May 13, 2004

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RE: Review of Government of Nunavut (Department of Environment) Comments on the HHERA for the Nanisivik Mine Closure

Dear Ms. Filiatrault

As per your request Dillon Consulting Limited has reviewed the comments on the Human Health Ecological Risk Assessment (HHERA) for the Nanisivik Mine Closure, recently received from the Government of Nunavut, Department of Environment. The review was conducted to determine if the review raised issues that had not been addressed previously. The review was also to determine if additional work was required to address issues raised in the Government of Nunavut review.

A detailed assessment of the review comments provided by GN-DE is included in the attachment to this letter. The GN-DE review has not raised any issues that have not been previously addressed by other reviews. The review does raise issues of clarity and is justified in stating that the report cannot be considered as a stand-alone document. GN-DE reviewers have also identified several places in the report where minor corrections should be made. These corrections would add to the clarity of the report but will not substantially change the conclusions.

Our review of the current report shows that the major issues raised in previous reviews have been adequately addressed and that the overall conclusions presented in the report are reasonable.

Should you have any further questions, please contact me at (905) 975-0646.

Sincerely,

Bryan Leece, Ph.D.
Senior Toxicologist/Risk Assessment Specialist
Dillon Consulting Limited

Attachment…..

Nanasivik Mine Human Health and Ecological Risk Assessment
Review of Government of Nunavut Department of Environment Comments

Perpared by Dillon Consulting Limited

The following table provides a summary of the comments provided by the Government of Nunavut, Department of Environment on the human health and ecological risk assessment prepared by Jacques Whitford Environmental Limited (JWEL). The comments provided by the Government of Nunavut are reproduced in Column 1 of the table, Column 2 provides an response to the comments and Column 3 provides recommendations regarding the need for additional any additional work that may be required to address the issues raised by the comments.

Based on the review of, the comments provided by the Government of Nunavut have not raised any issues that have not already been addressed. These comments also note several minor errors that could be addressed. However, these errors do not affect the scientific soundness of the report, nor the overall conclusions.

Review Comment Summary Table

Comments from GN-DE	Review Response	Recommendations
1. Section 3.2.1 - Current Data, pg. 12, 4th paragraph. It reads "For the purpose of the risk assessment…only soil samples that accurately reflect concentrations…are relevant to potential exposures." *How were soil samples concentrations selected to reflect 'accuracy'? More data and clarification is needed. There should be information in the HHERA of sufficient detail that a reviewer can check and verify the calculations which were performed to determine this.*	Based on the description provided in Section 3.2.1, sample concentrations were not selected to reflect accuracy as suggested in this comment. Samples were selected to reflect concentrations in the top 0 – 30 cm of soil. This is standard risk assessment practice. It is the top 30 cm that are generally considered to contribute to human exposures. At greater depths, non-volatile contaminants, such as metals, are generally inaccessible and do not contribute to human exposures. Section 3.2.1 outlines the process used to select sample data for inclusion in the risk assessment. To ensure that only relevant data was included, only samples that were collected within the top 30 cm horizon were included. Samples that included soil from depths greater than 30 cm were excluded. This approach prevents the inappropriate inclusion of samples that will not contribute to potential exposures.	The approach used in the present report is appropriate and adequate. No additional work is required to address this issue

Comments from GN-DE	Review Response	Recommendations
2. *Section 3.2.2 – Background data, pg. 13, 4th paragraph.* It reads "The soil geochemistry survey completed in 1985…all data from this survey were used to represent the regional background conditions." This survey was done almost 10 years after mining operations started. Does this survey data truly represent background soil concentrations or it represents artificially 'higher' background soil concentrations?. Again this is referred to in *Section 6.2.2, Table 6.12, pg. 50, "Evaluations of Assumptions in the Risk Analysis", Numeral 3.*It reads "1985 geochemistry survey is representative of natural background conditions. However, *Section 7.1.1 – Town Area, pg. 56, 3rd paragraph.*`It reads "EPC for Lead in town area (192.3 mg/kg) is not significantly different (ANOVA p>0.005) from the 1985 site-specific background data for the town area (204.2 mg/kg). This statement is also repeated in a *footnote on Table 7.1, pg. 57.* It reads "****It could not be determined with certainty that the 1985 Background 95% UCL concentrations were unaffected by anthropogenic (i.e. Mining) activities**…" These statements are in <u>contradiction</u> with the assumption (pg. 13 and 50) that the 1985 geochemistry survey data is representative of the natural background concentration of metals. <u>This reaffirms that using the 1985 survey data was not appropriate as background soil concentration.</u> Particularly since statistically there is no difference between the EPC and the 1985 Background level concentration, as in the case of Lead, which is a critical metal in determining the extent of clean up needed.	It should be noted that the issue of the relevancy of the 1985 background data has been discussed in detail in previous reviews. The data set used covered a very large area, much of which would not have been affects by mining activities. Based on this information, it was generally agreed that the 1985 data set was appropriate for use a background. Unfortunately, the information presented at the September meeting has not been included in this report. The inclusion of a diagram to outline the extent of the 1985 sampling program would help to clarify the issue. It is unclear why JWEL included this statement in the footnote for Table 7.1. This however, does not invalidate the use of the 1985 data as background. It should also be noted that the lack of a statistically significant difference between the EPC and background concentration for lead does not mean that the background data is inappropriate. Background data is used in the screening process to identify contaminants of concern for risk assessment. Exposure point concentrations (EPCs) for a site are compared to screening guidelines and background. If site EPCs are below background the compound is not considered to be a contaminant of concern and is not evaluated in the quantitative risk assessment. Local or regional background data are included in the screening process to ensure that remediation targets do not recommend clean-up to levels that are lower than local background conditions. It is also generally considered that naturally occurring elevated levels of contaminants (particularly metals) do not pose human or ecological health risks.	The 1985 survey data is appropriate for use a background data for the purposes of this risk assessment. A diagram outlining the extent of the 1985 sampling program would be a useful addition to the report.

Comments from GN-DE	Review Response	Recommendations
3. Furthermore, *Section 3.2.1 - Current Data, pg. 13, 2nd paragraph.* It reads "EPCs calculated using this second data set [sample interval within 0.3m of the soil profile] were lower than EPCs based on only the surface soil samples" This means that the surface soil layer (0.1-0.15m) has higher metal concentration that the subsurface layer (0.3m). This implies that the surface soil is contaminated, again reaffirming that the survey data (when considering only surface samples) does not truly represent background soil values. In addition to this point, it becomes clear that it is very important to consider airborne transport of pollutants, particularly due to dust dispersion and transportation. This is of great importance in considering pathways of exposure, particularly for Lead, since Lead sulphide is present in powder form.	The second sample interval (which includes any sample that has any portion within the top 30 cm) was included as a check to ensure that the data set used to establish EPCs for the screening process were conservative. The fact that the EPCs calculated for the larger soil horizon are lower than the EPCs calculated for the 0 – 30 cm horizon demonstrates that the approach used to identify contaminants of concern is conservative. It should also be noted this data is not based on the 1985 survey data. It is based on the GLL and EBA soil sampling programs conducted in 2002. Neither of these were intended as background sampling programs. Consideration of airborne transport is incorporated into the risk assessment. Consideration of airborne deposition is not considered in establishing EPCs, which are intended to assess current conditions within a defined area.	The approach used in the present report is appropriate and adequate. No additional work is required to address this issue.
4. Adding to the previous points, *Section 7.1.3 - General Mine Area, pg. 58, 2nd Paragraph.* It reads "that the EPC for copper in the General Mine Area is not significantly different (ANOVA p>0.05) from the 1985 site specific background data, and copper is therefore not carried forward as a hazard into the risk assessment." How was it determined that the difference between EPC (66.7 mg/kg) and 1985 SSB (45.4 mg/kg) was not significantly different? If the difference is significant, the HHERA needs to be re-written to include copper as a hazard in the risk assessment. There should be information in the HHERA of sufficient detail that a reviewer can check and verify the calculations which were performed to determine this.	The current report indicated what basis was used to determining the statistical significance of the differences in EPC and background concentrations for copper and other metals. The approach used in the report is generally accepted risk assessment practice. Given that there is no statistical difference between the EPC calculated for copper and the background level calculated from the 1985 background data, the exclusion of copper as a contaminant of concern for the general mine area is valid. However, the reviewer does raise a valid point in indicating that the present report does not provide sufficient information for a reviewer to determine that the statements made in the risk assessment are indeed correct. This information should be provided either in an appendix or as a separate report that is referenced in the HHERA.	The approach used in the present report is appropriate. The report should make reference to the report where the statistical calculations are available for review.

<table>
<tr><th>Comments from GN-DE</th><th>Review Response</th><th>Recommendations</th></tr>
<tr><td>5. Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 11 “1985 Specific Background (SSB) 95% UCL”
There are different SSB values for Lead and Zinc in both tables. Since these are background level values they should be the same among tables. In particular the differences are:

<table>
<tr><th></th><th>Lead (Pb) [mg/kg]*</th><th>Zinc (Zn) [mg/kg]*</th></tr>
<tr><td>Town Area</td><td></td><td></td></tr>
<tr><td>HHRA</td><td>31</td><td>29</td></tr>
<tr><td>ERA</td><td>204.2</td><td>322.8</td></tr>
<tr><td>Dock Area</td><td></td><td></td></tr>
<tr><td>HHRA</td><td>31</td><td>29</td></tr>
<tr><td>ERA</td><td>287</td><td>690.2</td></tr>
<tr><td>Mine Area</td><td></td><td></td></tr>
<tr><td>HHRA</td><td>31</td><td>29</td></tr>
<tr><td>ERA</td><td>67.9</td><td>89.7</td></tr>
</table>
* Assumed units, since units do not appear in either Table.

The correct values for this column (11) should appear in both Tables (6.1 and 7.1).</td><td>Section 3.2.2 of the report indicates that approximately 1,300 from the 1985 survey were used to establish background for the human health component of the HHERA. It also indicated that approximately 290 samples were used to establish background for the ecological risk assessment component of the HHERA. Given that different data sets were used, it is to be expected that different background values would de developed for the HHRA and ERAs within the three study areas.

Unfortunately, limited information is provided to explain why differing data sets were used for the HHRA and ERA.</td><td>The development of different background values for the HHRA and ERA is common practice.

No additional work is required to address this issue. However, additional explanatory text would help to make the document clearer.</td></tr>
<tr><td>6. Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 11 “1985 Specific Background (SSB) 95% UCL”.

In examining the background values (Column 11) according to the ERA (See Table above), the background values for the town and the dock area are larger than the mine ones. Is this correct? The expectation would be to have higher values in the mine area since it is there where mineral extraction happened.

Having higher concentration of Lead and Zinc in the town and dock area, when compared to the mine site data, points at a likelihood of contamination in the town and dock area. Again the validity of the 1985 survey data as background data is highly questionable.</td><td>A comparison of the 95% UCL values calculated for the HHRA shows that the same values have been determined for all three study areas. The differences reported for the three areas for the ERA reflect the different data sets used to calculate these values. This does not alter the validity of the 1985 data set for use as background.</td><td>No additional work is required to address this issue. However, additional explanatory text would help to make the document clearer.</td></tr>
</table>

Comments from GN-DE	Review Response	Recommendations
7. Section 5.0 – Risk Assessment Framework, pg. 16, Box 2. It reads "For the HHRA result were screened against only human health based guidelines primarily taken from CCME and where these were not available from OMOE." All metal screening guidelines are available from CCME, with the exception of Boron. However, in Table 6.1 the OMOE standards for Silver, Cobalt, Nickel and Zinc were used, instead of CCME ones. This need to be corrected. In addition, *Section 6.1.1 Hazard Identification, pg. 19, 2nd paragraph.* It states "For the HHRA, these metals are then screened specifically against human health based generic guidelines. In order of preference, these guidelines are taken from CCME (1999), OMOE (1996) or the USEPA (2002)." Again, the CCME guidelines should have been preferentially used in Table 6.1 (pg. 20), which is not the case. This needs to be corrected.	In establishing guidelines the CCME, and most regulatory agencies, develop both human health based and ecologically based guidelines. The lower of these values is selected as the final guideline value. This approach provided protection of both human and ecological receptors. When screening for contaminants of concern for a human health risk assessment, it is standard practice to use guideline values that are protective of human health and not those that are set to provide protection for ecological receptors. Although CCME does have guidelines for most metals, as indicated by the reviewer, the CCME guidelines for silver, cobalt, nickel and zinc are based on ecological end-points. The use of these guidelines is inappropriate in a HHRA. In the absence of human health based values from the CCME, it is necessary to use human health based values from other agencies such as the MOE or the US EPA. The approach used in the current report conforms to standard and customary risk assessment practice. The selection of human health based guidelines from the MOE for silver, cobalt, nickel and zinc is appropriate. It should be noted that the CCME guidelines were preferentially used and that guidelines from other agencies were used only when human health based guidelines were not available from CCME.	Appropriate guidelines have been used to screen for contaminants of concern. No corrections are needed to the screening guidelines. No additional work is required to address this issue.
8. Section 6.1.1 – Hazard Identification, pg. 19, 2nd paragraph. It reads "Based on preliminary screening data…the elements Antimony, Barium, Beryllium, Chromium, Mercury, Molybdenum, Selenium, Tin, and Vanadium were eliminated from the HHERA." The HHERA does not contain data to support the screening out of these elements. The information needed should be of sufficient detail that a reviewer can check and verify the calculations which were performed to screen out those elements.	The rationale provide for the exclusion of these metals is sound. However, the analytical data has not been provided or summaries in a way that allows for easy verification that the statement is correct.	The addition of data either as an appendix or a reference to the appropriate report where the data can be found.

Comments from GN-DE	Review Response	Recommendations
9. *Table 6.1, pg. 20, Column "Applicable Guideline" in the "Hazard Screening Procedure for Human Health Risk Assessment".* Many of the human health generic soil guidelines appear to be incorrect. In reviewing the sources quoted for the guidelines for soil ingestion, the quoted values in Table 6.1 differ from the values in the guidelines. See Table A (at the end of this document). If using CCME guidelines, as indicated in the HHERA, then several metals needed to be carried forward for the 'Background Soil Concentration Comparison' part of table 6.1. In particular these 11 metals are (aside from the ones already carried forward): • Town Area (3): Cobalt, Copper and Nickel. • Dock Area (5): Boron, Cadmium, Copper, Lead, Zinc. • General Mine Area (3): Silver, Boron and Copper. Units are not reported in Table 6.1 for metals concentration, it is assumed they are mg/kg. The unit's information is critical for comparison purposes. It is a ***fundamental*** scientific procedure to report units along with numerical data.	As noted in the response to point #7, screening of contaminants of concern for the HHRA is appropriately based on human health-based screening guidelines. The guidelines listed in Table 6.1 are appropriate for the HHRA. The use of the CCME guidelines for silver, copper, nickel and zinc is inappropriate. Also the use of the generic MOE value for boron, which is based on the protection of plants, is inappropriate for use in a HHRA. As noted above, the values used in the Table 6.1 are appropriate for the HHRA and the additional compounds identified in the review comments should not be considered in the HHRA.	Appropriate screening guidelines have been used in the HHRA. No additional contaminants of concern need to be considered in the HHRA. No additional work is required to address this issue.
10. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 4 "Applicable guideline values".* The applicable guideline values for screening purposes should be the same, since the applicable guideline is CCME (2002) – Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. In any case, is there an explanation why the 'Applicable guidelines' quoted for the HHRA are 'larger' than the ones for ERA? It should be that the more strict guidelines should be applied to HHRA and not the contrary.	As noted in the responses to Point #7 and Point #9, the use of different screening guidelines for HHRA and ERA is appropriate and standard risk assessment practice. It should also be noted that both human health and ecological guidelines are based on assumed exposure scenarios that help to define the dose received by a receptor. In general ecological receptors will have a much greater exposure to contaminants in the environment than humans. For example, plant and soil invertebrates spend an entire life-time in intimate and continuous contact with the soil while humans will have only limited direct contact with soil. Thus, it is reasonable to expect that these receptors will have a much greater exposure to contaminants in the soil than humans. As a result, the levels needed to ensure protection of ecological receptors are generally lower than those set to provide protection of the human population. It should be noted that this is not always the case. For carcinogenic chemicals, such as arsenic, the human health based values are generally lower than the ecological values. In these cases, the human health based value serves as the overall guideline.	The application of different human and ecological guidelines is standard risk assessment practice. No additional work is required to address this issue.

<table>
<tr><th>Comments from GN-DE</th><th>Review Response</th><th>Recommendations</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>11. Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 6 “Number of Samples”.
In Table 6.1 the number of samples (Dock Area) for Lead and Cadmium is ‘0’, while is reported as ‘29’ in Table 7.1. These values should be the same since they refer to the total number of samples tested for the applicable metal concentration.

In addition, in Table 7.1 the “% exceeding guideline” (Column 8), is 79.3% and 82.8%, for Pb and Cd. This is a significant amount of samples exceeding the guideline; hence this information should also appear on the HHRA Table (6.1).</td><td>As noted in Point #5, the HHRA and ERA are based on differing data sets. The report would benefit from some additional explanatory text to clarify this issue.

Also as noted in Point #7, #9 and #10, different screening guidelines are used for the human health and ecological risk assessments. Therefore, it is to be expected that the number of samples exceeding guidelines would be different between the two components of the study. It should also be noted that because different screening guidelines are used in HHRA and ERA it is not uncommon to find that the HHRA and ERA assess differing contaminants of concern.</td><td>The approach used in the current report is valid.

Some additional explanatory text describing the differences between the HHRA and ERA sample collection/analysis would help to clarify the report.</td></tr>
<tr><td>12. Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 8 “% Exceeding guideline”
In Table 7.1 the “% exceeding guideline” (Column 8, Dock area), is 79.3% or Pb. This is a significant amount of samples exceeding the guideline, <u>EVEN THOUGH the guideline has been misquoted</u>, CCME (2002) value for Lead (Residential/Parkland) is 140 mg/kg (not 300 mg/kg as reported in the table). Hence the <u>number of samples exceeding the actual guideline is likely higher than reported. This needs to be corrected</u>.</td><td>The ecological guideline has not been misquoted. For lead, the CCME general guideline for residential/parkland is, as indicated 140 mg/kg. However, this is a human health based value. The CCME ecological screening value for residential/parkland is 300 mg/kg as stated in the report.</td><td>The guideline value used in the report is correct.

No additional work is required to address this issue.</td></tr>
<tr><td>13. Table 6.9, pg. 45, Surface Soils SSTL$_{HH}$ (mg/kg) – Non-Carcinogenic Effects.
A comparison between maximum soil concentrations and the SSTL values is not presented, however it was done for Table 7.13, pg. 78, “Overall Ecological Site-Specific Threshold Limits derived for the Nanisivik Mine Site”. This comparison is important to assess the difference between the maximum concentrations and the SSTL chosen values.
<table>
<tr><th>Metal</th><th>Max Soil Conc. mg/kg)</th><th>SSTL$_{HH}$ Residential</th><th>SSTL$_{HH}$ Hunting/Rec.</th></tr>
<tr><td>Cadmium</td><td>230</td><td>35</td><td>50</td></tr>
<tr><td>Lead</td><td>9350</td><td>70</td><td>1050</td></tr>
<tr><td>Zinc</td><td>131000</td><td>10800</td><td>23400</td></tr>
</table>
From the data above, the maximum concentration of Cadmium is 5-7 times larger than SSTL$_{Cd}$, for Lead is 9-13 times larger than the SSTL$_{Pb}$, and for Zinc max value is 6-12 larger than SSTL$_{Zn}$. This gives an indication that clean up is necessary and likely in wide areas (vs. only on ‘hot spots’).</td><td>The inclusion of a comparison as indicated by the reviewer would aid in the interpretation of the report.

However, the conclusion that the large differences between the SSTLs and the maximum reported concentration, indicates that contamination is wide-spread is inaccurate. This type of conclusion can only be reached by considering the overall distribution of the concentrations across the area.

Maximum concentration represent single values, that may be outliers. Evaluation of other statistics such as the 95% UCL and/or the 95th percentile must be considered before it can be determined how wide-spread contamination is likely to be.</td><td>The conclusions of the report are valid. However, the report would benefit from some additional discussion of why the contamination is considered to be localized.</td></tr>
</table>

Comments from GN-DE	Review Response	Recommendations
14. *Table 6.12, pg. 52,* "*Evaluations of Assumptions in the Risk Analysis*", Numeral 3. It reads "Lead toxicity assessment was based on blood Lead levels". The blood Lead levels were from generic scientific literature. Since the residents and workers of the Nanisivik/Arctic Bay area have been exposed to Lead for a period of time, it would have been more accurate to use actual Lead blood levels from the residents/workers in the area. Using actual Lead blood level information (which is likely higher than generic literature values) would have rendered a better picture on the sensitivity of this population to Lead. From here it is possible that a stricter remediation and clean up, that is lower SQROs, likely are necessary.	Biological monitoring, of the type suggested by the reviewer, is not part of a standard HHRA. This type of work is done as part of a community health assessment. It should also be noted that when this type of work has been done in other communities (Sydney, Deloro, Wawa, Port Colborne), the have shown that measured blood lead levels are well below the levels predicted by the risk assessment. The HHRA process is designed to over-estimate exposures thereby, ensuring that problems are not under estimated. It is likely that a blood-lead testing program in the community would show results that are similar to the studies conducted in other communities. The results would also likely suggest a SQRO that is higher than the value calculated in the HHRA.	The SQRO calculated in the current report is appropriate and adequately protective of human health. No additional work is required to address this issue.
15. *Table 6.12, pg. 52,* "*Evaluations of Assumptions in the Risk Analysis*", Numeral 3. It reads "It is important to note that the forms of Lead that have been associated with tumor development in laboratory animal experiments were Lead salts of Lead acetate and Lead phosphate". The form of Lead in Nanisivik is largely Lead sulphide (galena, CAS 1314-87-0). In general Lead salts are absorbed in the gut; hence Lead salts are first dissociated and solubilized by gastric acids. The particular chemical composition of the Lead salt is not as relevant, as it is the presence and dose of Lead itself. This reason should have not been used to disregard the potential carcinogenity of Lead.	The chemical form of a metal can, and does, have a marked effect on the potential toxicity and biological mechanism of action. The note that the forms of lead considered in animal testing differ from the forms likely to be found in Nanasivik is justified. It should also be noted that the potential carcinogenicity of lead has not been discounted solely on the basis of the argument presented by the reviewer. The report provided substantial justification based on detailed toxicological evaluations undertaken by Health Canada, the US EPA and the ATSDR. It addition, it should be note that the Health Canada assessment builds on a similar assessment completed by the World Health Organization. None of these agencies recommend assessing lead as a potential human carcinogen. These arguments, in addition to the one noted by the reviewer have been used to justify treated lead as a non-carcinogenic compound.	The justification for assessing lead as a non-carcinogenic compound is appropriate. No additional work is required to address this issue.
16. *Table 7.1, pg. 57, Column "OTR1 Rural parkland" for Silver (Ag) in the "General Mine Area."* The value listed is 0.27 ug/g when if fact, from the MOEE 1993 document "Ontario Typical Range of Chemical Parameters in Soil, Vegetation Moss Bags and Snow," the OTR for Silver is 0.11 ug/g. Nonetheless, in Table 7.1, Silver is carried forward as a hazard for the Quantitative Ecological Risk Assessment for the General Mine Area, but the correct OTR should be used and 0.27 ug/g be corrected to 0.11 ug/g.	Value should be 0.11 µg/g (mg/kg)	Correction should be made but this will not alter the conclusions of the report.

Comments from GN-DE	Review Response	Recommendations
17. *Table 7.3, pg. 59, Column 3 "Dock Area".* The value for Surface Water Exposure Point Concentration for the Dock Area, for Zinc (3.30573 mg/L) is 2 orders of magnitude larger than the values for the Town and the Mine Area. This implies that the surface water near the Dock area is more contaminated than the one in the town and mine area. More information and action plan are required in this topic.	The value represents an EPC that is used as input to the ERA. Any decision on the need for remediation should not be based on this value. Rather, the decision on remediation is properly based on the results of the ERA which identify the level of risk associated with the EPC. If the ERA shows that the EPC concentration does not represent a potential risk, a remedial action plan would not be required.	No additional work is required to address this issue.
18. *Section 7.7 – Site-Specific Threshold Limits, pg. 78, 2nd and 3rd paragraphs.* In 2nd paragraph it reads "…$SSTL_{ECO}$ for Lead for Ptarmigan is lower than the highest measured concentration at the mine site." In 3rd paragraph it reads "…there might be some **perceived benefit** [*emphasis added*] to ecological receptors **if** [*emphasis added*] remedial activities are undertaken." These paragraphs seem to be incomplete and contradictory. There is no clarity on the need for remediation, even though clean up is needed according to the $SSTL_{ECO}$ values for Ptarmigan (for Lead). The SSTL value in this case is about half of the maximum soil concentration value (4569 vs. 9350 mg/kg, for SSTL and max. respectively). Clarification is needed on what it means and what is implied when an $SSTL_{ECO}$ value is smaller than the maximum soil concentration. This is similar to the case of Zinc values for Ptarmigan and Arctic Fox, where the maximum soil concentration values are as high as 3 times the SSTL values. Clarification is needed on what it means and what is implied when an $SSTL_{ECO}$ value is smaller than the maximum soil concentration.	The information presented in Table 7-12 and 7-13 is based on a comparison of maximum reported concentrations and the calculated $SSTL_{ECO}$. As noted in Point # 13, generalizations about the need for remediation should not be based solely on a comparison between SSTLs and maximum values. Comparisons between SSTLs and maximum values are valid when the SSTLs are above the maximum values. When the SSTLs are below the maximums additional analysis is required (comparison with 95% UCL or 95th percentile *etc*) before decisions regarding remediation can/should be made.	Text that discusses the steps necessary in making remediation decisions in situations where the SSTLs are below the maximum values would help the clarity of the report.
19. *Table 7.14, pg. 79, "Evaluation of Assumptions and Uncertainties in the Ecological Risk Assessment", Numeral 3.* It reads (Numeral 3, 3rd column) "…since SSTLs were all well above EPCs, and maximum measured concentrations". The second part of the statement is not accurate; there are SSTLs that are in fact smaller than the maximum measured concentrations (See Tables 7.13, pg. 78), specifically in the case of Lead for Ptarmigan, and Zinc for Ptarmigan and Arctic Fox (See previous comment). This is an invalid conclusion. Correction is needed.	The statement that the SSTLs are all higher than the EPCs and maximum concentrations needs to be corrected as indicated by the reviewer. However, it should be noted that this table is an evaluation of the uncertainties associated with the assessment and not a summary of the conclusions of the report. Although the SSTLs for some contaminants are lower than the maximum values, the overall conclusion that the assumption is acceptable is valid.	The assumption is valid. No additional work is required to address this issue.

Comments from GN-DE	Review Response	Recommendations
20. *Table 7.14, pg. 80, Column 2, "Justification", Numeral 1.* Incorrect cross-reference. Receptor Characteristics should be changed from, "See Section 7.3 (Receptor Identification)" to "See Section 7.2 (Receptor Identification)."	Correction required	Reference should be corrected.
21. *Table 8.2, pg. 84, "SQROs (mg/kg) for Surface Soils: Dock Area".* The values on the 1st row (Human Health SSTL) need to be changed, in accordance to corrections on Table 6.1 (pg. 20) as suggested on points 9 & 10 above. When Human Health SSTL are added, the SQROs values change for Cadmium (from 2800 to 35), for Lead (from 4570 to 700), and for Zinc (from 44000 to 10800). <u>These changes on SQROs values have significant implications on the clean up and remediation planning, since likely there will be a larger number of sampling exceeding the SQROs values.</u>	The dock area has not been considered as part of the human health risk assessment. Therefore, the inclusion of the human health based SSTLs for this area would be inappropriate. The estimates of the number of samples that exceed the SSTLs in the dock area does not need to be changed.	The approach used in the report is correct. No additional work is required to address this issue.
22. *Tables 8.1 to 8.3, pg. 84. compared with Tables 7.13 (pg. 78) and 6.9 (pg. 45).* The values for Ecological SSTL for Cadmium and Copper are slightly different than in Table 7.13 (pg. 78). For instance the lower SSTL, and hence SQRO value for Cadmium should be 2840 mg/kg (not 2800 mg/kg), for Copper 5920 mg/kg (not 5900 mg/kg). Similarly the SSTL value (Human Health) for Zinc (General mine area) should be 23400 mg/kg (not 23200 mg/kg). If the purpose was to round up the values to the nearest thousand, then it should be uniformly applied on Tables 8.1 to 8.3. Otherwise more care is needed when transcribing data among tables.	The data presented in these tables have been rounded down to lower, or more conservative values.	The approach used in the report is correct. No additional work is required to address this issue.

Comments from GN-DE	Review Response	Recommendations
23. *Tables 8.4, pg. 84, Column 7 "Soil Quality Remedial Objective" in "Comparison of Sample Concentrations to SQROs".* The values in Column 7 "Soil Quality Remedial Objective (mg/kg)" are different than the values for SQROs on Tables 8.1 to 8.3. The carelessness in the transcription of data among tables is shocking, particularly in this very critical table where the main conclusions for the whole HHERA are drawn.	The table in the final report is appears to have been reproduced from the earlier draft. The changes noted by GN-DE with respect to the transcription of data in Column 7 are correct and should be incorporated into the report.	The table should be updated to reflect the values reported in Table 8.1 - 8.3 in the current report.
When using the appropriate SQRO data in Column 7, then Column 9 changes to include Cadmium in the Town area and General mine area, since the 'Comment' should be "EPC< SQRO<Max, risk management of hot spots may be required". This appears to be the case in the conclusions (bullet 7, pg. 87), but it is not the case in Table 8.4. Correction is needed. In addition, the SQROs values from Tables 8.1 to 8.3 have been used in the graphs at the beginning of the HHERA (pp. ix-x).	This change should be make.	The additional change to the conclusions for cadmium should also be made. It should be noted that these changes will not alter the conclusions of the study.
Need to also check the conclusions (Column 9) for Cadmium in the Dock area. If the SSTL for human health is used, then the SQRO (35 mg/kg) is similar than EPC (33 mg/kg), and both smaller than Max (156 mg/kg). This indicates that area-wide clean up is necessary in the Dock area.	The dock area was not included in the HHRA. This change does not need to be made.	
Need to also check the conclusions (Column 9) for Lead in the Dock area. If the SSTL for human health is used, then the SQRO (700 mg/kg) which is smaller than EPC (916.2 mg/kg), and both smaller than Max (4330 mg/kg). This indicates that area-wide clean up is necessary in the Dock area.	The dock area was not included in the HHRA. This change does not need to be made.	
In addition the value of Lead on Column 4 (Generic Soil Quality Guideline: Ecological), should be 140 mg/kg not 300 mg/kg. This change will result in a larger number of samples exceeding the guideline. Hence corrections are needed accordingly in the rest of the Table.	The ecological guideline for lead of 300 mg/kg has been properly stated in the report. The generic guideline cited by GN-DE represents a human health based value. Using this value as a screening guideline in the ERA component of the study is inappropriate.	

Comments from GN-DE	Review Response	Recommendations
24. *Tables 8.4, pg. 84, Columns 3 and 4 "Generic Soil Quality Guidelines" in "Comparison of Sample Concentrations to SQROs".* The values in these columns should change accordingly to the actual guideline values, as pointed for Table 6.1 (pg. 20) and Table 7.1 (pg. 57). The metals carried over for risk assessment and the conclusions from Table 8.4 should change accordingly. The changes in Column 3 and 4 will likely indicate the need for area-wide clean up required for a number of metals (vs. no site clean-up required or localized hot spot clean up required). <u>This is of critical importance for the transparency and credibility of the HHERA.</u>	As noted elsewhere, appropriate guideline values have been used in both the HHRA and the ERA. The changes suggested by GN-DE are not appropriate.	No additional work is required to address this issue.
25. *Conclusions, pg. 87, Bullet 7.* It reads "…a limited number of sample concentrations exceeded the SQROs, indicating that isolated "hot spots" may require risk management". <u>This conclusion needs to be rewritten after the appropriate changes</u> in Tables 6.1, 7.1 and 8.4. There is a likelihood of more samples exceeding the SQROs; hence that remediation will not be limited to "hot spots".	As noted elsewhere, appropriate screening guidelines have been used in both the HHRA and the ERA. The numbers of samples exceeding SQROs will not change.	No additional work is required to address this issue.
26. *Conclusions, pg. 88, Bullet 8.* It reads "…Cadmium, Lead and Zinc EPCs in the dock area are lesser than their SQROs, indicating that there is not unacceptable area-wide impact." <u>This conclusion needs to be rewritten after the appropriate changes</u> in Tables 8.2 and 8.4. There is likelihood that EPCs will exceed the SQROs. This will result in clean up needed in the Dock area.	As noted elsewhere, appropriate screening guidelines have been used in both the HHRA and the ERA. The numbers of samples exceeding SQROs will not change.	No additional work is required to address this issue.