Avalon Rare Metals Inc.

RESPONSE TO THE JANUARY 13, 2012 INFORMATION REQUESTS FROM ABORIGINAL AFFAIRS AND NORTHERN DEVELOPMENT CANADA FOR THE THOR LAKE RARE EARTH ELEMENT PROJECT DEVELOPER'S ASSESSMENT REPORT

Submitted To:
MACKENZIE VALLEY ENVIRONMENTAL IMPACT REVIEW BOARD

February 2012

Avalon Rare Metals Inc. (Avalon) is pleased to provide the following responses to Aboriginal Affairs and Northern Development Canada's (AANDC) information requests provided via Mackenzie Valley Environmental Impact Review Board (MVEIRB) on January 13, 2012. Avalon's responses are found after each information request.

IR Number:	**AANDC #1**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water - Water Quality - Water Quality Objectives
Document:	DAR Sections 6.3 & 6.4 and Conformity Responses
TOR Section:	

Preamble

Water Quality Objectives (WQ0s) are determined to ensure that the aquatic environment will not be significantly impacted by the project (terms used to describe WQ0s in other Northern projects include EA Threshold and Water Quality Benchmarks).

AANDC notes that if effluent release/discharges are causing downstream receiving water quality to exceed WQ0s, then the effluent is considered to be potentially causing significant impacts at the current concentration (i.e. EQC) or discharge rates (i.e. volumes).

WQ0s can be established based on local environmental sensitivities, generic water quality guidelines and background conditions. AANDC notes that Avalon has compared downstream water quality to CCME water quality guidelines and MMER regulations in Section 6.4.2.5 of the DAR.

AANDC Request #1

1. Please detail the anticipated last point of control and mixing zone (including efficiency of mixing within Drizzle Lake for all parameters such as metals, nutrients and major ions) for effluent pipe decant/discharge.
2. Determine appropriate WQOs for the receiving environment.
3. Identify if WQ0s can be achieved at the edge of the mixing zone under the currently proposed discharge strategy. Describe how possible release/discharge complications could affect the environment and the previous mixing analysis from things such as freezing/icing of the ditch, plugging of the decant pipe and unexpected high TSS releases to Drizzle Lake.
4. Discuss how far downstream general changes in water quality and aquatic community are expected and identify any long-term change/impact on Drizzle Lake, Murky Lake, Thor Lake, Fred Lake, etc.

Avalon Response #1.1

Based on the plan for the Nechalacho Mine Tailings Management Facility (TMF), the last point of control for effluent leaving the TMF will be the Polishing Pond, before the water is decanted to the downstream receiving environment. The Polishing Pond has been designed to retain the water for polishing (i.e., settlement of fine particulates) for up to 30 days before it is released to the environment. The mixing zone will include the area where the decant ditch releases water to Drizzle Lake.

Avalon Response #1.2

In responding to this IR, it is important to initially note that as indicated in the DAR, any water decanted from the TMF to the downstream receiving environment will be discharged in compliance with MVLWB Water Licence and federal MMER discharge criteria. If it is determined by the regulatory bodies that site-specific water quality objectives need to be established for the downstream receiving environment at the Nechalacho Mine site, Avalon is committed to working with these agencies to develop the appropriate water quality objectives.

In this regard, as reported in Section 6.4.2.6 of the DAR and various follow-up responses to the MVEIRB, and Environment Canada, the water quality modelling conducted for the Thor Lake Project during the operations period, indicates that in the downstream receiving environment, the CCME guideline values are predicted to be met over the entire 20 year simulation period.

This will be an important consideration for the development of site-specific water quality objectives if determined to be necessary for this project by the regulatory authorities.

Avalon Response #1.3

Please see Avalon Response #1.2 above for responding to the first part of this IR. Regarding the remainder of this response, the decant pipe is not expected to become plugged since no solids or debris will be flowing through the pipe and it will be buried, thus preventing freezing. If required, any exposed pipe will be heat-traced to ensure that it does not freeze.

The primary purpose of the Polishing Pond is to settle out most of the residual fine particulates (solids) from the discharge water being released downstream to Drizzle Lake. Any water release from the TMF will be provided adequate time to settle in the Polishing Pond prior to being released to Drizzle Lake.

Icing in the ditch is also not expected to be a problem. The water balance indicates that there is not likely to be much release of water from the Polishing Pond during the winter months and none between the months of December to April inclusive.

Avalon Response #1.4

As indicated in Avalon Response #1.2 above, the water quality modelling conducted for the Thor Lake Project during the operations period indicates that in the downstream receiving environment (including Drizzle, Murky, Thor and Fred lakes) the CCME guideline values are predicted to be met over the entire 20 year simulation period.

This is expected to be the case even for aluminum and iron, which are the only metals in the effluent predicted to exceed CCME guideline values. Concentrations of metals reaching Thor Lake are predicted to be extremely low. For example, arsenic will be 0.034% of the CCME guideline; mercury 0.3% of the CCME guideline; and, copper, 0.04% of the MMER guideline.

Considerable further dilution of water flowing out of Thor Lake is anticipated as it progresses through Fred Lake and a series of wetlands, streams and lakes towards Great Slave Lake, comprising a watershed estimated to be more than three times the catchment of Thor Lake. As such, it is expected that metal levels in water entering Great Slave Lake will be similar to pre-development background levels.

IR Number: **AANDC #2**
Source: Aboriginal Affairs and Northern Development Canada
To: Avalon Rare Metals Inc.
Subject: Water Quality - Choice of Contaminant of Potential Concern (COPCs)
Document: DAR and Conformity Responses
TOR Section:

Preamble

The Developers Assessment Report (DAR) shows that Avalon did screen predicted downstream water quality against the CCME (and MMER), and it appears that the choice of COPCs is based on whether or not an element exceeded available guidelines. A concern with applying this approach is that the ore being mined is enriched with elements for which there is little toxicity data and consequently there are few toxicity-based benchmarks available.

AANDC acknowledges, as stated in the DAR, that rare earth elements in the ore and concentrate tend to be inert and are not liberated easily. However, it is difficult to have confidence that there will be no effects without investigating the chemistry data further.

Another possible approach for selecting COPCs is to include elements if their predicted concentrations in mine effluent are notably higher than the local background water concentrations. Data required for this comparison appears to be provided in the SGS 2011 report.

Once a COPC list is established, benchmarks would be needed to identify which elements may result in unacceptable effects. These benchmarks may be taken directly from available government guidelines, criteria or standards, or they may be based on available toxicity data from the scientific literature. One excellent place to find available toxicity data is USEPA's ECOTOX database (USEPA 2007).

Another approach is to create benchmarks based on a reasonable upper range of natural background concentrations of rare earth elements (REEs) in the receiving water body. Typically, a mean+2SD concentration (or 90th percentile) is calculated and adopted as a benchmark (background concentration procedure; CCME 2003).

The rationale is that if the estimated concentration of an RRE in the receiving environment is still within the range of background variation after the mine becomes operational, then the possibility of observing a significant ecological effect is low.

AANDC Request #2

1. Please compare the predicted concentrations of REEs as they are being discharged from the polishing pond with baseline concentrations of the same elements in the Drizzle, Murky and Thor Lakes. Please use the full list of elements provided in the SGS (2011) report. A table showing the difference as a factor would be very helpful. Those elements

exhibiting a significant increase should be included as COPCs, and additional assessment should be considered.

2. For identified COPCs, please show that you have consulted literature, government sources and on-line databases (i.e., USEPA's ECOTOX Database) for available toxicity-based benchmarks.
3. For COPCs which have no available toxicity data, please consider and discuss physio-chemical and/or Quantitative Structure—Activity Relationship (QSAR) reasons why that element should not result in any effects; and
4. If an element is a COPC, but there is no available toxicity data, and there is no compelling reason to drop it from the list of COPCs, please describe how the proponent proposes to derive benchmarks.

Avalon Response #2.1

Analyses were not carried out for rare earth elements (REE) in water samples collected in the Avalon Thor lake Project Area. However, predictions for the concentrations of these elements in Thor Lake from years 1-20 were made utilizing the H3D Hydrodynamic Model, as described in Section 6.4.2.4 of the DAR. The input variables for each element consisted of the Day 5 decant metal concentrations in the tailings discharge, as shown in Table 1 below.

Since neither baseline data nor water quality guidelines or objectives could be found for these elements, they were compared against available toxicity data available from the USEPA ECOTOX Database. Table 1 shows the maximum predicted concentration for each REE in Thor Lake over the 20 year period following plant start-up, and the lowest LC 50 concentration for the most sensitive organisms reported in the ECOTOX database for each element.

A comparison of the predicted values with the toxicity data indicates that in all cases, worst-case concentrations of REEs will be considerably lower (ranging from 320 to over one million times lower) than LC 50 concentrations for the amphipod crustacean that was used as the test organism. In the one case where toxicity testing involved fish (rainbow trout), the LC 50 was more than three orders of magnitude greater than the maximum predicted concentration of the test parameter, lanthanum.

As a result of this analysis, we conclude that none of the REEs should be designated as COPCs.

TABLE 1: COMPARISON OF PREDICTED RARE EARTH ELEMENT CONCENTRATIONS WITH AVAILABLE TOXICITY DATA – THOR LAKE				
Element	**Day 5 Decant Concentration in Tailings Discharge (mg/L)**	**Max. Predicted Concentration Years 1-20 (mg/L)**	**LC 50 Concentration (mg/L)**	**Aquatic Organism Affected**
Cerium (Ce)	1.39E-1	1E-4	0.032	*Hyalella Azteca* (amphipod crustacean)
Dysprosium (Dy)	2.52E-3	1.9E-6	0.162	*Hyalella Azteca*
Erbium (Er)	5.81E-4	4.4E-7	0.191	*Hyalella Azteca*
Europium (Eu)	1.09E-3	8.3E-7	0.112	*Hyalella Azteca*
Gallium (Ga)	2.86E-3	2.2E-6	>1.0	*Hyalella Azteca*
Gadolinium (Gd)	9.37E-3	7.1E-6	0.150	*Hyalella Azteca*
Holmium (Ho)	3.12E-4	2.4E-7	n/a	
Lanthanum (La)	6.88E-2	5.2E-5	0.018 0.020	*Hyalella Azteca* *Oncorhynchus mykiss* (Rainbow trout)
Lutetium (Lu)	3.3E-5	2.5E-8	0.029	*Hyalella Azteca*
Niobium (Nb)	2.57E-3	1.9E-6	0.026	*Hyalella Azteca*
Neodymium (Nd)	6.16E-2	4.7E-5	0.143	*Hyalella Azteca*
Praseodymium (Pr)	1.73E-2	1.3E-5	0.035	*Hyalella Azteca*
Scandium (Sc)	3.39E-3	2.6E-6	0.029	*Hyalella Azteca*
Samarium (Sm)	1.10E-2	8.3E-6	0.074	*Hyalella Azteca*
Tantalum (Ta)	2.30E-4	1.7E-7	0.002	*Hyalella Azteca*
Terbium (Tb)	8.19E-4	6.2E-7	0.084	*Hyalella Azteca*
Thulium (Tm)	4.6E-5	3.5E-8	n/a	
Ytterbium (Yb)	3.24E-4	2.5E-7	0.069	*Hyalella Azteca*
Zirconium (Zr)	3.29E-3	2.5E-6	>1.0	*Hyalella Azteca*

References

Based on searches of CCME guidelines, Ontario Provincial Water Quality Objectives, and the BC Compendium of Working Water Quality Guidelines.

Medupin, C. 2011. Phytoplankton Community and Their Impact on Water Quality: An Analysis of Hollingsworth Lake, UK. J. Appl. Sci. Environ. Manage. 15(2) 347-350.

U.S. Environmental Protection Agency (USEPA). 2012. ECOTOX Database. Accessed at: http://cfpub.epa.gov/ecotox/

Avalon Responses #2.2 to 2.4

Please see response to AANDC IR # 2.1 above.

IR Number:	**AANDC #3**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Quality - toxicity testing
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

There is insufficient information to assess the potential for toxicity. AANDC understands that those elements in the proposed effluent with specific CCME guidelines or MMER criteria are generally predicted to be present at concentrations below their respective guidelines/criteria. However, there is likely a wide range of elements for which there are no toxicity benchmarks available and; therefore, it is not possible to assess whether or not the expected concentrations of these elements will be below toxicity thresholds. Furthermore, the effluent will contain numerous contaminants that may result in additive or synergistic effects. One way to assess a complex effluent for potential effects is to subject a simulated effluent to toxicity testing. This testing should be done with representative species of different levels of biological organization (i.e., fish, invertebrates, plants). The testing should also favor chronic or sublethal tests as these are more sensitive and representative of possible effects within the receiving environment.

The SGS report (2011) reported the results of two acute toxicity tests (Daphnia magna and trout survival); however, these tests are not sufficiently sensitive to identify potential effects at environmentally relevant concentrations. If toxicity is observed at concentrations expected in Thor Lake, then a toxicity identification evaluation (TIE) would be appropriate. A TIE would help Avalon identify the contaminant most likely resulting in the toxicity. Avalon could then consider mitigative approaches.

AANDC Request #3

1. Please provide the results of sublethal and chronic toxicity tests on a sample of simulated effluent. If this is not practical, please provide a compelling reason why toxicity testing should not be done.

Avalon Response #3.1

Avalon is pleased to advise that preliminary acute toxicity testing was completed for the 5-day decant solution generated in the pilot plant testing program which was undertaken by SGS Canada Inc. in 2010. The acute toxicity test results were presented in Section 4.9 of the SGS report, which is available on the MVEIRB public registry. The interim report version of this document was provided as Appendix L of the DAR.

A summary of the test results is provided as follows. Acute toxicity testing was conducted in 2010 on the simulated 5-day decant (effluent) using Daphnia (*Daphnia magna*) and rainbow trout. The test work was carried out by Aquatox Testing and Consulting Inc., in accordance with the Daphnia Acute Lethality Toxicity Protocol EPS 1/RM/14 and the Acute Lethality of Liquid Effluents to Fish Protocol EPS 1/RM/13 of Environment Canada.

The test organisms (*Daphnia* and rainbow trout) were exposed to a range of effluent concentrations including 100%, 50%, 25%, and 6.3% and no mortalities occurred at any of the exposure concentrations or the controls. It was therefore determined that the 5-day decant solution tested was not acutely toxic to either Daphnia or rainbow trout.

Chronic toxicity testing was not completed at that time. Avalon has now directed SGS and its bioassay laboratory sub to complete a new round of both acute and chronic toxicity testing on Nechalacho Flotation plant effluent in conjunction with the next round of pilot plant testing expected to occur in March 2012, with results available within 60 days.

It should be noted that a 5-day decant test is considered extremely conservative considering that no discharge from the TMF polishing pond will occur in less than 30 days of decanting.

IR Number:	**AANDC #4**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Quality - Hydrometallurgical Site
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

AANDC assumes that the decant discharged to pit L-42 will result in an increase of hydraulic head within the Presqu'ile aquifer.

AANDC Request #4

1. Please explain how an increased hydraulic head will change the movement of groundwater and estimate how long it will take for water from L-42 to daylight (i.e. downstream or in Great Slave Lake).

Avalon Response #4.1

It should be noted that excess water will be discharged into the **N-42** pit, not the L-42 pit.

As discussed in Section 6.5.2.1 of the DAR, a groundwater flow model (using visual MODFLOW software) was created to simulate the current hydrogeological flow conditions at the Pine Point site and to estimate the effects of implementing the water management plan for the Hydrometallurgical Plant site, including the pumping of water from the T-37 pit and the infiltration of excess water into the N-42 pit. It should, however, be noted that the T-37 pit is no longer being used as the process water supply pit, rather, J-44 pit will be used.

The results of this model were summarized in Knight Piesold (2010g), which was presented in Appendix C.10 of the DAR. Avalon is of the opinion that the modelling results for water withdrawal from the T-37 pit are equally applicable to water withdrawal from the J-44 pit.

Particle tracing was used to track flow from the N-42 pit to Great Slave Lake during the 20 year operations life and there were no noticeable effects to the groundwater flow directions or travel times over existing conditions. Figure 6.5-3 of the DAR illustrates the simulated piezometric contours and particle tracking for the Pine Point area after 20 years of pumping and discharge.

Based on the conceptual model of the site and the steady state modelling results, groundwater flowing through the N-42 pit would take approximately 80 years to discharge into Great Slave Lake. The average groundwater velocity along the flow path from the N-42 pit to Great Slave Lake was simulated as 0.75 m/day. Within the Presqu'ile Formation, the average simulated velocity was about 0.5 m/day. The travel time estimation assumes that groundwater will not discharge to surface between the N-42 pit and Great Slave Lake.

In conclusion, the results of the groundwater flow model suggest that there is expected to be very little effect on the groundwater regime at the Pine Point site in response to the pumping and discharge/infiltration proposed as part of the Hydrometallurgical Site water management plan, given the rates used in the model. Groundwater levels in the vicinity of the N-42 pit are expected to increase by approximately 0.1 m above the simulated pre-discharge conditions after 20 years of discharge/infiltration.

It should be noted that this analysis is considered extremely conservative as it is based on the assumption that no water will be recycled from the L-37 pit to the hydrometallurgical plant. Should Avalon determine that recycling water is possible, then it will investigate potential implementation.

IR Number:	**AANDC #5**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Biomagnification - fish tissue assessments
Document:	DAR, Appendix 1 and Conformity Responses
TOR Section:	

Preamble

The final Baseline Assessment by Stantec (May 2011) indicates that concentrations of mercury and selenium in fish tissue were close to, or for some fish, above fish tissue guidelines. Selenium body burdens in fish can have significant effects on fish embryo development; the best predictor of selenium-related effects in fish appears to be selenium concentration in the ovaries or eggs of mature females (Deforest et al 2011). Mercury in fish muscle can pose a health risk to humans that consume fish. Given that an active mine will likely result in an incremental input of mercury and selenium, and given that an increase in nutrient loadings may result in increased uptake of mercury and selenium (via methylation), some predictions regarding future concentrations of mercury and selenium in fish tissue should be made.

AANDC Request #5

1. Please estimate the mercury and selenium concentrations in the tissues of fish once the mine becomes active, and after 20 years operation.

Avalon Response #5.1

As described in Section 6.4.2.4 of the DAR, a hydrodynamic model was used to predict the concentration of metals in waterbodies downstream of the TMF as a result of effluent discharges. The model was run for a 20-year period starting at the commencement of mine operations. The transport and fate of the dissolved contaminants modelled in the study were represented as a conservative tracer. The tracer with unity concentration (i.e., 1.0) was released into the tailings pond. The concentration of any dissolved metal contaminants of concern can be readily calculated anywhere in the model domain by multiplying the tracer concentration by the actual concentration of the metal contaminants at the release point. Based on this model, the predicted input concentrations of mercury and selenium to Thor Lake from years one to twenty were calculated and are shown in Table 2 below.

TABLE 2: PREDICTED CONCENTRATIONS OF HG AND SE IN EFFLUENT ENTERING THOR LAKE IN YEARS 1-20				
Year of Simulation	**Plant Discharge**	**Thor Lake modelled tracer concentration (mg/L)**	**Hg Tracer x Decant conc. [decant = 0.0001 mg/L]**	**Se Tracer x Decant conc. [decant = 0.001 mg/L]**
1	1.0	<0.00001	1×10^{-9}	1×10^{-8}
2	1.0	0.00001	1×10^{-9}	1×10^{-8}
3	1.0	0.00004	4×10^{-9}	4×10^{-8}
4	1.0	0.00009	9×10^{-9}	9×10^{-8}
5	1.0	0.00016	1.6×10^{-8}	1.6×10^{-7}
6	1.0	0.00024	2.4×10^{-8}	2.4×10^{-7}
7	1.0	0.00031	3.1×10^{-8}	3.1×10^{-7}
8	1.0	0.00038	3.8×10^{-8}	3.8×10^{-7}
9	1.0	0.00044	4.4×10^{-8}	4.4×10^{-7}
10	1.0	0.00050	5.0×10^{-8}	5.0×10^{-7}
11	1.0	0.00057	5.7×10^{-8}	5.7×10^{-7}
12	1.0	0.00058	5.8×10^{-8}	5.8×10^{-7}
13	1.0	0.00061	6.1×10^{-8}	6.1×10^{-7}
14	1.0	0.00063	6.3×10^{-8}	6.3×10^{-7}
15	1.0	0.00066	6.6×10^{-8}	6.6×10^{-7}
16	1.0	0.00070	7.0×10^{-8}	7.0×10^{-7}
17	1.0	0.00068	6.8×10^{-8}	6.8×10^{-7}
18	1.0	0.00067	6.7×10^{-8}	6.7×10^{-7}
19	1.0	0.00070	7.0×10^{-8}	7.0×10^{-7}
20	1.0	0.00071	7.1×10^{-8}	7.1×10^{-7}

As shown, concentrations of Hg and Se reaching Thor Lake are predicted to be extremely low. Mercury will be 0.3% of the CCME guideline (0.000026 mg/L) by year 20; selenium will be 0.07% of the CCME guideline (0.001 mg/L). These predictions reflect conservative values, since no allowance was made in the model for decreases in concentration due to natural remediation processes including degradation, chemical oxidation, precipitation, and biodegradation.

Since the concentrations of these metals reaching Thor Lake are so low, no residual effect on biota is anticipated.

IR Number:	**AANDC #6**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water — Effluent Quality — Nutrification
Document:	DAR Sections 6.3 & 6.4, Conformity Responses, and Conceptual AEMP
TOR Section:	

Preamble

Nitrogen (ammonia, nitrate, and nitrite) is a major by-product of blasting residues (e.g. ANFO). It is also a nutrient in aquatic systems. At higher concentrations, and in certain forms, it can be toxic. Phosphorous, another major nutrient, may be present in both process and mine water. As local water bodies are relatively pristine and exhibit low nutrients, the addition of nutrients is of concern. When discussing nutrient additions into an aquatic system it is important to consider nitrogen's relationship with Dissolved Oxygen (DO). Generally, as nutrient levels increase biological activity increases, this growth and decomposition consumes oxygen (0_2) thus lower DO concentrations (particularly under ice). Low DO conditions can impact aquatic organisms and fish.

Major Ions, such as TDS, chloride, fluoride, sulphate, calcium, etc., can also affect water quality. The accumulation of major ions in the receiving environment can cause toxicity and impair the aquatic environment. At other operations in the North, connate groundwater has typically been high in both TDS and chloride.

AANDC Request #6

1. Please discuss possible sources of phosphorus from the mine.
2. Provide estimates of major ion concentrations in the receiving environment over the life of the project. Describe impacts from increased nutrient and major ion concentrations have on the immediate receiving body (i.e. initial dilution zone) and beyond (Drizzle Lake, Murky Lake, Thor Lake, Fred Lake, etc.) from both a nutrient and toxicity perspective. Provide these calculations using expected worst case concentrations/loads.
3. Determine how shifts in the aquatic community (phytoplankton and zooplankton) may affect DO concentrations in these receiving lakes during operations and closure with emphasis on under ice DO concentrations.

Avalon Response #6.1

The primary, but very minor source, of phosphorus associated with the Nechalacho Mine and Flotation Plant site, will be the 'state-of-the-art' packaged RBC sewage treatment system (with nitrogen and phosphorous removal), which will be used to effectively treat the domestic sewage generated at the Nechalacho Mine and Flotation Plant site.

The treated effluent contribution of the RBC sewage treatment system will comprise less than 2% of the Flotation Plant process effluent, which will be co-mingled prior to being pumped to the TMF.

Avalon Response #6.2/3

The following conclusions from the nutrient and phytoplankton modelling described in DAR Section 6.4.3.2, serve to inform the prediction of effects from seasonal increases in nitrogen from the TMF:

- the additional nitrogen introduced by the TMF decant water may trigger an additional early and short-lived spring bloom, followed by a more typical extended summer bloom; however, the estimated maximum NO_3-N concentration in Thor Lake is not anticipated to exceed 0.053 mg/L, which is <2% of the CCME guideline level of 2.9 mg/L.
- the summer bloom remains about the same as the existing baseline case;
- the main result of the addition of nitrogen to the system may be to initiate algal production in the spring;
- phosphorous, which is not anticipated to increase in concentration, will continue to limit algal production;
- the annual peak phytoplankton biomass remains stable even as the annual peak nitrogen values rise in the system; and,
- Oxygen supply due to wind and waves is predicted to exceed oxygen consumption due to the decay of additional planktonic biomass.

Existing baseline data indicates that DO in Thor Lake is uniformly distributed through the water column in all seasons except winter (DAR Figure 2.6-2b), indicating relatively thorough mixing of oxygen due to the action of wind and waves. In winter, DO levels gradually diminish, reaching levels <2 mg/L near the bottom. At ice-out and subsequent spring turnover, high oxygen levels at depth are quickly restored.

Changes in water quality due to cultural nutrient enrichment can result in modifications to phytoplankton community composition (Medupin 2011) and biomass, with potential cascading effects on higher trophic levels. Prolonged algal blooms would have the potential to increase biological oxygen demand, particularly in winter. However, since phosphorous is expected to limit phytoplankton production and is not anticipated to increase in concentration as a result of the Project, overall production in Thor Lake and further downstream is not predicted to increase significantly. It is apparent that oxygen levels during the open water season are more than adequate to satisfy demand. In winter, a depression of oxygen concentrations below baseline levels at depth is not anticipated to occur, since the small increases in biomass in the spring will not likely lead to appreciable benthic accumulations of organic material.

Major ion concentrations were also modeled using the same H3D hydrodynamic model described in the DAR Section 6.4.3.2, for a period of 20 years following the start of mine operations. The results of this modelling is shown in the table below:

TABLE 3: MAXIMUM CONCENTRATION IN THE THOR LAKE SYSTEM AND WATER QUALITY GUIDELINES FOR THE PARAMETERS OF CONCERN								
Species	Background Concentration			Thor Lake	Murky Lake	Drizzle Lake	CCME Water Quality Guideline	MMER Effluent Criteria
	Thor Lake	Murky Lake	Drizzle Lake					
TDS (mg/L)	191	224	169	191.3	224.9	170.1	-	-
Cl (mg/L)	4.35	5.30	3.60	4.39	5.39	3.72	-	-
SO_4 (mg/L)	0.28	0.30	< 0.5	0.351	0.514	< 0.771	-	-
F (mg/L)	1.11	1.04	0.893	1.11	1.05	0.91	-	-
NO_3* (as N mg/L)	0.053	0.014	-	0.053	0.014	0.014	2.9	-
Ammonia (as N mg/L)	< 0.02	0.70	0.71	< 0.02	0.70	0.71	-	-

* The background concentration value for NO_3 in Drizzle Lake was missing and assumed to have the same value as the background concentration in Murky Lake.

The results of modelling indicate that maximum levels of TDS, as well as the major ions included in the analysis roughly approximated background concentrations of those parameters. TDS has been shown to result in adverse effects on aquatic organisms, but at levels exceeding the maximum levels anticipated to result from discharges from the TMF (Weber-Scannell and Duffy 2007). As noted by Weber-Scannell and Duffy (2007), the measurement of TDS, which integrates all anions and cations, does not necessarily indicate the potential for adverse effects, since some ions or combinations of ions are more toxic than others. Those authors therefore recommend that different limits be defined for different categories of ions, with lower limits set for periods of particular sensitivity (e.g. spawning), rather than relying only on a guideline for TDS. However, the results of the modelling suggest that the establishment of limits is not necessary since background levels are not likely to be exceeded.

These predictions will be validated during the operations phase of the mine by focused monitoring, (including winter water quality sampling) to measure ionic, nutrient and oxygen levels.

References:

Medupin, C. 2011. Phytoplankton Community and Their Impact on Water Quality: An Analysis of Hollingsworth Lake, UK. J. Appl. Sci. Environ. Manage. 15(2) 347-350.

Webber-Scannell, Phyllis K. and Lawrence K. Duffy. 2007. Effects of total dissolved solids on aquatic organisms: a review of literature and recommendation for salmonid species. Am. J. Env. Sci. 3(1): 1-6.

IR Number:	**AANDC #7**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Quality - Project Effects - Assessment Boundaries – Conceptual AEMP - Action Levels/ Triggers - Adaptive Management
Document:	MVEIRB TOR, Document 6.14.1, Conformity Responses #46 & #47, MVERIB Request #1.3 and Conceptual AEMP
TOR Section:	

Preamble

The Environmental Assessment process is used to determine the potential significance of a Project. The DAR provides information on significance and assessment tools/scales such as Magnitude, Frequency, Duration, Extent, Reversibility, etc. As the EA moves forward, impact assessment boundaries (i.e. spatial boundaries) specific to environmental effect metrics (e.g. water quality, eutrophication, wildlife, etc.) should be further delineated and discussed. This will form the basis for action levels and triggers in the AEMP and Adaptive Management Plan (AdMP). The AEMP and AdMP are intended to ensure that any unforeseen water quality impacts or unexpected ecological impacts can be detected and acted upon before unacceptable impacts occur.

Avalon has demonstrated that their proposed mining operation will cause some degree of change in the receiving environment. It is the monitoring program's role to assess these changes/ impacts and determine if these changes/impacts are within the acceptable range. Triggers or action levels are used in the AEMP and AdMP to initiate response/mitigation to reduce impacts. The EA is a critical component for establishing the action levels within these monitoring programs, which rely on the assessment of impacts on a scale of Low (Early Warning), Moderate and High levels. These effects level classifications are directly linked to the assessment tools mentioned above (Magnitude, Frequency, Duration, Extent, etc.).

The Conceptual AEMP provided by Avalon as part of IR Response #1.3 provides a general description of a monitoring program for the site. However, the framework provides very few details and is missing key linkages regarding assessment locations, action/trigger levels and the potential scale of response actions based on severity of effects (Low, Moderate or High).

<u>AANDC Request #7</u>

1. Rationalize the choice of downstream monitoring points (e.g. assessment boundaries and sample site locations) to ensure actions levels/triggers (based on levels of significance such as negligible, low, medium, and high) can and will be applied before unacceptable impacts occur in the downstream environment.

2. Generally identify low, medium and high level response actions. Note that a `high action level' is generally considered to be a point that should not be reached and requires an immediate halt to discharge.
3. Provide a discussion on how potential responses (e.g. reduced discharge volume or load) will impact site operations and the tailings impoundment capacity.

Avalon Response #7.1

The Conceptual Aquatic Effects Monitoring Plan (AEMP) (Attachment 1) is specific in identifying sampling locations that will be monitored to identify and quantify adverse effects (if any) due to Project activities. These locations were chosen to conform to the Metal Mining Effluent Regulation (MMER) Guidance Documents (Environment Canada 2002, 2011) and to ensure that sampling locations would be sufficiently distributed to determine the geographic extent of potential aquatic and airborne pollutants.

Water quality, sediment quality and biological variables will be sampled at Murky Lake, Thor Lake, and A Lake, which reflect nearfield, midfield, and farfield exposure sites, respectively, and will be directly subject to impacts (if any) from the TMF effluent releases. In addition, Surveillance Network Program (SNP) sampling sites provide a larger geographic range for water quality sampling. These sites, shown on Figure 6 of the conceptual AEMP, were selected to include all major waterbodies within the presumed effects footprint of the project.

Avalon Response #7.2

Specific action levels and responses to effects on valued ecosystem components will be established as part of the final AEMP. Action levels will be determined on the basis of the assessment criteria identified in the Preamble to IR #7 (magnitude, frequency, duration, extent, reversibility), and in comparison with accepted guidelines, criteria, and existing baseline data. When action levels are met, the responses outlined in the AEMP will be triggered. The following are the general responses that might be expected at each Action Level.

Low: Low action levels are "early warnings" based on developing trends toward increasing contaminant levels or changes in population characteristics, such as abundance, density, community structure, condition, etc.). Low action levels will be established for each parameter. In some cases, objective criteria exist, such as for potential contaminants (e.g., metals). In other cases, action levels will be parameter specific, based on chronic and acute toxicity data, and the degree of change from background levels, considering natural and seasonal variability resulting from a combination of biological activity, temperature, precipitation, and runoff volumes.

Low level action will involve the detailed assessment of cause, possibly requiring the collection and analysis of additional samples to verify the original results The low action level is investigative. Small, consistent increases in contaminants will lead to attempts to identify the sources of these substances and to identify appropriate mitigation measures if trends indicate increasing levels over time.

Moderate: Moderate action levels take effect when established criteria have the potential to be exceeded, or are narrowly exceeded. These criteria may be ones included in permits or approvals, or established within regulations. Trend analysis will often be employed to predict likely exceedances. Within the context of the MMER, these levels are established for specific substances within the Regulation, result from statistical differences between reference and exposure areas, or reflect differences in before-after comparisons. Actions taken will be to increase sampling frequency, carry out investigations to determine the source of contaminants or causes of the measured effects, and to apply pre-determined mitigation measures.

High: The High Level Action Response is initiated when there are exceedances of regulated substances downstream of the TMF, or when biological monitoring indicates an 'effect' on invertebrate or fish populations (including fish tissue), as defined by the MMER. High level responses consist of the development and implementation of new or additional mitigation strategies or techniques (i.e., effluent treatment). New mitigation and remedial measures will be developed in consultation with regulatory agencies.

Reference:

Environment Canada. 2002, 2011. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. National EEM Office. Environment Canada, Ottawa, Ontario.

Avalon Response #7.3

Based on the current modelling results as reported in the DAR, the treatment of the tailings effluent to further reduce concentrations and loading of potentially deleterious substances is not anticipated to be necessary. In addition, the limited volume of water to be extracted from Thor Lake is not anticipated to result in adverse effects since water recycling will substantially reduce the volumes required.

However, further effluent treatment, if determined to be required due to currently unforeseen water quality deterioration (e.g., excessive nitrogen), is not anticipated to affect mine operations other than through the possible need to temporarily stop processing while the appropriate treatment system is installed. The capacity or operation of the TMF is not expected to be affected.

IR Number:	**AANDC #8**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Use - Water Quality - AEMP
Document:	DAR and Conformity Responses and Conceptual AEMP
TOR Section:	

Preamble

AANDC's AEMP Guidelines (2009) identify community consultation as a key component to the development monitoring questions, assessment endpoints and acceptable levels of change.

The AEMP functions as a "safety net" with respect to those concerns addressed through consultation. Avalon has identified that even relatively small additions of some substances could result in adverse effects to water quality and aquatic biota. Synergistic and unanticipated effects may also occur once operations commence. Accordingly, from an ecological perspective, the measurement endpoints contained within the AEMP should be sensitive to the contaminants being released and with a known relationship between observed changes and cascading effects in the ecosystem of the receiving environment.

AANDC requests the following information to assess the appropriateness of the AEMP as provided by the proponent to identify potential downstream effects relevant to local Aboriginal Groups and users.

AANDC Request #8

1. The proponent should describe the community consultation with respect to measurement endpoints and levels of acceptable changes for the proposed AEMP.

Avalon Response #8.1

Avalon anticipates that the current Conceptual Aquatic Effects Monitoring Program (AEMP) will be subject to engagement activities with a number of interested parties and stakeholders including AANDC, Fisheries and Oceans Canada (DFO), Environment Canada, Mackenzie Valley Land and Water Board (MVLWB) and the Aboriginal communities located in the vicinity of the Thor Lake Project. The measurement endpoints and levels of acceptable changes will be among the key topics addressed through the engagement process. The key outcomes of these engagement activities are expected to be incorporated into the more detailed AEMP that will be produced and eventually implemented for the Project.

IR Number:	**AANDC #9**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Quality - Effects - AEMP
Document:	DAR, Conformity Responses, and Conceptual AEMP
TOR Section:	

Preamble

Avalon has correctly identified that "the development of an AEMP involves a multidisciplinary approach to defining the aquatic environmental issues that may result from the construction, operations, and decommissioning phases of a project, and identification of mitigation measures to avoid or minimize potential adverse effects." Avalon has also provided an overview of Pathways of Effects and has correctly noted that the effects of various components based on terrestrial and aquatic habitat disturbances must be examined. AANDC believes more work is required to improve this assessment and identify pathways at both project sites.

AANDC has specific technical comments on sample location, sampling frequencies and AEMP concepts identified in the Conceptual AEMP. AANDC feels these comments are better addressed in face to face meetings and is willing to meet with Avalon to discuss AEMP framework and its further refinement as the EA progresses.

However, AANDC requires the following information to assess the thoroughness and appropriateness of the AEMP to monitor for and confirm project related effects.

AANDC Request #9

1. Document and explain linkages between the local groundwater monitoring that will occur at the Pine Point project and the AEMP/SNP plans.
2. Include an overview of how local surface water will be sampled and assessed as part of the AEMP to confirm that no leachate from tailings at the Pine Point site make its way to surface water bodies, streams and Great Slave Lake.
3. Include an overview of monitoring that will occur near dock and barge loading facilities at the south shore of Great Slave Lake near the Pine Point site.

Avalon Response #9.1

The Conceptual AEMP to be developed for the Thor Lake Project is focussed on the Nechalacho Mine component of the overall Project. The AEMP does not include consideration of the Hydrometallurgical Plant site and associated infrastructure because there are no natural streams or water bodies within the general area and the effluent to be discharged from the Plant will be directed to the L-37 pit and excess decanted water will be pumped to the N-42 pit for infiltration into the groundwater (Presqu'ile aquifer). Groundwater monitoring associated with the Hydrometallurgical

Plant site and associated infrastructure will be conducted in accordance with the conditions of the MVLWB Water Licence and will be reported to the MVLWB as will be specified.

Avalon Response #9.2

As discussed in Avalon Response #9.1 above, local surface water (natural waterbodies) will not be sampled as none exist within the general area of the hydrometallurgical facility. However, it is anticipated that requirements to sample the surface water in the L-37 pit and the N-42 pit will be specified in the MVLWB Water Licence. These data will be used to correlate with downstream groundwater quality monitoring that is anticipated to be required, to determine the expected dilution of the infiltrated water to natural background conditions, as this water migrates over an estimated 80 year period towards Great Slave Lake.

Avalon Response #9.3

At this time, Avalon does not anticipate that water quality monitoring will be required at the proposed seasonal dock facility and marshalling yard to be located on the south side of Great Slave Lake, to service the Hydrometallurgical Plant site. The primary reason for this is that no direct discharges of any kind are planned to occur at the seasonal dock facility.

IR Number:	**AANDC #10**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Water Balance and Effluent Discharge and Site Hydrology
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

Sections 4.7.3 and 4.7.4 of the DAR describe the proposed waste management and discharge strategy and provide a water balance flowsheet. The water balance is negative for years 1 to 4 and 5 to 20.

Figure 6.3.9 plots the estimated monthly discharge from the Thor Lake Watershed, and shows mean discharges pre-production, during production and post-production as well as the pre-production discharges for dry and wet conditions. Production discharges are predicted to be slightly above pre-production dry season flows from April to June, but will generally be less than dry season flows for the remainder of the year.

This pattern suggests that discharge from the Thor Lake watershed during a dry period could be very low once the mine is producing.

AANDC requires additional information and detail to assess the water balance and discharge strategy to assess potential environmental impacts.

AANDC Request #10

1. Provide an assessment of expected discharges from Thor Lake during a dry period, once production has started.
2. Provide greater detail on the water balance and discharge plan. Include any adjustments based on seasonal changes to water balance (higher runoff wet years, lower or higher mine inflows, lower or higher processing recycling rates, etc.).

Avalon Response #10.1

The water balance analysis for the Nechalacho Mine and Flotation Plant site was completed by Knight Piesold using a spreadsheet approach, and was developed for a nine month pre-production period (January 1 - September 30) followed by the projected 20 year mine life (Oct 1 start-up for operations) and a two year post-production period. A deterministic approach was taken using average precipitation conditions.

A probabilistic approach was taken using a risk based/simulation analysis to forecast a range of wet and dry (extreme) precipitation conditions as well as the 1 in 25 year 24-hour Environmental Design Storm (EDS). The probabilistic modelling utilized the Microsoft Excel add-on program @RISK, which has the capability to perform Monte Carlo type simulations and track the various outputs that result from variations in the input.

Based on the results of the current water balance, the annual discharge from Thor Lake for the extreme dry year would be in the range of 1,330,000 m^3 to 1,470,000 m^3 per year, (i.e., average daily flows ranging from 3,643 m^3 to 4,027 m^3 per day) over the life of the production period. This represents a reduction of approximately 15 percent from the average discharge volumes expected under average precipitation conditions over the production period.

The corresponding average daily flows expected under dry conditions for the Pre-production case would be approximately 4,090 m^3/day. Based on this result, there is a possibility that Thor Lake could be drawn down by a volume of approximately 57,000 m^3 during an exceptionally dry year in the winter months (during operations). This is approximately one percent (1%) of the total lake volume and would result in a lake level drop of less than 5 cm. There would be little impact on water levels during the summer months.

In addition to the extreme wet and dry cases modelled using @RISK, a sensitivity analysis for drawdown of Thor Lake was conducted for a case where there was no reclaim from the TMF and with reduced inflow (no inflow for 4 months in winter). Under these extreme circumstances, the resulting drawdown was 81,000 m^3 in winter and 35,000 m^3 in summer.

In all cases for the operation phase, winter water withdrawal from Thor Lake will be significantly less than the 10% limit stipulated by DFO (10% of available water below maximum expected ice cover).

Avalon Response #10.2

The water balance was completed to estimate water movement throughout the system associated with the project, including the operations (flotation plant, paste backfill, mine dewatering), the TMF, Drizzle Lake/Murky Lake and Thor Lake. Long-term regional rainfall and snowfall data were used, and @RISK was applied to ensure that varied data were considered. Snowpack melt, ice thickness, evaporation and runoff were also considered. Runoff values were varied according to different mediums (active beach, dry beach, upstream naturally vegetated areas, and pond). Variations between winter and summer conditions have been accounted for based on meteorological factors.

The discharge from the TMF is based on a maximum pumping rate, and is also linked to the volume of total supernatant water and the amount reclaimed to the Flotation Plant. Controlled discharge to the Polishing Pond will takes place via a decant pipe. Discharge over the emergency spillway will only occur in the event of precipitation exceeding the Environmental Design Storm (EDS). Discharge from the Polishing Pond is based on a maximum pond volume of 50,000 m^3 (30 days retention time) and a maximum pumping rate. Controlled discharge from the Polishing Pond to Drizzle Lake will be through a decant pipe. Discharge over the emergency spillway will only occur in the event of precipitation exceeding the Environmental Design Storm.

The resulting discharge of water from the TMF (via the Polishing Pond) under dry, average and wet conditions, was determined from the above modelling. The annual volume discharged ranges from approximately 88,000 m^3 for dry conditions, to approximately 175,000 m^3 for wet conditions. Under average precipitation conditions, the discharge will vary, from approximately 145,000 m^3 in the earlier years of operation, to approximately 108,000 m^3 in the later years.

IR Number:	**AANDC #11**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology - Uncertainty in Thor Lake water supply
Document:	DAR and Conformity Responses and Appendix 1
TOR Section:	

Preamble

In the NWT, the major source of water is precipitation. To estimate flows and to adequately manage water, accurate input values of all environmental variables to the water balance equation must be available. The water balance simulations presented in the DAR calculate the water supply into Thor Lake on a monthly timescale, based primarily on:

i) estimated precipitation inputs from long-term climate data (from snowmelt release or rainfall);

ii) the upstream contributing areas (including the proposed TMF area, Drizzle and Murky watersheds- 38%, Long Lake catchment- 45%, and remaining areas- 17%); and

iii) spatially-invariant, monthly runoff coefficients.

However, there are various sources of information in the DAR and consultant reports that suggest that the hydrology of the area requires improved understanding. In particular, the water supply from Long Lake (the largest subcatchment) to Thor Lake appears uncertain for the following reasons:

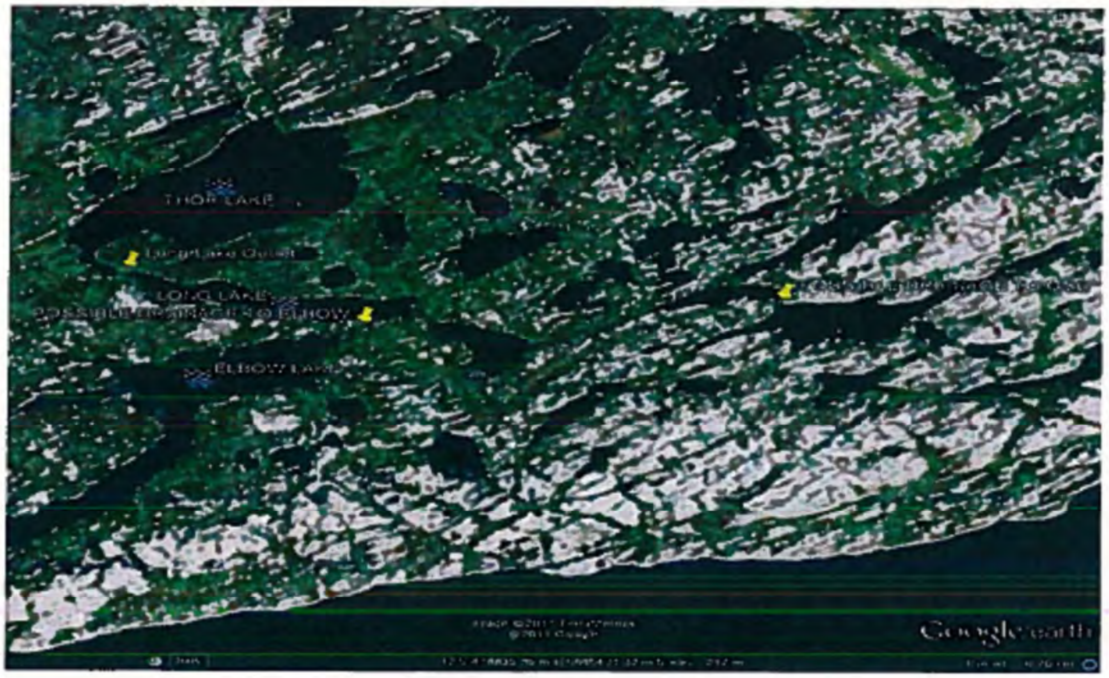
- Stantec Final Interim Report (section 4.2.1, p.10)- The stream flow in the channel between Long and Thor Lakes is relatively stagnant and was observed to reverse during stream measurements. The banks along the Long Lake outlet feature many failures and fallen trees in the water. The decreased capacity of the stream and low stream power may reflect changes in lake levels in Thor and Long Lakes, which may be related to beaver activity or changes in the drainage at Thor Lake, and (section 4.2.3, p.11) - 'During site visits in 2008 and 2009, reverse flows were observed in both Long Lake outlet and Beaver Dam channel at Thor Lake indicating stream flow was traveling into Long Lake from Thor Lake'.
- As a result, there is no stage-discharge relationship (R^2 = 0.00) from 5 measurements at the Long Lake Outlet (stage remains the same for all five measured discharges which vary one order of magnitude: 0.005 - 0.05 m^3/s; Appendix D, Stantec Final Interim Report).
- In the Stantec Final Interim Report (section 3.3.3, p.7), it is stated that 1:250,000 NTS topographic maps were used for basin delineation and site drainage, with some assistance from air photos and site reconnaissance on air and foot (although this was believed to concentrate on the area draining Thor Lake to Fred Lake and down to GSL). Delineation in this rolling, near-flat topography is inevitably very difficult, especially given the scale of topographic data used. Drainage patterns will also vary as pond and lake levels e.g. increase

during freshet and become more interconnected, but field verification of these differences may be prohibited by the environmental conditions during freshet (e.g. ease of walking access, air temperatures, etc.). In the case of Long Lake, the topographic maps alone indicate at least two places where elevation changes were small (2-4 m) or non-existent, where water could potentially drain south and directly into Elbow and Great Slave Lakes, therefore effectively bypassing Thor Lake. The potential of this occurrence would increase during snowmelt (or strong precipitation) inputs, and this is critical since a large proportion of the projected water supply from Long to Thor Lake occurs during freshet in April and May (see Figure 2.5-11, p.65 of the DAR). On further inspection using Google Earth, although the imagery is coarse and difficult to accurately decipher, it appears there is a discernible drainage channel through at least one of the two query locations (closest to Long Lake outlet in the image below, note that this appears more discernible than Long Lake outlet itself). (See also Figure 2.5-3 p.53 in the DAR for higher resolution image; this image also apparently indicates likely flow direct to Elbow Lake).

AANDC Request #11

1. Please summarize available field observations relating to observed drainage patterns, especially at locations where flat topography separating water sources would raise the potential for drainage courses to vary in direction. Specifically discuss the potential for water in Long Lake (and Long Lake catchment) to flow south towards Great Slave Lake (GSL) instead of through Thor Lake. Also discuss the implications of such a flow on the hydrological modeling conducted to date.

   Even if a southerly flow of Long Lake water occurs during freshet alone, when water levels rise, much of the annual volume will not reach Thor Lake. In a 'worst-case' scenario, given the close proximity of the (western) potential Elbow Lake drainage location to the Long Lake outlet, assume that the freshet water supply to Thor Lake is reduced by 10% increments up to a maximum of 40% (the runoff into Thor Lake from Long Lake, based on the relative area of Long Lake watershed). Present water balance diagrams for each of these four scenarios, during the production phase, to identify the resulting water available at Thor Lake and the necessary adjustments that would need to occur on the outflows to the concentrator plant. Based on these calculations, if more water were required for the production process, identify other potential sources. Describe any adjustments to the constructions such as tailings dams (crest heights and spillways, etc.) that would be required in light of these recalculations.



Avalon Response #11.1

An updated watershed review was completed by Knight Piesold in March 2011 based on detailed topographic mapping generated from satellite imagery. The accuracy of this imagery is significantly better than the 1:250,000 NTS topography which was referenced by Stantec in their preliminary assessment. The updated watershed flow review was presented in KPL memo NB11-00132, which is located in Appendix C.14 of the DAR.

Knight Piesold reviewed the contours and determined the outlet elevations for the various lakes as summarized below:

- Thor Lake to Fred Lake: between 236 and 237 m;
- Long Lake to Thor Lake: approximately 237 m;
- The lowest portion of the height-of-land separating Long Lake and Elbow Lake has a minimum elevation of approximately 241.5 m.

Based on these results, water elevations within Thor Lake and Long Lake would need to reach at least 241.5 m in order to initiate any flow into Elbow Lake. This would represent an increase of approximately 5 m from the normal level of Thor Lake. As a result, there are no concerns associated with flow occurring from the Thor Lake watershed into Elbow Lake.

As part of the in-depth water balance analyses completed to date, Knight Piesold have modelled the 'worst case' where there is an extreme dry year, all water for the Flotation Plant is taken from Thor Lake, and there is no inflow into Thor Lake for 4 months of the year. This has minimal and only short-term impact on the Thor Lake volume as described in Avalon Response #10.

For the TMF, the dam heights and spillway elevations are primarily designed based on water and solids storage requirements and runoff within the basin in consideration of extreme wet scenarios and storm events as mandated by the regulatory agencies. No additional water balance modelling or storm water scenarios are deemed necessary to be completed at this time.

IR Number:	**AANDC #12**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology - Uncertainty in Thor Lake drainage
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

As discussed in AANDC IR 11, there is some evidence of hydraulic conductivity between Thor Lake and Great Slave Lake via Long Lake and Elbow Lake. This assertion was made after a review of contour maps, satellite imagery and flow rates in and out of Thor Lake. Some reported flow data have indicated flows into Fred Lake less than flows into Thor Lake, suggesting that under certain circumstances water may exit Thor Lake via Long Lake. Possible situations where this may occur include:

(1) periods where beaver or debris dams partially obstruct flow to Fred Lake; and

(2) freshet, when water levels in the lakes are at a seasonal high resulting in short term seasonal hydraulic conductivity. There is a lack of hydraulic data/observations during freshet and therefore it is possible that a modified seasonal flow patterns have not been observed.

AANDC Request #12

1. Please comment on the probability that Thor Lake may discharge to Long Lake under certain conditions. If there is very little probability of this occurring, please provide evidence capable of dismissing this possibility. If Thor Lake may discharge to Great Slave Lake via Long Lake and Elbow Lake, please comment on how this shorter flow path influences the dilution of mine-related discharges once water reaches Great Slave Lake. Please include the possible influence of the relative size of drainage areas that the two paths follow (67 km^2 if Thor Lake drains via Fred Lake, 6 km^2 if Thor Lake drains via Long Lake).

Avalon Response #12.1

As per the response to AANDC IR#11 above, water will not flow from the Thor Lake watershed into Elbow Lake (via Long Lake) due to the topographic impossibility of such an occurrence. It is possible that seasonally the water flow direction between Thor Lake and Long Lake may temporarily reverse (as has been documented and reported in the DAR); however, this will not cause release of water to Elbow Lake from the system. Under all circumstances, the Thor Lake catchment will discharge through Fred Lake, via a 67 km^2 watershed to Great Slave Lake.

IR Number: **AANDC #13**
Source: Aboriginal Affairs and Northern Development Canada
To: Avalon Rare Metals Inc.
Subject: Hydrology - Absence of baseline monitoring in the proposed TMF (Tailings Area)
Document: DAR and Conformity Responses
TOR Section:

Preamble

It appears that there is very little baseline monitoring information of the water resources upstream of Thor Lake, including those forming an integral part of the proposed TMF (Tailings Management Facility, at Ring and Buck Lakes), and Drizzle Lake in between the TMF and Thor Lake (more data is available at the Murky Lake Outlet). These are the aquatic areas most affected by the project (section 2.5, p.48), and where water toxicity and quality are likely to be of most concern. Since site hydrological characteristics are used in annual flow estimations, and water balance estimates, additional baseline data upstream of Murky Lake would be useful to better characterize the baseline water quality, water levels and runoff characteristics of the Upper Thor basin. It is stated that the stream flows between these upstream lakes were of insufficient depth to reliably obtain water depth data with pressure transducers, but this is not the case with lake levels.

AANDC Request #13

1. Please estimate based on the topography and upstream contributing areas, how the response times of Ring, Buck and Drizzle Lake depths may have varied in comparison to those measured downstream (e.g. at Thor and Fred) assuming the same precipitation inputs such as melt water release and rainfall events. Related to this, please comment on the safety margins applied in the design of proposed dams (specifically dam heights) given that response times may be expected to be faster in these smaller headwater lakes (these constructions are based on predicted water volumes at a monthly time scale and use spatially-invariant runoff coefficients).

   There is also mention of wave effects at Thor Lake due to the high winds occasionally experienced in this wider area; please identify to what extent extreme wind events may affect lake levels at the TMF lakes and to what extent this may also reduce safety margins to proposed dam heights etc.

Avalon Response #13.1

After operations commence, the topography and characteristics of the Ring/Buck Lakes basin will change. These changes have been modelled in the water balance and hydrologic analyses to account for runoff and increases/decreases to lake volumes.

Over the start of operations, the water in the lakes will slowly be displaced and the pre-production conditions will no longer exist. The dams have been designed to account for the extreme precipitation/runoff conditions and a 1 in 25 year Environmental Design Storm (EDS) prior to the need to discharge through the Emergency Spillway. In the unlikely event that the Emergency Spillway needs to be activated, it has been designed to accommodate the flows from a 1 in 1000 year precipitation event plus an additional freeboard allowance for wave run-up.

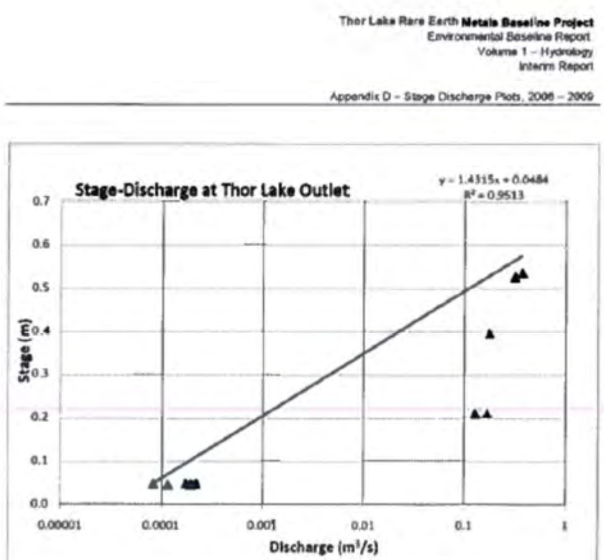
The analyses and design of all embankments and water management structures take into full consideration the modified characteristics of the Ring/Buck Lakes basin. Sufficient freeboard has been included in the dam designs to account for extreme annual runoff, all design storms, and the aforementioned freeboard allowance for wave run-up.

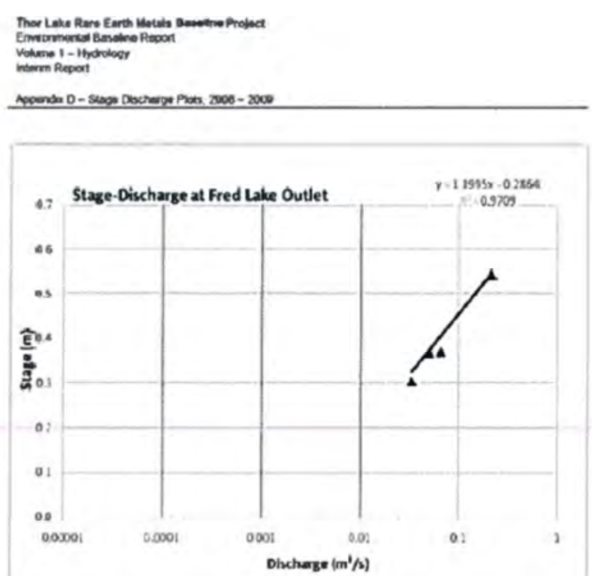
IR Number:	**AANDC #14**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology - Stream flow comparison at Fred and Thor Lakes
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

In section 2.5.2 of the DAR (p50), it is stated that 'water flows from Thor Lake to Fred Lake through a defined channel that has a 1.5 m waterfall near its outlet', and is simulated accordingly in all water balances. In 2009 (Figure 2.5-8, p.58 of the DAR), both measured and estimated discharges appear to be greater at Thor Lake than Fred Lake and the causes of this pattern are not immediately apparent. The potential source of error in estimated flows using rating curve information is outlined below. In 2008, the opposite occurred and flows from Fred Lake were consistently higher, with observations that a debris blockage altered flow patterns between the two lakes. In 2010, discharge was higher from Fred Lake outlet in May and October, and vice versa from June-September.

Related to this, in the rating curve developed from Stantec's measurements for Thor Lake Outlet (see below), please note that the rating curve developed for Thor Lake incorporates measurements obtained under very different stream conditions during 2008 (outlet blocked by debris; all flows less than 0.01 m^3/s) and 2009 (outlet not blocked from June; flows all above 0.1 m^3/s).





AANDC Request #14

1. Thor Lake inevitably represents a key component of the proposed mining project, and requires a clear understanding of the water supply into and out of the lake. Uncertainties in the water supply inputs to Thor Lake were introduced in AANDC IRs 11 and 12, and this IR focuses more on the output supply.

   Please identify a set of physical processes that would combine to explain the relative differences observed in measured discharges from Thor (upstream) and Fred (downstream), for each year including 2008 (F > T), 2009 (T > F) and 2010 (both F > T and T > F). For instance, if there were other potential outlets from Fred Lake than the one measured, especially during higher water levels, please provide any supporting information. If the candidate processes include physical impoundments (as noted for Thor Lake in 2008, but this may also be the case at Fred Lake), how would this be expected to affect the timing and quantity of Thor Lake outflow (stated as 1.725 million m^3/yr)? This could be addressed by re-estimating the Thor Lake outflows using separate rating curves developed from measurements obtained during blocked conditions (pre-June 2009) and unblocked conditions. If water supply does become 'impounded' at Thor Lake, what would the implications be on water quality?

Avalon Response #14.1

The differences in estimated outlet flows from Thor Lake and Fred Lake over the study period may be attributable to a series of physical processes. For context, Thor Lake and Fred Lake are two distinct lake systems. Thor Lake is a glacial-remnant feature, bound by bedrock, while Fred Lake appears to have developed initially as a low depression filled by water spilling from Thor Lake but impounded by downstream controls (i.e., down-basin bedrock control). In time, the areas downstream and above Fred Lake (specifically to the north) have developed into marsh areas. These characteristics of each lake contribute to the variable lake balance patterns apparent from the field monitoring data at the Thor Lake study area. The physical processes and technical issues noted below reflect these lake characteristics.

- Groundwater recharge and discharge to the lakes are unaccounted for. Groundwater movement may be affected by:
  - Spatial distribution of talik zones at the study area
  - Discontinuous permafrost distribution
  - Differences in permeability of sub-surface material
  - Fault zone along north shore of Thor Lake
- Seasonal differences in lake capacity due to:
  - Lake bed sediment ice melt processes (specifically in Fred Lake)
    - Ice is known to persist in the lake sediments of many of the shallow sections of the lakes until July in some cases.

        - The persistence of the lake sediment ice would also affect the lake energy balance by maintaining cooler water later in the open-water season (relative to Thor Lake), and potentially reducing lake evaporation in Fred Lake.
    - Seasonal differences in lake elevations due to outlet controls at Thor Lake and Fred Lake:
        - Thor Lake outlet is a bedrock controlled outlet where drainage may cease if lake levels drop.
        - Fred Lake outlet is controlled by a down-basin marsh where water levels would be expected to be controlled by differences in seasonal melt (affected by tree and over-burden cover, aspect, and slope) and precipitation.
- Water contributions from poorly defined marsh areas to the north of Fred Lake (draining from the direction of Cressy Lake).
- Inherent variability in the rating curves:
    - Particularly the low flow curves, as there was greater variability in the low flow estimates and, temporally, the low flow curves were required for a longer duration (relative to the "primary" curves) over the study period.
- The rating curves at Thor Lake outlet are applicable to the so-called "blocked" condition since the staff gauges were stable (based on repeated control surveys of the staff gauges) and the configuration of the channel cross-section at the Thor Lake outlet gauge was stable. Therefore measured volumes in spring 2009 (i.e., blocked) are comparable to other periods of low streamflows (i.e., late summer 2010 and 2011), just as high streamflow periods are comparable.

IR Number:	**AANDC #15**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology - Baseline precipitation measurements
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

A short-term climate station was set up at the Nechalacho Mine Site for the purpose of characterizing local-scale weather patterns and assessing the similarity of data with nearest long-term stations maintained by Environment Canada (e.g. Yellowknife, Hay River). There are potentially several sources of error within the estimated precipitation data at Nechalacho Mine due to the methods used, and may explain the lower absolute precipitation values measured compared to the EC stations, and lower correlation coefficients (R^2 = 0.79) relative to other variables (e.g., air temperature- R^2 = 0.99). Potential reasons for this lower correlation include:

i) the more random, local-scale process of precipitation occurrence,

ii) real and detectable differences in long-term precipitation inputs between the Thor Lake area and regional stations due to topographic or other factors, and

iii) errors within the precipitation measurements both within the Environment Canada (EC) and Avalon data.

Some level of measurement error can be expected given the harsh conditions experienced in the NWT, and less frequent maintenance visits due to trip costs, but the DAR should at least identify potential sources of error so that any revisions can be made to measured or estimate precipitation data. A selection of potential errors are introduced below.

Rainfall

There was no wind shielding of the tipping bucket rain gauge, located at height on the weather station. In windy environments such as this one, there is likely to be substantial underestimation of true rainfall amounts due to the decrease of surface area for the gauge to collect falling rain at large incident angles. If a wind-shield could not be used due to cost and maintenance, an attempt should have been made to apply standard wind correction factors to the unshielded TBRG data (where precipitation is corrected as a function of wind speed, e.g. http://hydroviz.cilat.org/hydro/rain_gauges.pdf). This study states that for US 8-inch standard rain gauges, under-catch can be in the order of 5 to 10% on an annual basis but can be relatively larger on individual storm scales.

Snowfall

In lieu of expensive, weighing-scale precipitation gauges, winter adapters exist to convert tipping-bucket gauges into all-season measuring devices, although occasional maintenance (e.g. checking of antifreeze levels used to melt snowfall) is recommended to obtain the highest quality of data. Winter precipitation can also be estimated as the product of snowfall amounts (as measured by the snow-sensor) and an assumed snowfall density, but large errors can be inherent in both data sources (standard density estimates for NWT are available at:

http://www.usask.ca/geography/MAGS/Data/Public_Data/precip_corr/pcpncor_e.htm)

The method chosen as part of this study, to estimate a seasonal (winter) precipitation amount equivalent to the mean snowpack snow-water equivalent (SWE) value at the end of March, can incur large errors since this assumes that there is no prior losses of snowpack due to processes such as sublimation, or any melting during the shoulder seasons (e.g., October-November). This also assumes that no further snowfall occurs in April subsequent to the snowpack measurement. Note that errors can also be introduced depending on the snow tube used to obtain SWE and snow density measurements (e.g. published snow density measurements are commonly overestimated by approximately 10% using a Federal Snow Tube). At the very least, the estimated value of winter precipitation in 2009 using the snow course method, (94 mm, section 2.3.1.6) should be compared with more robust estimates collected at regional climate stations.

AANDC Request #15

1. To reduce the uncertainties in precipitation data, please provide revised estimates of precipitation using accepted correction techniques and algorithms on the measured data; these may include those outlined above (e.g. rainfall corrections as a function of wind speed; snowfall estimates compared to the EC direct measurements or using snow sensor and assumed density estimates) or from other sources. Based on the revisions, please update monthly precipitation estimates at Thor Lake and update the correlation coefficient to EC data, for the purpose of more accurately determine the representativeness of EC data and whether any modifications should be introduced for the local Thor Lake area.

Avalon Response #15.1

The climatic conditions used by Knight Piesold to complete the water balance and hydrologic analyses for the preliminary designs of the tailings and water management structures for the Thor Lake Project are based on regional historic weather data that has been interpolated from four (4) Environment Canada monitoring sites including Fort Reliance, Hay River A, Yellowknife A and Yellowknife Hydro. The climate normals for these four stations are based on at least 20 years of recorded data between 1971 and 2000.

A detailed discussion of the climate data is included in the KPL memo entitled *Review of Meteorological Data for Thor Lake Project* (NB09-00477), which is provided in Attachment 2.

IR Number:	**AANDC #16**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology - Use of steady-state inputs to water balance scenarios
Document:	DAR Section 2.3.2, Table 2.3-3 and Conformity Responses
TOR Section:	

Preamble

In the DAR Section 2.3.2, trend analysis is performed on the long-term EC climate datasets as measured at Yellowknife/Fort Reliance/Hay River, including temperature, precipitation, and related variables (e.g. date of first snowfall and snow-free ground). As with most northern areas, air temperatures have been and continue to increase, precipitation is increasing, and snow-free conditions occur earlier in the year. For simplicity, simulations of water volumes available to the Tailings Facility and Thor Lake over the 20-year project (including pre-production/production and postproduction phases) appear to be run using steady-state input conditions. A deterministic approach using average precipitation conditions is used in calculations, although a probabilistic approach is introduced to forecast extreme wet and dry precipitation conditions. Implicitly, the 'wet' precipitation conditions used in the probabilistic approach can instead be used to infer runoff conditions in much wetter conditions if the estimated increases in precipitation actually occur in future decades. In snowmelt dominated environments such as this, changes to the timing of precipitation amounts (including snowmelt release) under future climate scenarios may be as important as changes in the precipitation volume.

Additionally, the water balance scenarios do not introduce the potential risk of rain-on-snow events (when rain causes enhanced snowmelt and runoff rates) to increase runoff and potential flooding during the freshet months. This may not be important in the Thor Lake watershed; Table 2.3-3 of the DAR summarizes the monthly average climate data from Hay River and indicates that monthly precipitation is lowest in April (13.1mm). Conversely, while rain-on-snow events increase during fall (rain- and snowfall amounts are -18mm each in October), active layer depths and ground storage capacity are often increased due to summertime heating and evaporation, reducing the potential of rapid surface runoff.

<u>AANDC Request #16</u>

1. In current water-balance and runoff simulations, both precipitation and discharges across the Thor Lake project area are simulated to be highest in April, since the accumulated snow and ice is assumed to melt at ratios of 15/70/15% for March/April/May respectively (Appendix C-13, p.4).

   Given that the average snow free date in Yellowknife is now in April (formerly second week of May historically; Figure 2.3-21 chapter 2), an assumption can be made that towards the end of the production (and post-production) phases in 15+ years' time, snow consistently melts out before May. Given simulated upstream flows into Lakes are already greatest in April (often 2x all other months; Figure 2.5-11), would there be ramifications for pond storage amounts and required dam crest elevations, if monthly runoff became even higher during April (and less in May). For instance, instead of the ratio 15/70/15 being used in calculations, what would the effect be of using 20/80/0?

Associated with this, please discuss qualitatively the effect that possible rain-on-snow events would have on water resources and stream flows, especially during freshet. To provide a simple quantitative model estimate of a large rain-on-snow event, please provide a revised version of Figure 2.5-11 (p.65 of the DAR) estimating effective precipitation inputs and lake-to-lake discharges, by artificially raising the current runoff coefficients during April and May (currently 49%), by an amount that would be acceptable based on rain-on-snow literature or otherwise. Based on these simulations, re-run the estimated water levels at the TMF and identify any risk increase to the tailings dams from overtopping during the freshet period. Note that any increase to the coefficient values in April and May should be offset by decreases to the coefficients in subsequent months, to simulate the effects of reduced water supplies available in these subsequent months.

Avalon Response #16.1

The design of the embankment crests, water management structures and spillways will be completed with due consideration for changing climate trends. As part of the future detailed design, the most feasible yet conservative approach will be taken to ensure that the designs meet all regulatory requirements and factors-of-safety.

It should be noted that within the TMF and Polishing Pond, the pond volumes/level can be fully controlled and adjusted by the water reclaim rate and decant rate. In addition to this, the pond has sufficient capacity to retain significant amounts of water from monthly precipitation plus a significant Environmental Design Storm (EDS).

Due to the lack of runoff during the winter months, the constant rate of reclaim and considerably depleted pond volumes, under the current 15/70/15 snowmelt scenario, there will typically be no release of water from the TMF until the month of May. A review using the 20/80/0 snowmelt scenario shows that there is a negligible impact (i.e., increase in effect precipitation in April of 7 to 8 mm) and still no required water release until the month of May.

Regarding rain-on-snow events, Knight Piesold has accounted for rain and snowmelt inputs simultaneously in the water balance. Also the @RISK results are expected to accommodate the potential slight differences due to increased runoff coefficient. If more water pumping were to be required, water can be reclaimed or decanted from the facilities at an increased rate to control water and decrease the likelihood of overtopping.

IR Number:	**AANDC #17**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrology — Stream flow estimates
Document:	DAR Section 2, Figure 2.5-11 and Conformity Responses
TOR Section:	

Preamble

For the purpose of forecasting available water supply at Thor Lake, monthly stream flows are simulated in Fig.2.5-11 of the DAR, including both the inflows to Thor Lake (e.g. from Murky and Long Lake watersheds) and outflow (into Fred Lake). It appears that each of these monthly flow values are estimated as the product of upstream contributing area, precipitation values that vary monthly (using historical regional data), and runoff coefficients that also vary monthly based on expected surface conditions (e.g. highest during freshet when the soil is saturated, lower during fall). No attempt appears to be made; however, to check the accuracy of this model using a sample of the collected field data and other estimated values.

AANDC Request #17

1. Please identify months in which both precipitation and stream flow were measured during fieldwork. For these months, please simulate monthly stream flows as per the DAR; i.e. the product of monthly precipitation totals, the appropriate monthly runoff coefficient, and the appropriate upstream contribution area. Then compare these estimated values with measured stream flow values, and outline % differences. Please identify the most likely sources of any major discrepancies between these values, such as beaver impoundments or possible errors in drainage area due to the aforementioned seasonal changes in connectivity. Based on this, please identify whether these natural processes could be incorporated within the model to improve the accuracy of estimated flows and overall water resources. Outline key data gaps that may still exist and that would benefit most from any future field sampling.

Avalon Response #17.1

The objective of simulating the watershed flow in and out of Thor Lake was to provide an estimate of the relative change in water volume from pre-production to mine operation and into the post production phase. The model shows that a small reduction in flow out of the Thor Lake Basin is expected due to water loss associated with the operations (i.e., less than 10%). These changes in absolute flow volumes are estimated based on rates of water consumption from the mining operation, and changes in the basin due to alteration of surface conditions (e.g., runoff coefficients).

It is important to emphasize that the focus of the model was to estimate the effect of these changes on the flow dynamics and relative discharge in and out of the watersheds. The monthly water balance approach that has been used is the best method for determining the monthly flow estimates for the project. Added to this is the fact that a probabilistic approach was taken using a risk based/simulation analysis to forecast a range of wet and dry (extreme) precipitation conditions and therefore the full range of possible runoff scenarios have been considered. The probabilistic modelling utilized the Microsoft Excel add-on program @RISK, which was used to perform Monte Carlo simulation and track the various outputs that result from variations in the input.

Comparing the modeled estimates to actual flow conditions holds little value as it was not the objective of the modeling and there is no way to validate estimates of flow during the operation and post-production phases. Nevertheless, there is insufficient concurrent site-specific data (i.e., flows and meteorological) available to complete an accurate correlation as suggested. An extensive database of precisely timed flow data and site-specific rainfall records would be required to complete such a detailed analyses.

Hence, any review of the model at this time should be focused on determining if the input parameters are adequate, and if the potential impacts to flow from the alteration of the watershed are plausible. The input parameters used to date are considered valid and based on long-term regional meteorological information. The runoff coefficients used in the model were selected based on careful review of regional Water Survey of Canada data, other relevant literature and previous experience on sites with similar surface cover, permafrost conditions and topography.

IR Number:	**AANDC #18**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Fish Habitat - Possible Reduction in Available Food for Fish
Document:	DAR and Conformity Responses
TOR Section:	

Preamble

Information provided in DAR indicates that the drainage area currently containing Buck and Ring Lakes will be used as the Tailings Management Facility (TMF) and will no longer be functional lakes. Baseline monitoring suggests that these lakes are not fish bearing, although they do contain significant benthic invertebrate communities. Given the hydraulic connection between these lakes and Thor and Long Lake, which are fish bearing, there is uncertainty as to whether:

1) Buck and Ring lakes represent a source of food for fishes of Thor lake (e.g., through benthic drift), and
2) to what extent the loss of this food resource will have on fishes of Thor Lake.

AANDC Request #18

Please comment on:

1. the likelihood that Buck and Ring Lakes provide food for fishes of Thor Lake; and
2. the loss of this food resource would have an impact on fishes of Thor Lake.

Avalon Response #18.1

Although Ring Lake and Buck Lake do contain invertebrate communities, largely consisting of amphipods, chironomids, and small freshwater clams, it is unlikely that they form a significant portion of the diet of fish in Thor Lake or Long Lake. Ring Lake is the highest lake in the basin and is connected to Buck Lake via a marsh. Buck Lake is bounded at its downstream end by bedrock outcrops and does not have a discernible channel at its outlet. While water may occasionally overflow from Buck Lake to Drizzle Lake, this would occur infrequently. Water from Drizzle Lake flows into Murky Lake through a small marsh.

Maximum depths of Ring and Buck lakes are 1.8 m and 2.0 m, respectively. Combined, they have a total surface area of 29 ha. The small size of these lakes and their watersheds indicates that outflows would also be small and would mainly be restricted to spring freshet, prior to peak invertebrate production. Discharges from Buck Lake to Drizzle Lake have not been directly measured. However, flows from Murky Lake have been recorded and provide an indication of the flow patterns through the seasons. Flows are highest in May and then rapidly fall to low levels during the summer and fall. Summer outflows from Murky Lake average between 0.01 and 0.07 m^3/s; flows out of Buck Lake, when they occur, would be much lower.

Invertebrates transported in flows out of Buck Lake would settle in marshy flowages or in Drizzle and Murky lakes, and would have very little chance of reaching Thor Lake. This, coupled with the lack of flows from Buck Lake through much of the open water season, provides compelling evidence that invertebrate production in Ring and Buck lakes does not provide food for fish in Thor or Long lakes.

Avalon Response #18.2

The evidence provided in Avalon Response #18.1 indicates that there would be no loss of food for fish in Thor and Long lakes due to the development of the TMF.

IR Number:	**AANDC #19**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Baseline groundwater quality at Nechalacho Mine Site
Document:	DAR Section 2.6.3; Table 2.6-8
TOR Section:	

Preamble

The Proponent pointed out that several total metal concentrations observed in local groundwater at the Nechalacho mine site exceed MMER and/or CSR guidelines (see table 2.6-8). However the dissolved concentrations for most of those metals (including aluminum, iron) were much lower (often below the detection limit). Total metal concentrations may not be representative of actual metal concentrations in groundwater due to the presence of suspended solids which will be digested as part of the total metal analysis.

AANDC Request #19

1. Please explain why total metal analyses (instead of dissolved metal analyses) were used to describe baseline groundwater quality at the Nechalacho mine site.

Avalon Response #19.1

With respect, as discussed in Section 2.6.3.2 of the DAR, all groundwater samples were analyzed for concentrations of total and dissolved metals. The measured total and dissolved metal concentrations were compared to CSR and CCME water quality guidelines for the protection of aquatic life. As indicated in the DAR, the CSR guideline values apply to both surface and groundwater, whereas the CCME guidelines only apply to surface water.

However, as groundwater ultimately discharges to surface water bodies, the CCME guideline values were included here for reference. All exceedances were identified in Tables 2.6-5, 2.6-6 and 2.6-7 of the DAR. Exceedances of the CSR and/or CCME guidelines were summarized in Table 2.6-8.

As also indicated in the DAR, these reported exceedances of the CCME and/or CSR guidelines did not imply that the groundwater at the study area is currently contaminated; only that background concentrations of these parameters were higher than typically found in groundwater at other natural sites in Canada. These background groundwater quality results merely reflect the natural geologic and hydrogeologic conditions within these specific areas of the property (Stantec 2010b).

IR Number:	**AANDC #20**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrogeological characterization of Nechalacho Mine Site
Document:	DAR Section 2.7.1
TOR Section:	

Preamble

The DAR acknowledges that the hydrogeological characterization of the Nechalacho mine site is limited. For example, "due to the limited number of monitoring wells there is little information to estimate flow direction in bedrock" (p.101). Furthermore, no hydrogeological characterization work (drilling, hydraulic testing, groundwater monitoring) was completed in proximity of the proposed TMF prior to submission of the DAR. Seven additional monitoring wells ("HG series") and geotechnical holes ("GT series") were installed in March/April 2011. However, no information was available on additional hydraulic testing and/or water level monitoring in those wells/boreholes.

Additional monitoring and testing at the Nechalacho mine site (in particular near the proposed TMF site) will be required to evaluate the environmental impact on local groundwater and surface water.

AANDC Request #20

1. Please provide details on the scope and scheduling of additional baseline characterization work (drilling, hydraulic testing, monitoring of groundwater levels and groundwater quality) the Proponent has recently completed (HG series and GT series in March/April 2011(?)) and/or is planning to complete at the Nechalacho mine site, in particular in proximity of the proposed TMF.

Avalon Response #20.1

Section 2.7.1.6 of the DAR summarized the initial hydrogeological work conducted at Nechalacho. The more detailed results were presented in Knight Piesold Technical Memos NB10-00587 and NB10-000570 which were included in the DAR as Appendices C.8 and C.9, respectively.

Subsequently, monitoring wells have been installed and sampled surrounding the TMF area (two sampling events), as described in KPL memos NB11-00454 (Attachment 3) and NB11-00542 (Attachment 4), including collection of water levels where possible (note: many wells were frozen). Additional water samples and water level measurements will be collected during three additional sampling events in May, July and October 2012.

Packer testing was completed during the drilling in August 2011, as summarized in KPL memo NB11-00527 (Attachment 5). Generally it was found that the bedrock in the area surrounding the proposed TMF has very low hydraulic conductivity (< 1.44E-06 cm/s).

IR Number:	**AANDC #21**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Hydrogeological characterization at Hydrometallurgical Site (Pine Point)
Document:	DAR Section 2.7.2
TOR Section:	

Preamble

The DAR relies heavily on historical information to describe the regional and local hydrogeology of the former Pine Point mine site. While this historical information is valuable and adequate to describe the regional hydrogeology it lacks site-specific data in close proximity of the open pits proposed to be used for groundwater extraction, tailings deposition and process water infiltration. Of particular interest in this context is the potential interaction of these pits with the local groundwater system.

AANDC Request #21

Please provide additional information on the local hydrogeology at the Pine Point plant site in proximity of the proposed pits to be used for water supply (T-37), HMF (L-37) and infiltration pit (N-42), including:

1. Information on total depth, volume and historic dewatering rates in each of these open pits.
2. Information on the local hydrostratigraphy near these open pits, including depth of overburden, thickness and type of bedrock units (within depth range of these open pits).
3. Information on hydraulic testing completed (or planned) in proximity of these pits (e.g. slug testing in the new monitoring wells, pumping tests).
4. Information on seasonal fluctuations in pit water levels and local groundwater levels (to determine the interaction of these pits with local groundwater)
5. Information on current direction of groundwater flow (using geodetic groundwater levels observed in new and existing monitoring wells and geodetic pit water levels).
6. Estimates of seasonal flow and quality of shallow seepage discharging into these pits.

Avalon Response #21.1

Detailed topographic surveys of the L-37, N-42 and J-44 pits were conducted using satellite imagery with 50 cm contours of the entire area. As indicated in the DAR, LiDAR data for the area indicates that the L-37 pit has more than sufficient capacity to contain all of the Hydrometallurgical Plant tailings solids for the 20 year projected life of the Project, and longer if necessary. Regarding the other two pits, as previously indicated, the J-44 pit is the new water source and the N-42 pit will be used for excess process water infiltration back into the Presqu'ile formation.

A copy of Cominco's 1987 Annual Water Use Licence Report is provided as Attachment 6; it provides a useful summary of the historic dewatering rates in the general Pine Point area. In addition, as described in Section 2.7.2.2 of the DAR, over the period between 1968 and 1982, the yearly average dewatering rate from the Presqu'ile aquifer due to mining activities was as high as 269,000 m^3/day and expected to increase to over 378,000 m^3/day by 1985 (GTC 1983).

GTC (1983) also estimated that the maximum drawdown of the water table in response to this dewatering was approximately 20 m; and that the source of the pumped water was the Presqu'ile aquifer and associated local and regional recharge, with none of the pumped water coming from Great Slave Lake.

Avalon Response #21.2

Surrounding the L-37 pit, the average depth to bedrock is 5.7 m with the overburden being made up of thin organic silt/till. The bedrock surrounding the pit (walls) is primarily dolostone. Underlying the pit bottom is sandstone.

No drilling was completed in the vicinity of the J-44 pit, but it is expected to have similar conditions to the rest of the site. We suspect that the overburden depth is approximately 10 m and it is mainly comprised of till. The pit is hosted in dolostone bedrock with suspected sandstone underlying the pit, as in the rest of the area.

Surrounding the N-42 pit, the average depth to bedrock is approximately 11 m (mainly till overburden). The bedrock surrounding the pit is mainly dolostone with small interbedded sandstone/greywacke layers.

Avalon Response #21.3

Packer testing was completed in the vicinity of the L-37 and N-42 pits in September 2011. Based on the results of this testing, the permeability of the bedrock ranges from 1.23E-03 cm/s to 7.36E-06 cm/s. No additional testing is being planned as the available information is considered to be adequate.

Avalon Response #21.4

All water level measurements to date in Pine Point monitoring wells are summarized in Table 4. As noted from the data presented in this table, there is some difference in water level elevations between summer and winter measurements (varies by location). However, there is no clear pattern of higher or lower water levels in the summer compared to the winter. Although it is not expected that there is a large seasonal variation in the groundwater table at the Pine Point site, additional measurements will be needed to verify this.

TABLE 4: PINE POINT GROUNDWATER MONITORING WELLS, MEASURED WATER LEVEL ELEVATIONS		
Monitoring Well	**Date**	**Water Level Elevation (m)**
DH-2010-01	3-Mar-11	190.28
	9-Aug-11	Well Dry
DH-2010-02D	24-Feb-11	190.00
	9-Aug-11	189.66
DH-2010-02S	22-Feb-11	189.14
	9-Aug-11	189.67
DH-2010-03	25-Feb-11	187.74
	9-Aug-11	186.22
DH-2010-04	2-Mar-11	184.28
	9-Aug-11	184.87
DH-2010-05	26-Feb-11	191.50
	9-Aug-11	193.07
GT-PP11-08	30-Oct-11	188.95
	22-Nov-11	188.90
HG-PP11-01	22-Nov-11	188.73
HG-PP11-02	22-Nov-11	188.94
HG-PP11-03	22-Nov-11	189.38
HG-PP11-04	22-Nov-11	189.17
HG-PP11-05	22-Nov-11	189.85
HG-PP11-06	22-Nov-11	190.09

Avalon Response #21.5

Based on the water level measurements recorded and reported to date in the Pine Point monitoring wells, definitive site-specific conclusions related to the current direction of groundwater flow cannot be confirmed; however, there are more than 20 years of groundwater data that have been used to ascertain the groundwater flow, as discussed in the DAR.

As discussed in Section 2.7.2.2 of the DAR, based on work completed by Stevenson (1983), the groundwater gradient in the Pine Point area is generally northwards towards Great Slave Lake while to the south of the Pine Point area, the groundwater gradient trends from west to east as shown in Figure 2.7-4 of the DAR. Local gradients range from about 0.4% northwards along the north part of the area and about 0.25% westward along the south portion.

Furthermore, as discussed in Section 6.5.2.1 of the DAR, particle tracing used to track flow from the N-42 pit to Great Slave Lake during the 20 year operations life indicated that there were no noticeable effects to the groundwater flow directions or travel times over existing conditions. Figure 6.5-4 of the DAR, illustrated simulated piezometric contours and particle tracking for the Pine Point area after 20 years of pumping and discharge.

Avalon Response #21.6

As discussed in Section 2.7.2.2 of the DAR, local surface water/groundwater flows through the till, then downwards through fractured bedrock towards the water table. Several minor seepage points observed in pit walls indicated that there is some lateral flow within the unsaturated bedrock. This seepage was thought to be due to local infiltration being directed horizontally along bedding planes. The staining observed suggested that the local seepage was highly mineralised and, in some cases, sulphurous.

IR Number:	**AANDC #22**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Baseline groundwater quality at Pine Point Hydrometallurgical Plant Site
Document:	DAR Section 2.7.2.2 and 6.5.2.4
TOR Section:	

Preamble

The text and photos in section 2.7.2.2 suggests that the local groundwater at the Pine point plant site "is highly mineralized and sulphurous" (p. 103). In section 6.5.2.4, three groundwater quality types are described:

(i) calcium-bicarbonate water,

(ii) sulphur water, and

(iii) salty water.

Historical groundwater quality data from historic dewatering operations at the former Pine Point Mine are presented in Table 6.5-4 to support this general description.

No recent site-specific groundwater quality data was presented in the DAR. However, the Proponent provided additional groundwater quality data (collected in 2011) in a subsequent submission (Knight Piesold memo dated September 30, 2011). The data provided in this memo suggested that pit water typically contains higher mineralization than the surrounding groundwater screened in the new (DH-2010) monitoring wells.

AANDC Request #22

Please provide more details on the baseline groundwater quality at the Pine Point hydrometallurgical site:

1. Provide a definition for "sulphurous" groundwater and provide details on the spatial and vertical extent of such sulphurous groundwater in the Pine Point region and the local area surrounding the proposed plant and tailings facilities.
2. Provide details on the depth interval where saline water was historically encountered at Pine Point.
3. Reconcile the chemical composition of local groundwater observed in recently installed monitoring wells and baseline groundwater quality provided in Table 6.5-4.
4. Explain the difference in chemical composition of pit water (e.g. SO4 -400-1,700 mg/L) versus local groundwater in nearby monitoring wells (e.g. SO4 -10-300 mg/L).

5. Please clarify whether the Proponent considers the most recent groundwater quality data obtained from the 2010 series of wells to be representative of baseline groundwater quality at Pine Point.
6. What is the chemical composition of the groundwater near the proposed infiltration pit N-42 (no monitoring well is available near this pit).
7. Is there any evidence of groundwater quality impacts in proximity of these pits due to historical (or present) seepage from the old Cominco tailings storage facility?

Avalon Response #22.1

As discussed in Section 6.5.2.2 of the DAR, Weyer et al. (1978, 1979) reported that three basic types of groundwater occur in the Pine Point area including sulphur water (referred to in the DAR as "sulphurous" water, which was described as water containing a sulphate-bicarbonate with Ca^{2+} as the main cation (with $S0_4^{2-}$)).

Weyer et al. (1978) determined that this groundwater was probably derived from the Devonian gypsum layers. Conductivities in this groundwater were found to typically be between 1,000 and 2,000 µs/cm. They also reported that this type of groundwater is commonly found in springs along the south shore of Great Slave Lake from the Little Buffalo River to Sulphur Point and across to Windy Point.

Avalon Response #22.2

As also discussed in Section 6.5.2.2 of the DAR, Weyer et al. (1978) referred to the salty water as sodium chloride brines, derived from groundwater contact with the Devonian evaporite layers. Brandon (1965) reported 420 mg/L chloride in a water sample collected in 1961 at the mouth of the Buffalo River.

Analysis of natural spring water and of deep well pump discharges by Cominco Ltd.'s Pine Point Operations in 1978 indicated two distinct groundwater types: salty and sulphur water (Durston 1978). The range of analyses of these waters is presented in Table 6.5-4 of the DAR. Their differing characteristics were believed to reflect different flow regimes. The Devonian limestones and dolomites are underlain by evaporate beds of salt and gypsum.

Based on these available studies, it appears that the chemistry of most groundwater samples collected in the Pine Point area over the past 30 years reflect mixing or evolution of these three basic water types.

Avalon Response #22.3

The groundwater quality data provided in Table 6.5-4 of the DAR represented the range of analyses reported for groundwater sampled at Pine Point in 1978 (Durston 1978). The results from this table are re-presented below as Table 5, with the addition of the recent groundwater quality data obtained by KPL in 2011.

TABLE 5: COMPARISON OF 2011 GROUNDWATER QUALITY DATA WITH DURSTON (1978) DATA

Sample Type	Units	2011 Groundwater (3 sampling events)		DAR Table 6.5-4 (Durston 1978)
		Min.	Max.	
Colour, True	T.C.U.	ND	52.2	40 - 79
Conductivity	µS/cm	332.0	1530.0	1,000 – 20,000
Hardness (as $CaCO_3$)	mg/L	185.0	962.0	1,000 – 2,000
pH	pH	7.5	8.2	7.0 – 8.0
Total Suspended Solids	mg/L	ND	1220.0	0 – 200
Total Dissolved Solids	mg/L	179.0	1200.0	1,500 – 3,000
Turbidity	NTU	3.5	564.0	475 – 741*
Alkalinity, Total (as $CaCO_3$)	mg/L	144.0	366.0	366 - 420
Chloride (Cl)	mg/L	ND	28.7	20 – 300
Total Phosphate as P	-	ND	0.72	<0.005
Sulfate (SO_4)	mg/L	9.9	753.0	1,000 – 1,500
Calcium (Ca)-Dissolved	mg/L	48.2	283.0	150 – 500
Copper (Cu)-Dissolved	mg/L	ND	0.0015	<0.1
Iron (Fe)-Dissolved	mg/L	ND	1.22	<0.1
Lead (Pb)-Dissolved	mg/L	ND	0.0069	<0.1
Magnesium (Mg)-Dissolved	mg/L	15.7	74.9	75 – 200
Potassium (K)-Dissolved	mg/L	0.52	7.79	2 – 10
Sodium (Na)-Dissolved	mg/L	1.2	86.3	20 – 100
Zinc (Zn)-Dissolved	mg/L	0.0035	3.01	<0.1
Copper (Cu)-Total	mg/L	ND	0.029	<1
Iron (Fe)-Total	mg/L	0.2	9.5	<1
Lead (Pb)-Total	mg/L	ND	0.062	<1
Zinc (Zn)-Total	mg/L	0.0120	3.72	<1

Notes:
* 1 JTU = 19 NTU
ND = Non-Detect

Groundwater quality results from the 2011 sampling program are largely within the range of results reported by Durston (1978). Elevated concentrations of total suspended solids and several total and dissolved metals were recorded exclusively in several newly installed groundwater wells sampled in late October 2011. As such, Avalon considers these results anomalous as they are incongruent with trends in groundwater quality in the Pine Point area. Additional sampling is required to confirm whether these results are typical of groundwater in the vicinity of newly installed monitoring wells.

Avalon Response #22.4

Avalon is currently unable to provide an explanation for the apparent differences observed in the concentrations of SO_4 in pit water compared to the concentrations recorded in the local groundwater. However, it should be noted that Durston (1978) reported SO_4 concentrations ranging from 1,000 to 1,500 mg/L in groundwater sampled at that time, which is comparable to the elevated maximum values reported in pit water in 2011 by KPL.

Avalon Response #22.5

The most recent groundwater quality data obtained for the 2010 series of wells established in the Pine Point area represent the best available data for groundwater in this area. However, it is Avalon's opinion that more sampling will be required before these data can be considered to be representative of baseline groundwater quality in the Pine Point area. Additional sampling (groundwater and surface water) is planned to be carried out in 2012. The results of this future sampling will be provided to the MVEIRB when they become available.

Avalon Response #22.6

KPL installed two groundwater monitoring wells in the vicinity of pit N-42 in late October 2011. Unfortunately, the first round of groundwater quality sampling from these wells indicated that the groundwater samples collected and analyzed had been significantly contaminated with suspended sediments, which in turn resulted in artificially high turbidity values and elevated metals for several parameters. Thus, only the surface water quality sample results obtained from the N-42 pit are presented in Table 6. Additional sampling (groundwater and surface water) is planned to be carried out in 2012. The results of this future sampling will be provided to the MVEIRB when they become available.

TABLE 6: CHEMICAL COMPOSITION OF SURFACE WATER IN N-42 PIT						
Date Sampled				28-Feb-2011	09-Aug-2011	31-Oct-2011
Samples	Sample Type	Units	MDL	SW6 (N-42)		
Physical Tests	Colour, True	T.C.U.	2.0	-	2.6	<2.0
	Conductivity	µS/cm	0.20	2810	2660	2630
	Hardness (as $CaCO_3$)	mg/L	-	2110	1920	1910
	pH	pH	0.10	7.92	8.20	7.94
	Total Suspended Solids	mg/L	3.0	8.0	<3.0	<3.0
	Total Dissolved Solids	mg/L	-	2560	2380	2440
	Turbidity	-	0.10	1.14	0.51	2.00
	Acidity (as $CaCO_3$)	mg/L	5.0	-	<5.0	<5.0
Anions and Nutrients	Alkalinity, Bicarbonate (as $CaCO_3$)	mg/L	5.0	211	204	-
	Alkalinity, Carbonate (as $CaCO_3$)	mg/L	5.0	<5.0	<5.0	-
	Alkalinity, Hydroxide (as $CaCO_3$)	mg/L	5.0	<5.0	<5.0	-
	Alkalinity, Total (as $CaCO_3$)	mg/L	5.0	173	167	163
	Ammonia-N, Total	-	0.050	<0.050	<0.050	<0.050
	Bicarbonate (HCO_3)	mg/L	5.0	-	-	199
	Bromide (Br)	-	1.0	<1.0	<1.0	<1.0
	Carbonate (CO_3)	mg/L	5.0	-	-	<5.0
	Chloride (Cl)	mg/L	0.50	12.8	11.5	13.1
	Hydroxide (OH)	mg/L	5.0	-	-	<5.0
	Nitrate (as N)	mg/L	0.050	<0.050	<0.050	<0.050
	Nitrate and Nitrite as N	mg/L	0.071	<0.071	<0.071	<0.071
	Nitrite (as N)	mg/L	0.050	<0.050	<0.050	<0.050
	Total Kjeldahl Nitrogen	-	0.2	<0.20	<0.20	<0.20
	Total Nitrogen	-	0.21	<0.20	<0.21	<0.21
	Orthophosphate-Dissolved (as P)	-	0.010	<0.010	-	-
	Total Phosphate as P	-	0.020	-	<0.020	<0.020
	Sulfate (SO_4)	mg/L	0.50	1730	1620	1680
Cyanide	Cyanide, Total	mg/L	0.0020	<0.0020	<0.0050	<0.0020
Total Metals	Aluminum (Al)-Total	mg/L	0.010	<0.010	<0.010	<0.010
	Antimony (Sb)-Total	mg/L	0.00040	<0.00040	<0.00080	<0.00080
	Arsenic (As)-Total	mg/L	0.00040	0.00079	<0.00080	<0.00080
	Barium (Ba)-Total	mg/L	0.0030	0.0161	0.0169	0.0146
	Beryllium (Be)-Total	mg/L	0.0010	<0.0010	<0.0020	<0.0020
	Boron (B)-Total	mg/L	0.050	<0.050	<0.050	<0.050
	Cadmium (Cd)-Total	mg/L	0.000050	0.000227	<0.0010	<0.0010

TABLE 6: CHEMICAL COMPOSITION OF SURFACE WATER IN N-42 PIT						
Date Sampled				28-Feb-2011	09-Aug-2011	31-Oct-2011
Samples	Sample Type	Units	MDL	SW6 (N-42)		
	Calcium (Ca)-Total	mg/L	0.50	453	414	439
	Chromium (Cr)-Total	mg/L	0.0050	<0.0050	<0.0050	<0.0050
	Cobalt (Co)-Total	mg/L	0.0020	<0.0020	<0.0020	<0.0020
	Copper (Cu)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010
	Iron (Fe)-Total	mg/L	0.010	0.184	0.028	0.181
	Lead (Pb)-Total	mg/L	0.00010	0.0142	0.0118	0.0171
	Lithium (Li)-Total	mg/L	0.010	0.012	<0.010	0.012
	Magnesium (Mg)-Total	mg/L	0.10	206	174	161
	Manganese (Mn)-Total	mg/L	0.0020	0.0386	0.0492	0.0328
	Mercury (Hg)-Total	mg/L	0.00010	<0.00010	-	-
	Molybdenum (Mo)-Total	mg/L	0.0050	<0.0050	<0.0050	<0.0050
	Nickel (Ni)-Total	mg/L	0.0020	0.0174	0.0148	0.0221
	Potassium (K)-Total	mg/L	0.10	3.43	2.67	2.45
	Selenium (Se)-Total	mg/L	0.00080	<0.00040	<0.00080	<0.00080
	Silver (Ag)-Total	mg/L	0.0050	<0.00010	<0.0050	<0.0050
	Sodium (Na)-Total	mg/L	0.01	6.6	5.4	5.0
	Strontium (Sr)-Total	mg/L	-	0.333	0.307	0.338
	Thallium (Tl)-Total	mg/L	0.050	<0.00010	<0.050	<0.050
	Tin (Sn)-Total	mg/L	0.050	<0.050	<0.050	<0.050
	Titanium (Ti)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010
	Uranium (U)-Total	mg/L	0.00010	0.0257	0.0261	0.0309
	Vanadium (V)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total	mg/L	0.0040	3.60	3.13	3.16
Dissolved Metals	Aluminum (Al)-Dissolved	mg/L	0.010	-	-	-
	Antimony (Sb)-Dissolved	mg/L	0.00080	-	-	-
	Arsenic (As)-Dissolved	mg/L	0.00080	-	-	-
	Barium (Ba)-Dissolved	mg/L	0.0030	-	-	-
	Beryllium (Be)-Dissolved	mg/L	0.0010	-	-	-
	Bismuth (Bi)-Dissolved	mg/L	0.000050	-	-	-
	Boron (B)-Dissolved	mg/L	0.050	-	-	-
	Cadmium (Cd)-Dissolved	mg/L	0.00010	-	-	-
	Calcium (Ca)-Dissolved	mg/L	0.50	489	444	456
	Chromium (Cr)-Dissolved	mg/L	0.0050	-	-	-
	Cobalt (Co)-Dissolved	mg/L	0.0020	-	-	-
	Copper (Cu)-Dissolved	mg/L	0.0010	-	-	-

TABLE 6: CHEMICAL COMPOSITION OF SURFACE WATER IN N-42 PIT						
Date Sampled				28-Feb-2011	09-Aug-2011	31-Oct-2011
Samples	Sample Type	Units	MDL	SW6 (N-42)		
	Iron (Fe)-Dissolved	mg/L	0.010	-	-	-
	Lead (Pb)-Dissolved	mg/L	0.0050	-	-	-
	Lithium (Li)-Dissolved	mg/L	0.0030	-	-	-
	Magnesium (Mg)-Dissolved	mg/L	0.10	217	197	188
	Manganese (Mn)-Dissolved	mg/L	0.0020	-	-	-
	Mercury (Hg)-Dissolved	mg/L	0.00010	-	-	-
	Molybdenum (Mo)-Dissolved	mg/L	0.0050	-	-	-
	Nickel (Ni)-Dissolved	mg/L	0.0020	-	-	-
	Potassium (K)-Dissolved	mg/L	0.50	3.59	3.19	2.89
	Selenium (Se)-Dissolved	mg/L	0.00040	-	-	-
	Silver (Ag)-Dissolved	mg/L	0.00010	-	-	-
	Sodium (Na)-Dissolved	mg/L	1.0	6.8	6.5	6.0
	Strontium (Sr)-Dissolved	mg/L	0.00010	-	-	-
	Thallium (Tl)-Dissolved	mg/L	0.00010	-	-	-
	Tin (Sn)-Dissolved	mg/L	0.050	-	-	-
	Titanium (Ti)-Dissolved	mg/L	0.0010	-	-	-
	Uranium (U)-Dissolved	mg/L	0.00010	-	-	-
	Vanadium (V)-Dissolved	mg/L	0.0010	-	-	-
	Zinc (Zn)-Dissolved	mg/L	0.0020	-	-	-
	Ion Balance	%	-	107	104	99.9
	Total Organic Carbon	mg/L	1.0	-	-	-

Avalon Response #22.7

Avalon has no information on groundwater quality associated with the old Cominco tailings storage facility. However, it should be noted that this facility is located to the north (i.e. downgradient) of the proposed Hydrometallurgical Plant and associated infrastructure. These tailings facilities are currently under lease with Teck and, subsequently, are monitored by them.

IR Number:	**AANDC #23**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Seepage from TMF at Nechalacho Mine Site
Document:	DAR Section 4.7.3.3 and 6.5.1.5; Figure 4.7-10
TOR Section:	

Preamble

Section 4.7.3.3 describes the design of the tailings management facility (TMF) for the flotation plant at the Nechalacho mine site. However, very little information is provided on aspects of seepage control through the foot print of the TMF. Test pitting in the foot print area has shown the presence of fractured bedrock outcrops and glaciolacustrine and glaciofluvial sediments which represent a potential for tailings seepage. Furthermore, any shallow permafrost which could inhibit tailings seepage can be expected to thaw subsequent to placement of tailings.

Figure 4.7-10 indicates a seepage estimate of 1,800 m^3/year (or 0.06 L/s) from the tailings deposit and the Polishing Pond each. However, no rationale is provided for this estimate. The only reference to tailings seepage is in section 4.7.3.3 indicating that "Foundation preparation may also include the treatment of fractures and discontinuities within the bedrock surface with slush grout to reduce any potential" (p.498).

Note that tailings seepage is not discussed at all under section 6 (Environmental Assessment) and no mitigation measures are proposed to minimize tailings seepage through the foundation of the TMF (tailings deposit and associated polishing ponds) (see section 6.5.1.5).

AANDC Request #23

Please provide additional details on the potential for, and implications of, seepage of process water through the foundation of the tailings deposit and associated polishing ponds, including:

1. Provide assumptions and calculations to estimate seepage through the base of the tailings deposit and polishing ponds.
2. Evaluate potential for environmental impact to local receiving water (groundwater and surface water) from tailings seepage.
3. Provide details on potential mitigation measures to minimize seepage from the TMF at Nechalacho.

Avalon Response #23.1

Seepage values presented for the TMF/Polishing Pond were estimated to establish conservative values from a surface water balance perspective.

The installation of a bituminous geomembrane on the upstream slope of the TMF and Polishing Pond embankments is intended to minimize the potential for seepage through or below the embankments. Additionally, a primary reason for founding the embankments on bedrock is that the bedrock in this area is of high quality and is expected to act as a reasonable barrier to seepage under the TMF and Polishing Pond facilities.

From recent packer testing, the permeability of the bedrock is a maximum of 1E-06 cm/s in the vicinity of the TMF and Polishing Pond. As a result, it is expected that seepage from the TMF and Polishing Pond facilities will be negligible. As part of the detailed design, detailed seepage analyses incorporating newly acquired permeability data will be conducted to better estimate the range of expected seepage values. In the event that unacceptable seepage and seepage quality occurs below the embankments under the final design, seepage collection measures could be incorporated into the design to allow collection and return of seepage to the facility.

Avalon Response #23.2

There is very low potential for environmental impact due to very little seepage through tight bedrock and supernatant pond perched over tailings solids. Any areas of the underlying bedrock requiring treatment during embankment construction will be treated. The upstream slope of the TMF embankments and Polishing Pond embankments will be lined with a bituminous geomembrane tied into good quality bedrock.

Avalon Response #23.3

Natural conditions combined with construction of a suitable cut-off at the embankments are expected to be sufficient for keeping seepage well below tolerable quantities. Should additional measures be deemed necessary to minimize and control seepage, they will be incorporated into the design. These may include:

- Additional treatment of bedrock during excavation of the perimeter embankment areas;
- Foundation grouting; and/or
- Seepage collection systems could be incorporated into the design as required to allow collection and return of seepage to the facility.

IR Number:	**AANDC #24**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Seepage from HMF (pit L-37) at Pine Point
Document:	DAR Section 4.8.3.1 and 6.5.3.2; Figure 4.8-7
TOR Section:	

Preamble

Section 4.8.3.1 describes the design of the hydrometallurgical tailings management facility (HMF) for the Metallurgical Plant at the Pine Point plant site. However, very little information is provided on the potential for seepage from this facility to the surrounding environment. Historical information and recent drilling near pit L-37 suggests that the pit walls consist of glacial tills and highly permeable dolostone of the Presqu'ile formation with significant potential for seepage of process water.

Section 4.8.3.1 discusses options for seepage control including use of local materials (till and/or waste rock) as a separation/filter barrier to the tailings solids, collection of supernatant process water in a lined portion of the pit and water treatment. However, it is unclear when such seepage mitigation measures would be implemented.

Figure 4.8-7 indicates a seepage estimate of 1,800 m^3/year (or 0.06 L/s) from the HMF. No rationale is provided for this seepage estimate and it is unclear whether this estimate assumes that seepage mitigation measures are implemented or not.

Note that tailings seepage is not discussed at all under section 6 (Environmental Assessment) and no mitigation measures are proposed to minimize tailings seepage through the base and walls of the HMF (see section 6.5.3.2).

AANDC Request #24

Please provide additional details on the potential for, and implications of, seepage of process water through the side walls and base of the HMF (pit L-37), including:

1. Provide assumptions and calculations for seepage estimate used in water balance (Figure 4.8-7).
2. Describe potential for shallow seepage from the backfilled pit into surrounding till or shallow bedding planes in unsaturated bedrock.
3. Describe potential for discharge of (perched) seepage impacted by process water at surface (in local depressions, nearby pits and/or surface runoff etc).

Avalon Response #24.1

Seepage values presented for the Hydrometallurgical Plant tailings facility (HTF) were estimated to establish conservative values from a surface water management perspective. The more seepage that occurs directly into the HTF walls, the less water that will need to be transferred to the Excess Water Infiltration Pit. Seepage rates are expected to be significantly higher based on the recently obtained permeability data for the bedrock.

Based on recent Pine Point packer testing, the permeability of the bedrock averages 1.23E-03 cm/s in the vicinity of the HTF. The seepage rates are, however, expected to fluctuate as the facility fills with tailings over the life of operations. All designs will be carried out to account for the worst case from a surface water management perspective (i.e., least seepage expected). During the design process more detailed analyses will be carried out using the recently acquired data to quantify what benefits can be realized through the increased seepage at the HTF.

Avalon Response #24.2

Most of the HTF tailings will be confined by the bedrock of the pit wall with limited depths confined by the upper till stratum; however, any till that may be exposed to tailings or water is expected to create significantly less seepage than the bedrock due to the high fines content of the till materials. The shallow bedrock is not expected to have any higher permeability/seepage rates than the bedrock deeper in the pit, as the permeability was relatively consistent with depth. Seepage will be greatest in the northeast corner of the HTF where the supernatant pond contacts the pit wall. This seepage is expected to migrate quickly to the natural water table level below.

Avalon Response #24.3

Water seeping into the pit walls will dilute within the aquifer and is expected to be fully diluted to natural background conditions before it daylights at surface in any location. The process water is expected to be of better quality for a number of parameters than the natural groundwater in the area.

IR Number:	**AANDC #25**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Seepage from Infiltration Pit (pit N-42) at Pine Point
Document:	DAR Section 4.8.3.1 and 6.5.3.2; Figure 4.8-7
TOR Section:	

Preamble

Section 4.8.3.1 discusses discharge of supernatant process water into an infiltration pit ("N-42"). The water flow sheet shown in Figure 4.8-7 indicates that on average 152,000 m^3/year (or 4.8 L/s) will have to infiltrate through the base of this pit into the surrounding aquifer. A regional flow model has been used to demonstrate that the local aquifer can accept this flow without significant local mounding (see IR # 10 below). However, no site-specific hydraulic information has been presented to confirm that the permeability of the materials exposed in the local pit walls is adequate to accept this flow rate.

The water quality for the tailings process water (Table 6.5-6) is predicted to have significantly (up to 100 times) higher TDS, hardness and sulphate than the surrounding local groundwater. Selected dissolved metals (Ni, Cu) and nitrate are also predicted to be elevated relative to local groundwater. The flow sheet in Figure 4.8-7 indicates the potential for treatment of the supernatant water prior to discharge into the pit. However, no details are provided on what type of treatment would be required and under what circumstances such a treatment plant would be operated.

AANDC Request #25

1. Please provide additional details on the feasibility to infiltrate the required amount of supernatant process water into the N-42 pit and the requirements for treatment of the supernatant process water prior to discharge into the infiltration pit.

Avalon Response #25.1

The excess supernatant and runoff water that does not infiltrate into the pit walls in the HTF (L-37 pit), will be pumped to the N-42 pit for infiltration. The groundwater flow model (using visual MODFLOW software) was created to simulate the current hydrogeological flow conditions at the Pine Point site and to estimate the effects of implementing the water management plan for the Hydrometallurgical Site, including the pumping of water from the J-44 pit and the infiltration of excess water into the N-42 pit. The model is considered to be conservative, in that it assumes very little infiltration of water would occur at the HTF and therefore more water would need to be transferred to the N-42 Pit. The model results were summarized in KPL memo NB10-00665 issued on March 8, 2011, which was provided in Appendix C.10 in the DAR.

Results of the groundwater flow model suggest that even with full transfer of supernatant to the N-42 Pit, there is expected to be very little effect on the groundwater regime at the Pine Point site in response to the discharge/infiltration at the N-42 Pit, given the rates used in the model. Groundwater levels in the vicinity of the N-42 pit are expected to increase by approximately 0.1 m above the simulated pre-discharge conditions after 20 years of discharge/infiltration.

Particle tracing was used to track flow from the N-42 pit to Great Slave Lake during the 20 year operations life and there were no noticeable effects to the groundwater flow directions or travel times over existing conditions. Figure 6.5-4 of the DAR illustrated the simulated piezometric contours and particle tracking for the Pine Point area after 20 years of pumping and discharge.

Recently completed packer testing indicates that the permeability of the rock in the N-42 pit is 1.8E-04 cm/s to 2.6E-05 cm/s. Knight Piesold is confident given these results and information from historical operations that the rock will have more than enough capacity to accept all infiltrated water from the project. The volumes of water for the Hydrometallurgical operation are significantly less than 1% of the flows associated with historical operations.

As indicated in the DAR, Avalon does not anticipate that the supernatant process water will require any further treatment (other than the settling of tailings solids in the HTF prior to discharge of excess decanted process water into the infiltration pit).

IR Number:	**AANDC #26**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Groundwater model for Nechalacho Mine Site
Document:	DAR Section 6.5.1.2 to 6.5.1.4
TOR Section:	

Preamble

The Proponent used a groundwater flow model to predict groundwater inflow to the underground workings (including ramp) and to predict reflooding times after closure (KP, 2011f). Insufficient information is provided in the DAR (and accompanying Appendix C17) to evaluate the flow model with respect to modeling assumptions such as model grid, model boundaries, recharge etc. used for those predictions.

AANDC Request #26

Please provide additional details on the groundwater flow model for the Nechalacho mine site including:

1. Model domain and model discretization (including a figure showing FD grid).
2. Boundary conditions used (including a figure showing the spatial representation of the ramp and mine workings in MODFLOW)
3. Recharge assumed for the steady-state model.
4. Details on model calibration, model convergence and model water balance.

Avalon Response #26.1

Information regarding the model is as follows:

- The model domain includes the area of the proposed ramp and underground workings, extending in the X-direction from 414,000 to 422,000 m and in the Y-direction from 6,884,000 to 6,890,000 m. No flow conditions based on the watershed areas constrained the area of the model simulation.
- The finite difference (FD) grid had non-uniform grid cells with increased discretization in the area of the ramp and underground development.
- The model was comprised of 37 layers to improve the simulation of flow toward the proposed ramp and underground workings. These layers were assigned similar hydrostratigraphic properties with the exception of the simulation of the ramp and underground workings, which were assigned higher hydraulic conductivity values.
- The total thickness of the model was 400 m.

Figures of the model domain and discretization are shown in Figures 1, 2 and 3 (below).

Figure 1: Nechalacho Groundwater Flow Model Domain

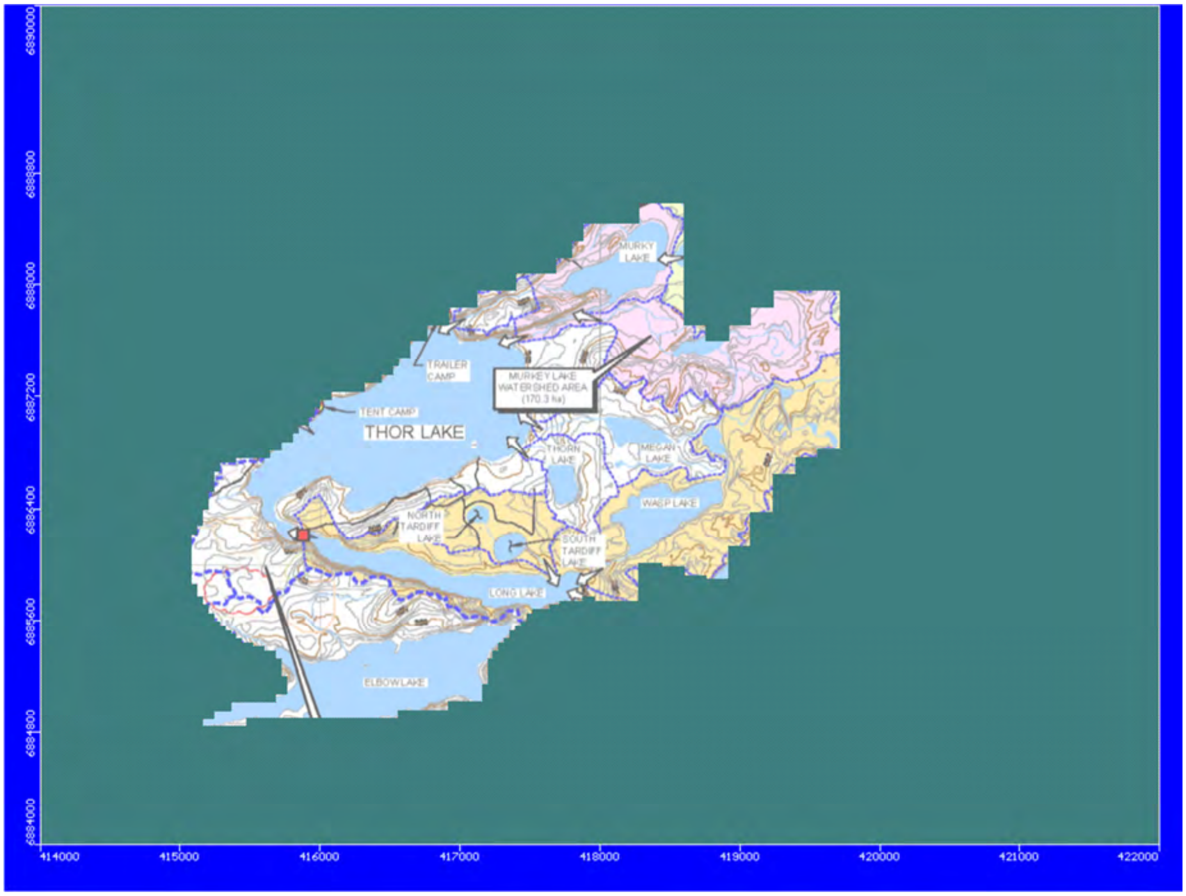


Figure 2: Nechalacho Groundwater Flow Model Finite Difference (FD) Grid

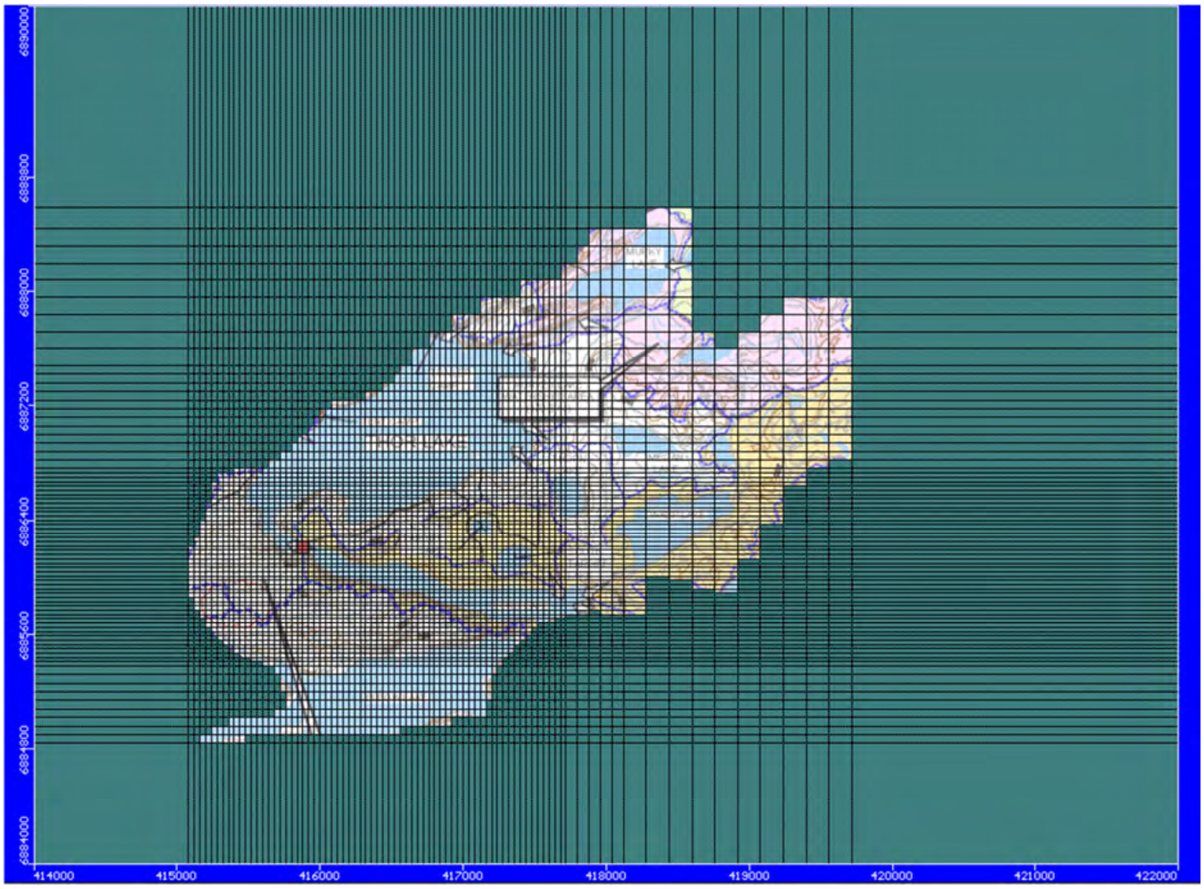
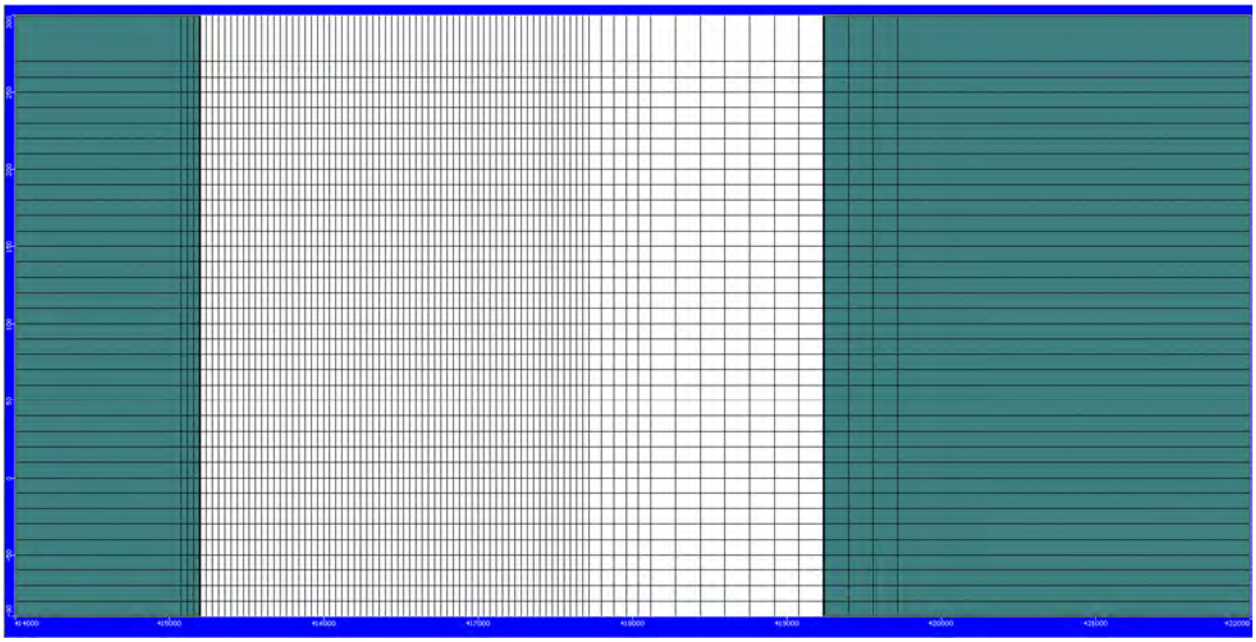


Figure 3: Nechalacho Groundwater Flow Model Layers



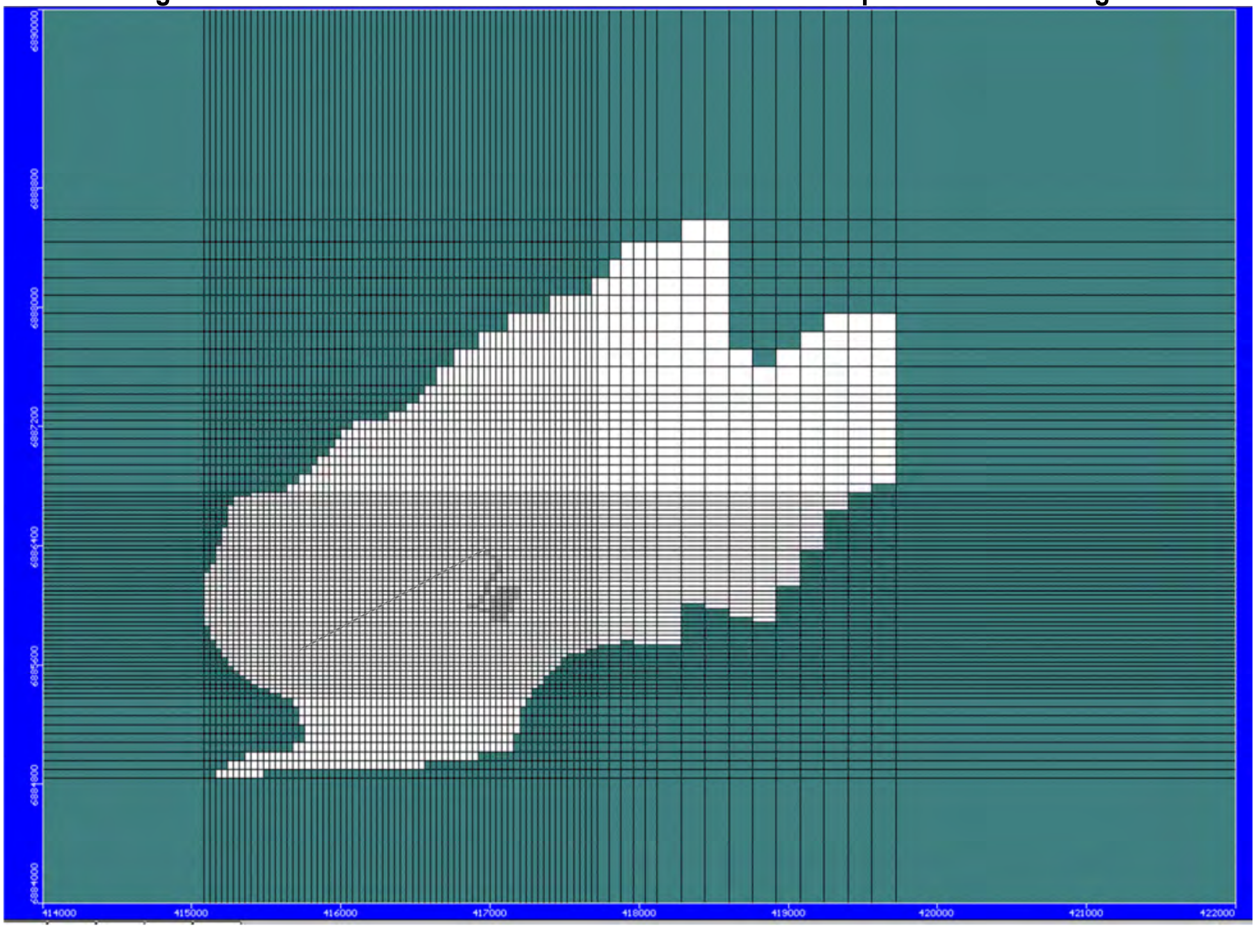
Avalon Response #26.2

The types of boundary conditions defined in the groundwater model included the following:

- No flow conditions were selected based on the watershed areas developed for the site and considering the potential influence of the mining on the groundwater regime.
- Lakes were represented using the Constant Head package. A value of 300 m was applied to all lakes.
- Meteoric recharge was represented using the Recharge package. A value of 10 mm/year was applied to the uppermost layer.
- Inflow to the ramp and underground workings was represented using the Drain package. Drain values were based on the elevation of the grid cell and simulated the decline of the ramp to the mine workings.

The spatial representation of the ramp and mine workings is shown in Figure 4 (below). The ramp is within layers 2 to 19 of the model.

Figure 4: Schematic of Plan View of Nechalacho Mine Ramp and Mine Workings



Avalon Response #26.3

A recharge of 10 mm/year was assumed for the steady state model.

Avalon Response #26.4

The model was set up and evaluated based on the conceptual groundwater model for the site. The conceptual model was developed using current understanding of the geology, groundwater levels, hydraulic testing and hydrometeorological conditions, based mainly on historic information. The WHS solver was used with a convergence criterion of 0.01 m. The mass balance of the converged model showed a discrepancy of less than 0.5%.

IR Number:	**AANDC #27**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Estimates of groundwater inflow to Nechalacho U/G Mine
Document:	DAR Section 6.5.1.2 to 6.5.1.3
TOR Section:	

Preamble

The Proponent estimated that steady-state groundwater inflows to the underground workings would range from 3 to 10 L/s. The drawdown in the surrounding bedrock aquifer was predicted to range from 2 to 10 m. Several assumptions were made to arrive at these estimates:

(i) shallow and deep bedrock have identical hydraulic properties,

(ii) the bedrock K has an upper limit of Kh=$2*10^{-8}$ m/s and Kv=$1*10^{-8}$ m/s, and

(iii) the open area of the mine was greatest just prior to the start of paste backfilling (at the end of Year 4).

Information provided in the DAR suggests that these assumptions may not be sufficiently conservative for estimating mine inflow. First, the conceptual model described in section 2.7.1.5 distinguishes a shallow (more permeable) aquifer and a deep (less permeable aquifer. No such differentiation is made in the numerical model.

Second, hydraulic testing completed in the shallow aquifer ranged from $7.6*10^{-7}$ m/s to $3.1*10^{-5}$ m/s (p. 101 of DAR) and hydraulic testing completed in the deep bedrock aquifer ranged from $4.1*10^{-8}$ m/s to $1.7*10^{-7}$ m/s (p. 101 of DAR). Packer testing completed in the Nechalacho Deposit rock mass indicated bedrock permeabilities ranging from 310-9 m/s to 210-7 m/s (p. 102 of DAR). The upper limit of K values observed is significantly greater than the "high K" estimate. In fact the "high K" used for modeling is equal to the geometric mean of the packer testing completed in deep bedrock ($2*10^{-8}$ m/s).

Finally, the third assumption appears to assume that all backfilled mine workings have the same K as "tight" bedrock. This seems unlikely considering the stress relief in mined-out areas, the difficulty of "complete" backfilling and the presence of open tunnels for access and venting.

<u>AANDC Request #27</u>

1. Please provide additional justification(s) for the selection of the above model assumptions for mine inflow estimates. Please also provide results of sensitivity analyses that illustrate the sensitivity of the predicted mine inflow rates and drawdown in the local aquifer to the assumed modeling assumptions discussed above.

Avalon Response #27.1

Knight Piesold previously completed a review of the historic hydrogeological information for the site in 2009 (results presented in KPL memo NB09-00655 – Appendix C.10 of the DAR) during which no areas of concern were identified, and all hydrogeological parameters appeared favourable for underground mine development at the site. However, to further this theory, a robust geomechanical/hydrogeological site investigation program was carried out in 2010.

The 2010 investigations were used to define the rock mass characteristics and hydraulic characteristics in and around the Nechalacho Deposit. The work included drilling of eight (8) oriented core drillholes, detailed geomechanical core logging, packer testing and the installation of two (2) thermistors. Further to these investigations, Avalon site geology staff continued to collect rock mass quality data from exploration drillholes for incorporation into the rock mass quality database.

Results of the geomechanical program (as presented in KPL memo NB10-00570 - Appendix C.9 of the DAR) suggested that the Rock Mass Rating in the area of the deposit indicates GOOD to VERY GOOD rock, with the design values typically being in the upper end of the GOOD range. Flat-lying (horizontal) joints form the dominant joint set. Vertical to sub-vertical joint sets are also present, although not as prominent.

The deposit area is surrounded by a Sodalite Cumulate zone, a cap rock of the Nechalacho mineralized intrusion that was subsequently eroded away. The Sodalite Cumulate material is described as hydrothermally altered and is a mixture of illitic clays and sericite. There are no persistent records of drill fluid loss within this zone and it is judged to have very low hydraulic conductivity. To date, no significant water bearing fractures or faults have been encountered in the vicinity of the mine workings.

All investigations have shown very few regions of reduced rock mass quality (e.g., shear, faults, rubblized or broken zones) with only some slightly lower RQD zones close to surface. The rock mass quality increases significantly with depth. A more recent review of the 2011 geomechanical data collected in the vicinity of the proposed ramp did not identify any rock quality issues that would be indicative of high groundwater inflows.

Groundwater inflows to the underground mine were previously estimated using a numerical model for a range of permeability values. Based on site investigations, packer testing, core logging and review of historic information completed to date, it is judged that the range of permeability values (i.e. $4x10^{-9}$ m/s to $2x10^{-8}$ m/s) used to model the potential groundwater inflows into the mine are considered representative and slightly conservative at this time (as presented in KPL memo NB10-00587 – Appendix C.8 of the DAR).

These values are consistent with expected values for intrusive and metamorphic crystalline rock (Freeze and Cherry 1979). To date no evidence of water bearing fractures/faults have been encountered that would justify the use of higher permeability values at depth in the mine. Some lower permeability results were obtained near surface and are not applicable to the rock quality associated with the underground workings. The rock mass quality increases significantly with depth.

These conclusions are supported by reports from past mining in the relatively nearby T Zone, where it was reported that "there was little to no water incursion into the mine workings" (Trueman 2010). Additional packer tests were recently completed by KPL to investigate the TMF (Ring and Buck

Lakes). These tests have indicated that the rock is of high quality with very low permeability values close to surface in the bedrock, with the majority of the test zones experiencing no water take during testing.

The model results indicate that groundwater would tend to flow downward as a response to underground mine dewatering. The major sources of water that will contribute to flows into the mine include recharge from precipitation and water from nearby surface water bodies including Thor Lake, Long Lake and Elbow Lake. To assess the effects of mine dewatering, the flow from these different sources were partitioned in the numerical model and compared to the estimated flow into the lakes from runoff and precipitation. In each case, the loss of water from each lake was less than 10% of the inflow to the lake.

During development of the mine, although not expected, the chance of high, long term groundwater inflows resulting from an unidentified higher permeability zone can be reduced during advancement of the ramp through investigation in advance of the face. Should higher than manageable flows be observed during the investigation, the area can be grouted prior to advancing the ramp through the area. It should be noted that the site drill program conducted numerous condemnation holes along the entire length of the proposed underground access ramp during the summer of 2011; results were as expected.

During closure and post closure, the underground workings will be allowed to flood. It is estimated that about 95% of the void space of the underground mine will be filled with paste backfill and the remaining space flooded with groundwater.

IR Number:	**AANDC #28**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Groundwater model for Pine Point Metallurgical Plant Site
Document:	DAR Section 6.5.2.1
TOR Section:	

Preamble

The Proponent used a groundwater flow model to predict to estimate the effects of implementing the water management plan for the Hydrometallurgical Site, including the withdrawal of water from the T-37 pit and the infiltration of excess water into the N-42 pit. Insufficient information is provided in the DAR (and accompanying Appendix C10) to evaluate the flow model with respect to modeling assumptions such as model grid, model boundaries, recharge etc. used for those predictions.

AANDC Request #28

Please provide additional details on the groundwater flow model for the Pine Point mine site including:

1. Explain discrepancy between rate of groundwater extraction used for water balance (695 m^3/day in figure 4.8-7) and rate used in modeling for impact assessment (1,950 m^3/d).
2. Describe model domain and model discretization (including a figure showing FD grid).
3. Describe boundary conditions used (including a figure showing the BCs in MODFLOW).
4. Specify aquifer thickness assumed in model (specifically near the pits to be used).
5. Specify recharge assumed for the steady-state model.
6. Provide details on model calibration, model convergence and model water balance.
7. Clarify assumption on type of aquifer (Confined vs Unconfined).
8. Explain what, if any, effects the high TDS of the process water (saline seepage) has on local groundwater flow and migration of the seepage plume in the local aquifer.

Avalon Response #28.1

The water balance and design criteria indicate an extraction rate of approximately 695 m^3/day of water from the process water supply pit. The extraction rate used in the MODFLOW model was 1,950 m^3/day, which is considered to be a conservative, worst-case scenario for the groundwater model in assessing the impact of the operations on the groundwater regime. Ultimately the overall effects of the project on the groundwater table will be negligible.

Avalon Response #28.2

Information regarding the model is as follows:

- The model domain extended in the X-direction from 606,000 to 686,000 m and in the Y-direction from 6, 730,000 to 6,770,000 m. The area of simulated flow was bounded by Great Slave Lake, Buffalo River and Little Buffalo River.
- The finite difference grid had uniform grid cells of 400 x 400 m.
- The model was comprised of one layer with a thickness ranging from about 50 to 450 m.

Figure 5: Pine Point area Groundwater Flow Model Domain and Discretization

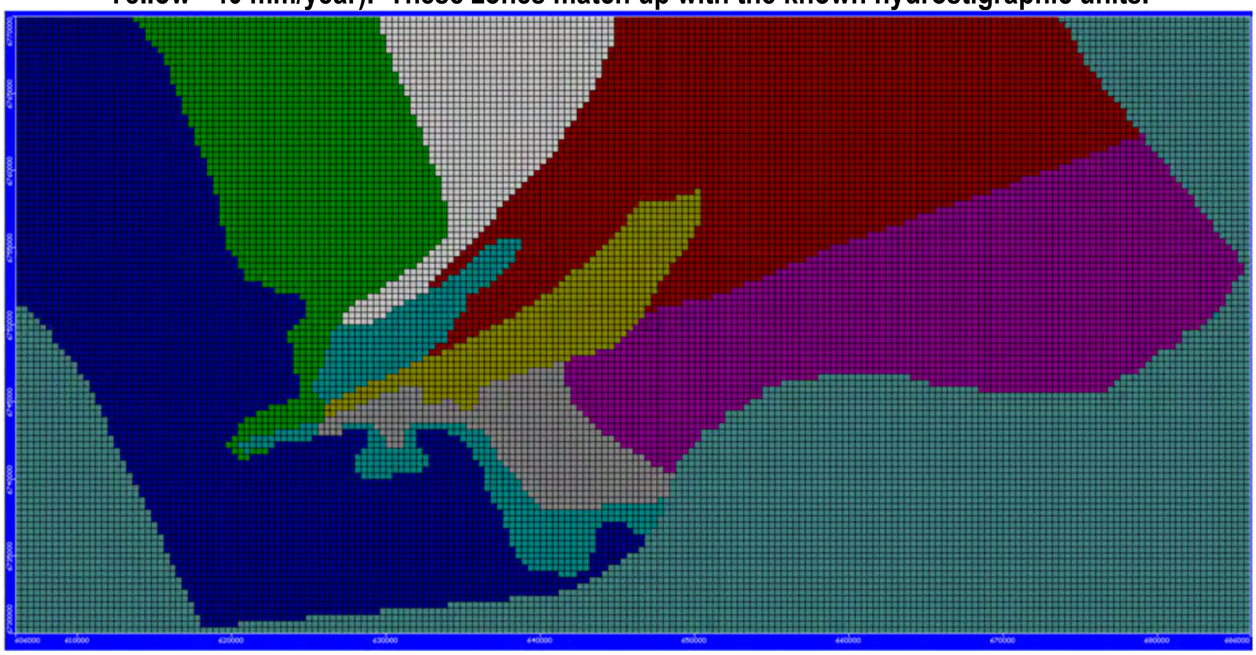
Avalon Response #28.3

The types of boundary conditions defined in the groundwater model included the following:

- Great Slave Lake and regional groundwater flow from the south of the Pine Point area were represented using the River package.
- Buffalo River and Little Buffalo River were represented using the Constant head package.
- Meteoric recharge was represented using the Recharge package. Recharge was applied to areas of relatively higher hydraulic conductivity (i.e., Watt Mountain Limestone, Sulphur Point Formation, Presqui'le Formation).

Figure 6: Pine Point area Groundwater Flow Model Constant Head Boundaries shown in Blue and River Boundaries shown in Red

Figure 7: Pine Point area Groundwater Flow Model Recharge Boundaries (All values are 0 mm/year except Turquoise = 5 mm/year, Grey = 30 mm/year and Yellow =40 mm/year). These zones match up with the known hydrostigraphic units.



Avalon Response #28.4

The model thickness varied across the model domain, generally increasing from southeast to northwest. The thickness of the model in the area of the pits is shown by two sections taken across the model domain (Figure 8 and Figure 9, below).

Figure 8: Section of modelled section through T-37 pit area

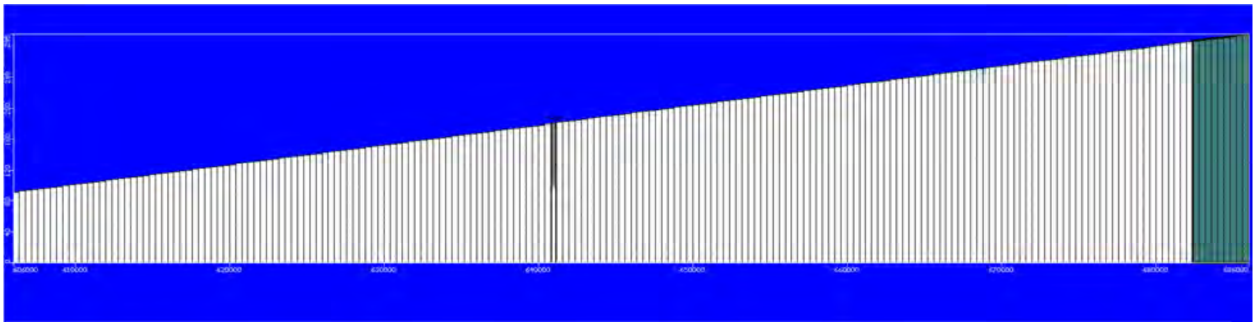
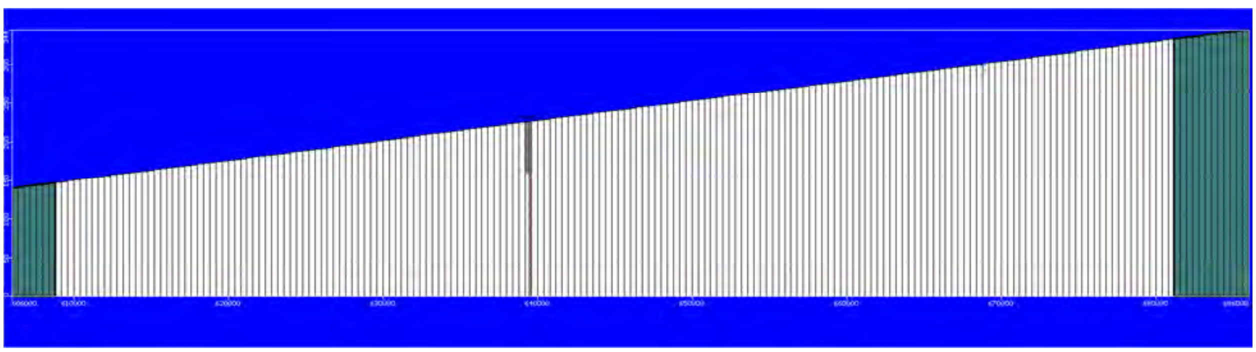


Figure 9: Section of modelled section through N-42 pit area.



Avalon Response #28.5

Please refer to Figure 7 in #28.3.

Avalon Response #28.6

The model was set up and evaluated based on the conceptual groundwater model for the site. The conceptual model was developed using our current understanding of the geology, groundwater levels, hydraulic testing and hydrometeorological conditions. The WHS solver was used with a convergence criterion of 0.01 m. The mass balance of the converged model showed a discrepancy of less than 0.5%.

Avalon Response #28.7

A confined/unconfined layer type was selected for the MODFLOW model. Using this layer designation, the layer is assumed to be confined if the modelled head is above the layer elevation. If the modelled head is below the layer elevation, the layer is assumed to be unconfined.

Avalon Response #28.8

Avalon anticipates that some of the TDS constituents (e.g., microgranular components) initially contained in the Hydrometallurgical Plant raw process water will likely be precipitated/filtered out into the gypsum tailings as the process water is retained and/or migrates through the L-37 pit or for excess water, through the N-42 pit out into the Presqu'ile formation. Avalon does not anticipate that the residual TDS levels in the infiltrated process water will not have a significant effect on the local groundwater flow or the migration/dispersion of the seepage plume in the local aquifer. However, it is anticipated that the groundwater monitoring program to be established for the L-37 and N-42 pits will help to confirm these predictions.

IR Number:	**AANDC #29**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Environmental Impact - Groundwater quality at Metallurgical Plant Site
Document:	DAR Section 6.5.3.2
TOR Section:	

Preamble

In section 6.5.3.2 that proponent states "*The pH of the tailings water is expected to be slightly above neutral (7.7), while conductivity, sodium, chloride and other parameters that contribute to water hardness, including calcium, magnesium and sulphate will be elevated compared to current background conditions. However, these elevated levels are expected to rapidly diffuse and dilute to natural background values within the Presqu'ile Formation*" (p. 729 of DAR).

No calculations or numerical modeling is presented in the DAR to support the contention that the saline seepage plume will "rapidly diffuse and dilute" in the Presqu'ile aquifer.

AANDC Request #29

Please provide additional information on the potential impact of seepage from the infiltration pit N-42 on the local aquifer:

1. Evaluate the spatial extent of a seepage plume developing downgradient of the infiltration pit N-42.
2. Provide details on a groundwater monitoring plan that would be implemented to monitor the effect of the proposed infiltration on the local aquifer.

Avalon Response #29.1

The spatial extent of the plume would be generally represented by the groundwater flow paths simulated by the groundwater modelling, as previously discussed in Avalon Response #28.

Avalon Response #29.2

Groundwater monitoring wells have been installed upgradient and downgradient of the N-42 and L-37 pits to monitor groundwater entering and leaving the pits. Additional groundwater monitoring wells located further downgradient can and will be tested to ensure that the anticipated dispersion/dilution has been successful.

IR Number:	**AANDC #30**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Environmental Impact — Contingency Planning
Document:	DAR Section 6.5.3.2
TOR Section:	

Preamble

No mitigation measures and/or contingency plans are discussed in section 6.5.3.2 that would be implemented if the process water quality (or supernatant water quality) does not meet applicable effluent water quality guidelines. Note, however, that a water treatment plant is indicated on the flow sheet (Figure 4.8-7).

AANDC Request #30

1. Please provide additional information on proposed mitigation measures that would be implemented if the process water quality (or supernatant water quality) does not meet applicable effluent water quality guidelines. Clarify if and when these mitigation measures would be implemented.

Avalon Response #30.1

It is important to note that Figure 4.8-7 of the DAR, which presented the Hydrometallurgical Plant site water balance flowsheet, indicated that a water treatment plant could be installed if determined to be necessary. At this time additional water treatment is not anticipated to be required. This is primarily based on the general understanding that excess water remaining after settlement of the tailings in the L-37 and/or N-42 pits will be infiltrated into the Presqu'ile aquifer, where it will become rapidly diluted to natural background conditions, as this water migrates over an estimated 80 year period towards Great Slave Lake.

IR Number:	**AANDC #31**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Cumulative Effects on Surface Water Quality at Nechalacho mine site
Document:	DAR Section 10.6.2.1
TOR Section:	

Preamble

Section 10.6.2.1 only considers the potential for surface water quality impact to Thor lake via surface flow from the TSF but does not consider the potential cumulative impact due to additional seepage from the TSF (via shallow groundwater) to Thor Lake.

AANDC Request #31

1. Please provide additional information on the cumulative impact of surface and subsurface loading of potential contaminants of concern to Thor Lake.

Avalon Response #31.1

As previously indicated in response to AANDC IR #23.1, seepage values presented for the TMF/Polishing Pond were estimated to establish conservative values from a surface water balance perspective.

The installation of a bituminous geomembrane on the upstream slope of the TMF and Polishing Pond embankments is intended to minimize the potential for seepage through or below the embankments. In addition, a primary reason for founding the embankments on bedrock is that the bedrock in this area is of high quality and is expected to act as a reasonable barrier to seepage under the TMF and Polishing Pond facilities.

Based on recent packer testing, the permeability of the bedrock is a maximum of 1E-06 cm/s in the vicinity of the TMF and Polishing Pond. As a result, it is expected that seepage from the TMF and Polishing Pond facilities will be negligible. As part of the detailed design, detailed seepage analyses considering the newly acquired permeability data to better estimate the range of seepage values that can be expected. In the event that unacceptable seepage and seepage quality occurs below the embankments under the final design, seepage collection measures could be incorporated into the design to allow collection and return of such seepage to the facility.

Thus, Avalon is confident that there is a very low potential for cumulative impact of surface and subsurface loading of potential contaminants of concern to Thor Lake to occur.

IR Number:	**AANDC #32**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Cumulative Effects on Groundwater Quality at Hydrometallurgical Pant Site
Document:	DAR Section 10.6.3.1
TOR Section:	

Preamble

Section 10.6.3.1 briefly discusses the potential for groundwater quality impacts to the local groundwater due to infiltration of process water from the infiltration pit N-42. However, this section does not address the potential cumulative effects on the local groundwater quality due to (i) historic operations at the site (including seepage from the historic tailings impoundment; seepage from open pits) plus proposed new operations (seepage from pits L-37 and N-42).

AANDC Request #32

Please provide additional information on the cumulative effects on groundwater quality in the local aquifer(s), including:

1. Describe existing and/or potential future impacts to local groundwater from the historic mine operations, including seepage from Cominco tailings pond and/or seepage from/to historic open pits
2. Describe migration of any historic seepage plume from the tailings impoundment (if any) over the last 40 years
3. Discuss potential influence of proposed activities (HMF and infiltration pit) on future movement of any impacted groundwater at Pine Point

Avalon Response #32.1

As indicated in Avalon Response #22.7, Avalon has no information on groundwater quality associated with the old Cominco tailings storage facility. However, it should be noted that this facility is located to the north (i.e., downgradient) of the proposed Hydrometallurgical Plant and associated infrastructure.

Regarding the existing groundwater quality in the Pine Point area, Avalon Response #22.3 reviewed the current status of groundwater quality in the Pine Point area and provided a comparison with groundwater quality data reported by Durston (1978).

This potential cumulative concern was discussed in Section 10.6.3.1 of the DAR and, to assist in answering the information request, key information from this Section was modified as necessary to reflect changes that have occurred to the project and is re-presented as follows.

As indicated in several other responses, the proposed Hydrometallurgical Plant tailings facility (HTF) will be located within an historic open pit (L-37 pit) located south of the proposed

Hydrometallurgical Plant location. Excess supernatant water from the HTF will be pumped to another historic open pit (N-42 pit), located to the southwest, for discharge and infiltration into the Presqu'ile aquifer.

The results of groundwater flow modelling discussed in Section 6.5.2.1 of the DAR, suggest that there is expected to be very little effect on the groundwater regime at the Pine Point site in response to the pumping and discharge/infiltration proposed as part of the Hydrometallurgical Plant site water management plan. Groundwater drawdown in the vicinity of the T-37 pit (now the J-44 pit) is estimated to be approximately 1 m below the expected pre-pumping level after 20 years of pumping. Groundwater levels in the vicinity of the N-42 pit are expected to increase by approximately 0.1 m above the simulated pre-discharge conditions after 20 years of discharge/infiltration.

Based on the conceptual model of the site and the steady state modelling results, groundwater flowing through the N-42 pit would take approximately 80 years to discharge into Great Slave Lake. Travel time may be reduced if groundwater discharged to surface and flowed towards Great Slave Lake.

A comparison of the projected chemical properties of the tailings water with the historic and more recent groundwater quality data obtained in the Pine Point area in 2011, shows that the concentrations of all metals parameters in the tailings water will be lower than or within the same range of concentrations for these parameters in the existing groundwater of the area. The radionuclide parameters including 226Ra, 228Ra and 210Pb are all expected to be at or below detection limits.

The pH of the tailings water is expected to be slightly above neutral (7.7), while conductivity, sodium, chloride and other parameters that contribute to water hardness, including calcium, magnesium and sulphate will be elevated compared to current background conditions. However, these elevated levels are expected to rapidly diffuse and dilute to natural background values within the Presqu'ile Formation.

To verify these predictions, Avalon is committed to implementing a groundwater quality monitoring program designed to monitor the effects of the proposed tailings water infiltration program on the quality of the groundwater in the area of the Hydrometallurgical Plant and associated infrastructure.

Since the projected concentrations of all parameters of potential concern will be lower than or within the range of existing conditions, the anticipated residual effects on groundwater quantity and quality in the Pine Point area are expected to be insignificant and no cumulative effects on groundwater quantity or quality in the Pine Point area are predicted to occur.

Avalon Response #32.2

As previously indicated, Avalon has no information on groundwater quality associated with the old Cominco tailings storage facility. However, it should be noted that this facility is located to the north (i.e. downgradient) of the proposed Hydrometallurgical Plant and associated infrastructure.

Avalon Response #32.3

Please see response to AANDC IR# 32.1 above.

IR Number:	**AANDC #33**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Closure and Reclamation — Post Closure Assessments
Document:	DAR Section 11 & Section 6.1.1.6 & Section 6.1.3.2 & Conceptual AEMP
TOR Section:	

Preamble

Avalon states that " The closure and reclamation of all TLP site facilities will be conducted in accordance with the terms and conditions of the future MVLWB Land Use Permit and Water Licence and accepted mine reclamation practices in the NWT that are applicable (e.g., INAC 2007, 2002)." Avalon also indicates that it will conduct "long-term water outflow monitoring and water management around the mine site" (Section 6.1.1.6 - Closure and Reclamation, Both Sites).

However, Section 6.1.3.2 of the DAR suggests that the closure period is estimated to be “2 years and five years of post-closure monitoring.” Section 11.1 of the DAR suggests "Post-closure monitoring will be limited to evaluating the success of the re-vegetation effort. Post-closure monitoring for re-vegetation success is envisioned to be conducted at Year 1 and Year 5 post-closure." Section 11.4 indicates that monitoring will occur until conditions stabilizes and water licences conditions are met but then suggests that monitoring after reclamation will only occur for re-vegetation.

AANDC understands that Avalon is planning to design the mine for closure but Avalon must assess the performance of the reclamation strategies and cover designs by monitoring seepage quality and runoff from various mine components and disturbed areas. AANDC notes that other northern mine site have conducted closure and reclamation activities and post closure monitoring for many years (e.g. Pine Point, Colomac, Tundra, Discovery, etc.).

AANDC Request #33

1. Avalon must explain how they will optimize mine designs for closure and ensure that post closure groundwater, surface water, and site runoff from both project sites will be acceptable and achieve reclamation goals. AANDC notes that tailings water quality will continually degrade over the course of operations and Avalon has indicated that tailings water treatment may be an option during operations. Will Avalon consider post closure water treatment to achieve reclamation goals in the timelines they are currently proposing?
2. Avalon must provide more details on the type and schedule of post-closure monitoring of surface and groundwater quality at both the Nechalacho mine site and the Pine Point Hydrometallurgical Plant site.

3. Avalon must explain how re-vegetation will be enhanced to be successful at both mine sites (including vegetation succession) and that potential contaminant uptake from plant roots on reclaimed tailings facilities will not pose a risk to local wildlife.
4. Have any agreements been reached with the GNWT or CN (limestone Quarry and Railhead). In the end, who will hold liability for limestone quarry and railhead post closure?

Avalon Response #33.1

Since AANDC's Information request references both sites, the following response is structured accordingly.

Nechalacho Mine Site

As indicated in Section 11.2.2 of the DAR and the Conceptual Closure Plan prepared for the Thor Lake Project, closure and reclamation planning at the Nechalacho Mine TMF will focus on stabilizing and covering the exposed tailings surface and re-establishing surface flow patterns, while ensuring that acceptable downstream water quality is maintained. The most updated general concept for closure of the Nechalacho Mine TMF is shown in Figure 7.1.

As shown in this figure, the proposed closure of the TMF will include the re-development of several marsh and wetland areas and the re-establishment of surface flow patterns within the limits of the TMF and associated polishing pond.

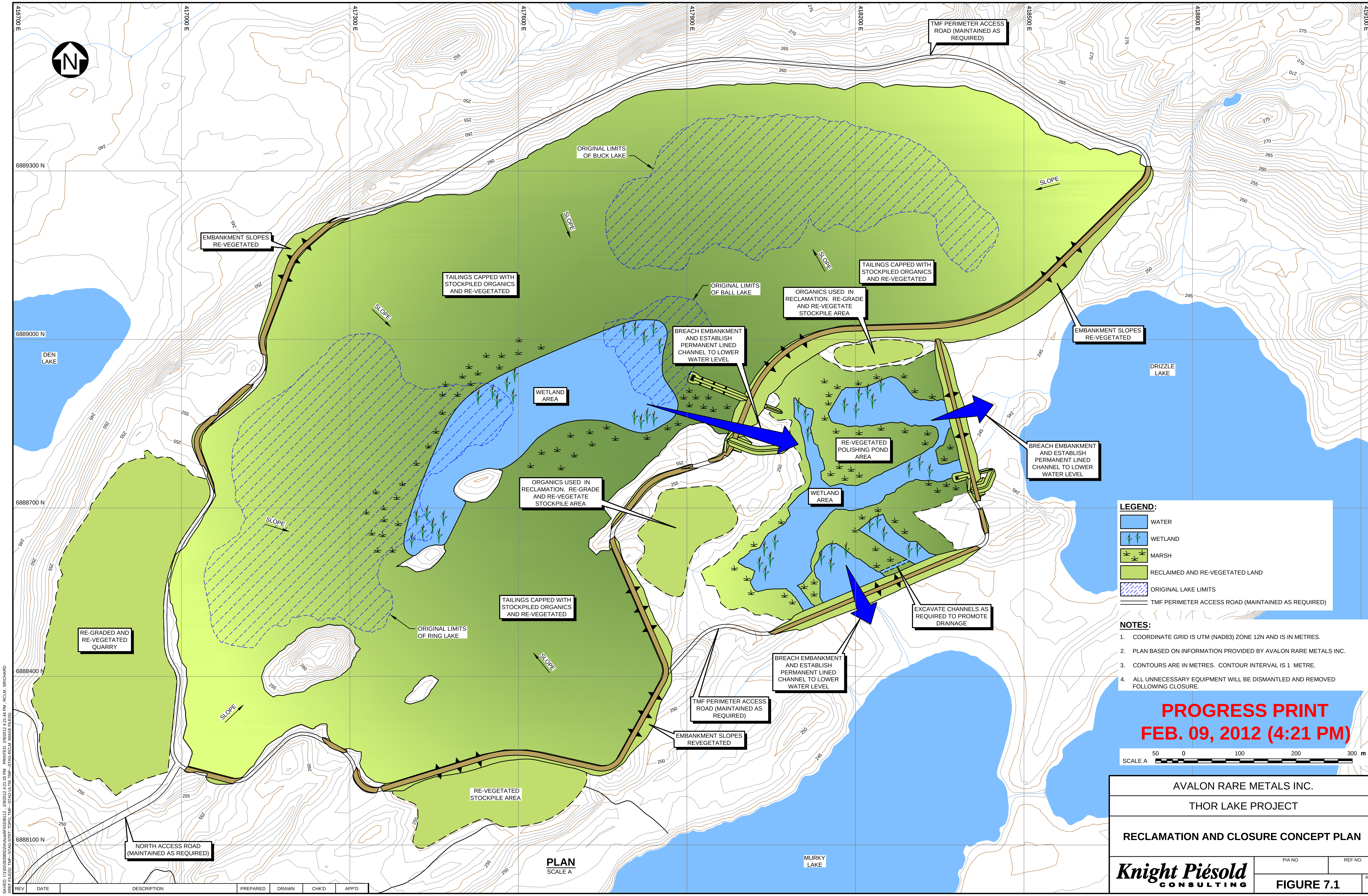
Given the relatively inert and non-reactive nature of the Flotation Plant tailings that will be directed into the TMF, Avalon currently does not envisage the need for a complex tailings cover design. Instead, Avalon's current strategy is to focus on the development of a suitable vegetative cover that will enable the establishment of the marsh, wetland and vegetated upland conditions illustrated in Figure 7.1.

As reported in Section 6.4.2.6 of the DAR and various follow-up responses to the MVEIRB and Environment Canada, the water quality modelling conducted for the Thor Lake Project during the operations period, indicates that in the downstream receiving environment, the CCME guideline values will be met over the entire 20 year simulation period.

Concentrations of metals reaching Thor Lake are predicted to be extremely low. For example, arsenic will be 0.034% of the CCME guideline; mercury 0.3% of the CCME guideline; and copper will be 0.04% of the MMER guideline.

Further dilution of water flowing out of Thor Lake is anticipated as it progresses through a series of wetlands, streams and lakes towards Great Slave Lake, comprising a watershed estimated to be more than three times the catchment of Thor Lake. As such, it is expected that metal levels in water entering Great Slave Lake will be similar to pre-development background levels.

Based on these results, Avalon is confident that closure and post-closure water quality conditions will be maintained. The post-closure water quality monitoring that will be conducted is anticipated to confirm this prediction. Thus, Avalon does not anticipate that post closure water treatment will be needed to achieve the reclamation goals.


N
417700 E
417000 E
417300 E
417600 E
417900 E
418200 E
418500 E
418800 E
419100 E
6889300 N
6889000 N
6888700 N
6888400 N
6888100 N
TMF PERIMETER ACCESS ROAD (MAINTAINED AS REQUIRED)
ORIGINAL LIMITS OF BUCK LAKE
SLOPE
EMBANKMENT SLOPES RE-VEGETATED
TAILINGS CAPPED WITH STOCKPILED ORGANICS AND RE-VEGETATED
ORIGINAL LIMITS OF BALL LAKE
ORGANICS USED IN RECLAMATION. RE-GRADE AND RE-VEGETATE STOCKPILE AREA
TAILINGS CAPPED WITH STOCKPILED ORGANICS AND RE-VEGETATED
EMBANKMENT SLOPES RE-VEGETATED
BREACH EMBANKMENT AND ESTABLISH PERMANENT LINED CHANNEL TO LOWER WATER LEVEL
DEN LAKE
DRIZZLE LAKE
WETLAND AREA
RE-VEGETATED POLISHING POND AREA
BREACH EMBANKMENT AND ESTABLISH PERMANENT LINED CHANNEL TO LOWER WATER LEVEL
ORGANICS USED IN RECLAMATION. RE-GRADE AND RE-VEGETATE STOCKPILE AREA
WETLAND AREA
TAILINGS CAPPED WITH STOCKPILED ORGANICS AND RE-VEGETATED
ORIGINAL LIMITS OF RING LAKE
RE-GRADED AND RE-VEGETATED QUARRY
EXCAVATE CHANNELS AS REQUIRED TO PROMOTE DRAINAGE
BREACH EMBANKMENT AND ESTABLISH PERMANENT LINED CHANNEL TO LOWER WATER LEVEL
TMF PERIMETER ACCESS ROAD (MAINTAINED AS REQUIRED)
EMBANKMENT SLOPES REVEGETATED
RE-VEGETATED STOCKPILE AREA
NORTH ACCESS ROAD (MAINTAINED AS REQUIRED)
MURKY LAKE
PLAN
SCALE A
LEGEND:
WATER
WETLAND
MARSH
RECLAIMED AND RE-VEGETATED LAND
ORIGINAL LAKE LIMITS
TMF PERIMETER ACCESS ROAD (MAINTAINED AS REQUIRED)
NOTES:
1. COORDINATE GRID IS UTM (NAD83) ZONE 12N AND IS IN METRES.
2. PLAN BASED ON INFORMATION PROVIDED BY AVALON RARE METALS INC.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 METRE.
4. ALL UNNECESSARY EQUIPMENT WILL BE DISMANTLED AND REMOVED FOLLOWING CLOSURE.
PROGRESS PRINT
FEB. 09, 2012 (4:21 PM)
50 0 100 200 300 m
SCALE A
AVALON RARE METALS INC.
THOR LAKE PROJECT
RECLAMATION AND CLOSURE CONCEPT PLAN
Knight Piésold
CONSULTING
P/A NO.
REF NO.
FIGURE 7.1
REV
REV
DATE
DESCRIPTION
PREPARED
DRAWN
CHK'D
APP'D

Hydrometallurgical Plant Site

As previously discussed in the DAR and in response to an MVEIRB Part 2 question (#29), it is important to emphasize that the existing condition at the proposed Hydrometallurgical Plant Tailings Management Facility (L-37 pit) is currently representative of a highly disturbed un-natural environment as shown in Photo 1.

Photo 1: L-37 Pit, looking southwest

This will continue to be a key consideration for the future closure of the Hydrometallurgical Plant TMF. The current plan is to place a cover, comprised of the readily available till, over the top of the gypsum tailings, to facilitate the establishment of a more natural vegetative cover over the impacted area.

The most updated general concept for the future closure of the L-37 pit is shown in Figure 7.2. As shown in this figure, the proposed closure of the HTF will include the development of a pond/ wetland area and the establishment of a vegetated cover over the impacted area. This will represent a considerable improvement over the current condition of the L-37 pit.

In addition, based on the general understanding that excess water remaining after settlement of the tailings in the L-37 and/or N-42 pits will be infiltrated into the Presqu'ile aquifer, where it will become rapidly diluted to natural background conditions, as this water migrates over an estimated 80 year period towards Great Slave Lake, Avalon does not anticipate that post-closure water treatment will be needed to achieve the reclamation goals.

SAVED: I:\1\01\00390\02\A\Acad\FIGS\B113, 2/9/2012 4:22:55 PM , SRICHARD PRINTED: 2/9/2012 4:23:14 PM, YR RCLM, SRICHARD
XREF FILE(S): HTF~-STAG-STRT; HTF~-STAG-ULTM; PINE-FEAT; HTF~-STAG-RCLM IMAGE FILE(S):

LEGEND:

- WATER
- WETLAND
- MARSH
- RECLAIMED AND RE-VEGETATED LAND
- ORIGINAL TILL STOCKPILE LIMITS
- ACCESS ROAD (MAINTAINED AS REQUIRED)

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 11N AND IS METRES.
2. PLAN BASED ON INFORMATION PROVIDED BY AVALON RARE METALS INC., DATED NOVEMBER 1, 2010.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 0.5 METRES.
4. ALL UNNECESSARY EQUIPMENT WILL BE DISMANTLED AND REMOVED FOLLOWING CLOSURE.

PROGRESS PRINT
FEB. 09, 2012 (4:23 PM)

SCALE A 40 20 0 40 80 120 160 200 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

RECLAMATION AND CLOSURE CONCEPT PLAN

Knight Piésold CONSULTING

P/A NO. | REF NO. | REV

FIGURE 7.2

Avalon Response #33.2

Avalon currently anticipates that post-closure monitoring activities at both sites will occur for a five (5) year period. However, this is partially dependent on the achievement of licensed criteria and closure goals that will be established for the Project. If the closure criteria are not being met, corrective action will be taken and the monitoring period may need to be extended.

The amount and frequency of post-closure monitoring required is expected to diminish as reclamation activities near completion and the results of monitoring indicate that environmental performance is meeting the established reclamation objectives. Monitoring will continue after reclamation is complete and will focus on re-vegetation efforts, surface stabilization efforts, and surface and groundwater quality. Post-closure monitoring is envisioned to be conducted at Year 1 and Year 5 post-closure, as a minimum.

Avalon Response #33.3

Avalon plans to tailor its revegetation efforts to the local ecological conditions, which will involve assessing both areas that require revegetation as well as adjacent undisturbed areas prior to the development of a revegetation strategy. Revegetation is anticipated to involve the use of seed (collected locally and/or supplied commercially) as well as transplanted or salvaged materials (e.g., from development areas), where feasible.

Avalon intends to use native plant species wherever possible, which will include using cultivars of native species developed for use in reclamation activities in northern latitudes. Seed mixtures of these cultivars have been used successfully in reclamation efforts elsewhere in the NWT (e.g., Giant Mine, EKATI Diamond Mine, Discovery Mine, Colomac Mine, amongst others), and may include some or all of the following species:

- Polar grass [*Arctagrostis latifolia* (R. Br.) Beauv.],
- Bluejoint [*Calamagrostis canadensis* Michx.],
- Tundra bluegrass [*Poa glauca* Beauv.],
- ARC Glacier alpine bluegrass [*Poa alpina* L.],
- Bering's tufted hairgrass [*Deschampsia beringensis* Hulten],
- Tufted hairgrass [*Deschampsia caespitosa* L.], and
- Common creeping red fescue [*Festuca rubra* L.].

As discussed in Avalon Response #33.1, the covers to be placed over both of the tailings management facilities are expected to lead to the development of viable new upland, marsh and wetland habitats at both sites. It should also be noted that although the cover material and associated growth medium will serve to segregate the plant roots of vegetation growing on the reclaimed tailings, as indicated in the DAR, the tailings at both Thor Lake Project sites have been demonstrated to be very inert. As a result, contaminant uptake through plant roots is not anticipated to occur at either site, and thus no risks to local wildlife from possible contamination are predicted to occur.

Avalon Response #33.4

The Hydrometallurgical Plant will require a supply of limestone. Avalon has provided its estimates of the quantity of limestone that it will require to the GNWT. The GNWT is working with local and Aboriginal businesses to develop a northern limestone supplier. The liability for the limestone quarry would rest with that supplier. Avalon will not be involved in the limestone quarry; the limestone supplier will hold all permits and conduct activities at the quarry.

Avalon envisions that the railhead facility will be located on CN Rail's property near Hay River and will be managed by CN. CN owns the railhead facility, including the secured enclosure for storage. Avalon will pursue a contractual arrangement with CN to handle and transfer the products shipped from the railhead site. The liability for the railhead facility will rest with CN.

IR Number:	**AANDC #34**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Closure and Reclamation at Nechalacho Mine Site — TMF Closure
Document:	DAR Section 11.2.2
TOR Section:	

Preamble

Section 11.2.2 indicates that the exposed tailings surface of the TMF will be capped after closure and revegetated. No details are provided on the length of time that will be required for settlement of the tailings (in particular the slimes) prior to final tailings recontouring and cover placement.

AANDC Request #34

1. Please provide more details on the consolidation characteristics of the tailings and the influence of tailings consolidation on the timing of cover placement.

Avalon Response #34.1

Sub-aerial deposition of tailings will be used to the maximum extent possible. This will involve tailings being spigoted from the perimeter embankments of the facility thus pushing the supernatant and runoff water pond to the centre of the facility. Through good water management practices, the water levels within the TMF will be kept as low as possible within the constraints of the water balance and operational plan. Operation in this manner will maximize the settling and consolidation of the deposited tailings, especially toward the perimeter of the facility. In addition to the increased strength characteristics of the tailings, the increased density will serve to create more storage space within the TMF and thus require lower embankments.

With this method of depositional operation, the tailings in the majority of the facility will consolidate and settle during operations, allowing the surface to be ready for reclamation shortly after the cessation of operations, or even for possible progressive reclamation of select areas during operations. The 'wet' area toward the centre of the facility is expected to remain, to some degree, following closure as precipitation will continue to collect and eventually proceed downstream to the Drizzle Lake watershed. Likely, wetland-like vegetation will be established in this wet area.

Detailed testing of the tailings material has been completed to better quantify the settling and achievable density characteristics and to confirm the assumption made to date. Further testing will be completed as required throughout the design process to address changes to the tailings or operations parameters should they arise.

IR Number:	**AANDC #35**
Source:	Aboriginal Affairs and Northern Development Canada
To:	Avalon Rare Metals Inc.
Subject:	Closure and Reclamation at Hydromet Site — HMF Closure
Document:	DAR Section 11.3.2
TOR Section:	

Preamble

Section 11.3.2 indicates that the exposed tailings surface will be stabilized and capped after closure. No details are provided on the length of time that will be required for settlement of the tailings (in particular the slimes) prior to final tailings recontouring and cover placement.

AANDC Request #35

1. Please provide more details on the consolidation characteristics of the tailings and the influence of tailings consolidation on the timing of cover placement.

Avalon Response #35.1

Although sub-aerial deposition of tailings will also be used at the HTF, due to their nature, it is expected that the tailings deposited within the HTF will require a longer period of time to consolidate than those at the TMF. Although there will be very good drainage of the tailings mass into the confining bedrock/pit walls at the perimeter of the facility, the fine grained nature of the tailings will require additional time to dry and gain the necessary strength to allow placement of capping materials.

It is anticipated that a robust, relatively thick layer (i.e., 0.75 to 1.25 m, as required) of previously stockpiled till material would be placed and spread over the tailing surface to establish the growth medium. The thickness of the layer would be determined based on trafficability during placement. It may be advantageous to construct the cap (or initial layer) during the winter months when the surface of the tailings beach is frozen. The need for geotextile over the tailings/below the fill could also be evaluated.

Detailed testing will be carried out to better quantify the settling and achievable density characteristics of the Hydrometallurgical tailings.

Attachment 1: EBA, A Tetra Tech Company (EBA). February 2012. Conceptual Aquatic Effects Monitoring Plan. A plan prepared by EBA for Avalon Rare Metals Inc.

Attachment 2: Knight Piesold Consulting Limited (KPL). August 7, 2009. Review of Meteorological Data for Thor Lake Project (Contract No. NB09-00477). A memo prepared by KPL for Avalon Rare Metals Inc.

Attachment 3: Knight Piesold Consulting Limited (KPL). September 20, 2011. Thor Lake Project - Mine Site Groundwater Quality Test Results (Contract No. NB11-00454). A memo prepared by KPL for Avalon Rare Metals Inc.

Attachment 4: Knight Piesold Consulting Limited (KPL). November 17, 2011. Thor Lake Project - Thor Lake Site Groundwater Quality Test Results (Event 2) (Contract No. NB 11-00542). A memo prepared by KPL for Avalon Rare Metals Inc.

Attachment 5: Knight Piesold Consulting Limited (KPL). November 16, 2011. Thor Lake Site - Phase 3 Site Investigations (Contract No. NB11-00527). A memo prepared by KPL for Avalon Rare Metals Inc.

Attachment 6: Cominco Ltd. February 1987. Water Use Licence NIL3-0034.

Department of Indian and Northern Affairs. November 8, 2006. Ground Water Recharge – Pine Point Area.

Attachment 1

Avalon Rare Metals Inc.

CONCEPTUAL AQUATIC EFFECTS MONITORING PLAN

Prepared for:
AVALON RARE METALS INC.

Prepared by:
EBA, A TETRA TECH COMPANY

FEBRUARY 2012

ISSUED FOR USE

FILE: V15101007.004

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Avalon Rare Metals Inc. and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Avalon Rare Metals Inc., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix A of this report.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Avalon Rare Metals Inc. proposes to mine, mill, and produce rare earth carbonate and oxides, zirconium, niobium and tantalum oxides from the Nechalacho deposit, located on its Thor Lake Property. The proposed project is referred to as the Thor Lake Project (the Project).

Approximately 12-14 million tonnes of mineral resources will be mined from the Nechalacho deposit over a period of about 20 years of operations. Construction will begin 16-18 months before the start of operations. At the end of mine life, reclamation activities will begin and continue for a period of about three years.

The proposed TLP has two main site components: an underground mine and flotation plant (Nechalacho Mine and Flotation Plant site), to be located at the Thor Lake Property, and a hydrometallurgical plant (Hydrometallurgical Plant site) to be located at the existing brownfields site of the former Pine Point Mine, 85 km east of Hay River, NT on the south shore of Great Slave Lake (Figure 1).

Rare earth elements (REEs) will be mined underground and concentrated at the Nechalacho Mine and Flotation Plant site. The resulting REE concentrates will be barged during the summer months across the east end of Great Slave Lake to the Hydrometallurgical Plant site. Upon arrival, the concentrate will be trucked from the south shore of Great Slave Lake to the Hydrometallurgical Plant site via a short (8 km) haul road. The concentrate will be further processed at the Hydrometallurgical Plant. The resulting final products will be hauled to the Hay River railhead in sealed containers via truck, and direct shipped by the CN railway for further processing in the south.

The Developer's Assessment Report (DAR; Avalon 2011) for this Project provides a full description of the project, baseline environmental study results, effects assessments, and an outline of the proposed aquatic effects monitoring program (AEMP).

The present conceptual (framework) report is the next step in developing a comprehensive AEMP for this Project. It generally follows Indian and Northern Affairs Canada (now Aboriginal Affairs and Northern Development Canada) *Recommended Procedures for Developing Data Quality Objectives and a Conceptual Study Design* (INAC 2009), which is one of a series of guidance documents for the design and preparation of AEMP programs in the NWT.

The initial phase in the development of an AEMP involves a multidisciplinary approach to defining the aquatic environmental issues that may result from the construction, operations, and decommissioning phases of a project, and identification of mitigation measures to avoid or minimize potential adverse effects. In anticipation of, and adherence to regulatory requirements, Avalon Rare Metals Inc. retained teams of specialist consultants to carry out multi-year baseline studies to characterize existing aquatic environmental conditions (Stantec 2010), and to consolidate existing information, assess potential effects, and recommend mitigation strategies (Avalon 2011).

The Effects assessment was guided by the Terms of Reference (TOR) issued by the Mackenzie Valley Environmental Impact Review Board (MVEIRB 2011), which identified specific Key Lines of Enquiry and required the description and assessment of effects based on all Project activities and phases. The information and data compiled as a result of these efforts form the basis for the preparation of a science based AEMP.

2.0 AEMP STUDY DESIGN FRAMEWORK

INAC (2009) identifies a number of Data Quality Objective steps in the preparation of a conceptual study design for an AEMP. The first four steps: stating the problem; identifying the goals of the study; identifying the information inputs; and, defining the boundaries of the study, have been covered by the design and implementation of the baseline studies and subsequent effects assessment, as described in the following sections:

2.1 Stating the Problem

The 'problem', or the potential aquatic consequences of the mine development, was the focus for the design of baseline studies necessary to evaluate project-related effects. The approach that was adopted for this step was to characterize as completely as possible, water and sediment quality, and phytoplankton, zooplankton, and fish within the predicted effects area of the Project, as well as within Reference water bodies. Corresponding studies were carried out to identify environmental stressors resulting from Project activities and then to quantify or model the probable effects of these stressors. Pathways of effects (PoE) diagrams illustrating Construction and Operations Phase activity-stressor-effect linkages were included in the DAR (Avalon 2011), and are reproduced below as Figures 1 and 2, respectively.

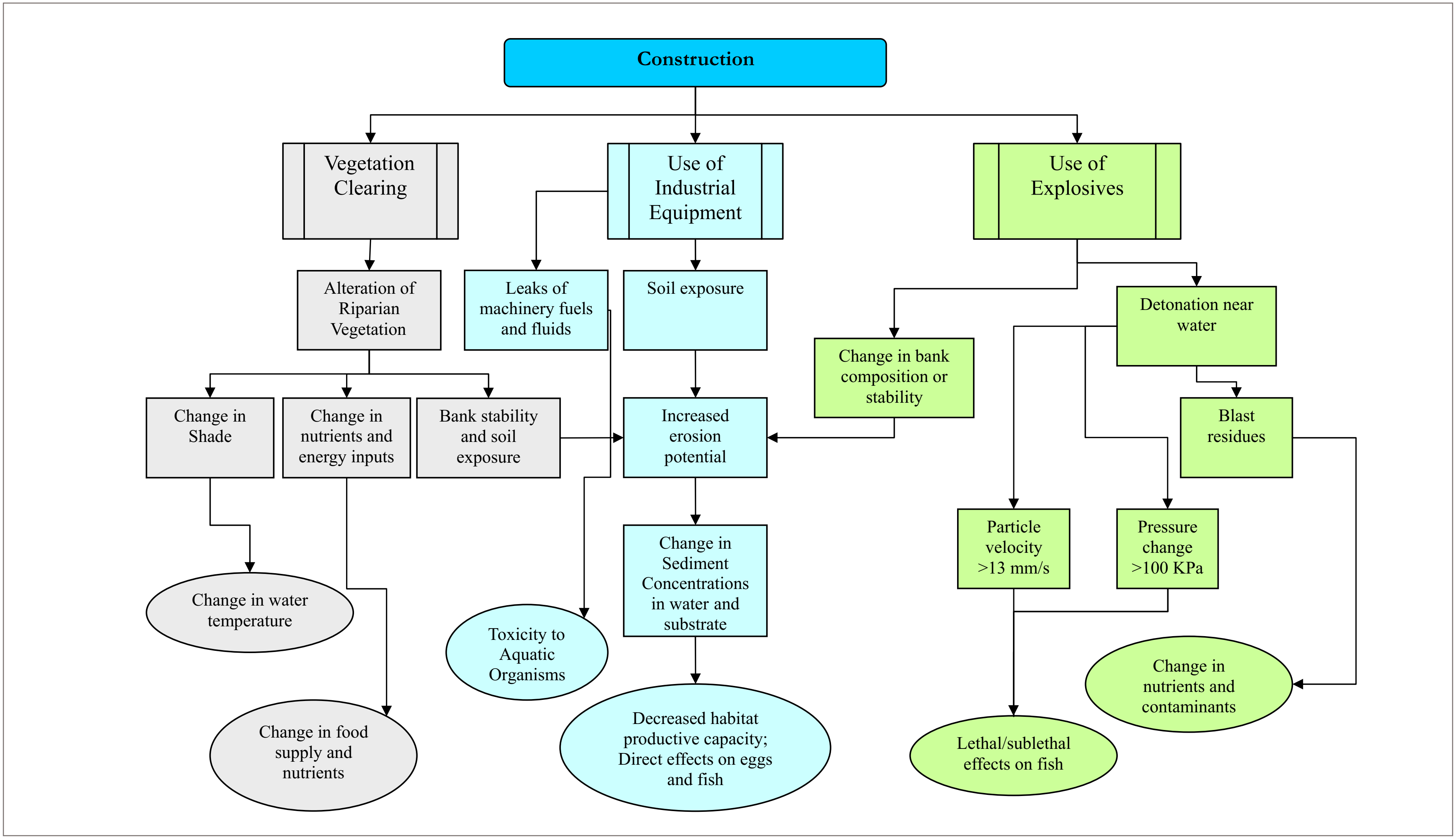
2.2 Identifying the Goals of the Study

This step involves identifying key questions or potential environmental issues that should be addressed as part of study design and implementation. This involves examining potential effects on the various components of the aquatic ecosystem based on anticipated terrestrial or aquatic habitat disturbances, and changes in water quality and quantity. For the purposes of the AEMP, identification of aquatic environmental sensitivities will lead to decisions regarding Action Levels, which are thresholds for the implementation of mitigation measures.

The DAR (Avalon 2011) discusses each issue (i.e. activity and stressor) that was identified during the scoping process in relation to potential effects, mitigation measures, residual effects, and the significance of the residual effects. These issues serve as the focus for the design of the monitoring program and the development of appropriate Action Levels, based on environmental component sensitivities, established guidelines, and background variability.

The key questions that provide the focus for aquatic background studies and the monitoring program include:

- How will water quantity, including total flows, lake levels, and seasonal flow patterns, be affected by water use and recirculation?
- What will be the effect on flows and flow patterns in downstream waterbodies due to the conversion of Ring, Buck, and Ball lakes to a Tailings Management Facility (TMF)?
- What are the potential stressors resulting from construction activities (i.e. land development), and what are the aquatic components/variables that might be affected by these stressors?
- Which aquatic organisms should the baseline studies include, and which would be suitable as sentinel organisms for the AEMP?



LEGEND

Activity

Stressor

Effect

NOTES

1.

STATUS

ISSUED FOR USE

CLIENT

AVALON RARE METALS INC.

eba A TETRA TECH COMPANY

THOR LAKE PROJECT

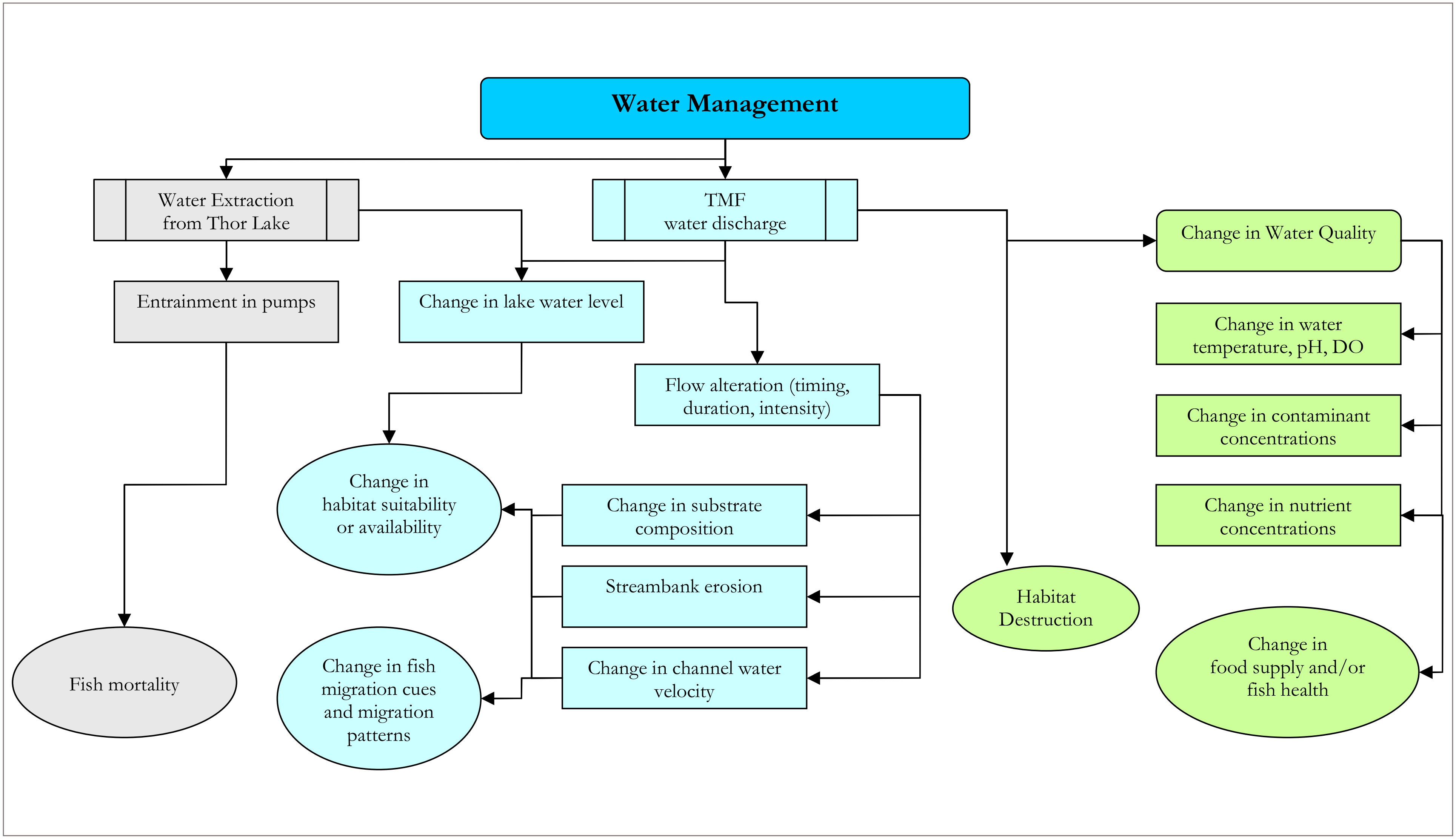
Aquatic Pathways of Effects for the Construction Phase of the Nechalacho Mine Site

PROJECT NO.	DWN	CKD	APVD	REV
V15101007.004	SL	DM	DM	0

OFFICE	DATE
EBA-VANC	November 30, 2011

Figure 1

Q:\Vancouver\Graphics\ENGINEERING\V151\V15101007_ThorLake\004\V15101007_004_CDR001_PathwaysConstruction.cdr



LEGEND

Activity
Stressor
Effect

NOTES

1.

STATUS

ISSUED FOR USE

CLIENT

AVALON RARE METALS INC.

eba A TETRA TECH COMPANY

THOR LAKE PROJECT

Aquatic Pathways of Effects for the Operations Phase of the Nechalacho Mine Site

PROJECT NO.	DWN	CKD	APVD	REV
V15101007.004	SL	DM	DM	0

OFFICE	DATE
EBA-VANC	November 30, 2011

Figure 2

- What are the chemical parameters in the effluent that have the potential to adversely affect aquatic organisms downstream of the final discharge location, and what is the potential downstream effect of predicted concentrations of these parameters, based on the integration of effluent concentrations and probable flow levels ?
- Will routine barging activities affect water or habitat quality in Great Slave Lake?

2.3 Identifying the Information Inputs and Defining the Boundaries of the Study

Responses to the issues raised by the above questions are provided throughout the DAR (Avalon 2011). Recent baseline studies that were conducted between 2008 and 2010 (Stantec 2010) included investigations of water quality, aquatic ecology (phytoplankton, zooplankton, benthic invertebrates), and fish and fish habitat studies in 26 lakes. In addition, the field program included fish and fish habitat investigations in 13 stream channels between lakes in the footprint area. The waterbodies were selected as being potentially affected by the Project; representing local aquatic conditions; and, potentially suitable as reference lakes.

Aquatic and fisheries sampling locations were selected based on the direct Project footprint, potential future expansion, and known information about the surface water drainage in the Nechalacho Mine site area. All lakes and streams that would potentially directly interact with the mine footprint and operations (i.e., lakes above the underground excavations, and lakes and streams affected by water extraction and/or discharge), tailings storage areas, and concentrate transport routes were selected, as was the first lake downstream of the mine area.

Sampled lakes are shown on Figure 3 (reproduced from the DAR (Avalon 2011)). Kinnikinnick Lake was selected as a suitable near-field reference lake, while Redemption Lake, located approximately 18 km northeast of the Nechalacho Mine site camp, was chosen as an appropriate far-field reference lake.

Table 1 (reproduced from the DAR (Avalon 2011) identifies the environmental issues potentially resulting from the various activities associated with mine development. It is apparent that many of these activities may interact with natural water resources.

Q:\Vancouver\GIS\ENGINEERING\V151\V15101007_ThorLake\Maps\004\V15101007_004_Map001_ThorSA.mxd modified 2/13/2012 by stephanie.leusink

LEGEND

- Aquatic Sample Station
- Fisheries Lake
- Watercourse
- Waterbody
- Wetland

NOTES
Figure Source: Appendix A, Figure 3-1, Stantec 2010c.

STATUS
ISSUED FOR USE

THOR LAKE PROJECT

Nechalacho Mine Site Study Area

PROJECTION	DATUM	CLIENT
UTM Zone 12	NAD83	AVALON RARE METALS INC.

Scale: 1:70,000
1 0.5 0 1 2
Kilometres

eba A TETRA TECH COMPANY

FILE NO.				
V15101007_004_Map001_ThorSA.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
V15101007.004	SL	DM	DM	0
OFFICE	**DATE**			
EBA-VANC	December 6, 2011			

Figure 3

Table 1: Thor Lake Project: Nechalacho Mine and Flotation Plant Site Environmental Issue Matrix

Project Component	Air Quality	Water Quality	Fish	Wildlife	Vegetation
Site Preparation and Construction	✓	✓	✓	✓	✓
Underground Mining	✓	✓			
Mine Rock Storage		✓	✓	✓	✓
Acid Rock Drainage (ARD) if present		✓	✓		
Thor Lake Flotation Plant	✓	✓	✓	✓	✓
Power Generation	✓			✓	✓
Sewage		✓	✓		
Tailings Containment		✓	✓	✓	✓
Water Supply/Water Management		✓	✓		
Solid and Hazardous Waste Management	✓	✓	✓	✓	
Airstrip	✓			✓	✓
Access Roads	✓	✓	✓	✓	✓
Temporary Docking Facility		✓	✓	✓	✓
Seasonal Barge Traffic	✓	✓	✓	✓	

The assessment determined that for all valued ecosystem components (VEC), with the application of the proposed mitigation measures, the residual environmental effects of the Thor Lake Project were anticipated to be negligible and insignificant. Furthermore, any identified environmental effects were generally limited to the immediate footprints and local study areas of the Nechalacho Mine and Flotation Plant and associated infrastructure, and most were reversible once activities ceased. The AEMP, based on the framework identified in this document, is intended to confirm the assessment conclusion, and provide an approach to resolve unanticipated adverse effects.

The following subsections provide further information regarding the key aquatic environmental issues and questions resulting from the assessment of the Project.

2.3.1 Water Quantity

- Mine water and Plant site runoff will be collected and directed into the process as appropriate.
- All excess water released from the TMF will be returned to Thor Lake via the Drizzle Lake/Murky Lake drainage system.
- Water will be recycled from the TMF to the greatest extent possible to minimize the fresh water requirement (currently 50% recycle and 50% fresh water has been modelled).
- Extraction of fresh water from Thor Lake will be managed to conform to the 2010 Department of Fisheries and Oceans (DFO) Protocol for Winter Water Withdrawal (DFO 2010), which specifies the use of no more than 10% of the available under-ice water volume.
- Natural flows and conditions will be monitored and mimicked as closely as possible throughout operations to minimize possible effects on the local hydrological regime.

The development of a TMF within the Ring and Buck Lakes basin will result in slightly higher flows through Drizzle and Murky Lakes during operations, compared to pre-development baseline flows, assuming a 50% maximum recycle rate from the TMF. This increase is expected to be in the order of a 6% increase in flow at the start of operations. This initial increase is expected to slowly decline to an increase of about 3% in later years of operation as expected evaporation and tailings beach size increase.

2.3.2 Water Quality

A hydrodynamic model was run by EBA to predict the transport and fate of metals and nutrients. The modelled metals of concern were Mercury (Hg), silver (Ag), Aluminum (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Molybdenum (Mo), Nickel (Ni), Lead (Pb), Selenium (Se), and Zinc (Zn). Three radioactive metals, Uranium (U), Thorium (Th), and Radium-226 (Ra-226) were also included in the simulation. Nitrogen levels were also modeled due to the possible release of elevated levels of this nutrient originating from explosive chemicals (ANFO) used for underground mine blasting during the mining operation. The model also incorporated anticipated effluent phosphorous concentrations, as well as phytoplankton and herbivore zooplankton levels in Thor Lake, to determine downstream effects of possible nutrient enrichment.

The model predicts that the Metal Mining Effluent Regulation (MMER) effluent criteria for all parameters will be met over the entire 20 year simulation period, in each of the lakes within the Thor Lake system. Concentrations of metals reaching Thor Lake are predicted to be extremely low, especially since modelled concentrations represent conservative values, since no allowance was made in the model for decreases in concentration due to natural remediation processes including degradation, chemical oxidation, precipitation, and biodegradation.

The model predicts that the input of additional nitrogen from the TMF decant water to the Thor Lake system may lead to seasonally increased phytoplankton growth and concentration. Although the nitrogen level is predicted to continue to increase over the ten-year model simulation period, phytoplankton productivity appears to remain very similar from year to year. It also appears that the phytoplankton biomass is likely limited by the amount of bio-available phosphorus in the water body as the annual peak phytoplankton biomass remains stable even as the annual peak nitrogen values rise in the system. However, since the potential for seasonally increased primary and secondary production of the system exists, a major focus of the biological and water quality monitoring program will be identification of changes in phytoplankton, zooplankton, fish, and nutrient levels.

This step of the Framework also includes the identification of Action Levels, or values for *"… a measurement endpoint that provides a basis for choosing one or more of the various management alternatives."* Action levels for effluent discharge at the final discharge point will be set for substances regulated by the MMER, namely: arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids, radium 226, and pH, and/or maximum levels identified in the Water Licence. In addition, periodic sampling pursuant to the MMER will also include analyses for aluminum, cadmium, iron, molybdenum, ammonia, nitrate, and mercury.

2.3.3 Action Levels

Action levels for metals and nutrients in water bodies downstream of the final discharge point will be guided by: the requirements of the Mackenzie Valley Land and Water Board (MVLWB) Water Licence, which may require the establishment of Surveillance Network Program (SNP) sampling locations; the Metal Mining Effluent Regulations (MMER); and, the Canadian Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life (CCME 2007). The analysis of monitoring results will require the identification of background levels of those parameters which approach licence or guideline limits, since even relatively small additions of these substances could result in adverse effects to water quality and aquatic biota.

The MMER further requires periodic sublethal testing of effluent on fish, invertebrates, plants, and algae. The results of these tests provide a sensitive measure and early warning of potential biotic effects since it is the effluent that is tested, rather than the receiving waters, in which the effluent is diluted.

Action Levels for water discharges will be based on variances from predicted seasonal discharge levels from the TMF to Drizzle Lake. Differences of greater than 20% of predicted levels will require detailed assessments of causes, with consideration of natural precipitation and runoff variability.

The availability of background biological data from all potentially affected lakes and from two reference lakes provides the basis for a before-after control-impact (BACI) monitoring design to account for environmental variability and temporal trends found in both the control and exposure areas. Action levels will be based on multivariate statistical tests of significance.

2.4 A Conceptual Design for Obtaining Data

Data and information required to resolve the questions and issues identified in Section 2.2 of this report throughout all phases of the Project will be based, in part, on regulatory requirements and on studies intended to validate predictions and modelling results identified in the DAR (Avalon 2011). The following summarizes the regulatory environment pertaining to development and implementation of the AEMP for this project:

- The MMER identifies water sampling and analysis requirements, for effluent and receiving water bodies. In addition, the MMER includes requirements for sublethal toxicity testing and periodic environmental effects monitoring (EEM) involving biological sampling. The MMER regulates levels of particular substances in effluents.
- The MVLWB Water Licence for this Project will regulate water use, water discharge, and effluent and downstream water quality. Water and effluent quality sampling and analysis will be regulated through a Surveillance Network Program (SMP) that identifies sampling locations, scheduling, and required analyses. It may also include recommendations or requirements for additional studies targeting specific issues of concern.
- The *Fisheries Act*, administered by Fisheries and Oceans Canada (DFO), prohibits the harmful alteration, disruption or destruction of fish habitat (HADD), where fish habitat is inclusively defined as “spawning grounds and nursery, rearing, food supply, migration and any other areas on which fish

depend directly or indirectly in order to carry out their life processes." Based on this prohibition, DFO may request plans or specifications as part of the AEMP to demonstrate that the Project is not adversely affecting the productive capacity of fish habitats.

- Although not part of legislation, the CCME Guidelines for the Protection of Aquatic Life (CCME 2007) are generally recognized as the established general biological effect levels in receiving water bodies. Their interpretation and application requires judgement based on site-specific conditions, particularly respecting ambient water quality conditions and biotic assemblages.

2.4.1 Metal Mining Effluent Regulations

Because the MMER provides very specific requirements for monitoring at metal mines, these will necessarily form the core of the AEMP developed for this Project.

2.4.1.1 Effluent Characterization

The elements of the MMER pertaining to characterization of the effluent include:

- Weekly effluent monitoring at the final discharge point for analysis of pH, arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids, and radium 226;
- Monthly acute lethality testing from samples of effluent collected at the final discharge point;
- Monthly Daphnia magna monitoring tests; and
- Monthly cumulative measurement of effluent volume at the final discharge point and calculation of effluent loading of the substances identified above.

The MMER also requires the design and implementation of environmental effects monitoring studies (EEM) partitioned into *effluent and water quality monitoring studies*, and *biological monitoring studies* as follows:

2.4.1.2 Effluent and Water Quality Monitoring Studies

- Quarterly sampling and analysis *of the effluent* at the final discharge point, for aluminum, cadmium, iron, mercury, molybdenum, ammonia, and nitrate, to further characterize the chemical composition of the effluent;
- Quarterly sampling of water *from an exposure area* in a receiving water body surrounding the point of entry of effluent into water from the final discharge point, for analysis of pH, hardness, alkalinity, as well as the substances noted above; and
- Twice yearly sublethal testing, based on specified criteria, of a fish species, an invertebrate species, a plant species, and an algal species, using effluent samples collected at the final discharge point.

2.4.1.3 Biological Monitoring Studies

The required biological monitoring studies involve site characterization, fish populations, fish tissue analysis, and assessment of the benthic invertebrate community. These studies are conducted at prescribed intervals, beginning about 18 months following mine start-up, and thereafter:

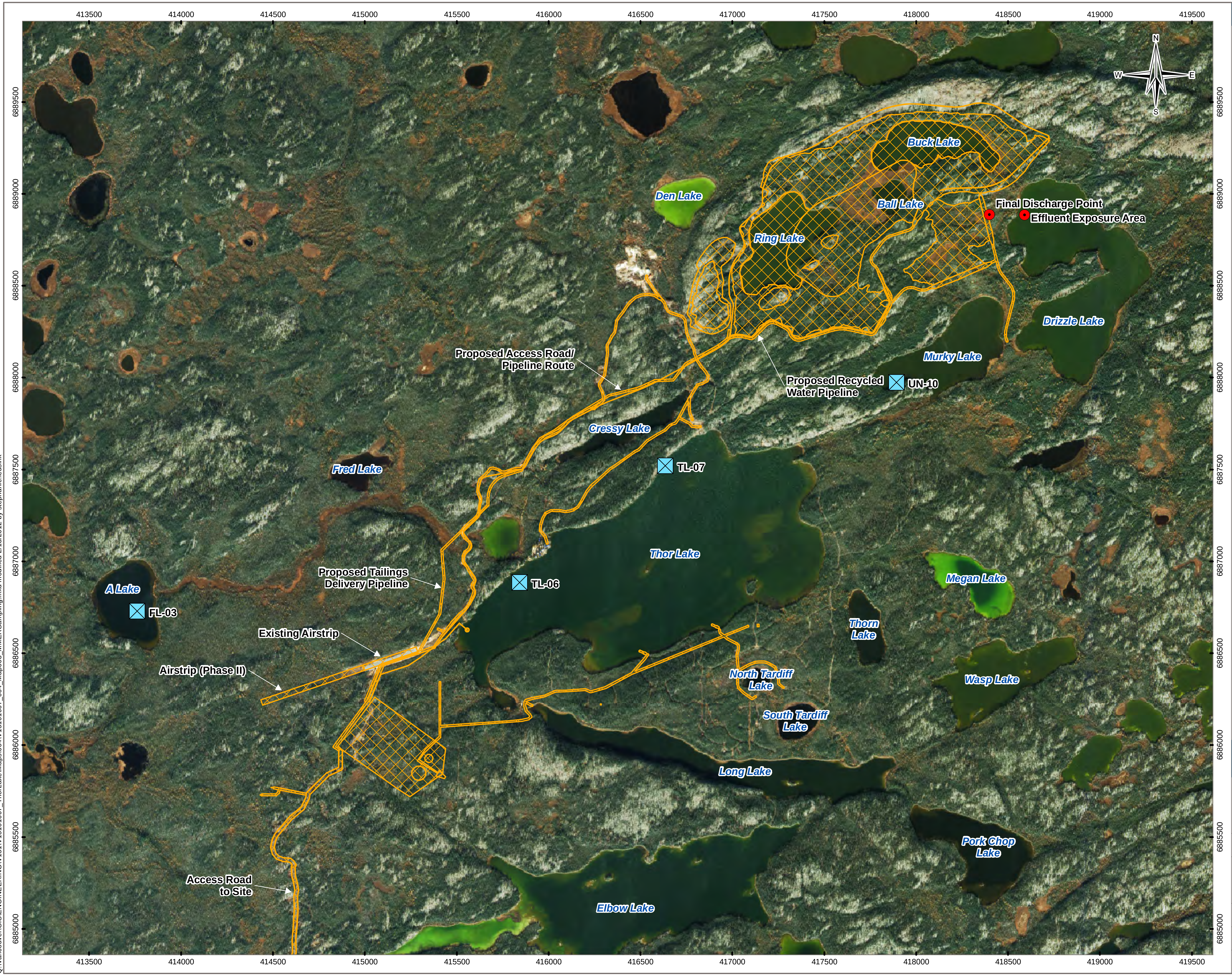
- every two years if effects on fish populations, fish tissue and the benthic community are detected;
- every three years if no effects are indicated from the previous study;
- every 72 months if no effects are detected from two previous consecutive studies; and
- within one year following notice of mine closure.

The biological monitoring studies are based on detailed study designs, which must be submitted and approved by Environment Canada following review by a technical advisory panel consisting of representatives of stakeholder agencies. These designs include details and justification for the proposed sampling methods, reference and exposure site locations, and analytical methods that will be followed during the study. As prescribed in the MMER, a detailed study design for each biological monitoring study will be submitted to Environment Canada a minimum of six months prior to the commencement of field sampling. It is anticipated that sampling for this program will normally occur in August.

The study design will include designation of a sentinel fish species, which will be selected in consultation with Environment Canada. Lake whitefish (*Coregonus clupeaformis*), which are common in Thor Lake, may be suitable as a sentinel species. However, due to the low productivity of northern waters, lethal sampling should be very limited to minimize the impact of the study on fish populations. All sampling and analysis will follow the methods recommended in the MMER guidance documents (Environment Canada 2002, 2011).

2.4.1.4 MMER Sampling Locations

Sampling locations proposed as part of MMER effluent characterization sampling and the EEM study program are shown in Figure 4. Effluent from the TMF will be discharged from the TMF outlet into Drizzle Lake. As such, this outlet represents the final discharge location for the proposed mine. Effluent discharges into the Thor Lake system will follow a path through Drizzle Lake to Murky Lake, and then into Thor Lake. Thor Lake discharges to Fred Lake and then follows an 18 km route through A Lake to Great Slave Lake. Based on this flow pattern, it is proposed that EEM biological monitoring study sites be established at Murky Lake, Thor Lake, and A Lake, to provide nearfield, midfield, and farfield sampling locations. Reference sites will be established at Kinnikinnick and Redemption lakes.



Q:\Vancouver\GIS\ENGINEERING\V151\V15101007_ThorLake\Maps\004\V15101007_004_Map003_MMERSampling.mxd modified 2/13/2012 by stephanie.leusink

LEGEND

- Effluent Characterization
- EEM Biological Monitoring Site
- Infrastructure Footprint

NOTES

1. Base footprint generated from data provided by Avalon (April 2011).
2. Base imagery provided by Avalon (October 2010).

STATUS
ISSUED FOR USE

THOR LAKE PROJECT

Proposed MMER Sampling Locations

PROJECTION	DATUM	CLIENT
UTM Zone 12	NAD83	AVALON RARE METALS INC.

Scale: 1:20,000
250 125 0 250 500
Metres

FILE NO.
V15101007_004_Map003_MMERSampling.mxd

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
V15101007.004	SL	DM	DM	0

OFFICE	DATE
EBA-VANC	December 8, 2011

Figure 4

2.4.2 Water Licence

The MVLWB, upon overall approval for the commencement of mining operations, will issue a Water Licence in accordance with the *Northwest Territories Water Act*. It is anticipated that the conditions of this Licence will:

- Require submission of monthly and annual volumes related to: water use, discharges of mine waste to the TMF, discharges of treated sewage to the TMF, and flow releases from the TMF;
- Set limits to water extraction from natural water bodies and identify pump screening specifications;
- Identify conditions related to the design, construction, and operation of the TMF;
- Establish effluent quality requirements; and
- Outline the SMP, including sampling locations and sampling and analysis requirements see Section 2.4.2.1).

The proposed water balance during mine operations is shown in Figure 5 (reproduced from Avalon 2011). Flows will be continuously monitored and reported, according to the schedule required by the Water Licence. In addition, water levels in Thor Lake will be monitored weekly to detect changes in lake level beyond those expected due to normal seasonal variation.

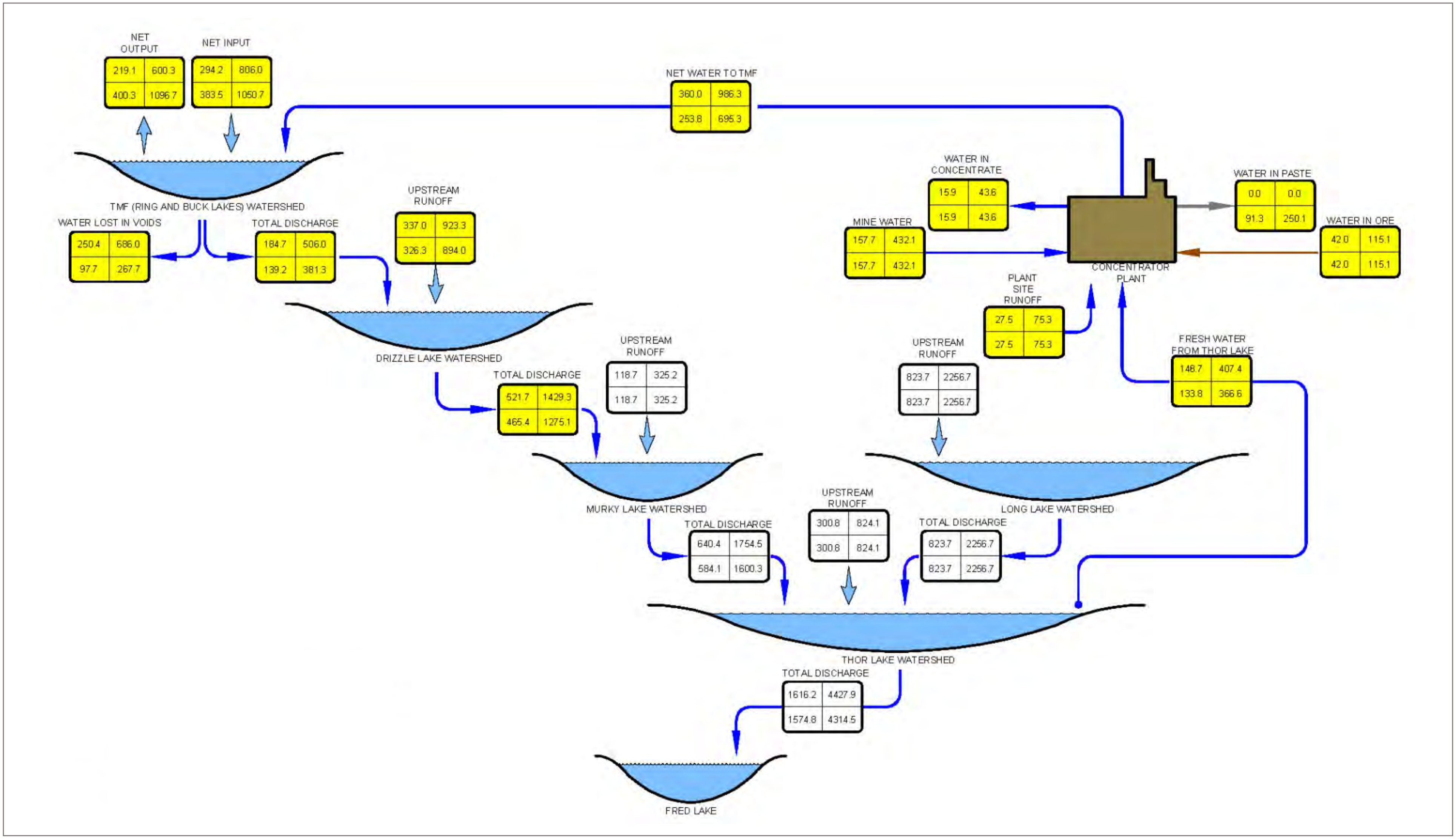
It is expected that the effluent quality criteria and sample scheduling identified in the Water Licence will, at a minimum, follow those listed in the MMER.

2.4.2.1 Surveillance Network Program

The SNP details regarding water sampling locations, timing, and analysis requirements will be issued with the Water Licence. The SNP is intended to provide frequent water quality monitoring within natural waterbodies that may be affected by Project activities with the purpose of providing early warning of degraded water quality conditions. Because this AEMP framework is intended to provide an outline of the proposed aquatic monitoring program, suggestions for sampling locations, scheduling, and analysis are included to complement the sampling program required under the MMER.

Table 2 indicates the sampling lakes, frequency and specific sites for the proposed SNP. All sites would be georeferenced to enable re-sampling at the same locations. Georeferenced sampling locations would be established at the following locations, as indicated in Figure 6: Drizzle, Murky, Thor (two locations), Long, Fred, A, Elbow, and Great Slave Lake (two locations). Drizzle, Murky, and Fred lakes are very shallow and may not have open water under the ice during winter.

Analysis should include major anions, alkalinity, total suspended solids (TSS), total dissolved solids (TDS), pH, conductivity, total metals, dissolved metals, total Kjeldahl nitrogen (TKN), nitrate and nitrite nitrogen, total phosphate, orthophosphate, and dissolved organic carbon (DOC). In addition, water samples should be analyzed for radionuclides including radium-226 (226Ra), radium-228 (228Ra), lead-210 (210Pb), thorium-230 (230Th) and thorium-232 (232Th). Detection limits must be set to permit comparison with regulated limits, or in their absence, with CCME Guidelines for the Protection of Aquatic Life. It is recommended that the requirement to analyze for radionuclides be discontinued after three years of sampling if the levels of these elements are consistently below guideline or detection limits, and if no increasing trend is detected.



LEGEND

	ANNUAL FLOW IN THOUSAND m³/yr	AVERAGE FLOW IN m³/day
Years 1 to 4	1616.2	4427.9
Years 5 to 20	1574.8	4314.5

NOTES

1. Estimates are for average precipitation conditions and do not include extreme precipitation events.
2. Highlighted values are taken from KPL Memo Cont. No. NB10-00596.
3. Upstream runoff to each lake includes direct precipitation and evaporation on the lake.
4. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00132, Figure 5).

STATUS
ISSUED FOR USE

CLIENT
AVALON RARE METALS INC.

eba
A TETRA TECH COMPANY

THOR LAKE PROJECT

Annual Watershed Flowsheet
Mine Operations

PROJECT NO.	DWN	CKD	APVD	REV
V15101007.004	SL	RH	DM	0

OFFICE	DATE
EBA-VANC	December 6, 2011

Figure 5

Q:\Vancouver\Graphics\ENGINEERING\V151\V15101007_ThorLake\004\V15101007_004_CDR003_Flowsheet.cdr

Table 2. Proposed SNP Surface Water Sampling Locations and Sampling Frequency

Location	Sample Frequency	Sample Site* (site no./Easting/Northing)
Drizzle	Monthly during open water season; December and March under ice (if open water is present)	Surface grab sample UN-13 418851 6888823
Murky	Monthly during open water season; December and March under ice (if open water is present)	Surface grab sample UN-10 417893 6887973
Thor	Monthly year round	Surface grab sample TL-06 415842 6886885 TL-07 416636 6887520
Fred	Monthly during open water season; December and March under ice (if open water is present)	Surface grab sample FL-01 415751 6887108
A	Monthly year round	Surface grab sample FL-03 413762 6886729
Long	Monthly year round	Surface grab sample LL-02 417273 6885871
Elbow	Monthly year round	Surface grab sample EL-01 416388 6885140 EL-02 415576 6883908
Great Slave Barge embayment	Monthly year round	Surface grab sample GL-01 413845 6882398
Great Slave At inflow from Thor L. system	Monthly year round	Surface grab sample location to be determined based on site examination
Kinnikinnick (reference)	Monthly year round	Surface grab sample UN-08 420757 6885658
Redemption (reference)	Monthly year round	Surface grab sample UN-14 429566 6899312

*Note: Site numbers and locations follow those of Stantec (2010; also reproduced in Avalon 2011).

Water quality analyses will be compared against background levels (Stantec 2010; Avalon 2011) and regulatory/guideline levels to identify exceedances presumably resulting from Project activities, or trends toward these levels. Exceedances or trends indicating deteriorating water quality conditions will result in an examination of the effluent discharge pathway to identify the source of the contaminant(s), and will initiate contingency plans that will be established to resolve such issues.

The construction phase of the Project may result in relatively short term effects on water quality and fish habitat, resulting from land disturbance involving vegetation removal, soil exposure, and blasting (see Figure 1), as well as the possible requirement to construct stream crossing structures for roads or pipelines. Construction, land clearance, and stream crossing activities will adhere to the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993) to avoid or minimize adverse effects. Similarly, blasting will follow the DFO blasting guidelines (DFO 1998) to avoid direct or indirect effects on fish or fish habitat.

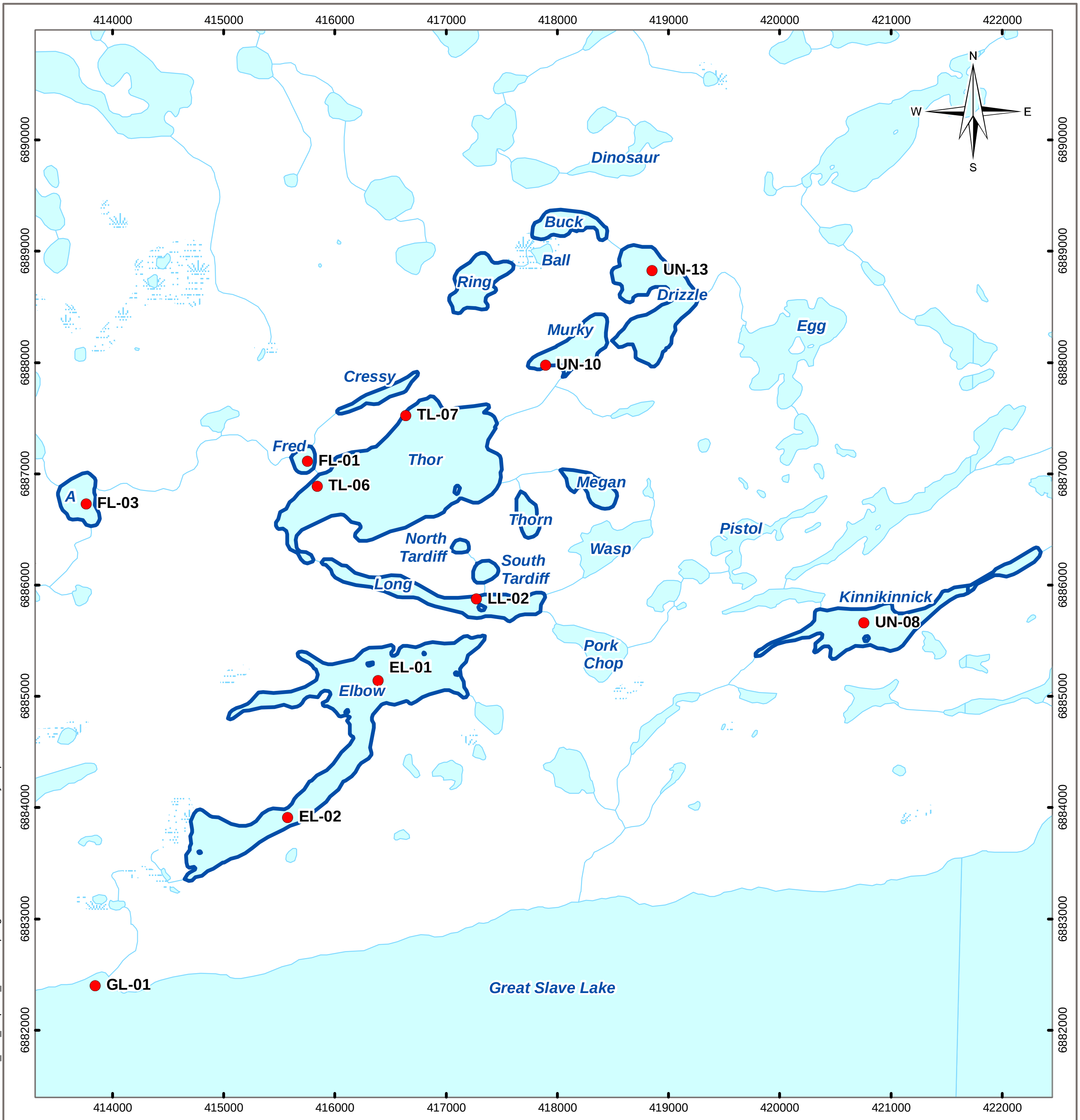
The preliminary site layout design shows that infrastructure construction will be generally restricted to the northwest of the property, where overland drainage flows to Fred, Cressy, Thor, Ring, Buck, Ball, Drizzle, and Murky lakes (see Figure 4). During the construction phase, one or more environmental monitors will be retained to oversee construction activities, conduct water quality and habitat monitoring, and ensure implementation of the Construction Environmental Management Plan (EMP) and Environmental Protection Plan (EPP), which will be developed for this Project.

2.4.3 Additional Monitoring Initiatives

Fish and benthic invertebrate sampling, analysis, and assessment will be conducted as part of regulated MMER EEM studies. However, those sampling efforts generally occur every three years, which may not be sufficient to detect cumulative biotic effects resulting from chronic releases of deleterious substances. As such, this AEMP Framework includes annual sampling and analysis of phytoplankton, zooplankton, and benthic invertebrates at the locations identified in Table 2. Sampling for these organisms will follow the methods reported by Stantec (2010) to permit direct comparisons.

Changes to the community structure and abundance of organisms within each of these trophic levels can serve as a sensitive indicator of effects from a variety of factors, including water discharge, water quality, or habitat modifications. Cause and effect relationships can then be identified from an integration of the biological information with evidence provided by background, reference, and current water quality data.

Fish sampling is not recommended as part of this initiative. Fish are relatively slow growing and long lived, and as such, are not rapid indicators of environmental change. In addition, fish productivity in northern latitudes is restricted due to cold temperatures and the short growing season. As such, excessive sampling by gill netting can result in excessive mortalities and adverse effects on fish abundance.



Q:\Vancouver\GIS\ENGINEERING\V151\V15101007_ThorLake\Maps\004\V15101007_004_Map002_SNPSampling.mxd modified 2/13/2012 by stephanie.leusink

LEGEND

- Proposed SNP Sampling Site
- Fisheries Lake
- Watercourse
- Waterbody
- Wetland

NOTES

1. Not shown: Redemption Lake and Great Slave Lake at the outflow from Thor Lake System.
2. Base data source: NTS 1:50,000 (Sheets 85I01 and 85I02).

STATUS
ISSUED FOR USE

THOR LAKE PROJECT

Proposed SNP Sampling Sites

PROJECTION	DATUM	CLIENT
UTM Zone 12	NAD83	AVALON RARE METALS INC.

Scale: 1:50,000

1 0.5 0 1

Kilometres

FILE NO.
V15101007_004_Map002_SNPSampling.mxd

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
V15101007.004	SL	DM	DM	0

OFFICE	DATE
EBA-VANC	December 12, 2011

Figure 6

2.4.4 Monitoring Summary

Table 3 summarizes the sampling that is proposed as part of the Thor Lake Project AEMP.

Table 3. Summary of AEMP Sampling Program

Reason for Sampling	Sampling for…	Location	Frequency
MMER	Effluent characterization (MMER regulated substances)	Final discharge point	Weekly
	Acute lethality testing	Final discharge point	Monthly
	Daphnia magna testing	Final discharge point	Monthly
	Cumulative effluent volume	Final discharge point	Monthly
	Effluent analysis (analyses other than MMER regulated substances)	Final Discharge Point	Quarterly
	Water quality (analyses other than MMER regulated substances)	Exposure area adjacent to final discharge point	Quarterly
	Sublethal testing of 4 trophic level organisms	Final discharge point	Twice yearly
	Biological monitoring studies (fish, invertebrates, sediments, water quality)	Murky, Thor, A, Kinnikinnick and Redemption lakes*	Variable (see Section 2.4.1.3) Usually every 3 years
SNP*	Water quality	13 locations in 10 lakes	Monthly
Avalon Initiative	Phytoplankton, zooplankton, benthic invertebrates	Same as SNP sampling sites	Annually

*Proposed

3.0 MANAGEMENT RESPONSE PLANNING

Adaptive Management, also called Management Response Planning (INAC 2009) for the Thor Lake Project will involve establishing alternative options in the event of regulatory or guideline exceedances, or if trends indicate deteriorating aquatic environmental conditions. Action levels will be determined in advance of project initiation in consultation with regulatory agencies.

During construction, contingencies included in the EMP and EPP will include the installation of replacement of additional silt fences, progressive revegetation where feasible, or the redirection of surface flows to sediment ponds. The presence of a full time environmental monitor will permit rapid responses to ongoing or potential adverse effects. The EMP and EPP will include procedures for the management of unanticipated spills of hazardous materials or elevated levels of suspended sediment in receiving water bodies.

A detailed Management Response Plan for the Operation and Decommissioning phases of the Project will be developed as part of the AEMP. This plan will involve preparation for unexpected adverse effects based on the results of project mitigation techniques as well as experiences at other, similar locations. Avalon will prepare remedial plans in the event that trends point toward potential negative changes in environmental indicators. Early indicators may include water chemistry parameters and/or shifts in lower trophic level organisms and community structure, which have short generation times and react rapidly to changing environmental conditions. These plans may involve treatment of tailings, modification of TMF discharge levels or flow patterns, changes to plant operations, or any combination of these options.

Importantly, AEMP will integrate considerations of water chemistry, hydrologic, and biological factors that combine to determine environmental effects, as required by a properly designed adaptive management program. For example, the identification of effluent water chemistry alone is not sufficient to determine downstream effects, since valued environmental components are affected by a variety of chemical, physical and biological characteristics which interact to influence species composition, abundance, and health. It is for this reason that Avalon is proposing to include annual sampling for lower trophic level organisms, which will serve as 'early warning' indicators of environment change.

As described in the DAR Section 6.4.2.6, modelling predicts that the MMER effluent criteria for all parameters will be met over the entire 20 year simulation period, in each of the lakes within the Thor Lake system. However, nutrient modelling identifies the possibility that seasonally increased primary and secondary production of the system may occur as a result of potential inputs of additional nitrogen from the TMF decant water. Nitrogen additions might not significantly affect lower trophic level community structure and composition due to the limitation of primary production by phosphorous. However, this potential effect must be carefully assessed and will therefore be a major focus of the biological and water quality monitoring program. Trends toward higher levels of nitrogen coupled with changes in phytoplankton species composition and abundance (through analysis of species richness, diversity, evenness, etc.) will result in the identification and implementation of additional mitigation to reduce nitrate levels in the TMF.

4.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

EBA, A Tetra Tech Company

Prepared by:

David Morantz, M.Sc., R.P. Bio.
Senior Biologist
Tel: 604.685.0017 x352
dmorantz@eba.ca

Reviewed by:

Richard Hoos, M.Sc., R.P. Bio.
Principal Consultant
Tel: 604-685.0017 x239
rhoos@eba.ca

REFERENCES

Avalon. 2011. Developer's Assessment Report, Thor Lake Project, Northwest Territories. Submitted to the Mackenzie Valley Environmental Impact Review Board.

Canadian Council of Ministers of the Environment (CCME). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table. Updated December 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment.

Department of Fisheries and Oceans. (DFO). 1993. Land Development Guidelines for the Projection of Aquatic Habitat. Retrieved from: http://www.dfo-mpo.gc.ca/Library/165353.pdf.

Department of Fisheries and Oceans (DFO). 1998 Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p. Retrieved May 5, 2011 from: http://www.dfo-mpo.gc.ca/Library/232046.pdf

Department of Fisheries and Oceans. (DFO). 2010. DFO Protocol for Winter Water Withdrawal in the Northwest Territories.

Environment Canada. 2002, 2011. Metal mining guidance document for aquatic environmental effects monitoring. National EEM Office. Environment Canada, Ottawa, Ontario.

INAC. 2009. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the Northwest Territories: Recommended procedures for developing data quality objectives and a conceptual study design. Prepared by MacDonald Environmental Sciences Ltd., Zajdlik & Associates Inc., Water Resources Division. Indian and Northern Affairs Canada.

Mackenzie Valley Environmental Impact Review Board (MVEIRB). 2011. Final Terms of References for Environmental Assessment of Avalon Rare Earth Metals Incorporated's Thor Lake Rare Earth Element Project EA1011-001.

Stantec Inc. 2010. Thor Lake Rare Earth Metals Baseline Project Environmental Baseline Report: Volume 3 – Aquatics and Fisheries. Final Report. Report prepared for Avalon Rare Metals Inc., Toronto, ON.

APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA’s client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA’s Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.