DEC Review of Additional Response to Selected Public Comments (Compiled in September 2005 by ADEC) from Public Meetings held April 19 – 25, 2005 regarding the April 2005 Draft DMTS Fugitive Dust Risk Assessment

Public Meeting Comment	Initial Response	DEC Recommendation	Supplemental Response	
Topic: Caribou				
How many caribou were in the herd? Are you confident that 10 animals are adequate for this analysis and are you comfortable that they spent time in the area? You sampled every six years? Was there a difference between 1996 and 2002? The NPS requests that future monitoring/sampling be done in animals for lead in marrow and bone. Despite all those good questions, you may have sampled the wrong part – i.e., not including bone – so this raises a higher level of uncertainty. I am concerned that your comment that the food is safe may not be fully accurate.	About 750,000 animals are in that herd. The caribou are mostly migratory but the 10 that were harvested overwintered in the port, road or mine vicinity. [Additional Note: if metals from the DMTS affect metals concentrations in caribou, the animals used in the study would have a higher likelihood of showing those effects than other animals in the herd. Because they had overwintered at the site, they would have had a higher potential for exposure. Despite this, metals concentrations in the study caribou looked much like metals concentrations in caribou from other areas of Alaska and the rest of the world.] It is a small dataset, but sampling these animals is a significant undertaking. These caribou were harvested opportunistically because they apparently had overwintered there. Comparisons with other Arctic caribou databases show similar results. What has been discussed was the 2002 study. In 1996, there also was another caribou study performed at the Red Dog Mine and during that study, another 10 caribou were harvested and sampled the same way and showed results similar to the 2002 study. The data are consistent between the two sampling events, and are consistent with reference data from elsewhere in Alaska. Request noted. Studies show that local people eat mostly muscle so while there is some uncertainty, we are confident that the animals are safe to eat. [Additional Note: See note above regarding the proportion of marrow consumption relative to other foods, and the fact that lead is primarily stored in the mineralized portion of bone. Also, Exponent's analysis shows little or no consistent difference between metals concentrations in caribou that overwintered near the DMTS and caribou from elsewhere. The lack of differences in comparison with reference data appears to be consistent regardless of the specific organ or metal. Thus, there is no reason to believe that metals would be preferentially increased in bone marrow, which is not a significant lead storage organ.] The concern is noted. However, Exponent included many health-protective assumptions in the risk assessment, so that builds in many factors of safety. Despite uncertainties, the level of exposure of people in the villages is likely to be lower than the scenarios modeled in the risk assessment. Exponent believes that the risk assessment is protective, and that subsistence foods are safe to eat.	Please provide details regarding the analysis conducted to support this response. What were the levels of Cd, Pb, and Zn in tissues from the two groups? Were statistical tests used to detect differences? Please provide more detail regarding CoPC levels in caribou tissue and comparisons made between groups (site versus reference) and years (1996 versus 2002). Were statistical tests used to detect differences? If so, at what confidence level. Future studies should address this comment. Please provide details regarding the analysis conducted for overwintering caribou near the site and those from elsewhere. What were the levels of Cd, Pb, and Zn in tissues from the two groups? Were statistical tests used to detect differences? If so, at what confidence level? Safe should be defined relative to site-related CoPCs.	The 2002 caribou study report is included in Appendix H of the risk assessment. The report details the collection and analysis methods used and the results of those analyses. Metals concentrations in the caribou collected from the site were compared with concentrations in caribou collected near the site in 1996, caribou from elsewhere in Alaska, and caribou from elsewhere in the world. Because raw data were not available for the other data sets, only means and standard deviations could be compared. Nevertheless, when the data were graphed it was clear in most cases that concentrations would not be statistically elevated compared to the reference datasets, and in fact site concentrations were usually less than concentrations found elsewhere in Alaska and the world. Among the caribou collected in 2002, concentrations in animals from near the mine were compared to concentrations in animals from Mile 14 on the road using a t-test, with a p-value less than 0.05 considered significant. There were a few instances of metals concentrations being statistically different between the two groups, but no pattern of higher concentrations from one area relative the other. Although the 2002 caribou study provided evidence that caribou metals concentrations are not elevated relative to reference caribou, exposure to terrestrial CoPCs via subsistence consumption of caribou was still included in the risk assessment. A discussion of uncertainties related to lack of data on bone and bone marrow lead has been added to the risk assessment. The added text follows: *It should be clarified that bone and bone marrow are two different tissues. When discussing "bone" in this context, it is the mineralized (hard) portion of the bone. Bone marrow is part of the lymphopoietic system (lymphatics, blood, and blood forming tissue) and is related to bone only in its location in the body and in that it shares a name. While bone is a storage site for lead, bone marrow is not, and therefore it is important to discuss the two tissues separately.* *Bone marrow is the more likely of the two tissues to be consumed. Bone marrow would not be expected to be preferentially enriched in lead relative to the organs sampled. In fact, because caribou bone marrow is more than 95 percent fat (Nutrition Data 2006), it is not a good source of minerals in general, and would be less likely to store the metals being evaluated at the site than the muscle and organ tissues that were sampled. In addition, bone marrow would make up an exceedingly small portion of the caribou tissue consumed by humans relative to muscle. Thus, because it is not a storage site and is a relatively small part of dietary intake, inclusion of bone marrow would have little or no impact on the results of the risk assessment.*	Responses are acceptable.

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Is the assumption that the animal spends its life at the port or the mine?	For small mammals, Exponent assumed the animal lives next to the port, but for a larger animal that ranges over a larger area they evaluated several scenarios, for animals that might live near the mine, or near the road, or near the port, or range over the whole area. For caribou, Exponent evaluated both animals that would migrate through in a short time, as would most of the herd, and animals that overwinter near the port, road, or mine areas.	Indicate the over-wintering caribou were assumed to spend 150 days per year at the site and that the rest of the herd was assumed to spend only 7 to 9 days.	*Nevertheless, collection of bone marrow will be considered during the development of the risk management plan.* *Bone is a storage site for lead, and would be more likely to reflect very long-term exposure than soft tissues such as liver, muscle, and kidney. However, as with bone marrow, if bone consumption were included in the risk assessment, it would have little impact on overall risk results because bone would comprise a very small portion of the overall amount of caribou consumed by people, compared with muscle tissue. In addition, it is important to remember that the caribou metals concentrations used in the risk assessment come from caribou that over-wintered at the site. If site metals do affect metals concentrations in caribou, it would be reflected in the recent "exposure" experienced by these over-wintering caribou, and highly vascularized soft tissues such as liver should reflect that exposure.*	
Which metals are issues?	Aluminum and barium were predicted by modeling to be an issue for small mammals, near to the mine boundary, and near the road and port. Aluminum is found everywhere, including on any gravel road in Alaska, because it is a major component of the earth's crust. [Additional Note: Although some effects were predicted for small mammals from aluminum, this is based on lab studies that use a more bioavailable form of aluminum, so it is possible that effects may not actually be occurring in the field.] Barium is found in higher concentrations around the mine and in the waste rock from the mine. When you travel further away from the mine, levels decrease. The modeling predicted potential for effects to small mammals from barium. However, this is based on forms of barium used in laboratory studies that may be more bioavailable than the forms found in the tundra. [Additional Note: The actual potential for adverse effects to overwintering caribou is thought to be small given the highly conservative nature of the aluminum and barium TRVs and low bioavailability of aluminum and barium at the site (Shock et al. 2007).]	It should be noted that although aluminum is a common metal, concentrations were statistically elevated over background.		
We eat all bone marrow and nothing is wasted. We also feed the marrow to our children. I suggest that you test the marrow from the animals. What studies did you use before 1989 and what are those results?	The caribou studies at Red Dog were performed in 1996 and 2002. The data collected from those two studies were from muscle, liver, and kidney. [Additional Note: Pre-1989 data are not available for Red Dog, so Exponent compared 1996 and 2002 study results with reference data from other regional studies and other literature data. With regards to bone marrow consumption, as noted in response to previous comments, lead is stored in the body primarily in the hard mineralized portion of bones, not bone marrow, which is considered a different organ and does not preferentially store lead.] [Additional Note: Red Dog is committed to periodic continued caribou studies because of their importance to the people – Teck Cominco we will attempt to include marrow sampling in future work.]	Please specify what will be done with respect to bone marrow studies.		
So there is no effect of eating caribou to humans? What were the Noatak and Kivalina responses to this question? Other studies showed similar findings that there is no risk to human health from eating caribou. These were compared with studies of caribou sampled in Nome and Canada near the	The caribou and all of the rest of the subsistence food diet were found to be safe. It seems that there was some general reluctance by both groups to accept that the risk assessment found that there was no such risk. For example, at Kivalina or at a meeting with the Subsistence Committee, someone noted that they observed caribou near the road were getting less fat along their backs. However, at that meeting, Roland Booth noted that perhaps the animals in the area of the road were more stressed because of hunting from both directions (Kivalina and Noatak) by hunters on snow machines.	Meaning of "safe" should be defined. Critical assumption leading to this conclusion should be defined.	In the context of risk assessment, "safe" is defined primarily by the hazard indices calculated as part of the risk characterization. A hazard index equal to or less than one is considered "safe." Moreover, hazard indices are typically more likely to overestimate than underestimate risk because of the health protective assumptions regarding exposure and toxicity that are included in the risk assessment process. Also because of these health protective assumptions, a hazard index greater than one does not necessarily mean the situation is unsafe. A summary of the risk assessment results for ecological receptors is presented in Tables JS1 through JS7 (attached).	

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Alaska border. This was true except for one caribou that was harvested at Red Dog Mine, but that caribou was a sick animal. I suggest talking more with locals before and after a study. I also suggest that you talk to hunters from the villages.	No response.	Teck Cominco should indicate whether they intend to speak to more locals or hunters before conducting future work.	Local citizens were included in previous caribou, berry, and sourdock sampling programs. Teck Cominco will continue to seek local citizen involvement in the future.	
Topic: Berry Sampling				
What about berries outside of the ambient air boundary? You state that it is safe to pick berries and we pick berries by the port.	The risk assessment only used the berry data close to the port and road because it was the most conservative. Exponent used data from the berry studies within the port and along the road to be conservative [health protective] in their evaluation, although those areas within the ambient air boundaries are off limits to berry pickers because of safety issues associated with the mine's activities. Exponent also used data from another location just north of the ambient air boundary (from the south end of Ipiavik lagoon). They harvested ptarmigan along the DMTS, and caribou near the road and port. Using all of the subsistence foods data collected near the road and port in the risk assessment, Teck Cominco found that the subsistence foods diet is safe, and it is safe to eat the berries whether inside or outside of the port boundary (although again, harvesting inside the boundary is off-limits).	Please address this issue. It appears some berry data at the port was not included in the risk assessment. Same as above.	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 initially excluded because they were collected next to a facility unit, rather than in harvestable tundra areas. Harvestable areas on the site should be considered those areas that, if someone were to trespass on the site to harvest berries in an off limits area, would both be attractive and provide adequate resource (enough berries to be worth picking). Neither of those criteria applies to samples at the station adjacent to the fuel storage tanks. However, the revised risk assessment now incorporates these previously excluded samples and there is no change in the resulting risk estimates.	Responses are acceptable.
Topic: Marine Sediments and Ocean Currents				
Which way does the ocean current flow? Did you evaluate ocean currents between different years? I understand then that there are two reasons why metal concentrations have decreased in the marine environment which are because of 1) ocean currents and, 2) source reductions.	The port area is a highly dynamic area. Exponent looked at the currents, which are seasonal as well. Therefore, between the high impact of currents and the increased effort that has been performed to reduce sources of fugitive dust, the metal concentrations have been decreasing in the sediment. [Additional Note: There are ocean current surveys, which have been conducted by the government that were examined.] The commenter is correct. The ocean is a very dynamic environment with the wind, waves, currents, and icepack working the sediments and dissipating metals, as the dust inputs have decreased over time through improved source controls.	Please clarify; (1) whether seasonal currents are likely to move sediment in a discernable pattern. (2) If sediment accumulation is occurring along shoreline within a couple kilometers from the ship loader.	(1) The Corps of Engineers reports that prevailing currents are northward, both in frequency and magnitude, although there are shorter-duration southward currents of lower magnitude. Currents are generally weak in the winter, and stronger in the open water season. Longshore sediment transport is reportedly southward (Corps 2005). Away from the beach (e.g., at the shiploader), it is not clear which direction sediment transport would be, although the predominant northward currents away from the shore may result in northward transport prior to deposition at the sediment surface. Sediment data maps (e.g., Figures 4-14 and 4-16 of the risk assessment document) indicate northward transport, showing higher concentrations to the north of the shiploader than to the south. Regardless of the sediment transport pattern, it should be noted that sediment concentrations are well below all screening criteria values. (2) Sediment concentrations have been periodically monitored within 1 km of the port ship loading facility, as discussed in Section 4.3 of the risk assessment document. Sediment data show that concentrations decrease away from the shiploader facilities. All of the sediment concentrations have been below screening criteria in recent sampling events. Thus, sediment at greater distances is expected to have concentrations well below screening criteria.	Responses are acceptable.

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			Corps. 2005. Draft environmental impact statement: navigation improvements, DeLong Mountain Terminal, Alaska. U.S. Army Corps of Engineers, Alaska District.	
Topic: Human Health Risk Assessment (Receptors, Exposure, and other issues)				
Is there a study for elders versus other age groups? Are children included in the risk assessment? Were pregnant women evaluated?	The risk assessment looked at three different groups: children subsistence users, adult subsistence users, and adults who work at the mine and engage in subsistence activities. Pregnant women were evaluated, specifically for exposure to lead.	Please note that Elders were not addressed as a separate group in the RA.	The risk assessment uses assumptions about exposure and toxicity that are designed to protect even sensitive members of the population, including elders. Thus, the risk assessment should be protective of people who may be more susceptible to the effects of the metals being evaluated because of age, health status, or other factors. For example, most reference doses include an additional safety factor to protect people who are potentially more sensitive. Use of this safety factor ensures that exposure to metals will be more than 10 times below the level at which the science tells us there is no health effect. Other safety factors are usually also applied to make the reference dose even more health protective.	Responses are acceptable.
Are subsistence users a different category than the 'normal' person? Did you factor into the risk assessment that we have been exposed already for 10-14 years to contamination from the mine? Also, was your sampling done after Teck Cominco performed a lot of their improvements to minimize the dust? You need to take in data over some periods. I bet that the risk assessment document does not look at it over time.	To be protective, the risk assessment assumed that each person only eats subsistence foods, no grocery store or other outside foods. Also, it was assumed that each worker eats 25% subsistence food in his/her diet when they are at the mine working. Most of the sampling data was gathered between 2001 and 2004, and many dust control improvements have been made during that time. However, in the sense that metals accumulate in soil over the period of operation, soil incorporates the deposition over that period. The biggest intake people have of metals is from soil, as compared with food. Exponent used soil concentrations from road and port facilities areas, to be most conservative about the soil concentrations people might be exposed to. Also, with regard to subsistence foods, we assume that subsistence eating has been, and will be on-going for life. The State did the blood testing and that is another way to look at it. The risk assessment provides results that are like a snapshot in time, based on lifetime exposure to conditions as they are at present. There are uncertainties in the risk assessment evaluation, but the risk assessors look at all of those uncertainties and variables and consider what issues need to be evaluated in the future. [Additional Note: There will need to be some level of ongoing monitoring to assess changes relative to current conditions.]	Please explain how and why Fractional intake was used in risk assessment. Provide an explanation that although the risk assessment assumes long term exposure to current concentrations, it does not factor in previous metal contaminant levels, which may or may not have been higher than current concentrations.	A fractional intake (FI) term is used in the risk calculations because not all subsistence foods consumed, soil ingested, or water ingested comes from the site. For example, only a portion of berries eaten by someone from Kivalina or Noatak would be collected 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 and 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 off-site, than one on-site that is further away (and off-limits). Thus, it is reasonably likely that the FI, as calculated, overestimates fractional intake from the site. For large home range subsistence foods (i.e., caribou and fish), the metals concentrations in those animals already integrate the animal's exposure over their entire home range; therefore, the FI represents the fraction of the total metals concentrations in those animals that is attributed 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. In fact, the home ranges for both caribou and fish are far larger than the subsistence harvest areas for Kivalina or Noatak. 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	

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			concentrations, regardless of the FI applied, would be an overestimate of site-related risks. Additional text has been added to Section 5.4.3 of the human health risk assessment (HHRA) to further address the uncertainties discussed above regarding fractional intake. In addition, at the request of DEC risks were also calculated using an alternative caribou FI of 0.2. This value was calculated using the area reported to have cadmium levels elevated above background by Hasselbach et al. (2005) as the site harvest area. The risk assessment evaluates current and future risks based on current conditions. The risk assessment cannot evaluate past risks because information about past exposure concentrations is not available.	
What model did you use? What standards did you use to ensure that the children are safe?	Several models were used to evaluate risk. For example, we used the EPA child and adult models for lead. The risk assessors looked at how much and what types of food are used, and the toxicity of the metals. For lead, the risk ssessment used that information in an EPA child lead model. As with adults, it was assumed that children eat a 100-percent subsistence foods diet.	List models used and/or refer to RA report sections where they are described.	Standard U.S. EPA models were used for all risk estimates, as described in the risk assessment. For childhood lead exposure, the IEUBK model was used. For adult lead exposures, EPA's adult lead model was used. For other metals, standard U.S. EPA exposure models were used as described in EPA Superfund guidance.	
Topic: Site Area				
Did the risk assessment go beyond the road to investigate? Are there any studies outside of the ambient air boundary perimeter along the corridor between the port and the mine? What about studies further away?	The risk assessment studied areas surrounding the mine, the road, and the port, including the marine environment. A large part of the risk assessment was outside of the ambient air boundary to see what contaminant concentrations are and what effects are to the plants and animals there. The sampling occurred using a sampling scheme, with the transects oriented perpendicular to the road, and had several stations per transect with increasing distance from the road. The transects were placed on the north side of the road, because concentrations on the north side of the DMTS road have been found to be higher than those levels found on the south side of the road because that is where more deposition has occurred with the prevailing wind patters.	Response acceptable. (Figures 3-1 through 3-4 provide the sampling locations)	Comment noted.	Response is acceptable.
Topic: Samples of Animal Tissue				
Did you study the marrow from animals? Separate samples on each of the organism's body, such as the liver, should be taken.	For the ecological evaluation, whole small animals were analyzed (including bones); therefore the marrow was included. This is because animals would eat the whole small animal. Because small animals are food for some larger animals, the results from whole small animal samples were used to estimate concentrations in larger animals. For the human health evaluation, organs that are a subsistence food item were analyzed separately. For instance, caribou liver, kidney, and muscle tissue were analyzed separately for use in the human health evaluation.	Response acceptable. Future studies of lead in bone marrow are recommended.	Comment noted. Please see response in the caribou section, above. The possible need for such studies will be considered during development of the risk management plan.	Responses are acceptable.

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Topic: Fraction Ingested of Subsistence Food				
What would happen if a person got everything they eat from around the port and the road? Was that accounted for in the risk assessment?	In the risk assessment, it was assumed all of the foods consumed are subsistence foods, and the samples of subsistence foods used in the risk assessment were only collected from areas around the road and port, to be most protective.	The response should explain that the risk assessment use a fractional intake adjustment and what the risk estimate would be without that adjustment.	The FI adjustment is described in response to the HHRA questions, above. The implications of using alternative values for FI are discussed in Section 5.4 of the risk assessment. For example, in the child subsistence use scenario, a cumulative hazard index of 1.0 is estimated only when the assumed FI is increased to 0.36 (i.e., 36 percent of all soil, water, and food consumption is from the site). If an FI of 1.0 is assumed (i.e., 100 percent of all soil, water, and food consumption is from the site), the resulting cumulative hazard index is 2.9. While this hazard index exceeds the target of 1.0, it is still within the degree of uncertainty inherent in the reference doses used to calculate risks. In addition, risks from individual CoPCs are not typically considered cumulative and summed unless the target organ and mechanism of action on which the RfD is based are the same. Only two CoPCs (i.e., barium and cadmium) have RfDs based on effects in the same target organ (the kidney). In reality, the FI from the site would never be 1.0 for a child, and the FI of 0.09 used in the risk assessment likely significantly overestimates an actual child's contact with the site. For both the adult subsistence use and the combined worker/subsistence use scenarios, a cumulative hazard index of 1.0 was estimated only when the assumed FI was 0.95 (i.e., 95 percent of all soil, water and food consumption is from the site). If an FI of 1.0 is assumed, the resulting cumulative hazard index is 1.1. Again, this is within the degree of uncertainty inherent in RfD derivation, and no individual CoPC exposure would result in a cumulative hazard index exceeding 1.0, even with an FI of 1.0. Although an adult may come into contact with the site to a greater degree than a child, an actual adult would still never obtain 95 percent of their soil, water, and food from the site. Furthermore, site restrictions do not allow subsistence harvesting on the site at all.	Response is acceptable.
Topic: Metal Accumulation				
Do metals accumulate also in human bones?	For lead, Exponent used EPA models for children and adults, which simulates the blood lead concentrations, and we use that to assess the potential effects. [Additional Note: Some metals, for example lead, may accumulate in human bones. EPA's child lead model accounts for the amount of lead in various parts of the body, including bone. EPA's lead models use exposure information and what is known about how lead moves through the body to predict blood lead levels. The predicted blood lead level can then be compared to blood lead levels at which there may be a health effect. Currently, the best information available about the health effects of lead is related to blood lead levels. The relationship between bone lead levels and health effects is not well characterized. So even if bone lead levels were available for people residing near the DMTS, it would not be possible to draw any conclusions about the potential for health effects.] Teck Comino stated that they can include bone marrow analysis in the next study.	Please indicate whether any other CoPCs accumulate in bones. Please provide more information about this sampling.	None of the other CoPCs are known to be preferentially stored in bone. Cadmium may affect bone density. Although the mechanism is not well understood, it is believed to involve a mechanism that does not involve cadmium accumulation in the bone. Please see response to in the caribou section, above. The possible need for studies of bone marrow lead will be considered during development of the risk management plan.	Response is acceptable.

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Topic: Metals Bioavailability				
I have heard that metals are basically not bioavailable. However, for long-term I believe that they can be oxidized and take another form which can be bioavailable. Therefore, I suggest that long-term monitoring occur. [Additional Note: The commenter may be referring to the concentrate study that found the bioavailability of the lead in concentrate from Red Dog to be low.] The NPS and DEC had some previous comment that the metals were not totally unbioavailable. The commenter would like to see some more studies occur on this issue.	These compounds start in one form and over time change to another form such as zinc sulfite to zinc sulfate, and as sulfate is not necessarily any more bioavailable. [Additional Note: To be protective, in the ecological risk assessment, all metals were assumed to be 100-percent bioavailable. Also, in the human health risk assessment, all metals other than lead were assumed to be 100-percent bioavailable. For lead, both the site-specific bioavailability from the Red Dog ore-concentrate studies and the EPA default bioavailability were used, so results can be evaluated both ways.] [Additional Note: The definitions of bioavailability and bioaccumulation are the following: Bioavailability - The propensity of the chemical to be absorbed into the bloodstream across the gastrointestinal tract, skin, or lungs. For metals, different physical or chemical states of the metals can affect bioavailability. Bioaccumulation -The tendency of the chemical to accumulate in biota (plants animals or humans), either through the food chain or through other exposures.] No response.	Please provide a response to the question of bioavailability of metals from the concentrate and what long-term monitoring will be conducted, or refer to the sections of the RA that discusses these issues. There is evidence that metals are bioavailable to some extent – such as elevated metal concentration in ptarmigan compared to background. Please provide a response to the question of bioavailability of metals from the concentrate and what long-term monitoring will be conducted.	In the ecological risk assessment (ERA) and the HHRA, bioavailability was assumed to be 100%, with one exception. For lead in the HHRA, site-specific bioavailability values and EPA default bioavailability values were both used. The site-specific lead bioavailability information was developed from a 1993 National Toxicology Program study using Red Dog lead concentrate (Arnold and Middaugh 2001). Teck Cominco is conducting ongoing work on the question of metals bioavailability. This work includes *in vitro* bioaccessibility testing of barium and aluminum (Shock et al. 2007), and a laboratory study of particle fate when exposed to oxidation and weathering. This ongoing work will be considered further during development of the risk management plan, and any associated monitoring program that follows from it. Defining the nature of potential monitoring is beyond the scope of the risk assessment, but will be thoroughly evaluated as part of the risk management plan development, in cooperation with DEC and other stakeholders. The possible need for additional bioavailability studies will be considered during the development of the risk management plan.	Responses are acceptable.
Topic: Use of Surface Water for Drinking/Drinking Water in General				
We use freshwater from Umayutsiak Creek which is located about 2 miles south from the port and we also use freshwater from another creek next to it. Is that safe? There is a yellow discoloration in a stream just past the village of Kelly and usually this has been a creek that has had good spring water. What about the water?	Water samples were taken from some creeks that cross the road. All freshwater samples taken were found to be safe. The creeks that cross the road would be expected to have higher concentrations of metals than those creeks further away from the road if those metals come from the fugitive dust. Since water in creeks crossing the road is safe, creeks further away should also be safe. Teck Cominco indicated they were willing to address the concerns regarding water quality in the area. Jim Kulas of Teck Cominco indicated he would look into this issue. Teck Cominco performs monitoring on Kivalina's drinking water and so does EPA and DEC. All the monitoring results show that the water used for drinking is safe.	Please define what safe means. Teck Cominco should indicate what actions were taken. Please specify standards used to determine that drinking water is safe and/or refer to the applicable sections of the RA report.	In the context of risk assessment, "safe" is defined primarily by the hazard indices calculated as part of the risk characterization. A hazard index equal to or less than one is considered "safe." See the response in the caribou section, above, for additional details. For water consumption, risk estimates were very low. The water ingestion hazard index was only 0.01 for children and less for adults. This means the concentrations were 100 times lower than the "safe" level. So even if no FI were applied (i.e., if it was assumed that all water consumption occurred at the site), concentrations would still be almost 10 times lower than the "safe" level. Teck Cominco had indicated that they could sample Umayutsiak Creek. This has not been done at this point. Sampling of additional creeks can be considered during development of the risk management plan. However, as described above, water concentrations provide a very small contribution to the overall risk estimates. Section 2.3.3.2 discusses drinking water information used in the risk assessment. This text has been modified as follows: *Surface water drainages in the vicinity of the road ultimately flow into the Wulik River or into the Chukchi Sea near the port site (south of Kivalina). The*	Responses are acceptable

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			Wulik River is a source of drinking water for Kivalina residents. Sampling of Kivalina drinking water has been conducted on an ongoing basis and has not shown elevated metals concentrations in comparison with Alaska DEC drinking water maximum contaminant levels MCLs) and EPA risk-based screening levels, i.e., Region 9 Preliminary Remediation Goals (PRGs) (ADPH 2001). Because some streams crossing the DMTS flow into the Wulik River, which in turn provides drinking water for Kivalina, and because some use of drinking water from streams occurs during subsistence use activities , drinking water consumption from the freshwater environment has been identified as a primary exposure pathway for residents and is evaluated in both the subsistence use and the combined worker/subsistence use scenarios. Water data used in the human health risk assessment are 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, where Kivalina residents have indicated some use of water during subsistence activities. In the risk assessment, drinking water concentrations are compared against one-tenth of the DEC MCLs for a conservative screening step (see Section 3.3.2). Also note that exposure through drinking water amounts to a small proportion of the overall risk estimate, as described above.	
Topic: Risk Management Plan				
The National Park Service, DEC, and others were invited to come back to talk with the communities prior to making a decision at the site. A comment was received that those agencies are talking for the community members but they would like to know what the decision makers are thinking before determining the risk management decision.	Jim Kulas of Teck Cominco said they would involve those who wanted to be involved in the management plan and he will be getting back to those individuals regarding this issue.	Teck Cominco should provide further details about how they will involve the community in the risk management plan.	The draft risk management plan will be developed with input from the Subsistence Committee. This Committee was set up under the Operating Agreement between the NANA Regional Corporation and Teck Cominco Alaska Incorporated and is the recognized vehicle for communication between local communities and Red Dog. The Committee is comprised of eight individuals (four each from Kivalina and Noatak) who periodically meet with mine officials to discuss subsistence and environmental topics. In addition, mine officials periodically hold public meetings in Noatak and Kivalina. Using these venues, the draft risk management plan will be presented and feedback will be requested.	Response is acceptable.
Topic: Historical Data Availability				
Besides historical data, is there other information available that has been compiled in the 1980s used in the risk assessment?	There were environmental baseline studies conducted in the early 1980's, however, they did not have data for all of the media or metals that Exponent needed data for the risk assessment. That is why Exponent collected similar samples from reference areas for comparison.	Please describe if and how data collected in the 1980s was used in the Risk Assessment.	The location and number of samples and number of analytes available in the historical data sets from the 1980s baseline assessment work were insufficient to use for comparison with current data sets, which had much broader CoPC lists. However, observations and information from the 1980s baseline assessment work was used during development of the conceptual site model, and to help identify and select appropriate animal receptors to include in the assessment. In addition, information on subsistence use areas was obtained from these documents (e.g., Dames and Moore 1983a).	Response is acceptable.

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Public Meeting Comment	Initial Response	DEC Recommendation	Supplemental Response	
Topic: Barge Loading and Offloading				
Have you ever monitored when you off load the barges to the ships?	The State will be looking into that issue of loading barges. The COE has done some sampling in this area, which is about three (3) miles off shore. Recently, Foss Maritime made improvements, such as to the snorkel system for the barges by making the snorkels longer, which reduces the fugitive dust.	Teck Cominco should indicate which State agency he is referring to in this response.	The DEC air program is the agency that was referred to. Regarding monitoring of barge off loading to ships, an EPA multimedia compliance inspection occurred in 2006 starting on August 23rd and continuing through the 30th. The inspection team consisted of seven individuals, one from Anchorage, Seattle, and Washington DC, and the remaining four were from Colorado. During the inspection the group traveled to inspect the offloading operation from a Foss Maritime barge to a container ship. No issues were noted during inspection of the operation. A final written copy of the report has not yet been issued.	Responses are acceptable.
How far offshore are the ships?	Barge offloading occurs approximately 3 miles offshore because the water is too shallow at less than that distance. One ship is able to load a bit closer to shore. [Additional Response – all ships stay beyond the 3-mile limit due to regulatory restrictions]	Please clarify which is the correct answer?	All ships are loaded beyond 3 miles from the shore.	
The dust – risk assessment – can it be done from the barge to the ships and studies on the ships to where they came from? Also, does the dust from the Concentrate Storage Building go blowing to the ocean during winter season? Can there be studies done on that?		Please address this comment.	The risk assessment included evaluation of sediment and water data in the marine environment, both nearshore and offshore (including beyond 3 miles) where ships are loaded. Sample locations are shown on Figure 3-3 in the risk assessment document. Sediment concentrations provide a cumulative measure of dust from all sources and all seasons into the marine environment. As described in Section 4.3 and corresponding concentration map figures in the risk assessment, concentrations in sediment samples collected from the shiploader area in 2004 were below conservative screening criteria, and concentrations were even lower in areas further from the shiploader, including in samples that have been collected further offshore where the ships are loaded. Dust emissions controls at the port have been improved in recent years, further reducing the inputs to the marine environment. Ongoing monitoring is likely to be conducted at an appropriate frequency. This will be identified during the development of the risk management plan.	
Topic: Animal Deformities				
Skinny foxes without tails have been observed in the plume area. Teck Cominco should consider collecting and analyzing tissues from such animals.	No response provided about foxes.	Please provide a response to this comment.	The possible need for analysis of foxes will be considered during development of the risk management plan.	Response is acceptable.
Topic: Haul Road				
What is the distance of the haul road that is shown on the figure that is colored in purple?	The purple area is approximately 3 miles on either side of the road. This figure is simply a schematic showing the general areas evaluated in the risk assessment. The ambient air boundary for the road is not shown on this map. [Additional Note: The ambient air boundary is 300 feet on either side of the road centerline. The length of the road is approximately 52 miles from mine to port.]	Please provide a figure number for a similar figure in the RA report.	Figure 1-7 in the revised report illustrates the approximate area considered in the risk assessment.	Response is acceptable.

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Public Meeting Comment	Initial Response	DEC Recommendation	Supplemental Response	
Topic: Truck Spills				
What about the truck spills, were they part of the risk assessment? On the truck spill that you discussed, did you do something to address it?	Teck Cominco had a program that systematically evaluated truck spills and did additional cleanup where necessary. Teck Cominco did look at patterns of deposition, but the individual spills did not affect the overall pattern. [Note: ADEC has monitored this cleanup effort.] The NPS gave Teck Cominco some requirements that were used as the criteria to clean-up those truck rollovers and performed revegetation. [Additional Response – All spill sites were sampled to confirm there was adequate original clean-up. Those that required more work were excavated and confirmed clean with follow-up sampling. Sites outside the park will be hydroseeded. Those within the park will be left to naturally re-vegetate as requested by NPS.]	Page 2-3 of the Risk Assessment report provides further information about the Settlement Agreement between Teck Cominco and DEC that guides spill recovery.	DEC AND EPA conducted a Multimedia Inspection of the Red Dog facility on August 8 to 10, 2000. On May 21, 2001, a Notice of Violation was received for alleged exceedances of certain air permit conditions. TCAK and DEC entered into a Settlement Agreement to resolve this matter. One of the remedial actions required an evaluation of several spills that had occurred since 1990 where it was uncertain what cleanup and sampling procedures were used. Sites were located and sampled during the summer of 2002 to ensure that cleanup of those sites was satisfactory. TCAK developed a spill cleanup and sampling plan and methods to address future spills of zinc or lead concentrate into a creek or water body located along the road. The plan was completed and submitted to DEC by March 15, 2002, as required by the Settlement Agreement. Section 2.1.2 of the revised risk assessment document has been modified to provide additional information on the evaluation and closure of the former truck spill sites. The following sentence was added to that section: "Table WH1 provides summary information about each of the truck spills, and Table WH2 lists the closeout dates of the re-evaluation of each spill site, and the specific documents containing the closeout information." Copies of these tables are attached.	Responses are acceptable.
Topic: Chemicals of Potential Concern				
Were there other metals that you looked at?	Besides lead and zinc, the whole list of other metals that are present in the ore concentrate were evaluated.	Please refer to appropriate tables in the risk assessment report.	The metals evaluated in the risk assessment are listed in Table 3-1 of the risk assessment document.	Responses are acceptable.
What about silica?	Silica is found at the mine. It does pose a problem with the lungs, so we require a half-mask respirator be used by all workers who are exposed to silica.	Response acceptable.		
	Lead is found in the sulfide form at the mine and it is not as toxic in that form. It passes through the body as well. For example, at lead smelters, lead is a bigger problem since that form of lead can be much more available to the human body than the sulfide form found at the mine.	Please provide references to support the lead bioavailability statements.	Lead bioavailability is discussed in detail in Sections 5.2.2.1 and 5.4.3 of the risk assessment, including the appropriate references.	
What is the composition of the dust?	Teck Cominco ships five times more zinc than lead so there is a concentration in the soils or in the tundra that is proportional to this ratio.	Refer to appropriate tables in the risk assessment report.	The composition of the concentrates is shown in Table 2-1 of the risk assessment document.	
What about other impacts such as asbestos from truck brake linings?	The trucks use their gears to assist slowing down so less wear is placed on the brakes. [Additional Note: Research has shown that most of the chrysotile asbestos in brakes is transformed by heat into non-asbestos compounds during the braking process.] It is expected that asbestos release and exposure to asbestos would be insignificant.	Provide references for the statements about asbestos release and exposure?	The following papers address the questions about asbestos release and exposure in detail. <u>Release:</u> Lynch, J.R. 1968. Brake Lining Decomposition Products. J APCA 18:824. Anderson, A.E.; Gealer, R.L.; McCune, R.C.; et al. 1973. Asbestos Emissions from Brake Dynamometer Tests. Ford Motor Company Scientific Research Staff, Detroit, MI (Technical Report No.SR73-64). Jacko, M.G.; DuCharme, R.T.; Somers, J.H. 1973. Brake and Clutch Emissions Generated During Vehicle Operation. Automobile Engineering Meeting, SAE Passenger Car Meeting, Detroit, MI.	

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Public Meeting Comment	Initial Response	DEC Recommendation	Supplemental Response	
			Williams, R.L.; Muhlbaier, J.L. 1982. Asbestos Brake Emissions. Env Res 29:70–82. Cha, S.; Carter, P.; Bradow, R.L. 1983. Simulation of Automobile Brake Wear Dynamics and Estimation of Emissions. SAE Passenger Car Meeting, Detroit, MI. <u>Exposure:</u> Paustenbach, D.J., R.O. Richter, B.L. Finley, and P.J. Sheehan. 2003. An evaluation of the historical exposures of mechanics to asbestos in brake dust. Appl. Occup. Environ. Hyg. 18:786–804. Goodman, M., M.J. Teta, P.A. Hessel, D.H. Garabrant, V.A. Craven, C.G. Scrafford, and M.A. Kelsh. 2004. Mesothelioma and lung cancer among motor vehicle mechanics: A meta-analysis. Ann. Occup. Hyg. 48(4):309–326.	
Topic: Reclamation and Closure				
When I was at Sitka, they talked about long-term negative effects of a mine and I am concerned for my children.	Teck Cominco is developing a closure plan to ensure things like that do not happen. [Additional Response – the closure plan is required by state regulations and it will include a financial assurance agreement that sets aside money for the State to use for further cleanup or reclamation activities if necessary.]	Please describe key components of the closure plan.	The closure plan will describe how different areas of the site will be reclaimed, and how monitoring and treatment will be performed after closure. The primary objective of the closure plan is to apply for and obtain a solid waste disposal permit from the DEC. This planning process includes the requirement for public involvement and comment. The key components of the closure plan include: the development of a closure plan for mine pits, waste rock, tailings, and non-mining wastes; the characterization and prediction of acid rock drainage and mineral leaching; addressing water quality and water management; and the development of monitoring requirements. DEC regulations also state that "...(DEC) will require proof of financial responsibility to cover the cost of closing a landfill and, if monitoring is required, the cost of post-closure monitoring, if the department determines proof of financial responsibility is necessary to protect the public health, safety, welfare, or the environment."	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.

CoPC - chemical of potential concern
DEC - Department of Environmental Conservation (Alaska)
DMTS - DeLong Mountain Regional Transportation System
EPA - U.S. Environmental Protection Agency
ERA - ecological risk assessment
FI - fractional intake
HHRA - human health risk assessment
NPS - National Park Service
RA - risk assessment

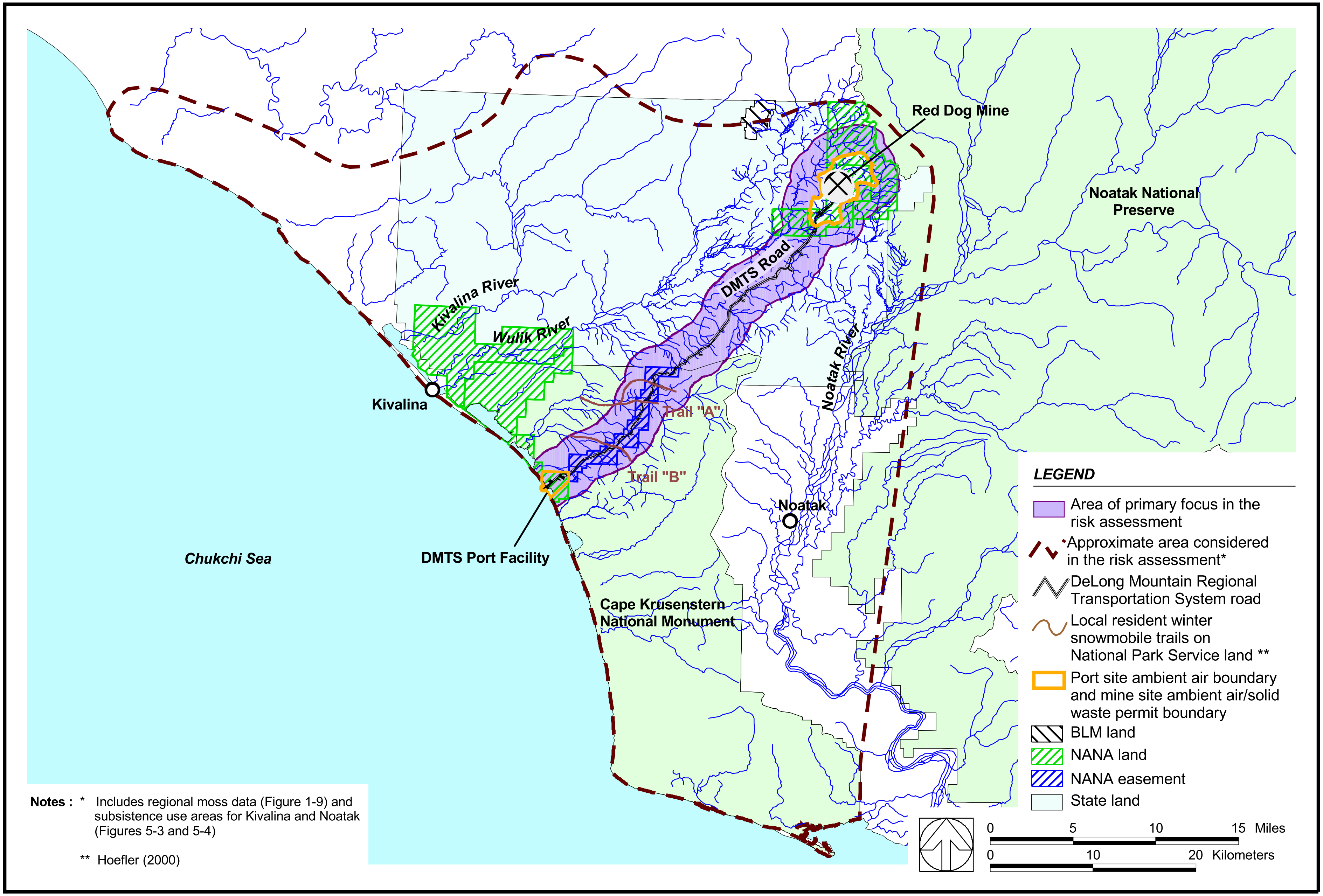

Figure 1-7. Areas evaluated in the risk assessment

Exponent

8601997.007 5400 | Jun 24, 2007 | Fig 1-7 evaluation view | Fig 1-7 RA evaluation layout | j:\red_dog\projects\post_fsp_2003_base_figures.apr

Table JS1. Summary of comparison of vegetation survey parameters at site and reference areas

	Coastal		Tundra and Coastal Plain Combined [a]					
Parameter	Plain	Tundra	All	10 m[b]	100 m[b]	1,000 m[b]	Hillslope	Lagoon
Forb cover	--	--	--	--	--	--	--	--
Graminoid cover	--	--	--	--	--	--	--	--
Deciduous shrub cover	--	Sig. Different	--	--	--	--	--	--
Evergreen shrub cover	--	--	--	Sig. Different	--	--	--	--
Moss cover	--	Sig. Different	Sig. Different	--	Sig. Different	--	--	--
Moss frequency	--		--	--	--	--	--	--
Lichen cover	--	Sig. Different	Sig. Different	Sig. Different	Sig. Different	Sig. Different	--	--
Lichen frequency	--	--	Sig. Different	Sig. Different	Sig. Different	--	--	--
Vegetative litter	--	--	--	--	--	--	--	--
Unvegetated cover	--	--	--	--	Sig. Different	--	--	--
Diversity	--	--	--	--	--	--	--	--
Evenness	--	--	--	Sig. Different	Sig. Different	Sig. Different	--	--
Richness	--	--	--	--	--	Sig. Different	--	--

Source: Table 6-3

Note: Significance level for the statistical comparison is $p < 0.10$.

-- - indicates site vegetation parameters not significantly different from reference site

Sig. Different - indicates site vegetation parameters significantly different from reference site

[a] Coastal plain and tundra communities were similar and thus were combined and tested against their corresponding combined reference samples to increase the sample size and thus increase the power of the test to detect differences between site stations and reference stations.

[b] The coastal plain and tundra communities showed similar changes with distance from the road, so samples were combined according to their respective distance.

Table JS2. Summary of vegetation parameter correlations with distance from DMTS road

	Hillslope, Coast Plain, Tundra Transects	Coastal Plain and Tundra Transects Only
Forb cover	Negative correlation	Negative correlation
Graminoid cover	--	--
Deciduous shrub cover	--	--
Evergreen shrub cover	Positive correlation	Positive correlation
Moss cover	--	Positive correlation
Moss frequency	--	--
Lichen cover	Positive correlation	Positive correlation
Lichen frequency	Positive correlation	Positive correlation
Vegetative litter	--	--
Unvegetated cover	Negative correlation	Negative correlation
Diversity	--	--
Evenness	Positive correlation	Positive correlation
Richness	Negative correlation	Negative correlation

Source: Table 6-4

Note: Spearman rank non-parametric correlation was used.
Positive and negative correlations were significant with distance ($p < 0.10$).

-- - no correlation
Negative correlation - indicates that as one variable increases, the other decreases
Positive correlation - indicates that as one variable increases, so does the other

Table JS3. Locations where phytotoxicity benchmarks were exceeded for vascular plants

CoPC	Number of Site Stations Exceeding Benchmarks	Number of Reference Stations Exceeding Benchmarks	Station Locations with Exceedances
Aluminum	11/29	5/11	TT2-0010, TT3-0100, TT5-0010, TT8-0010, TP-0100, TP-1000, TP-3, TP-4, AC-R, ARC-R, OR-R, ST-REF-3, ST-REF-5, ST-REF-6, TP-REF-3, TP-REF-5
Antimony	0/29	0/11	
Arsenic	0/29	1/11	TP-REF-5
Barium	0/29	0/11	
Cadmium	3/29	0/11	TT2-0010, TT5-0010, TT8-0010
Chromium	3/29	2/11	OR-R, TP1-0100, TP-4, TP-REF-3, TP-REF-5
Cobalt	4/29	2/11	TT3-0100, TT8-0100, TT8-1000, TP1-1000, TP-REF-5, TS-REF-5
Lead	2/29	0/11	TP1-0100, TP-4
Mercury	0/29	0/11	
Molybdenum	0/29	0/11	
Selenium	0/29	0/11	
Thallium	0/29	0/11	
Vanadium	0/29	1/11	TP-REF-3
Zinc	23/29	2/11	TT2-0010, TT2-0100, TT2-1000, TT3-0010, TT3-0100, T3-1000, TT5-0010, TT5-0100, TT5-1000, TT5-2000, TT6-0010, TT6-0100, TT6-2000, TT7-0010, TT7-1000, TT7-2000, TT8-0010, TT8-0100, TT8-1000, TP1-0100, TP-4, AC-R, ARC-R, TS-REF-7, TS-REF-11

Source: Tables 6-16, 6-17, 6-18, 6-22, 6-23

Note:

-0010, -0100, -1000	-	approximate distance of station from DMTS Road or facilities in meters
AC-R	-	Aufeis Creek station, just downstream of the DMTS road crossing
ARC-R	-	Anxiety Ridge Creek station, just downstream of the DMTS road crossing
OR-R	-	Omikviorok River station, just downstream of the DMTS road crossing
REF	-	reference stations
ST	-	stream station
TP	-	tundra pond station
TS	-	tundra soil station
TT	-	terrestrial transect station

Table JS4. Locations where phytotoxicity benchmarks were exceeded for mosses and lichens

CoPC	Number of Site Stations Where Moss Samples Exceeded Benchmarks	Number of Site Stations Where Lichen Samples Exceeded Benchmarks	Number of Reference Stations Where Moss or Lichen Samples Exceeded Benchmarks	Moss Station Locations With Exceedances	Lichen Station Locations With Exceedances
Copper	0/155	--	0/9	None	None
Zinc	120/155	15/32	0/9	001P-M01, 002P-M01, 003P-M01, 004P-M01, 005P-M01, 006-M01, 007P-M01, 008P-M01, 009D-M01, 009-M01, 010P-M01, 011P-M01, 013P-M01, 015-M01, 016P-M01, 017P-M01, 018D-M01, 018P-M01, 019P-M01, 020P-M01, 021P-M01, 022P-M01, 023P-M01, 024P-M01, 025P-M01, 026D-M01, 026D-M01, 028P-M01, 030P-M01, 031P-M01, 031R-M01, 032P-M01, 032R-M01, 036-M01, 036R-M01, 037P-M01, 038R-M01, 039P-M01, 041P-M01, 044P-M01, 044R-M01, 046P-M01, 050P-M01, 051A-M01, 052P-M01, 053D-M01, 053P-M01, 059D-M01, 059P-M01, 060P-M01, 161R-M01, HR01-01A, HR01-02M, HR01-03M, HR02-01M, HR02-02M, HR03-01M, HR03-02M, HR03-03M, HR04-01B, HR04-02M, HR04-03M, HR05-01M, HR05-02M, HR06-01M, HR06-02M, HR06-03M, HR06-04M, HS1N0003, HS1N0050, HS1N0100, HS1N0250, HS1S0003, HS1S0050, HS10100, HS2N0003, HS2N0050, HS2N0100, HSN0250, HSN1000, HS2S0003, HS2S0050, HS2S0100, HS3N0003, HS3N0050, HS3N0100, HS3N0250, HSN3N1000, HS3N1600, HS3S0003, HS3S0050, HS3S0100, HS3S0250, MI-02M, MI-108, MI-25-M, MI26-M, MI-42M, MI-45M, PO-01M, PO-02M, PO-04M, PO-05M, PO-06M, PO-07M, PO-09M, PO-10M, PO-11M, PO-13M, PO-15M, PO-16M, PO-17M, PO-18M, TT1-0100, TT1-1000, TT2-0010, TT2-0100, TT2-1000, TT3-0010, TT3-0100	HR01-02L, HR02-02L, HR01-01B, HR07-02L, PO-04L, PO-11L, PO-17L, TT2-0010, TT5-0010, TT5-0100, TT5-1000, TT7-0010, TT7-1000, TT7-2000, TT8-0010

Source: Tables CK1 and CK2

Note: Copper data not available for lichens along DMTS road.

CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
HR - DMTS road transect samples
HS - National Park Service samples collected along transects at Cape Krusenstern National Monument
MO - National Park Service samples collected in outlying areas at Cape Krusenstern National Monument
PO - Port site samples
TT - terrestrial transect station samples

Table JS5a. Locations and receptors for which NOAEL or LOAEL hazard quotients exceed 1.0

Assessment Unit Location	Aluminum	Antimony	Arsenic (arsenate)	Arsenic (arsenite)	Barium	Cadmium	Chromium	Cobalt	Lead	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc
DMTS Road and Port Operations															
Site Stations															
Whole Site	Moose, caribou				Caribou										
Port Site	Moose, fox, caribou				Caribou				Ptarmigan	Ptarmigan					Ptarmigan
Near Mine	Moose, caribou				Ptarmigan, caribou				Ptarmigan, caribou						Ptarmigan
Road Site	Moose, fox, caribou				Ptarmigan, caribou					Owl, fox					
Reference Stations															
Reference Site	Moose, fox, caribou														
Lagoon Environment															
Site Stations															
Control Lagoon	Moose, muskrat														
North Lagoon	Moose, muskrat														
Port Lagoon North	Moose, muskrat								Plover						
Reference Stations															
Reference Lagoon	Moose, muskrat														
Tundra Pond Environment															
Site Stations															
TP1-0100	Muskrat														
TP1-1000	Muskrat							Muskrat							
TP3	Muskrat				Muskrat										
TP4	Muskrat				Muskrat										
Reference Stations															
TP-REF-2	Muskrat														
TP-REF-3	Teal, muskrat			Muskrat	Muskrat		Teal, muskrat							Muskrat	
TP-REF-5	Teal, muskrat		Muskrat	Muskrat	Muskrat		Teal							Muskrat	
Stream Environment															
Site Stations															
ARC-R	Moose, muskrat				Moose, muskrat										
OR-R	Moose, muskrat			Muskrat	Muskrat									Muskrat	
AC-R	Moose														
Reference Stations															
ST-REF-3	Moose, muskrat			Muskrat											
ST-REF-5	Moose, muskrat				Muskrat										
ST-REF-6	Moose, muskrat				Muskrat										
Terrestrial Environment															
Site Stations															
TT2-0010	Vole, shrew, snipe			Shrew	Vole, shrew	Shrew			Shrew	Shrew				Vole, shrew	Shrew
TT2-0100	Vole, shrew				Vole, shrew	Shrew				Shrew		Shrew		Shrew	
TT2-1000	Vole, shrew									Shrew		Shrew			
TT3-0010	Vole, shrew, snipe			Shrew	Vole, shrew	Shrew				Shrew				Vole, shrew	
TT3-0100	Vole, shrew				Vole, shrew	Shrew				Shrew					
TT3-1000	Vole, shrew				Vole										
TT5-0010	Snipe, vole, shrew			Shrew	Vole, shrew	Shrew			Snipe, vole, shrew	Shrew		Shrew		Shrew	Shrew

Table JS5a. (cont.)

Assessment Unit Location	Aluminum	Antimony	Arsenic (arsenate)	Arsenic (arsenite)	Barium	Cadmium	Chromium	Cobalt	Lead	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc
Terrestrial Environment (cont.)															
Site Stations (cont.)															
TT5-0100	Vole, shrew			Shrew	Vole, shrew	Shrew			Snipe, vole, shrew	Shrew				Shrew	Shrew
TT5-1000	Vole, shrew				Vole					Shrew		Shrew			
TT5-2000	Vole, shrew					Shrew				Shrew		Shrew			Shrew
TT6-0010	Vole, shrew, snipe			Vole, shrew	Vole, shrew, snipe	Shrew								Vole, shrew	
TT6-0100	Vole, shrew				Vole, shrew, snipe	Shrew				Shrew					
TT6-1000	Vole, shrew				Vole, shrew	Shrew					Shrew			Shrew	
TT6-2000	Vole				Vole										
TT7-0010	Vole			Vole	Vole				Vole					Vole	
TT7-1000	Vole				Vole				Vole		Vole				
TT7-2000	Vole				Vole										
TT8-0010	Vole				Vole									Vole	
TT8-0100	Vole				Vole										
TT8-1000	Vole														
Reference Stations															
TS-REF-5	Vole, shrew, snipe				Vole, shrew							Shrew		Shrew	
TS-REF-7	Vole				Vole										
TS-REF-11	Vole														

Source: Appendix K tables of this report.

Note:
- -0010, -0100, -1000 - approximate distance of station from DMTS Road or facilities in meters
- AC-R - Aufeis Creek station, just downstream of the DMTS road crossing
- ARC-R - Anxiety Ridge Creek station, just downstream of the DMTS road crossing
- DMTS - DeLong Mountain Regional Transportation System
- LOAEL - lowest-observed-adverse-effect level
- NOAEL - no-observed-adverse-effect level
- OR-R - Omikviorok River station, just downstream of the DMTS road crossing
- REF - reference stations
- ST - stream station
- TP - tundra pond station
- TS - tundra soil station
- TT - terrestrial transect station

Table JS5b. Locations and receptors for which only LOAEL hazard quotients exceed 1.0

Assessment Unit Location	Aluminum	Antimony	Arsenic (arsenate)	Arsenic (arsenite)	Barium	Cadmium	Chromium	Cobalt	Lead	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc
DMTS Road and Port Operations															
Site Stations															
Whole Site	Caribou				Caribou										
Port Site	Caribou, fox								Ptarmigan						
Near Mine	Caribou				Ptarmigan, caribou				Ptarmigan						
Road Site	Caribou									Fox, owl					
Reference Stations															
Reference Site	Caribou														
Lagoon Environment															
Site Stations															
Control Lagoon															
North Lagoon															
Port Lagoon North															
Reference Stations															
Reference Lagoon															
Tundra Pond Environment															
Site Stations															
TP1-0100															
TP1-1000															
TP3															
TP4					Muskrat										
Reference Stations															
TP-REF-2															
TP-REF-3	Muskrat														
TP-REF-5	Muskrat														
Stream Environment															
Site Stations															
ARC-R	Muskrat														
OR-R	Muskrat														
AC-R															
Reference Stations															
ST-REF-3	Muskrat														
ST-REF-5	Muskrat														
ST-REF-6	Muskrat														

Table JS5b. (cont.)

Assessment Unit Location	Aluminum	Antimony	Arsenic (arsenate)	Arsenic (arsenite)	Barium	Cadmium	Chromium	Cobalt	Lead	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc
Terrestrial Environment															
Site Stations															
TT2-0010	Vole, shrew				Vole, shrew										
TT2-0100	Vole, shrew														
TT2-1000															
TT3-0010	Vole, shrew				Vole, shrew										
TT3-0100	Vole, shrew				Vole, shrew										
TT3-1000															
TT5-0010	Vole, shrew				Vole, shrew										
TT5-0100	Vole, shrew				Vole, shrew										
TT5-1000															
TT5-2000															
TT6-0010	Vole, shrew				Vole, shrew										
TT6-0100	Vole, shrew				Vole, shrew										
TT6-1000	Vole				Shrew										
TT6-2000															
TT7-0010	Vole				Vole										
TT7-1000	Vole				Vole										
TT7-2000					Vole										
TT8-0010	Vole				Vole										
TT8-0100	Vole				Vole										
TT8-1000															
Reference Stations															
TS-REF-5 Site	Vole, shrew														
TS-REF-7 Site															
TS-REF-11 Site															

Source: Appendix K tables of this report.

Note:
- -0010, -0100, -1000 - approximate distance of station from DMTS Road or facilities in meters
- AC-R - Aufeis Creek station, just downstream of the DMTS road crossing
- ARC-R - Anxiety Ridge Creek station, just downstream of the DMTS road crossing
- DMTS - DeLong Mountain Regional Transportation System
- LOAEL - lowest-observed-adverse-effect level
- OR-R - Omikviorok River station, just downstream of the DMTS road crossing
- REF - reference stations
- ST - stream station
- TP - tundra pond station
- TS - tundra soil station
- TT - terrestrial transect station

Table JS6. Summary of LOAEL hazard quotient exceedances

	Aluminum	Antimony	Arsenic (arsenate)	Arsenic (arsenite)	Barium	Cadmium	Chromium	Cobalt	Lead	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc
Tundra vole															
Site stations	13/20	--	0/20	0/20	12/20	0/20	0/20	0/20	0/20	0/20	0/20	0/20	0/20	0/20	0/20
Reference stations	1/3	--	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3
Common snipe															
Site stations	--	--	0/13	0/13	0/13	0/16	0/13	--	0/16	0/16	0/13	0/13	0/13	--	0/16
Reference stations	--	--	0/2	0/2	0/2	0/3	0/2	--	0/3	0/3	0/2	0/2	0/2	--	0/3
Lapland longspur															
Site stations	--	--	0/13	0/13	0/13	0/13	0/13	--	0/13	0/13	0/13	0/13	0/13	--	0/13
Reference stations	--	--	0/1	0/1	0/1	0/1	0/1	--	0/1	0/1	0/1	0/1	0/1	--	0/1
Black-bellied plover															
Site stations	--	--	0/3	0/3	0/3	--	--	--	0/3	0/3	0/3	0/3	0/3	--	0/3
Reference stations	--	--	0/1	0/1	0/1	--	--	--	0/1	0/1	0/1	0/1	0/1	--	0/1
Green-winged teal															
Site stations	--	--	0/6	0/6	0/6	0/6	0/6	--	0/6	0/6	0/6	0/6	0/6	--	0/6
Reference stations	--	--	0/6	0/6	0/6	0/6	0/6	--	0/6	0/6	0/6	0/6	0/6	--	0/6
Snowy owl															
Site stations	--	--	0/2	0/2	0/2	0/2	0/2	--	0/2	1/2	0/2	0/2	0/2	--	0/2
Reference stations	--	--	0/1	0/1	0/1	0/1	0/1	--	0/1	0/1	0/1	0/1	0/1	--	0/1
Willow ptarmigan															
Site stations	--	--	0/3	0/3	1/3	0/3	0/3	--	2/3	0/3	0/3	0/3	0/3	--	0/3
Reference stations	--	--	0/1	0/1	0/1	0/1	0/1	--	0/1	0/1	0/1	0/1	0/1	--	0/1
Brant															
Site stations	--	--	0/3	0/3	0/3	0/3	0/3	--	0/3	0/3	0/3	0/3	0/3	--	0/3
Reference stations	--	--	0/1	0/1	0/1	0/1	0/1	--	0/1	0/1	0/1	0/1	0/1	--	0/1
Arctic fox															
Site stations	1/2	--	0/2	0/2	0/2	0/2	0/2	0/2	0/2	1/2	0/2	0/2	0/2	0/2	0/2
Reference stations	0/1	--	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Caribou															
Site stations	4/4	--	0/4	0/4	2/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4
Reference stations	1/1	--	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Moose															
Site stations	0/10	--	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10
Reference stations	0/5	--	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5
Tundra shrew															
Site stations	8/13	--	0/13	0/13	8/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13
Reference stations	1/1	--	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
Muskrat															
Site stations	2/9	--	0/9	0/9	1/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9
Reference stations	5/7	--	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7	0/7

Source: Appendix K tables of this report.

Note: Ratios represent number of LOAEL exceedances/number of sites evaluated.
Shaded cells are those with one or more exceedances.

This summary is based on the most conservative scenarios presented in Appendix K.

-- - analyte not analyzed

LOAEL - lowest-observed-adverse-effect level

Table JS7. Summary of observed and predicted ecological effects[a]

Terrestrial Habitats	Observed or Predicted Effects		
Receptor	Near Port	Near Mine[b]	DMTS Road
Caribou	--	--	--
Moose	--	--	--
Lapland longspur	--	--	--
Snowy owl	--	--	--
Arctic fox	--	--	--
Ptarmigan	yes[c]	yes[c]	--
Tundra vole	--	--	--
Tundra shrew	--	--	--
Vegetation	yes[d]	yes[b,e]	yes[d]

Freshwater Habitats	Observed or Predicted Effects			
Receptor	Aufeis Creek	Omikviorok Creek	Anxiety Ridge Creek	Tundra Ponds
Benthic macroinvertebrates	--	--	--	[f]
Fish	--	--	--[g]	--[h]
Green-winged teal	--	--	--	--
Muskrat	--	--	--	--
Moose	--	--	--	--
Common snipe	--	--	--	--
Vegetation	[f]	[f]	[f]	--[i]

Coastal Lagoon Habitats	Observed or Predicted Effects
Receptor	Lagoons[j]
Benthic macroinvertebrates	--
Fish	--[k]
Brant	--
Muskrat	--
Moose	--
Black-bellied plover	--
Vegetation	--

Source: Summary based on Tables 6-42 and 6-43, and the interpretation of ecological significance (Section 6.7).

Note: -- - indicates very low or no likelihood of adverse effects

[a] Observed or predicted effects indicated as "yes" are to be addressed in a risk management plan, as discussed in Section 8.

[b] The areas evaluated near the mine were outside the mine boundary. The area within the mine boundary was beyond the scope of this assessment.

[c] Potential for adverse effects from lead.

[d] Vegetation survey parameters were statistically compared to reference area data (Tables 6-3 and 6-37), and several differences were observed, as summarized in Table 6-37. No individual metals were isolated as primary causative factors. Multiple causative factors are likely.

[e] The hillslope community vegetation did not show significant difference from the reference site (Tables 6-3 and 6-37). However, at one transect station just west of the mine's ambient air/solid waste permit boundary, some shrubs appeared to be in poor condition.

[f] Not evaluated.

[g] Cadmium and lead levels in some juvenile Dolly Varden exceeded conservative screening levels for fish tissue, but were also within the range of no-effects levels (Table 6-27).

[i] Exception: Effects possible from lead and zinc in ephemeral tundra ponds located within 100 m of port facility structures, based on exceedances of literature-derived effects thresholds. However, tundra pond vegetation appeared healthy during field sampling.

[j] Lagoons located within the port site boundary.

[k] No fish were present in port site lagoons, as they have no open water connections to the Chukchi Sea.

Table WH1. DMTS haul truck spill sites summary information

					Grid Reference Monument Location		
Spill Site	Date of Spill	Spill Type	Tons Spilled	DMTS Mile Post	Monument Site	Latitude (North)	Longitude (West)
SP-01	01/12/90	Zinc	15	41.85	SP01-001	67.94109	163.05006
SP-02	01/17/90	Zinc	72	48.1	SP02-001	68.01279	162.93477
SP-03	08/02/90	Zinc	36	4.1	SP03-019	67.60539	163.94122
SP-04	09/03/90	Zinc	35	29.4	SP04-001	67.82995	163.34785
SP-05	09/18/90	Zinc	36	4.95	SP05-001	67.61495	163.92287
SP-06	12/01/91	Lead	30	40.3	SP06-001	67.93362	163.09655
SP-07	02/20/92	Lead	72	8.5	SP07-002	67.63837	163.80674
SP-08	03/20/92	Lead	15	21.1	SP08-010	67.76672	163.56600
SP-09	07/29/92	Zinc	37	48.85	SP09-001	68.02160	162.93450
SP-10	07/14/93	Zinc	35	51.3	SP10-001	68.04481	162.86582
SP-11	12/15/93	Zinc	28	26.65	SP11-001	67.80349	163.42157
SP-12	09/06/94	Zinc	36	48.75	SP12-001/007	68.01966	162.93574
SP-13	08/05/96	Zinc	35	32.3	SP13-001	67.86341	163.29792
SP-14	12/10/96	Zinc	37	48.65	SP14-014	68.01856	162.93419
SP-15	01/02/97	Zinc	17	27	SP15-002	67.80696	163.41252
SP-16	08/19/97	Zinc	15	51.05	SP16/26-001	68.04253	162.87135
SP-17	08/21/97	Zinc	10	1	SP17-001	67.58687	164.02718
SP-18	01/17/98	Zinc	17	35	SP18-001	67.89438	163.24367
SP-19	02/07/98	Zinc	45	27.25	SP19-001	67.80876	163.40421
SP-20	04/17/98	Zinc	0.4	32.6	SP20-001	67.86890	163.29753
SP-21	07/11/98	Zinc	20	42.4	SP21-001	67.93950	163.07366
SP-22	08/01/98	Lead	76	RT	SP22-001	67.94109	163.05007
SP-23	11/21/98	Zinc	40	41.75	SP23-001	67.94623	163.04388
SP-24	01/06/99	Zinc	72.5	45	SP24-001	67.97663	162.98434
SP-25	01/21/99	Lead	38	9.02	SP25-008	67.64293	163.79299
SP-26	07/19/99	Lead	66	51.05	SP16/26-001	68.04253	162.87135
SP-27	10/09/00	Lead	30	32.5	Station "4"	67.92447	163.10250
SP-28	12/22/00	Zinc	40	44.7	Station "3"	67.97392	162.99184
SP-29	02/16/01	Zinc	14	42.2	Station "104"	67.94592	163.04355
SP-30	07/20/01	Zinc	10	39.25	Station "102"	67.92447	163.10250
SP-31A	03/22/98	Zinc	1 [a]	48-53	SP31A-001	68.01159	162.93434
SP-31B	03/22/98	Zinc	1 [a]	48-53	Road Side	68.01533	162.93524
SP-31C	03/22/98	Zinc	1 [a]	48-53	Road Side	68.01619	162.93483

Source: Teck Cominco (2003c)

[a] Total tonnage spilled at site SP-31 was estimated at 1 ton, distributed among three subsites.

Table WH2. Concentrate truck spill evaluation summary

Spill ID	Date of Spill	Closeout Date of Spill Re-evaluation	Re-evaluation Document
SP-01	January 12, 1990	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-02	January 17, 1990	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-03	August 09, 1990	May 2003	Concentrate Spill Site Recovery and Restoration Report for SP-03[2]
SP-04	September 03, 1990	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-05	September 18, 1990	May 2003	Concentrate Spill Site Recovery and Restoration Report for SP-05[3]
SP-06	December 1, 1991	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-07	February 20, 1992	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]
SP-08	March 20, 1992	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-09	July 29, 1992	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-10	July 14, 1993	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-10[5]
SP-11	December 16, 1993	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-12	September 06, 1994	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]
SP-13	August 05, 1996	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-13[6]
SP-14	December 10, 1996	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]
SP-15	January 02, 1997	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-15[7]
SP-16	August 19, 1997	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-17	August 21, 1997	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-17[8]
SP-18	January 17, 1998	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-19	February 7, 1998	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-20	April 17, 1998	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]

Spill ID	Date of Spill	Closeout Date of Spill Re-evaluation	Re-evaluation Document
SP-21	July 11, 1998	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-22	August 1, 1998	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-23	November 21, 1998	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]
SP-24	January 6, 1999	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-25	January 21, 1999	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-26	July 19, 1997	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-27	October 09, 2000	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-27[9]
SP-28	December 28, 2000	May 2005	Close out letter from TCAK to ADEC, Div. of Spill Prevention and Response[1]
SP-29	February 16, 2001	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-29[10]
SP-30	July 20, 2001	February 2004	2002–2003 DMTS Concentrate Spill Site Characterization Report for SP-30[11]
SP-31	March 22, 1998	February 2003	Report on the 2002 Spill Site Characterization Sampling Program[4]

[1] Teck Cominco. 2005. Delong Mountain Transportation System road historic concentrate spill site closeout reports for: SP-01, SP-02, SP-04, SP06, SP-08, SP-09, SP-11, SP-16 and 26, SP-18, SP-19, SP-21, SP-22, SP-24, SP-25, and SP-28. Prepared for Alaska Department of Environmental Conservation, Fairbanks, AK. Teck Cominco Alaska Incorporated, Anchorage, AK.

[2]Teck Cominco. 2003a. Memorandum from K. Turner to Teck Cominco Alaska Incorporated, Red Dog Mine, dated May 20, 2003, regarding concentrate spill site recovery and restoration report, spill site SP03, April 3–4, 2003. Teck Cominco Alaska Incorporated, Anchorage, AK.

[3]Teck Cominco. 2003b. Memorandum from K. Turner to Teck Cominco Alaska Incorporated, Red Dog Mine, dated May 20, 2003, regarding concentrate spill site recovery and restoration report, spill site SP05, April 3–4, 2003. Teck Cominco Alaska Incorporated, Anchorage, AK.

[4]Teck Cominco. 2003c. Report on the 2002 spill site characterization sampling program, sampling procedures and summary of data collected, DeLong Mountains Regional Transportation System, Alaska. Draft. Teck Cominco Alaska Incorporated, Anchorage, AK.

[5]Teck Cominco. 2004a. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-10. Teck Cominco Alaska Incorporated, Anchorage, AK.

[6]Teck Cominco. 2004b. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-13. Teck Cominco Alaska Incorporated, Anchorage, AK.

[7]Teck Cominco. 2004c. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-15. Teck Cominco Alaska Incorporated, Anchorage, AK.

[8]Teck Cominco. 2004d. 2002 DMTS concentrate spill site characterization report, spill site SP-17. Teck Cominco Alaska Incorporated, Anchorage, AK.

[9]Teck Cominco. 2004e. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-27. Teck Cominco Alaska Incorporated, Anchorage, AK.

[10]Teck Cominco. 2004f. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-29. Teck Cominco Alaska Incorporated, Anchorage, AK.

[11]Teck Cominco. 2004g. 2002–2003 DMTS concentrate spill site characterization report, spill site SP-30. Teck Cominco Alaska Incorporated, Anchorage, AK.