4.7.5.5 Rock Quarry

Fill materials required for construction during various phases of the Project will come from local borrow materials and development waste rock. During the construction phase in particular, fill materials will be obtained from a proposed quarry located southwest of the proposed TMF (Figure 4.7-6). In the absence of suitable quality till material, some quarried rock will also be processed as required to produce finer materials.

It is anticipated that approximately 446,000 m^3 of fill will be required during the early stages of construction, with another 332,500 m^3 of fill required during operations. Approximately 316,000 m^3 of material produced from cuts and initial underground development will offset the fill requirements during the construction period. Approximately 100,000 m^3 of suitable material from underground development is expected to be available for use during operations.

The proposed quarry will be developed in phases in response to the need for construction materials. Phase 1 has an approximate surface area of 4.6 ha and will provide roughly 130,000 m^3 (bulk) of material. Phase 2 will have a final surface area of 8.7 ha (inclusive of Phase 1) and will provide another 232,500 m^3 (bulk) of material.

4.7.5.6 Roads

Site roads will be constructed from the Flotation Plant site to the Mine's portal, fresh air raise and heater. Existing roads to the tailings management facility, water reclaim area and air strip will be upgraded.

The existing five (5) km road that connects the Nechalacho Mine and Flotation Plant site with the planned dock facility will be upgraded to allow the efficient and safe movement of containers, fuel, equipment and other supplies between the dock and the plant site.

4.7.5.7 Dock Facility

The Great Slave Lake shore topography south of the proposed Nechalacho Mine and Flotation Plant site is generally rocky with moderate elevation changes. The requirements for a barge loading-unloading dock include a water depth of about 3 m near shore and the need for a moderate-graded marshalling yard for the efficient loading and unloading of the barges.

In the past, barge loads of fuel and equipment were brought in at the proposed location without incident. The same access road for loading and unloading will continue to be utilized. A site reconnaissance concluded that this location will be suitable for the proposed seasonal dock facility. The seasonal dock facility will consist of a single barge moored to dolphins and connected to the shore by a ramp capable of handling the cargo loading and unloading equipment and associated activities.

The seasonal dock will be utilized only during the open water period. The adjacent upland area will be developed into a marshalling yard to handle load/offload materials and transfer containers between the Nechalacho Mine and Flotation Plant site and the dock as previously shown in Figure 4.7-11. Yard elements will include:

- A 20 to 30 m long removable ramp to access the barge deck for loading and unloading barges;
- A 50 m by 50 m (3.0 M litre capacity) lined bermed fuel storage area;
- A minimum 16,000 m^2 area for full containers (3,285 containers stacked 2 high);
- Minimum 1,200 m^2 area for empty and returning containers;
- Parking area for intermodal freight and trucks;
- Diesel pumps and piping for the transfer of fuel from the barges to the fuel storage tanks;
- A small receiving/security office; and
- 100 KW diesel generator to power fuel pumps and warming office.

4.7.5.8 Great Slave Lake Barging Operation

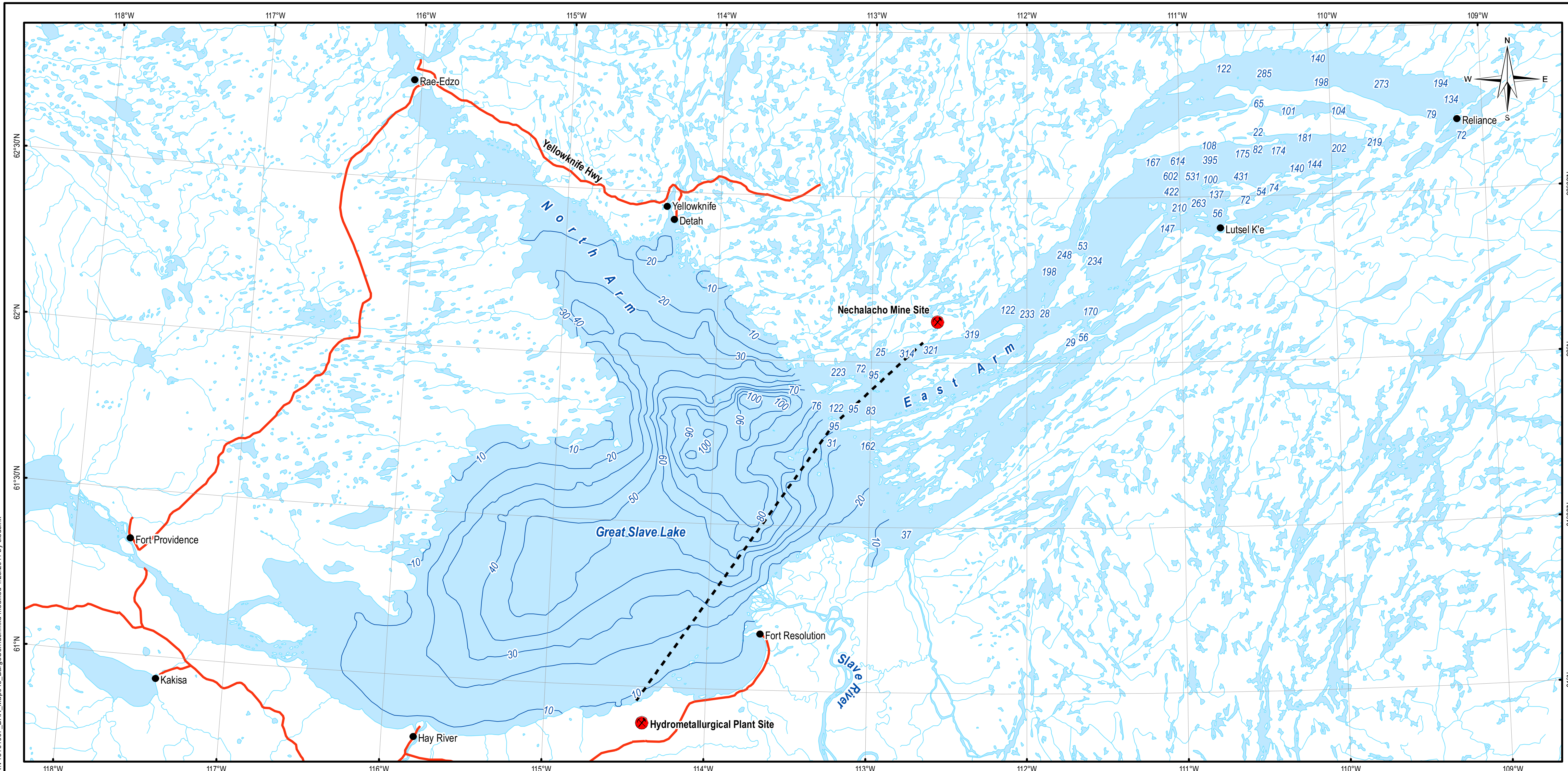
The concentrate produced at the Nechalacho Mine and Flotation Plant site will be barged on a seasonal basis across Great Slave Lake to the seasonal dock site, installed annually, at the Pine Point landing site (Figure 4.7-12). Barge trains will consist of three barges and a tug. Two barge trains will be operational at any one time. A single barge will hold 38 containers, equivalent to 1,710 t of concentrate. It is anticipated a total of 78 barge trips will be required during the open water season, requiring approximately 60 days of favourable weather to complete all shipments.

Barges with concentrate will be offloaded and transferred to the Hydrometallurgical Plant site. Empty containers and containers carrying freight will be backhauled to the TLP site.

4.7.5.9 Airstrip

Float planes, ski planes, wheeled twin Otters and turbo Beavers with rotary wing support have been used to service the site to date. Avalon has a current 300 m long by 30 m wide airstrip on the West side of Thor Lake. Avalon anticipates lengthening the airstrip to approximately 1,000 m as the Thor Lake Project advances. The airstrip extension is included in Avalon's land use application.

Once completed, the airstrip will allow safe year-round access for medium sized aircraft with light freight and personnel. The most common connection will be with Yellowknife, approximately 100 km from the site. Additional instrument controls will be investigated to maximize safe operation of the airstrip and to minimize delays due to limited daylight during the winter operations.



LEGEND

- Site Location
- Community
- Bathymetric Contour (10m)
- Approximate Barging Route
- All Weather Road
- Watercourse
- Waterbody

NOTES

Base data sources: Canadian Hydrographic Service Nautical Chart 6341 (2004); Leon et al (2005).

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THOR LAKE PROJECT

General Barging Corridor Across Great Slave Lake

PROJECTION	DATUM
NWT Lambert	NAD83

Scale: 1:1,300,000

0 25 50

Kilometres

FILE NO.
V15101007_DAR_Map043_BargeCorridor.mxd

PROJECT NO.	DWN	CKD	REV
V15101007.006	SL	RH	0

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EBA-VANC	March 16, 2011

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Figure 4.7-12

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4.8 HYDROMETALLURGICAL PLANT SITE

4.8.1 Site Preparation and Construction

The proposed Hydrometallurgical Plant will further process the REE concentrates produced at the Nechalacho Mine and Flotation Plant site. The Hydrometallurgical Plant will be located at the site of the former Pine Point Mine. A preliminary GA for the Hydrometallurgical Plant site is depicted in Figure 4.8-1.

Locating the Hydrometallurgical Plant and its associated components at the former Pine Point Mine site presents significant environmental and operational benefits for the overall Project. In particular, the site is a very large brownfields area having been reclaimed by industry and government since the closure of the mine in 1987. A substantial amount of infrastructure exists that the proposed Project can utilize including:

- Known and adequate foundation conditions for the Hydrometallurgical Plant;
- Known and adequate historic open pits that can be utilized as a tailings basin for the hydrometallurgical tailings facility;
- Nearby supply of process water from an existing open pit;
- Existing disturbed area which minimizes further environmental disturbance in the area;
- Direct Access via Territorial Highways 5 and 6. Highway 5 is classified as an all-weather highway by the GNWT Department of Transportation (DOT). The highway is rated for year-round use by commercial vehicles with no load restrictions for haul truck traffic and connects directly to the Canadian National Railways (CN) railhead located at Hay River; and
- Substation and line power service through the Northwest Territories Power Corporation (NTPC) from the Taltson Dam.

Additional site preparation and construction for the Hydrometallurgical Plant will include:

- Upgrading existing property access roads;
- Upgrading the existing road from the Hydrometallurgical Plant to the dock facility at Great Slave Lake; and,
- Utilizing a combination of steel and prefabricated structures for most surface facilities.

NOTES

1. Coordinate grid is UTM (NAD83) Zone 11N.
2. Image provided by Avalon Metals Inc.
3. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00024, Figure 2).

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THOR LAKE PROJECT

Feasibility Water/Solids Balance General Hydrometallurgical Site Layout

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V15101007.006	SL	RH	0
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Figure 4.8-1

4.8.2 Processing

4.8.2.1 Hydrometallurgical Plant

The design for the Hydrometallurgical Plant assumes a concentrate throughput at a 2,000 tpd mining rate. Based on this assumption, the Hydrometallurgical Plant will process 131,400 tonnes per annum (tpa) of concentrate on a dry basis. At 351 operating days per year and 90% availability, the Plant will operate for 7,582 hours each year for an average concentrate throughput of 15.6 tph or 374 tpd.

A REE mineral flotation concentrate will be shipped as a moist filter cake (10-12% moisture content) from the Nechalacho Mine and Flotation Plant site to the Hydrometallurgical Plant site.

Pre-leach and Acid Bake

Concentrate will be dumped from the shipping containers, mixed with dilute acid in the pre-leach operation, filtered, mixed with concentrated sulphuric acid, heated to a temperature of 200ºC and held with agitation for about one hour in a rotary kiln. The solution from the pre-leach filtration step is processed for light rare earth recovery and partial heavy rare earth recovery.

The acid-baked product will be quenched with water and the resulting slurry will be pumped to automatic filter presses. The filtrate solution will be used in the pre-leach circuit. The washed and blow-dried acid bake residue will be shipped off-site for further processing.

Acid Bake Residue Concentrate

Acid bake residue will be loaded into trucks and transported to the rail head near Hay River. There it will be transferred to gondola cars for shipment south to the caustic cracking and separation facility and the recovery of zirconium and heavy rare earths.

Light Rare Earth and Rare Metal Recovery

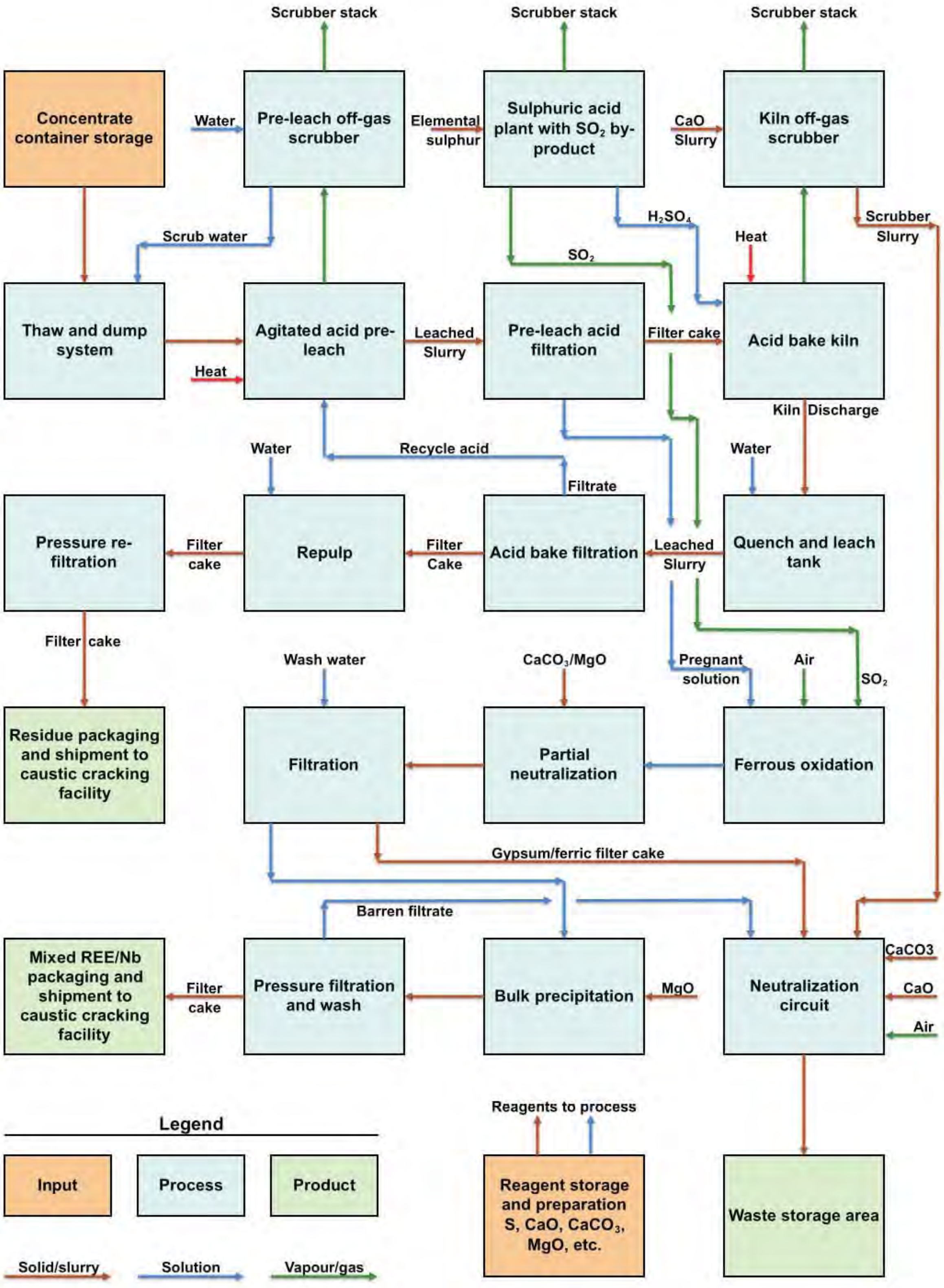
The filtrate from the pre-leach step will be processed for the recovery of the light rare earths and rare metals. Testwork is continuing but it is expected that the recovery process will include double salt precipitation using sodium sulphate, filtration to recover the rare earths, oxidation of the filtrate, precipitation of ferric iron and filtration, then precipitation and filtration of residual rare earths and niobium.

The two precipitates will be placed in shipping containers, transported by truck to the Hay River railhead, and transferred to rail cars for transport to a refining facility.

Tailings Neutralization

Excess solutions from both acid bake and light rare earth leaching and recovery operations will be neutralized with limestone and lime in a series of neutralization tanks. The final tailings from the Hydrometallurgical facility will predominantly consist of gypsum. It will be pumped to the tailings facility described in Section 4.8.3.

The overall process is illustrated in the following block diagram (Figure 4.8-2).



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NOTES
1.

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THOR LAKE PROJECT

Hydrometallurgical Plant Process Block Diagram

PROJECT NO.	DWN	CKD	REV
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EBA-VANC	March 21, 2011		

Figure 4.8-2

4.8.2.2 Reagents

The main process reagents currently planned to be used in the Hydrometallurgical Plant process when processing 360 tpd of concentrate (2,000 tpd mining rate) are included in Table 4.8-1. Avalon does not consider the list complete and anticipates changes in quantities as the process is optimized.

TABLE4.8-1: HYDROMETALLURGICAL PLANT AVERAGE REAGENT CONSUMPTION ESTIMATE (TPA)

Reagent	Life of Mine
	360 tpd@ 2,000 tpd Mining rate
Limestone	27,000
Lime	3,500
Elemental Sulphur (Used on site to produce acid and SO_2)	30,000
H_2SO_4 (produced on site from sulphur)	79,000
Flocculant	2.5
Sodium Sulphate	13,000

Limestone

The Hydrometallurgical Plant will utilize limestone and lime as neutralizing agents that will be added to the waste stream prior to discharge into the tailings management facility. The total annual limestone requirements will be approximately 27,000 tpa. Of this amount, 27,000 tpa will be minus 15 mm crushed limestone (containing >95% $CaCO_3$). This limestone will be ground at the site to minus 44 micron prior to introduction into the waste stream. Additionally, 3,500 tpa of burnt lime will be shipped to the site as a burnt lime.

Supply. Avalon plans to obtain the limestone from local Pine Point area sources. The Company intends to work with the GNWT and its Aboriginal partners to develop supply contracts for limestone originating from the Alexandra Reef-Complex, a known limestone complex (Gal and Anastas 2007), located approximately 100 km from the proposed Hydrometallurgical site.

Avalon is also investigating alternative limestone sources located within the immediate Hydrometallurgical Plant site area. The Pine Point area is known to contain widespread dolomites and limestone. The geologic marker referred to as the "Slave Point Formation" contains micritic limestone which can range from 40-80 m thick (Hannigan 2006). The Company is considering several open pits that remain from the historic Pine Point operations as potential limestone sources. Avalon does not intend to become a limestone supplier and will therefore be working with the GNWT and local suppliers to provide the crushed limestone required for operations.

Sulphuric Acid

Sulphuric acid will be needed to operate the Hydrometallurgical Plant. The Company anticipates purchasing elemental sulphur and producing the sulphuric acid in a plant located at the Hydrometallurgical Plant site.

A small sulphuric acid plant will be installed to meet the processing and heating requirements of the plant. Approximately, 30,000 tpa of elemental sulphur will be required to produce 79,000 tpa of required sulphuric acid and some sulphur dioxide needed in the process.

Supply. Avalon intends to construct a sulphuric acid plant at the Hydrometallurgical Plant site where elemental sulphur, brought to the site by truck, will be converted to sulphuric acid. The sulphuric acid plant specified by Avalon would be a Double Conversion, Double Absorption (DCDA) unit designed to meet the highest environmental standards. Heat recovery would be an important part of the design. Sulphuric acid produced in the plant would be stored in a tank prior to use in the Hydrometallurgical Plant.

4.8.2.3 Concentrate Storage and Loading

The concentrate from the Nechalacho Mine and Flotation Plant will be barged in custom built enclosed 40 tonne intermodal containers to the seasonal Hydrometallurgical Plant dock facility to be located on the south shore of Great Slave Lake. The concentrate will be unloaded from the barges and trucked 8.6 km to a secure storage area located on the west side of the Hydrometallurgical Plant.

Heavy duty forklift trucks will be used to take containers to a thaw shed. A walking beam conveyor system or similar will be used for moving containers through the thaw shed and into the dumping system. The thaw system will use excess heat from the acid plant generated as steam.

Containers will be dumped by elevating one end of the container allowing the contents to slide out. The dumped material will fall onto grizzly bars above a hopper and conveyor system to break the fall and for safety reasons.

After dumping, any material on the outside of the container will be removed by washing using a minimal amount of water or by vacuuming. The container is then inspected, re-assembled, and returned to the storage yard. A dry dust collection system captures any dust.

4.8.2.4 Product Transportation to Railhead

The Hydrometallurgical Plant will produce approximately 418 tpd of moist concentrate and light rare earth products. The moist acid baked residue makes up 330 tpd while the moist light rare earth filter cake is 88 tpd. Both concentrate and light rare earth products will be blow dried during filtration to minimize moisture content and prepare the products for shipment to Avalon's separation plant.

Acid bake residue will be filtered and loaded into 20 tonne trucks and pup trailers with covers for direct shipment to the railhead facilities operated by CN rail. The final light rare earth products will be placed in either sealed bulk bags or intermodal containers for shipment to ensure that product is not lost during the handling and/or transportation process. The light rare earth product packages will be hauled 85 km from the Hydrometallurgical Plant to the Hay River railhead on flatbed trucks. Truck shipments are expected to occur daily during one twelve hour shift. The concentrates and rare earth products will be direct-shipped south from the railhead to Avalon's separation plant

4.8.2.5 Hay River Railhead

The packaged products transferred from the Hydrometallurgical Plant site to the railhead facility located outside Hay River will be temporarily stored in a secured enclosure. The enclosure will be operated by CN rail with equipment capable of loading and unloading supplies coming north and products going south. Avalon envisions that this railhead facility will be located on CN's current property and will be managed by CN. Avalon will pursue a contractual arrangement with CN to handle and transfer the products shipped from the railhead site.

4.8.3 Hydrometallurgical Plant Site Waste Management

The following subsections discuss Avalon's Hydrometallurgical Plant waste management strategies for:

- Hydrometallurgical Plant tailings;
- Sewage and greywater; and
- Site, solid and hazardous waste.

4.8.3.1 Hydrometallurgical Plant Tailings

Tailings from the Hydrometallurgical Plant will be directed to the Hydrometallurgical Tailings Facility (HTF) described below.

Hydrometallurgical Tailings Facility

The proposed HTF will be located within an historic open pit (L-37 pit) located south-southwest of the proposed Hydrometallurgical Plant location, near the town of Pine Point. The proposed site is located approximately 85 km east of Hay River and 5 km north of the former town of Pine Point (Figure 4.8-3). 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.

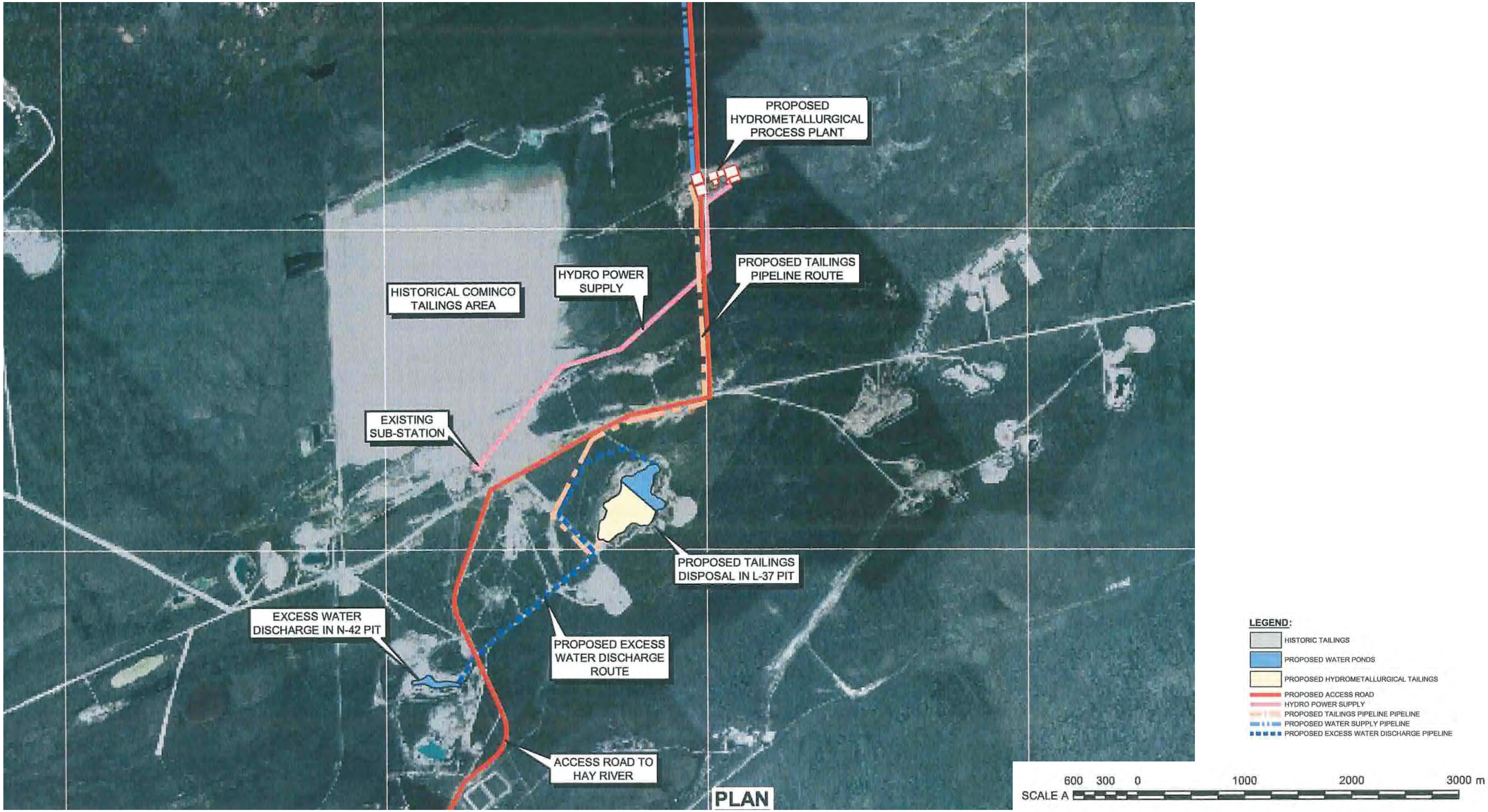
The L-37 pit has been selected as the HTF for several reasons:

- Pit is located in historic brownfield area that has already been impacted by mining activities;
- Proximity to the Hydrometallurgical Plant site;
- Limited free water/groundwater exposed in the pit;
- Availability of local till and waste rock sources nearby;

- No evidence that historic pit was used for other types of waste disposal; and,
- Volume of pit is projected to be sufficient to contain all tailings solids and the proposed maximum supernatant water pond.

A design basis memo prepared by Knight Piésold (2010h) summarizes the process flow information for the Hydrometallurgical Plant. This information was used to determine the volume of tailings and process water expected to be produced over the operational life. The L-37 pit allows the tailings and supernatant water to be contained without the need for external embankment construction.

The L-37 pit will be prepared for tailings deposition prior to tailings discharge, if required. This may involve covering the areas of exposed groundwater with available local materials (till and/or waste rock) that will act as a separation/filter barrier to the tailings solids. A temporary separator dyke is proposed near the northern side of the pit. This dyke will allow supernatant water to collect in the northern portion of the pit and northward sloping tailings to cover the remainder of the pit bottom. The area containing the water could be lined if water testing prior to infiltration into the groundwater is required. The northward sloping tailings will ensure that the supernatant pond remains at the northern side of the pit over the life of the facility, to allow for successful reclaim of supernatant water to be sent to the N-42 infiltration pit.



NOTES

1. Coordinate grid is UTM (NAD83) Zone 11N.
2. Image provided by Avalon Metals Inc.
3. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00024, Figure 2).

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THOR LAKE PROJECT

Tailings Layout Hydrometallurgical Plant Site

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V15101007.006	SL	RH	0
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EBA-VANC	March 21, 2011		

Figure 4.8-3

The principle objective of the HTF design is to ensure protection of the environment during operations and in the long-term (after closure) in order to achieve effective reclamation at Mine closure. The design takes into account the following requirements:

- Permanent, secure and total confinement of all tailings solids within an historic open pit with adequate capacity and stability;
- Removal of excess supernatant water from the HTF for infiltration into the Presqu'ile aquifer through the N-42 historic open pit and
- Inclusion of monitoring features for all aspects of the facility to ensure performance goals are achieved and that design criteria and assumptions are met.

Design and Construction

The design for the HTF is based on a Project life of 20 years and a throughput of tailings from the Hydrometallurgical Plant of 468 dtpd based on processing 360 dtpd concentrate. On-going testwork and studies are investigating a reduction of the mass of tailings below the design level.

The tailings stream from the Hydrometallurgical Plant sent to the HTF will be in slurry form at a solids content by weight or pulp density of 40%. The HTF is proposed to be located within an historic open pit (L-37 pit) and it is proposed that excess water accumulation within the pit be pumped to a nearby pit (N-42 pit) for discharge and infiltration within the Presqu'ile aquifer, as required. The use of these historic pits is described in Knight Piésold (2011a, 2011l).

- The annual throughput of tailings from the Hydrometallurgical Plant will be 170,820 tonnes based on a concentrate production rate of 131,400 tpa (360 tpd), and a 1.3:1 ratio of tailings to concentrate.
- Should the concentrate production rate increase, it is expected that the throughput from the Hydrometallurgical Plant will increase proportionately.

A mining and process flow summary, by production year for Hydrometallurgical tailings which corresponds to the predicted mining rates is provided in Table 4.8-2. Currently it has been assumed that there will be no reclaim of water from the HTF back to the Hydrometallurgical Plant.

Hydrometallurgical tailings properties consist of solids from the proposed milling process made up predominantly of gypsum and miscellaneous other solids (e.g., hydroxides) and are expected to be similar to phosphogypsum tailings in terms of void ratio, dry densities and consolidation properties.

The specific gravity for tailings solids is estimated to be 2.40 based on high gypsum content (Vick 1990). Given a final solids content or pulp density of approximately 65% by weight and a void ratio of 1.3 (Vick 1990) the calculated final average settled dry density for phosphogypsum tailings is 1.05 t/m^3. A slightly lower or conservative density value of 0.9 t/m^3 has been selected for HTF design until final testwork on tailings samples has been completed.

TABLE 4-8-2: UPDATED HYDROMETALLURGICAL PLANT TAILINGS PROCESS RATE SUMMARY

Assumptions						
Slurry Percent Solids		40.0%	Recycle Rate:	0%	Density (t/m³):	0.9
Year	Tailings tps[1]	Process Water m³/yr	Recycle m³/yr	Fresh Water m³/yr	Cumulative Tailings (t)	Cumulative Volume (m³)
1	153,738	230,607	-	230,607	153,738	170,820
2	170,820	256,230	-	256,230	324,558	360,620
3	170,820	256,230	-	256,230	495,378	550,420
4	170,820	256,230	-	256,230	666,198	740,220
5	170,820	256,230	-	256,230	837,018	930,020
6	170,820	256,230	-	256,230	1,007,838	1,119,820
7	170,820	256,230	-	256,230	1,178,658	1,309,620
8	170,820	256,230	-	256,230	1,349,478	1,499,420
9	170,820	256,230	-	256,230	1,520,298	1,689,220
10	170,820	256,230	-	256,230	1,691,118	1,879,020
11	170,820	256,230	-	256,230	1,861,938	2,068,820
12	170,820	256,230	-	256,230	2,032,758	2,258,620
13	170,820	256,230	-	256,230	2,203,578	2,448,420
14	170,820	256,230	-	256,230	2,374,398	2,638,220
15	170,820	256,230	-	256,230	2,545,218	2,828,020
16	170,820	256,230	-	256,230	2,716,038	3,017,820
17	170,820	256,230	-	256,230	2,886,858	3,207,620
18	170,820	256,230	-	256,230	3,057,678	3,397,420
19	170,820	256,230	-	256,230	3,228,498	3,587,220
20	170,820	256,230	-	256,230	3,399,318	3,777,020

Source: Knight Piésold (2011g)

Notes:

1. tpa = TONNES PER ANNUM OR YEAR (DRY).

Tailings discharge will generally be from end of pipe rather than by spigots due to the cold operating temperatures. Tailings beach slopes are estimated to be approximately 1%. Tailings will be inert due to treatment, as required, prior to discharge from the Hydrometallurgical Plant.

The required capacity in the HTF will be a function of solids storage requirements and water management design assumptions. The following summarizes values utilized in the hydromet tailings facility design:

Tailings solids storage requirement will be based on the aforementioned tailings properties and subsequent estimated annual volume, as indicated on Table 4.8-2.

The Minimum Supernatant Pond Volume will be based on 2 weeks of retention time or 2,084,000 m^3 / 52) * 2 = 80,154 m^3 (~80,000 m^3).

The Maximum Operating Supernatant Pond Volume has been selected to correspond to 1.5 months (6 weeks) of process flows in excess of the Minimum Required Pond Volume, i.e. (2,084,000 m^3 / 8) + 80,154 m^3 = 340,654 m^3 (~340,000 m^3). This volume will be used to determine the Normal Maximum Operating Water Level in the HTF.

Design Storm storage in the HTF will be equivalent to a 1 in 25 year 24 hour storm. This will ensure that no effluent water is released from the pit unless a storm with greater magnitude than the 1 in 25 year event occurs.

The maximum storage capacity of the Excess Water Infiltration Pit (N-42 pit) is dependent on the total volume of the pit, less the freeboard. The maximum storage capacity of the pit is estimated to be at least 2,000,000 m^3.

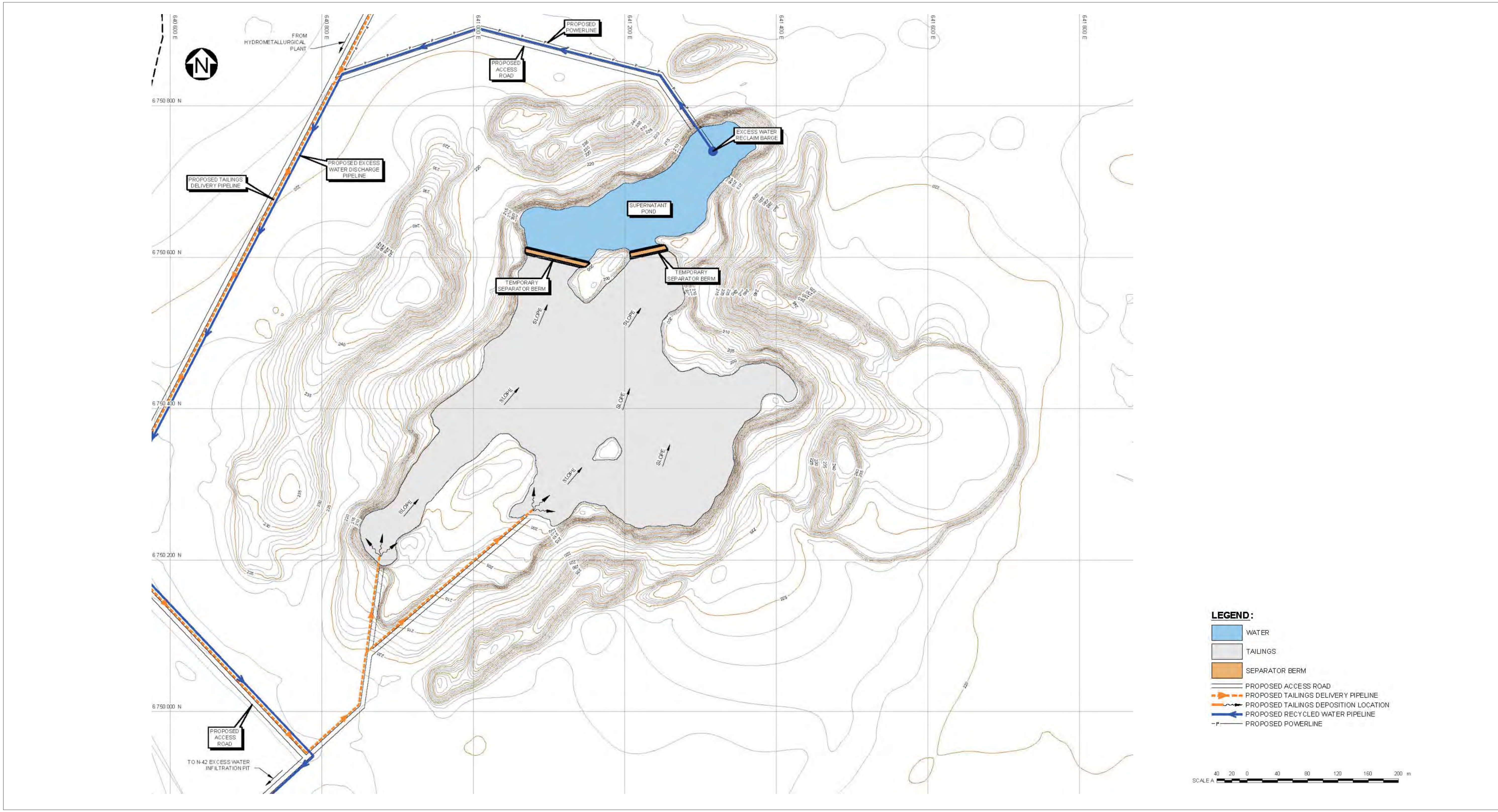
For both the HTF and the Excess Water Infiltration Pit, a minimum of 2 metres of freeboard will be incorporated into the design, to accommodate storm events and wave run-up.

Tailings Delivery and Distribution

Tailings slurry will be pumped from the proposed Hydrometallurgical Plant site to the tailings basin via an insulated and heat traced tailings delivery pipeline located mostly along existing access roads in the area.

Tailings distribution will take place into the L-37 pit from the south end, to create northward sloping tailings and to establish the supernatant pond on the north side of the pit. Tailings deposition to the basin will consist of single end-of-pipe discharge from the tailings deposition pipeline to reduce icing concerns during the winter months. During the entire operations, 100% of the tailings solids will be pumped to the HTF at a slurry consistency of 40% solids by weight.

The cumulative volume of solids and water for Years 2 and 20 (ultimate case) were modelled in the L-37 pit as shown in Figures 4.8-4 and 4.8-5, respectively. A section through the HTF that shows the pit at these filling stages is provided in Figure 4.8-6. As illustrated, the Year 20 (ultimate) tailings and supernatant water will be contained within the L-37 pit without the need for external bank construction.



NOTES
1. Coordinate grid is UTM (NAD83) Zone 11N and is in metres.
2. Plan based on information provided by Avalon Rare Metals Inc., dated November 1, 2010.
3. Contours are in metres. Contour interval is 1 metre.
4. Tailings configuration shown represents estimated layout for end of Year 2 operations.
5. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00024, Figure 7).

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THOR LAKE PROJECT

Feasibility Water/Solids Balance Hydrometallurgical Tailings Facility L37 Pit - Year 2

PROJECT NO.	DWN	CKD	REV
V15101007.006	SL	RH	0
OFFICE	DATE		
EBA-VANC	March 17, 2011		

Figure 4.8-4

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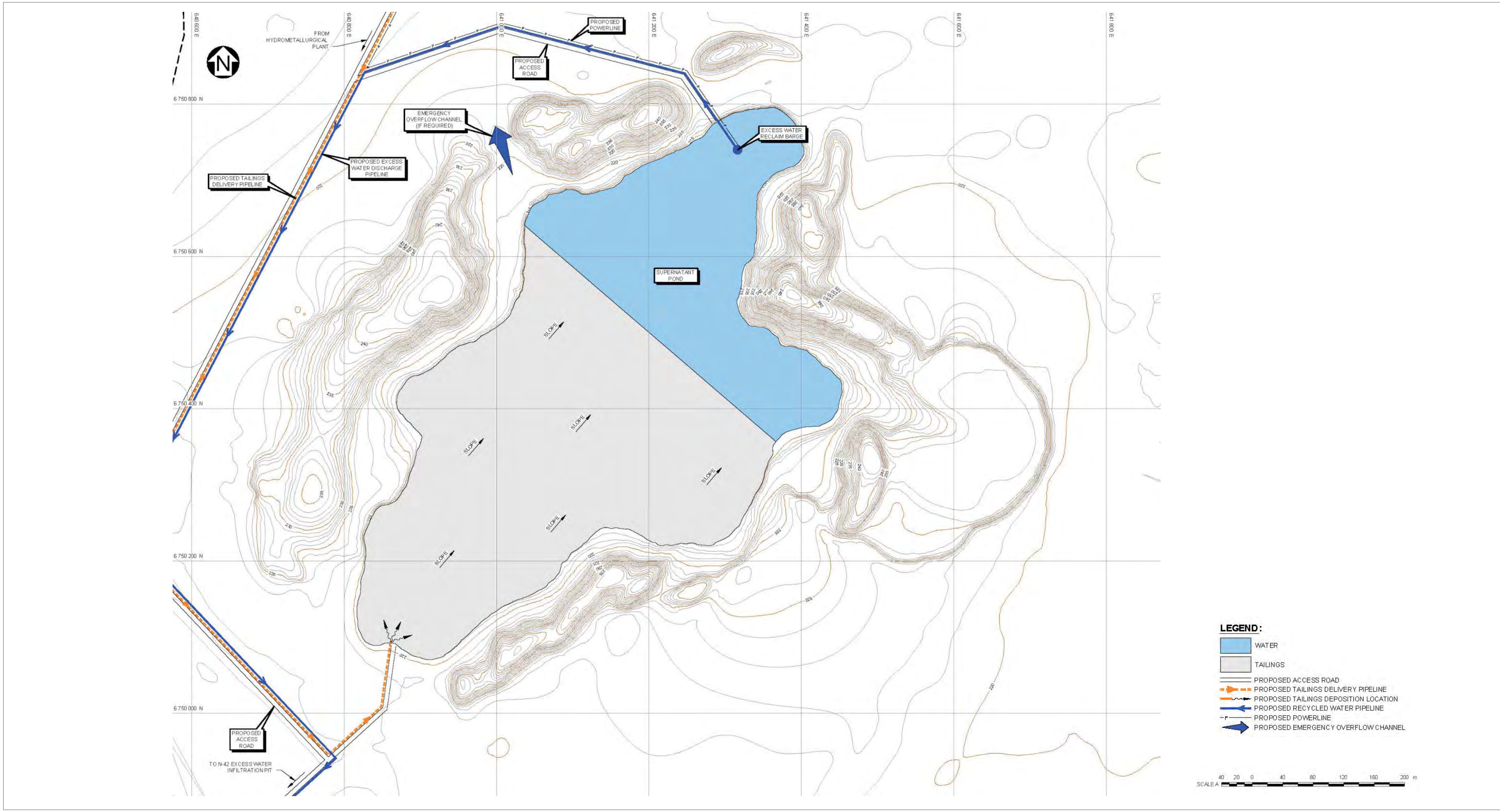

NOTES

1. Coordinate grid is UTM (NAD83) Zone 11N and is in metres.
2. Plan based on information provided by Avalon Rare Metals Inc., dated November 1, 2010.
3. Contours are in metres. Contour interval is 1 metre.
4. Tailings configuration shown represents estimated layout for end of Year 20 operations.
5. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00024, Figure 8).

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Feasibility Water/Solids Balance Hydrometallurgical Tailings Facility L37 Pit - Year 20 (Ultimate)

PROJECT NO.	DWN	CKD	REV
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EBA-VANC	March 17, 2011		

Figure 4.8-5

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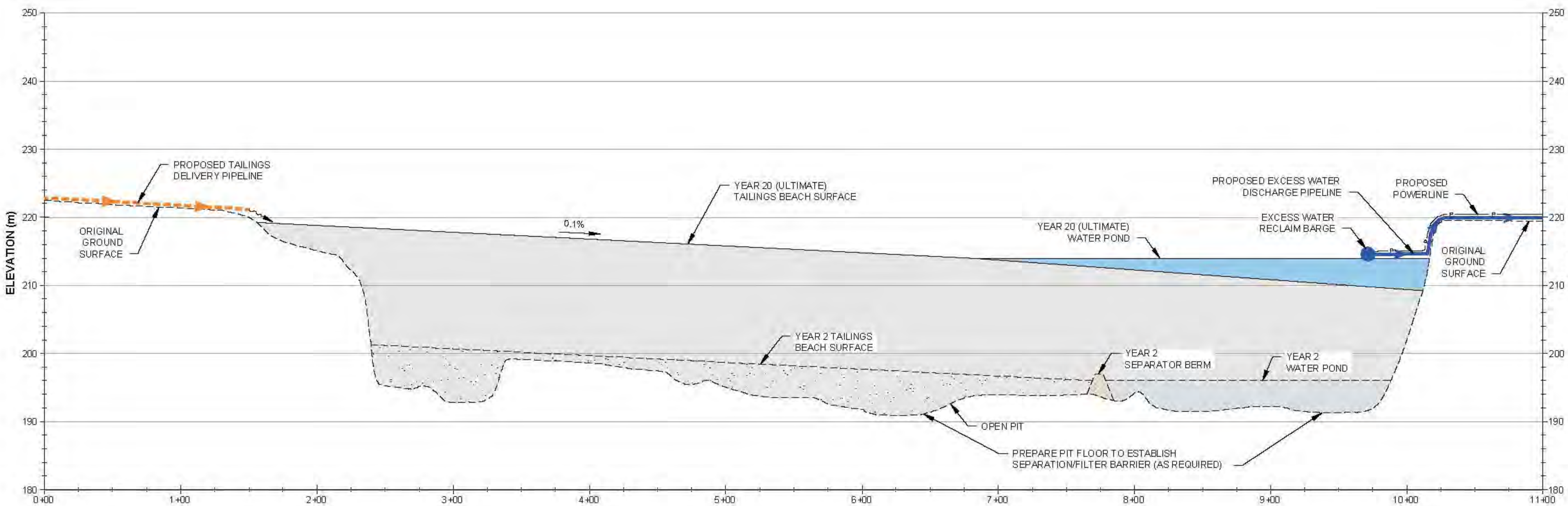
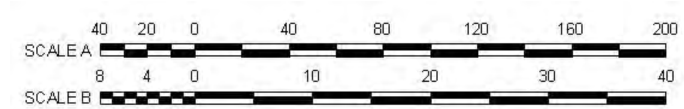


1 3,4 FIG — **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B

LEGEND:

- WATER (YEAR 20) ULTIMATE
- WATER (YEAR 2)
- TAILINGS (YEAR 20) ULTIMATE
- TAILINGS (YEAR 2)
- SEPARATOR BERM (YEAR 2)
- PROPOSED TAILINGS DELIVERY PIPELINE (ULTIMATE)
- PROPOSED TAILINGS DEPOSITION LOCATION (ULTIMATE)
- PROPOSED RECYCLED WATER PIPELINE (ULTIMATE)
- PROPOSED POWERLINE (ULTIMATE)



NOTES

1. Elevations are in metres.
2. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00115, Figure 5).

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THOR LAKE PROJECT

L37 Pit
Tailings Management Design Summary
HTF Section

PROJECT NO.	DWN	CKD	REV
V15101007.006	SL	RH	0
OFFICE: EBA-VANC	DATE: March 17, 2011		

Figure 4.8-6

4.8.3.2 Sewage and Greywater

Sewage and greywater waste from the operation will be processed through a standard packaged sewage treatment plant (Rotating Biological Contactor). Treated sewage effluent will report to a tailings sump that will be comingled into the tailings slurry. The slurry will report to the HTF.

4.8.3.3 Site, Solid, and Hazardous Waste

Garbage will be collected daily and incinerated consistent with current industry good management practices. Recyclable materials will be collected separately and shipped out on a regular basis for processing. A waste management site will be established on-site for the temporary storage of waste materials prior to removal.

Generated solid wastes will be managed in accordance with NWT regulations and issued licenses and permits similar to Avalon's current management of site solids and wastes. Hazardous materials waste will be disposed of in accordance with current GNWT hazardous waste management guidelines using standard best management practices. Waste will either be disposed of on-site or be shipped to an approved off-site facility designed to handle hazardous wastes.

4.8.4 Water Management

The primary objectives of the Hydrometallurgical Plant site water management plan are to:

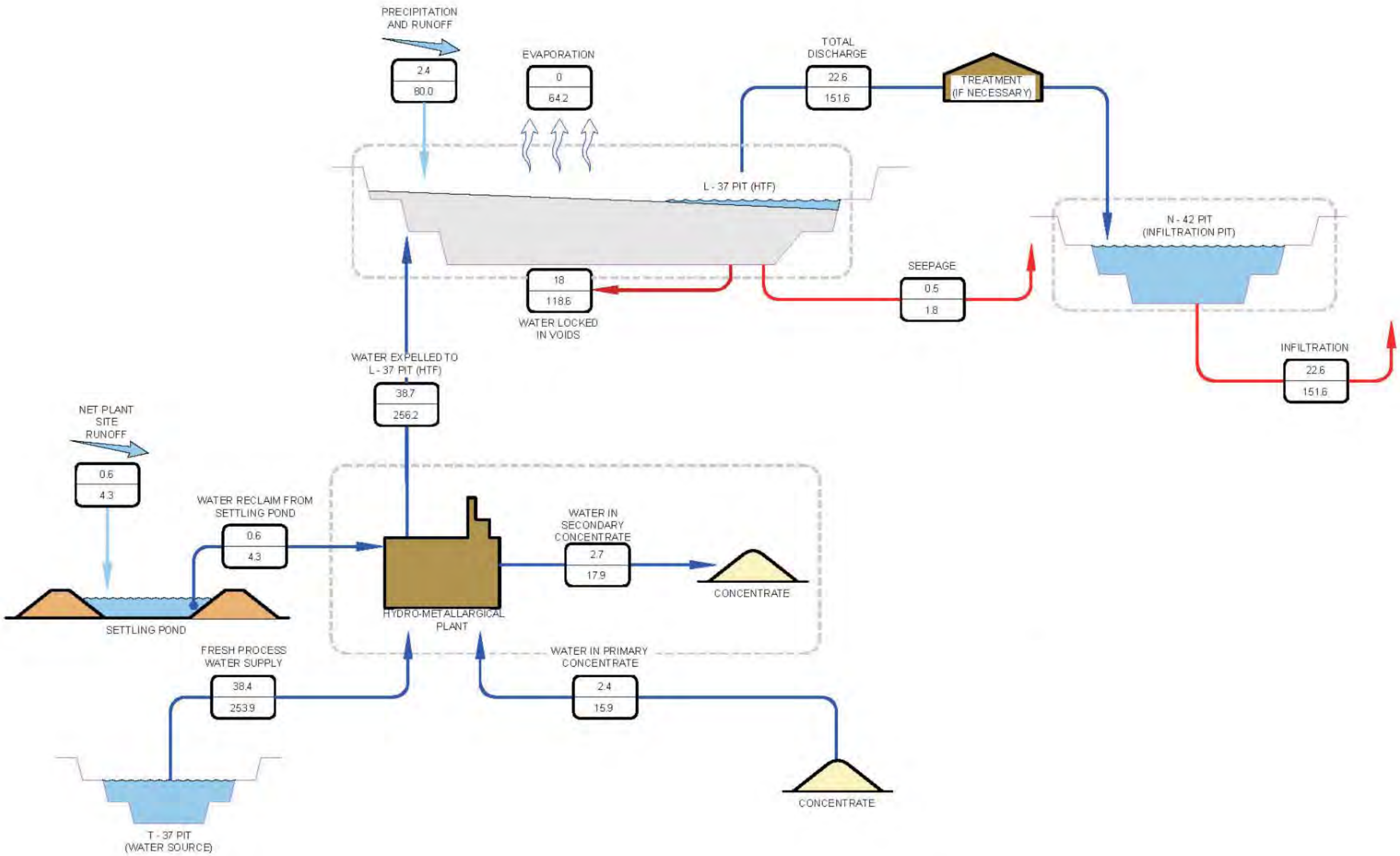
- Provide potable water for surface facilities;
- Provide the Hydrometallurgical Plant with a reliable water supply throughout the Project; and
- Contain and manage all discharge water in the proposed hydrometallurgical tailings facility.

4.8.4.1 Water Balance

Water for the Hydrometallurgical Plant site will be sourced from the former T-37 open pit that remains from the historic Pine Point mining activities. The pits' water supply originates primarily from the unlimited groundwater resource that is characteristic of the Pine Point area.

All tailings solids and fluids, as well as, impacted water from the Hydrometallurgical Plant will report to the HTF. Excess water from the tailings basin will be discharged from the L-37 historic open pit for natural reintroduction into the groundwater aquifer through the existing historic N-42 open pit.

Any water released from the L-37 open pit is expected to be in compliance with anticipated MVLWB Water License criteria. Water balance details are summarized in (Figure 4.8-7).



LEGEND:

PP AND START-UP	
YEARS 1-20	ANNUAL FLOW IN THOUSAND m³/yr

NOTES

1. Estimates are for average precipitation conditions and do not include extreme precipitation events.
2. Figure Source: Knight Piesold Consulting, March 2011 (Ref No. NB11-00130, Figure 3).

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THOR LAKE PROJECT

Hydrometallurgical Plant Site Water Balance Flowsheet

PROJECT NO.	DWN	CKD	REV
V15101007.006	SL	RH	0
OFFICE	DATE		
EBA-VANC	March 18, 2011		

Figure 4.8-7

4.8.5 Support Infrastructure

4.8.5.1 Power

Average power consumption for the Hydrometallurgical Plant during start-up and throughout the life of operations is estimated at 3.5 MW demand. This power will be provided through the existing Northwest Territories Hydro Corporation (NTHC) power grid and substation located at the former Pine Point Mine site. The substation power feed comes from the NTPC Talston Hydroelectric Dam, located approximately 64 km north of Fort Smith on the Talston River. Due to the Taltson dam's inability to provide guaranteed and continuous supply, additional diesel generation of 1.3 MW will be required for backup and safety control systems only.

4.8.5.2 Site

The Hydrometallurgical Plant will be comprised of a combination of prefabricated and steel structures to house the process components. The structures are planned to be organized into a compact unit to optimize the Hydrometallurgical Plant's operations efficiencies. An uncovered limestone storage and handling area will be located adjacent to the temporary concentrate storage area, southwest of the other Plant structures. The Hydrometallurgical Plant structures are planned to include:

- Acid Bake Facility; Administration Offices;
- Leach/Neutralization Facility;
- Precipitation and Packaging Facility;
- Temporary Product Storage;
- Acid Plant and Storage;
- Limestone Grinding;
- Temporary Concentrate Storage; and,
- Thaw Shed.

4.8.5.3 Fuel Storage

Limited amounts of fuel will be used at the Hydrometallurgical Plant for personnel vehicles, product transport trucks and other mobile equipment. A small fuel storage area (diesel and gasoline) will be located immediately adjacent to the Plant in an approved and designed cache designed to accommodate 110% of the largest tank capacity in conformance with the CCME Environmental Code of Practice for Fuel Storage Tanks. Avalon estimates that the storage area will contain between 10-20,000 litres of fuel, with resupply obtained from local fuel suppliers as needed.

4.8.5.4 Limestone Storage

Limestone will be used to neutralize the Hydrometallurgical Plant's waste stream prior to discharge to the HTF. The Hydrometallurgical Plant will require 75 tpd of limestone during the proposed Project life. The crushed limestone will be supplied by local supply sources and stockpiled in a designated area that is in close proximity to the Hydrometallurgical Plant. Because the limestone is a neutralizing product, no special stockpile considerations will be necessary.

Avalon will be sourcing limestone through a third party local supplier.

4.8.5.5 Roads

An existing haul road will be upgraded to transport the offloaded concentrate from the dock facility to the Hydrometallurgical Plant. The haul road will be approximately 8.6 km long and will be aligned directly north-south along an existing local access road and drainage ditch for approximately 4.9 km prior to connecting to an existing haul road from a former mine pit located to the north of the main Pine Point Mine area. The haul road will be constructed using readily available local road construction material derived from the historic Pine Point Mine operations.

4.8.5.6 Dock Facility

The Great Slave Lake shore topography on the south side of the lake is generally low-lying and the water is relatively shallow (< 2 m). To reach the necessary 3 m minimum water depth required for the seasonal barging operation, the Hydrometallurgical Plant dock facility will consist of two moored barges that will extend offshore and be connected to the shore by a ramp. The ramp will be capable of handling the cargo loading and unloading equipment and associated activities. The seasonal dock will be utilized only during the open water period. The adjacent upland area will be developed into a marshalling yard to receive the concentrate containers from the Nechalacho Mine and Flotation Plant site. The yard will also handle and load/offload the annual consumables needed for the Mine. The conceptual barge configuration for the Hydrometallurgical Plant site dock facility is depicted in Figure 4.8-8.

NOTES

1.

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THOR LAKE PROJECT

Hydrometallurgical Plant Site Dock Facility Layout

PROJECT NO.	DWN	CKD	REV
V15101007.006	SL	RH	0
OFFICE	DATE		
EBA-VANC	March 18, 2011		

Figure 4.8-8

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4.9 HUMAN RESOURCES

As already noted, Avalon's proposed Thor Lake Project comprises two primary locations: the Nechalacho Mine and Flotation Plant site, and the Hydrometallurgical Plant site. The Nechalacho Mine and Flotation Plant site will be located approximately 100 km southeast of Yellowknife. The proposed Hydrometallurgical Plant site will be located at the historic Pine Point Mine approximately 85 km east of Hay River. Human resources considerations for both locations are included in this section.

Avalon is committed to employing local and Aboriginal residents to the greatest extent possible. Avalon is committed to treating all key stakeholder groups fairly within the limits of each group's capacity and ability to participate in various aspects of the Project, including those associated with direct and indirect employment.

Avalon believes that with the effective implementation of the company's Human Resources (HR) Management Plan and the support of the federal and territorial human resource-related agencies, the TLP will generate a considerable number of employment and training opportunities for residents of both the North and South Great Slave Lake regions.

To this end, Avalon is committed to progressive HR practices and compliance with all applicable governing labour laws and regulations. Avalon's human resources plan will include internal company policies and procedures for each department function that will be communicated and distributed to employees, as well as goals and objectives for its employee population. Avalon's human resources staff will administer the following four primary human resources functions as shown in Table 4.9-1:

- Employment;
- Compensation/benefits;
- Employee relations; and
- Training and development to its employee population for the life of the Project.

TABLE 4.9-1: HUMAN RESOURCES PLAN OUTLINE

Function	Element
Employment	• Recruitment/Selection
	• Hiring
	• Orientation
Compensation/Benefits	• Medical/Dental
	• Vacation
	• Disability
	• Other
Employee Relations	• Performance Management
	• Ethics
	• Drug Use
Training and Development	• Pre-Employment/Apprenticeship

TABLE 4.9-1: HUMAN RESOURCES PLAN OUTLINE	
Function	**Element**
	• On-the-Job
	• Environmental Protection
	• Archaeological Resource Protection

Successful implementation of Avalon's HR policies and procedures will enable the company to achieve its goals and objectives for its employees. Avalon does not intend to distribute the policies and procedures as a public document. Avalon's employee population goals and objectives are outlined in Table 4.9-2.

Avalon is committed to worker training during the duration of the TLP. As shown in Table 4.9-1, a priority of Avalon's Human Resources Management Plan will be to focus on providing pre-employment training opportunities. The application of this strategy is expected to contribute to increased opportunities for local stakeholders to gain access to jobs and to obtain employment at the TLP.

TABLE 4.9-2: HUMAN RESOURCES GOALS AND OBJECTIVES BY FUNCTION	
Function	**Goals and Objectives**
Employment	• Optimize employment of local Aboriginal people and northerners
	• Offer and distribute employment opportunities fairly and equitably
Compensation/Benefits	• Create healthier and more stable individuals, communities and workforce
Employee Relations	• Encourage employees to take advantage of career advancement opportunities
	• Assist employees in meeting zero tolerance regulations
Training and Development	• Provide training opportunities to address skilled employment for Aboriginal and other workers
	• Offer and distribute training opportunities fairly and equitably
	• Improve qualifications for employment
	• Recognize traditional knowledge and its value for cultural strengthening
	• Recognize and respect Aboriginal traditional land use areas

Avalon is committed to:

- Recognizing and building cultural diversity and awareness about its Aboriginal communities through collaboration cultural education;
- Identifying and minimizing employment barriers for Aboriginal people in the communities;
- Remedying past discrimination in employment opportunities and preventing future barriers through education and appropriate learning and training initiatives;

- Improving distributions for all Aboriginal-designated groups throughout all occupational Levels; and
- Fostering a climate of unity, and equity in the organization.

Avalon's Human Resources Management Plan and hiring process will initially be designed to fill apprenticeship and technological occupations. In addition, all TLP contractors and sub-contractors will be required to adhere to Avalon's goal of maximizing Northern and Aboriginal employment.

4.9.1 Worker Schedule and Transportation

4.9.1.1 Nechalacho Mine and Flotation Plant Site

The Nechalacho Mine and Flotation Plant site is planned to operate 365 days per year with a 24 h/day and 7 day/week schedule (24/7). Crews will have 12 hour scheduled shifts during a one week in/one week out rotation. Management and technical personnel may have a varied schedule.

The rotation work schedule is based on fly-in/fly-out transportation, with onsite camp facilities. The planned rotation will include periods of overlap for key personnel to ensure continuity and safe operations. Avalon will provide employees' flights to and from the site. Flights are planned to originate from Edmonton, Yellowknife, Lutsel K'e and Hay River.

4.9.1.2 Hydrometallurgical Plant Site

The Hydrometallurgical Plant site is planned to operate 351 days per year with a 24/7 schedule. The Plant will shut down for maintenance 14 days every year during the summer. All employees, with the exception of staff and contract maintenance crews, will take vacation during the annual shutdown. Crews will have 12-hour scheduled shifts. Management and technical personnel may have a varied schedule.

Avalon will provide employees with daily bus transportation from Hay River and Fort Resolution to and from the Hydrometallurgical Plant site. The site is accessible year round via Territorial Highways 5 and 6.

4.9.2 Personnel Requirements

4.9.2.1 Nechalacho Mine and Flotation Plant Site

Approximately 80 positions will be required at site at any given time during construction of the underground mine and the surface infrastructure, including the flotation process plant. Construction jobs include employment generated through the third-party business contract opportunities needed to service the Project.

During the operations phase of the Project, approximately 216 full time employees will be required. Approximately 20 employee positions will be retained during the reclamation phase assuming reclamation of the TLP site commences immediately following completion of all operations. An estimated distribution of required personnel by by skill level for the Nechalacho Mine and Flotation Plant is located in Table 4.9-3.

Skilled employees are those with post-secondary education, training or work experience in their field. Unskilled employees are those that lack post-secondary education and experience, positions for unskilled employees are typically entry level positions (Rio Tinto 2011).

TABLE 4.9-3: PERSONNEL REQUIREMENTS AT NECHALACHO MINE SITE

Component	Number of Personnel	Skill Level	
		Skilled	Unskilled
Mine Administration			
General Manager	1	Skilled	
Assistant Mine Manager	1	Skilled	
Human Resource Manager	1	Skilled	
Safety Trainer	3	Skilled	
Accountant	2	Skilled	
Payroll	2	Skilled	
Clerk	2	Skilled	
Assistant HR Manager	1	Skilled	
Environmental Coordinator	2	Skilled	
Total Mine Administration	**15**	**15**	**0**
Skill Level Percentage		**100.0**	**0**
Mine Supervision			
Mine Superintendent	1	Skilled	
General Mine Foreman	1	Skilled	
Mine Shift Boss	4	Skilled	
Master Mechanic	1	Skilled	
Mechanical Foreman	1	Skilled	
Total Mine Supervision	**8**	**8**	**0**
Skill Level Percentage		**100.0**	**0**
Mine Engineering			
Chief Engineer	1	Skilled	
Engineer	3	Skilled	
Senior Surveyor	2	Skilled	
Mine Technician	2	Skilled	
Total Mine Engineering	**8**	**8**	**0**
Skill Level Percentage		**100.0**	**0**
Mine Geology			
Chief Geologist	1	Skilled	
Exploration Geologist	1	Skilled	
Assistant Chief Geologist	4	Skilled	
Geological Technician	4	Skilled	
Total Mine Geology	**10**	**10**	**0**
Skill Level Percentage		**100.0**	**0**

TABLE 4.9-3: PERSONNEL REQUIREMENTS AT NECHALACHO MINE SITE

Component	Number of Personnel	Skill Level	
		Skilled	Unskilled
Mine Labour			
Development	12	Skilled	
Longhole Drill Blast	12	Skilled	
Muckers	8	Skilled	
Bolting/Scaling	6	Skilled	
Nipper	2	Skilled	
Construction	6		Unskilled
Total Mine Labour	**46**	**40**	**6**
Skill Level Percentage		**87.0**	**13.0**
Mine Maintenance			
Mechanic	16	Skilled	
Helper	6		Unskilled
Welder	4	Skilled	
Electrician	3	Skilled	
Total Mine Maintenance	**29**	**23**	**6**
Skill Level Percentage		**79.0**	**21.0**
Mill Operations			
Mill Superintendent	1	Skilled	
Mill General Foreman	1	Skilled	
Metallurgists	2	Skilled	
Mill Foremen	4	Skilled	
Mill Operators	18	Skilled	
Mill Helpers	12		Unskilled
Assayers	2	Skilled	
Assay/Metallurgical Technicians	2	Skilled	
Total Mill Operations	**42**	**30**	**12**
Skill Level Percentage		**71.0**	**29.0**
Mill Maintenance			
Mill Maintenance Foremen	2	Skilled	
Electrician/Instrument Technologists	2	Skilled	
Millwrights	6	Skilled	
Apprentices	8		Unskilled
Total Mill Maintenance	**18**	**10**	**8**
Skill Level Percentage		**56.0**	**44.0**
Surface Supervision			
Surface Superintendent	1	Skilled	
Assistant Surface Superintendent	1	Skilled	
Surface Supervisor	2	Skilled	

TABLE 4.9-3: PERSONNEL REQUIREMENTS AT NECHALACHO MINE SITE			
Component	Number of Personnel	Skill Level	
		Skilled	Unskilled
Maintenance Planner	2	Skilled	
Total Surface Supervision	**6**	**6**	**0**
Skill Level Percentage		**100.0**	**0**
Surface Labour			
Equipment Operator	4	Skilled	
Carpenter	2	Skilled	
Labourer	4		Unskilled
Plumber's Helper	1		Unskilled
Mechanic	2	Skilled	
Plumber/Gasfitter	1	Skilled	
Electrician	8	Skilled	
Powerhouse	2	Skilled	
Total Surface Labour	**24**	**19**	**5**
Skill Level Percentage		**79.0**	**21.0**
Warehouse			
Senior Buyer	2	Skilled	
Floor/Shipping/Receiving	2		Unskilled
Security FA	2	Skilled	
Total Warehouse	**6**	**4**	**2**
Skill Level Percentage		**67.0**	**33.0**
Sales			
Marketing and Sales Manager	1	Skilled	
Clerk	1	Skilled	
Total Sales	**2**	**2**	**0**
Skill Level Percentage		**100.00**	**0**
Distribution			
Warehouse Manager	1	Skilled	
Loader Operator	1		Unskilled
Total Distribution	**2**	**1**	**1**
Skill Level Percentage		**50.0**	**50.0**
Total Nechalacho Site	**216**	**176**	**40**
Skill Level Percentage (%)		**81.0**	**19.0**

4.9.2.2 Hydrometallurgical Plant Site

Approximately 87 positions will be required at site any given time during construction of the Pine Point Hydrometallurgical Facilities and the associated surface infrastructure. The construction jobs will include employment generated through the third-party business contract opportunities needed to service the Project.

During hydrometallurgical processing operations at Pine Point, approximately 69 full time employees will be required. Assuming reclamation of the hydrometallurgical site commences immediately following completion of all operations, approximately 10 positions will be retained during the reclamation phase. The estimated distribution of required personnel by skill level for the hydrometallurgical plant is summarized in Table 4.9-4.

TABLE 4.9-4: PERSONNEL REQUIREMENTS AT HYDROMETALLURGICAL PLANT SITE

Component	Number of Personnel	Skill Level	
		Skilled	Unskilled
Hydrometallurgical Plant Supervision			
Shift supervisors	4	Skilled	
Clerk	1	Skilled	
Total Plant Supervision	**5**	**5**	**0**
Skill Level Percentage		**100.0**	**0**
Hydrometallurgical Plant Operations			
Thaw shed and acid bake operator	4	Skilled	
Leaching operator	4	Skilled	
Packaging operator	4	Skilled	
Mill helper	8		Unskilled
Total Plant Operations	**20**	**12**	**8**
Skill Level Percentage		**60.0**	**40.0**
Hydrometallurgical Plant Maintenance			
Maintenance foreman	2	Skilled	
Mechanics/Welders	4	Skilled	
Electrical technicians	2	Skilled	
Instrumentation technicians	1	Skilled	
Apprentices	2		Unskilled
Total Plant Maintenance	**11**	**9**	**2**
Skill Level Percentage		**82.0**	**18.0**
Hydrometallurgical Plant Technical			
Metallurgist	1	Skilled	
Senior assayer	1	Skilled	
Sample preparation	1	Skilled	
Assayers	1	Skilled	
Total Plant Technical	**4**	**4**	**0**
Skill Level Percentage		**100.0**	**0**
Hydrometallurgical Plant Surface			
Front-end-loader/fork lift operator	4	Skilled	
Trainees/scrap gang	4		Unskilled
Truck drivers	2	Skilled	

TABLE 4.9-4: PERSONNEL REQUIREMENTS AT HYDROMETALLURGICAL PLANT SITE			
Component	**Number of**	**Skill Level**	
Total Hydrometallurgical Plant	**10**	**6**	**4**
Skill Level Percentage		**60.0**	**40.0**
Acid Plant			
Lead operators	4	Skilled	
Helper	4		Unskilled
Mechanics/Welders	1	Skilled	
Instrumentation technicians	1	Skilled	
Apprentices	1		Unskilled
Total Acid Plant	**11**	**6**	**5**
Skill Level Percentage		**55.0**	**45.0**
Surface Administration			
General Manager	1	Skilled	
Human Resource Coordinator	1	Skilled	
Accountant	1	Skilled	
EHS Coordinator	1	Skilled	
Total Surface Administration	**4**	**4**	**0**
Skill Level Percentage		**100.0**	**0**
Warehouse			
Senior Buyer	1	Skilled	
Clerk	1	Skilled	
Security FA	1	Skilled	
Total Warehouse	**3**	**3**	**0**
Skill Level Percentage		**100.0**	**0**
Surface Supervision			
Surface Supervisor	1	Skilled	
Total Surface Supervision	**1**	**1**	**0**
Skill Level Percentage		**100.0**	**0**
Total Hydrometallurgical Plant Site	**69**	**50**	**19**
Skill Level Percentage		**72.0**	**28.0**

4.9.3 Recruitment Strategy

Avalon is committed to contributing to the socio-economic development and economic base of the Northwest Territories and local Aboriginal and municipal communities. Avalon's goal is to attract, recruit and retain qualified candidates; with priority given to Avalon's Aboriginal stakeholders and local communities. Selection criteria will include candidates' knowledge, skill, work-related experience and adherence to strict safety guidelines, as well as compatibility with the local culture. Avalon's recruitment plan has five elements including:

- Define: Identification phase;

- Plan: Strategic development phase;
- Attract: Recruitment phase;
- Screen: Selection phase;
- Select: Job offer phase.

The large number of positions required during the first year of start-up will require that the recruitment process be ongoing and continuous. In particular, the first six months will require concurrent recruitment cycles with varying strategies that will include both advertising and physical recruitment drives.

All open positions will be posted in local newspapers and websites within the immediate area of Yellowknife and Hay River. Advertisements will be posted in mining communities throughout the territories and neighbouring provinces to reach secondary regional candidates. Employment advertisements will also be posted on mining websites such as InfoMine and Misco Jobs. Recruitment searches will be expanded throughout Canada as required.

Physical recruitment drives will also be used to attract employees. Avalon will visit communities and be available to respond to questions about Avalon and the Thor Lake Proejct, accept resumes, and conduct interviews. Recruitment drives will be used most often to recruit hourly positions with multiple openings. Recruitment drives will be advertised in the regional newspapers where the drives will be held.

4.9.4 Training Programs

Avalon's goal of increasing the local participation rate will be the company's training and development initiatives. Avalon is committed to worker training during the duration of the TLP. As shown in Table 4.9-5, a priority of Avalon's Human Resources Management Plan will be to focus on providing pre-employment training opportunities. The application of this strategy is expected to contribute to increased opportunities for local stakeholders to gain access to jobs and to obtain employment at the TLP.

Avalon is committed to:

- Recognizing and building cultural diversity and awareness about our Aboriginal communities through collaboration cultural education;
- Identifying and minimizing employment barriers for Aboriginal people in the communities;
- Remedying past discrimination in employment opportunities and preventing future barriers through education and appropriate learning and training initiatives;
- Improving distribution of Aboriginal employees throughout all occupational levels; and,
- Fostering a climate of unity, and equity in the organization.

TABLE 4.9-5: HR GOALS AND OBJECTIVES BY FUNCTION	
Function	**Goals and Objectives**
Employment	• Optimize employment of local Aboriginal people and northerners
	• Offer and distribute employment opportunities fairly and equitably
Compensation/Benefits	• Create healthier and more stable individuals, communities and workforce
Employee Relations	• Encourage employees to take advantage of career advancement opportunities
	• Assist employees in meeting zero tolerance regulations
Training and Development	• Provide training opportunities to address skilled employment for Aboriginal and other workers
	• Offer and distribute training opportunities fairly and equitably
	• Improve qualifications for employment
	• Recognize traditional knowledge and its value for cultural strengthening
	• Recognize and respect Aboriginal traditional land use areas

Avalon's Human Resources Management Plan and hiring process will initially be designed to fill apprenticeship and technological occupations. In addition, all TLP contractors and sub-contractors will be required to adhere to Avalon's goal of maximizing Northern and Aboriginal employment.

Avalon will consult and collaborate with local Aboriginal interests and communities to encourage the effective development and delivery of the training programs. The Government of Canada and the Government of the Northwest Territories are also committed to enhancing training opportunities through the support of a number of initiatives. These include the provision of training allowances and support services, career counselling, and training program delivery.

The federal government has recognized that certain areas of the country are experiencing significant demands for skilled labour and that many of these areas include Aboriginal communities who can benefit from the potential employment opportunities.

Consequently, the federal government, through Human Resources and Skills Canada, launched the Aboriginal Skills and Employment Partnership (ASEP) program in 2004. ASEP is a partnership of Aboriginal groups, businesses, and governments. The purpose of ASEP is to secure and increase Aboriginal participation in economic developments in their communities. The NWT Mine Training Society administers ASEP funding in the NWT. ASEP's overall objective is sustainable employment for Aboriginal people in economic activities, leading to lasting benefits for Aboriginal communities. Avalon is already receiving support from ASEP for its training initiatives. Additionally, the Aurora College has been instrumental in supporting Aboriginal/community based training to enhance local employment opportunities. Avalon intends to work with the Aurora College to develop training courses that will better define specific job functions as it relates to the TLP.

Training programs will focus on site-based programs to train northerners on specific equipment. Anticipated training areas will be related to:

- Safety systems and safe work practices
- First aid and emergency response
- Environmental and waste management
- Construction equipment operation and maintenance
- Mining equipment operation and maintenance
- Process plant operation and maintenance
- Administration functions

Avalon's commitment to training will include site-based, on-the-job training and support for different apprenticeships. With the success of the TLP and continued development, training programs will be expanded as appropriate. They will be guided by sustainable development principals to generate further economic and social benefits while ensuring continued responsible environmental stewardship for the benefit of future generations.

All production employee training records will be managed by the HR Manager and stored in Avalon's training database. The database tracks and monitors all employee skill sets and training dates to ensure that employees have the proper certification and training required for the tasks they are assigned or promoted to perform. Annual review of personnel and training records are conducted to ensure that all employees have current job specific certification, if required.

4.9.4.1 Supervisor Training Module

All supervisory personnel will have supervisor-specific training based on the Northwest Territory *Mine Health and Safety Act* and regulation requirements and location of operation being either Nechalacho deposit or Pine Point Hydrometallurgical Plant. Avalon will ensure that all supervisors have met company training requirements, which will include a mixture of train-the-trainer and personal training in the following areas:

- Site Specific Safety Training (Train-the-trainer);
- Site Specific Environmental Training (Train-the-trainer);
- General First Responder Review;
- Key Responsibilities of the NWT *Mine Health and Safety Act* and Regulations;
- Ventilation Review;
- Do's and Don'ts during an Accident/Emergency (Mine, Mill and HydroMet specific);
- Front Line Responder Training;
- Handling Unacceptable Behaviours;

- Company Policy and Procedures (Train-the-trainer); and
- Administrative Responsibilities.

Avalon will hold its supervisors to the highest level of performance and expectations to ensure a safe and productive environment. All supervisors will be expected to lead by example and effectively administer company policy and procedures fair and equitably.

4.9.4.2 Miner Training Program

A two week introductory training program for underground miners will be implemented by Avalon for the Nechalacho deposit. The program includes several modules that teach the skills required to work safely and productively underground. The modules include a combination of classroom theory, practical underground instruction/training, and on-the-job supervised experience.

The topics addressed in the program include:

1.	Mine Health and Safety Act	16 h
2.	Safe Mining Practices (typical hazards)	16 h
3.	Zero Tolerance Behaviours (fall protection, confined spaces, lock out / tag out)	8 h
4.	Introduction to Scaling and Ground Control	12 h
5.	Introduction to Drilling	12 h
6.	Introduction to Loading and Blasting	12 h
7.	Introduction to Haulage	12 h
8.	Introduction to LHD operation	12 h
9.	Radiation Health and Safety	8 h

Trainees receive 40 hours (5 days) of classroom training and a minimum of 60 hours (5 days) of underground on-the-job training. For all on-the-job training, new employees will spend one full shift with an experienced miner in all facets of operations. This miner training program is not intended to allow new employees to begin working individually. Upon completion of these requirements, trainees are paired with an experienced miner for an undetermined period of mentoring prior to being allowed to work independently.

4.9.4.3 Process Plant Training Program

A one-week, new hire introductory training program will be provided by Avalon for flotation plant and Hydrometallurgical Plant operations. The program will be tailored for each area of operation to include a minimum of six modules as follows:

1.	*Mine Health and Safety Act*	16 h
2.	Safe Process Plant Operations (typical hazards)	16 h

3. Zero Tolerance Behaviours 8 h
4. Environmental Hazards / Spills Response 8 h
5. Reagent Handling 8 h
6. General Process Operations 44 h
7. Radiation Health and Safety 8 h

Trainees receive 40 hours (5 days) of classroom training and a minimum of 60 hours (5 days) of site specific processing on-the-job training. For all on-the-job training, new employees will spend one full shift with an experienced process operator in all facets of the plant. This process training program is not intended to allow new employees to begin working individually. Upon completion of these requirements, trainees will be given lower level jobs from which they will have the opportunity to advance or will be paired with an experienced operator.

4.9.5 Emergency Medical Response

Avalon will comply with all Emergency Medical Response criteria associated with required health and safety acts. An Emergency Response Plan will be developed and distributed to all employees and posted for easy access in the event of an emergency. Selected employees will be trained in First Aid at both sites, and a mine rescue crew will be on-site at the Nechalacho Mine and Flotation Plant site.

A dedicated first aid facility will be located at both sites. Plans at the Nechalacho Mine and Flotation Plant will include a designated ground vehicle for evacuation to the first aid facility then to the air strip. Seriously injured personnel will be evacuated from the site by air to Yellowknife. Plans at the Hydrometallurgical Plant site will include a designated ground vehicle for evacuation to Hay River and may include medical evacuation options.

4.9.6 Radiation Protection Program

Avalon is committed to ensuring that all employees, contractors and the general public will be safe in all respects while working at or visiting the Nechalacho Mine and Flotation Plant site, the Hydrometallurgical Plant site or any of the associated transportation components of the TLP. Avalon is fully aware that in addition to the rare earth metals and a number of other metals, the Nechalacho ore also contains naturally occurring radioactive material (NORM). The NORM consists of naturally occurring uranium and thorium and associated radioactive decay products, including radon gas.

NORM is ubiquitous and is present in all rocks and soils throughout the earth in highly varying concentrations, especially in areas of mineralization, but background concentrations are typically in the order 1 to 10 parts per million (ppm). The uranium and thorium concentrations in the Nechalacho ore average approximately 24 ppm and 130 ppm, respectively. For perspective, the uranium concentration at a low grade uranium mine (0.1% grade) is about 1000 ppm.

To address possible concerns related to this subject, SENES Consultants Limited (SENES) was retained to identify potential radiological issues associated with mining and processing of the Nechalacho ore arising from the natural radioactivity in the ore (NORM), and to provide a perspective on the magnitude and significance of potential radiation exposures that could possibly result from the activities undertaken in relation to the proposed TLP. A complete copy of the SENES (2011a) report on this subject is provided in Appendix G.

Coincidentally, the MVEIRB Terms of Reference (2011) requested Avalon to describe the specific hazards to employees as well as to public safety and health from Project-related radiation or other hazards that may arise from Thor Lake Rare Earth Element Project operations.

4.9.6.1 Regulatory Considerations

Potential radiation exposures of workers are specifically addressed in the *NWT Mines Act*. The NWT regulations provide limits on allowable radiation dose and exposure to radon gas and its radioactive decay products. The NWT regulations are based on the regulations of the Canadian Nuclear Safety Commission (CNSC), the federal agency that regulates the use of nuclear energy and materials. However, the mandate of the CNSC specifically excludes NORM; the CNSC regulations apply only to radioactive substances used in the nuclear fuel cycle, and to the transport and import/export of radioactive materials. To address situations where the exposure to NORM is not regulated in Canada, the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) were developed in 2000 by a federal-provincial-territorial NORM working group, with the support of Health Canada and the CNSC.

Radiation Limits

The basic principle of the Canadian NORM Guidelines is that persons exposed to NORM should be subject to the same regulations as those exposed to CNSC-regulated radioactive materials. The NORM radiation dose limits recommended in the Guidelines are:

- For occupationally exposed workers, 100 millisieverts (mSv) in any five years, or an average of 20 mSv/y, with a maximum of 50 mSv/y in any single year;
- For incidentally exposed workers or members of the public, 1 mSv/y.

[The mSv is a unit of radiation dose. For perspective, the average Canadian is exposed to about 2 mSv/y from natural background sources of radiation.]

Occupationally exposed workers are employees who are exposed to NORM sources of radiation as a result of their regular duties. Incidentally exposed workers are employees whose regular duties do not include exposure to NORM sources of radiation. They are considered as members of the public in terms of their dose limits.

The NORM guidelines provide dose limits and workplace management practices. However, if the dose to members of the public due to operations of a facility is anticipated to be less than 0.3 mSv/y, and to workers to be less than 1 mSv/y, the NORM program classification is considered unrestricted and no further action is needed to control doses or materials.

Transport Regulations

As previously noted, naturally occurring radioactive materials (NORM) are specifically excluded from the mandate of the Canadian Nuclear Safety Commission (CNSC), except for the transport and import/export regulations which govern all radioactive materials. (The import/export regulations for transporting materials across international borders were not a subject of this report. The regulations apply only to materials exceeding 500 ppm of uranium and thorium).

The Canadian transport regulations are based largely on the regulations of the International Atomic Energy Agency (IAEA). The transport regulations provide radioactivity concentration limits below which the regulations do not apply. The radioactivity limits correspond to 810 ppm and 2,460 ppm of uranium and thorium, respectively.

Based on the concentrations of uranium and thorium in the Nechalacho ore and the levels estimated in the concentrate from the mine, it is not anticipated that that the concentrate transported from the mine would exceed these levels, and therefore would be exempt from the transport regulations.

Periodic analysis of the concentrate would be used to determine if transport regulations would apply. Should any materials exceed these limits, the material would be classified as Low Specific Activity (LSA-1) material. The transport requirements for such material are relatively straightforward. The material could be shipped in standard steel drums, or even in bulk shipping containers. The containers would have to be labelled as LSA-1.

4.9.6.2 Potential Worker Exposures

The workers at the proposed Thor Lake Project will be exposed to NORM at various work locations. The potential exposures will depend on the radioactivity concentrations in the materials being mined and/or processed. To provide a perspective on potential exposures, illustrative calculations of potential radiation doses were undertaken. The nominal average uranium and thorium concentrations in the ore were used. The radiation exposure pathways considered were external gamma radiation and internal exposure from inhalation and ingestion of radioactive materials.

Under the assumptions used (e.g., exposure to miners completely surrounded by ore), the dose to workers was estimated at 1.4 mSv/y, with the largest contributor (>90%) being direct gamma radiation. For perspective, this is below the average annual dose of approximately 2 mSv/y that Canadians receive from natural background radiation.

The radionuclides in natural thorium were estimated to contribute about 70% of the total dose under the assumptions of the calculations. The calculations were based on radioactive equilibrium, a good assumption for ore. This would not likely be the case for all the NORM materials at the Hydrometallurgical Plant, where radioactive concentrations in the various workplaces and the relative contributions of the exposure pathways would differ.

Additionally, underground miners would also be exposed to radon and its short-lived decay products. Source control and standard mine ventilation practices developed for conventional pollutants, such as diesel exhaust, are expected to control radon and its decay products to acceptable levels (below regulatory limits).

The estimated dose of 1.4 mSv/y to NORM workers is well below the 20 mSv/y dose limit (averaged over 5 years) in the Canadian NORM Guidelines for workers, but is above the 1 mSv/y dose considered as "unrestricted" in terms of radiological protection requirements for occupationally exposed workers.

The calculations, although based on conservative assumptions and necessarily approximate, therefore suggest the possibility of exceeding the Canadian NORM guideline of 1 mSv/y. If occupationally exposed workers were to exceed this level, this would result in the lowest NORM classification of *Dose Management* and the possible need for a worker and workplace radiation protection program.

Based on the conservative assumptions used in the calculations, the radiation dose to some occupationally exposed workers when exposed to average ore grades at the Nechalacho Mine could potentially exceed 1 mSv per year (the recommended dose limit for such NORM workers is an average of 20 mSv/y). Should such exposures occur, a radiation protection program would be indicated.

In general terms, a radiation protection program would include an ALARA program to ensure that doses to workers are "As Low As Reasonably Achievable" (one of the principles of radiation protection), monitoring, training and the development of emergency preparedness programs (spill response plan for example) among other elements.

Given the quite modest levels of NORM and the implementation of a radiation protection program consistent with these levels, no undue radiological concerns are expected at the Proposed Thor Lake Project.

4.9.6.3 Screening-Level Radioactivity Pathways Assessment

Although not specifically requested in the MVEIRB Terms of Reference, Avalon retained SENES to prepare a screening-level radioactivity pathways assessment of the Thor Lake Project to determine if there were any potential environmental pathways for radiological exposures, in particular, to vegetation, wildlife or fish and fish habitat. (SENES 2011b). The complete memorandum, prepared by SENES, is provided in Appendix G.

The following is an overview of the methodology used to conduct the pathways assessment, valued ecosystem components (VECs) and receptors, constituents of potential concern (COPC), and findings of the assessment.

A radiological exposure pathways assessment was conducted to evaluate contaminant sources, assesses the environmental fate of released radioactive species, and estimate doses to members of the working public, people who hunt, fish or live in the surrounding area, and to non-human biota (aquatic and terrestrial receptors) present in the area. Utilizing findings of baseline studies of environmental media and receptors (Stantec 2010c), test-run laboratory results of mine wastes (SGS 2011); mathematical modelling of air dispersion

(RWDI 2011) and water dispersion (Section 6.4.2), the potential risks to both the human and ecological populations were assessed.

The assessment exclusively examined pathways of radiological exposure to ecological and human receptors, and did not assess other potential contaminants to receptors (e.g. metals, organic compounds). A separate technical memorandum has used a conservative modelling approach to determine that it is unlikely that the Thor Lake Project will result in any health impacts to workers as a result of underground low level radiation (Appendix G).

Assessment Methodology

The environmental modelling and pathways analysis were performed at a screening level and, as such, simplifying assumptions were made. Environmental modelling estimated the steady-state (long-term) concentrations of the COPC in the environmental media of interest. Pathways modelling combines the receptor characteristics (i.e., ingestion rate, body weight, time at site, etc.) with the estimated environmental media concentrations of COPC to estimate exposure of each receptor.

For this screening level assessment, a spreadsheet pathways model was used. This spreadsheet model was built on the INTAKE pathways model, which calculates exposures and doses to ecological and human receptors. The INTAKE model has been applied to several uranium mining projects in northern Saskatchewan to simulate radiological and non-radiological constituent fate and transport in the environment and the subsequent evaluation of exposures to ecological species and humans. The dose estimates are then compared to appropriate limits in the risk assessment to identify any areas of concern.

The focus of this assessment is to evaluate radiation exposure pathways to members of the public and biota living in and around the Project area. Two receptors were selected to represent the members of the public, Aboriginal peoples that may obtain country food in the area; and, members of the working public (e.g. camp cook, office worker). The Nechalacho Mine and Flotation Plant site was evaluated separately from the Hydrometallurgical Plant Site, as the two areas are distant from each other with differing infrastructure, processes, and land use which results in unique pathways for the two sites.

The pathways assessment methodology utilized the following procedures to assess the exposure and risk attributable to the Thor Lake Project:

- *Identification and Characterization of VECs and Receptors:* Principal components of the ecosystem were selected on a site-specific basis, with receptors selected to best represent the ecosystem and identify potential impacts.
- *Identification and Characterization of COPC:* Radiological COPC were identified for the Thor Lake Project. The parameters necessary to model the fate and transport of the selected COPC (e.g. transfer factors) were collected for use in the assessment.
- *Pathways Assessment:* The potential exposure pathways of the COPC to each of the selected receptors was identified for the two sites of the Thor Lake Project.
- *Risk Characterization:* INTAKE spreadsheets were utilized to quantify the exposure and dose to receptors from all pathways. Radioactivity doses were compared to benchmarks

set to be protective of the receptors, to identify potential radioactivity hazards to receptors.

Valued Ecosystem Components (VEC) and Receptors

Valued Ecosystem Components (VECs) in the existing environment are environmental attributes or components identified as having a "legal, scientific, cultural, economic or aesthetic value". From each VEC, a suitable receptor was selected for use in the pathways assessment. Using the VEC selection criteria, the findings of the Baseline Wildlife Studies (EBA 2010a, b), wildlife species with special conservation status (under Canada's Species at Risk Act (SARA) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)), and species known to have particular importance (as a food source or of cultural significance) to local Aboriginal communities, receptors were selected for inclusion in the assessment.

Exposure of ecological receptors to radioactivity was considered in both the aquatic and terrestrial environment. Receptors in the aquatic environment were selected to include consideration of external radiation from water and sediment as well as radiation exposure through water consumption, and through the consumption of fish, benthic invertebrates and aquatic vegetation. Terrestrial receptors were chosen in consideration of radiation through direct sources (e.g. gamma radiation), intake of water, and consumption of food sources. Ecological receptor characteristics were assumed to represent a reasonable maximum exposure scenario, in that cautious assumptions were made regarding the receptor's behaviour and home range.

The ecological receptors that have been selected for inclusion in the pathways assessment include the following:

- Aquatic biota (including aquatic plants, benthic invertebrates, predatory and forage fish, etc.)
- Waterfowl (mallard, merganser, and scaup);
- Predatory birds (Peregrine falcon);
- Small mammals (hare);
- Predatory large mammals (wolf and black bear); and,
- Non-predatory large mammals (barren-ground caribou and moose).

The human receptors selected for the evaluation are a working member of the public (e.g. site cook or security guard) and Aboriginal peoples who hunt in the area.

Constituents of Potential Concern (COPC)

The average uranium concentration in Thor Lake ore (about 24 ppm) is higher than typical background rock and soil levels (which would typically be less than 10 ppm except in areas of mineralization) but is far below those of even very low grade uranium deposits (e.g. 1000 ppm). Average thorium levels in the Nechalacho deposit are higher at about 130 ppm (Appendix G). Site-specific COPC were identified for the Thor Lake Project.

Radionuclides of potential concern include the thorium series radionuclides (including thorium-232, radium-228 and thorium-228) and the uranium series (including uranium-238, thorium-230, radium-226, lead-210 and polonium-210). These radionuclides will normally be in secular equilibrium (i.e., each radionuclide will be present at the same activity, Bq/g, as the parent U-238 for the uranium -238 decay chain, and as the parent Th-232, for the thorium-232 decay chain. This allows for radioactivity to be calculated from the mass concentrations of U and Th, where radioisotope concentrations are unavailable.

Baseline and incremental radionuclide concentrations were determined from available baseline studies (Stantec 2010c), mine material assessments (SGS 2011), air quality modelling (RWDI 2011), and water modelling (Section 6.4.2).

Exposure Pathways

A conceptual site model was developed for the Nechalacho Mine and Flotation Plant site, identifying potential pathways of exposure. This site consists of an underground mine, diesel generator, flotation plant, tailings management facility, and docking area. COPC may be introduced to the water and sediment through the use of the Thor Lake water system as a Tailings Management Area (TMA). Ore extraction, transfer, and processing may introduce radiological COPC to the air as suspended particulate, which may be respired by receptors, or fall as dust to enter the soil profiles and be taken up by vegetation. Radioactivity pathways to human and ecological receptors were determined using conservative assumptions and are provided in Table 4.9-6. Source terms included in the Nechalacho Mine and Flotation Plant models include:

- Air emissions of radon;
- Total of dust emitted from mining, milling, and site operations (RWDI 2011) which was used to estimate the radionuclides associated with dust; and
- Radionuclide concentrations in Thor Lake, modelled from inputs to the upstream tailings management area (Section 6.4.2).

Owing to the absence of radiological source data for the downstream environments, Aboriginal groups were conservatively modeled to obtain food and water from the Thor Lake Project area proper. Adult and toddler age groups were assessed, using studies of traditional land use and food consumption to determine exposure scenarios.

At the Hydrometallurgical Plant Site, there were no pathways identified that could lead to a significant incremental increase in radioactivity exposure for receptors. Ore is to be containerized while mobilizing to and from site, and hydrometallurgical processing is within an enclosed facility. Results of air quality modelling at the site indicated there is no significant increase to suspended particulate or dustfall due to the Hydrometallurgical Plant, with no subsequent loadings of particulate (or radioactive particulate) to the air, soil, or vegetation. The tailings slurry is to be discharged to the L-37 pit (former pit within the brownfield site), and excess water to the N-42 pit. The pits are isolated from the surface hydrological regime and tailings water will discharge to the groundwater system, requiring decades within the groundwater flow regime before discharge to Great Slave Lake. The residence time, dilution factors, and processes of natural attenuation in flow through porous media, eliminate the groundwater pathway as a source of radiological concern. There are consequently no pathways of incremental radioactivity due to the Hydrometallurgical Plant Site, and the plant was removed from the assessment.

TABLE 4.9-6: NECHALACHO MINE AND FLOTATION PLANT EXPOSURE PATHWAYS

Receptor*	EXPOSURE PATHWAYS					
	Intake of Water	Intake of Terrestrial Vegetation	Inhalation of Dust+	Radon	Consumption of Aquatic Biota	Consumption of Game (waterfowl, hare, caribou)
Camp Cook**	Y[A]	N	Y[B]	Y[B]	N	N
Aboriginal Peoples***	Y[A]	Y[B]	Y[B]	Y[B]	Y[A]	Y
Aquatic Biota	Y[A]	N	N	N	Y[A]	N
Waterfowl	Y[A]	N	Y[B]	N	Y[A]	N
Predatory Birds	Y[A]	N	Y[B]	N	Y[A]	Y
Non-Predatory Terrestrial Birds	Y[A]	Y[B]	Y[B]	N	N	N
Small Mammals	Y[A]	Y[B]	Y[B]	N	N	N
Large Predators	Y[A]	N	Y[B]	N	Y[B]	Y
Non-Pred. Large Animals	Y[A]	Y[B]	Y[B]	N	Y[B]	N

* Conservative assumptions made for all receptors. Receptors placed in the location of maximum possible exposure (Nechalacho Mine and Camp Area).

N=No Exposure

Y=Exposure possible, quantified in assessment

**=Workers are not permitted to hunt or consume local biota while on site

***=Members of Aboriginal groups are not expected to occupy the main mine area, but are assessed at this location as a conservative assumption

+=Dust was conservatively assessed assuming 100% ore when in fact both ore and waste rock are associated with mining.

A=Thor Lake

B=Nechalacho Mine/Camp Area

Dose Characterization Summary

The water quality modelling (Section 6.4.2) showed that the impact of radionuclides in the tailings is expected to be low; additional calculations showed that potential radon concentrations due to mine emissions were very low. Dose Coefficients (DCs) were used to estimate the doses to human receptors as a result of ingestion and inhalation exposure. The incremental doses were then compared to the dose constraint of 0.3 millisieverts per year (300 μSv/y) recommended by Health Canada in the Canadian NORM Guidelines (Health Canada 2000). Doses below this level are considered as "unrestricted" and no further action is needed to control doses or materials. Since the appropriate comparison benchmark is incremental, the estimated doses exclude background. The estimated doses to both the site worker and Aboriginal peoples were well below the dose constraint.

The results of the pathways assessment showed that the dose to aquatic biota were below the accepted benchmark dose. A range of values of relative biological effectiveness (RBE) for alpha radiation were used in the assessment to account for the uncertainty associated with the choice of RBE. The results showed that no adverse effects on aquatic biota are expected from the release of low levels of radionuclides to the water.

Similar to the approach adopted for aquatic biota, a range of RBE and dose benchmarks were used in the assessment of terrestrial biota. The results showed that no adverse effects on terrestrial biota are expected from the release of low levels of radionuclides to the air and water.

Considering the conservative nature of the calculations, it is unlikely that there would be any environmental effects resulting from exposure to radioactivity from the Thor Lake site.