessment. Therefore, the comparison of ptarmigan thallium tissue concentrations at the site to reference concentrations should not be conducted and thallium should be included as a COPC in both ptarmigan and caribou. Please include thallium as a COPC or show why the ptarmigan site-samples should be compared to the reference samples in the risk assessment.	Additional supporting information has been added to the main text. Regarding use of the mean rather than UCL concentrations to calculate ratios, see the response to comment 5-4. Thallium was not detected in any ptarmigan muscle sample, so it should not be considered a CoPC for either ptarmigan or caribou muscle tissue. Thallium was detected in only one site liver sample at a concentration below any reference sample. It was detected in only two of five kidney samples, at concentrations near or below the reference concentrations. Concentrations at or below reference imply that the site has no impact on ptarmigan thallium levels. Moreover, calculation of ratios of barium to other metals based almost exclusively on non-detects would be biologically meaningless. On a practical level, muscle tissue is assumed to comprise 91 and 96 percent of the subsistence consumption of ptarmigan and caribou, respectively. Therefore, any minor contribution of liver and kidney thallium to overall risks would be negligible. Finally, the purpose of the risk assessment is to provide an estimate of additional, site-related risk, not an estimate of risks associated with background. Thallium can only be described as a very minor contributor to site risks, at best, as borne out by the results of the risk assessment where thallium was included as a CoPC. Thus, inclusion of thallium when it is not detected, at background, or below background is both inconsistent with the	Response is acceptable.

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					purpose of the risk assessment and without practical impact on the results. Please refer to comment HH-9 for revisions to Section 5.2.1.2.3 regarding ptarmigan, which were used in the risk assessment, but not to calculate risks.	
HH-13	5-6	5.2.1.2.7	Technical/ Moderate	Weighting of edible tissue introduces the following concerns: -It assumes that eating habits reflect weight proportions. This may not always be the case for at least certain segments of the population. The goal of any risk assessment should be to protect those with higher than average exposure. -It is unclear if the weight percentages are the percent of the edible tissue of the caribou or the total weight -A grouse can reach a weigh of up to 3-1/2 pounds, whereas a ptarmigan's upper weight limit is 1-1/2 (ADF&G). Combining these two birds to estimate weight percentages of certain organs is going to result in inaccuracies. Please verify that the kidney and liver weight percentages used in the risk assessment are based on edible tissue and not an overall caribou weight.	It is true that the edible tissue weighting assumes eating habits, on average, reflect weight proportions. It is also true that a risk assessment, while still being based on realistic exposure assumptions, should be protective of sensitive populations; sensitive because of higher than average exposure, higher than average susceptibility, or both. There are a number of areas where, because of uncertainty, exposure assumptions were used that tend to overestimate actual exposure. For example, subsistence food consumption rates were based on the assumption that subsistence foods are the only foods eaten. This has the effect of inflating the estimated metals intake from subsistence foods. Although some individuals may eat a larger proportion of caribou liver, for example, this is compensated for by the consumption rate overestimate, as well as other conservative assumptions in the risk assessment. The weight percentages for caribou are based on edible tissue only. Although there may be size differences between sage grouse and ptarmigan, the sage grouse size data provide the best available data for liver and edible muscle weight. It is possible that ptarmigan liver and muscle weight may be smaller than that of the sage grouse, which would result in an underestimation of the contribution of kidney. However, as noted in Section 5.2.1.2.7, the total muscle edible tissue weight is also underrepresented because Remington and Braun (1988) only report breast and wing tissue weight.	Response is acceptable.

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HH-14	5-6 to 5-7	5.2.2.1 and Table 5-6	Technical/ High	Provide a reference for the lead diet intake value. The source is listed as "update to EPA default". This should be referenced and supported. The Environmental Protection Agency (EPA) does not recommend a quantitative adjustment of the soil/dust ingested daily variable unless significant data is available to support the adjustment (see excerpt from EPA 1999, below). Please use the EPA default values for this variable. Please confirm that the alternate source, subsistence food variable is set at 1.6 µg/day for all age groups. EPA, December 1999, *Short Sheet: IEUBK Model Soil/Dust Ingestion Rates*, OSWER, Washington, D.C., OSWER 9285.7-33; EPA 540-F-00-007. **Substitution of Default Values of Ingestion Rates: Technical Considerations** The IEUBK model default values for the rate of soil/dust ingestion do not reflect differences associated with variables that may affect ingestion rates at different sites. Examples of such variables include ground cover, climate, activity patterns, and behavior. While inclusion of such information in a risk assessment is desirable, often such data are not available to support quantitative adjustment of ingestion rates in the IEUBK model. Recognizing the technical difficulties of interpreting soil and dust ingestion studies, the *Administrative Reform for Lead Risk Assessment* specified that adjustments to the IEUBK model default ingestion rates be performed only after OERR recommends such a change. The process for obtaining a recommendation is to submit all information pertaining to the ingestion study to OERR for review by the TRW. The results of the TRW review will be sent to the requestor, and, if any improvement in the soil and dust ingestion estimate is warranted, will be incorporated into guidance and shared among other EPA Regions. This process promotes the sharing of data and consistency in lead risk assessments.	The updated dietary intake data recommended by U.S. EPA can be accessed through the "Help" function of the IEUBK lead model: Under the "Help" function, search for "dietary data," and click on the link to "FAQ on the TRW website." Under the "Miscellaneous" category, there is an FAQ titled "Newer lead in food data are available from the Food and Drug Administration (FDA) total diet study. How can I use these data in my risk assessment?" The updated dietary data are available in the response to that FAQ. The FAQ can also be accessed directly at: http://www.epa.gov/superfund/programs/lead/ieubkfaq.htm. As requested, the risk assessment has been modified so that the fractional intake (FI) is no longer applied to the soil ingestion rate, and the model default soil ingestion rates are used. Instead, as recommended by U.S. EPA (2003) guidance, the FI was applied to the soil concentration. The subsistence food lead intake was set at 1.6 µg/day for all age groups when running the IEUBK model. New Reference: *U.S. EPA. 2003. Assessing intermittent or variable exposures at lead sites. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., OSWER 9285.7-76; EPA 540-R-03-008.*	Response is acceptable.
HH-15	5-9	5.2.2.2 and Table 5-10	Editorial/Low	Section 5.2.2.2 indicates that, "Because adults could potentially have a greater exposure to COPCs in subsistence foods than children, adults were also evaluated for exposure to non-lead COPCs." Table 5-10 and 5.2.2.2.3 show that exposure to non-lead chemicals in subsistence foods were evaluated for both adults and children, which is appropriate. Please clarify the text in Section 5.2.2.2.	The text has been modified to clarify the issue.	Response is acceptable.
HH-16	5-11	5.2.2.2.2	Editorial/Low	The chemical concentration in water should be expressed in µg/L, not mg/kg as stated in the text. The units shown in Table 5-1 and the water intake equation are in µg/L.	The typographical error has been corrected.	Response is acceptable.

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HH-17	5-12	5.2.2.2.3	Technical & Editorial/ Moderate	It seems appropriate to apply the same 5 km downwind and 2 km upwind boundary around the port, please clarify if this was done. (Figure 5-3 makes it appear as though this is not the case)	The same 5-km downwind and 2-km upwind boundary was applied around the port, road, and mine. At the port, it was applied from the port facilities, rather than from the port ambient air boundary.	Response is acceptable.
HH-18	5-12	5.2.2.2.3	Technical/ High	ADEC has some concerns about the data used to derive the FI. By using a ratio of the area of the site within the subsistence use area compared to the total Kivalina subsistence use area assumes that harvesting and hunting occur equally throughout the area. The information provided does not support the FI used for caribou and fish. Site-specific information should be provided to support the use of 0.09 as the FI for these species.	In response to the comment, Section 5.4.3.7 (Fractional Intake) was updated as follows: *The fractional intake from the site is an area of uncertainty. Fractional intake is intended to account for the fraction of total media exposure (soil, water, berries, sourdock, and ptarmigan) that occurs at the site.* *For stationary subsistence foods (i.e., berry and sourdock) and foods with a small home range (i.e., ptarmigan) the FI represents the fraction of that food type collected from the site relative to all areas where it is collected. It is true that harvesting can only occur where the food item is available, and not evenly throughout the subsistence harvest area. However, in the absence of data to the contrary, it is a reasonable assumption that a person would be equally likely to harvest a given food on a similarly sized area off the site as on the site. As an example, berries do not grow evenly throughout the site. However, the proportion of the "site" harvest area covered by berries can reasonably be assumed to be similar to the proportion of the "non-site" harvest area covered by berries. And if a person is equally likely to harvest from each of the berry harvesting areas, an FI based just on berry-harvesting areas would be the same as the FI that was calculated based on the entire harvest use area. And a person may, in fact, be more likely to use a berry harvesting area nearer to home, which would be offsite, than one onsite that is further away (and off limits). Thus, it is likely that the FI, as calculated, overestimates fractional intake from the site.* *For subsistence food animals with large home ranges (e.g., caribou and fish), FI is intended to account for the fraction of the animal's life that is spent at the site, and thus the fraction of metal content in the animal that is theoretically attributable to the site. As with the plant foods and ptarmigan, it is based on the area of the site relative to the total area of subsistence harvest. For caribou and fish, the metals concentrations in those animals already integrate the animals' exposure over their entire home range. But only a fraction of the metals detected in these animals would have been derived from site exposure. Given that there appears to be no significant difference in metals concentrations in site caribou relative to caribou from elsewhere in Alaska (Appendix H), it can be inferred that site caribou do not appear to have been exposed to greater amounts of metals at the site than elsewhere in their home range. Thus, the fraction*	Response is acceptable.

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					of metals detected in those caribou that could be attributed to site exposure can be estimated by the fraction of time spent at the site relative to elsewhere in their home range, which can in turn be estimated by the fraction of the area of the site relative to their entire home range. In fact, the home ranges for both caribou and fish are far larger than the subsistence harvest areas for Kivalina or Noatak. Subsistence use over a larger area would reduce the FI related to the site because it would increase the denominator (i.e., the total area used for subsistence harvesting and hunting), without affecting the numerator (i.e., the portion of subsistence use area on the site) in the FI calculation. A lower FI would result in lower risk estimates. Thus, the FI likely greatly overestimates the fraction of metals in these animals that is attributable to the site. In addition, the results of the caribou metals evaluation (Appendix H) suggest that metals concentrations in caribou harvested at the site are not elevated relative to background. If that were indeed the case, any risk estimate based on caribou metals concentrations, regardless of the FI applied, would be an overestimate of site-related risks. In addition, at the request of DEC, risks were also calculated using an alternative caribou fractional intake of 0.2. The following paragraph was added to the end of Section 5.2.2.2.3 (Subsistence Food): *An additional set of risk estimates was calculated using an alternative caribou FI of 0.2 because of the uncertainty surrounding the amount of impact site metals might have on caribou metals concentrations, and because of the unique role of caribou in the diet and culture of people from the region. At the request of DEC, this alternative value was calculated using the area reported to have cadmium levels elevated above background by Hasselbach et. al. (2005) as the site harvest area.*	
HH-19	5-16	5.2.2.3 (also Table 5-11, Table 5-8)	Technical/ Moderate	Table 5-11 incorrectly highlights caribou mean per capita consumption, which causes confusion regarding what consumption rate is used in the risk calculations	The typographical error has been corrected.	Response is acceptable.

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HH-20	5-16	5.2.3.1 and Table 5-13	Technical/ Medium	The equation presented on page 5-17 to calculate the geometric mean blood lead level for adults does not incorporate the soil ingestion rate or fractional intake from soil that is specific to subsistence activities and activities while working. The equation should be adjusted to account for IR_{S_w}, IR_{S_s}, FI_{S_w}, and FI_{S_s}. Currently these variables are not incorporated into the equation. It is unclear if the equation on page 5-18, accounting for ingestion of lead from additional sources (i.e. subsistence foods), is correct. Daily lead intake from subsistence foods IR_f is presented in g/day units. This variable takes into account both ingestion rate and tissue concentration. This variable should be expressed in µg/d to ensure the units for the equation are correct. In addition, using the variable IR for both ingestion rate and daily intake is confusing. The ingestion rate does not incorporate the media concentration yet the daily intake variable does. These issues should be checked and the equation verified. The units in both the text and the table need to be adjusted. Please note that the daily lead intake from subsistence food for the adult lead model should be the value calculated in Table 5-14 for adults, not Table 5-8 which calculates intake for children. The value presented in Table 5-13 is the correct value for adults but the units are incorrect. The value for IR_f is 3.2 µg/day not 3.2 g/day, as shown in Table 5-13. The equations and input parameters should be checked and the results recalculated. The reviewer calculated the geometric blood lead level for the fetus and the probability of exceeding the EPA goal of 10 µg/dL for the 12% lead bioavailability scenario using equations incorporating the changes above and replicated the results shown in Section 5.4.2.1. Therefore, it appears the correct parameters and equations were used. This should be verified and the text of the risk assessment and Table 5-13 should be corrected.	The general equation and text presented in Section 5.2.3.1 have been supplemented with additional text and a more specific equation that represents the actual algorithm used in the risk assessment, including IR_{S_w}, IR_{S_s}, FI_{S_w}, and FI_{S_s}. Text, equations, and units in Section 5.2.3.1 and Tables 5-13 and 5-17 have been modified for more clarity and to reflect the actual algorithm and exposure assumptions used in the risk assessment. These tables, as part of a complete set of revised tables for the HHRA, are attached to this comment response document.	Response is acceptable.
HH-21	5-19 to 5-20	5.2.3.1.4 (see also Table 5-7)	Technical & Policy/ Moderate	In our comments on the 2004 work plan, ADEC requested that a discussion of the uncertainties associated with using the lead bioavailability derived from the Arnold and Middaugh studies be included in the risk assessment. We were unable to locate this discussion. The uncertainty associated with the Arnold and Middaugh value should be noted in the main text (Section 5.2.3.1.4) with a more thorough discussion included in the uncertainty section.	There is some degree of uncertainty with regard to soil lead bioavailability at the site. To address this uncertainty, the risk assessment presents results using both EPA default bioavailability values and site-specific bioavailability values (as determined by the NTP rat study). The following text has been added to Section 5.2.2.1.2 of the risk assessment: *There are two areas of uncertainty associated with the use of the NTP study results in the risk assessment. First, the NTP bioavailability study was conducted on Red Dog ore. After weathering, the lead in site soils may become more or less bioavailable. It should be noted, however, that many of the*	Response is acceptable.

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					geochemical forms of lead that would most likely be formed from oxidation of lead sulfide in the environment (e.g., lead sulfites, lead sulfates, and lead oxides) are also considered by U.S. EPA (1999b) to have less than default bioavailability. Second, the NTP study used rats, whereas juvenile swine are the preferred animal model for development of site-specific bioavailability values (U.S. EPA 1999b). These issues are further discussed in the uncertainty assessment (Section 5.4.3), and addressed in the DMTS risk assessment by evaluating risks using both the IEUBK model default absolute bioavailability of 30 percent and the site-specific value of 9.7 percent. In addition, text was added to the uncertainty section. The following addition at the beginning of Section 5.4.3.3 addresses the fact that the NTP studies were performed using Red Dog ore, not surface soil: *When the ore concentrate particles, primarily galena, are exposed to air and water in the environment over time, the surfaces of these particles could become more oxidized. Increased oxidation could, in turn, increase solubility, which could be associated with increased bioavailability (Brown et. al. 1999). With environmental weathering, the lead in site soils may become more or less bioavailable in the environment. While there are no data available on the bioavailability of soil lead along the DMTS corridor, USGS (2003) has reported on the mineralogy of lead in Red Dog ore concentrate, port soil, Ikalukrok Creek alluvium, and colluvial samples from deposits in the area. Scanning electron microscopy shows that galena particles in port soil exhibit morphology similar to ore galena particles: well-developed cubic cleavage with smooth faces. This is in contrast to galena particles from stream alluvium, which are rounded from physical/mechanical processes, and from colluvial samples, which are etched and rounded. It is noteworthy that neither the soil nor the alluvial galena particles are etched, indicating less oxidation than in colluvial samples, which could be related to a lack of acidic conditions. In any case, it should be noted that many of the geochemical forms of lead that would most likely be formed from oxidation of lead sulfide in the environment (e.g., lead sulfites, lead sulfates, and lead oxides) are also considered by U.S. EPA (1999b) to have less than default bioavailability. Thus, the approach used in the risk assessment of estimating risks based on both the IEUBK model default absolute bioavailability of 30 percent and the site-specific value of 9.7 percent should adequately address this area of uncertainty.* *The second area of uncertainty associated with the NTP study is the animal model used. Juvenile swine are the preferred animal*	

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					model for development of site-specific bioavailability values (U.S. EPA 1999b). However, the NTP study used rats. This area of uncertainty is somewhat mitigated by the fact that the results are based on relative, not absolute bioavailability. Specifically, the data resulting from the NTP study provide an estimate of the bioavailability of concentrate ore lead relative to soluble lead acetate. The resulting relative bioavailability is then applied to the EPA default value for absolute bioavailability of soluble lead acetate. Although there may be differences in absolute lead bioavailability between animal species related to differences in their respective digestive systems, the differences in relative bioavailability of lead from two sources should be less. This is because much of lead bioavailability is related to its ability to go into solution (i.e., solubility); the higher the solubility, the greater the bioavailability. This is the basis of the in vitro bioaccessibility test used to estimate bioavailability. Lead bioaccessibility testing measures the potential of lead from a test source to go into solution, relative to lead acetate, under acidic and basic conditions designed to mimic the gastrointestinal system. The results of this test provide a surrogate for relative bioavailability. In a similar way, the NTP study should provide a reasonable estimate of the solubility, and thus the bioavailability, of lead from Red Dog ore relative to lead acetate.	
HH-22	5-22	5.2.3.2 and Table 5-15	Editorial/ Medium	The equations presented for soil intake in Section 5.2.3.2.1 and Table 5-15 are not consistent. Intake should be a cumulative intake from intake during work and intake during the time engaging in subsistence activities. The equation in the table is correct; the text should be changed to match the table. Please define all variables, especially the IR and FI with S_W and S_S subscripts. The FI in the water ingestion equation in Table 5-15 should be FI_{WW} not FI_{WF}, as shown.	The general equation in the text has been modified to show the specific equation used to calculate dose from soil ingestion. All variables are now defined in the text when they are first called out in an equation. FI_{WW} is now correctly identified in the equation in Table 5-15.	Response is acceptable.
HH-23	5-33	5.4.3	Technical/ High	It appears that some major areas of uncertainty were not addressed in the uncertainty section. For example, some discussion is needed regarding the limited data set used to derive site-specific lead bioavailability values. In addition, the uncertainty associated with weighted EPCs should be discussed, not just in relation to lead modeling. The limitations of the Alaska Division of Public Health (ADPH) 2005 report are under represented in Section 5.4.3.3. The sample size for this study was extremely small and therefore the reviewer is not comfortable with the general conclusions made on page 5-37. The statement made in Section 5.4.3.2.1 regarding children not being present at the site should be substantiated.	Additional discussion of site-specific lead bioavailability (see response to HH-21) and weighted EPCs has been added to the uncertainty section. The small sample size of ADPH (2005) does limit specific conclusions based on that study. However, the results of that study are consistent with certain observations regarding the risk assessment. The points listed at the end of this section were meant to identify these areas of consistency. The second paragraph of the uncertainty section in Section 5.4.3.4 of the risk assessment has been revised to address limitations in the blood lead studies as follows: *None of the 58 individuals had a blood lead level exceeding 10 µg/dL. Among the Kivalina participants, the geometric mean*	Response is acceptable.

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					blood lead among individuals over 18 years of age was 1.1 µg/dL, with individual blood lead levels ranging from less than 1 up to 7 µg/dL. Among Noatak residents, the geometric mean blood lead among individuals over 18 years of age was 1.7 µg/dL, with individual blood lead levels also ranging from less than 1 up to 7 µg/dL. It is noteworthy that the geometric mean values in both Kivalina and Noatak are less than or equal to the geometric mean for adult women estimated by the ALM for this risk assessment. As shown in Table 5-17, the ALM predicted geometric means of 1.9 µg/dL and 1.7 µg/dL for the 30 percent and 9.7 percent bioavailability scenarios, respectively. Blood cadmium levels were similarly low. In addition, the last paragraph of the section prior to the numbered bullets was revised as follows: *Although interpretation of the results of the 2004 blood lead survey from a population level standpoint is limited by the small numbers of participants and the lack of data for small children (0-6 years old), the survey data are consistent with the following observations:* The text regarding children not being present at the site in Section 5.4.3.2.1 has been removed and the remainder of the section has been modified to focus on soil ingestion fractional intake because we are no longer modifying the soil ingestion rate (see response to comment HH-14).	
HH-24	5-39	5.4.3.5	Technical/ Low	The text states that none of the COPCs have the same target organ. This is inconsistent with the data provided in Table 5-16. Both barium and cadmium target the kidney. Although no adverse effects were determined in the study presented in IRIS for barium, additional investigation and supporting documentation would be needed to eliminate the kidney as a potential target organ for barium.	In July of 2005 (following the submittal of the Draft DMTS Risk Assessment), EPA updated its IRIS file for barium. The RfD for barium is now based on a study showing kidney effects in mice after 2 years of exposure to barium in drinking water. The new RfD is 0.2 mg/kg-day, compared to old RfD of 0.07 mg/kg-day. The risk assessment has been revised to incorporate the new barium RfD, including elimination of the text to which comment HH-24 refers.	Response is acceptable.
HH-25	5-40	5.4.3.7	Technical/ Medium	Not all references indicated in this section are provided in Appendix H. Garry et al, 2004 is not provided and there is no corresponding reference in Section 9 for Exponent 2004e. The reviewer assumed Exponent 2004e is the technical memo provided in Appendix H dated April 7, 2005. This should be verified. The comment that muscle lead concentration in area caribou do not appear to differ from those found in the U.S. meat supply (Section 5.4.3.7.1) should be referenced and supported or eliminated from the uncertainty discussion. This information is not provided in the report provided in Appendix H.	The text has been clarified so that it does not appear to imply that Garry et al (2004) is included in Appendix H. Garry et al (2004) was a poster presentation at a Society of Toxicology meeting, which contained the same information that the technical memo in Appendix H contains. The berry and sourdock analysis presented in that memo should have been referenced as Exponent (2004d), not Exponent (2004e). This has been corrected. The appropriate reference (ATSDR 1999) regarding lead in the U.S. meat supply has been added to the text in the uncertainty section. This is the same reference cited in the last paragraph of the caribou technical memo (Exponent 2002e) provided in Appendix H.	Response is acceptable.

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				When discussing general conclusions from the studies in Appendix H in relation to the risk assessment uncertainty, some discussion should also be provided regarding the limitations of each study. For instance, discussion should be provided regarding the small samples sizes and adequacy of reference locations.	Additional text has been added to the uncertainty section that identifies limitations of the studies included in Appendix H. For caribou (Section 5.4.3.10.1), the following text was added: *The primary limitation in this study was the lack of access to data for individual animals for the 1996 study groups from Red Dog and elsewhere in Northern Alaska. Although the comparisons made using means and standard deviations consistently indicate a lack of difference between Red Dog and other areas, a statistical comparison using individual sample concentrations would further clarify this area of uncertainty.* For salmonberry and sourdock (Section 5.4.3.10.2), the following text was added: *The primary area of uncertainty in the salmonberry and sourdock subsistence food study is the potential variation in metals concentrations based on the temporal proximity of sampling and rainfall. It is possible that a rain event just prior to sampling could wash off dust that otherwise might have been included in the analyses, thereby potentially decreasing the detected metals concentrations. This uncertainty can be further evaluated in future sampling events as part of an ongoing monitoring program.* For ptarmigan (Section 5.4.3.10.3), the following text was added: *The primary limitation of the ptarmigan study is small sample size. In particular, only three animals were captured in the reference area. This limits the strength of the conclusions that can be drawn on the basis of the ptarmigan data alone.*	
HH-26	7-2	7.3	Technical/ Medium	Action levels were not calculated at this time. The text states that this is because risks are not significantly elevated. Hazard indices above 1 were calculated for some ecological receptors. Please indicate why action levels were not calculated in these instances.	Consistent with DEC (2000) guidance and 18 AAC 75.340, action levels based on human health were not calculated because there were no elevated human health risk estimates. Because hazard indices were above 1 for some ecological receptors, the use of action levels will be evaluated in the risk management plan. The text in this section and related sections has been clarified, and the following revisions were made to Section 7: *The risk assessment process defined in the DEC risk assessment procedures manual (DEC 2000) and 18 AAC 75.340 provides for the calculation of site-specific risk-based alternative cleanup levels (alternative to the default DEC cleanup levels) if site conditions are not "protective of human health, safety, and welfare, and of the environment," as indicated by a site-specific risk assessment. However, because the DMTS is an active facility (rather than a closed facility typically dealt with by the contaminated sites program guidance), and conditions*	Response is acceptable.

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					are expected to change over time, it would be most practical to develop alternative cleanup levels following mine closure, where appropriate. In the meantime, changes in conditions and in potential human and ecological exposures over the life of the operation can be addressed through implementation of risk management, control, and monitoring activities, as illustrated in Figure 1-1, which is based on the decision-making framework from DEC et al. (2002). A risk management plan will be developed to more clearly define the actions to be taken. *This is a prudent and health-protective approach because:* *1. Human health risks were not found to be elevated, precluding the necessity of calculating human-health-based action levels. Nevertheless, conditions may change over time. The risk management plan will provide the means to monitor changes in conditions, and trigger additional actions, if needed, to control risks.* *2. Although some ecological effects were identified and potential risks were predicted for some receptors, these issues are not well addressed by environmental cleanup levels. The risk management plan will provide a variety of tools to monitor and minimize changes in conditions and pursue environmental improvements.* *More specifics about the risk management plan are described below.* ***Risk Management Plan*** *A risk management plan will be developed to address the issues identified by this risk assessment. The plan will include evaluation of risk management options within the general categories of institutional controls, engineering controls, monitoring, and remediation/ restoration. The plan will identify the most appropriate combination of actions to minimize risk to human health and the environment over the life of the mine.* *A variety of actions have already been taken to reduce risk of metals exposure from fugitive dust. For example, many measures have already been undertaken throughout mine, road, and port operations to reduce fugitive dust emissions, including significant improvements in engineering controls and operational procedures, as described in Section 2.2.4 (Fugitive Dust Control Measures). Soils containing elevated metals concentrations have been recovered and recycled to reduce the potential for exposure to occur or dust to be generated from these soils (Exponent 2002b). In addition, studies have been undertaken to evaluate areas of uncertainty, such as bioavailability (Shock et*	

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					al. 2007) and weathering potential of metals in fugitive dust (Teck Cominco 2007b, c). Teck Cominco uses its environmental management systems program to define objectives and track progress for continuous improvement on their environmental performance, including with respect to fugitive dust emissions (e.g., see Teck Cominco 2007a). Current efforts in the mine area are summarized by Teck Cominco (2007d) and reported regularly at http://www.dec.state.ak.us/air/reddog.htm. *As described previously, human health risks are not significantly elevated. However, some ecological risks were identified, as described in Sections 7.2. As a result, monitoring of metals concentrations in environmental media will be an important part of the risk management plan. The frequency of monitoring could potentially be increased or decreased in response to increases or decreases in the rate of change in concentrations. For example, in response to increased mining activity (potential increase in rate of change), or improved dust control (potential decrease in rate of change). In this way, increases or decreases in human and ecological exposures (relative to exposures evaluated in this risk assessment) can be closely monitored and managed through a decision process tied to these changes.* *Development of the risk management plan will be a collaborative process involving DEC and other stakeholders throughout the process of identifying and evaluating options and methodologies, and determining an agreed-upon course of action.*	
HH-27	8-2	8.1.3	Editorial/Low	The text states that, "The results of the risk assessment, along with the results from the subsistence foods evaluations (Appendix H), support continued harvesting of subsistence foods without limitations." A similar statement is made in Section 5.4.3.7.3. This is a risk management statement and should not be included in the risk assessment.	The text in question has been modified to state: *Taken together, the results from the three subsistence foods investigations, in conjunction with the risk assessment, suggest that the risks associated with continued harvesting of subsistence foods from the site, including in unrestricted areas near the DMTS, are not significantly elevated.*	Response is acceptable.
HH-28		Table 5-8	Technical/ Low	For clarity, please provide the equation for calculating the daily food intake for use in the Integrated Exposure Uptake Biokinetic (IEUBK) model. It is not entirely clear based on the footnote or chronic daily intake algorithm. It is assumed the equation used is the following: $\text{Daily Food Intake} = \dfrac{10^{-3} \times CR \times ED \times ED \times FI}{AT}$ All variables are defined in Section 5.2.2.2.3.	The daily food intake equation has been added to Tables 5-8 and 5-14.	Response is acceptable.
HH-29		Tables 5-9 and 5-10	Editorial/Low	Footnote 'a' references Section 5.2.1.1 for calculation of the fraction of the assumed subsistence use area. This discussion is found in Section 5.2.2.2.3. The footnote should be adjusted accordingly.	The footnote has been corrected.	Response is acceptable.

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HH-30	Table 5-13		Technical/ Moderate	The exposure frequency of 200 days per year was intended for site with contaminate soil that would be frozen or covered in snow for a large portion of the year. At Red Dog transport of ore along the DTMS occurs year round and dust control is a greater challenge in the winter since water cannot be used. 200 days per year may not be adequate for the particular conditions at this site.	The site fits the criteria of snow coverage or frozen ground for at least 165 days per year, as indicated in DEC (2002) guidance. U.S. EPA (2003d) indicates that soil ingestion during the winter may be greatly reduced because of snow cover and frozen ground. Although EPA notes that soil ingestion can continue at a lower level in the winter months through tracking outdoor soil inside and through contact with indoor dust in the home, they are referring to situations where outdoor soil is still intermittently not snow covered and not frozen during winter months, which is not the case in the arctic zone of Alaska. Also, dust inside Kivalina and Noatak residences would have little to no impact from the site because of the distance from the DMTS. The majority of soil ingestion occurs through hand to mouth contact. During snow coverage there would be no direct contact with soil. When the ground is frozen, soil would be physically less available for ingestion because it would not adhere to skin in the same way as dry, thawed soil. Likewise, dust that has settled onto the snow would be frozen and would not adhere to the skin in the same way as dry, thawed soil. In addition, people's skin, including their hands, would be covered during much of the year, limiting hand to mouth contact. Based on DEC (2002) and U.S. EPA (2003d) guidance, our understanding of the site, and the dynamics of the soil ingestion pathway, we believe the recommended arctic zone exposure frequency of 200 days per year is appropriate for the site. The IEUBK model for child lead exposure was applied assuming a more conservative exposure frequency of 365 days per year. The minimal impact on risk estimates that would occur as a result of using the more accurate exposure frequency does not warrant the complicated adjustment necessary to incorporate this less conservative modification into the IEUBK model. This additional discussion has been added to Section 5.4.3.	Response is acceptable.
HH-31		Table 5-20	Technical/ Medium	The intake rate for adult ingestion of surface water for the subsistence receptor, using the equation presented Section 5.2.2.2.2 and Table 5-9, is 3.6E-7 mg/kg-day resulting in a HQ of 0.0045. The intake rate presented in Table 5-20 appears to be incorrect.	The error has been corrected. The effect on surface water ingestion risks is negligible, and overall risks are unchanged.	Response is acceptable.

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HH-32	Appendix G	Table G-1	Technical/ High	There are only three tundra soil samples in vicinity of the mine. This may not be adequate to fully characterize this portion of the site. Was the sample taken 10 m from the road included in the risk assessment? Why were no samples included between 10 m and 1000 m? The data submitted to ADEC early in 2005 showed lead concentrations outside the ambient air boundary southwest of the mine ranging between 665 and 7,308 ppm. The average of the seven values near TT7 outside the ambient air boundary is 2475 ppm. Based on the available information, transect samples do not seem to provide a conservative estimate of the pollution in the vicinity of the mine.	The 10-meter station TT7-0010 had a tundra soil concentration of 2,630 ppm, which is similar to the mean of 2,475 ppm from the seven Teck Cominco tundra soil samples (Teck Cominco 2005). The 10-meter station is essentially at the ridgetop ambient air boundary, in a comparable location to the Teck Cominco samples. It appears that results from these stations near the mine boundary may reflect a localized dust deposition occurring on the lee side of the ridge. The TT7 transect stations at 10, 1,000, and 2,000 meters were on successive ridgetops and peaks, as planned in the RA work plan. The Teck Cominco data are now included in the ERA, along with the existing transect data, to characterize tundra soil concentrations for use in food web models. For the purpose of calculating people's exposure to metals in soil in the HHRA, only port, road surface, and road shoulder surface soil samples were used to characterize CoPC concentrations in surface soil. New Reference: *Teck Cominco. 2005. Summary of mine-related fugitive dust studies, Red Dog Mine Site, March 14, 2005. Teck Cominco Alaska Incorporated, Anchorage, Alaska.*	Response is acceptable.

Notes: Please note that RA text quoted herein may differ from that in other comment response documents, and in comparison with the final RA document, as a result of successive revisions made during the comment resolution process.

ADEC - Alaska Department of Environmental Conservation
ADPH - Alaska Division of Public Health
COPC - chemical of potential concern
CSM - conceptual site model
E & E - Ecology and Environment, Inc.
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
ERA - ecological risk assessment
FI - fractional intake
HHRA - human health risk assessment
IEUBK - integrated exposure uptake biokinetic model
RAWP - risk assessment work plan
RA - risk assessment
UCL - upper confidence limit

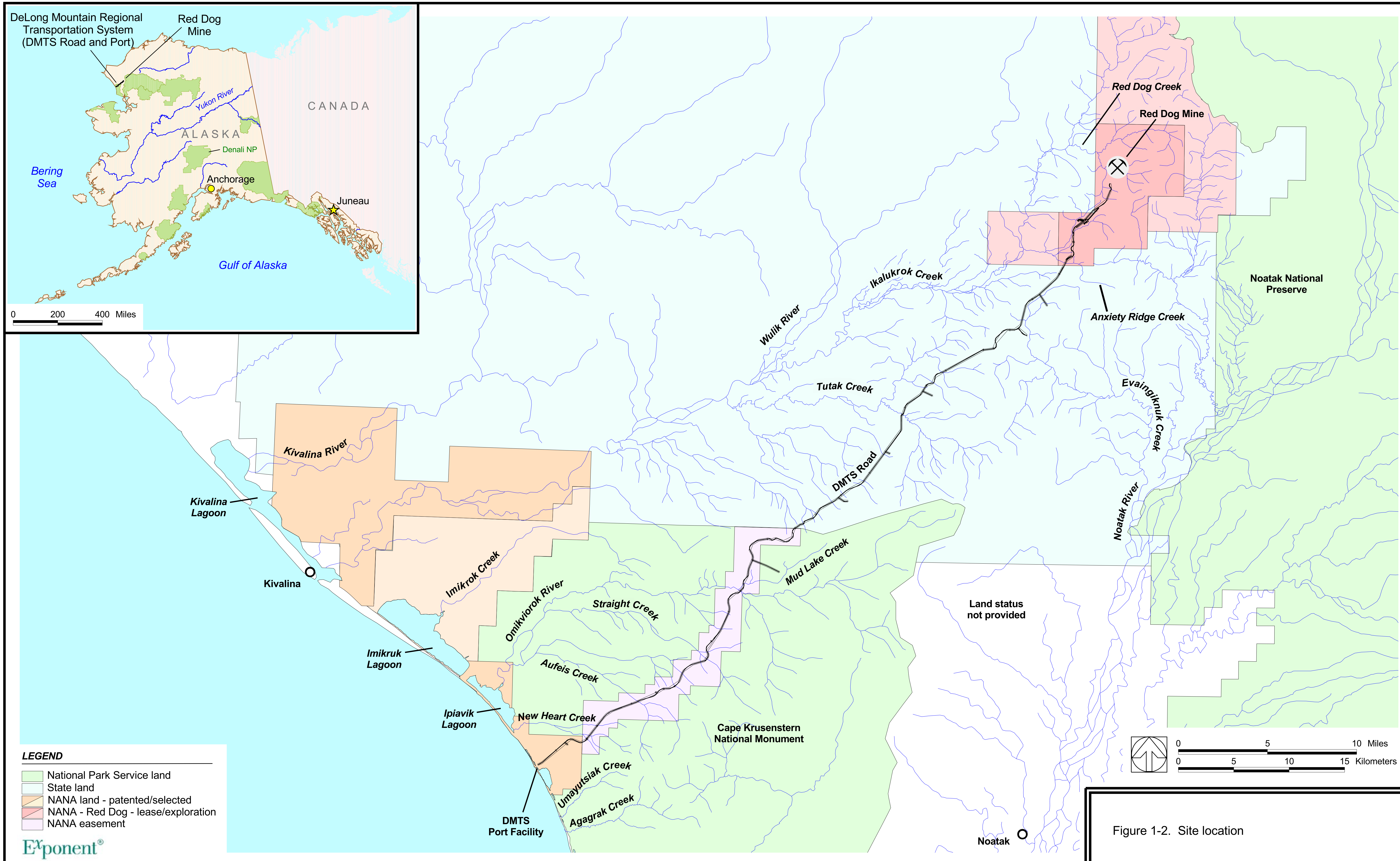

Figure 1-2. Site location

8601997.001 2400/2500 | Dec 28, 2005 | Fig 1-2 zoom to site view | Fig 1-2 site location layout | j:\red_dog\projects\post_fsp_2003_base_figures.apr

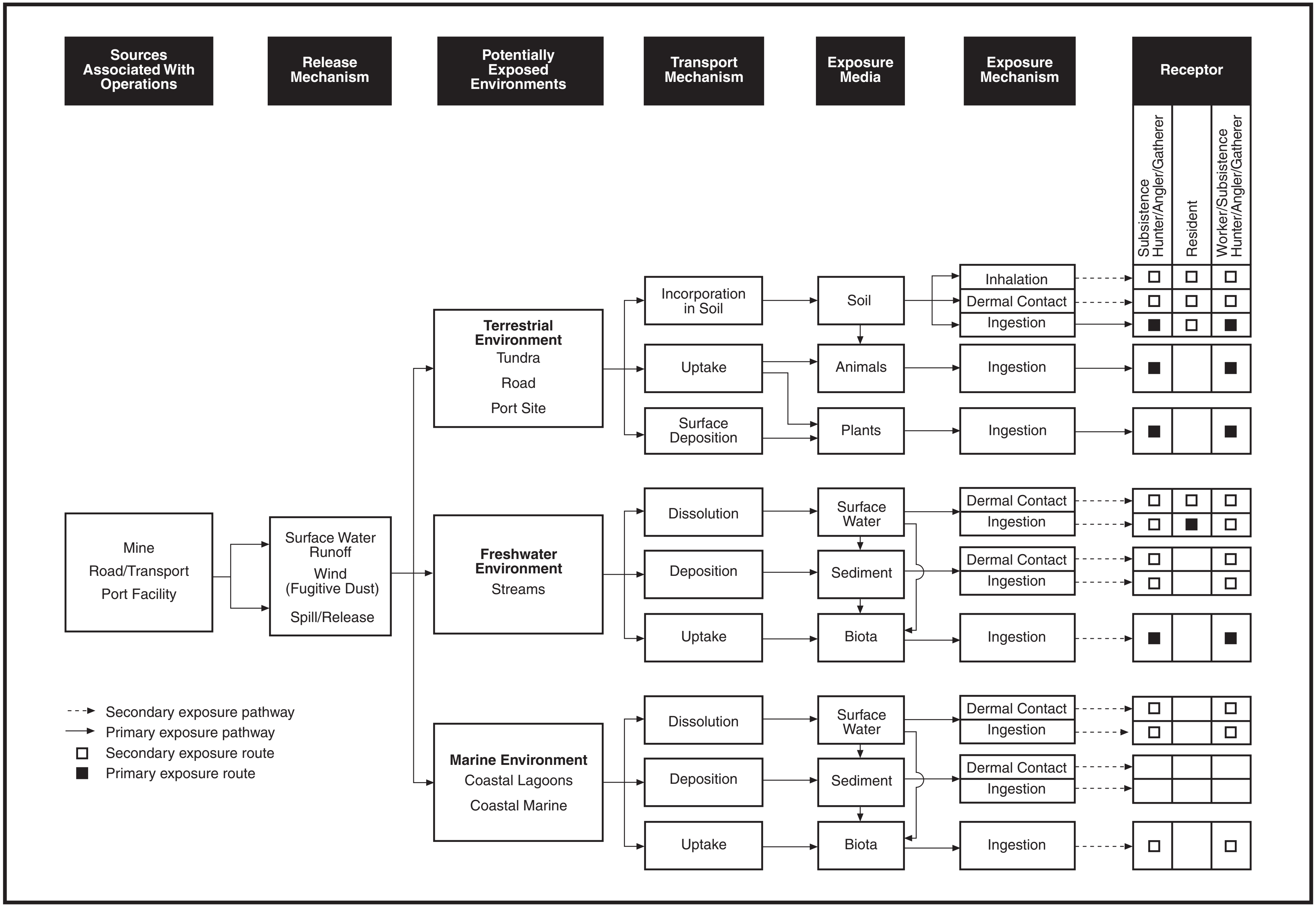

Figure 5-1. Refined conceptual site model for the DMTS human health risk assessment

8601997.001 4400 724/06 WA

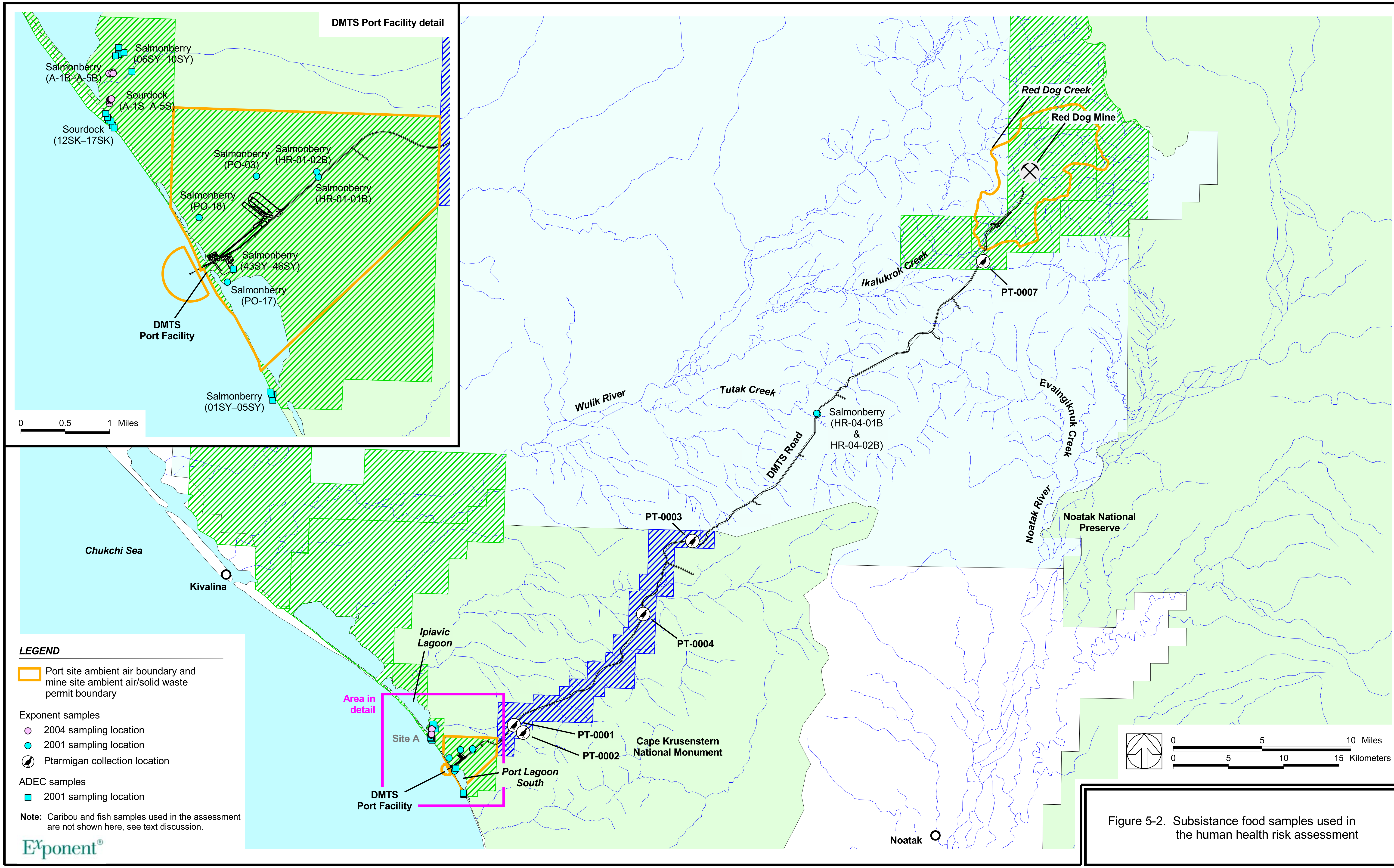

Figure 5-2. Subsistance food samples used in the human health risk assessment

8601997.001 4500 | Mar 23, 2005 | FSP04 Fig 5-2 subs foods view | Fig 5-2 subs foods layout | j:/red_dog/projects/ra_2004.apr

Table 5-1. Summary of exposure point concentrations for environmental media

	N	#ND	%ND	Min.	Max.	Mean	Std.Dev.	Distribution Tests: normal	Distribution Tests: gamma	Distribution Tests: lognormal	UCL Method	UCL	EPC	
Stream Surface water (µg/L)														
Lead	229	145	63%	0.018	7.3	0.33	0.75	--	--	--	--	--	0.33	Mean
Thallium	28	24	86%	0.016	0.55	0.055	0.11	No	No	No	Chebyshev NP	0.14	0.14	UCL
Soil Subareas (mg/kg)														
Port Soil (mg/kg)														
Antimony	23	18	78%	0.93	26.0	9.6	8.8	No	No	No	Chebyshev NP	17.5	17.5	UCL
Barium	23	0	0%	357	2,110	1,304	383	Yes	Yes	No	Student's-t	1,441	1,441	UCL
Cadmium	428	41	10%	0.40	388	27.6	39.2	No	No	No	Chebyshev NP[a]	39.4	39.4	UCL
Lead	433	12	3%	8.5	48,300	1,255	2,921	--	--	--	--	--	1,255	Mean
Thallium	4	0	0%	0.29	0.78	0.53	0.21		n <10		--	--	0.78	Max
Zinc	433	0	0%	37.4	64,300	4,494	6,415	No	No	No	Chebyshev NP[a]	6,419	6,419	UCL
Road Soil (mg/kg)														
Antimony	12	6	50%	0.38	5.5	2.9	2.4	No	No	No	Chebyshev NP[b]	9.8	5.5	Max
Barium	12	0	0%	650	6,290	2,216	1,870	No	Yes	Yes	Approx. gamma	3,373	3,373	UCL
Cadmium	32	2	6%	0.50	29.3	4.0	5.5	No	No	No	Chebyshev NP	8.3	8.3	UCL
Lead	32	0	0%	13.5	2,440	198	423	--	--	--	--	--	198	Mean
Thallium	6	0	0%	0.11	0.46	0.22	0.13		n<10		--	--	0.46	Max
Zinc	32	0	0%	102	4,840	731	952	No	No	Yes	H-statistic	962	962	UCL
DMTS Area-weighted Soil (mg/kg)[c]														
Antimony	--	--	--	--	--	--	--	--	--	--			6.5	UCL/Max
Barium	--	--	--	--	--	--	--	--	--	--			3,219	UCL
Cadmium	--	--	--	--	--	--	--	--	--	--			10.8	UCL
Lead	--	--	--	--	--	--	--	--	--	--			282	Mean
Thallium	--	--	--	--	--	--	--	--	--	--			0.49	Max
Zinc	--	--	--	--	--	--	--	--	--	--			1,399	UCL
DMTS Area-averaged Soil (mg/kg)[d]														
Antimony	--	--	--	--	--	--	--	--	--	--			11.5	UCL/Max
Barium	--	--	--	--	--	--	--	--	--	--			2,407	UCL
Cadmium	--	--	--	--	--	--	--	--	--	--			23.8	UCL
Lead	--	--	--	--	--	--	--	--	--	--			726	Mean
Thallium	--	--	--	--	--	--	--	--	--	--			0.62	Max
Zinc	--	--	--	--	--	--	--	--	--	--			3,691	UCL

Table 5-1. (cont.)

Note: All UCL calculations were done using ProUCL 3.0. UCL methods are recommendations per EPA guidance (U.S. EPA 2002b).
Undetected sample results included based on one-half of the detection limit.

-- - not applicable N - number of results

DMTS	-	DeLong Mountain Regional Transportation System	ND	-	not detected
EPC	-	exposure point concentration	NP	-	nonparametric
Min.	-	minimum result	Std.Dev.	-	standard deviation
Max.	-	maximum result	UCL	-	upper confidence limit

[a] 97.5% UCL was used to obtain 95% coverage level, per ProUCL recommendation.

[b] 99% UCL was used to obtain 95% coverage level, per ProUCL recommendation.

[c] A DMTS area-weighted soil concentration was derived for each metal assuming that the port area soil samples represent an area of 26 hectares and that the road area soil samples represent an area of 312 hectares (see Figure 5-2). The total assumed DMTS site area is (26 + 312) 338 hectares; therefore, the port soil mean was adjusted by 0.08 (26/338) and the road soil mean was adjusted by 0.92 (312/338): DMTS Area-weighted Soil = (Port Area EPC x 0.08) + (Road Area EPC x 0.92).

[d] A DMTS area-averaged soil concentration was derived for each metal by averaging the EPC for port soil and the EPC for road soil:
DMTS Area-averaged Soil = (Port Area EPC + Road Area EPC) / 2

Table 5-2. Summary of exposure point concentrations for subsistence foods

	N	#ND	%ND	Min.	Max.	Mean	Std.Dev.	Distribution Tests: normal	Distribution Tests: gamma	Distribution Tests: lognormal	UCL Method	UCL	EPC
Caribou (mg/kg wet)[a]													
Caribou Tissue-Specific Data													
Kidney													
Barium	--	--	--	--	--	--	--	--	--	--	--	--	3.2 [b]
Cadmium	11	0	0%	1.3	9.9	4.7	2.9	yes	yes	yes	Student's-t	6.3	6.3 UCL
Lead	11	0	0%	0.35	5.8	2.0	1.8	--	--	--	--	--	2.0 Mean
Zinc	11	0	0%	10.0	53.8	22.1	11.8	no	yes	yes	Approx. Gamma	29.1	29.1 UCL
Liver													
Barium	--	--	--	--	--	--	--	--	--	--	--	--	2.7 [b]
Cadmium	11	0	0%	0.36	3.3	1.4	0.96	yes	yes	yes	Student's-t	1.9	1.9 UCL
Lead	11	0	0%	0.72	5.6	2.6	1.7	--	--	--	--	--	2.6 Mean
Zinc	11	0	0%	20.3	120	39.1	28.0	no	yes	no	Approx. Gamma	54.1	54.1 UCL
Muscle													
Barium	--	--	--	--	--	--	--	--	--	--	--	--	1.2 [b]
Cadmium	11	3	27%	0.0050	0.080	0.041	0.025	yes	yes	no	Student's-t	0.055	0.055 UCL
Lead	11	0	0%	0.020	0.26	0.11	0.086	--	--	--	--	--	0.11 Mean
Zinc	11	0	0%	20.1	69.0	29.1	13.8	no	no	no	Modified-t NP	36.6	36.6 UCL
Edible Tissue Weighted Average[c]													
Barium	--	--	--	--	--	--	--	--	--	--	--	--	1.3 [b]
Cadmium	33	--	--	--	--	--	--	--	--	--	--	--	0.22 UCL
Lead	33	--	--	--	--	--	--	--	--	--	--	--	0.19 Mean
Zinc	33	--	--	--	--	--	--	--	--	--	--	--	36.8 UCL
Fish (mg/kg wet)													
Lead	151	83	55%	0.0015	0.091	0.010	0.016	--	--	--	--	--	0.010 Mean
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	0.0026 [d]
Ptarmigan (mg/kg wet)													
Ptarmigan Tissue-Specific Data													
Breast													
Barium	5	0	0%	0.040	0.48	0.19	0.17		n<10		--	--	0.48 Max
Cadmium	5	0	0%	0.16	0.48	0.31	0.12		n<10		--	--	0.48 Max
Lead	5	0	0%	0.011	0.045	0.025	0.013		n<10		--	--	0.025 Mean
Zinc	5	0	0%	6.3	10.2	8.6	1.5		n<10		--	--	10.2 Max
Kidney													
Barium	5	0	0%	0.38	3.8	1.2	1.5		n<10		--	--	3.8 Max
Cadmium	5	0	0%	52.6	108.1	80.9	26.2		n<10		--	--	108 Max
Lead	5	0	0%	0.44	2.7	1.3	0.9		n<10		--	--	1.3 Mean
Zinc	5	0	0%	41.0	67.1	54.5	9.7		n<10		--	--	67.1 Max

Table 5-2. (cont.)

	N	#ND	%ND	Min.	Max.	Mean	Std.Dev.	Distribution Tests normal	gamma	lognormal	UCL Method	UCL	EPC	
Liver														
Barium	5	0	0%	0.12	0.53	0.29	0.16		n<10		--	--	0.53	Max
Cadmium	5	0	0%	7.8	22.5	15.2	6.8		n<10		--	--	22.5	Max
Lead	5	0	0%	0.11	0.97	0.38	0.34		n<10		--	--	0.38	Mean
Zinc	5	0	0%	28.2	64.8	41.8	14.1		n<10		--	--	64.8	Max
Edible tissue weighted average[e]														
Barium	15	--	--	--	--	--	--	--	--	--	--	--	0.52	Max
Cadmium	15	--	--	--	--	--	--	--	--	--	--	--	3.5	Max
Lead	15	--	--	--	--	--	--	--	--	--	--	--	0.07	Mean
Zinc	15	--	--	--	--	--	--	--	--	--	--	--	15.7	Max
Salmonberry (mg/kg wet)														
Barium	6	0	0%	0.022	0.078	0.052	0.019		n<10		--	--	0.078	Max
Cadmium	27	0	0%	0.0069	0.21	0.041	0.038	no	yes	yes	Approx. Gamma	0.052	0.052	UCL
Lead	27	1	4%	0.0011	1.8	0.15	0.34	--	--	--	--	--	0.15	Mean
Zinc	27	0	0%	1.9	9.2	4.2	1.7	no	yes	yes	Approx. Gamma	4.7	4.7	UCL
Sourdock (mg/kg wet)														
Antimony	6	0	0%	0.0037	0.012	0.0084	0.0034		n<10		--	--	0.012	Max
Barium	6	0	0%	0.76	10.6	3.4	3.7		n<10		--	--	10.6	Max
Cadmium	12	0	0%	0.0032	0.021	0.010	0.0053	yes	yes	yes	Student's-t	0.013	0.013	UCL
Lead	12	0	0%	0.047	0.42	0.21	0.11	--	--	--	--	--	0.21	Mean
Thallium	6	4	67%	0.00012	0.00049	0.00020	0.00015		n<10		--	--	0.00049	Max
Zinc	12	0	0%	0.00012	7.4	4.6	1.5	yes	yes	yes	Student's-t	5.4	5.4	UCL

Note: All UCL calculations were done using ProUCL 3.0. UCL methods are recommendations per EPA guidance (U.S. EPA 2002b).
Undetected sample results included based on one-half of the detection limit.

-- - not applicable
CoPC - chemical of potential concern
EPC - exposure point concentration
Min. - minimum result
Max. - maximum result
N - number of results
ND - not detected
NP - non parametric
Std.Dev. - standard deviation
UCL - upper confidence limit
EPA - U.S. Environmental Protection Agency

[a] Caribou tissue samples were not analyzed for antimony, barium, and thallium. Ptarmigan tissue EPCs were used to predict the caribou barium concentration. Antimony was never detected in ptarmigan, and thallium was only rarely detected and at concentrations near or below reference concentrations. Therefore, antimony and thallium were not included as caribou or ptarmigan CoPCs (see Section 5.2.1.2.1.2).

[b] This calculated EPC value used for barium is based on the relationship between barium and lead in the corresponding ptarmigan tissue (see Section 5.2.1.2.1.2).

[c] The EPC concentration for the edible caribou tissue weighted average was calculated using a mass-weighted calculation. Kidney and liver tissue each contributed 2 percent and muscle tissue contributed 96 percent of the concentration (ADPH 2001).

[d] This calculated EPC value used for thallium is based on the relationship between thallium and lead in stream surface water.

[e] The EPC concentration for the edible ptarmigan tissue weighted average was calculated using a mass-weighted calculation. Muscle tissue contributed 90 percent, kidney tissue contributed 1 percent, and liver tissue contributed 9 percent of the concentration (Kalas et al. 1995; Remington and Braun 1988) (Section 5.2.1.2.2).

Table 5-3. Calculation of predicted fish thallium exposure point concentration

	Max.	Mean	UCL	EPC		Ratio of Thallium Mean to Lead Mean in Surface Water	
Stream Surface Water (µg/L)							
Lead	7.3	0.33	0.55	0.33	Mean		
Thallium	0.55	0.055	0.14	0.14	UCL	0.17	(0.055/0.33)

	Max.	Mean	UCL	EPC		Calculation of Thallium EPC from Lead UCL in Fish	
Fish (mg/kg wet)							
Lead	0.091	0.010	0.016	0.010	Mean		
Thallium	--	--		0.0026 [a]		0.0026	(0.016*0.17)

Note: EPC - exposure point concentration
UCL - upper confidence limit

[a] The fish thallium EPC is calculated by multiplying the 95%UCL for lead in fish by the ratio of the mean thallium to mean lead concentrations in surface water.

Table 5-4. Calculation of predicted caribou barium exposure point concentrations for kidney, liver, and muscle tissue

	Max.	Mean	UCL	EPC	Ratios of Ptarmigan Mean Barium Value to Means for: Cadmium	Lead	Zinc
Kidney Tissue							
Ptarmigan (mg/kg wet)							
Barium	3.8	1.2			0.015	0.96	0.023
Cadmium	108	80.9			(1.2/80.9)	(1.2/1.3)	(1.2/54.5)
Lead	2.7	1.3					
Zinc	67.1	54.5					

	Max.	Mean	UCL	EPC	Calculation of Barium EPC from Caribou EPCs through Application of Ratios for Other Metals: Cadmium	Lead	Zinc
Caribou (mg/kg wet)							
Barium	--	--		3.2 [a]	0.10	3.2	0.66
Cadmium	9.9	4.7	6.3	6.3 UCL	(6.3*0.015)	(3.4*0.96)	(29.1*0.023)
Lead	5.82	1.97	3.4	2.0 Mean			
Zinc	53.8	22.1	29.1	29.1 UCL			

	Max.	Mean	UCL	EPC	Ratios of Ptarmigan Mean Barium Value to Means for: Cadmium	Lead	Zinc
Liver Tissue							
Ptarmigan (mg/kg wet)							
Barium	0.53	0.29			0.019	0.77	0.007
Cadmium	22.5	15.2			(0.29/15.2)	(0.29/0.38)	(0.29/41.8)
Lead	0.97	0.38					
Zinc	64.8	41.8					

	Max.	Mean	UCL	EPC	Calculation of Barium EPC from Caribou EPCs through Application of Ratios for Other Metals: Cadmium	Lead	Zinc
Caribou (mg/kg wet)							
Barium	--	--		2.7 [a]	0.038	2.7	0.38
Cadmium	3.32	1.42	1.9	1.9 UCL	(1.9*0.019)	(3.5*0.77)	(54.1*0.007)
Lead	5.6	2.6	3.5	2.6 Mean			
Zinc	120	39.1	54.1	54.1 UCL			

	Max.	Mean	UCL	EPC	Ratios of Ptarmigan Mean Barium Value to Means for: Cadmium	Lead	Zinc
Muscle Tissue							
Ptarmigan (mg/kg wet)							
Barium	0.48	0.19			0.62	7.67	0.022
Cadmium	0.48	0.31			(0.19/0.31)	(0.19/0.025)	(0.19/8.6)
Lead	0.045	0.025					
Zinc	10.2	8.6					

	Max.	Mean	UCL	EPC	Calculation of Barium EPC from Caribou EPCs through Application of Ratios for Other Metals: Cadmium	Lead	Zinc
Caribou (mg/kg wet)							
Barium	--	--		1.2 [a]	0.034	1.2	0.80
Cadmium	0.080	0.041	0.055	0.055 UCL	(0.055*0.62)	(0.16*7.67)	(36.6*0.022)
Lead	0.26	0.11	0.16	0.11 Mean			
Zinc	69.0	29.1	36.6	36.6 UCL			

Note: EPC - exposure point concentration
UCL - upper confidence limit

[a] The predicted caribou barium EPCs were calculated by:
1) Calculating ratios of mean barium to mean cadmium, lead, and zinc in each of the ptarmigan tissues (i.e., kidney, liver, and muscle). For all tissues the ratio of barium to lead gave the highest ratio.
2) Multiplying the barium to lead ratio for each tissue by the 95%UCL for lead in the corresponding caribou tissue.

Table 5-5. Ptarmigan tissue weight calculations

Tissue	Weight (g-wet weight)	Fraction of Total	Basis	Source
Kidney	3	0.01	Twice the highest value for one kidney reported for willow ptarmigan (range was 1.2–1.5 g).	Kalas et al. (1995)
Liver	26.5	0.09	Average liver weight for adult male and female sage grouse.	Remington and Braun (1988)
Muscle	257	0.90	Average weight for adult male and female sage grouse pectoralis and supracorocoideus muscles.	Remington and Braun (1988)
Total	286.5			

Table 5-6. EPA IEUBK lead model exposure parameters and input values

Parameter	Input Value(s)	Source
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.100	EPA default
Indoor air lead concentration (percent of outdoor air)	30%	EPA default
Time spent outdoors (hours/day)	1, 2, 3, 4, 4, 4,4	EPA default[a]
Ventilation rates (m^3/day)	2, 3, 5, 5, 5, 7 ,7	EPA default[a]
Lung absorption (percentage)	32	EPA default
Diet		
Diet intake (μg/day)	3.16, 2.60, 2.87, 2.74, 2.61, 2.74, 2.99	Update to EPA default[a,b]
Alternative diet values	Not used	EPA default
Alternate source, subsistence food (μg/day)	1.6	Site data, see Table 5-8
Bioavailability of lead in food (percent)	50	EPA default
Drinking Water		
Lead concentration in drinking water (μg/L)	0.33	Site data
Drinking water intake (L/day)	0.20, 0.50, 0.52, 0.53, 0.55, 0.58, 0.59	EPA default[a]
Alternative water values	Not used	EPA default
Bioavailability of lead in drinking water (percent)	50	EPA default
Soil/Dust		
Soil lead levels (ppm; μg/g)	25, 65	Site data[c]
Indoor dust lead levels (percent of soil levels)	70%	EPA default
Ingestion weighting factor (percent soil/percent dust)	45/55	EPA default
Amount of soil/dust ingested daily (g/day)	0.085, 0.135, 0.135, 0.135, 0.100, 0.090, 0.085	EPA default[a]
Bioavailability of lead in soil and dust (percent)	30, 9.7	EPA default and site-specific[d]
Other		
Alternate source, subsistence food (μg/day)	1.6, 3.4	Site data[e], see Table 5-8
Bioavailability of lead from subsistence foods (percent)	50	EPA default
Maternal contribution method	Infant model	EPA default
Maternal blood lead at birth of child (μg/dL)	2.5	EPA default
Geometric standard deviation	1.6	EPA default

Note: EPA - U.S. Environmental Protection Agency
IEUBK - integrated exposure uptake/biokinetic

[a] Value varies by age group. Values listed are for the following ages, respectively: 0–1, 1–2, 2–3, 3–4, 4–5, 5–6, 6–7.

[b] EPA recommends use of updated dietary intake values (citation).

[c] IEUBK model results were derived based on both the area-weighted soil concentration (282 μg/g) and the area-averaged soil concentration (726 μg/g). Each value was multiplied by the site fractional intake (FI) of 0.09 to derive the soil lead level inputs for the model (i.e., 282 x 0.09 = 25; 726 x 0.09 = 65).

[d] The EPA default for the IEUBK lead model is 30 percent. The site-specific value is 9.7 percent (see Table 5-7), based on data from the lead bioavailability study conducted by the National Toxicology Program and reported by the Alaska Division of Public Health (ADPH 2001; Arnold and Middaugh 2001; Arnold et al. 2003).

[e] IEUBK model results were derived using both the site-specific FI of 0.09 and the alternative caribou FI of 0.2 to calculate lead intake from subistence foods.

Table 5-7. Bioavailability of lead in Red Dog ore concentrate

Lead Concentration in Amended Food (mg/kg)[a]	Blood Lead (μg/dL)		Relative Bioavailability	Child Absolute Bioavailability[b]	Adult Absolute Bioavailability[b]
	Lead Acetate	Red Dog Concentrate			
0		5.05	--	--	--
10	16	4.32	27.0%	13.5%	5.4%
30	31.8	5.65	17.8%	8.9%	3.6%
100	84.8	11.5	13.6%	6.8%	2.7%
Average	--	--	19.4%	9.7%	3.9%

Source: ADPH (2001); Arnold and Middaugh (2001); Arnold et al. (2003)

Note: -- - not applicable

[a] Animals were fed a diet amended with either Red Dog ore concentrate or soluble lead acetate so that the animals' food had the specific lead concentrations listed.

[b] Absolute bioavailability is calculated by multiplying the relative bioavailability of Red Dog concentrate by the absolute bioavailability of lead acetate. The absolute bioavailability of lead acetate was assumed to be 50 percent for children and 20 percent for adults, per U.S. EPA (U.S. EPA 1994, 1996c) guidance. For the adult lead model, absolute bioavailability is referred to as absorption fraction.

Table 5-8. Calculaton of subsistence food lead intake for EPA IEUBK child lead model

Scenario Timeframe: Current/Future
Exposure Medium: Food
Exposure Point: Subsistence Food
Receptor Population: Subsistence User
Receptor Age: Young child

Exposure Route	Food		EPC Value	EPC Units	Daily Food Intake[a]	Daily Food Intake Units	Chronic Daily Intake	Chronic Daily Intake Units
Based on Caribou FI=0.09								
	Caribou	Lead	195	µg/kg	7.6E-3	kg/day	1.5	µg/day
	Fish	Lead	10.2	µg/kg	5.6E-3	kg/day	0.06	µg/day
	Ptarmigan	Lead	69.3	µg/kg	9.0E-5	kg/day	0.006	µg/day
	Salmonberry	Lead	147	µg/kg	3.8E-4	kg/day	0.06	µg/day
	Sourdock	Lead	211	µg/kg	6.3E-5	kg/day	0.01	µg/day
						Total	1.6	µg/day
Based on Alternative Caribou FI=0.2								
	Caribou	Lead	195	µg/kg	1.7E-2	kg/day	3.3	µg/day
	Fish	Lead	10.2	µg/kg	5.6E-3	kg/day	0.06	µg/day
	Ptarmigan	Lead	69.3	µg/kg	9.0E-5	kg/day	0.006	µg/day
	Salmonberry	Lead	147	µg/kg	3.8E-4	kg/day	0.06	µg/day
	Sourdock	Lead	211	µg/kg	6.3E-5	kg/day	0.01	µg/day
						Total	3.4	µg/day

Note:
-- - not applicable
AT - averaging time
BW - body weight
Cf - concentration in food
CR_f - consumption rate for food
ED - exposure duration
EF - exposure frequency
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
FI - fractional intake
IEUBK - integrated exposure uptake biokinetic

[a] Daily Food Intake = $CR_f \times 10^{-3} \times FI \times EF \times ED / (BW \times AT)$
Chronic Daily Intake (CDI) (mg/kg-day) = C_f x Daily Food Intake
Derivation of consumption rates presented in Table 5-11. All variables defined in Section 5.2.2.2.3.
The daily food intake incorporates the site FI of 0.09 or the alternative caribou FI of 0.2.

Table 5-9. Exposure assumptions used to calculate risk for non-lead metals for adults in the subsistence use scenario

Scenario Timeframe: Current/Future
Receptor Population: Subsistence Use
Receptor Age: Adult

Exposure Medium and Route	Parameter Code	Parameter Definition	Units	Value	Rationale/ Reference	Intake Equation/ Model Name
Soil Ingestion						
	C_S	Chemical concentration in soil	mg/kg	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/mg	0.000001	--	C_S x CF x IR_S x FI x EF x ED / (BW x AT)
	IR_S	Ingestion rate - soil	mg soil/day	100	DEC (2002)	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a]	
	EF	Exposure frequency	days/year	200	DEC (2002)	
	ED	Exposure duration	years	30	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	10,950	DEC (2002)	
Water Ingestion						
	C_W	Chemical concentration in surface water	µg/L	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	mg/µg	0.001	--	C_W x CF x IR_W x FI x EF x ED / (BW x AT)
	IR_W	Ingestion rate for surface water	L/day	2	DEC (2002)	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	30	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	10,950	DEC (2002)	
Food Ingestion						
	C_F	Chemical concentration in food[b]	mg/kg-wet wt.	see Table 5-2	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/g	0.001	--	C_F x CR_F x CF x FI x EF x ED / (BW x AT)
	CR_F	Consumption rate for food[b]	g/day	see Table 5-11	DFG (2001a)	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a,c]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	30	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	10,950	DEC (2002)	

Note: -- - not applicable
RME - reasonable maximum exposure

[a] Based on a calculation of the fraction of the assumed subsistence use area on the site divided by the total subsistence use areas for Kivalina and Noatak (see Figures 5-2 and 5-3 and Section 5.2.2.2.3).

[b] A separate calculation is done for each food item.

[c] Risks are calculated using both the site-specific FI of 0.09 and the alternative caribou FI of 0.2.

Table 5-10. Exposure assumptions used to calculate risk for non-lead metals for children in the subsistence use scenario

Scenario Timeframe: Current/Future
Receptor Population: Subsistence Use
Receptor Age: Child

Exposure Medium and Route	Parameter Code	Parameter Definition	Units	Value	Rationale/ Reference	Intake Equation/ Model Name
Soil Ingestion						
	C_S	Chemical concentration in soil	mg/kg	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/mg	0.000001	--	C_S x CF x IR_S x FI x EF x ED / (BW x AT)
	IR_S	Ingestion rate - soil	mg soil/day	200	DEC (2002)	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a]	
	EF	Exposure frequency	days/year	200	DEC (2002)	
	ED	Exposure duration	years	6	DEC (2002)	
	BW	Body weight	kg	15	DEC (2002)	
	AT	Averaging time	days	2,190	DEC (2002)	
Water Ingestion						
	C_W	Chemical concentration in surface water	μg/L	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	mg/μg	0.001	--	C_W x CF x IR_W x FI x EF x ED / (BW x AT)
	IR_W	Ingestion rate for surface water	L/day	1	?	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	6	DEC (2002)	
	BW	Body weight	kg	15	DEC (2002)	
	AT	Averaging time	days	2,190	DEC (2002)	
Food Ingestion						
	C_F	Chemical concentration in food[b]	mg/kg-wet wt.	see Table 5-2	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/g	0.001	--	C_F x CR_F x CF x FI x EF x ED / (BW x AT)
	CR_F	Consumption rate for food[b]	g/day	see Table 5-11	DFG (2001a)	
	FI	Fractional intake from site	unitless	0.09	Area calculated[a,c]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	6	DEC (2002)	
	BW	Body weight	kg	15	DEC (2002)	
	AT	Averaging time	days	2,190	DEC (2002)	

Note: -- - not applicable
RME - reasonable maximum exposure

[a] Based on a calculation of the fraction of the assumed subsistence use area on the site divided by the total subsistence use areas for Kivalina and Noatak (see Figures 5-2 and 5-3 and Section 5.2.2.2.3).

[b] A separate calculation is done for each food item.

[c] Risks are calculated using both the site-specific FI of 0.09 and the alternative caribou FI of 0.2.

Table 5-11. Estimated subsistence food consumption rates

	Mean per Capita Consumption (g/day)			Caloric Intake Weighted Mean per Capita Consumption (g/day)	
	Kivalina	Noatak	Average of two villages	Adult	Child
Land Mammals	212.1	305.8	259.0	168	84
Caribou[a]	177.5	300.6	239.1	155	78
Moose	70.0	36.9	53.4	35	17
Migratory Birds	10.6	9.9	10.3	6.7	3.3
Game Birds	3.1	3.1	3.1	2.0	1.0
Ptarmigan[a]	3.1	3.1	3.1	2.0	1.0
All Fish	314.8	248.7	281.7	183	91
Salmon	29.2	216.1	122.6	80	40
Non-salmon fish[a]	296.4	85.0	190.7	124	62
Char	252.3	57.7	155.0	101	50
White fish	28.2	36.0	32.1	21	10
Cod	24.8	1.1	12.9	8.4	4.2
Marine Invertebrates	1.8	3.8	2.8	1.8	0.9
Clams	0.0	1.3	0.6	0.4	0.2
Crabs	0.8	6.4	3.6	2.3	1.2
Shrimp	1.6	0.0	0.8	0.5	0.3
Marine Mammals	415.1	106.0	260.6	169	85
Seal	251.8	101.6	176.7	115	57
Walrus	101.1	52.9	77.0	50	25
Whale	89.8	20.2	55.0	36	18
Vegetation	18.3	7.5	12.9	8.4	4.2
Berries[a]	17.5	8.2	12.9	8.4	4.2
Plants/greens/mushrooms[a]	1.5	2.5	2.0	1.3	0.7
Sum of Main Categories	976	685	830	539	270
Total kcal/day (@5.1 kcal/g)	4,977	3,492	4,234	2,750	1,375
Caloric Intake Weighting Factor	--	--	--	0.65	0.32

Note: Data from Community Profile Database (DFG 2001a). Kivalina data are from 1992. Noatak data are from 1994.

The sum of consumption rates for individual food items, or for sub-categories within a category, does not equal the consumption rate for the entire category in the database. For example, the sum of salmon and non-salmon fish consumption does not equal all fish consumption. This could be an artifact of the statistical methods used to derive consumption rates for entire categories based on data for individual items.

Boxed values are the consumption rates used in the risk assessment.

-- - not applicable

EPC - exposure point concentration

[a]Consumption rates for ptarmigan and non-salmon fish were used to derive risk estimates using EPCs for those foods. Consumption of land mammals was evaluated using EPCs for caribou. Consumption of all berries was evaluated using EPCs for salmonberries. Consumption of all plants, greens, and mushrooms was evaluated based on EPCs for sourdock.

Table 5-12. Daily dietary intake of Alaska native adults

	Males		Females	
	grams	kcal	grams	kcal
Protein	127	508	90	360
Fat	117	1,053	81	729
Carbohydrates	282	1,128	214	856
Total Energy[a]	526	2,689	385	1,945
Average kcal/g		5.1		5.1

Source: Nobmann et al. (1992)

Note: kcal - kilocalories; commonly called calories. Caloric intake was calculated by multiplying the intake in grams from Nobmann et al. (1992) by the number of kcal/g in each energy source: protein, 4 kcal/g; fat, 9 kcal/g; carbohydrate, 4 kcal/g

[a] The total energy estimates differ slightly from the values reported by Nobmann et al. (1992) (i.e., 2,750 kcal for males and 1,950 kcal for females), likely because of the standard rounding used for the specific energy content of protein, fat, and carbohydrates. The values calculated here are used solely for the purpose of calculating the average caloric density of the diet.

Table 5-13. Adult lead model exposure parameters

Scenario Timeframe: Current/Future
Receptor Population: Worker/Subsistence User
Receptor Age: Adult

Parameter Code	Parameter Definition	Units	Input Parameters	Rationale
C_S	Soil lead concentration average	μg/g or ppm	282, 726	site data[a], see Table 5-1
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	EPA default
BKSF	Biokinetic slope factor	μg/dL per μg/day	0.4	EPA default
GSD_i	Geometric standard deviation PbB	--	2.1	U.S. EPA (2002a)
PbB_0	Baseline PbB	μg/dL	1.53	U.S. EPA (2002a)
IR_{S_W}	Soil ingestion rate while at work (including soil and dust)	g/day	0.100	DEC (2006)
IR_{S_S}	Soil ingestion rate during subsistence activities (including soil and dust)	g/day	0.100	DEC (2004a)
AF_S	Absorption fraction	--	0.039, 0.12	EPA default, site specific[b]
EF_S	Exposure frequency	days/year	200	DEC (2002)
FI_{S_W}	Fractional intake for soil ingestion while at work	--	0.67	Site specific
FI_{S_S}	Fractional intake for soil ingestion during subsistence activities	--	0.03	Site specific
ADI	Average daily intake of lead from subsistence foods	μg/day	1.6, 3.4	site data[c], see Table 5-14
AF_F	Absorption fraction for food	--	0.20	U.S. EPA (1994, 1996c)
EF_F	Exposure frequency for food	days/year	182.5	Site specific
AT	Averaging time	days/year	365	365

Note: -- - not applicable
EPA - U.S. Environmental Protection Agency
PbB - blood lead

[a] Adult lead model results were derived using both the area-weighted lead EPC of 282 μg/g and the area-averaged lead EPC of 726 μg/g.

[b] Adult lead model results were derived using both the site-specific soil lead absorption fraction of 0.039 and the EPA default of 0.12. See Table 5-7 for derivation of the site-specific absorption fraction, also referred to as absolute bioavailability.

[c] Adult lead model results were derived using both the site-specific FI of 0.09 and the alternative caribou FI of 0.2 to calculate subsistence food lead intake.

Table 5-14. Calculaton of subsistence food lead intake for adult lead model

Scenario Timeframe: Current/Future
Exposure Medium: Food
Exposure Point: Subsistence Food
Receptor Population: Worker/Subsistence User
Receptor Age: Adult

Exposure Route	Food		EPC Value	EPC Units	Daily Food Intake[a]	Daily Food Intake Units	Chronic Daily Intake[b]	Chronic Daily Intake Units
Based on Caribou FI=0.09								
	Caribou	Lead	195	μg/kg	7.5E-3	kg/day	1.5	μg/day
	Fish	Lead	10.2	μg/kg	5.6E-3	kg/day	0.06	μg/day
	Ptarmigan	Lead	69.3	μg/kg	9.0E-5	kg/day	0.006	μg/day
	Salmonberry	Lead	147	μg/kg	3.8E-4	kg/day	0.06	μg/day
	Sourdock	Lead	211	μg/kg	5.8E-5	kg/day	0.01	μg/day
						Total	1.6	μg/day
Based on Alternative Caribou FI=0.2								
	Caribou	Lead	195	μg/kg	1.7E-2	kg/day	3.3	μg/day
	Fish	Lead	10.2	μg/kg	5.6E-3	kg/day	0.06	μg/day
	Ptarmigan	Lead	69.3	μg/kg	9.0E-5	kg/day	0.006	μg/day
	Salmonberry	Lead	147	μg/kg	3.8E-4	kg/day	0.06	μg/day
	Sourdock	Lead	211	μg/kg	5.8E-5	kg/day	0.01	μg/day
						Total	3.4	μg/day

Note: AT - averaging time

BW - body weight

Cf - concentration in food

CR_f - consumption rate for food

ED - exposure duration

EF - exposure frequency

EPC - exposure point concentration

FI - fractional intake

FI_{WF} - fractional intake of food from site for workers

[a] Daily Food Intake = $CR_f \times 10^{-3} \times FI_{WF} \times EF \times ED / (BW \times AT)$

Derivation of consumption rates presented in Table 5-11. All variables defined in Section 5.2.2.2.3.
The daily food intake incorporates the site FI of 0.09, giving a worker/subistence user FI_{WF} of 0.045, or the alternative caribou FI of 0.2, giving a worker/subsistence user FI_{WF} of 0.1.

[b] Chronic Daily Intake (CDI) (mg/kg-day) = C_f x Daily Food Intake

Table 5-15. Exposure assumptions used to calculate risk for non-lead metals for adults in the combined worker/ subsistence user scenario

Scenario Timeframe: Current/Future
Receptor Population: Combined Worker/Subsistence Use
Receptor Age: Adult

Exposure Medium and Route	Parameter Code	Parameter Definition	Units	Value	Rationale/ Reference	Intake Equation/ Model Name
Soil Ingestion						
	C_S	Chemical concentration in soil	mg/kg	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/mg	0.000001	--	C_S x CF x IR_S x (FI_{S_W} + FI_{S_S}) x EF x ED / (BW x AT)
	IR_S	Ingestion rate for soil	mg soil/day	100	DEC (2004a)	
	FI_{S_W}	Fractional intake of site soil for workers	unitless	0.67	Area calculated[a]	
	FI_{S_S}	Fractional intake of site soil during subsistence activities	unitless	0.03	Area calculated[a]	
	EF	Exposure frequency	days/year	200	DEC (2002)	
	ED	Exposure duration	years	25	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	9,125	DEC (2002)	
Water Ingestion						
	C_W	Chemical concentration in surface water	µg/L	see Table 5-1	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	mg/µg	0.001	--	C_W x CF x IR_W x FI_{WW} x EF x ED / (BW x AT)
	IR_W	Ingestion rate for surface water	L/day	2	DEC (2002)	
	FI_{WW}	Fractional intake of water from site for workers	unitless	0.045	Area calculated[a]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	25	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	9,125	DEC (2002)	
Food Ingestion						
	C_F	Chemical concentration in food[b]	mg/kg-wet wt.	see Table 5-2	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion factor	kg/g	0.001	--	C_F x CR_F x CF x FI_{wf} x EF x ED / (BW x AT)
	CR_F	Consumption rate for food[b]	g/day	see Table 5-11	DFG (2001a)	
	FI_{WF}	Fractional intake of food from site for workers	unitless	0.045	Area calculated[a,c]	
	EF	Exposure frequency	days/year	365	DEC (2002)	
	ED	Exposure duration	years	25	DEC (2002)	
	BW	Body weight	kg	70	DEC (2002)	
	AT	Averaging time	days	9,125	DEC (2002)	

Note: -- - not applicable
RME - reasonable maximum exposure

[a] Based on a calculation of the fraction of the total subsistence use area comprised of the site, combined with the relative amount of time individuals spend at work vs. off work (see Section 5.2.3.2).

[b] A separate calculation is done for each food item.

[c] Risks are calculated using both the site-specific FI of 0.09, giving a worker/subsistence user FI_{WF} of 0.045, and the alternative caribou FI of 0.20, giving a worker/subsistence user FI_{WF} of 0.10.

Table 5-16. Noncancer toxicity data—oral reference doses

Chemical of Concern	Oral Chronic RfD (mg/kg-day)	Primary Target Organ or System	Uncertainty Factor	Source	Date RfD Accessed
Inorganics					
Antimony	0.0004	Longevity; metabolic	1,000	IRIS	2/1/06
Barium	0.2	Kidney	300	IRIS	2/1/06
Cadmium (food and soil)	0.001	Kidney	10	IRIS	2/1/06
Cadmium (water)	0.0005	Kidney	10	IRIS	2/1/06
Lead	NA	NA	NA	NA	NA
Thallium	0.00008	Liver enzymes	3,000	IRIS	2/1/06
Zinc	0.3	Iron and copper status	3	IRIS	2/1/06

Note: IRIS - Integrated Risk Information System
NA - not applicable
RfD - reference dose

[a] No adverse effects were observed in the studies on which the RfD is based.

Table 5-17. Results for IEUBK child lead model

Scenario Timeframe: Current/Future Exposure Medium: Surface soil, foods, water Exposure Point: DMTS surface soil and subsistence foods Receptor Population: Child subsistence Receptor Age: Child

	Area-weighted Soil Lead				Area-averaged Soil Lead			
	Site-Specific Bioavailability		Default Bioavailability		Site-Specific Bioavailability		Default Bioavailability	
	Geometric Mean Blood Lead (ug/dL)	Percent Chance of Exceeding 10 ug/dL	Geometric Mean Blood Lead (ug/dL)	Percent Chance of Exceeding 10 ug/dL	Geometric Mean Blood Lead (ug/dL)	Percent Chance of Exceeding 10 ug/dL	Geometric Mean Blood Lead (ug/dL)	Percent Chance of Exceeding 10 ug/dL
Site fractional intake	1.0	< 0.0005	1.2	< 0.0005	1.1	< 0.0005	1.6	0.005
Alternative caribou fractional intake	1.3	0.001	1.5	0.004	1.5	0.002	1.9	0.023

Table 5-18. Results for adult lead model

Scenario Timeframe: Current/Future
Exposure Medium: Surface soil and foods
Exposure Point: DMTS surface soil and subsistence foods
Receptor Population: Combined worker/subsistence user
Receptor Age: Adult

Exposure Variable	Description of Exposure Variable	Units	Area-weighted Soil Lead: Site-Specific Bioavailability	Area-weighted Soil Lead: Default Bioavailability	Area-averaged Soil Lead: Site-Specific Bioavailability	Area-averaged Soil Lead: Default Bioavailability
C_S	Soil lead concentration average	μg/g or ppm	282	282	726	726
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic slope factor	μg/dL per μg/day	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.1	2.1	2.1	2.1
PbB_0	Baseline PbB	μg/dL	1.53	1.53	1.53	1.53
IR_S	Soil ingestion rate (including soil and dust)	g/day	0.100	0.100	0.100	0.100
AF_S	Absorption fraction	--	0.039	0.12	0.039	0.12
EF_S	Exposure frequency	days/year	200	200	200	200
FI_{S_W}	Fractional intake for soil ingestion while at work	--	0.67	0.67	0.67	0.67
FI_{S_S}	Fractional intake for soil ingestion during subsistence activities	--	0.03	0.03	0.03	0.03
CDI	Chronic daily intake of lead from subsistence foods (see Table 5-14)	μg/day	1.6	1.6	1.6	1.6
AF_f	Absorption fraction for food	--	0.20	0.20	0.20	0.20
EF_f	Exposure frequency for food	days/year	182.5	182.5	182.5	182.5
AT	Averaging time	days/year	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	μg/dL	1.8	2.1	2.0	2.9
PbB_{fetal}	PbB among fetuses of adult workers, geometric mean	μg/dL	1.6	1.9	1.8	2.6
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	μg/dL	5.4	6.5	6.2	9.0
PbB_t	Target PbB level of concern (e.g., 10 μg/dL)	μg/dL	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distribution	%	0.7%	1.3%	1.1%	3.7%

Note: $PbB_{adult} = PbB0 + (BKSF \times ((C_S \times IR_{S\_W} \times (FI_{S\_W} + FI_{S\_S}) \times EF_S \times AF_S) + (CDI \times EF_F \times AF_F)))/AT$

$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$

DMTS - DeLong Mountain Regional Transportation System
PbB - blood lead

Table 5-19. Results for adult lead model using alternative caribou fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Surface soil and foods
Exposure Point: DMTS surface soil and subsistence foods
Receptor Population: Combined worker/subsistence user
Receptor Age: Adult

Exposure Variable	Description of Exposure Variable	Units	Area-weighted Soil Lead Site-Specific Bioavailability	Area-weighted Soil Lead Default Bioavailability	Area-averaged Soil Lead Site-Specific Bioavailability	Area-averaged Soil Lead Default Bioavailability
C_S	Soil lead concentration average	μg/g or ppm	282	282	726	726
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic slope factor	μg/dL per μg/day	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.1	2.1	2.1	2.1
PbB_0	Baseline PbB	μg/dL	1.53	1.53	1.53	1.53
IR_S	Soil ingestion rate (including soil and dust)	g/day	0.100	0.100	0.100	0.100
AF_S	Absorption fraction	--	0.039	0.12	0.039	0.12
EF_S	Exposure frequency	days/year	200	200	200	200
FI_{S_W}	Fractional intake for soil ingestion while at work	--	0.67	0.67	0.67	0.67
FI_{S_S}	Fractional intake for soil ingestion during subsistence activities	--	0.03	0.03	0.03	0.03
CDI	Chronic daily intake of lead from subsistence foods (see Table 5-14)	μg/day	3.4	3.4	3.4	3.4
AF_f	Absorption fraction for food	--	0.20	0.20	0.20	0.20
EF_f	Exposure frequency for food	days/year	182.5	182.5	182.5	182.5
AT	Averaging time	days/year	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	μg/dL	1.8	2.2	2.1	3.0
PbB_{fetal}	PbB among fetuses of adult workers, geometric mean	μg/dL	1.7	2.0	1.9	2.7
$PbB_{fetal,\ 0.95}$	95th percentile PbB among fetuses of adult workers	μg/dL	5.6	6.7	6.4	9.2
PbB_t	Target PbB level of concern (e.g., 10 μg/dL)	μg/dL	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distribution	%	0.8%	1.5%	1.3%	4.0%

Note: $PbB_{adult} = PbB0 + (BKSF \times ((C_S \times IR_{S\_W} \times (FI_{S\_W} + FI_{S\_S}) \times EF_S \times AF_S) + (CDI \times EF_F \times AF_F)))\ /AT$

$PbB_{fetal,\ 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$

DMTS - DeLong Mountain Regional Transportation System
PbB - blood lead

Table 5-20. Noncancer hazards for adult subsistence soil ingestion based on area-weighted soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Weighted Surface Soil
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	6.5	mg/kg	4.6E-7	mg/kg-day	4.0E-4	mg/kg-day	0.001
	Barium	3,219	mg/kg	2.3E-4	mg/kg-day	2.0E-1	mg/kg-day	0.001
	Cadmium	10.8	mg/kg	7.6E-7	mg/kg-day	1.0E-3	mg/kg-day	0.0008
	Thallium	0.49	mg/kg	3.4E-8	mg/kg-day	8.0E-5	mg/kg-day	0.0004
	Zinc	1,399	mg/kg	9.9E-5	mg/kg-day	3.0E-1	mg/kg-day	0.0003
						Total Hazard Index for All CoPCs		0.004

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-21. Noncancer hazards for adult subsistence soil ingestion based on area-averaged soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Averaged Surface Soil
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	11.5	mg/kg	8.1E-7	mg/kg-day	4.0E-4	mg/kg-day	0.002
	Barium	2,407	mg/kg	1.7E-4	mg/kg-day	2.0E-1	mg/kg-day	0.0008
	Cadmium	23.8	mg/kg	1.7E-6	mg/kg-day	1.0E-3	mg/kg-day	0.002
	Thallium	0.62	mg/kg	4.4E-8	mg/kg-day	8.0E-5	mg/kg-day	0.0005
	Zinc	3,691	mg/kg	2.6E-4	mg/kg-day	3.0E-1	mg/kg-day	0.0009
							Total Hazard Index for All CoPCs	0.006

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-22. Noncancer hazards for child subsistence soil ingestion based on area-weighted soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Weighted Surface Soil
Receptor Population: Subsistence User
Receptor Age: Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	6.5	mg/kg	4.2E-6	mg/kg-day	4.0E-4	mg/kg-day	0.01
	Barium	3,219	mg/kg	2.1E-3	mg/kg-day	2.0E-1	mg/kg-day	0.01
	Cadmium	10.8	mg/kg	7.1E-6	mg/kg-day	1.0E-3	mg/kg-day	0.007
	Thallium	0.49	mg/kg	3.2E-7	mg/kg-day	8.0E-5	mg/kg-day	0.004
	Zinc	1,399	mg/kg	9.2E-4	mg/kg-day	3.0E-1	mg/kg-day	0.003
						Total Hazard Index for All CoPCs		0.04

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-23. Noncancer hazards for child subsistence soil ingestion based on area-averaged soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Averaged Surface Soil
Receptor Population: Subsistence User
Receptor Age: Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	11.5	mg/kg	7.6E-6	mg/kg-day	4.0E-4	mg/kg-day	0.02
	Barium	2,407	mg/kg	1.6E-3	mg/kg-day	2.0E-1	mg/kg-day	0.008
	Cadmium	23.8	mg/kg	1.6E-5	mg/kg-day	1.0E-3	mg/kg-day	0.02
	Thallium	0.62	mg/kg	4.1E-7	mg/kg-day	8.0E-5	mg/kg-day	0.005
	Zinc	3,691	mg/kg	2.4E-3	mg/kg-day	3.0E-1	mg/kg-day	0.008
						Total Hazard Index for All CoPCs		0.06

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-24. Noncancer hazards for adult subsistence surface water ingestion

Scenario Timeframe: Current/Future
Exposure Medium: Surface Water
Exposure Point: Site Stream Surface Water
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.14	μg/L	3.6E-7	mg/kg-day	8.0E-5	mg/kg-day	0.005
							Total Hazard Index for All CoPCs	0.005

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-25. Noncancer hazards for child subsistence surface water ingestion

Scenario Timeframe: Current/Future
Exposure Medium: Surface Water
Exposure Point: Site Stream Surface Water
Receptor Population: Subsistence User
Receptor Age: Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.14	µg/L	8.5E-7	mg/kg-day	8.0E-5	mg/kg-day	0.01
							Total Hazard Index for All CoPCs	0.01

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-26. Noncancer hazards for adult subsistence caribou consumption based on site fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	2.7E-4	mg/kg-day	2.0E-1	mg/kg-day	0.001
	Cadmium	0.22	mg/kg	4.7E-5	mg/kg-day	1.0E-3	mg/kg-day	0.05
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	8.0E-3	mg/kg-day	3.0E-1	mg/kg-day	0.03
							Total Hazard Index for All CoPCs	0.07

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-27. Noncancer hazards for adult subsistence caribou consumption based on alternative caribou fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	6.1E-4	mg/kg-day	2.0E-1	mg/kg-day	0.003
	Cadmium	0.22	mg/kg	1.0E-4	mg/kg-day	1.0E-3	mg/kg-day	0.1
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	1.8E-2	mg/kg-day	3.0E-1	mg/kg-day	0.06
						Total Hazard Index for All CoPCs		0.2

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-28. Noncancer hazards for child subsistence caribou consumption based on site fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	6.4E-4	mg/kg-day	2.0E-1	mg/kg-day	0.003
	Cadmium	0.22	mg/kg	1.1E-4	mg/kg-day	1.0E-3	mg/kg-day	0.1
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	1.9E-2	mg/kg-day	3.0E-1	mg/kg-day	0.06
						Total Hazard Index for All CoPCs		0.2

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-29. Noncancer hazards for child subsistence caribou consumption based on alternative caribou fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	1.4E-3	mg/kg-day	2.0E-1	mg/kg-day	0.007
	Cadmium	0.22	mg/kg	2.4E-4	mg/kg-day	1.0E-3	mg/kg-day	0.2
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	4.1E-2	mg/kg-day	3.0E-1	mg/kg-day	0.1
					Total Hazard Index for All CoPCs			0.4

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-30. Noncancer hazards for adult subsistence fish consumption

Scenario Timeframe: Current/Future
Exposure Medium: Fish
Exposure Point: Site Fish
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.0026	mg/kg	4.2E-7	mg/kg-day	8.0E-5	mg/kg-day	0.005
						Total Hazard Index for All CoPCs		0.005

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-31. Noncancer hazards for child subsistence fish consumption

Scenario Timeframe: Current/Future
Exposure Medium: Fish
Exposure Point: Site Fish
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.0026	mg/kg	9.7E-7	mg/kg-day	8.0E-5	mg/kg-day	0.01
							Total Hazard Index for All CoPCs	0.01

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-32. Noncancer hazards for adult subsistence ptarmigan consumption

Scenario Timeframe: Current/Future
Exposure Medium: Ptarmigan
Exposure Point: Site Ptarmigan
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.52	mg/kg	1.3E-6	mg/kg-day	2.0E-1	mg/kg-day	0.000007
	Cadmium	3.5	mg/kg	9.1E-6	mg/kg-day	1.0E-3	mg/kg-day	0.009
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	15.7	mg/kg	4.0E-5	mg/kg-day	3.0E-1	mg/kg-day	0.0001
							Total Hazard Index for All CoPCs	0.009

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-33. Noncancer hazards for child subsistence ptarmigan consumption

Scenario Timeframe: Current/Future
Exposure Medium: Ptarmigan
Exposure Point: Site Ptarmigan
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.52	mg/kg	3.1E-6	mg/kg-day	2.0E-1	mg/kg-day	0.00002
	Cadmium	3.5	mg/kg	2.1E-5	mg/kg-day	1.0E-3	mg/kg-day	0.02
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	15.7	mg/kg	9.4E-5	mg/kg-day	3.0E-1	mg/kg-day	0.0003
						Total Hazard Index for All CoPCs		0.02

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-34. Noncancer hazards for adult subsistence berry consumption

Scenario Timeframe: Current/Future
Exposure Medium: Berries
Exposure Point: Site Salmonberries
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.078	mg/kg	8.4E-7	mg/kg-day	2.0E-1	mg/kg-day	0.000004
	Cadmium	0.052	mg/kg	5.6E-7	mg/kg-day	1.0E-3	mg/kg-day	0.0006
	Zinc	4.7	mg/kg	5.1E-5	mg/kg-day	3.0E-1	mg/kg-day	0.0002
							Total Hazard Index for All CoPCs	0.0007

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-35. Noncancer hazards for child subsistence berry consumption

Scenario Timeframe: Current/Future
Exposure Medium: Berries
Exposure Point: Site Salmonberries
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.078	mg/kg	2.0E-6	mg/kg-day	2.0E-1	mg/kg-day	0.00001
	Cadmium	0.052	mg/kg	1.3E-6	mg/kg-day	1.0E-3	mg/kg-day	0.001
	Zinc	4.7	mg/kg	1.2E-4	mg/kg-day	3.0E-1	mg/kg-day	0.0004
							Total Hazard Index for All CoPCs	0.002

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-36. Noncancer hazards for adult subsistence sourdock consumption

Scenario Timeframe: Current/Future
Exposure Medium: Sourdock
Exposure Point: Site Sourdock
Receptor Population: Subsistence User
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	0.012	mg/kg	2.1E-8	mg/kg-day	4.0E-4	mg/kg-day	0.00005
	Barium	10.6	mg/kg	1.8E-5	mg/kg-day	2.0E-1	mg/kg-day	0.00009
	Cadmium	0.013	mg/kg	2.2E-8	mg/kg-day	1.0E-3	mg/kg-day	0.00002
	Thallium	0.00049	mg/kg	8.2E-10	mg/kg-day	8.0E-5	mg/kg-day	0.00001
	Zinc	5.4	mg/kg	9.0E-6	mg/kg-day	3.0E-1	mg/kg-day	0.00003
						Total Hazard Index for All CoPCs		0.0002

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-37. Noncancer hazards for child subsistence sourdock consumption

Scenario Timeframe: Current/Future
Exposure Medium: Sourdock
Exposure Point: Site Sourdock
Receptor Population: Subsistence User
Receptor Age: Young Child

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	0.012	mg/kg	5.2E-8	mg/kg-day	4.0E-4	mg/kg-day	0.0001
	Barium	10.6	mg/kg	4.5E-5	mg/kg-day	2.0E-1	mg/kg-day	0.0002
	Cadmium	0.013	mg/kg	5.5E-8	mg/kg-day	1.0E-3	mg/kg-day	0.00005
	Thallium	0.00049	mg/kg	2.1E-9	mg/kg-day	8.0E-5	mg/kg-day	0.00003
	Zinc	5.4	mg/kg	2.3E-5	mg/kg-day	3.0E-1	mg/kg-day	0.00008
						Total Hazard Index for All CoPCs		0.0005

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-38. Noncancer hazards for adult DMTS worker/subsistence user soil ingestion based on area-weighted soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Weighted Surface Soil
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	6.5	mg/kg	3.5E-6	mg/kg-day	4.0E-4	mg/kg-day	0.009
	Barium	3,219	mg/kg	1.8E-3	mg/kg-day	2.0E-1	mg/kg-day	0.009
	Cadmium	10.8	mg/kg	5.9E-6	mg/kg-day	1.0E-3	mg/kg-day	0.006
	Thallium	0.49	mg/kg	2.6E-7	mg/kg-day	8.0E-5	mg/kg-day	0.003
	Zinc	1,399	mg/kg	7.6E-4	mg/kg-day	3.0E-1	mg/kg-day	0.003
							Total Hazard Index for All CoPCs	0.03

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-39. Noncancer hazards for adult DMTS worker/subsistence user soil ingestion based on area-averaged soil concentrations

Scenario Timeframe: Current/Future
Exposure Medium: Surface Soil
Exposure Point: DMTS Area Averaged Surface Soil
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	11.5	mg/kg	6.3E-6	mg/kg-day	4.0E-4	mg/kg-day	0.016
	Barium	2,407	mg/kg	1.3E-3	mg/kg-day	2.0E-1	mg/kg-day	0.007
	Cadmium	23.8	mg/kg	1.3E-5	mg/kg-day	1.0E-3	mg/kg-day	0.013
	Thallium	0.62	mg/kg	3.4E-7	mg/kg-day	8.0E-5	mg/kg-day	0.004
	Zinc	3,691	mg/kg	2.0E-3	mg/kg-day	3.0E-1	mg/kg-day	0.007
						Total Hazard Index for All CoPCs		0.05

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-40. Noncancer hazards for adult DMTS worker/subsistence user surface water ingestion

Scenario Timeframe: Current/Future
Exposure Medium: Stream Surface Water
Exposure Point: Site Stream Surface Water
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.14	μg/L	1.8E-7	mg/kg-day	8.0E-5	mg/kg-day	0.002
							Total Hazard Index for All CoPCs	0.002

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-41. Noncancer hazards for adult DMTS worker/subsistence user caribou consumption based on site fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	1.4E-4	mg/kg-day	2.0E-1	mg/kg-day	0.0007
	Cadmium	0.22	mg/kg	2.3E-5	mg/kg-day	1.0E-3	mg/kg-day	0.02
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	4.0E-3	mg/kg-day	3.0E-1	mg/kg-day	0.01
							Total Hazard Index for All CoPCs	0.04

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-42. Noncancer hazards for adult DMTS worker/subsistence user caribou consumption based on alternative caribou fractional intake

Scenario Timeframe: Current/Future
Exposure Medium: Caribou
Exposure Point: Site Caribou
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	--	mg/kg	--	mg/kg-day	4.0E-4	mg/kg-day	--
	Barium	1.3	mg/kg	3.0E-4	mg/kg-day	2.0E-1	mg/kg-day	0.002
	Cadmium	0.22	mg/kg	5.2E-5	mg/kg-day	1.0E-3	mg/kg-day	0.05
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	36.8	mg/kg	8.8E-3	mg/kg-day	3.0E-1	mg/kg-day	0.03
							Total Hazard Index for All CoPCs	0.08

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-43. Noncancer hazards for adult DMTS worker/subsistence user fish consumption

Scenario Timeframe: Current/Future
Exposure Medium: Fish
Exposure Point: Site Fish
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Thallium	0.0026	mg/kg	2.1E-7	mg/kg-day	8.0E-5	mg/kg-day	0.003
							Total Hazard Index for All CoPCs	0.003

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-44. Noncancer hazards for adult DMTS worker/subsistence user ptarmigan consumption

Scenario Timeframe: Current/Future
Exposure Medium: Ptarmigan
Exposure Point: Site Ptarmigan
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.52	mg/kg	6.6E-7	mg/kg-day	2.0E-1	mg/kg-day	0.000003
	Cadmium	3.5	mg/kg	4.5E-6	mg/kg-day	1.0E-3	mg/kg-day	0.005
	Thallium	--	mg/kg	--	mg/kg-day	8.0E-5	mg/kg-day	--
	Zinc	15.7	mg/kg	2.0E-5	mg/kg-day	3.0E-1	mg/kg-day	0.00007
							Total Hazard Index for All CoPCs	0.005

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-45. Noncancer hazards for adult DMTS worker/subsistence user berry consumption

Scenario Timeframe: Current/Future
Exposure Medium: Berries
Exposure Point: Site Salmonberries
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Barium	0.078	mg/kg	4.2E-7	mg/kg-day	2.0E-1	mg/kg-day	0.000002
	Cadmium	0.052	mg/kg	2.8E-7	mg/kg-day	1.0E-3	mg/kg-day	0.0003
	Zinc	4.7	mg/kg	2.5E-5	mg/kg-day	3.0E-1	mg/kg-day	0.00008
							Total Hazard Index for All CoPCs	0.0004

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-46. Noncancer hazards for adult DMTS worker/subsistence user sourdock consumption

Scenario Timeframe: Current/Future
Exposure Medium: Sourdock
Exposure Point: Site Sourdock
Receptor Population: Worker/Subsistence
Receptor Age: Adult

Exposure Route	CoPC	EPC Value[a]	EPC Units	Intake	Intake Units	Reference Dose[b]	Reference Dose Units	Hazard Quotient
Ingestion								
	Antimony	0.012	mg/kg	1.0E-8	mg/kg-day	4.0E-4	mg/kg-day	0.00003
	Barium	10.6	mg/kg	8.8E-6	mg/kg-day	2.0E-1	mg/kg-day	0.00004
	Cadmium	0.013	mg/kg	1.1E-8	mg/kg-day	1.0E-3	mg/kg-day	0.00001
	Thallium	0.00049	mg/kg	4.1E-10	mg/kg-day	8.0E-5	mg/kg-day	0.000005
	Zinc	5.4	mg/kg	4.5E-6	mg/kg-day	3.0E-1	mg/kg-day	0.00001
						Total Hazard Index for All CoPCs		0.0001

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
EPC - exposure point concentration
UCL - upper confidence limit

[a] Values for all chemicals reflect the lower of either the 95th percentile UCL on the mean or the maximum concentration.

[b] Toxicity values obtained from the EPA Integrated Risk Information System (IRIS) (January 2005).

Table 5-47. Summary of total hazard indices for reasonable maximum exposure scenarios

Receptor/Exposure Pathway	Adult Hazard Index	Adult % Contribution by Pathway	Young Child Hazard Index	Young Child % Contribution by Pathway	Chemicals Accounting for 90 percent of Hazard Indices for each Pathway
Subsistence User—Current/Future					
Surface soil ingestion, area-weighted	0.004	4%	0.04	14%	Antimony, barium, cadmium, thallium
Surface soil ingestion, area-averaged	0.006	6%	0.06	22%	Antimony, cadmium, zinc, barium
Water ingestion	0.005	5%	0.01	4%	Thallium
Caribou consumption	0.07	76%	0.2	68%	Cadmium, zinc
Fish consumption	0.005	5%	0.01	5%	Thallium
Ptarmigan consumption	0.009	9.3%	0.02	8.4%	Cadmium
Berry consumption	0.0007	0.7%	0.002	0.7%	Cadmium, zinc
Sourdock consumption	0.0002	0.2%	0.0005	0.2%	Barium, antimony, zinc
Total for Subsistence User based on area-weighted soil	**0.1**	100%	**0.3**	100%	
Total for Subsistence User based on area-averaged soil	**0.1**	100%	**0.3**	100%	
Worker—Current/Future					
Surface soil ingestion, area-weighted	0.03	38%			Antimony, barium, cadmium, thallium
Surface soil ingestion, area-averaged	0.05	60%			Antimony, cadmium, thallium, barium
Water ingestion	0.002	3%			Thallium
Caribou consumption	0.04	49%			Cadmium, zinc
Fish consumption	0.003	3%			Thallium
Ptarmigan consumption	0.005	6.0%			Cadmium
Berry consumption	0.0004	0.5%			Cadmium, zinc
Sourdock consumption	0.0001	0.1%			Barium, antimony, zinc
Total for DMTS Worker based on area-weighted soil	**0.08**	100%			
Total for Subsistence User based on area-averaged soil	**0.09**	100%			

Note: DMTS - DeLong Mountain Regional Transportation System

Lead risks are evaluated using separate models that do not predict hazard indices, so they cannot be directly compared to risks from other metals. Thus, the contribution of lead to pathway risks is not included.

Table 5-48. Summary of total hazard indices based on reasonable maximum exposure scenarios with alternative caribou fractional intake

	Adult		Young Child		
Receptor/Exposure Pathway	Hazard Index	% Contribution by Pathway	Hazard Index	% Contribution by Pathway	Chemicals Accounting for 90 percent of Hazard Indices for each Pathway
Subsistence User—Current/Future					
Surface soil ingestion, area-weighted	0.004	2%	0.04	8%	Antimony, barium, cadmium, thallium
Surface soil ingestion, area-averaged	0.006	3%	0.06	12%	Antimony, cadmium, zinc, barium
Water ingestion	0.005	2%	0.01	2%	Thallium
Caribou consumption	0.2	88%	0.4	83%	Cadmium, zinc
Fish consumption	0.005	3%	0.01	3%	Thallium
Ptarmigan consumption	0.009	4.8%	0.02	4.6%	Cadmium
Berry consumption	0.0007	0.4%	0.002	0.4%	Cadmium, zinc
Sourdock consumption	0.0002	0.1%	0.0005	0.1%	Barium, antimony, zinc
Total for Subsistence User based on area-weighted soil	**0.2**	100%	**0.5**	100%	
Total for Subsistence User based on area-averaged soil	**0.2**	100%	**0.5**	100%	
Worker—Current/Future					
Surface soil ingestion, area-weighted	0.03	24%			Antimony, barium, cadmium, thallium
Surface soil ingestion, area-averaged	0.05	38%			Antimony, cadmium, thallium, barium
Water ingestion	0.002	2%			Thallium
Caribou consumption	0.08	68%			Cadmium, zinc
Fish consumption	0.003	2%			Thallium
Ptarmigan consumption	0.005	3.8%			Cadmium
Berry consumption	0.0004	0.3%			Cadmium, zinc
Sourdock consumption	0.0001	0.1%			Barium, antimony, zinc
Total for DMTS Worker based on area-weighted soil	**0.1**	100%			
Total for Subsistence User based on area-averaged soil	**0.1**	100%			

Note: DMTS - DeLong Mountain Regional Transportation System

Lead risks are evaluated using separate models that do not predict hazard indices, so they cannot be directly compared to risks from other metals. Thus, the contribution of lead to pathway risks is not included.

Table G-25. Analytical results for salmonberry

Survey	Survey Station	Date	Sample ID	Field Replicate	Total Solids (dry wt. as % of wet wt. or volume) (% wet)	Antimony (mg/kg wet)	Barium (mg/kg wet)	Cadmium (mg/kg wet)	Lead (mg/kg wet)	Thallium (mg/kg wet)	Zinc (mg/kg wet)
2001 salmonberry results used in human health risk assessment (onsite)											
ADEC01	01	08/20/01	OIDMTO01SY	0	13.0			0.013	0.015		2.6
ADEC01	02	08/20/01	OIDMTO02SY	0	13.0			0.018	0.029		3.4
ADEC01	03	08/20/01	OIDMTO03SY	0	13.3			0.014	0.035		2.7
ADEC01	04	08/20/01	OIDMTO04SY	0	13.8			0.018	0.022		2.8
ADEC01	05	08/20/01	OIDMTO05SY	0	13.2			0.020	0.030		3.1
ADEC01	06	08/20/01	OIDMTO06SY	0	11.9			0.024	0.040		3.1
ADEC01	07	08/21/01	OIDMTO07SY	0	12.9			0.025	0.037		3.1
ADEC01	08	08/21/01	OIDMTO08SY	0	12.9			0.031	0.026		3.8
ADEC01	09	08/21/01	OIDMTO09SY	0	13.7			0.023	0.015		3.1
ADEC01	10	08/21/01	OIDMTO10SY	0	12.7			0.022	0.020		2.9
ADEC01	43	09/07/01	01DMT043SY	0	14.2			0.058	0.20		4.5
ADEC01	44	09/07/01	01DMT044SY	0	14.2			0.056	0.17		4.5
ADEC01	45	09/07/01	01DMT045SY	0	14.7			0.081	0.24		4.6
ADEC01	46	09/07/01	01DMT046SY	1	15.9			0.060	0.31		4.8
ADEC01	47	09/07/01	01DMT046SY	2	15.9			0.067	0.34		5.3
FUGDST01	HR01-01B	08/26/01	HR-01-01-B	0	13.1			0.21	1.8		9.2
FUGDST01	HR01-02B	08/21/01	HR-01-02-B	0	12.0			0.042	0.13		3.0
FUGDST01	HR04-01A	08/20/01	HR-04-01-B	0	11.5			0.048	0.48		4.3
FUGDST01	HR04-02B	08/21/01	HR-04-02-B	0	11.8			0.0069	0.055		1.9
FUGDST01	PO-03B	08/23/01	PO-03-B	0	16.4			0.068	0.093		3.6
FUGDST01	PO-17B	08/23/01	PO-17-B	0	12.4			0.045	0.085		2.2
FUGDST01	PO-18B	08/24/01	PO-18-B	0	14.5			0.033	0.12		3.7
2004 salmonberry results used in human health risk assessment (onsite)											
PHASE2RA	A-1B	7/31/2004	SB-023	0	18.7	0.00094 *U*	0.050	0.043	0.0082	0.00037 *U*	7.5
PHASE2RA	A-2B	7/31/2004	SB-025	0	16.9	0.00085 *U*	0.048	0.039	0.0093	0.00034 *U*	5.6
PHASE2RA	A-3B	7/31/2004	SB-027	0	17.1	0.00086 *U*	0.050	0.034	0.0041	0.00034 *U*	5.9
PHASE2RA	A-4B	7/31/2004	SB-029	0	16.3	0.00082 *U*	0.022	0.024	0.0034	0.00033 *U*	5.6
PHASE2RA	A-5B	7/31/2004	SB-031	0	14.8	0.00074 *U*	0.066	0.025	0.0084	0.00030 *U*	4.9
PHASE2RA	A-6B	7/30/2004	SB-033	0	15.2	0.00076 *U*	0.078	0.021	0.0011 *U*	0.00030 *U*	5.7
2004 salmonberry results not used in human health risk assessment (offsite)											
PHASE2RA	A-1B	7/31/2004	SB-024W	0	17.3	0.00087 *U*	0.065	0.039	0.010	0.00035 *U*	7.0
PHASE2RA	A-2B	7/31/2004	SB-026W	0	16.8	0.00084 *U*	0.044	0.037	0.0091	0.00034 *U*	6.0
PHASE2RA	A-3B	7/31/2004	SB-028W	0	16.1	0.00081 *U*	0.085	0.029	0.0072	0.00032 *U*	5.8
PHASE2RA	A-4B	7/31/2004	SB-030W	0	16.2	0.00081 *U*	0.022	0.027	0.0053	0.00032 *U*	5.6
PHASE2RA	A-5B	7/31/2004	SB-032W	0	15.1	0.00076 *U*	0.038	0.021	0.0027	0.00030 *U*	5.2
PHASE2RA	A-6B	7/30/2004	SB-034W	0	16.1	0.00081 *U*	0.15	0.024	0.0055	0.00032 *U*	6.2
PHASE2RA	B-1B	7/30/2004	SB-013	0	16.1	0.00081 *U*	0.27	0.022	0.0011 *U*	0.00032 *U*	5.2
PHASE2RA	B-1B	7/30/2004	SB-014W	0	16.2	0.00081 *U*	0.46	0.028	0.0011 *U*	0.00032 *U*	4.1

Table G-25. (cont.)

Survey	Survey Station	Date	Sample ID	Field Replicate	Total Solids (dry wt. as % of wet wt. or volume) (% wet)	Antimony (mg/kg wet)	Barium (mg/kg wet)	Cadmium (mg/kg wet)	Lead (mg/kg wet)	Thallium (mg/kg wet)	Zinc (mg/kg wet)
2004 salmonberry results not used in human health risk assessment (offsite) (cont.)											
PHASE2RA	B-2B	7/31/2004	SB-015	0	18.3	0.00092 *U*	0.45	0.053	0.0013 *U*	0.00037 *U*	5.0
PHASE2RA	B-2B	7/31/2004	SB-016W	0	16.1	0.00081 *U*	0.55	0.058	0.0013	0.00032 *U*	3.5
PHASE2RA	B-3B	7/31/2004	SB-017	0	16.1	0.00081 *U*	0.08	0.027	0.0011 *U*	0.00032 *U*	3.4
PHASE2RA	B-3B	7/31/2004	SB-018W	0	17.3	0.00087 *U*	0.11	0.032	0.0029	0.00035 *U*	3.4
PHASE2RA	B-4B	7/31/2004	SB-019	0	13.8	0.00069 *U*	0.23	0.043	0.0010 *U*	0.00028 *U*	4.5
PHASE2RA	B-4B	7/31/2004	SB-020W	0	14.4	0.00072 *U*	0.23	0.038	0.0010 *U*	0.00029 *U*	4.6
PHASE2RA	B-5B	7/31/2004	SB-021	0	14.8	0.00074 *U*	0.25	0.015	0.0013	0.00030 *U*	3.7
PHASE2RA	B-5B	7/31/2004	SB-022W	0	17.1	0.00086 *U*	0.14	0.023	0.0012 *U*	0.00034 *U*	5.1
PHASE2RA	C-1B	7/30/2004	SB-001	0	14.5	0.00073 *U*	0.20	0.021	0.0019	0.00029 *U*	3.6
PHASE2RA	C-1B	7/30/2004	SB-002W	0	15.5	0.00078 *U*	0.17	0.021	0.0011 *U*	0.00031 *U*	4.5
PHASE2RA	C-2B	7/31/2004	SB-003	0	15.3	0.00077 *U*	0.26	0.021	0.0012	0.00031 *U*	5.7
PHASE2RA	C-2B	7/31/2004	SB-004W	0	15.6	0.00078 *U*	0.40	0.033	0.0016	0.00031 *U*	4.6
PHASE2RA	C-3B	7/31/2004	SB-005	1	15.4	0.00077 *U*	0.34 *J*	0.020	0.0011 *U*	0.00031 *U*	4.0
PHASE2RA	C-3B	7/31/2004	SB-005	2	17.5	0.00088 *U*	0.15 *J*	0.020	0.0012 *U*	0.00035 *U*	5.5
PHASE2RA	C-3B	7/31/2004	SB-006W	1	14.8	0.00074 *U*	0.28	0.024	0.0010 *U*	0.00030 *U*	3.6
PHASE2RA	C-3B	7/31/2004	SB-006W	2	15.4	0.00077 *U*	0.27	0.031	0.0012	0.00031 *U*	3.9
PHASE2RA	C-4B	7/31/2004	SB-009	0	14.2	0.00071 *U*	0.23	0.023	0.0013	0.00028 *U*	3.7
PHASE2RA	C-4B	7/31/2004	SB-010W	0	16.2	0.00081 *U*	0.28	0.028	0.0011 *U*	0.00032 *U*	4.4
PHASE2RA	C-5B	7/31/2004	SB-011	0	16.1	0.00081 *U*	0.61	0.030	0.0029	0.00032 *U*	4.5
PHASE2RA	C-5B	7/31/2004	SB-012W	0	16.1	0.00081 *U*	0.25	0.030	0.0011 *U*	0.00032 *U*	7.0

Notes: All results for *Rubus chamaemorus* berries.
Only unwashed samples from stations at or near the site were used in the human health risk assessment.

J - estimated value
U - undetected; value reported is the full detection limit

Survey names and citations:

ADEC01	ADEC (2001)
FUGDST01	Exponent (2002a)
PHASE2RA	Exponent (2004a) and Appendix E of this document

Appendix L

Chronology of Dust Control Improvements to the DMTS Road and Port Operations

Appendix L
Chronology of Dust Control Improvements to the DMTS Road and Port Operation

The following is a summary of improvements that have been made to the DMTS road and port operations for dust control.

Summer 1990

- Added vibrators to concentrate trailers to reduce carry-out from the truck unloading building (TUB)
- Tested the application of calcium chloride to road gravel for dust control.

Spring 1991

- Added a drop-tube to the P11 shiploader discharge to minimize fugitive dust while loading lightering barges.

Summer 1991

- Installed additional dust collection in gallery and transfer points
- Enclosed all transfer points
- Installed a floor on the first level of the surge bin
- Improved the truck unloading station ventilation
- Installed equipment wash bay building to the concentrate storage building (CSB)
- Installed new doors for existing CSB
- Installed improved doors on the TUB.

Fall 1991

- Began application of calcium chloride for dust control on port road.

Spring 1992

- Began application of calcium chloride for dust control on port site yards.

Summer 1992

- Outfitted all port system conveyors, except for shiploader, with canvas tent style enclosures (Conveyors P7, P8, and P10)
- Installed module over P10 conveyor drive unit
- Installed plywood covers over tail ends of P8 and P10 conveyors.

Fall 1992–June 1993

- Installed entirely new P11 shiploader conveyor with improved enclosure.

June–July 1994

- Installed additional siding to enclose P9-A and P9-B (surge bin) conveyors.

August–September 1994

- Further enclosed conveying system surge bin.

Winter 1996–1997

- Changed trailer wing deflectors to stainless steel for reduced adhesion and carry-out from the TUB.

1996–1997

- Conducted port site expansion and upgrade (production rate increase)
- Upgraded most of the conveyor system (new conveyors enclosed in steel tubes and additional baghouses at P22, P22-A, P23, P27, P28) and added second CSB
- Placed P7/P8 (Transfer Tower #4) transfer in enclosed steel building.

Winter 1998–1999

- Began using Chem-Loc® release agent in concentrate trailers to minimize residuals and carry-out following dumping (reduced need for air-lancing residual concentrate from trailers)
- Switched to improved reinforced covers on concentrate trailers
- Began using Bobcat loader to clean up TUB dumping platform between dump events to reduce potential concentrate track-out from TUB.

Spring 1999

- Added a spill deflector gate in the TUB and removed deflector wings from concentrate truck trailers to minimize carry-out from TUB.

Fall 1999

- Added concrete apron to south door of TUB.

Spring 2000

- Added man–door to TUB control room to allow personnel to enter/exit building without opening large equipment doors.

Spring–Summer 2001

- Enclosed P8 conveyor (CSB#1 to Surge Bin) in metal tube (completed prior to 2001 shipping season). The conveyor was previously enclosed with a canvas tent-style enclosure system.
- Replaced covers on P11 shiploader conveyor
- Upgraded to motorized conveyor belt scrapers from standard blade scrapers
- Installed and utilized a truck wash outside of the TUB exit for use during non-freezing conditions
- Began to utilize new self-dumping trailers with hydraulically operated hard covers and no side doors to eliminate potential for concentrate leakage.

August 2001

- Installed temporary stilling curtains over the TUB hopper to promote dust settling, until a permanent more complex arrangement was installed.

June–November 2001

- Initiated a change out of the concentrate haulage fleet during the summer of 2001 (Teck Cominco and NANA Lynden Logistics). Existing A-train 85-ton haulage units with side-opening doors were replaced by B-train 130-ton haulage units. Fleet change out completed in November 2001. The new self-dumping trailers include:
  - Hydraulically operated steel covers to minimize spills
  - No side doors to eliminate potential for concentrate leakage

– More stability, thereby reducing risk of accidents.

Winter 2001–2002

- Updated standard operating procedures for concentrate handling
- TUB improvements:
  - Extended 26 ft to accommodate length of new trailers
  - Installed enhanced stilling curtains over the TUB hopper to promote dust settling
  - Installed temporary baghouse (14,500 cfm) at truck dump hopper
  - Eliminated air lancing of trucks.
- Port CSB improvements:
  - Equipped loader and dozers with exhaust particulate filters.

Spring 2002

- Equipped the four loading hoppers inside of the CSBs with passive stilling bin hoods and curtains to reduce dust generation inside the CSB during shiploading operations. Modifications completed prior to 2002 shipping season.

July 2002

- Conducted a test paving program utilizing a “Hi-Float” product on approximately 2.5 miles of the DMTS haul road from the fuel island to the New Heart Creek Bridge. Also placed Hi-Float at the access to the CSBs, TUB, and on limited operating areas.

Spring 2002

- Completed surge bin dust control modification prior to 2002 shipping season. Modifications include:

- Re-routed baghouse ducting for better dust capture
- Insulated ducting to reduce potential of dust “caking”
- Installed improved baghouse controls
- Improved sealing on surge bin
- Improved sample door seals
- Installed belt skirting.

July–November 2002

- Installed new TUB “air wash” dust control system incorporating a 55,000 cfm baghouse that draws dust-laden air from the truck unloading hopper and concurrently uses positive airflow across the concentrate trailer to minimize the potential of dust adhering to the concentrate haul trucks during the unloading process.

June 2003

- Completed shiploader dust control modification, including:
  - Installed new P10/P11 transfer chute baghouse
  - Installed new P10/P11 transfer chute seals
  - Redesigned and upgraded the cover tail end, extension hood, conveyor belt cover and enclosure, chute and ducting of the P11 conveyor
  - Upgraded skirting, scrapers and inspection doors on P11 conveyor
  - Enclosed the P10 drive house.

July 2003

- Modified barge dust control systems (installed prior to shipping season). Modifications include:
  - Installed baghouse systems on each barge to control dust at transfer points

- Raised and improved the seal on the barge canopy system
- Modified the boom conveyor scraper system to eliminate carry-back
- Modified the boom conveyor discharge chute
- Upgraded scrapers and skirting on other conveyors.