3.0 PROJECT DESCRIPTION

3.1 OVERVIEW

A description of the Project as it is currently conceived is provided in this chapter. As described in Chapter 2, a feasibility study of the Project was completed in January 2013. The Project will undergo more detailed engineering, and will be constructed and operated in accordance with currently accepted safety and construction standards and will incorporate technology that is technically and economically viable both in terms of efficient mining and processing as well as for its environmental performance.

This Chapter provides a description of the facilities and equipment that will comprise the Sisson Project, based on the available information at the time of writing. The description that follows is based largely on the feasibility study for the Project as documented in the Technical Report entitled "Canadian National Instrument 43-101 Technical Report on the Sisson Project, New Brunswick, Canada" ("the Technical Report"; Samuel Engineering 2013). Other sources of information include the Project Description for the Sisson Project ("the *CEAA* Project Description"; Stantec 2011), the most recent mineral resource estimate for the Project (RPA 2012), and supplemental information provided by Northcliff/SML.

The Project as described in this document is likely to evolve as detailed engineering design is completed and as a result of the iterative planning process associated with the environmental impact assessment (EIA). So as to not understate the potential environmental consequences of the Project at this planning stage, the Project Description provided in this Chapter presents an "outer envelope" or conservative estimate of the scope, footprint, and environmental effects of the Project, including the magnitude and extent of emissions, discharges and wastes. The Project will ultimately be built and operated within the outer envelope presented in this EIA Report.

The key aspects of the Project are described below, including:

- the Project components, including the likely infrastructure and associated facilities, and planned mitigation for potential environmental effects;
- alternative means of carrying out the Project;
- the activities that will be carried out during Construction, Operation, and eventual Decommissioning, Reclamation and Closure of the Project; and
- Project-related emissions, wastes, and other requirements, and their management.

3.1.1 Project Summary

The Project is a conventional, open pit tungsten and molybdenum mine located near the community of Napadogan, New Brunswick (Figure 1.1.1). The mine will operate for an estimated 27 years at a nominal mining rate of 30,000 dry metric tonnes per day (t/d) of tungsten- and molybdenum-containing ore, processed in an ore processing plant to produce tungsten and molybdenum mineral products. The main activities associated with the Project include:

- mining by conventional open pit methods, and storage of ore and waste rock;
- stockpiling of organics and overburden for future reclamation use;
- on-site processing of ore in an ore processing plant to produce mineral concentrates and tailings, and further processing of tungsten concentrate to a higher-value crystalline tungsten product and solid precipitate waste products;
- development and operation of a tailings storage facility (TSF), and associated storage of tailings;
- diversion of clean surface water away from Project facilities (*e.g.,* open pit, TSF);
- collection and storage of all precipitation on the Project site and groundwater flows into the open pit (termed "mine contact water") for re-use in the ore processing plant, and discharge of surplus water, with treatment as needed to meet permitting conditions;
- transportation of the mineral products to off-site buyers; and
- decommissioning of facilities, and reclamation and closure of the site at the end of the Project life.

3.1.2 Geographic Location

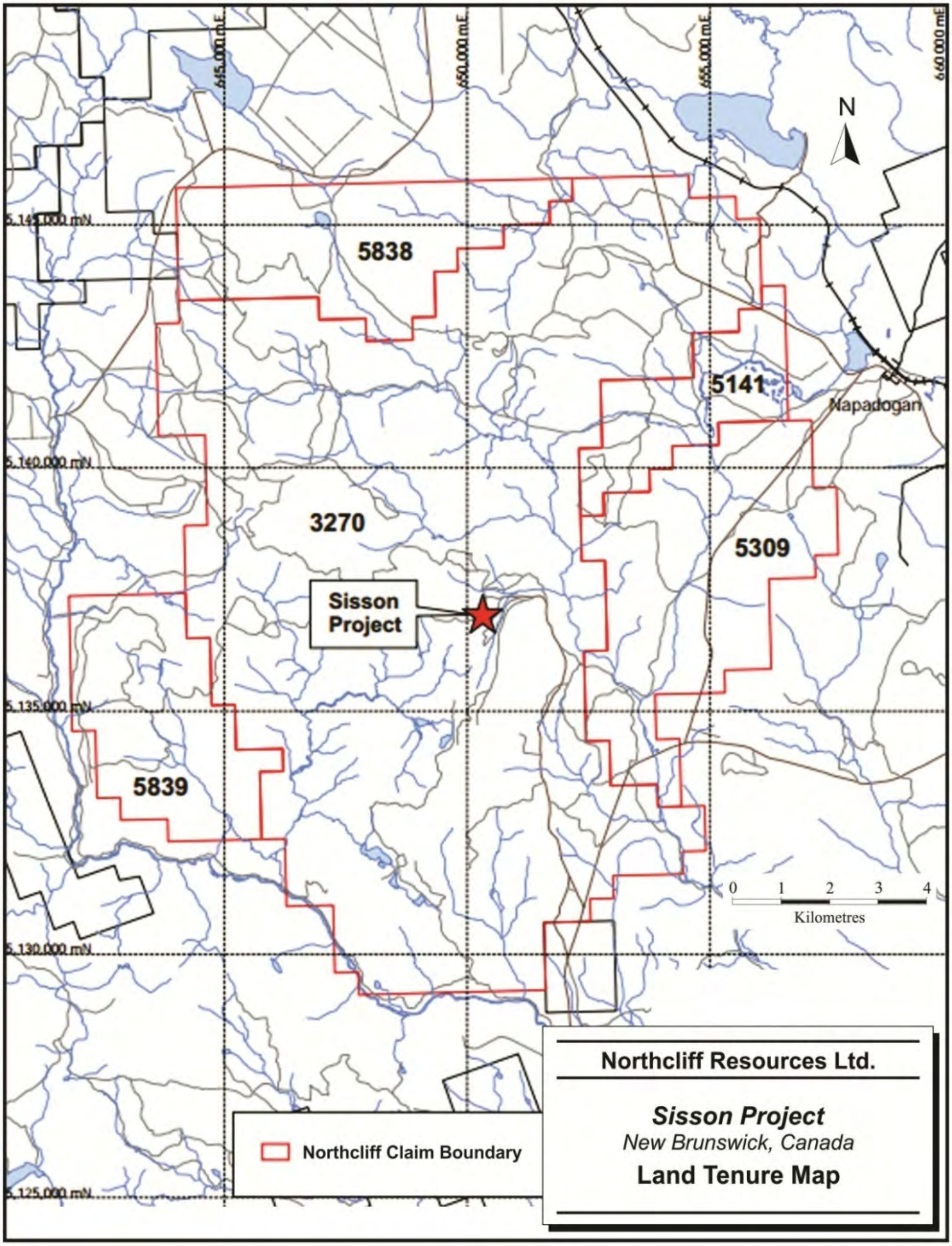
The Project site is located at approximately N 46º 22' by W 67º 03', in east-central New Brunswick, approximately 60 km directly northwest of the city of Fredericton, and approximately 10 km southwest of the community of Napadogan (Figure 1.1.1).

3.1.2.1 Property Ownership

The Project will be situated entirely on provincial Crown land, administered by the New Brunswick Department of Natural Resources (NBDNR), within an 18,800 hectare (ha) claim block with mineral rights held by SML. Project elements will be located on a parcel of land identified by Service New Brunswick (SNB) as Parcel Identifier (PID) Number 75140541. This is referred to in this EIA Report as the Project Development Area ("PDA", defined as the area of physical disturbance associated with the Project), which with the planned linear facilities associated with the Project encompasses an area of approximately 1,253 ha.

3.1.2.2 Land Tenure

Tenure for the mineral rights is held via five contiguous claim groups comprising a total of 850 units (Figure 3.1.1). In New Brunswick, claims are staked online as blocks of units which measure 500 m by 500 m each. The list of mineral claims held by SML is provided in Table 3.1.1.



Source: Samuel Engineering (2013).

Figure 3.1.1 Land Tenure Map, Sisson Project

Table 3.1.1 Mineral Claims Held By SML

Claim Group Number	Mineral Claim Name	Mineral Claim Type	Mineral Claim Sub Type	Issue Date	Expiry Date	Status	Units
5141	Turnbull Mountain	Mineral	Claim	2007-06-14	2012-06-14	Active	40
5839	Barker Brook	Mineral	Claim	2010-08-17	2012-08-17	Active	66
5838	West Branch Napadogan	Mineral	Claim	2010-08-17	2012-08-17	Active	77
5309	Napadogan Brook	Mineral	Claim	2007-11-28	2012-11-28	Active	106
3270	Sisson Brook	Mineral	Claim	1997-09-04	2012-09-04	Active	561
						Total	**850**

Source: NBDEM (2013).

SML owns a 100% interest and 100% of the mineral claims for the Sisson Project. Mineral claims for the Project were acquired through two agreements with Geodex, signed in October 2010 and May 2012. There are no royalties on the property or back-in rights. SML does not hold any surface rights within the claim block. The New Brunswick *Mining Act* allows for access and use of the surface for mining through the permitting process.

The mineral resources associated with the Sisson tungsten and molybdenum ore deposit are all located within claim group number 3270.

3.1.3 The Sisson Deposit

3.1.3.1 Property History

As discussed in the Technical Report (Samuel Engineering 2013), the first significant work in the Sisson area was carried out in the late 1950s by Nashwaak Pulp and Paper Co. Twelve holes were completed in 1955 and 43 holes in 1959-1960, which resulted in the discovery of the Nashwaak polymetallic vein deposit.

From 1967 to 1969, Penarroya Canada Ltée conducted geological mapping, a ground magnetic survey, and soil sampling mostly south of the Sisson deposit. Texasgulf Inc. and Kidd Creek Mines Ltd. carried out exploration work from 1973 to 1983 comprising soil sampling, geological mapping, trenching, ground geophysical surveys, and drilling. Relatively limited work was conducted by various operators between 1977 and 2001.

From 2004 to 2009, Geodex, initially in joint venture with Champlain Resources Inc., carried out ground and airborne geophysical surveys, compilation of historical data, trenching, re-analysis of historical drill core, geological mapping and prospecting, and extension of previous soil and till sampling grids over and around the Sisson deposit. Approximately 210 drill holes were completed. Preliminary economic assessments with positive conclusions were completed by Wardrop Engineering Inc. in 2007 and Geodex in 2009. Northcliff signed a joint venture agreement with Geodex in October 2010, and has since conducted diamond drilling and test pitting. In 2012, Northcliff announced an updated mineral resource estimate for the Sisson Project (RPA 2012), and became sole owner of the Project by acquiring Geodex's remaining interest in it.

3.1.3.2 Deposit Geology

The Sisson ore deposit is defined as an intrusion-related, structurally controlled, bulk tonnage tungsten-molybdenum deposit. Deposits of this type are generally hydrothermally similar to porphyry copper deposits and they form in convergent margin to collisional tectonic environments and are related to highly-evolved granitic melts formed from continental crust.

The Sisson ore body was initially identified between 1979 and 1982 and drilling by Geodex between 2005 and 2009 served to better delineate the deposit. Drilling campaigns by Northcliff between 2010 and 2012 further improved the understanding of the mineral resources for the feasibility study and provided sufficient evidence of the resource to move forward with the Project. The most recent mineral resource estimate filed by Roscoe Postle Associates Inc. (RPA) was found to be consistent with historical estimates (RPA 2012).

The location and dimensions of the open pit mine will be determined by the geology and mineralization of the deposit to optimize the economic recovery of the resource. An aerial view looking west over the area of the ore body is shown in Photo 3.1.1.

Source: Sisson Mines Ltd.

Photo 3.1.1 Aerial View of Project Site, Looking West Over the Middle of the Sisson Ore Body

Minimal outcrop exists in the Sisson project area; the geological interpretation is based on various exploration activities in the area and regional interpolation. The Sisson ore deposit area is centred on a north-trending contact between Acadian plutonic rocks, which include the Howard Peak Granodiorite and the Nashwaak Granite to the west, and older metavolcanic and metasedimentary rocks of the Tetagouche and Miramichi Groups to the east. The metavolcanic and metasedimentary host rocks formed during the Taconic Orogeny are of Cambrian to Ordovician age and include the predominantly clastic sedimentary sequences of the Miramichi Group overlain by Ordovician felsic to mafic volcanic strata and clastic sedimentary rocks of the Tetagouche Group. The plutons intruded the host rocks during the Acadian Orogeny. A simplified geology map is shown on Figure 3.1.2 which also illustrates that mineralization occurs in four contiguous zones in the Sisson deposit area. The bulk of the mineralization is hosted in Zone III, with two narrow, structurally controlled zones that extend north, Zone I and Zone II. The Ellipse Zone extends northwest from the southwest corner of Zone III.

The lithologies of the Sisson deposit area from West to East include the following:

- Nashwaak Granite – massive, likely multiphase, equigranular biotite Acadian granite batholith;
- Howard Peak Granodiorite – this occurs in three phases, granodiorite, quartz diorite, and gabbro, as follows:
    - Granodiorite Phase – equigranular biotite granodiorite which grades into quartz diorite to the east and is intruded by the Nashwaak Granite in the west;
    - Quartz Diorite Phase – this rock type hosts mineralization in the western part of the Ellipse Zone and consists of medium grained, subporphyritic, hornblende quartz diorite; and
    - Gabbro Phase – this rock type hosts mineralization in the eastern part of the Ellipse Zone and the western part of Zone III and consists of medium grained, porphyritic pyroxene hornblende gabbro. The eastern contact marks the boundary with the rocks of the Tetagouche Group and is a near-vertical disrupted zone or fault;
- Turnbull Mountain Formation (Tetagouche Group) – consists of bimodal tuffaceous volcaniclastic rocks and biotite wacke, this is the main host to the mineralization in Zone III;
- Miramichi Group – dominated by siliceous wacke interbedded with siltstones and quartzites with minor interbeds of intermediate volcanicalastics; these rocks may host low grade mineralization on the eastern margin of the Sisson deposit; and
- Hayden Lake Formation (Tetagouche Group) – includes black shales, flow banded felsic rocks, and fragmental mafic volcanic rocks that overlie the Miramichi Group east of the Sisson deposit.

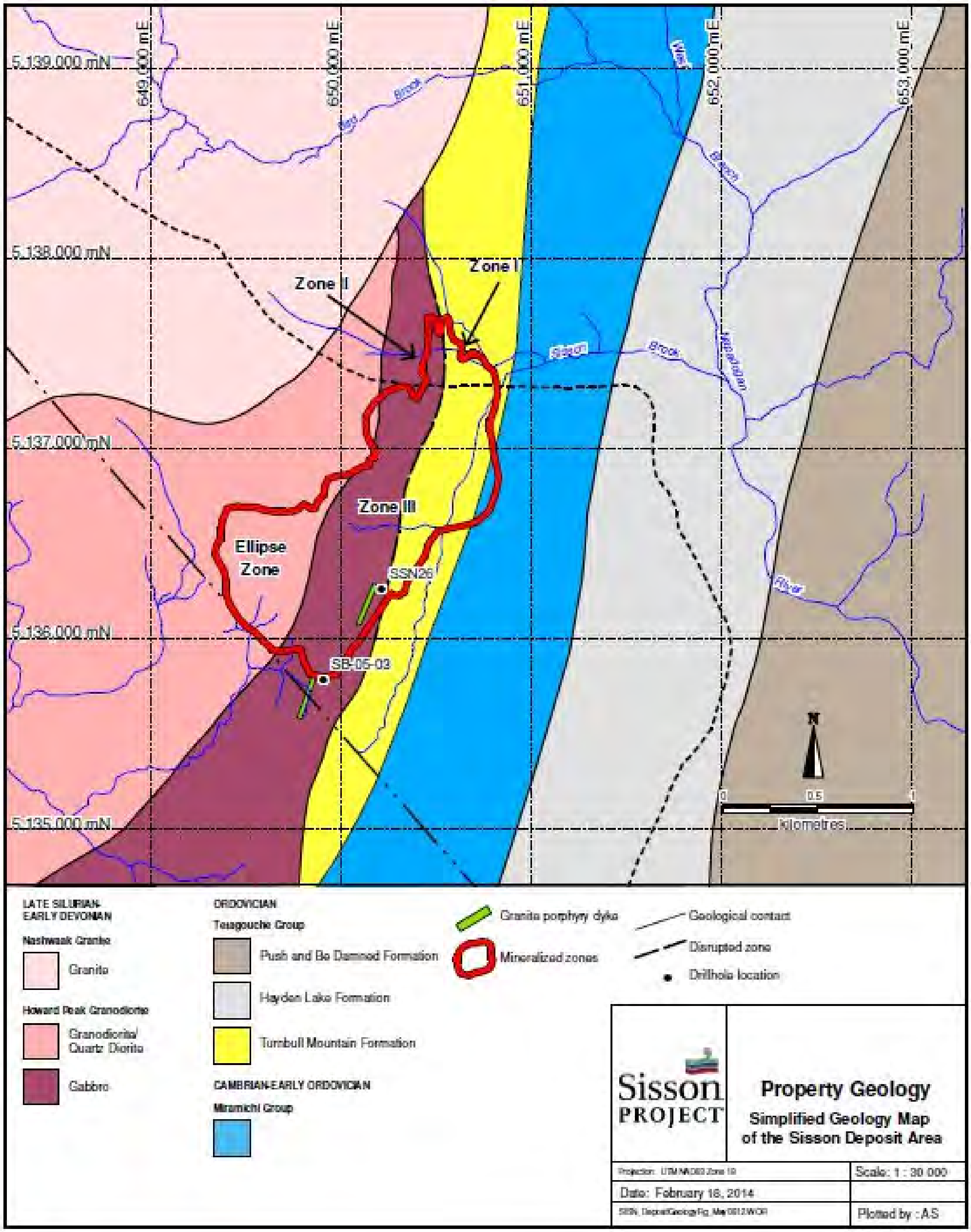


Figure 3.1.2 Simplified Geology Map of the Sisson Deposit Area

Mineralization in the Sisson deposit is hosted by:

- the quartz diorite and gabbro phases of the Howard Peak Granodiorite;
- felsic, mafic, and mafic crystal tuffs in the western part of the Turnbull Mountain Formation;
- biotite wacke with minor interbeds of tuff in the eastern part of the Turnbull Mountain Formation; and
- volumetrically minor granite dykes and very rare mafic dykes.

Low-grade mineralization on the eastern edge of the deposit is hosted by more siliceous biotite-sericite wackes that may be part of the Miramichi Group.

Mineralization at Sisson occurs almost exclusively in quartz veins, fractures, and their alteration envelopes. Tungsten and molybdenum are the metals of principal economic interest throughout the deposit. Several other metals, including copper, zinc, lead, arsenic, and bismuth, occur more erratically in geochemically anomalous but sub-economic concentrations.

Deformation of the Sisson Project area is characterized by folding and various types of cleavage and foliation development. The stratified rock sequences were folded into a series of D2 anticlines and synclines that consistently strike north-northeast and dip steeply to the east; this deformation occurred during the Taconic Orogeny predominantly in the Ordovician. The rocks of the Miramichi Group lie in the core of an anticline, flanked to the east and west by conformably overlying volcanic-bearing sequences of the Tetagouche Group. The D2 deformation is characterized by folding. The presence of a fault between the Miramichi Group on the western limb of the anticline was proposed by Fyffe *et al.* (2008) on the basis of their interpretation of missing stratigraphic section and increased intensity of structural fabrics from west to east across the area (Fyffe and Thorne 2010). A number of major, northerly to north-northeasterly trending faults that displace earlier fold structures have been mapped in central New Brunswick. However, no evidence of a fault in this location has been indicated by drilling results in the Sisson deposit. Fyffe and Thorne (2010) determined that a fault would be consistent with the intensely sheared nature of the rocks hosting the Sisson mineralization, but on the basis of drilling results this is more likely caused by the disrupted contact between the Howard Peak Granodiorite Pluton and the sediments of the Tetagouche Group because the eastern margin of the pluton is intensely sheared, cataclastized, and contains abundant xenoliths derived from the adjacent folded host rock.

There is evidence to suggest the emplacement of the Howard Peak pluton, which at least locally contains a strong foliation and has been dated by U-Pb on zircon at 432 million years (Ma) (Lentz, D. Personal communication, 2011), likely took place during the D2 deformational event of Fyffe *et al.* (2008). Granitic dykes which cut and partially assimilate the gabbroic rocks vary from weakly foliated to unfoliated, and have been dated by U-Pb zircon methods at approximately 375-380 Ma, which is equivalent to Re-Os dates on molybdenite of approximately 378 Ma (Lentz, D. Personal communication, 2011). Differing orientations of the foliation in some gabbroic xenoliths indicate that they were rotated during their incorporation into the granite dykes and that the stronger deformation significantly pre-dated emplacement of the dykes, which is consistent with the isotopic ages. The granitic dykes are likely offshoots of the Late Devonian Nashwaak pluton, which therefore must have been emplaced during the waning stage, and after the cessation, of D2 deformation. Granitic dykes were probably emplaced along localized zones of high strain which would, in turn, have provided permeable pathways for the introduction of the hydrothermal fluids which were the source of mineralization. Deformation of the Sisson Project area significantly pre-dates the formation of the deposit.

Very few fractured contacts or faults were identified in the 2011 open pit geomechanical/ hydrogeological site investigation program. The overall rock mass quality at the Sisson deposit is good and the intact rock strength is strong. The identified rubble zones and gouge filled structures were localized in the drillholes, and do not imply any large-scale continuous fractured features at the drillhole locations. The deformation of the Sisson project area likely served to strongly anneal the affected rock types which may account for their current strength and the scarcity of extensive brittle deformation. Exploration drilling at the Sisson deposit has intersected a near-vertical, strongly disrupted zone along the contact between the Howard Peak gabbroic rocks and the metavolcanic rocks of the Turnbull Mountain Formation. Similar disrupted zones passing through the entire deposit area have not been identified to date.

3.1.3.3 Geological Resource and Mine Life

In June 2012, RPA conducted an audit of an updated mineral resource estimate for the Project prepared by Northcliff/SML personnel (RPA 2012). The effective date of this estimate was February 29, 2012, and is considered to be current to December 31, 2012. The mineral resource estimate is summarized in Table 3.1.2.

Table 3.1.2 Mineral Resource Estimate

Category	Tonnage (Mt)	Tungsten (as WO_3) (%)	Molybdenum (Mo) (%)	WO_3 (M mtu)	Mo (M lb)	WO_3 Equivalent (%)	Average NSR ($/t)
Measured	108	0.072	0.023	7.70	55.3	0.096	26.67
Indicated	279	0.065	0.020	18.0	122	0.086	23.42
Measured + Indicated	387	0.067	0.021	25.7	178	0.089	24.33
Inferred	187	0.050	0.020	9.41	82.6	0.074	18.63

Notes:

1) Canadian Institute of Mining (CIM) definitions were followed for mineral resources.
2) Mineral resources are estimated at a net smelter return (NSR) cut-off grade of $US9.00/t.
3) Mineral resources are estimated using a long-term metal prices of US$350 per mtu WO_3 and $US15/lb Mo, and a US$/C$ exchange rate of 0.9:1.
4) Metallurgical recoveries for the NSR calculation were 82% for Mo and averaged 77% for WO_3 over the life of mine. WO_3 recovery is a function of mill head grade.
5) Numbers may not add due to rounding.

Legend:

t = dry metric tonnes
WO_3 = tungsten trioxide
MO = molybdenum
M = million
mtu = metric tonne unit
lb = pounds
NSR = net smelter return

Source: Samuel Engineering (2013).

The mine life has been estimated at 27 years, according to an optimized mining schedule detailed in Section 3.4.2.1.3. That life could be extended depending on further on-site drilling and future metal prices on the commodity markets.

3.1.4 Project Schedule

The Project schedule is as follows.

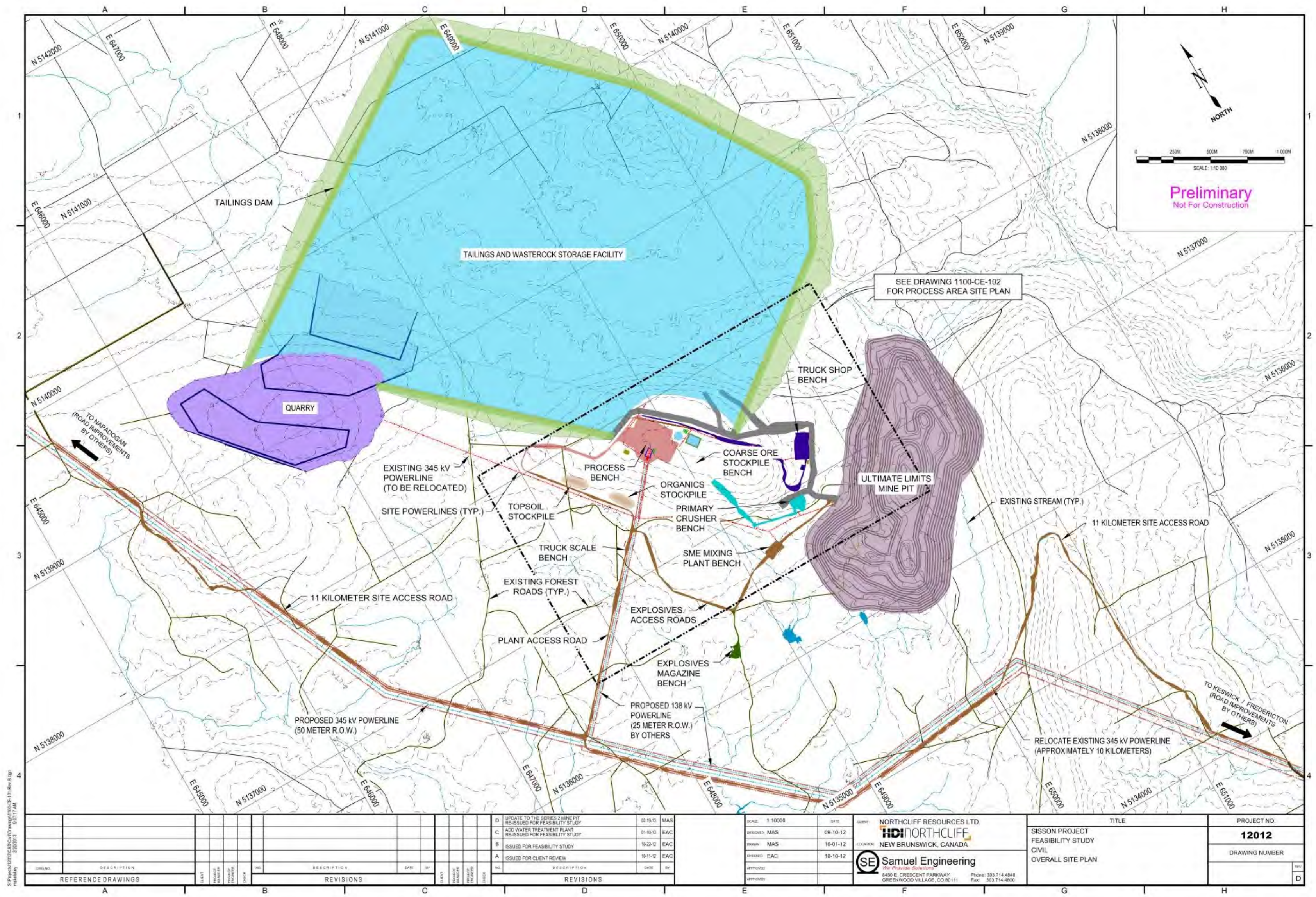
- **Construction:** Construction will proceed for a period of up to 24 months, commencing as soon as the EIA is approved, the applicable permits, approvals or other forms of authorization have been obtained, and Project financing has been secured. For the purpose of this EIA Report, it has been assumed that Construction will begin in the second half of 2015.

- **Operation:** Operation will commence immediately following Construction and will continue for an approximate period of 27 years or until the mineral resource is depleted.

- **Decommissioning, Reclamation and Closure:** Decommissioning of Project facilities and Reclamation of the Project site will occur following the completion of Operation. Closure will commence during the Decommissioning and initial Reclamation period, and will continue until the pit lake fills with water over about 12 years. Post-Closure (*i.e.*, when the pit lake is completely filled) will follow.

3.2 DESCRIPTION OF MAJOR PROJECT COMPONENTS AND FACILITIES

The Project will involve an open pit mine and associated processing, storage, and waste management facilities. In the sections below, each of the major components and facilities for the Project are described. The specific locations of the various Project facilities are shown in Figure 3.2.1.



Source: Samuel Engineering (2013).

Figure 3.2.1 Site Layout

3.2.1 Development of Project Design Since April 2011

In April 2011, the Project Description (Stantec 2011) was accepted by the Canadian Environmental Assessment Agency (CEA Agency) to initiate the federal environmental assessment process under the *Canadian Environmental Assessment Act* (*CEAA*).

Since the filing of the Project Description, engineering design has advanced to support the feasibility study, completed in January 2013. The Project design will continue to evolve as basic engineering, planning, detailed engineering, and procurement is carried out. In consideration of the results of the baseline studies, selection of best-available technologies and economic considerations, the conceptual design of the Project described in Stantec (2011) has since been revised to consider the various environmental and engineering constraints and opportunities.

Some of the major changes that have been made to the Project design since April 2011 include the following.

- The ore processing plant, TSF, and associated facilities are all sited within a single watershed, Napadogan Brook, for maximum effectiveness of responsible water management and ultimate ease of closure of the Project.

- The ore processing plant, TSF, and other major Project components are sited in very close proximity to the open pit location, thereby minimizing hauling and pumping distances for maximum energy efficiency.

- The TSF has been designed to exceed the requirements set out in the Canadian Dam Association's "Dam Safety Guidelines" (Canadian Dam Association 2007) to ensure it will readily withstand the effects of extreme storm events and earthquakes.

- The size and configuration of the TSF have been optimized to avoid unnecessary disturbance of brooks, lakes and fish habitat, and areas of elevated archaeological potential, particularly in the northwest corner of the TSF.

- All waste rock (some of which is potentially acid generating) will be stored sub-aqueously (*i.e.,* under water) in the TSF rather than in a separate waste rock storage area, to avoid the generation of acid rock drainage (ARD) and associated metal leaching (ML).

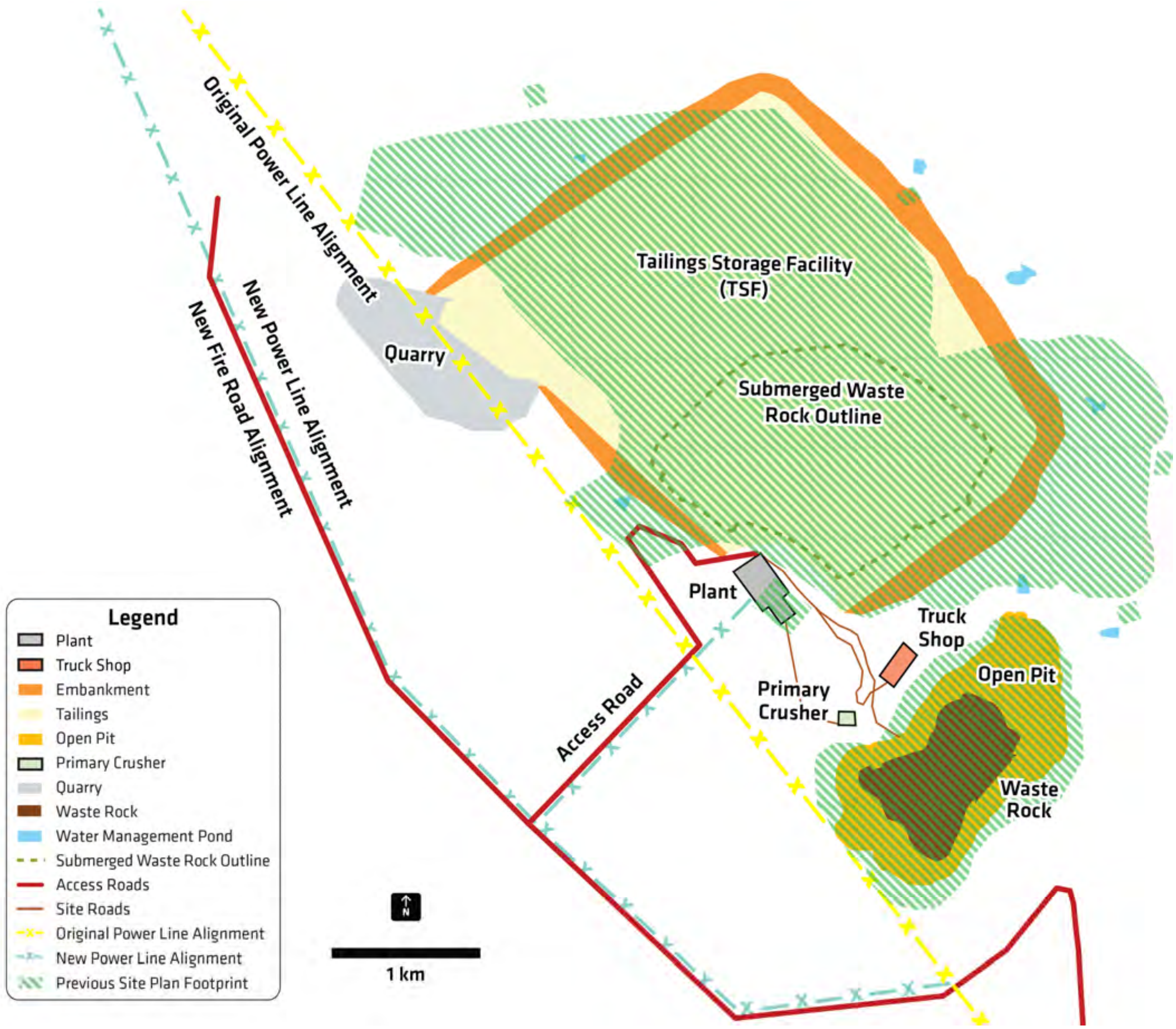
- No waste rock will be used to build the TSF embankments since some is potentially acid generating (PAG). Instead, a quarry will be developed on-site to provide non-potentially acid generating (NPAG) rock for the embankments.

- Ammonium paratungstate (APT) will be produced on-site as an added-value end product thereby enhancing job creation and economic benefits for the people of New Brunswick and Canada.

- An existing 345 kV transmission line and the existing Fire Road that currently cross the Project site will be re-routed to make way for Project facilities, both within the same corridor to minimize footprint and habitat fragmentation.

- Fish habitat offsetting will be included as part of the Project.

An overview of major changes in the layout of Project components since April 2011 is provided in Figure 3.2.2.



Source: Sisson Mines Ltd.

Figure 3.2.2 Overview of Major Changes in the Sisson Mine Layout Since April 2011

3.2.2 Open Pit Mine

An open pit mine is an excavation in the ground for the purpose of extracting ore, and which is open to the surface for the duration of the mine's life. To expose and mine the ore, it is necessary to remove surface soils (*i.e.,* overburden), and excavate and relocate waste rock (*i.e.,* material that does not contain the target mineral(s), also called barren rock).

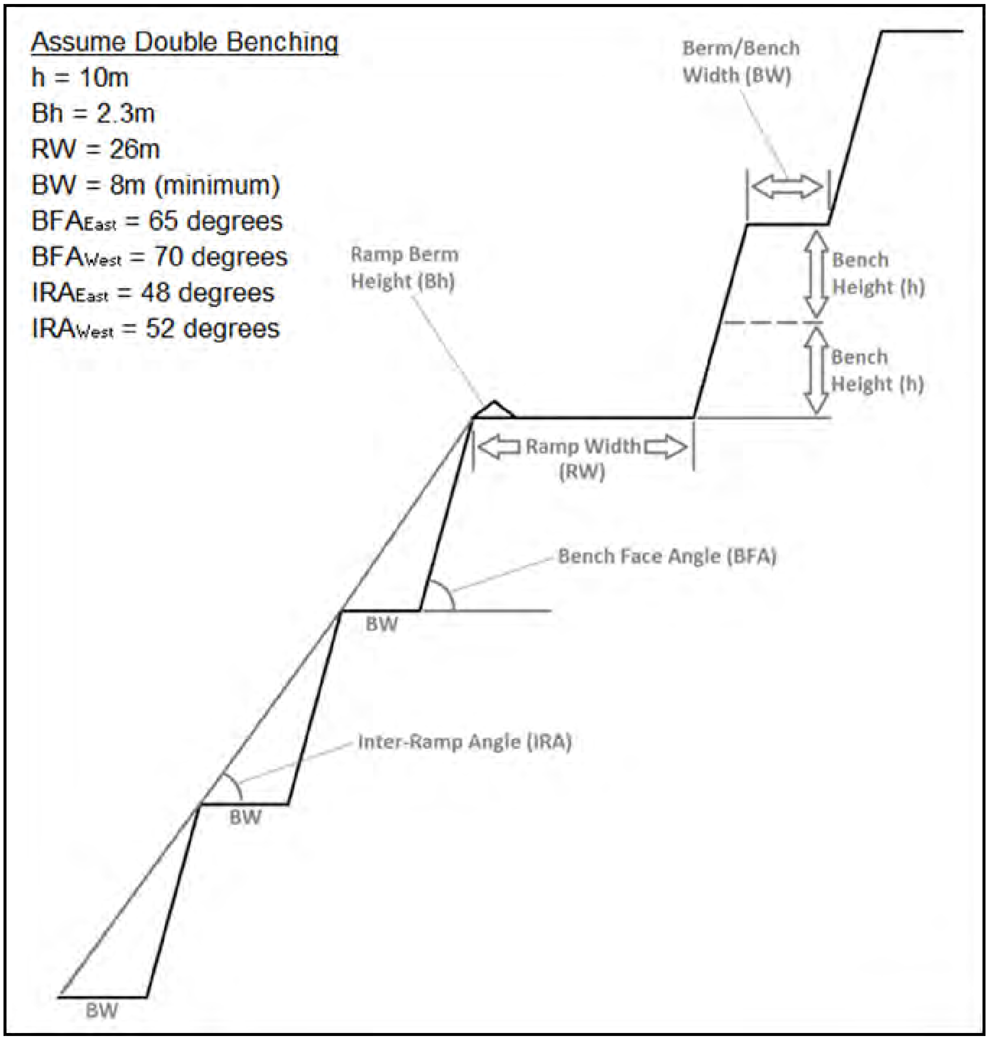
The layout of the open pit is developed to facilitate ore extraction and accommodate the equipment operation in the pit. The open pit includes benches, haul roads, and overburden disposal. A bench is the term used for each ledge that forms a single level of operation within the pit above which mineral or waste materials are mined back to the bench face. The mineral or waste is removed in successive layers, each of which is a bench. Several benches may be in operation simultaneously in different parts of, and at different elevations in, the open pit mine.

The open pit will cover an area of about 145 ha at its ultimate extent, and will be 300 to 370 m deep (compared to current elevations) upon completion of mining at approximately Year 27.

As currently designed, the open pit will intersect several fingertip streams that are tributaries to Sisson Brook, as well as Sisson Brook itself. Some of the smaller fingertip streams that are tributaries to McBean Brook to the south of the pit will also be eliminated. Engineered drainage channels around the open pit will divert some of the Sisson Brook catchment into McBean Brook. Further details on these aspects are provided in Section 7.4.

3.2.2.1 Mine Development and Mining Methods

Geotechnical parameters used in the pit optimization process were provided by Knight Piésold in support of the feasibility study and are summarized in Figure 3.2.3.

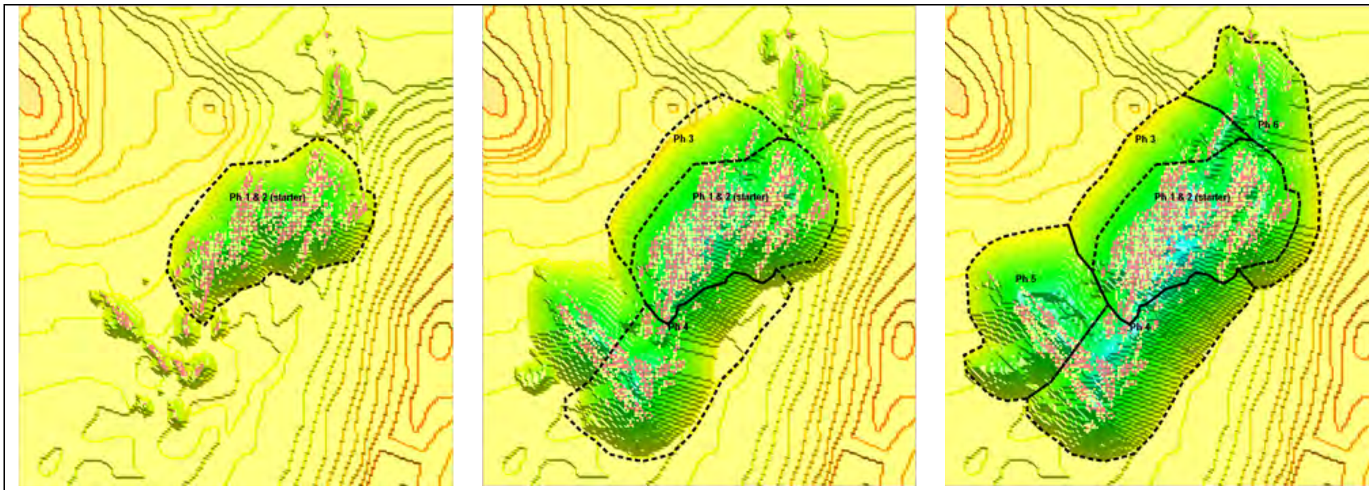


Note: Figure not to scale. Source: Samuel Engineering (2013).

Figure 3.2.3 Cross-Sectional Schematic of Open Pit Wall with Geotechnical Design Parameters

3.2.2.1.1 Open Pit Design

The pit design for the Project has six phases (Samuel Engineering 2013). Details considered were the addition of roads and bench access, removal of impractical mining areas with a width less than the minimum working width, and ensuring the pit slopes meet the detailed geotechnical recommendations. The phase designs are presented in Figure 3.2.4.



Series1 Pit04: Phase 1 & 2 | Series1 Pit06: Phase 3 & 4 | Series1 Pit08: Phase 5 & 6

Note: Figure not to scale. Source: Samuel Engineering (2013).

Figure 3.2.4 Open Pit Phase Design

3.2.2.2 Blasting and Ore Extraction

Open pit mining will operate year-round on a 24 hour per day, seven day per week schedule, for approximately 360 days per year. The pit will be excavated by drilling and blasting successive benches, and removing the broken rock with a hydraulic shovel and/or wheeled loaders. Blasting will occur two to three times per week using emulsion explosives.

The broken rock will be hauled out of the open pit by truck. Ore will be delivered to the primary crusher adjacent to the open pit, or to a small run-of-mine (ROM) ore stockpile located adjacent to the primary crusher. Waste rock will be hauled by truck to the TSF for sub-aqueous storage.

An on-site explosives magazine will be located near the open pit, in a secure area in compliance with applicable regulations. A magazine license will be obtained from Natural Resources Canada. Explosives use will be approximately 20,000 kg per week, with approximately 30,000 kg of explosives in storage at any given time.

3.2.2.3 Primary Crushing and Conveying to Ore Processing Plant

The ore extracted from the open pit will be delivered by truck to the primary crusher and then conveyed to the ore processing plant. The equipment will include:

- a 30,000 t/d primary gyratory crusher, fed via a truck dump hopper, and equipped with a dust collector;
- conveyors from the primary crusher to the coarse ore stockpile located outside the ore processing plant; and
- conveyors from the coarse ore stockpile to the secondary screening surge bin located within the ore processing plant; these conveyors are equipped with a dust collector.

3.2.2.4 Mobile Equipment Fleet

The mine vehicle fleet will consist of common large mining equipment as outlined in Table 3.2.1.

Table 3.2.1 Mobile Mining Equipment

Activity Area	Type of Equipment	Number of units		Fuel Type	Power (kW)
		Initial Quantity	Life-of-Mine Maximum Quantity		
Drilling	Diesel Hydraulic Drill – 165 mm	1	3	Electrical	520
Blasting	Blasthole Loader	1	1	Diesel	75
Loading	ELEC Hydraulic Shovel – 16.5 m^3	1	3	Electrical	900
	Dozer – 433 kW	1	1	Diesel	433
	Wheel Dozer – 372 kW	1	1	Diesel	372
Hauling	Haul Truck – 136 t	3	14	Diesel	1,080
	Water Truck – 4,000 gal	1	2	Diesel	750
	Water Truck – 20,000 gal	0	1	Diesel	750
	Dozer – 306 kW	1	2	Diesel	306
	Grader – 221 kW	1	2	Diesel	221
	Tire Manipulator - 293 kW	1	1	Diesel	293
Pit Maintenance	Dozer – 306 kW	0	0	Diesel	306
	Excavator – 301 kW	1	1	Diesel	301
	Mobile Screening Plant	1	1	Diesel	75
	Light Plant – 20 kW	2	4	Diesel	20
	Forklift – 10 t	1	1	Diesel	110
	Forklift – 30 t	1	1	Diesel	175
	Fuel/Lube Truck – 4,000 l	1	1	Diesel	280
	Jaw Crusher	1	1	Diesel	300
	274 kW - Loader	1	1	Diesel	274
	Crew Van - 15 Passenger	2	2	Gasoline	190
	Warehouse Truck – 1 t	1	1	Diesel	280
	Crew Cab Pickup	4	8	Gasoline	190
	Service Truck – 1 t	1	2	Diesel	280
	Welding Truck – 1 t	1	2	Diesel	280
	Picker Truck	0	1	Diesel	280
	Dozer – 306 kW (Quarry/TSF)	0	1	Diesel	306

Source: Samuel Engineering (2013).

3.2.2.5 Stockpiles and Storage Areas

A 30,000 t coarse ore stockpile will be located outside of the ore processing plant on a concrete pad with drainage to the TSF. Mine waste rock and low grade ore will be stockpiled in the TSF at a rate of approximately 18,000 and 4,000 t/d, respectively. Topsoil storage piles will be established surrounding the perimeter of the TSF, for future use during reclamation activities.

3.2.3 Ore Processing Plant

The principal economic minerals of the Sisson deposit are scheelite ($CaWO_4$) and molybdenite (MoS_2) and the Sisson concentrator process is based on the recovery of concentrates from these two minerals.

The ROM ore will be processed through an on-site concentrator that will produce a molybdenum flotation concentrate and a tungsten flotation concentrate. The molybdenum concentrate will be shipped off-site for further processing, while the tungsten concentrate will be processed on-site to produce a high-purity ammonium paratungstate (APT) product.

3.2.3.1 Concentrator Process Facilities

The concentrator facilities and process design for the Project includes the following major processing steps:

- three-stage crushing;
- single-stage, dual-line grinding and classification;
- molybdenum rougher-scavenger and bulk sulphide flotation;
- molybdenum regrind and four-stage cleaner flotation;
- molybdenum concentrate dewatering and packaging;
- tungsten rougher-scavenger flotation;
- tungsten three-stage cleaner flotation; and
- reagent preparation and utilities.

A simplified block diagram for the concentrator process is provided in Figure 3.2.5. The Sisson concentrator is designed to handle 10.5 million t/a of ROM feed using conventional comminution and flotation techniques, and to operate 365 days per year at an average operating availability of 92%. The daily average operating throughput rate is 28,767 t/d, and the design operating rate is 31,269 t/d.

A description of the concentrator process steps and equipment is provided in Section 3.4.2.2 (Ore Processing). Further details on the process and processing plant design characteristics are described in the Technical Report (Samuel Engineering 2013). These processes, configurations, and design characteristics may change slightly during detailed engineering design, but the outer envelope of resulting emissions and wastes of the Project will not change from that described and assessed in this EIA Report.

The major concentrator facilities consist of:

- equipment to size the materials being processed (*e.g.,* crusher, grinder, ball mill, screen, cyclone);
- flotation cells which are circular tanks in which a slurry is stirred and air is bubbled from below to “float” off the desired product for further processing. Different types of reagents are used to enhance the froth flotation process at different stages (*e.g.,* frother, collector, depressant, and pH conditioner);

- dewatering equipment (*e.g.,* thickener, filter, dryer); and
- various mixing and storage tanks, transfer pumps and piping.

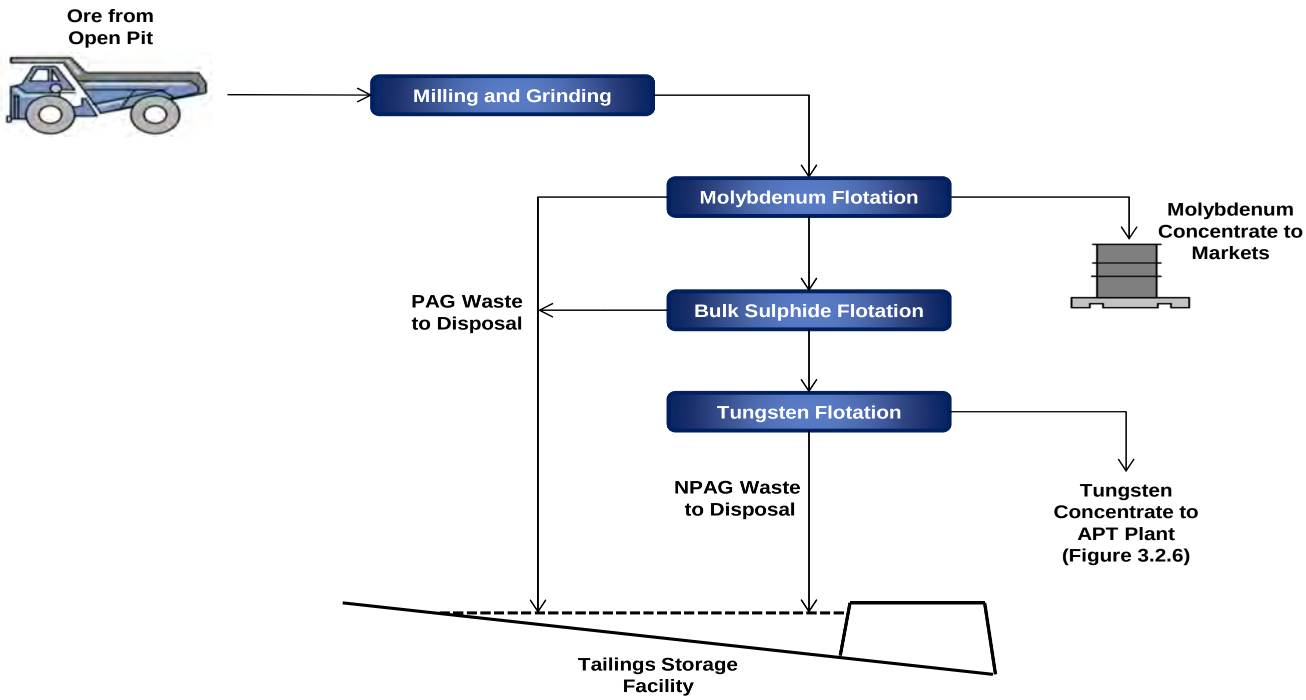


Figure 3.2.5 Simplified Block Diagram of the Ore Concentrator Plant

In summary, the concentrator process involves a three-stage crushing and screening circuit followed by two parallel closed circuit ball mills to produce a suitable feed for flotation.

A molybdenite rougher concentrate is then floated, reground and cleaned in four stages. The final molybdenite concentrate is thickened, filtered, dried and bagged for markets. The molybdenite tailings stream enters an adjoining Bulk Sulphide Flotation (BSF) circuit. The BSF concentrate will contain pyrite and other sulfide minerals which are removed to mitigate their interference in the downstream tungsten flotation process. Furthermore, the BSF concentrate forms the potentially ARD-generating molybdenum tailings stream and is sent to the TSF for sub-aqueous disposal to prevent oxidation.

The BSF tailings stream is then conditioned in two stages with depressants and collectors for tungsten flotation. The conditioned pulp enters the tungsten rougher circuit followed by an adjoining scavenger flotation circuit. The rougher concentrate is cleaned three times, thickened, filtered, dried and then refined to APT in the APT plant. The scavenger concentrate is recycled to the tungsten conditioners while the tailings, containing low levels of sulphides, are disposed to the TSF as NPAG tungsten tailings from the plant.

3.2.3.2 Reclaim Water Clarification

The concentrator will use reclaimed water from the TSF. Reclaim water from the TSF, containing low levels of unsettled fine suspended solids, will first be clarified with lime treatment. The clarification plant major equipment will include two conditioning tanks, a clarifier, and lime and flocculant preparation/mixing systems. After clarification and pH adjustment with carbon dioxide, the clarified water will be pumped to the concentrator process water tank for use in the process. Settled solids from the water clarification plant will be sent to the TSF for storage. The water clarification plant is designed to process approximately 2,635 m^3/h of recycled water.

3.2.3.3 Tailings Disposal

Flotation plant tailings will consist of both PAG and NPAG streams. As the tungsten flotation circuit tailings contain less than 0.1% sulphur, they are expected to be NPAG, and they will constitute approximately 95% of the total tailings mass. The molybdenum circuit tailings are expected to be PAG. The two tailings streams will be pumped to the TSF separately, to allow the sub-aqueous deposition of the PAG molybdenum tailings in the TSF and surface deposition of the NPAG tungsten tailings on the tailings “beaches” within the TSF.

Process water will be reclaimed from the TSF pond by pumps located on a floating barge to the reclaim water clarification plant.

Further details on the TSF are provided in Section 3.2.4.4 below.

3.2.3.4 Ammonium Paratungstate (APT) Production Facilities

The APT plant design was based on proven metallurgical and chemical processes and confirmed by testing conducted at the laboratories of SGS Lakefield, an independent testing facility in Ontario, supplemented by substantial in-house metallurgical expertise relating to APT production and the related technologies. The process as designed is a series of continuous and batch operations, with storage hold points, based on alkali pressure leach technology. The APT plant includes the following major processing steps:

- feed preparation;
- digestion and residue filtration;
- alkali recovery and solution purification;
- conversion to ammonium tungstate;
- APT crystallization;
- APT drying and packaging; and
- reagent preparation and utilities.

A simplified block diagram of the APT plant is provided in Figure 3.2.6. The APT plant is designed to process Sisson tungsten concentrate at a maximum feed rate of 29,000 t/a containing 881,000 metric tonne units of tungsten trioxide (mtu WO_3) per year (note: 1 mtu = 10 kg of material). On average, and based on feasibility study life of mine (LOM) mine plan, the APT plant will process 19,000 t/a of concentrates containing 581,000 mtu of WO_3 per year to produce 555,000 mtu/a of WO_3 contained in a high-quality APT product.

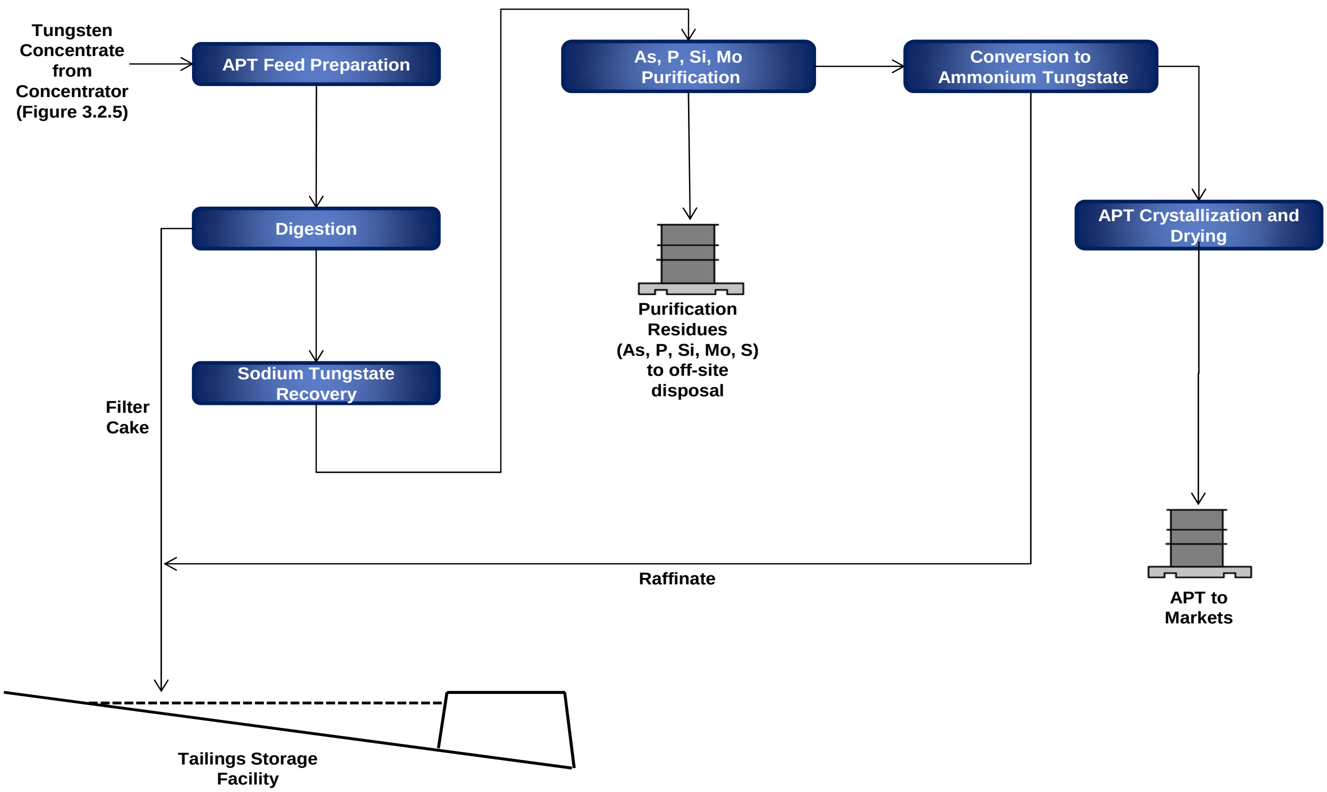


Figure 3.2.6 Simplified Block Diagram of the Ammonium Paratungstate (APT) Plant Process

A description of the APT plant process and equipment is provided in Section 3.4.2.2 (Ore Processing). Further details on the APT process and plant design characteristics are described in the Technical Report (Samuel Engineering 2013). These processes, configurations, and design characteristics may change slightly during detailed engineering design, but the outer envelope of resulting emissions and wastes of the Project will not change from that described and assessed in this EIA Report.

The major APT plant facilities consist of:

- equipment to size the materials being processed (*e.g.,* grinding mill, cyclone);
- dewatering equipment (*e.g.,* thickener, filter, dryer);

- reaction vessels and crystallizers; and
- various mixing and storage tanks, transfer pumps and piping.

In summary, tungsten concentrate will first be reground and dewatered in the feed preparation circuit in order to allow a uniform feed ahead of digestion. Tungsten in the concentrates will be digested using an alkali leach system, and the sodium tungstate solution will be filtered from the undigested leach residue. The residue will be stored within dedicated cells in the TSF, while the sodium tungstate solution will be processed through an alkali recovery and purification process. Common impurities will be removed and stored for off-site disposal. The resulting sodium tungstate solution will be converted to ammonium tungstate, and subsequently to APT crystals.

3.2.3.5 Reagent Storage

Reagents and chemicals for the process plants will be used in flotation, dewatering, reclaim water clarification and APT conversion circuits. Reagents will be delivered in bulk or by specific container and stored on-site in separate, secure, designated areas near or attached to process plant buildings. Covered and open storage areas for all reagents will be self-contained and equipped with spill recovery sump pumps as needed. Reagents used in the ore processing and APT processes are discussed further in Section 3.4.2.2.5.

3.2.4 Mine Waste and Water Management

3.2.4.1 Mine Waste

Waste from mining operations includes tailings generated from the mill process and waste rock generated from open pit mining. All tailings will be directed to a TSF for permanent storage and disposal in two streams: the NPAG tungsten tailings (about 95% of the total) and the PAG molybdenum tailings (about 5% of the total). All PAG tailings and waste rock will be stored sub-aqueously within the TSF to effectively mitigate the potential onset of acid generation. Waste rock will be stored in the TSF for the first 21 years of the mine life in layers which will become sequentially inundated under water in the TSF pond. Starting in Year 22 until the end of life of mine, waste rock will back-filled into mined-out parts of the open pit, where it will be flooded along with the pit during Closure.

3.2.4.2 Water Management

The general water management plan is to divert non-contact surface water outside of the PDA back to natural drainages using diversion channels, away from the PDA, to the fullest extent possible, and to collect all mine contact water within the PDA and store it in the TSF. The sources of mine contact water are primarily the water management ponds (WMP) around the TSF (which collect embankment run-off and seepage for recycle back to the TSF) and dewatering of the open pit during Operation. Surface run-off collected throughout the mine site (*e.g.,* precipitation falling on other areas of the site, such as near the ore processing plant) will also be treated as mine contact water and directed to the TSF for storage.

Direct precipitation and groundwater infiltration into the open pit will need to be pumped during mining. Sumps will be installed in the low points within the open pit from which water will be pumped to a water management pond located at the open pit rim, and then to the TSF. The pumps and pipelines will be sized to remove the inflow volume resulting from the 1 in 10-year design flood event within 10 days.

Mine contact water surplus to Project needs will be stored in the TSF and reclaimed as a process water source for the ore processing plant. There will be no need to release any water contained in the TSF during Years 1-7 of Operation. It is expected that there will be a surplus of water starting at about Year 8 of Operation, thus requiring surplus water to be treated as necessary to meet water quality objectives established by government as part of the facility's Approval to Operate, then released to downstream environments via the former Sisson Brook channel. The surplus water will be drawn from the clarifier discharge and further treated in a water treatment plant (WTP) before discharge.

During Closure, surplus water from the TSF and quarry will be directed to the open pit via engineered channels to accelerate filling of the pit. When the pit lake reaches a pre-determined level, this will mark the end of the Closure period, and the beginning of Post-Closure. During Post-Closure, the lake water will be treated in the WTP before discharge for as long as required to meet water quality objectives established by the government's Approval to Operate. When the pit lake water is of sufficient quality that it can be discharged directly, it will be allowed to do so via an engineered channel from the north end of the pit lake to the former Sisson Brook channel.

3.2.4.3 Tailings Storage Facility (TSF)

3.2.4.3.1 Overview

Tailings from ore processing will be transported through slurry pipelines to the TSF where the tailings solids will be deposited, settle and compact over time. PAG tailings will be stored sub-aqueously in the TSF, encapsulated in the NPAG bulk tailings, to effectively mitigate potential oxidation, acid generation, and metal leaching in the TSF. The NPAG tailings will be deposited from pipeline spigots around the TSF embankments to form beaches and thus keep the supernatant TSF pond away from the embankments. The PAG tailings will be deposited at the bottom of the supernatant pond and remain under water.

The TSF will be located in the area formerly covered by Bird Brook and its various tributaries, and will cover an area of approximately 751 ha at its ultimate extent at the end of mine life.

The base of the TSF embankments will be native overburden, compacted as required to minimize seepage. The engineered embankments, constructed of NPAG quarried rock or local borrow materials, will retain the tailings. The TSF embankments and operational procedures are designed to minimize seepage, and otherwise direct seepage to water management ponds (WMPs) located at low points around the TSF embankments. The WMPs will recycle this seepage, and run-off from the embankment faces, back into the TSF. Groundwater monitoring wells will be installed below the WMPs to monitor water quality; if necessary to protect downstream water quality, they may be converted to pump-back wells to return water to the TSF. The base case Project design includes pump-back wells at the northwest corner of the TSF to capture some seepage that is not collected by the WMPs. Monitoring and adaptive management will provide for additional pump-back wells as required to meet water quality objectives. As discussed below, TSF embankments will be designed and built to meet or exceed standards established in the Canadian Dam Association's "Dam Safety Guidelines" (Canadian Dam Association 2007).

The TSF is designed for secure and permanent storage of approximately 282 million metric tonnes (Mt) of tailings, 287 Mt of waste rock (*i.e.,* 270 Mt of barren rock and 17 Mt of mid-grade ore) from the mining operations over a 27-year mine life. All PAG materials will be stored sub-aqueously within the TSF. General arrangements of the TSF over the mine life are shown in Figures 3.4.1 to 3.4.6, and a typical cross-section of the TSF embankment design is provided in Figure 3.2.7.

3.2.4.3.2 Elements of the TSF

Tailings and waste rock will be impounded in the TSF in an area formerly occupied primarily by the Bird Brook watershed, to the northwest of the open pit and immediately north of the plant site. A single TSF, confined by a perimeter embankment on the northwest, northeast, and southeast sides, and a saddle embankment on the southwest side, will be constructed to store all tailings and waste rock produced over the mine life.

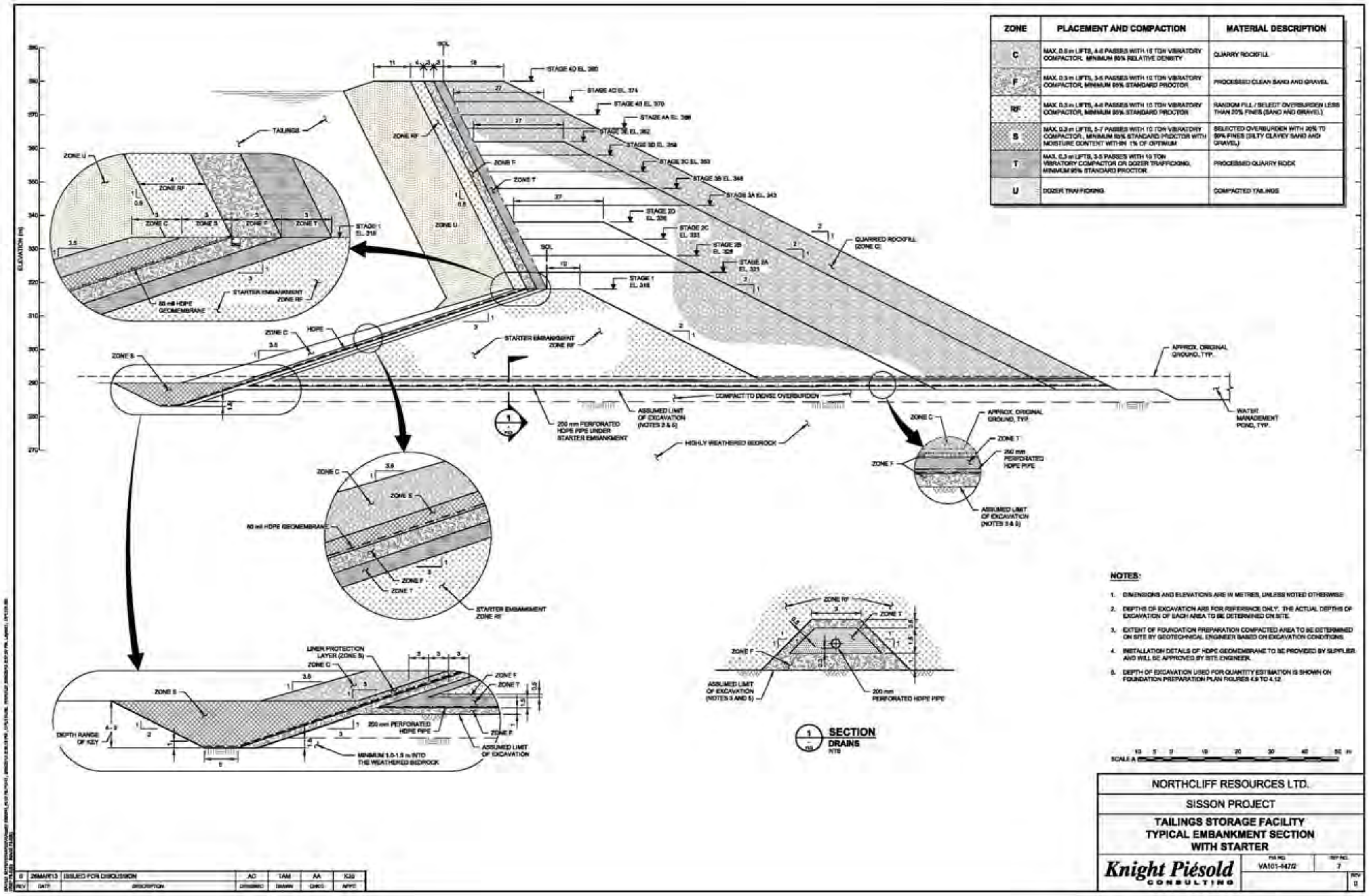
The primary aspects of the TSF design include:

- zoned embankments constructed of earthfill and rock;
- upslope TSF diversion channels;
- access roads and haul roads for embankment construction;
- seepage and embankment run-off collection ditches and ponds;
- tailings transport and deposition system;
- reclaim water system;
- tailings beaches;
- supernatant water pond; and
- sub-aqueous waste rock and mid-grade ore storage.

The TSF embankments are designed for staged expansion as the volume of the stored tailings and ponded water increases with time. Further details on the TSF design and construction are provided below.

3.2.4.3.2.1 Embankments

The embankments will be constructed in stages as zoned rock fill structures. Stage 1 includes the initial starter embankment that will be constructed prior to mill start-up. Stages 2 through 4 represent the ongoing raises throughout the mine life needed to meet tailings storage requirements. The final embankment has an elevation of 376 m above sea level (masl) and a crest length of approximately 8.8 km.



Source: Samuel Engineering (2013).

Figure 3.2.7 Typical Cross-Section of TSF Embankments

Starter Embankments (Stage 1): Three starter embankments will be constructed at the low points in the TSF impoundment area using select overburden from local borrow sources near the embankment sites. The embankments will have a geosynthetic liner on the upstream face to allow collection of a start-up water pond and for containment of the first year of tailings deposition. The liner will be anchored into a trench keyed into the lower permeability bedrock on the upstream side of the embankment.

Ongoing Embankment Raises (Stages 2 to 4): The TSF embankments will be progressively raised by the modified centerline construction method using quarried rock fill. Transition and filter zones will be incorporated to ensure compatibility and internal stability of the embankment fill materials. A low permeability zone of compacted tailings will be constructed on the upstream side of the exposed tailings beaches using dozer compaction in hydraulic sand cells. The tailings zone will also have a relatively low permeability, and will mitigate seepage migration through the base of the TSF and the embankments.

3.2.4.3.2.2 Access

Temporary roads will be constructed within the TSF impoundment area to provide access to the TSF starter embankments, borrow sources, and the initial water management ponds. Access will be provided by upgrading existing forest resource roads with new extensions built as needed. The construction access roads will eventually be flooded by the TSF.

Permanent access to the TSF and water management ponds will be provided by the active haul roads built by the mine fleet. The crest of the embankments has been sized to allow for two-way haul truck traffic with additional width for safety berms and pipelines. The location of access roads will change throughout the mine life to suit the demands of the mining operations and TSF construction.

3.2.4.3.2.3 Surface Water Diversion Channels

Diversion structures will be constructed upstream of the TSF to limit the inflow of non-contact surface run-off where possible. These diversion channels will consist of trapezoidal ditches or collection berms to divert flow away from the TSF.

3.2.4.3.2.4 Tailings Distribution

NPAG tailings slurry from the tungsten circuit in the mill will be distributed around the TSF in pipelines and discharged from a series of off-takes located along the embankment crest. The coarse fraction of the tailings is expected to settle rapidly and will accumulate closer to the discharge points forming a gentle beach with a slope of about 1%. Finer tailings particles will travel further and settle at a flatter slope adjacent to and beneath the supernatant pond. The beaches will be developed with the intent of maximizing the storage capacity and to control the location of the supernatant pond. Selective tailings deposition will be used to maintain tailings beaches and keep the supernatant pond a suitable distance from the embankments. Effective management of tailings deposition and beach development will reduce seepage through the embankments and ensure that water is accessible for reclaim to the mill.

A separate tailings line will run from the mill directly into the TSF pond for subaqueous discharge of the molybdenum tailings, which are considered PAG and which represent approximately 5% of the total tailings produced over the mine life.

3.2.4.3.2.5 Waste Rock and Mid-Grade Ore Stockpile

The TSF is sized to store the tailings, water, all waste rock (both barren rock and mid-grade ore) produced over the life of the mine. The waste rock will be placed in the TSF by the mine trucks; the active lift will remain above the supernatant TSF pond to provide a safe working platform. The waste rock will be located a sufficient distance from the embankment to ensure that the pile is completely encapsulated by deposited tailings solids.

3.2.4.3.2.6 Seepage and Contact Water Management

Seepage from the TSF will be largely controlled by the tailings beach and the upstream compacted tailings zone; seepage that is intercepted in the embankment will be gathered in piping at the base of the embankment and directed to several lined water management ponds (WMPs) at the bottom of the embankment. Surface water run-off from the embankment faces or other disturbed areas in the vicinity of the TSF will also be collected in the WMPs located at topographic low points along the downstream toe of the embankments.

Water collected in the WMPs will be continuously monitored and pumped back into the TSF depending on water quality. Groundwater monitoring wells will be installed around the TSF to monitor seepage and water quality.

If necessary, pump-back (groundwater interception) wells will be developed where seepage is detected that may jeopardize downstream water quality. Intercepted groundwater will either be pumped to the WMPs, or directly to the TSF. Pump-back wells are planned at the northeast corner of the TSF, and may be installed at other locations depending on the results of water quality monitoring and adaptive management measures required to maintain acceptable water quality in receiving watercourses. Other measures that can be implemented during Operation to reduce seepage losses include:

- maintain low water levels in the perimeter ditches and WMPs to minimize potential seepage;
- line the downstream face of the perimeter ditches in areas with higher seepage losses;
- increase the number of WMPs to reduce the length of the perimeter ditches between WMPs; and
- construct secondary perimeter ditches to capture lost seepage from the seepage collection system.

3.2.4.3.3 Design Basis for the TSF

The TSF is being designed to exceed the requirements set forth in the Canadian Dam Association “Dam Safety Guidelines” (Canadian Dam Association 2007) to ensure it will readily withstand the effects of extreme storm events and earthquakes. These Guidelines are the recommended standard design practice for major impoundments, water management facilities and dams, and are used by the Province of New Brunswick in permitting structures like the Sisson TSF.

Application of the Dam Safety Guidelines requires that a “hazard classification” be made of the TSF to enable appropriate design earthquake and flood events to be determined based on the classification criteria provided by the Guidelines. The classification of a TSF is carried out by considering the potential incremental consequences of an embankment failure. The incremental consequences of failure are defined as the total damage from an event with dam failure minus the damage that would have resulted from the same event had the dam not failed. The incremental losses consider loss of life, environmental and cultural values, and infrastructure and economic impacts. At Sisson, a failure of the TSF embankment and resultant tailings or process water release could significantly affect downstream watercourses and habitats that have substantial ecological and societal value, and the hazard classification of the Sisson TSF was therefore set to ensure a design that will protect these values.

3.2.4.3.3.1 Storm Events

Selection of an appropriate Inflow Design Flood (IDF) was required to carry out a safety assessment of the TSF and to estimate flood storage requirements. The size of the IDF increases with increasing consequences of failure. Based on the hazard classification assigned to the Sisson TSF, an appropriate IDF is a probabilistically-derived event with a return period of two-thirds between the 1-in-1,000-year flood and the Probable Maximum Flood (PMF). The PMF is defined as the most severe flood that may reasonably be expected to occur at a particular location. Although the deterministically derived PMF does not have a probability of occurrence associated with it, it can be compared to approximately a 1-in-20,000 year event. To be conservative, the IDF for the Sisson TSF was set at the deterministically derived 24-hour PMF. The TSF is designed with sufficient capacity and freeboard to store the PMF at all times during Operation. The storm storage volume required during Operation is approximately 4.8 Mm^3, corresponding to an equivalent run-off depth of 0.58 m.

3.2.4.3.3.2 Earthquakes

An assessment of the regional seismicity has been carried out to enable selection of appropriate design earthquake events and ground motions.

Seismicity Assessment

As discussed in Section 6.3.1.4, Eastern Canada is located in a stable continental region within the North American tectonic plate, and has a relatively low rate of seismic activity. However, moderate to large earthquakes have occurred in the region and will occur in the future. Review of historical earthquake records and regional tectonics indicates that the Sisson Project site is situated in a region of low seismicity. A probabilistic seismic hazard analysis has been carried out using historical earthquake data and the regional tectonics to identify potential seismic sources and to estimate the maximum earthquake magnitude for each seismic source. The corresponding median maximum acceleration is 0.07g for a return period of 500 years.

Design Earthquake

Consistent with the current design philosophy for geotechnical structures such as dams, two levels of design earthquake have been considered: the Operating Basis Earthquake (OBE) for normal operations, and the Maximum Design Earthquake (MDE) for extreme conditions (ICOLD 1995). Values of maximum ground acceleration and design earthquake magnitude have been determined for both the OBE and MDE.

The Dam Safety Guidelines recommend that the mean maximum acceleration value should be used for dam design. This is likely to be similar or slightly higher (by about 20%) than the median value provided by Natural Resources Canada (NRCan 2013). Consequently, estimated mean maximum acceleration values have been adopted for the design earthquake events used in seismic stability analyses.

The OBE has been taken as the 1-in-500-year return period event for the design of the TSF. The probability of exceedance for this event is approximately 5% for a 27-year operating period. The mean average maximum acceleration is estimated to be 0.07g for the 1-in-500-year earthquake. A design earthquake magnitude of 7.0 on the Richter scale has been conservatively selected for the OBE based on a review of regional tectonics and historical seismicity. The TSF is expected to function in a normal manner after the OBE.

An appropriate MDE for embankment design has been selected based on the dam hazard classification defined for the TSF and the criteria for design earthquakes provided by the Dam Safety Guidelines. With this classification, the Dam Safety Guidelines require that a dam be designed for a probabilistically-derived event (known as the Earthquake Design Ground Motion) having an annual exceedance probability (AEP) of 1-in-5,000. Consequently, the MDE selected for the TSF is the 1-in-5,000-year earthquake which has an estimated mean average maximum acceleration of 0.37g. A design earthquake magnitude of 7.0 on the Richter scale has been conservatively selected for the MDE based on a review of regional tectonics and historical seismicity. Limited deformation of the tailings embankment is acceptable under seismic loading from the MDE, provided that the overall stability and integrity of the TSF is maintained and that there is no release of stored tailings or water (ICOLD 1995).

Stability Analysis

Embankment stability analyses were carried out for both static and seismic conditions under the following cases:

- static conditions during Operation and Post-Closure;
- earthquake loading from the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE); and
- post-earthquake conditions using residual (post-liquefaction) tailings strengths.

The results of the stability analyses satisfy the requirements for factor of safety and indicate that the proposed design is acceptable to maintain both short-term (Operation phase) and long-term (Post-Closure) stability. The seismic analyses indicate that any embankment deformations during earthquake loading from the OBE or MDE will be minor and will not have a significant impact on embankment freeboard or result in any loss of embankment integrity. The results also indicate that the embankments are not dependent on tailings strength to maintain overall stability and integrity.

3.2.5 Ancillary Facilities

3.2.5.1 On-Site Buildings

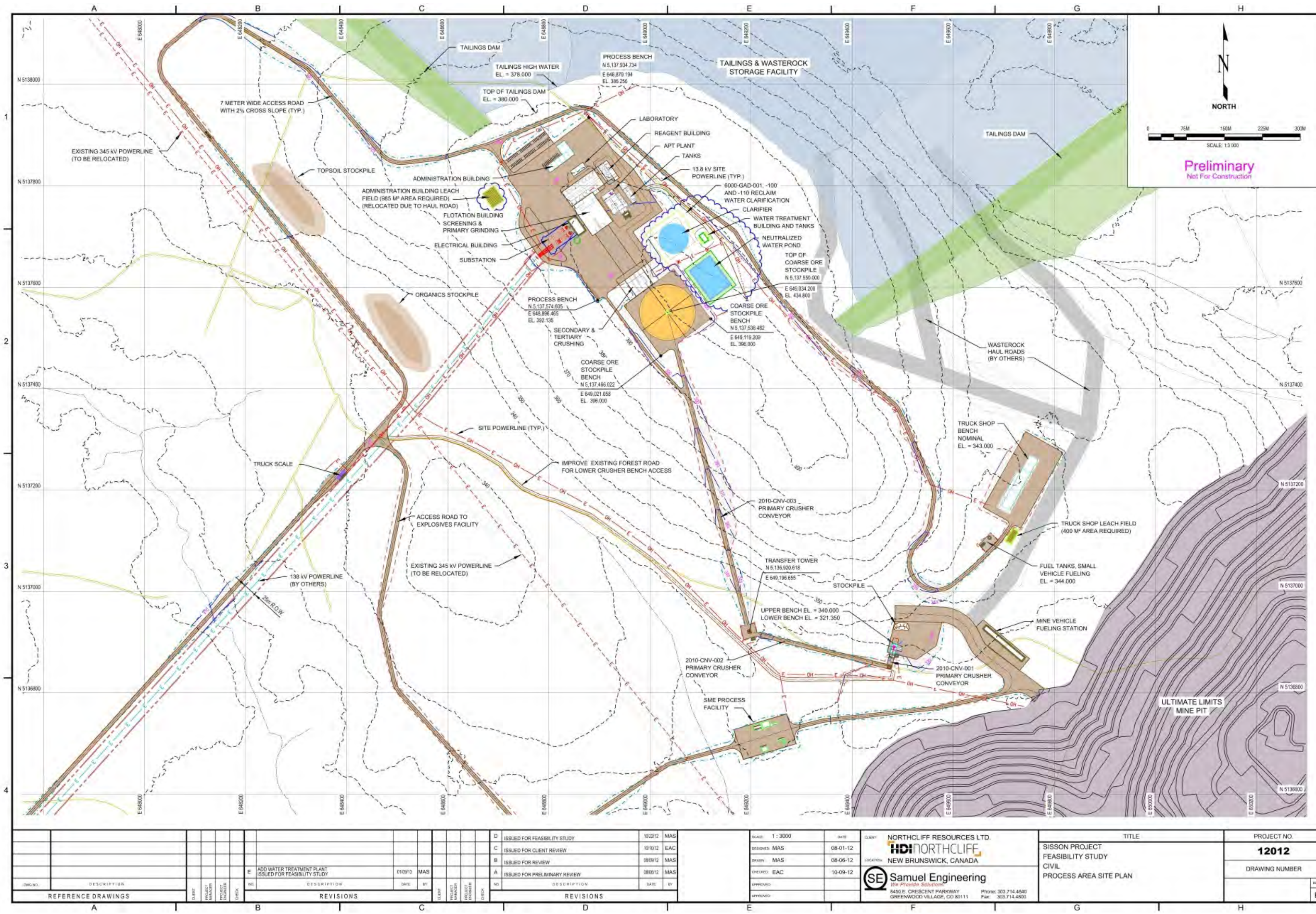
On-site buildings will include the process buildings, an administration building, a laboratory building, truck shop and warehouse, fuel storage, site mixed explosives (SME) plant, and explosives and detonator magazines. The general layout of the processing plant area and buildings and structures for the Project is shown in Figure 3.2.8.

3.2.5.1.1 Process Buildings

Secondary and tertiary crushing will be housed in a single crusher building with a total area of approximately 1,100 m^2.

The grinding circuit will be housed in a separate mill building with an area of approximately 3,400 m^2. The concentrator building measuring approximately 3,400 m^2 will house the molybdenum and tungsten bulk flotation and scavenger cells, and reagent preparation and storage area. This building will also house the mine main control room as well as all concentrator operating personnel offices and a maintenance shop. A reagent storage shed measuring about 250 m^2 will be erected outside the reagent preparation and storage area of the concentrator building.

The APT building will be a two story building covering approximately 1,100 m^2. This building will house APT processing equipment, an electrical room, APT control room, lab, and a small personnel office.



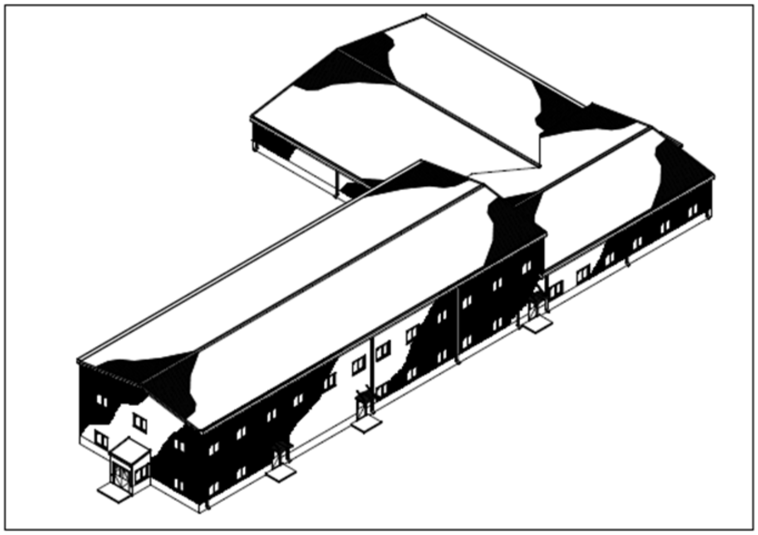
Source: Samuel Engineering (2013).

Figure 3.2.8 Process Plant Location, and Locations of Site Access Road and Internal Site Roads

3.2.5.1.2 Administration Building

The administration building will be a steel-framed, pre-fabricated, slab-on-grade building. The building footprint is L-shaped with a two-story segment covering approximately 560 m^2, and a single story segment covering approximately 680 m^2 (Figure 3.2.9).

The administration building will house space for site management, administration, mine management, engineering offices, conference rooms, archiving, building mechanical services, and washrooms. Dry change, and medical and safety offices will also be located in this facility. The building will be located north of the process plant.

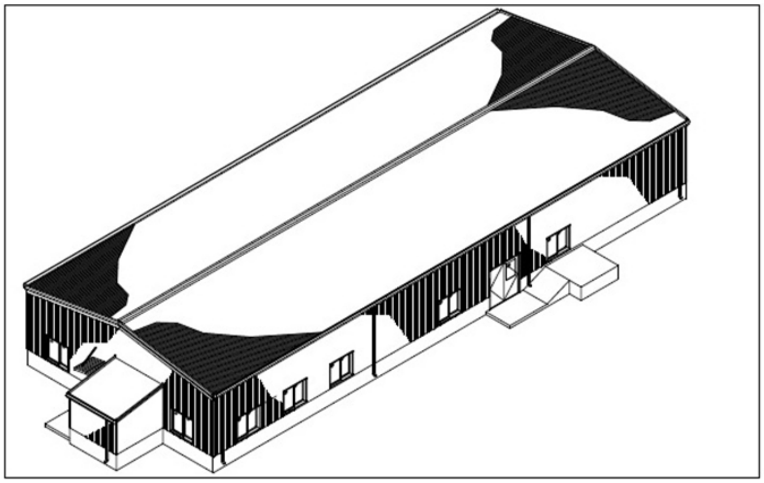


Note: Figure not to scale. Source: Samuel Engineering (2013).

Figure 3.2.9 Schematic of Administration Building

3.2.5.1.3 Laboratory Building

The laboratory building will be a single-story, steel-frame, prefabricated, slab-on-grade building covering approximately 360 m^2 (Figure 3.2.10). This building will house an analytical lab, metallurgical lab, sample preparation area, small office area, break room, and a washroom. The building will be located north of the process plant, adjacent to the administration building.



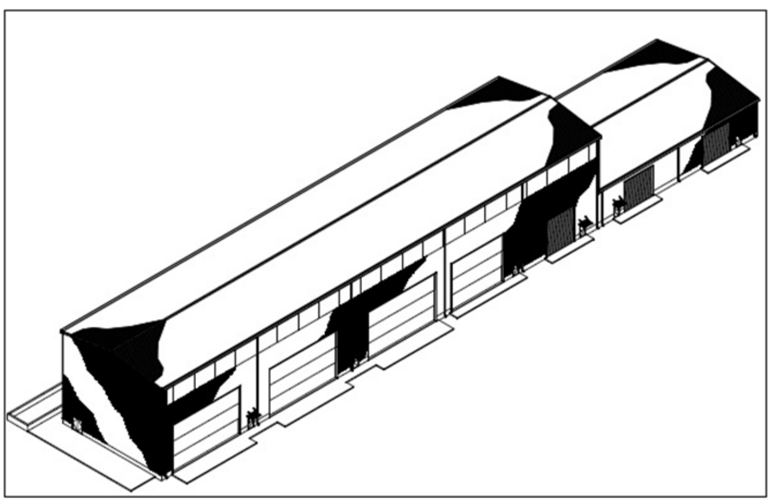
Note: Figure not to scale. Source: Samuel Engineering (2013).

Figure 3.2.10 Schematic of Laboratory Building

3.2.5.1.4 Truck Shop and Warehouse

The truck shop and warehouse building will be a single story, steel-framed, prefabricated, slab-on-grade building covering approximately 2,900 m^2 (Figure 3.2.11).

The building will house fleet repair facilities, wash bays, workshops, machine shop, a small office area, washrooms, and warehouse space for both mining and process facilities equipment. The building will be located approximately 800 m southeast of the process plant, close to the mine and mine haul roads.



Note: Figure not to scale. Source: Samuel Engineering (2013).

Figure 3.2.11 Schematic of Truck Shop and Warehouse

3.2.5.1.5 Fuel Storage and Distribution

Storage tanks will be used for storing diesel fuel and other petroleum products (*e.g.,* oils and lubricants) as well as reagents and other chemicals. The type, construction, capacity, and location of tanks will depend on their intended use and the materials stored.

All of the petroleum storage tanks will have secondary containment, as and required and will be designed and constructed in accordance with recognized industry standards and approved under the New Brunswick *Petroleum Product Storage and Handling Regulation – Clean Environment Act*. Chemical storage tanks will also be equipped with secondary containment.

A fuel storage depot and dispenser terminals will be located close to the truck shop. A storage shelter for a fire truck and mine rescue truck will be located adjacent to the truck shop.

A fuel oil tank located at the tank farm will be used to store and distribute fuel oil as required in a self-contained area which will be equipped with a sump pump for spill recovery.

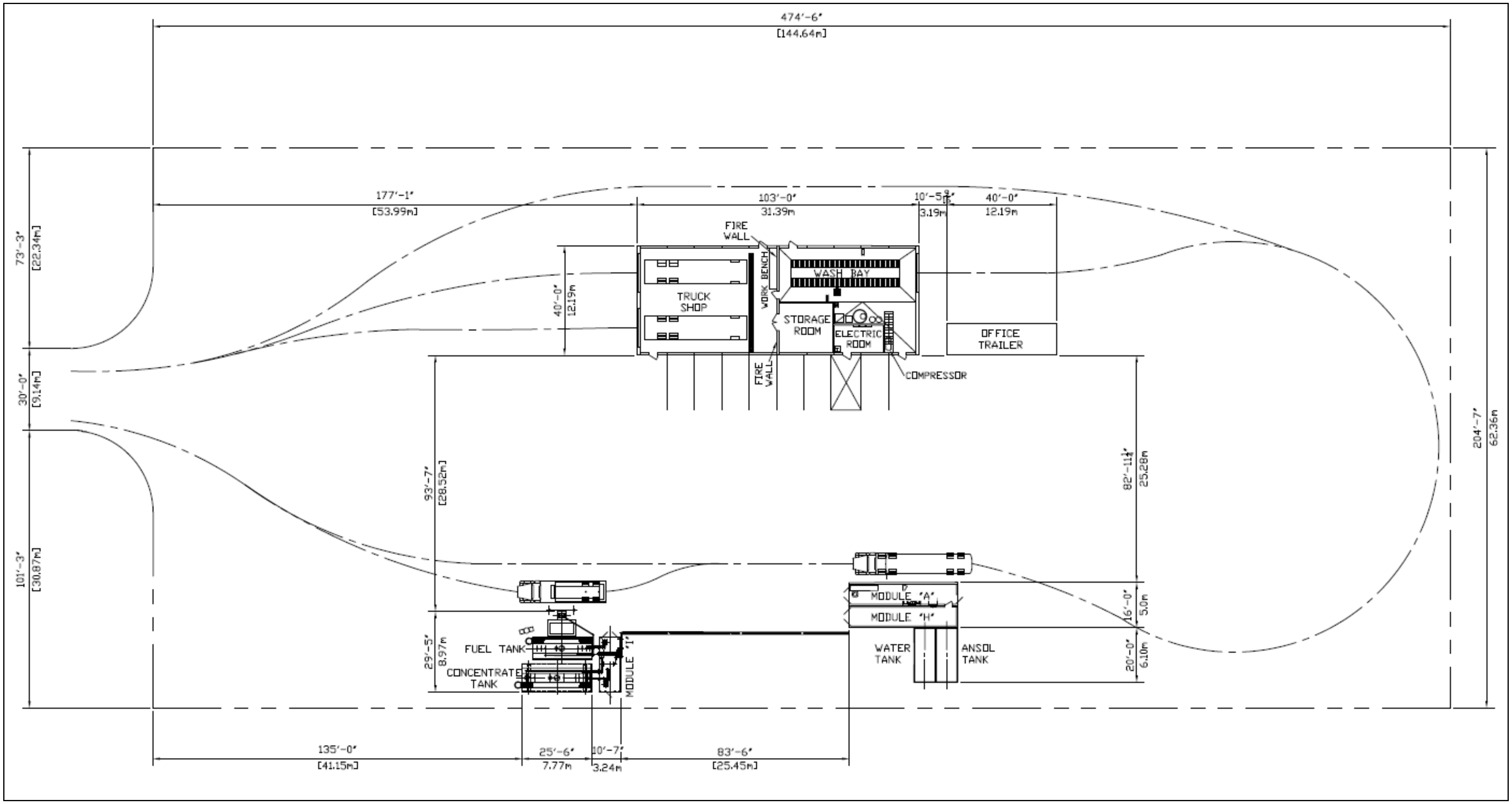
3.2.5.1.6 Site Mixed Explosives (SME) Plant and Storage

A site mixed explosives (SME) plant and explosives and detonator magazines will be located some distance west of the mine pit. The SME facility will store bulk ingredients required for producing the emulsion explosives used in the blast holes. It will also house all required pumps and tanks, truck wash bay and, blasting personnel offices and change rooms.

Specifications for blasting plant and explosives storage magazines and the locations of these facilities must adhere to the *Explosives Act* and regulations as published by the Explosives Regulatory Division of Natural Resources Canada (NRCan). The location of the blasting plant and the explosives magazines are determined by the table of distances that govern the manufacturing and storage of explosives and blasting agents. The contract explosives supplier will be responsible for proper placement of magazines and facilities.

Blasting accessories will be stored in the explosives and detonator magazines, with capacities of 32,000 kg of explosives and 124,500 detonators, respectively. The explosives magazine is located 730 m south of the SME plant, which houses the nearest inhabited building, and is in excess of 1 km from most other active site infrastructure. The nearest lightly travelled road is in excess of 265 m of the explosives magazine. The distance between the explosives and detonator magazine is a minimum of 50 m and includes effective barricades such as earthwork berms. Both the explosives magazine and detonator magazine meet or exceed all NRCan minimum distance requirements.

The SME facility will store bulk ingredients required for producing the emulsion explosive used in the blast holes. It will also house all required pumps and tanks, fuel storage, truck wash bay, and blasting personnel offices and change rooms. The location of both the SME facility and magazines, along with relative distances between each of the components of the SME facility, are shown in Figure 3.2.12.



Note: Figure not to scale.

Source: Samuel Engineering (2013).

Figure 3.2.12 Conceptual Site Mixed Explosives (SME) Facility Layout

The SME facility has capacity to store raw ingredients for the manufacture of approximately 87,000 kg of explosives. However, the manufacturing process is carried out at the blast holes and as such only the minimum NRCan distances of 270 m to the nearest inhabited building (in this case the primary crusher) and 30 m to the nearest lightly travelled road apply. Therefore, the SME facility meets or exceeds all NRCan distance requirements.

There are no temporary explosives facilities for storage or manufacturing of explosives used during pre-production or Project start-up.

3.2.5.2 Process Control System

The process control system (PCS) for the concentrator plant involves a microprocessor-based distributed control system (DCS) with components capable of being installed in separate locations and will incorporate APT plant wide digital process control communications. The control system will handle all process plant digital controls including motor control, interlocks, switches and all analog process control loops, process indicators and analog control devices. All concentrator data collection and plant operation will be operated from a single concentrator centralized control room located on the top floor between the flotation and grinding area with operator ability to view both areas from the control room. The primary crusher area, located away from the concentrator, will be operated from a primary crusher dedicated control room with operator ability to view the primary crusher and control primary crushing discharge and conveyor handling to coarse ore stockpile area. All data collection and APT plant operation will be from a single centralized control room located in a central location in the APT building near the digesters. The PCS level of automation will provide control room operators with the ability to perform all monitoring, direct control, regulatory, advanced control functions, supervisory control functions and data acquisition from any operator stations located in concentrator and APT plant areas. Any process equipment can be operated, started or stopped locally or remotely from the control room.

The PCS will use power supplies configured in a redundant format so that the failure of one power supply will not shut down the entire system. In addition, the PCS will have a dedicated uninterruptible power supplies (UPS) with batteries backup for the processors, communications, modules, and operator stations, so that these systems will remain operational for a specified time following a power outage.

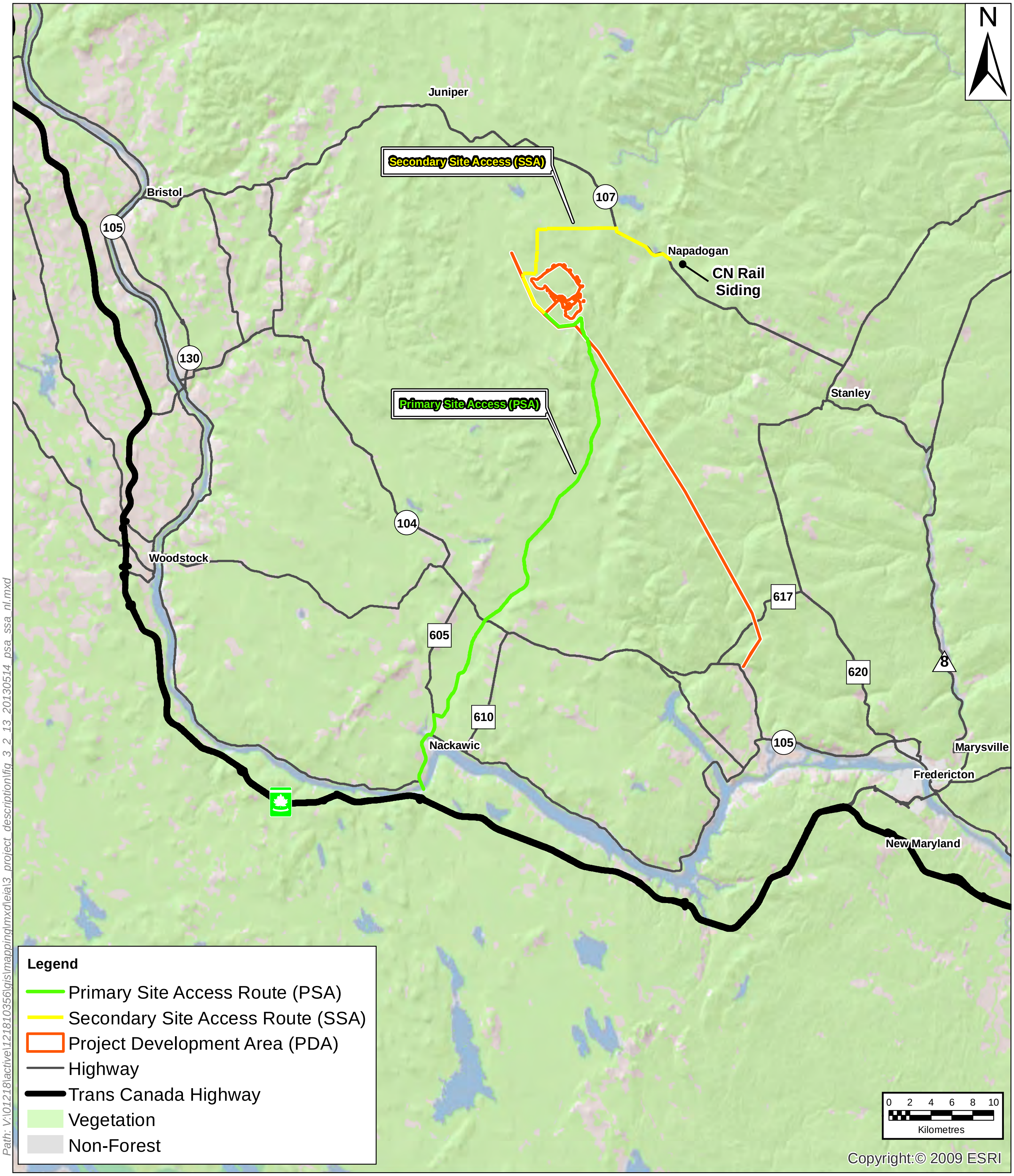
3.2.5.3 Access Roads

3.2.5.3.1 Existing Road Network

Existing forest resource roads will provide off paved highway access to the Project site. The two principal access routes to the Project are shown in Figure 3.2.13. They include the following.

- **Primary Site Access (PSA) route:** From the TransCanada Highway (Route 2), through Route 105 and Route 605, and finally through two forest resource roads, the Napadogan Road (also known as the Valley Forest Products Road) and the Fire Road, to the Project site.

- **Secondary Site Access (SSA) route:** From the CN Rail siding in Napadogan, through Route 107, and finally through two forest resource roads, the Four Mile Brook Road and the Fire Road, to the Project site.



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NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Primary Site Access (PSA) Route and Secondary Site Access (SSA) Route Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:500,000	Project No.: 121810356		Data Sources: NBDNR ArcGIS Online	Fig. No.: 3.2.13
Client: Sisson Mines Ltd.	Date: (dd/mm/yyyy) 23/11/2014	Dwn. By: JAB	Appd. By: DLM		

Map: NAD83 CSRS NB Double Stereographic

The PSA route uses two forest resource roads, the Napadogan Road and the Fire Road, that extend approximately 45 km from Route 105 and Route 605 at the AV Nackawic Mill Woodyard entrance in Nackawic to the Project site. It has been designated by SML as the primary route of access to the Project from the provincial highway network. The Napadogan Road intersects Route 104, approximately 10 km north of the AV Nackawic Mill Woodyard. From Route 104, it continues north another 28 km to the Fire Road. The Project is located approximately another 7 km north of this intersection (Figure 3.2.13). The SSA route also uses two existing forest roads, Four Mile Brook Road and Fire Road, that extend westward then southward from Route 107 to the Project site, a length of approximately 17 km. These roads have been designated by SML as the secondary route of access from the provincial highway network north of the Project. The SSA route intersects Route 107 at the Four Mile Brook Road, approximately 5 km west of the community of Napadogan (Figure 3.2.13).

3.2.5.3.2 Realignment of the Fire Road

One forest resource road, the Fire Road, runs through the Project site. As a result, the Fire Road will be relocated for a linear distance of approximately 11 km around the southwest side of the site, in a common corridor with the realigned 345 kV transmission line as discussed in Section 3.2.5.7. The location of the realigned Fire Road in relation to its existing alignment is shown in Figure 3.2.14.

3.2.5.3.3 Site Access Road

A 3 km-long site access road will be established from the relocated Fire Road to the main process site area. Forest resource roads north to Route 107 and south to Route 105 will be renovated, as needed, to accommodate the increased traffic associated with Project.

Site access roads will be designed to current forest road standards outlined in the New Brunswick Forest Management Manual (NBDNR 2004a) in consultation with the Crown Timber Licence Holders and approved by NBDNR.

The site access road is depicted in Figure 3.2.8.

3.2.5.3.4 Internal Site Roads

Internal site access roads from the main access road will connect to the primary crusher, the site mixed explosives (SME) facility, the TSF, and mine pit. Ancillary roads from the site process area will connect to the truck shop and fuel storage facility. All mine access roads will be designed and constructed in consideration of standards for forest resource roads in New Brunswick (NBDNR 2004a). Internal site roads have been designed to provide safe and efficient movement of equipment and personnel throughout the site and have restricted access for all non-mine equipment and vehicles.

The internal site roads are depicted in Figure 3.2.8.

3.2.5.4 Water Supply and Distribution

The plant water systems will consist of process water, filtered process water, fresh water, potable water, soft water, de-ionized water, and recycled raw water.

3.2.5.4.1 Process Water

The process water system is supplied primarily by reclaim water from the TSF and with lower quantities of thickener overflow waters.

The water balance indicates that the Project will operate in a surplus condition over the 27-year mine life, and discharge of the excessive surplus (with treatment as necessary) will start in about Year 8. Prior to mill start-up, water will be impounded in the TSF for two freshet periods in order to collect an adequate volume of water for mill start-up. Water for processing will be pumped from the TSF supernatant pond to a head tank located at the mill via a floating reclaim pump barge and pipeline. The process water system will supply water to the secondary and tertiary screening plant, grinding circuit, flotation circuits, hoses, and filtered process water system.

The filtered process water will be stored in and distributed from a tank, the lower portion of which will hold a dedicated amount of water for fire protection. The filtered water tank will be located outside the grinding building along with the process water and fresh water tanks.

3.2.5.4.1.1 Reclaim Water Clarification Facility

The reclaim water clarification facility will be a single-story, engineered, concrete building of approximately 180 m^2. The building will contain flocculant and lime systems with mixing and dosing equipment, storage and mixing tanks, and associated piping, pumps and electrical components. Barge-mounted pumps located in the TSF will feed the plant. Treated water will flow, by gravity, to a neutralized water pond and from there will be fed by gravity to the process water tank located at the process plant, or discharged to the receiving environment with further treatment if in surplus. The treatment plant will be located on the southeast side of the process area.

3.2.5.4.2 Fresh Water

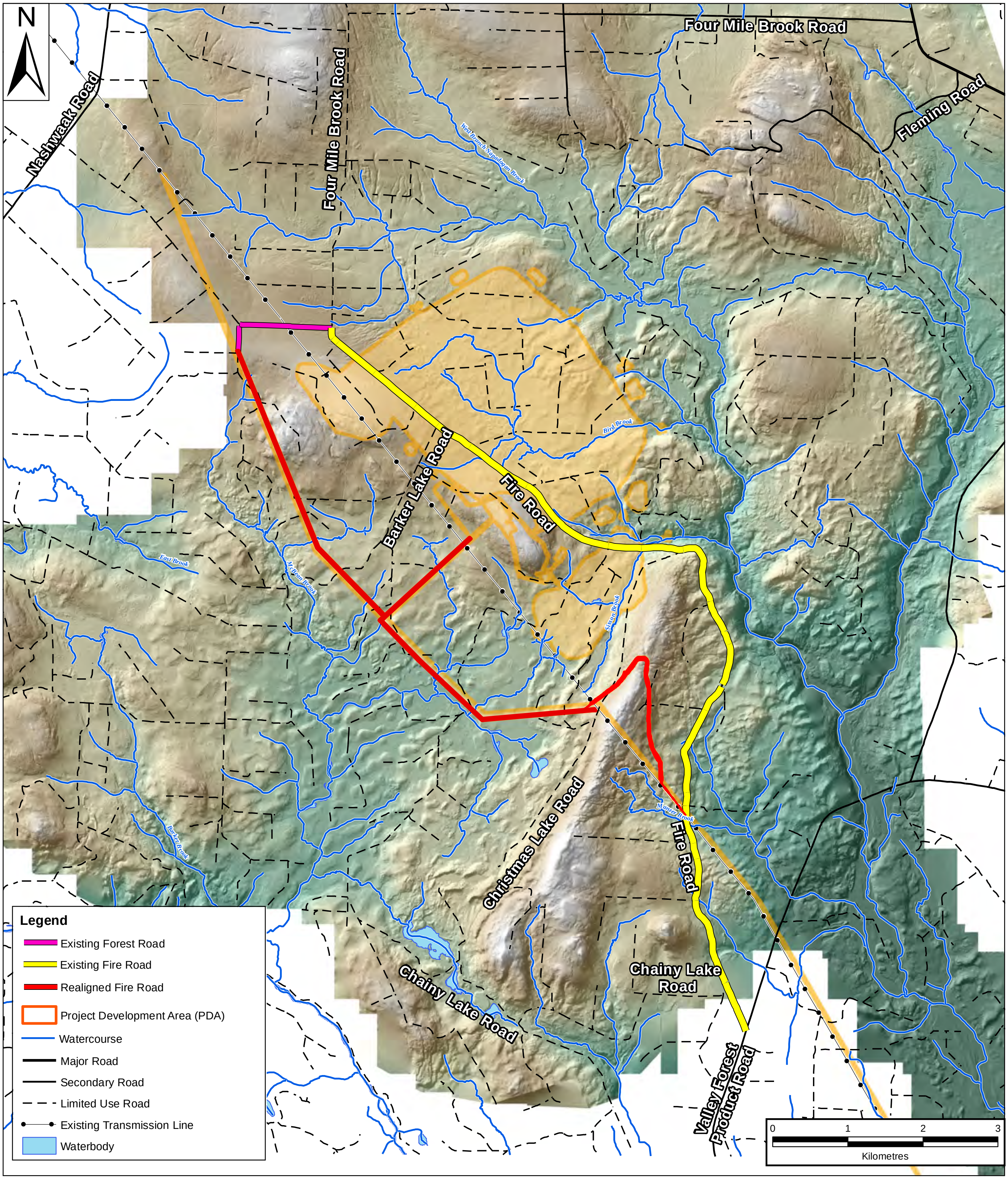
The fresh water system will be used to supply potable water system, APT plant, select reagent mixing and dust suppression. The fresh water will be obtained from a series of on-site groundwater wells. A fresh water supply pipeline from groundwater wells will supply Project fresh water requirements, estimated to be approximately 21 m^3/h.

Potable water for use in sanitary systems will be supplied by the groundwater wells. Drinking water will be treated as necessary, or delivered to site and used throughout the process plant and administration building areas, eye wash stations and showers, and dust suppression in selected areas.

De-ionized and soft water systems will be generated on site using fresh water supply. Both water systems will mainly serve the APT plant facility which will have its internal recycled water system.

3.2.5.4.3 Fire Protection

Fire water will be pumped from the filtered process water tank to the concentrator and APT plant fire water distribution system. Distribution will consist of a buried ring main around major facility buildings with hydrants and stand pipes connected to indoor hose stations. Allowances have been made for portable cart-type and handheld fire extinguishers for localized protection.



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NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Location of Realigned Fire Road Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:70,000	Project No.: 121810356	Data Sources: NBDNR, Leading Edge Geomatics Ltd.	Fig. No.: 3.2.14
	Date: (dd/mm/yyyy) 23/11/2014	Dwn. By: JAB	Appd. By: DLM	
Client: Sisson Mines Ltd.				

Map: NAD83 CSRS NB Double Stereographic

In addition to the hydrants and indoor stations, the APT building will employ a mist (fog) fire protection system at its solvent extraction area.

3.2.5.5 Sewage Treatment and Garbage Disposal

Sewage treatment for the process plant area, administration building, and laboratory will be by leach-bed system. Leach fields will be sized based on the personnel requirements at the ancillary facilities. The main leach field, approximately 1,000 m^2, will be located to the west of the main process area. In a failure event, the leach system will flow into the TSF. The truck shop and primary crusher leach field (approximately 400 m^2) will be located southeast of the truck shop.

No landfill will exist at site; rubbish will be hauled off-site for disposal at municipal landfills, recycling yards, and approved construction and demolition sites. APT waste and other process wastes will be stored in the TSF.

3.2.5.6 Security and Fencing

Security fencing will be installed around the substation and explosives storage area. No wildlife or security fencing is planned to encompass the entire PDA. A security gate and weigh scales used by delivery trucks, will be positioned on the site access road, remotely monitored and administered from the administration building.

The ore stockpile area and main process plant area will be large enough to accommodate laydown areas during Construction; no security is planned for these locations.

3.2.5.7 Power Supply

A 9-km-long section of an existing 345 kV transmission line (referred to by NB Power as Line 3011), which runs within the property boundary, will be re-routed a minimum of 500 m away from the open pit. This line is the main transmission grid line between New Brunswick and Québec, and is not intended to supply power directly to customers; thus, NB Power dismissed it as a Project supply option.

The Project requires approximately 50 MW of electrical power for its operation. A new 42-km-long, 138 kV transmission line from the NB Power Keswick terminal will supply power to the Project substation. This new line will be constructed by NB Power alongside the existing 345 kV transmission line, by expanding the existing 50 m-wide right-of-way by an additional 25 m to accommodate the new transmission line. Infrastructure at the Keswick terminal will be upgraded as necessary to accommodate the extension, though a vacant connection bay currently exists at the Keswick terminal to accommodate the new 138 kV transmission line. NB Power will own the line and the Keswick switchgear, but SML will own the mine site terminal station. The alignment of the new 138 kV transmission line and the realigned 345 kV transmission line is shown in Figure 3.2.15.

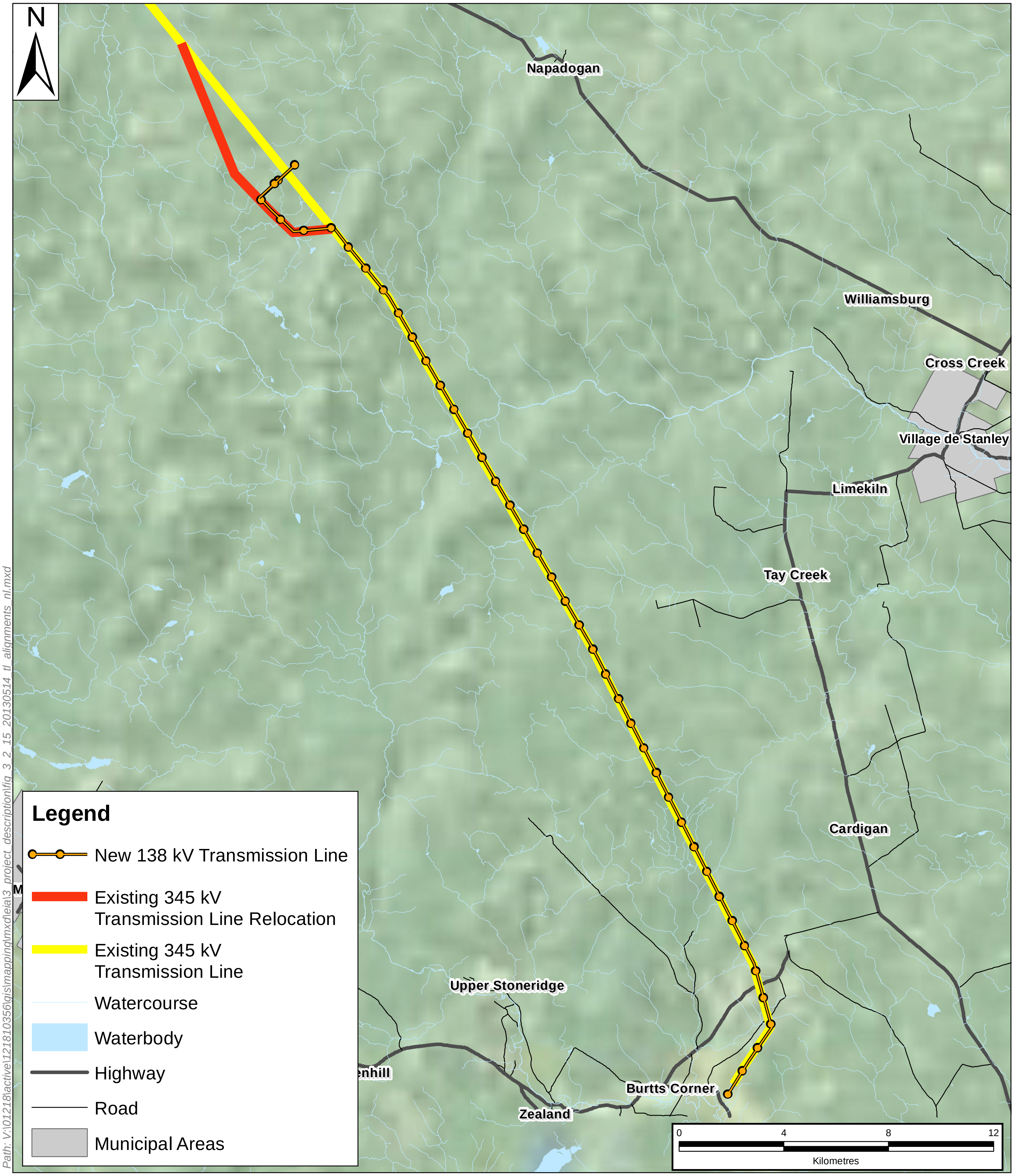
The relocated 345 kV transmission line will use steel poles, conductors (lines), insulators, guy wires, and concrete foundations. The new 138 kV transmission line will use a wood pole H-frame structure to support the conductors and insulators. A schematic of a typical wood pole H-frame structure is shown in Figure 3.2.16. These structures are safer, facilitate maintenance and minimize the environmental footprint along the right-of-way. Structures are also designed in accordance with a nationally recognized CSA standard to withstand known weather conditions and other related constraints.

The average height from ground to insulator of the wood pole H-frame structure will be approximately 18 m. The span between structures will be approximately 180 m, but could be as much as 213 m. Based on a preliminary line design, it is expected that approximately 200 structures will be required for the construction of the new transmission line. Three conductors will be suspended from the insulator strings (also two overhead ground wires for lightning protection). An easement interest will be acquired on all properties affected by the right-of-way to construct the new transmission line. The right-of-way is cleared to ensure safe electrical clearances and prevent trees from falling onto the line or coming into contact with the conductors.

The 138 kV transmission line will be terminated at a utility meter supplied by NB Power. The meter will be installed within a fenced substation located close to the site's main electrical room and concentrator building. The substation will include the main 138 kV disconnect switch, two 138 kV-13.8 kV transformers, and a 13.8 kV bus with distribution switchgear; the facility will operate on both transformers. The location of the Sisson substation was shown in Figure 3.2.8.

Power will be distributed to the plant facilities at 13.8 kV. Distribution will be routed via duct banks to facilities adjacent to the main substation while the power supply to remote locations such as primary crushing, reclaim water system, quarry, truck shop, open pit, and SME facility will be routed via overhead lines.

An 800 kW diesel-powered emergency generator will be provided at the process plant to provide an alternate power supply for lighting, critical process loads and other process sensitive areas during scheduled or non-scheduled power outages. A smaller 350 kW diesel-powered emergency generator will also be provided at the primary crusher.



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NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Alignments for the New 138 kV Transmission Line and Relocated 345 kV Transmission Line

Sisson Project:
Environmental Impact Assessment (EIA) Report, Napadogan, N.B.

Client: Sisson Mines Ltd.

Scale: 1:200,000

Project No.: 121810356

Date: (dd/mm/yyyy) 23/11/2014

Dwn. By: JAB

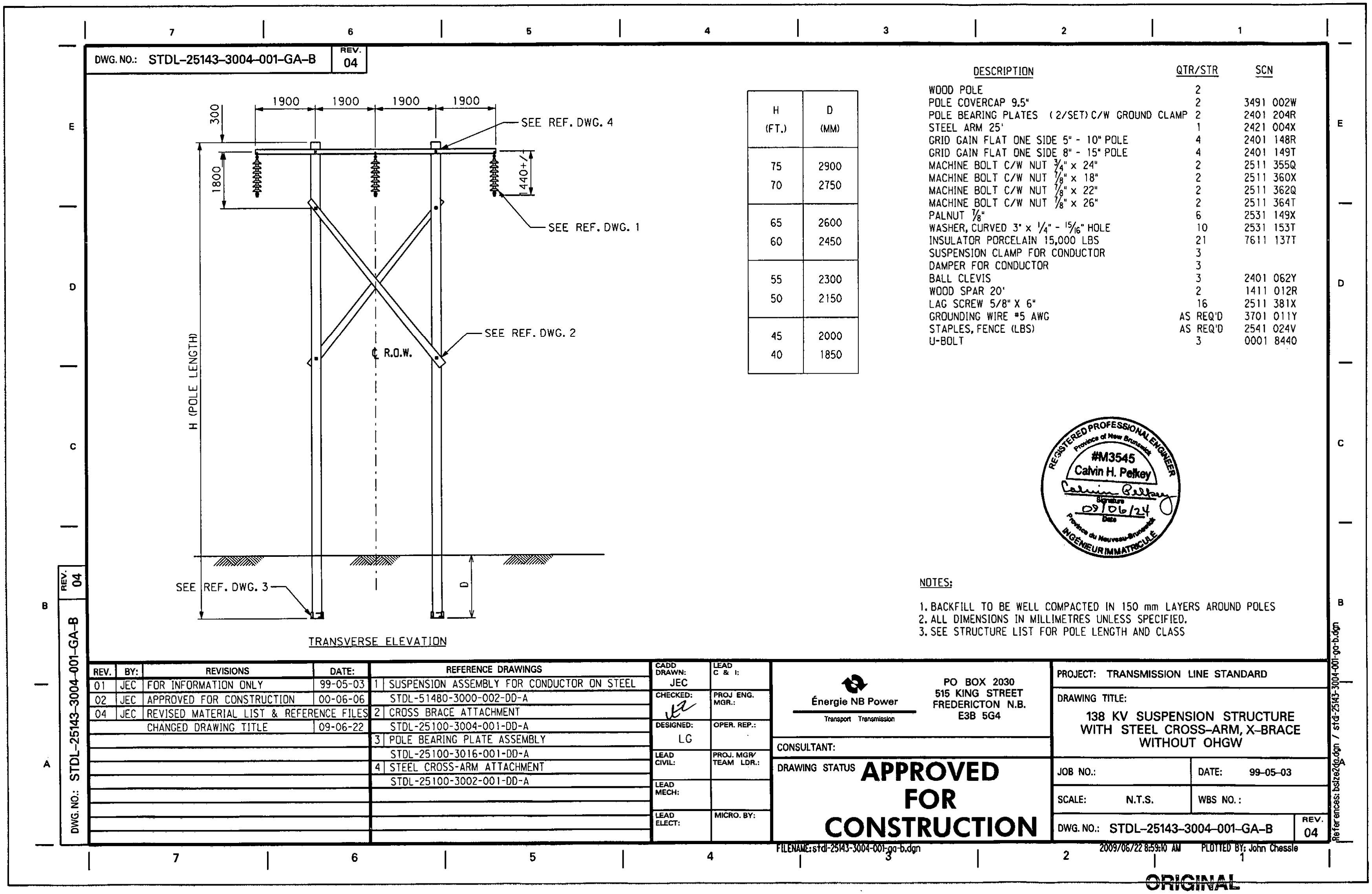
Appd. By: DLM

Data Sources: NBDNR, NRCAN, ESRI

Fig. No.: 3.2.15

Stantec

Map: NAD83 CSRS NB Double Stereographic



Source: NB Power (2012).

Figure 3.2.16 Typical Wood Pole H-frame Structure

3.2.5.8 Quarry

Quarried rock for construction of Project facilities and the TSF embankments will be provided by an on-site rock quarry developed at the northwest corner of the TSF. Rock from the quarry has been classified as NPAG rock. The quarry will cover an area of approximately 118 ha at its ultimate extent.

3.2.5.9 Logistics and Transportation

No on-site housing is required for the Project. Construction personnel (whether employed by SML or by contractors), and employees during Operation, will reside in the surrounding communities.

Buses will be made available to transport employees to and from the Project site during Construction. Bussing will be arranged and managed by each individual contractor. For the purposes of the feasibility study and this EIA, it is assumed that parking lots will be established at Napadogan and Nackawic, where Construction personnel will catch the bus to the Project site. It is also assumed that personnel during Operation will use personal vehicles or car-pool to the site from surrounding communities.

Deliveries of equipment, materials and supplies to the Project site will be by truck. Products (molybdenum concentrate in bags and APT in drums) will be trucked from site to a rail siding at Napadogan for on-shipment by rail. Overseas shipments of mineral products will be handled through existing ports at Saint John or Belledune.

3.3 ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT

This section discusses the various alternative means of carrying out the Project that are technically and economically feasible that have been considered and their environmental effects. These principally include the location of the main Project facilities such as the processing plant, waste rock storage, and tailings storage facility and include those identified in the Terms of Reference (Stantec 2012a). In general, it is desirable to locate these facilities as close as possible to each other in order to minimize the overall mine footprint and the cost of moving mined ore, waste rock and tailings. The currently preferred arrangement and size of these facilities is the most technically and economically feasible means of carrying out the Project. Some optimization will likely during detailed design and as environmental, engineering and cost factors are further refined.

3.3.1 Project Location and Mining Method

The Project location is fixed by the location of the ore body. The ore body at the Project site is near surface, with only 0.9 m to 4.0 m of overburden, so that underground mining is not a technically and economically feasible alternative. The only technically and economically feasible means of mining this ore body is by open pit.

Thus, in terms of location and method of mining, there are no technically and economically feasible alternative means of carrying out the Project.

3.3.2 Alternative Locations for Processing Plant

The principal factor that governs the location of the process plant is the distance between it and the open pit, and thus the cost of hauling or conveying ore to the plant. To minimize these costs, and other effects such as an expanded footprint and more truck travel, the processing plant will be located between the pit and the TSF location as was shown in Figure 3.2.8.

In terms of the location of the process plant, there are no technically and economically feasible alternative means of carrying out the Project.

3.3.3 Alternative Locations for Tailings Storage Facility

A thorough evaluation of potential options for locating and managing tailings, waste rock, and other waste materials arising from the Project was completed in support of the feasibility study. As part of this work, Knight Piésold and other consultants evaluated various TSF site locations, tailings technologies, and TSF embankment construction materials.

A TSF Site Alternatives Analysis was carried out following the general multi-criteria methodology described in Environment Canada's "Guidelines for the Assessment of Alternatives for Mine Waste Disposal" (Environment Canada 2011a). The analysis examined the various locations considered by SML to construct the TSF, and indicated a preferred location for the TSF in consideration of known environmental (including socioeconomic), technical, and economic factors.

The TSF Site Alternatives Analysis was conducted using the current Project description and location of Project components, based on the feasibility-level engineering design of the Project at the time of completing the EIA Report. A summary of the methods and results of this analysis is provided below.

3.3.3.1 Tailings Management Objectives

The principal objectives when considering where and how to store tailings were as follows:

- the site and methods will ensure that the tailings are stored in a way that is, and will be, physically and chemically stable;
- potentially ML/ARD materials can be managed to minimize the potential for oxidation and subsequent release of low pH leachate;
- the design and construction methods are technically and economically feasible, and appropriate for the site conditions; and
- adverse environmental effects are minimized and not significant.

3.3.3.2 Site Selection Criteria

The principal site selection criteria and considerations were as follows, with the nature of the criteria indicated in brackets as technical, economic, or environmental:

a) there is sufficient volume within the topographic constraints for the anticipated quantity of tailings and waste rock over the life of the Project (technical);

b) there are minimal upslope catchment areas that will require diversion around the site (technical, environmental and economic);

c) there is favourable topography to minimize the size of the required confining embankments (economic);

d) there is favourable topography to minimize the footprint of the storage area (environmental);

e) the site is in the same catchment as the open pit for most effective, integrated and reliable overall Project site water management during Operation and Post-Closure. The open pit area naturally drains primarily via Sisson Brook to Napadogan Brook (minor drainage to McBean Brook), and will do so entirely (with treatment if necessary) once the pit fills during closure of the Project. Thus, TSF sites that drain to Napadogan Brook are preferred over sites that drain to the Upper Nashwaak River watershed (*i.e.,* above the Napadogan Brook confluence) (environmental);

f) if possible, it is only land-based (*i.e.,* contains no lakes or watercourses) (environmental);

g) it has no geotechnical challenges and/or geohazards (*e.g.,* no deep unconsolidated materials, unstable slopes, karst potential) that would be technically challenging to overcome (technical, economic);

h) it involves no special environmental sensitivities (*e.g.,* lakes, environmentally significant areas (ESAs), deer wintering areas (DWAs)) (environmental); and

i) it is close to the open pit and process plant for ease of operation, minimized roads and pipelines, and minimized costs and greenhouse gas emissions from trucking (economic, environmental).

As noted in the above points, the criteria are to varying degrees reflective of technical, economic and environmental considerations that were factors in considering the technical and economic feasibility of the TSF site alternatives, and their potential environmental effects.

3.3.3.3 Evaluation of Alternatives against Site Selection Criteria for Technical and Economic Feasibility and Environmental Effects

The main factors that govern the technical and economic desirability of the location of a TSF are the distance between it and the process plant, and the elevation difference between the two. Longer distances result in longer connecting infrastructure such as pipelines, power lines, and access roads, and thus more land disturbance and associated environmental effects, and higher capital and operating costs (*e.g.,* for truck hauling waste rock for storage in the TSF). Site water management is also technically simpler and more economical for more compact sites, and with less consequential environmental effects. It is generally preferred that the TSF be at a slightly lower elevation than the process plant to allow gravity flow of the tailings from the plant where possible, all contributing to improved technical and economic feasibility, and less consequential environmental effects.

As discussed in the *CEAA* Project Description (Stantec 2011), four main alternatives for locating the TSF were considered by Geodex (the previous Project owner) and subsequently by Northcliff/SML. The four main alternatives were identified and considered based on their technical and economic feasibility according to the site selection criteria listed in Section 3.3.3.2 above. The environmental effects of those alternatives were also considered. The following important features should be emphasized.

- The topography of the Project area is characterized by rolling hills separated by broad valleys. The surface elevation typically ranges from approximately 300 to 350 m above mean sea level, with some hills rising to over 400 m. The uplands are typically well-drained, stream density is high, and small lakes and wetlands are common in low-lying areas. Thus, TSF site alternatives were sought near or at the top of individual drainages to avoid the need to divert water around them (criterion "b" above), and to take advantage of the natural topography to minimize the need for engineered embankments (*i.e.,* criterion "c" in Section 3.3.3.2 above).

- Because of the high stream density in the Project area, none of the alternatives could be located to avoid covering at least one watercourse (*i.e.,* criterion "f" in Section 3.3.3.2 above).

- For reasons described elsewhere in the EIA Report, all waste rock will be stored sub-aqueously in the TSF.

- All TSF alternatives would be designed, built and operated to the same standards (see Section 3.2.4.3.3 of this EIA Report) so there are no technical factors that distinguish them in terms of their resistance to earthquakes or extreme rainfall events, and their seepage management features.

The four main alternatives are shown in Figure 3.3.1 and were the following. Note that all distances noted refer to the distance from the ore processing plant to the centre of each TSF alternative site.

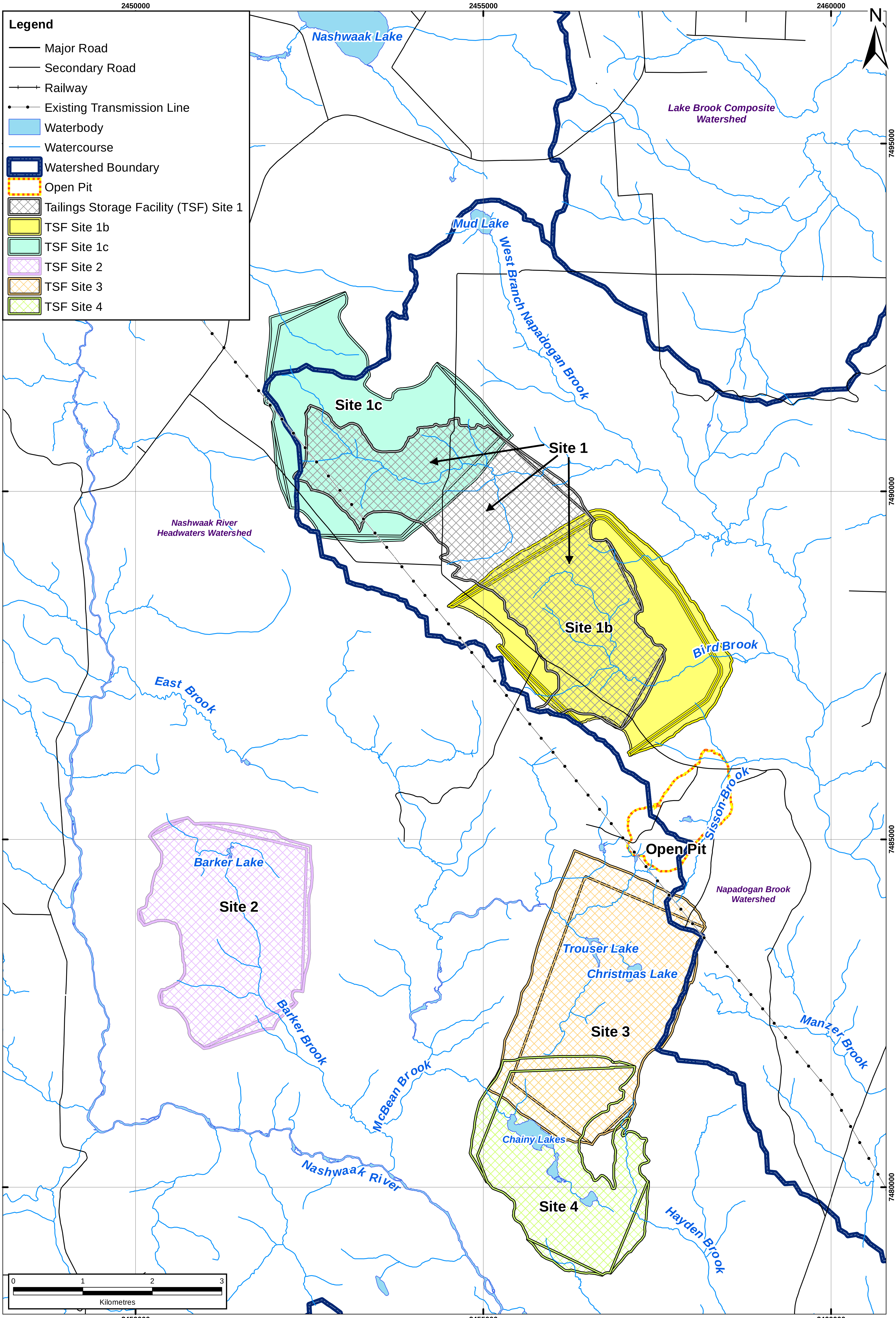
- **Bird Brook (Site 1)** is relatively close (3.3 km) to the proposed ore processing plant. Compared to the other alternatives, it has a relatively large "footprint" but does take good advantage of the natural topography (*i.e.,* criterion "c" in Section 3.3.3.2 above). It does not encroach on any lakes, and so meets criterion "h" in Section 3.3.3.2 above. It does cover much of the upper reaches of Bird Brook and one arm of West Branch Napadogan Brook, but does drain entirely to Napadogan Brook (criterion "e" in Section 3.3.3.2 above). Its proximity to the process plant means that the lengths of access roads, tailings and water pipelines, and power lines between the TSF and the plant site would be comparatively short.

- **Barker Lake (Site 2)**, located approximately 5.8 km to the southwest of the proposed ore processing plant location, has the advantage of constraining hills on its west side (*i.e.,* criterion "c" in Section 3.3.3.2 above). This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the attendant additional environmental effects related to greater distances for trucking and infrastructure. More importantly, it would entail covering a lake and drains entirely to the Upper Nashwaak River watershed, so it would not meet criteria "h" and "e" in Section 3.3.3.2 above. Thus, Site 2 is undesirable relative to Site 1 due to greater environmental effects and higher costs.

- **Trouser Lake (Site 3)**, located approximately 4.1 km to the south of the proposed ore processing plant location, has the advantage of constraining hills on east side (*i.e.,* criterion "c" in Section 3.3.3.2 above). However, it would result in the elimination of lakes (known to support a recreational fishery) and drains entirely to the Upper Nashwaak River watershed, so it would not meet criteria "h" and "e" in Section 3.3.3.2 above. This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the attendant additional environmental effects related to greater distances for trucking and infrastructure. These environmental effects, coupled with the location in the Upper Nashwaak River watershed and the covering of lakes, make this alternative undesirable relative to Site 1 due to greater environmental effects and higher costs. Additionally, the route of the relocated transmission line and relocated Fire Road will need to pass through the site.

- **Chainy Lakes (Site 4)**, located approximately 6.1 km to the south of the proposed ore processing plant location, has the advantage of constraining hills on its northeast and southeast sides (*i.e.,* criterion "c" in Section 3.3.3.2 above). However, it would result in the elimination of lakes (known to support a recreational fishery) and drains entirely to the Upper Nashwaak River watershed, so would not meet criteria "h" and "e" in Section 3.3.3.2 above. This alternative would be more costly to operate than Site 1 due to the distance from the process plant with the attendant additional environmental effects related to a greater distances for trucking and infrastructure. These environmental effects, coupled with the location in the Upper Nashwaak River watershed and the covering of lakes, make this alternative undesirable relative to Site 1 due to greater environmental effects and higher costs.

The four alternatives are all technically feasible. Compared to Site 1, Sites 2, 3 and 4 present clear economic disadvantages due to the greater distances from the process plant, and thus to the higher infrastructure and operating costs for trucking and pumping. From an environmental perspective, Site 1 is preferred for several reasons – it covers no lakes, it drains entirely to the Napadogan Brook watershed, and it entails the minimum trucking distance and thus greenhouse gas emissions. For these reasons, Site 1 was considered the alternative of choice and was carried forward in the analysis of TSF site alternatives.



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Location of Alternatives for the TSF Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:50,000	Project No.: 121810356	Data Sources: NBDNR, SNB NHN, NB Aquatic Data Warehouse	Fig. No.: 3.3.1	Stantec
Client: Sisson Mines Ltd.	Date: (dd/mm/yyyy) 16/05/2013	Dwn. By: JAB Appd. By: DLM			

Map: NAD83 CSRS NB Double Stereographic

In early 2011, Northcliff refined Site 1 into two preferred site alternatives, Site 1b and Site 1c, in order to take up less land area than initially envisaged, and to thus avoid covering more watercourses than is absolutely necessary (Figure 3.3.1). This would further reduce the potential environmental effects of the preferred Site 1. Sites 1b and 1c are depicted in Figures 3.3.2 and 3.3.3, respectively. These two sites are considered to be technically and economically feasible, and are the two preferred alternatives that are evaluated in more detail in this document in terms of their relative environmental, technical and economic characteristics.

It should be noted that, during the feasibility and EIA studies, Site 1b was refined by Northcliff to situate its northwestern embankment to the southeast of an unnamed tributary to West Branch Napadogan Brook, thus preserving its environmental values. As well, the embankments were situated to avoid areas of elevated archaeological potential along that tributary and to the southeast of the TSF and north of the open pit. This resulting TSF Alternative 1b is shown in Figure 3.3.2.

3.3.3.4 Evaluation of TSF Site Alternatives

The selection of the preferred TSF Alternative 1b was made during the course of the feasibility study based on scoping level costing, professional experience and judgment. In late 2012, Northcliff undertook a thorough due diligence evaluation of that selection process to ensure that the results are robust and reasonable. To carry out that evaluation, a method known as multi-criteria analysis (MCA) was used. MCA is the method prescribed by Environment Canada in its “Guidelines for the Assessment of Alternatives for Mine Waste Disposal” (Environment Canada 2011a).

MCA is a well-developed and widely-used method in applications such as this one, and is described below. Because MCA is a quantitative method, and some of the factors used in the analysis can only be characterized qualitatively, the numerical results of an MCA can only be approximate. Moreover, MCA cannot possibly incorporate all the factors that might be applied in comparing various alternatives, and must necessarily focus on those factors that are most useful in distinguishing among the alternatives. As consequence, MCA results are indicative of the relative strength of the alternatives considered, and MCA is understood to be a decision-support tool and not a decision-making tool.

The MCA of the TSF site alternatives was undertaken in several steps which are described in detail in the sections below. Basically, MCA proceeds by identifying the factors to be used in comparing alternatives, and then giving each factor a numerical score for each alternative. MCA then identifies numerical weights to be used in evaluating the relative contribution that each factor should make to the analysis. The scores are then multiplied by the weights, the products are summed, and the overall totals for the various alternatives are compared. Finally, sensitivity analyses are performed by varying the weights to determine if giving more or less weight to, say, environmental factors, changes the overall results of the analysis.

3.3.3.5 Factors for Analyzing TSF Site Alternatives

Three categories of factors were established for comparing the TSF site alternatives: environmental, technical and economic. The factors in each category were selected for their importance ecologically, socially, and to regulators. They were also selected for their usefulness in distinguishing between the TSF alternatives. The selected factors are described below.

3.3.3.5.1 Environmental Factors

Footprint Area. The TSF footprint area is the total area covered by the embankments, tailings and water control works along the toe of the embankments. The footprint area (measured in ha) was used to assign the relative scores of each alternative. The alternative with the smallest footprint is desired, and thus received the maximum score. The other alternative received a proportionately lower score.

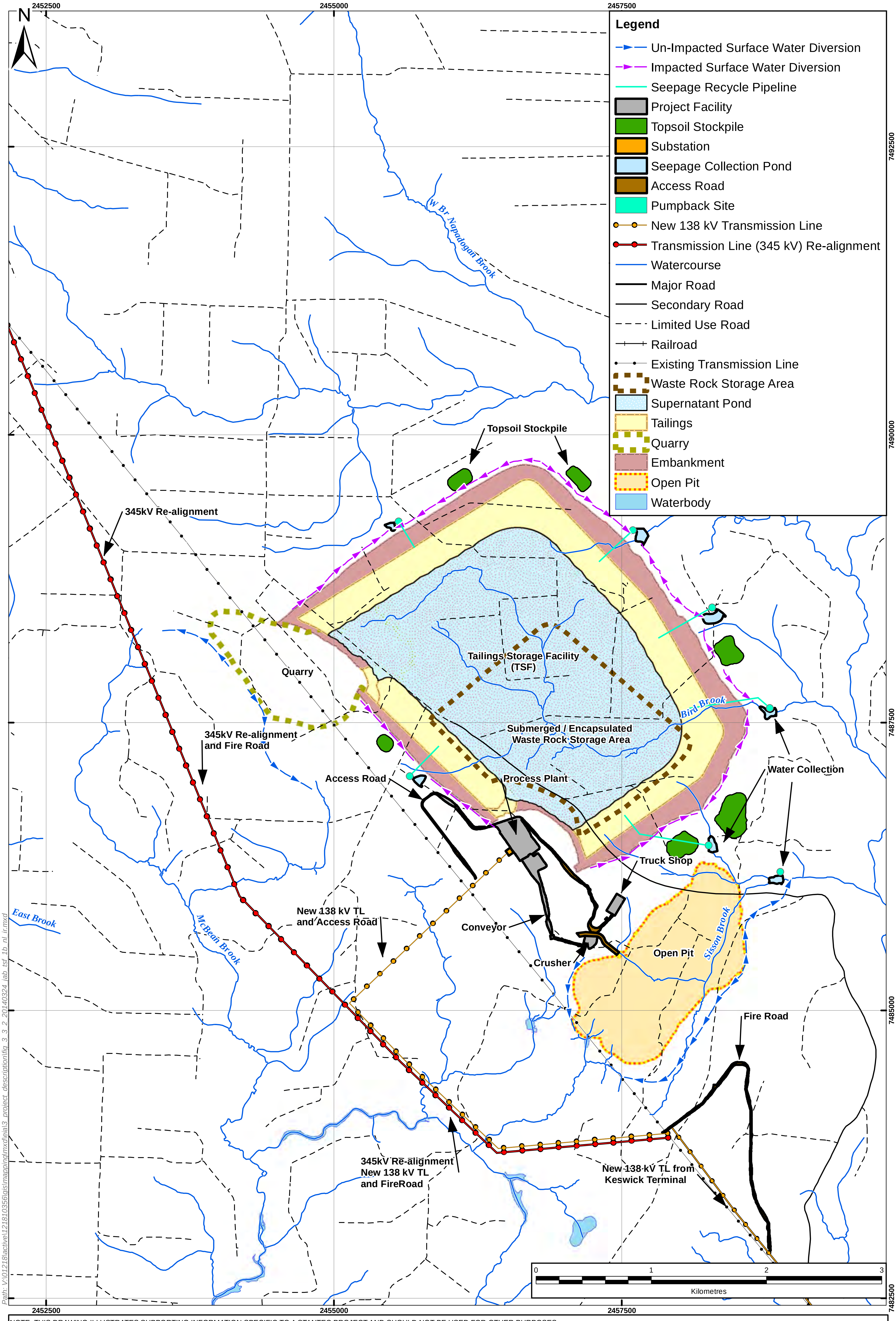
Area Within Napadogan Brook Watershed. The principal potential sources of contaminants to the aquatic environment are the TSF (from seepage) and the open pit, especially after closure of the mine, as well as releases of treated water from the water treatment plant. The open pit area naturally drains primarily via Sisson Brook to West Branch Napadogan Brook, and will do so entirely (with treatment if necessary) once the pit fills during Closure of the Project. For efficient and effective water management, and especially to minimize the number of drainages that might be affected by seepage, it is best if the TSF site also naturally drains to the same watershed. Thus, the TSF site with the largest proportion of its catchment area in the Napadogan Brook watershed received the maximum score, and the other alternative received a proportionately lower score.

Area of Permanent Aquatic Habitat Loss. The area of permanent aquatic habitat loss is the total area of aquatic habitat that will be covered by the TSF. The area of lost habitat (in m^2) was used to assign the relative scores. The alternative with the smallest habitat loss is most desired, and thus received the maximum score. The other alternative received a proportionately lower score.

The area of aquatic habitat in Site 1b was based on field measurements taken in 2011. Though some field surveys have been conducted within Site 1c, detailed aquatic surveys have not been conducted and the areas of aquatic habitat have not been field confirmed. The total length of watercourses within Site 1c is known based on digital elevation mapping (DEM) prepared for the Project. For the purposes of this MCA, the widths of watercourses in Site 1c were estimated based on stream order, as determined by aquatic scientists with field experience in the Project area. These widths multiplied by the known lengths (as obtained from a geographic information system) give the estimated amount of aquatic habitat in Site 1c.

Area of Permanent Wetland Loss. The area of permanent wetland loss is the total area of mapped wetland that will be covered by the TSF. The area of lost wetland (in ha) was used to assign the relative scores. The alternative with the smallest wetland loss is desired, and thus received the maximum score. The other alternative received a proportionately lower score.

As with aquatic habitat, detailed wetland field surveys have not been conducted in Site 1c, though they have been conducted in Site 1b. A wetland model was prepared for both TSF alternatives to predict areas that are likely wetland. This model was based on DEM data and depth to water table maps. Field verifications were conducted at Site 1b to ground truth the wetland areas predicted by the model; 74% of the modelled wetlands were confirmed to in fact be wetlands. As Site 1c is located within an area with similar conditions as Site 1b, it is considered to be a fair approximation that 74% of the modelled wetlands are actual wetlands. Accordingly, the modelled wetlands in Site 1c were reduced by 26% in order to estimate the area of permanent wetland loss.

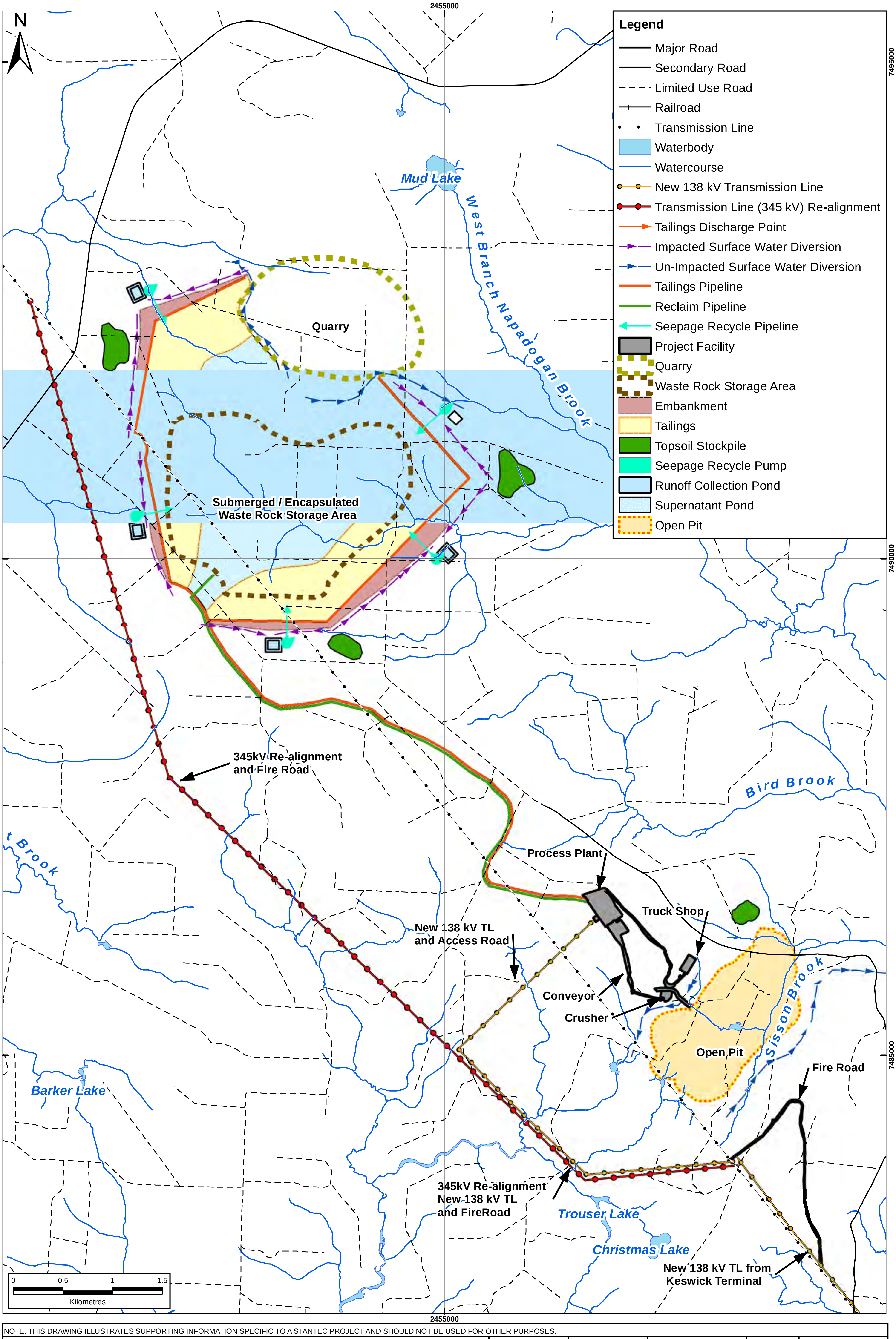


NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

TSF Alternative 1b Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:30,000	Project No.: 121810356	Data Sources: NBDNR	Fig. No.: 3.3.2	Stantec
Client: Sisson Mines Ltd.	Date: (dd/mm/yyyy) 23/11/2014	Dwn. By: JAB	Appd. By: DLM		

Path: V:\01218\active\121810356\gis\mapping\mxd\eia\3_project_description\fig_3_3_2_20140324_iab_tsf_1b_nl_lr.mxd

Map: NAD83 CSRS NB Double Stereographic



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TSF Alternative 1c Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:35,000	Project No.: 121810356	Data Sources: NBDNR, SNB	Fig. No.: 3.3.3
Client: Sisson Mines Ltd.	Date: (dd/mm/yyyy) 22/03/2014	Dwn. By: JAB / Appd. By: DLM		Stantec

Map: NAD83 CSRS NB Double Stereographic

Area of Permanent Loss of Interior Forest. Interior forest is an important wildlife habitat type. Interior forest is defined as continuous stands of mature forest greater than 10 ha that are free of edge effect. The area of permanent interior forest loss is the total area of interior forest that will be lost within the TSF either as a result of covering an interior forest stand, or reducing the total area of a stand to less than 10 ha such that it is no longer interior forest. The area of lost interior forest (ha) was used to assign the relative scores. The alternative with the smaller interior forest loss is desired, and thus received the maximum score. The other alternative received a proportionately lower score.

Greenhouse Gas Emissions. In response to comments from the Sustainability Working Group, a final environmental factor was added to the matrix to encompass emissions of greenhouse gases (as a surrogate for all air contaminant emissions) arising from one option over the other. The relative distance of the TSF from the ore processing plant results in emissions primarily associated with trucking waste rock from the open pit for storage within the TSF. The alternative with the lowest greenhouse gas (GHG) emissions is desired, and thus received the maximum score. The other alternative received a proportionately lower score.

Environment Factors Overall. It should be noted that including aquatic habitat and wetland losses as environmental factors in the alternatives analysis is inherently conservative since, in both cases, SML must agree to compensate for these losses before the Sisson Project can be approved. A plan to offset the lost aquatic habitat must be approved by the DFO, and a plan to compensate for lost wetlands must be approved by the NBDELG. Strictly speaking, an MCA should be based on the net effect on these factors which, with the required offsetting and compensation, will be nil and the factors should not be included in the MCA.

3.3.3.5.2 Technical Factors

Storage Efficiency. Storage efficiency is the ratio of available tailings storage volume to the embankment volume. Higher storage efficiency generally results in lower embankments and lower costs. The ratio was used to determine the score of each alternative. The alternative with the highest ratio received the maximum score, and the other alternative was scored proportionately less.

Ease of Operation. The relative ease of operation was qualitatively judged on a scale of low, medium, or high. Various factors were taken into account such as the number of personnel and the amount of mechanical equipment required, and susceptibility to difficulties caused by weather (*e.g.,* snow, wind, rain). An alternative that allows at least some gravity feed of tailings to the TSF is preferred over an alternative that does not. The alternative with the highest ease of operation was assigned the maximum score, and the other proportionately less.

It is expected that operation of a TSF at Site 1c will be slightly more difficult to operate than at Site 1b, largely because of the increased distance from the ore processing plant. TSF Site 1b and Site 1c were therefore assigned factor values of high and medium, respectively. Specific operational disadvantages associated with Site 1c include the following:

- longer roads between the ore processing plant and the TSF require proportionately more maintenance, including more manpower and materials;

- longer pipelines between the plant and TSF require proportionately higher pumping power, which often results in increased operating complexity; this is due in large part to the higher pressure pumps, pipelines, and fittings that are needed;

- longer pipelines between the ore processing plant and TSF, and a consequent greater susceptibility of pipe blockage due to freezing or sanding, require proportionately more maintenance, including more manpower and materials;

- ongoing construction of the TSF embankments and maintenance of mechanical equipment will be more difficult due to the relative remoteness of the site from the ore processing plant and open pit area where personnel and equipment are largely stationed; and

- the increased distance from the ore processing plant site means less timely mobilization of emergency response measures, should they be needed.

Ease of Closure. Closure refers to all post-mining activities including decommissioning of site infrastructure, reclamation of disturbed areas, and establishing long-term water management and site environmental monitoring and management. The relative ease of closure was qualitatively judged on a scale of low, medium or high. Various factors were taken into account such as:

- the number of personnel required;

- the availability of reclamation materials;

- ease of water management; and

- the effort required to ensure that the overall site is effectively stabilized for the long-term physically, biologically, and socially (*e.g.,* human safety).

The alternative with the highest ease of closure was assigned the maximum score, and the other alternative was scored proportionately less.

The two major aspects of closure of the TSF that were considered in this assessment are reclamation of the landforms and water management. Reclamation of the embankments and tailings beaches to provide a beneficial end land use will be similar at both sites though, being further from the ore processing plant site, Site 1c provides more of a closure challenge.

Water management was the major consideration in assigning Site 1c a ranking of medium when compared to Site 1b (high). Water management during Closure and Post-Closure is typically simpler when all the Project infrastructure is in close proximity. At the end of Operation for Site 1b, run-off from the TSF can be drained by gravity to the open pit to both accelerate filling of the pit and allow for a single water treatment plant and point of discharge. This will not be practical with Site 1c, where TSF run-off would need to be separately treated and discharged, or pumped through a long pipeline to the open pit. Thus, compared to TSF Site 1c, TSF Site 1b allows for a centralized approach to water treatment, and a single point of discharge for ease of managing and monitoring both water quality and potential environmental effects.

3.3.3.5.3 Economic Factors

Life of Mine Capital and Operating Costs. The Project costs that could vary the most between the two TSF site alternatives in order of expected magnitude are:

- initial and ongoing embankment construction earthworks;
- hauling of waste rock to the TSF for sub-aqueous storage;
- tailings and reclaim mechanical equipment; and
- ongoing power requirements for tailings delivery and water reclaim.

The construction of the TSF embankment will be similar for both alternatives since both will be constructed using locally quarried materials; Site 1c will require approximately 20% more fill material over the life of the Project due the lower storage efficiency. The cost of hauling waste rock to the Site 1c TSF will be significantly higher than for Site 1b due to the nearly four times longer haul distance from the open pit. The cost of mechanical equipment (pumps and pipelines) will be higher for Site 1c than Site 1b by approximately 50% because of the longer distance from the plant site. The ongoing power requirements for pumping tailings and reclaim water to and from Site 1c will be approximately 70% higher than for Site 1b.

The relative life-of-mine costs were qualitatively judged on a scale of low, medium, or high. The estimated overall life of mine comparative cost for Site 1c is in the order of two times the life of mine cost for Site 1b. The largest contributing factor is the haulage cost associated with transporting waste rock to the more remote Site 1c; this was the key consideration in assigning Site 1c a ranking of high when compared to Site 1b (medium).

3.3.3.5.4 Other Factors Considered

A number of other factors were considered for inclusion in the analysis, but were ultimately omitted for various reasons since they could not add value in distinguishing one site alternative from the other. The omitted factors were the following.

1. **Catchment Area:** Given the Project site and the location of both alternatives at the top of drainages, this area largely duplicates Footprint Area.

2. **Environmentally Sensitive Areas:** Neither site contains environmentally significant areas, or deer wintering areas, and there is no reason to expect the potential presence of species at risk to be different for the two sites.

3. **Water Quality**: Water discharged from the Project will be treated, as needed, to meet permit conditions that will be established by the Province of New Brunswick, so the quality of treated water released to the environment is not a distinguishing factor between the two alternatives. The only other potential source of environmental effects on water quality is seepage through the TSF embankments. Apart from embankment lengths, the main factors which affect seepage (*e.g.,* design of the TSF, depth to bedrock, permeability of the bedrock, characteristics of the

surficial material and overburden) are expected to be similar at the two sites. While Site 1c would have shorter embankments than Site 1b, Site 1c is higher in the Napadogan watershed where natural flows are lower and the effects of seepage on downstream water quality would thus be higher. Thus, neither site offers evident advantages in terms of seepage and downstream water quality management.

4. **Archaeological Potential:** Only Site 1b has been field surveyed to identify areas of elevated archaeological potential, and there was no meaningful way to estimate the size of these areas in Site 1c based only on the New Brunswick model for archaeological potential. Moreover, since the New Brunswick model for archaeological potential is based largely on proximity to watercourses, the environmental factor Area of Permanent Aquatic Habitat Loss is a reasonable proxy for archaeological potential.

5. **Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons**: The two sites have essentially the same natural environment, as modified by forestry operations through cutting and building access roads over many years. There is thus no reason to expect a difference in the intensity of Aboriginal use between the two sites, and any real difference in use would be accounted for in the environmental factor Footprint Area. Further, the traditional use study (Moccasin Flower 2013) did not distinguish between use of land and resources in these areas, and SML has not been made aware (by First Nations or the Crown) of any additional information that might make such a distinction.

6. **Land and Resource Use**: The two sites have essentially the same natural environment, as modified by forestry operations through cutting and building access roads over many years. There is thus no reason to expect a difference in the intensity of forestry operations and recreational land use between the two sites, and any real difference in use would be accounted for in the environmental factor Footprint Area.

7. **Operational Emissions:** The potential for emissions of dust from the two TSF sites was considered to be equivalent.

8. **Metal Leaching and Acid Generation:** The same methods for the sub-aqueous storage of PAG tailings and both PAG and NPAG waste rock would be used at both sites. Thus, neither site offers advantages in terms of ML/ARD management.

9. **Stability of Embankments:** Site conditions and the availability of suitable construction materials were considered equivalent at the two sites, and the same design standards will apply to both. Thus, neither site offers advantages in terms of embankment stability under seismic loads greater than anticipated in the design.

10. **Ease of Construction:** Neither TSF site alternative had obvious significant advantages or disadvantages for construction. The only major difference between the sites is the distance from the ore processing plant site; however, both sites have similar access from existing roads and to sources of borrow or quarry materials.

3.3.3.6 Scoring and Weighting the Factors in Comparing the TSF Site Alternatives

In order to evaluate each TSF alternative, and then compare the two alternatives, each alternative was first "scored" against each factor on a scale of 1 to 9. For each factor, the score provided a relative value of each alternative with the "best" alternative receiving a score of 9 and the other receiving a proportionately lower score according to the available information.

Each factor was then assigned a relative weight to introduce a value bias in the individual factors, based on the relative subjective importance of one factor versus another. The relative weights indicate the relative value or importance of the factors. The sum of the weights across all factors was 100. First, each category of factors (environmental, technical and economic) was assigned a portion of the 100 weight "points", then that portion was divided up among the factors in each category. The "base case" weights assumed approximately equal value of all categories of factors.

During the course of the alternatives analysis, the sensitivity of the analysis to various factor weights was tested by varying the weights to indicate how different sets of values affect the relative attractiveness of the TSF alternatives.

3.3.3.7 TSF Site Alternatives Analysis Results

As a final step, the comparison of TSF site alternatives was carried out by multiplying each factor score by its corresponding weight, and summing the products for each alternative. The alternative with the highest sum was considered the "best" TSF site. The results of the analysis are shown in Table 3.3.1 below.

Overall, the "base case" analysis resulted in Site 1b with an overall weighted score of 861 compared to a score of 706 for Site 1c. Thus, Site 1b is preferred over Site 1c. This preference held through the sensitivity analyses, even when environmental factors were weighted at 100% (Sensitivity Case 3 in Table 3.3.1).

Thus, the alternatives analysis confirmed the selection of TSF Alternative 1b (Site 1b) as the preferred location for the TSF.

Table 3.3.1 Results of TSF Site Alternatives Analysis

	Factor Value		Factor Score		Base Case			Sensitivity Case 1			Sensitivity Case 2			Sensitivity Case 3		
TSF Site Alternative	**1b**	**1c**	**1b**	**1c**	**Weight**	**1b**	**1c**	**Weight**	**1b**	**1c**	**Weight**	**1b**	**1c**	**Weight**	**1b**	**1c**
Environmental Factors																
Footprint Area (ha)	785	750	8.6	9.0	6	52	54	10	86	90	14	120	126	17	146	153
Area in Napadogan Brook Watershed (%)	100	80	9.0	7.2	6	54	43	10	90	72	13	117	94	17	153	122
Area of Permanent Aquatic Habitat Loss (m^2)	22,365	13,914	5.6	9.0	6	34	54	10	56	90	14	78	126	17	95	153
Area of Permanent Wetland Loss (ha)	161	202	9.0	7.2	6	54	43	10	90	72	13	117	94	17	153	122
Area of Permanent Loss of Interior Forest (ha)	109	70	5.8	9.0	5	29	45	10	58	90	13	75	117	16	93	144
GHG emissions (t CO2e/yr)	16,484	64,009	9.0	2.3	5	45	12	10	90	23	13	117	30	16	144	37
				Total	**34**	**267**	**251**	**60**	**470**	**437**	**80**	**625**	**586**	**100**	**784**	**732**
Technical Factors																
Storage Efficiency	11:1	9:1	9.0	7.4	11	99	81	7	63	52	4	36	30	0	0	0
Ease of Operation	High	Medium	9.0	7.0	11	99	77	7	63	49	3	27	21	0	0	0
Ease of Closure	High	Medium	9.0	6.0	11	99	66	6	54	36	3	27	18	0	0	0
				Total	**33**	**297**	**224**	**20**	**180**	**137**	**10**	**90**	**69**	**0**	**0**	**0**
Economic Factors																
Life of Mine Capital and Operating Costs	Medium	High	9.0	7.0	**33**	**297**	**231**	**20**	**180**	**140**	**10**	**90**	**70**	**0**	**0**	**0**
				Total	100	**861**	**706**	100	**830**	**714**	100	**805**	**725**	100	**784**	**732**

3.3.4 Alternative Tailings Management Technologies

As discussed in the Technical Report (Samuel Engineering 2013), a trade-off study was completed to evaluate the following tailings technologies:

- conventional (un-thickened) slurry tailings;
- thickened (paste) tailings; and
- filtered dry stack tailings.

The resulting recommendation was that an un-thickened tailings system, operating at approximately 35% solids content by weight, be used as the basis for Project development. This conclusion was based on several factors including the local climate, site water balance, overall system complexity, cost and ease of operation, and potential environmental effects and benefits.

Tailings management technologies include conventional slurry tailings, thickened/paste tailings, and filtered dry stack tailings. The preferred storage method for PAG tailings is sub-aqueous encapsulation within NPAG bulk tailings to preclude oxidation and acid generation, a very important environmental mitigation and consideration.

Thickened/paste or filtered tailings are placed within a tailings storage area at densities that are higher than typically achieved from the initial settling of conventional slurry tailings. However, tailings solids that are deposited as conventional slurries will also consolidate under their own weight over time; the ultimate tailings density in conventional tailings impoundments will tend to be comparable to the densities achieved with thickened/paste tailings. Thickened/paste tailings, and filtered dry stack tailings typically only make technical and economic sense where mines are developed in drier environments and the strict conservation of water resources is needed to avoid deficit situations.

A description of the three tailings management technologies considered, and a discussion of key issues which influence the selection of these technologies, follows.

3.3.4.1 Conventional Slurry Tailings

Conventional slurry tailings are typically discharged from the process plant at about 30% to 40% solids by total mass of slurry. These tailings may be pumped, flow by gravity, or some combination of both, depending on the available head and distance through pipelines from the plant to the TSF. The slurry is typically discharged through multiple off-takes from header pipes located around the periphery of the TSF confining embankments. The tailings solids settle and the resulting clear supernatant water is recovered from the TSF and pumped back for re-use in the process. The coarse fraction of the tailings typically settles rapidly and accumulates closer to the discharge points, forming a gentle “beach” with a slope of about 0.5 to 1%. Finer tailings particles tend to travel further and settle at a flatter slope to, and beneath, the supernatant pond. Selective tailings deposition is used to keep the supernatant pond away from the embankments, thereby reducing potential seepage losses, an important environmental mitigation and consideration.

This technology was selected for the Project because it has the advantage of being operationally simple, economical, of providing a stable water supply for use in the process and mine site, and of allowing for collection and treatment of all contact water streams associated with the mine site in one location, with one monitoring/treatment/discharge point. It also allows for the sub-aqueous storage and encapsulation of any PAG tailings and waste rock, an important environmental mitigation and consideration. The large buffering volume within the TSF pond is an important component of the site water management plan.

3.3.4.2 Thickened (Paste) Tailings Disposal

Thickened or paste tailings with higher slurry solids contents are produced in thickeners with the addition of flocculants to enhance liquid-solids separation. Therefore, a large proportion of the recoverable process water is reclaimed in the thickeners and the remaining thickened tailings are pumped to a TSF having similar embankments to those for conventional slurry tailings. Since thickened tailings are about the same density as the final settled density of slurry tailings, they require about the same size of TSF to accommodate tailings over the life of a mine. A thickened tailings TSF has no supernatant pond, so a separate, fully-lined water management pond is required for storage of stormwater run-off and snowmelt from the TSF surface, as well as for process water storage. Since a large volume of process water storage is required for start-up and winter operations, the water management pond needs to be correspondingly large resulting in an overall Project footprint, and consequent environmental effects, about the same as conventional slurry tailings.

As mentioned above, the advantage of employing thickened tailings is improved conservation of water, and especially the avoidance of evaporative losses from a TSF supernatant pond. Compared to conventional slurry tailings, the disadvantages include:

- higher processing costs for tailings thickening and thus higher energy use;
- higher pumping costs, and thus energy use, due to the thicker tailings as expensive and maintenance-intensive positive displacement pumps are typically required;
- high pressure tailings pipelines are more difficult to operate and maintain; and
- water management is complicated by the addition of a fully lined external pond.

The advantages of thickened tailings are typically more than offset by the disadvantages for a mine located in a cold winter climate with high net precipitation.

3.3.4.3 Filtered Dry Stack Tailings Disposal

Filtered tailings are produced using pressure or vacuum force in presses, drums, or belt filtration units, and are typically dewatered to a moist cake-like consistency. The materials are then transported by conveyors or trucks to a facility where they can be compacted in lifts (“dry stacked”) to improve density, traffic ability, and stability. The side slopes of the stack are supported by rock berms or buttresses and ultimately covered in a rock shell to prevent erosion. Like a thickened (paste) tailings facility, a filtered tailings stack has no supernatant pond, so a separate, water management pond is required for stormwater runoff, snowmelt and process water storage as described above for thickened (paste) tailings storage.

Compared to slurry or paste tailings, the advantages of filtered tailings are that they allow improved water conservation, and they are somewhat denser. The disadvantages of filtered dry stack tailings include:

- A water pond with a similar volume and storm capacity to the design described in Sections 3.2.4.3 and 3.4.2.3.1 would also be required, regardless of the tailings technology, in order to provide an equivalent level of environmental control of runoff from stormwater and snowmelt. In the case of a filtered tailings operation, this pond would need to be a separate facility contained by a water retaining dam, likely increasing the overall project footprint.

- They do not provide for effective isolation of PAG tailings and waste rock from oxygen diffusion and subsequent acid generation within a dry stack because a water cover is not possible.

- They require tailings filtering equipment that is expensive and complicated to build and operate, thus increasing operational complexity and energy use.

- The physical characteristics of tailings such as particle size distribution strongly influence the ability to dewater the tailings solids sufficiently so that they can be handled and placed in a compacted stack. The presence of excessive fines in the tailings may make it impractical to achieve a workable tailings product. The need to maintain the grind size in the mill within a very narrow range limits operational flexibility during ore processing.

Preventing snow or ice accumulations on a filtered tailings stack is a challenge in climates with cold, wet winters like New Brunswick. Adequate contingencies need to be provided for operations since placement of the tailings may be precluded by snow and ice on the surface of the stack, or by freezing of the tailings prior to placement:

- Wind-blown dust, and thus potential environmental effects, can worsen in winter months as freeze-drying and other frost processes can loosen the tailings.

- Wet months may cause problems as moisture addition can result in rapid degradation of surface traffic ability and prevent adequate compaction.

- The filtered tailings stack is susceptible to instability due to ice lenses or localized liquefaction if the pile becomes saturated due to rainfall, snow entrainment or percolation from run-off; and

- The operating cost, and thus energy, required to transport the large quantity of tailings to the dry stack is larger than for other tailings technologies.

No examples are known of filtered tailings management operations for comparable mining projects (*i.e.* similar climate, production rates, ore type, metallurgical process, project size) with similar waste and water management design needs, especially the need for subaqueous encapsulation of PAG tailings and waste rock. There are no known examples of a tungsten mine using paste or filtered tailings technology.

Several examples of filtered tailings management operations exist for northern mining projects north of the 60th parallel, but those have much smaller production rates (2,000 to 4,000 tpd, as compared to 30,000 tpd for the Sisson Project). Examples of small northern mining operations using filtered tailings management are: the Raglan Mine in Northern Québec, Minto Mine in the Yukon, Greens Creek Mine in Alaska, and the Pogo Mine in Alaska. An example of a larger production filtered tailings operation is La Coipa in northern Chile (approximately 17,000 tpd), which operates in an arid desert climate. Water conservation is critical for mining operations in an arid desert climate, or the far north where freezing and snow conditions are prevalent, and thus filtered tailings offer advantages in such climates. However, the relatively wet and temperate climate at the Sisson Project results in an overall water surplus at the site, negating the water conservation benefits of filtered tailings.

Filtered tailings technology can result in significant benefits where water conservation is paramount but, as discussed above, have many challenges that make this technology unfavorable in wetter climates, as at the Sisson Project site, where surplus water management is a key consideration. As well, the technology is not suited to safely encapsulating PAG tailings and waste rock so as to avoid acid generation since a water cover cannot be used, either during Operation or when the mine is closed. Effective surplus water management and avoidance of acid generation are key design, operational and closure imperatives for the Project, and thus filtered tailings are not a technically feasible technology at this site.

3.3.4.4 Summary

In consideration of the factors in the preceding sub-sections, the use of conventional slurry tailings disposal at the selected location represents the most technically and economically feasible means of carrying out the Project. Other options considered either carry technical challenges due to the Project location and climate, or are economically less desirable due largely to their energy requirements. Most importantly, slurry tailings provide for the storage of PAG tailings and waste rock sub-aqueously and encapsulated in NPAG tailings, and thus the most effective technology for effectively mitigating the potential for acid generation and consequent environmental effects. A complicated consideration of environmental effects of these or other alternatives is not warranted given these differences in environmental effects and benefits, and in consideration of other technical and economic factors.

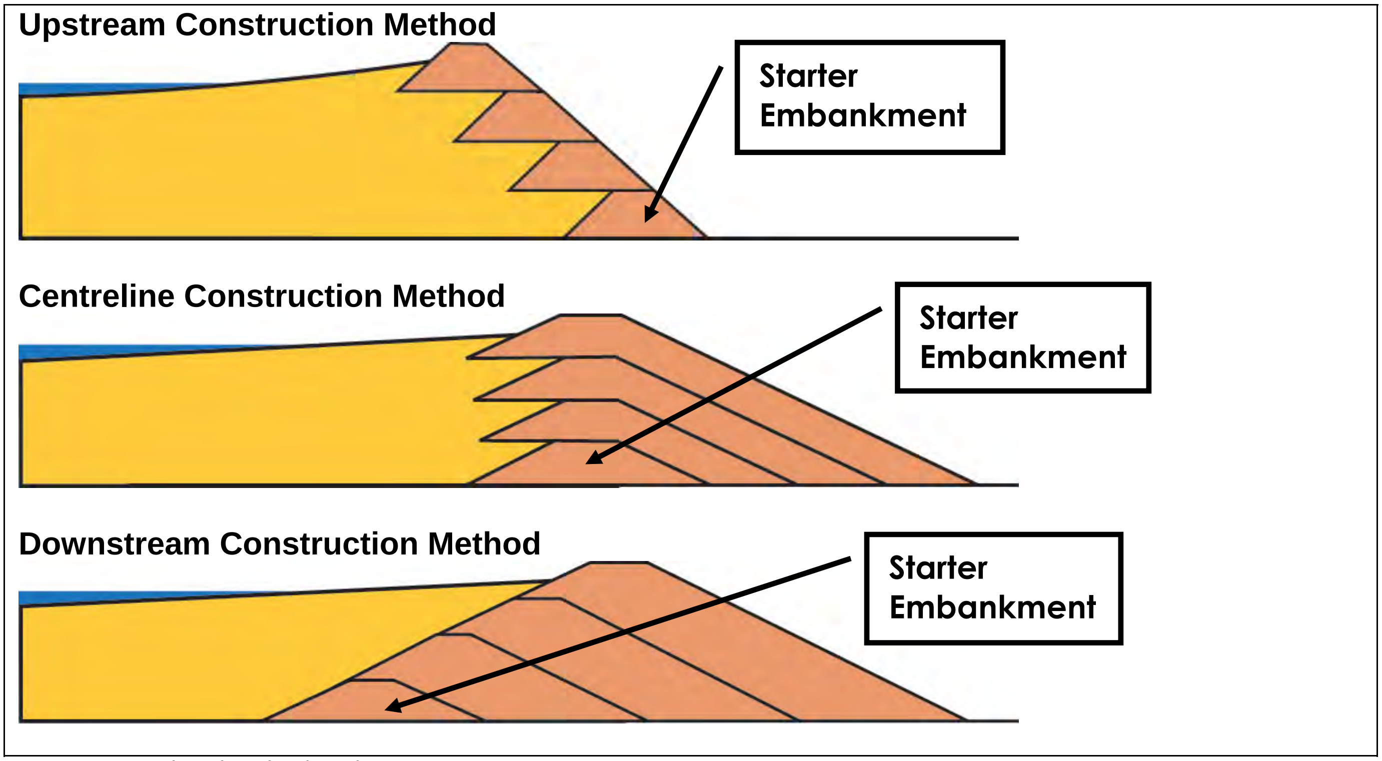
3.3.5 Alternative TSF Embankment Designs

The initial TSF embankment design assumed the use of waste rock from the open pit as a construction material for TSF embankments. Geochemical evaluation of the waste rock in early 2012 indicated that some of the waste rock may be PAG, will not be suitable for use as embankment fill material, and could not be practically mined separately from NPAG waste rock. The mitigation strategy is to place and submerge all waste rock within the TSF, and use quarried rock fill (characterized as NPAG and sourced from a quarry to be developed adjacent to the TSF) for embankment construction. There is no other technically or economically feasible alternative, and the proposed method affords appropriate mitigation for potential acid generation from PAG waste rock.

Knight Piésold further undertook a trade-off study in 2012 to compare the use of cycloned NPAG tailings sand vs. quarried rock fill as construction material alternatives for the TSF embankments. Both methods are technically feasible, though cycloned sand construction is rather more challenging due to the need to compact the deposited sand and to more complex water management requirements during embankment construction. Cycloned sand embankments are also more difficult to reclaim on Closure of the Project. At a feasibility level, one alternative was not evidently more economical than the other. For these operational reasons, and in view of the potential for regulatory and/or stakeholder concern with the use of cycloned sand which can be perceived to be less robust, quarried rock fill was selected as the preferred embankment fill material option.

The design of the TSF embankments was discussed in Section 3.2.4.3 and shown in Figure 3.2.7. The preferred design involves the progressive (staged) construction of the TSF embankments in a series of lifts that will be constructed over the life of the Project, the first of which is the initial starter embankment.

As illustrated in Figure 3.3.4, there are three principal methods of constructing the TSF embankments: upstream, centreline, and downstream that are described further below. All these methods involve sequentially raising the embankment as the TSF fills with tailings over the life of the Project; this is the typical approach for tailings embankment construction.



Source: Samuel Engineering (2013).

Figure 3.3.4 TSF Construction Methods

Upstream Construction. Of the three principal methods, the upstream construction method typically incorporates the smallest volume of compacted structural fill within the embankment. This method relies on hydraulically placed tailings as part of the foundation material for on-going embankment raises during staged expansion of the facility. Upstream construction has been used for many tailings embankments worldwide because of its lower costs. However, the seismic resistance of the upstream construction method is considered poor, and thus the great majority of embankment failures worldwide are in embankments of this type.

Centreline Construction. The centreline embankment construction method does not rely on hydraulically placed tailings for embankment stability during on-going staged expansion of the TSF. This type of embankment is inherently stable under static and seismic conditions, and is thus a construction method that is well-accepted and widely used.

Downstream Construction. The downstream construction method results in an embankment cross section that is similar to that of a conventional water retaining dam. It requires the largest volume of fill material as compared to the upstream and centreline construction methods. Downstream construction requires a greater footprint than centreline construction as each subsequent embankment stage extends the toe of the slope much further downstream of the TSF.

The upstream construction method is considered not technically feasible due to unacceptable geotechnical stability and is not considered further.

Both the centreline and downstream construction methods are technically feasible. Largely because of the additional rockfill material required, a tailings embankment constructed by the downstream method would cost in the order of $140 million more to build, over the life of the Project, than the proposed centreline embankment with no improvement in stability or other tangible technical benefit. The negative effect of this additional cost on the economics of the Project is not trivial. Apart from the cost disadvantage, compared to a centreline TSF embankment, a downstream embankment would:

- have a larger footprint due to the greater width of its base (by about 100 ha), and would need a larger quarry from which to obtain the rockfill material. Thus, the amount of aquatic, wetland and terrestrial habitat loss would be greater, as would be the compensation/offset required under the federal *Fisheries Act* (for lost fish habitat) and the New Brunswick *Clean Water Act* (for lost wetlands);

- provide no additional benefits in terms of seepage mitigation or collection and thus no additional benefits to downstream water quality management. Because of its larger base, the embankment drainage collection system under a downstream embankment would be more extensive than under a centreline embankment. However, the total amount of seepage from the TSF would not be substantially different, and the overall efficiency in capturing that total seepage through the larger embankment would not be expected to change;

- provide no additional resistance to extreme seismic events since the design basis for a downstream embankment is the same as for a centreline embankment (see Section 3.2.4.3.3.2); and

- provide no additional capacity to manage extreme storm events since, in both designs, the TSF would be designed and managed with sufficient capacity and freeboard to store the Probable Maximum Flood at all times during Operation (see Section 3.2.4.3.3.1).

In summary, both centreline and downstream embankment designs are technically feasible. However, compared to a centreline embankment, a downstream embankment would clearly cost substantially more and negatively affect the economics of the Project while offering no safety or environmental protection benefits. It would also result in a substantially increased environmental footprint with the associated adverse environmental effects. Thus, the results of the analysis of alternative embankment designs is that the Sisson TSF embankment will be constructed using the centreline construction method rather than the upstream or downstream method.

As shown in Figure 3.2.7, the centreline method will be slightly modified for the Sisson Project to incorporate compacted tailings on the upstream side of the embankments to reduce seepage. The modified centerline design provides the same level of security against slope failure as a centerline design, and meets or exceeds the factors of safety in the CDA Guidelines. In the case of the embankments for the Sisson Project, the target factors of safety are easily achieved or exceeded using a modified centerline design.

3.3.6 Alternatives for Low Grade Ore Storage and Waste Rock Storage

Low grade ore and waste rock storage was presented in the *CEAA* Project Description (Stantec 2011) as being stored in a designated storage area either north or west of the open pit. As detailed in Section 7.5 of this EIA Report and based on extensive ARD/ML characterization studies, waste rock generated by the Project is considered PAG and therefore not suitable for open waste rock storage or for use in building the TSF embankments. As a result, waste rock storage has been diverted to the TSF to effectively mitigate the potential for long-term ML/ARD issues consequent environmental effects on receiving water quality. The TSF as described in Section 3.2.4.4 will handle all tailings and waste rock, including the sub-aqueous disposal of PAG materials.

3.3.7 Alternative Means and Routes for Transporting Personnel, Equipment, Supplies, Materials, and Products

The Project is located in rural New Brunswick with a number of public highways and secondary roads that lead to the forest resource road network used to access the Project. To assist in the selection of Project routes and the assessment of potential environmental effects on road transportation as required by the Final Guidelines (NBENV 2009) and Terms of Reference (Stantec 2012a), SML retained exp Services Inc., a specialty engineering firm with considerable expertise in transportation planning and engineering, to carry out a Transportation Study for the Project. The Transportation Study (exp Services Inc. 2013a; 2013b) evaluated various means of accessing the Project site from major highways, with a focus on the transportation of Project personnel and the delivery of goods and materials to and from the Project site during the Construction, Operation, and Decommissioning, Reclamation and Closure phases of the Project.

The Transportation Study recommended the use of a Primary Site Access (PSA) route and a Secondary Site Access (SSA) route, as discussed in Section 3.2.5.3.1 and with their environmental effects evaluated in Section 8.15 (Transportation) of this EIA Report.

In terms of means of shipping mineral products from the Project, a combination of road and rail transportation will be used to ship mineral products from the Project site either directly to markets, or to port facilities in Saint John or Belledune. All such means of transportation will be considered and used through Operation of the Project, depending on the customer location, logistics, and economics.

In consideration of the Transportation Study, the residual environmental effects of the Project on Transportation, and planned mitigation, the selected means of transporting goods, materials and personnel to and from the Project site as discussed in this EIA Report represents the most technically and economically feasible means of carrying out the Project in this regard.

While most alternatives considered may have minor differences in the environmental effects experienced, since the Project will in all cases use existing public roads and forest resource roads with minimal increases in traffic levels (see Section 8.15), a complicated consideration of environmental effects of these or other alternatives is not warranted.

3.3.8 Alternative Electrical Transmission Line Routes

As discussed in Section 3.2.5.7, a new 138 kV electrical transmission line will be required to link the Project to the New Brunswick electrical grid. To assist in the planning and development of the Project, NB Power completed a Facilities Study (NB Power 2012) to identify potential options and routes for supplying electrical power to the Project. In its Facilities Study, NB Power identified five potential power supply options, including three distinct transmission line routes, for supplying the Project with electricity. The three routes, referred to herein as Potential Routes, were are analyzed in consideration of environmental, socioeconomic and engineering constraints trough a Route Alternatives Analysis, summarized briefly below.

3.3.8.1 Guiding Principles

A set of guiding principles was created to form the basis of constraint development and the approach and methodology to conduct the alternatives analysis. These guiding principles were to select a preferred route that:

- follows existing corridors to the extent possible;
- maximizes the use of public (Crown) land;
- avoids partitioning of large parcels of privately-owned land;
- minimizes its environmental footprint;
- minimizes watercourse crossings;
- avoids environmentally sensitive areas and features (*e.g.,* deer wintering areas (DWAs), ecologically significant areas (ESAs)) to the extent feasible; and
- is technically and economically feasible from an engineering and constructability perspective.

3.3.8.2 Route Evaluation Methods

3.3.8.2.1 Data Sources

The characteristics of the potential routes were determined by reviewing information collected from various information sources, including topographic maps, NBDNR wetland/hydrology maps land use mapping, land ownership mapping and associated records, and publications containing material of general and specific relevance to the area.

The Potential Routes were delineated using Geographic Information Systems (GIS) to allow for integration of multiple spatially referenced data sets and is a powerful tool in support of decision making. Information is easily combined and displayed in this format, allowing for easy interpretation and assessment of data.

3.3.8.2.2 Rankings

The Potential Routes were evaluated using three general categories of constraints: environmental, socioeconomic, and engineering. Each category was subdivided into smaller components. For each Potential Route, individual components within a category of constraints were evaluated and ranked using pre-determined criteria, according to the following methodology.

1. Components were ranked on a scale of 0 – 10. A ranking of 10 was given to the most favourable potential routes, whereas a ranking of 0 was given to potential routes of low favourability based on their respective criteria. Potential routes of equal favourability were ranked equally. No scores of less than 0 were assigned.

2. The ranking of each component within a category was then multiplied by its associated weighting factor to give a weighted component ranking.

3. All weighted component rankings were then summed to give an overall category ranking.

4. The overall category ranking was then multiplied by its weighting factor to give a weighted category ranking.

5. Weighted category rankings from each of the three categories were summed to give an overall ranking for each Potential Route. The overall rankings are displayed as a score out of 100, such that a score of 100 will be an ideal route, while a score of 0 signifies a very unfavourable route.

An example of the ranking system and calculation thereof is shown in Table 3.3.2.

Table 3.3.2 Potential Route Ranking Calculation Example

Constraints Category – Environmental (Weighting Factor 40%)									
Environmental Components	Component Weighting Factor		Potential Route Ranking		Component Weighted Ranking		Category Weighting Factor		Category Weighted Ranking
Watercourse Crossings	25%	x	4	=	1.0				
Wetlands	20%	x	9	=	1.8				
Ecologically Significant Areas	10%	x	8	=	0.8				
Deer Wintering Areas	10%	x	9	=	0.3				
Parallel to Existing Corridor	35%	x	10	=	3.5				
Category Ranking (sum)					**7.4**	**x**	**4 (40%)**	**=**	**29.6**

3.3.8.3 Constraints

A set of environmental, engineering, and socioeconomic constraints were developed based on the Guiding Principles detailed above. Each constraint was assigned a ranking criterion, against which each Potential Route was scored, and overall scores were totalled for each category of constraint and weighted to arrive at an overall score for each Potential Route.

Environmental Constraints: The following environmental constraints were considered:

- watercourse crossings;
- wetlands;
- ecologically significant areas (ESAs);
- deer wintering areas (DWAs); and
- parallel to existing corridor.

Adverse environmental effects, such as erosion, sedimentation, disturbance of ecologically significant areas, habitat disturbance and habitat fragmentation, are to be minimized. A route that is parallel to an existing corridor is preferred because no new fragmentation of habitat will be created.

Socioeconomic Constraints: The following socioeconomic constraints were considered:

- recreational areas; and
- bi-section of private property.

Adverse socioeconomic environmental effects, such as lost recreational area or disruption of trails and disturbance to private property, were also to be minimized.

Engineering Constraints: The following engineering constraints were chosen and considered:

- topography;
- length; and
- reliability of source.

Adverse environmental effects, such as excessive costs, were to be minimized while ensuring that a reliable electrical source can be provided to the Project.

3.3.8.4 Potential Routes

In its Facilities Study, NB Power identified potential transmission line routes by first identifying potential sources of electricity within the existing NB Power transmission system, based solely on engineering and constructability considerations. Four potential electrical sources that could be accessed to supply the electrical requirements for the Project were identified:

- the Keswick Terminal;
- Line 1126, a 138 kV line located to the west of the Sisson Project site, near Cloverdale;

- Line 3011, a 345 kV line that runs adjacent to and through the Sisson Project site; and
- Line 48, a 69 kV line located in Deersdale.

The Facilities Study identified the need to construct a new transmission line connected to one of the above noted potential sources in order to supply the electrical requirements for the Project. From this, three potential routes were identified, as follows.

Route A: Route A (Figure 3.3.5) originates at the Keswick Terminal and culminates at the Sisson Project site, running along the east side of an existing 345 kV transmission line (Line 3011). This route, approximately 42 km in length, parallels an existing linear corridor and is favourable due to facilitated access and reduced potential for habitat fragmentation concerns.

Route B: Route B (Figure 3.3.6) originates at the existing 138 kV transmission line (Line 1126) near Cloverdale, west of the Project, and culminates at the Sisson Project site. This route is approximately 23 km long and generally follows a straight path to the Project site. This entire route will require a new corridor to be developed between the Sisson Project site and the tie-in location to Line 1126.

Route C: Route C (Figure 3.3.7) originates at the 69 kV transmission line (Line 48) in Deersdale to the north of the Project, and culminates at the Sisson Project site. This route is approximately 13 km long and follows an essentially straight line path to the Project site. This route will require a new corridor to be developed between the Sisson Project site and the tie-in location to Line 48.

3.3.8.5 Route Alternatives Analysis Results

The complete quantitative evaluation and ranking of each Potential Route is shown in Table 3.3.3.

Table 3.3.3 Electrical Transmission Line Route Alternatives Analysis Results

Criteria		Weight (%)	Route A		Route B		Route C	
			Ranking	Score	Ranking	Score	Ranking	Score
A.	**Environmental Criteria**							
A.1	Watercourse Crossings	25%	4	1.0	7	1.8	8	2.0
A.2	Wetlands	20%	9	1.8	9	1.8	9	1.8
A.3	Ecologically Significant Areas	10%	8	0.8	5	0.5	8	0.8
A.4	Deer Wintering Areas	10%	3	0.3	7	0.7	10	1.0
A.5	Parallel to Existing Corridor	35%	10	3.5	0	0.0	2	0.7
	Score			**7.4**		**4.8**		**6.3**
	Weighted Score	**40%**		**29.6**		**19.0**		**25.2**
B.	**Socioeconomic Criteria**							
B.1	Recreational land use	45%	3	1.4	9	4.1	9	4.1
B.3	Bi-section of private property	55%	8	4.4	4	2.2	9	5.0
	Score			**5.8**		**6.3**		**9.0**
	Weighted Score	**20%**		**11.5**		**12.5**		**18.0**

Table 3.3.3 Electrical Transmission Line Route Alternatives Analysis Results

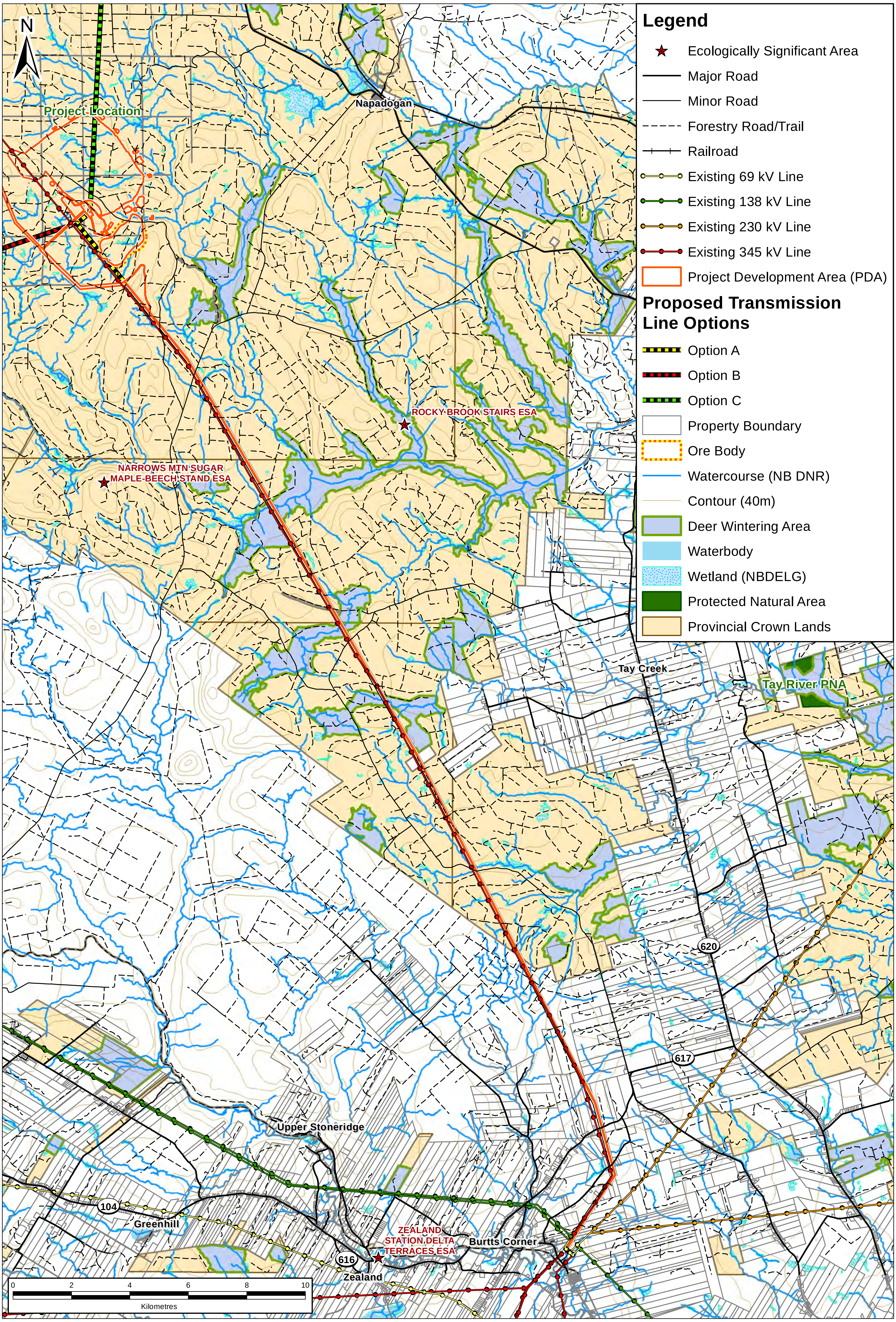
Criteria		Weight (%)	Route A		Route B		Route C	
			Ranking	Score	Ranking	Score	Ranking	Score
C.	**Engineering Criteria**							
C.1	Topography	10%	9	0.9	8	0.8	9	0.9
C.2	Length	25%	2	0.5	6	1.5	9	2.3
C.3	Reliability of source	65%	10	6.5	2	1.3	1	0.7
	Score			**7.9**		**3.6**		**3.8**
	Weighted Score	**40%**		**31.6**		**14.4**		**15.2**
	Total Weighted Score	**100%**		**72.7**		**45.9**		**58.4**

In each of the Potential Routes, the area is primarily Crown land, generally isolated, and rural, with only a few residential areas that are generally located at or near the source ends of the routes. Accordingly, a higher weighting was applied to environmental and engineering constraints than was applied to socioeconomic constraints.

Of the environmental constraint components, route location parallel to an existing corridor was assigned the highest weighting as compared to greenfield options. A parallel corridor will minimize habitat fragmentation and will use existing infrastructure (*e.g.,* access roads) reducing adverse environmental effects. The proposed transmission line design has the ability to span large areas and as a result the watercourse crossing component has been given a correspondingly lower weighting than for other constraints.

Of the engineering constraint components, reliability of source was assigned the highest weighting, as electrical supply problems could adversely affect both the Project itself as well as the stability and reliability of the New Brunswick electrical grid. The topography in the region surrounding the Project is favorable, and therefore this component was assigned a correspondingly lower weighting as compared to other constraints.

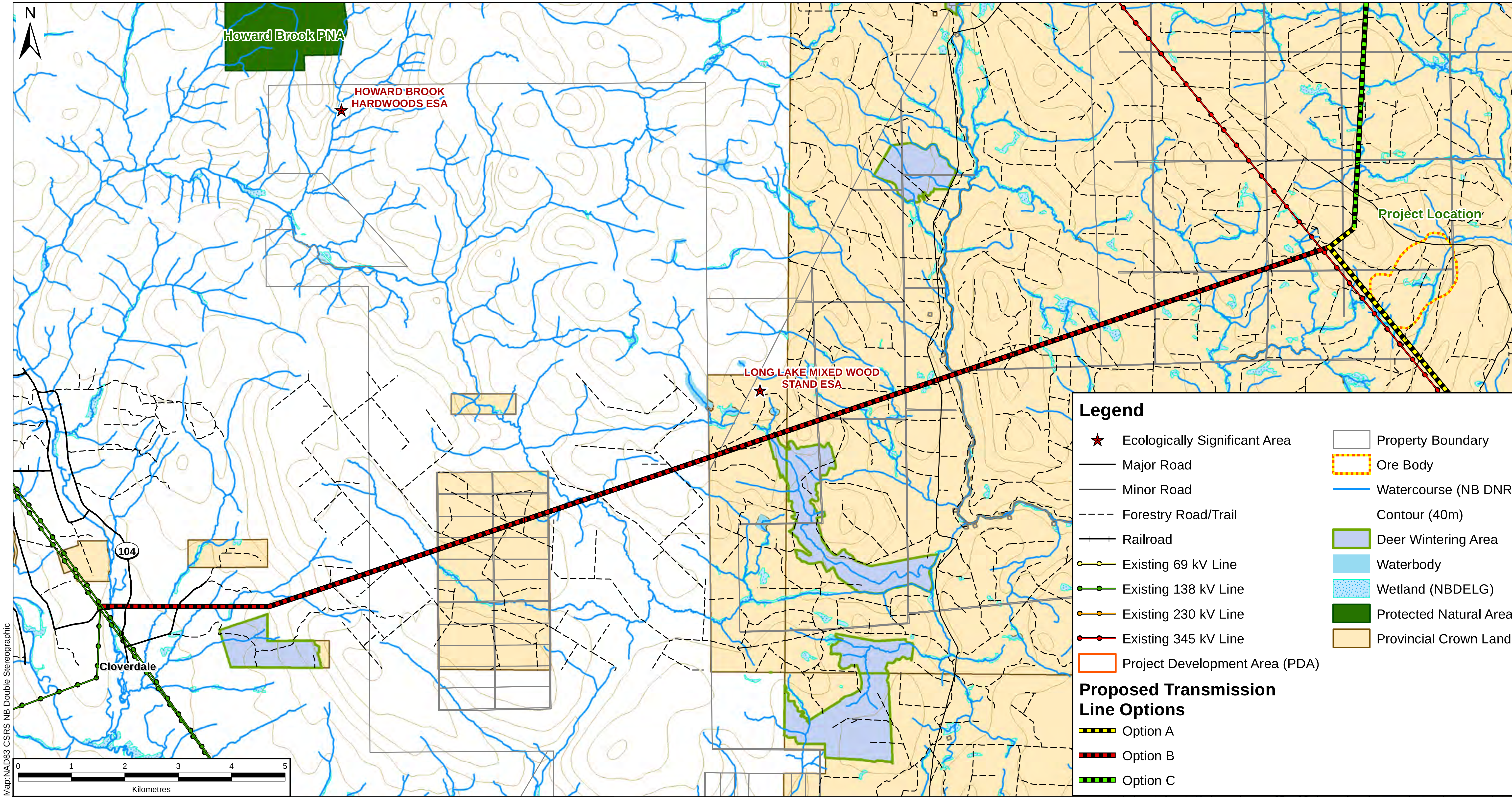
As a result of the analysis, Route A (Figure 3.3.5) received the highest overall weighted score (Table 3.3.3) and thus has been identified as the Preferred Route. Route A crosses several watercourses and wetlands; however, standard mitigation measures employed during the construction and operation of the electrical transmission line will minimize interactions with the surrounding environment and the potential for adverse environmental effects. For example, watercourses will be spanned by the electrical transmission line, and therefore no in-stream work will occur within 30 m of the watercourse. Cutting and clearing within the corridor of the Preferred Route will occur outside of the normal bird breeding season (May 1 – August 31) to minimize the potential for interaction with migratory birds and their nests. In locations where wetlands cannot be avoided, mitigation will be employed, including spanning the wetlands to avoid placing infrastructure within them. A wetland compensation plan will be developed and will consider any loss of wetland area or function that occurs as a result of the transmission line.



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Potential Route A for an Electrical Transmission Line Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:120,000	Project No.: 121810356	Data Sources: NB DNR NB DELG NRCAN	Fig. No.: 3.3.5	Stantec
Client: Sisson Mines Ltd.	Date: (dd/mm/yyyy) 6/11/2013	Dwn. By: KR / Appd. By: DM			

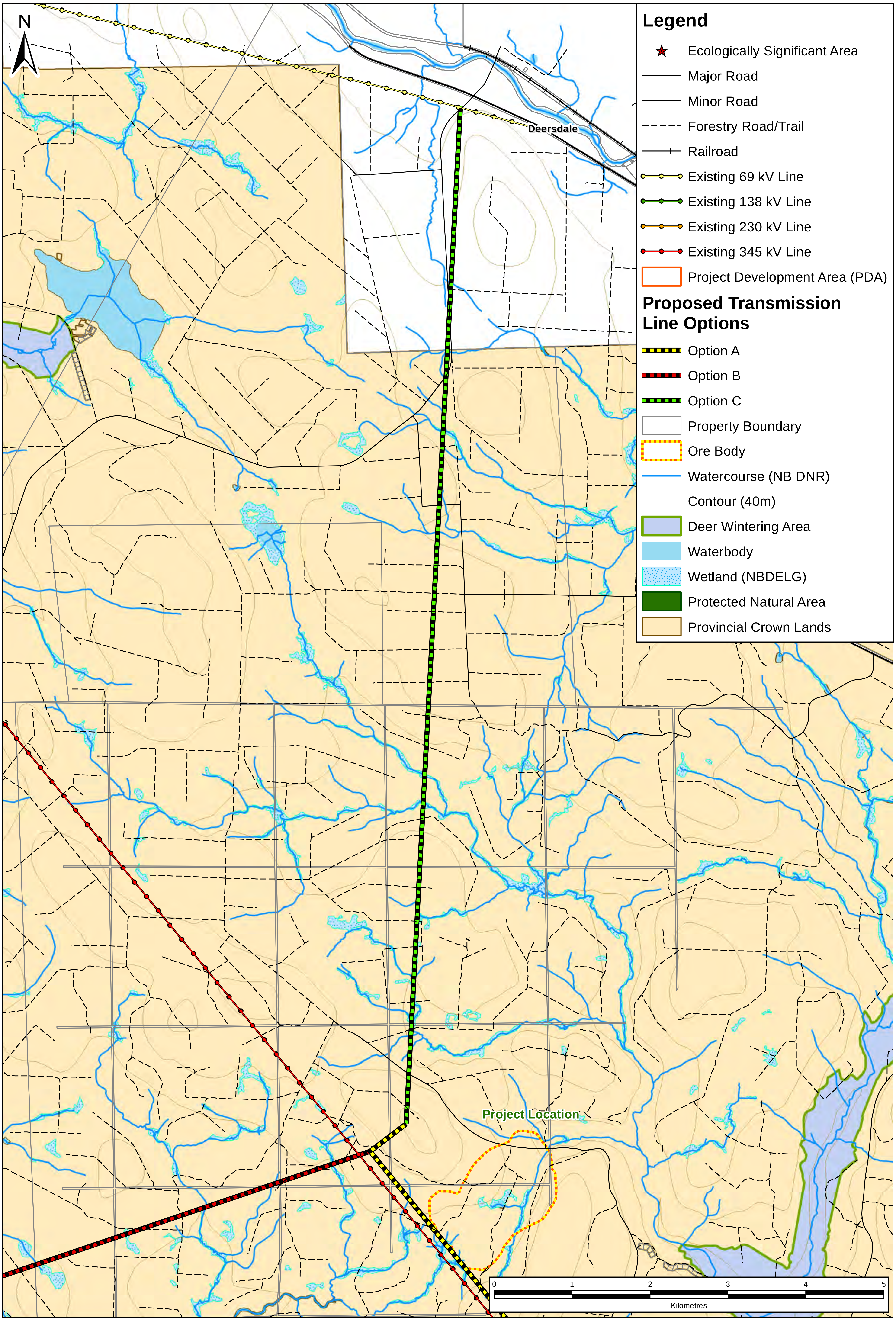
Map: NAD83 CSRS NB Double Stereographic



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Potential Route B for an Electrical Transmission Line Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:70,000	Project No.: 121810356		Data Sources: NB DNR, NB DELG, NRCAN	Fig. No.: 3.3.6
	Date: (dd/mm/yyyy): 6/11/2013	Fig. By: KR	Appd. By: DLM		
Client: Sisson Mines Ltd.					

Stantec



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Potential Route C for an Electrical Transmission Line Sisson Project: Environmental Impact Assessment (EIA) Report, Napadogan, N.B.	Scale: 1:45,000		Project No.: 121810356	Data Sources: NB DNR NB DELG NRCAN	Fig. No.: 3.3.7	Stantec
	Date: (dd/mm/yyyy) 6/11/2013	Dwn. By: KR	Appd. By: DLM			
Client: Sisson Mines Ltd.						

Map: NAD83 CSRS NB Double Stereographic

Route A was selected as the preferred route and alternative to supply electrical power to the Project. Other alternatives considered may be technically or economically feasible, but are not the preferred route in view of the technical and economic criteria employed in this analysis. While most alternatives considered may have minor differences in the environmental effects experienced, the facilities do not have substantive differences in footprints, emissions, discharges or wastes, and as such a complicated consideration of environmental effects of these or other alternatives is not warranted.

3.3.9 Alternative Options for Decommissioning, Reclamation and Closure

The *Mining Act* requires that a Mining and Reclamation Plan be developed for the Project as part of its approval under that Act.

SML has considered various options to achieve decommissioning, reclamation and closure of the Project site at the end of mine life. The Conceptual Reclamation and Closure Plan developed for SML (EvEco 2013) describes the conceptual approach to completing reclamation and closure of the Project as conceived in the feasibility study at this stage of Project development. This plan is described briefly in Section 2.6.3 of this EIA Report, and the activities that will be conducted during Decommissioning, Reclamation and Closure phase based on this plan are described in Section 3.4.3.

Monitoring and adaptive management will be carried out throughout the Project life, and invariably the conceptual plan to complete reclamation and closure will necessarily need to evolve as a result of potential changing requirements and features that cannot be anticipated at the onset of Project planning. The Reclamation and Closure Plan will thus be a dynamic document that will be updated throughout the mine life to reflect current plans and requirements to achieve successful reclamation and closure of the site.

Upon completion of mining activities, the plans for decommissioning, reclamation and closure that are developed and ultimately implemented by SML and subsequently approved by regulatory authorities will consist of the preferred (and only authorized) means of achieving these outcomes and the agreed-upon end land use objectives. In this light, there are no known technically or economically feasible alternatives to the current conceptual plans to complete decommissioning, reclamation and closure of the Project.

3.3.10 Alternative Options for Fish Habitat Offsetting

The Project will result in the loss of Sisson Brook, Bird Brook, and other small portions of watercourses to make way for Project facilities. The loss of fish habitat is considered to be “serious harm to fish” under the federal *Fisheries Act* that must be authorized under Sections 35(2) and 36 of the Act and offset to the satisfaction of the Department of Fisheries and Oceans Canada (DFO). As part of its evaluation of potential fish habitat offset opportunities for the Project, SML has identified four main options for consideration to offset the loss of Bird Brook and Sisson Brook as a result of the Project. These options, discussed briefly in Section 7.4 of this EIA Report, are:

- removal of the Campbell Creek Dam;
- removal of the Lower Lake Dam;

- provision of Atlantic salmon passage at the Dunbar Stream Falls; and
- replacing an old water-level control dam and road culvert on the Nashwaak River just below its exit from Nashwaak Lake with a woods road bridge.

Other opportunities are also being evaluated by SML for possible implementation, but the above four options represent what are believed to be the highest value options for offsetting the loss of fish habitat as a result of the Project such that no net loss of fish habitat will occur.

The evaluation of potential fish habitat offset alternatives was completed to compare the above-noted potential fish/fish habitat enhancement works and their potential suitability for fish habitat offset for the Project. The evaluation was undertaken in consideration of the following factors:

- consultation with federal and provincial regulators;
- hierarchy ranking within the framework in the former DFO Practitioners Guide (for HADD compensation opportunities) (DFO 2006);
- potential to offset the productivity of fish habitat in the brooks affected by the Project;
- engineering feasibility;
- value to brook trout and Atlantic salmon populations in the ecological unit;
- value to stakeholders and First Nations;
- heritage resource status (where applicable);
- other regulatory constraints (*e.g.,* presence of wetlands or Species at Risk);
- recognition of regulatory/stakeholder/public concerns; and
- estimated capital costs.

Further details on the evaluation process, considerations, and results are provided in Section 7.4. The evaluation resulted in the selection of the replacement of the old water-level control dam and road culvert on the Nashwaak River with a woods road bridge. Other alternatives considered did not meet all of the established criteria for selecting the preferred option, did not provide sufficient area available for compensation, and were less acceptable to regulatory agencies or stakeholders. As such, subject to regulatory approval, the Nashwaak Lake culvert replacement option has been brought forward to DFO as the most technically and economically feasible means of carrying out the Project in this regard. Since DFO will ultimately determine whether this preferred option is acceptable to offset the loss of fish habitat for the Project, consideration of environmental effects of this or other alternatives beyond that conducted in support of the evaluation presented in Section 7.4 of this EIA Report is not warranted.

3.4 DESCRIPTION OF PROJECT PHASES AND ACTIVITIES

Three Project phases are distinguished for this EIA Report. The **Construction** phase ends, and the **Operation** phase begins, at initial start-up of the ore processing plant. The **Decommissioning, Reclamation and Closure** phase begins when mining and ore processing are complete, and ends when the site is returned to a physically, chemically and biologically stable condition acceptable to the Province of New Brunswick. Within this third phase, "Closure" is defined as the time period between when mining operations cease and when the open pit has filled with water; "Post-Closure" begins when the open pit has been filled and starts discharging water, treated as required to meet water quality standards established by provincial approvals and permits.

Throughout this document, the Construction phase is identified as beginning in Year -2 and continues to completion in Year -1. The start of the Operation phase is in Year 1 and continues to Year 27 (the end of mine life). The Decommissioning, Reclamation and Closure phase begins in Year 28. It is important to note that there is no Year 0—the sequence is Year -2, Year -1, Year 1, Year 2, etc.

The key project phases, activities and physical works are identified in Table 3.4.1; these activities will be carried throughout the EIA of the Project. These key project phases and activities identify Project schedule milestones, characterize the physical works that will be carried out during an associated Project phase, and are representative of the activities that have the potential to result in a potential environmental effect as a result of the Project.

Table 3.4.1 Description of Project Phases, Activities, and Physical Works

Project Phase	Activity Category	Project Activities and Physical Works
Construction	Site Preparation of Open Pit, Tailings Storage Facility (TSF), and Buildings and Ancillary Facilities	The Project-related activities associated with preparing the open pit, TSF, and buildings site for physical construction, including: • surveying; • geotechnical investigations; • clearing; • grubbing; • removal and stockpiling of topsoil and overburden; and • grading/leveling.
	Physical Construction and Installation of Project Facilities	The physical construction of buildings and structures associated with the Project, and installation of equipment associated with its operation, including: • construction of surface facilities (*e.g.,* processing plants, electrical substation, primary crusher, ore conveyor, maintenance shop, explosives storage); • quarrying, aggregate crushing, and concrete batch plant; • development of starter pit and initial ore stockpile; • establishment of overburden and soil stockpiles; • construction of engineered drainage and diversion channels; • loss of Bird and Sisson brooks; • TSF preparation; • construction of TSF starter embankments, water management ponds, and ponding of start-up water; • establishment of water management system; and • equipment installation.
	Physical Construction of Transmission Lines and Associated Infrastructure	The physical construction of electrical transmission-related facilities associated with the Project, including: • site preparation (*e.g.,* clearing, development of access);

Table 3.4.1 Description of Project Phases, Activities, and Physical Works

Project Phase	Activity Category	Project Activities and Physical Works
		• relocation of existing 345 kV transmission line (*e.g.,* distribution of materials, foundation construction, erection of towers, stringing, reclamation); • construction of new 138 kV transmission line (*e.g.,* distribution of materials, foundation construction, erection of towers, stringing, reclamation); and • construction of electrical substation.
	Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads	The physical construction of roads associated with the Project, including: • site preparation (*e.g.,* clearing, sedimentation and erosion control, grubbing, cutting and filling, grading); • relocation of Fire Road (*e.g.,* road bed preparation, ditching, finishing); • construction of site access road and internal site roads (*e.g.,* road bed preparation, ditching, finishing); and • construction of watercourse crossings.
	Implementation of Fish Habitat Offsetting/Compensation Plan	The physical construction and/or demolition activities associated with implementing various initiatives that form the basis of the Fish Habitat Offsetting program for the Project, including: • replacement of the Nashwaak Lake culvert with a woods road bridge (*e.g.,* clearing of access, heavy vehicle movement, physical removal of culvert and infrastructure, construction of a woods road bridge, site rehabilitation).
	Emissions and Wastes	Emissions and wastes arising from Construction activities, including: • air contaminant emissions (*e.g.,* fugitive dust from roadways and construction activities, emissions from vehicles and heavy equipment); • sound emissions (*e.g.,* from construction activities or from vehicle/equipment movements); • vibration; • surface run-off; and • solid waste disposal.
	Transportation	The activities associated with the transportation of goods, materials, and personnel to and from the Project site during Construction, including: • transportation of equipment, supplies and materials; and • transportation of personnel to and from the Project site using buses and personal vehicles.
	Employment and Expenditure	The activities associated with Project-related employment and expenditures associated with Construction of the Project, including: • purchase of equipment, supplies, and materials; and • employment and incomes.
Operation	Mining	The activities associated with open pit mining, including: • open pit mine operation (operation of explosives magazine, blasting, extraction of ore and waste rock, on-site transportation of ore to crusher, and, until last mining phase, on-site transportation of waste rock to TSF); • ore crushing and conveyance to processing plant; and • rock quarrying, trucking and crushing as needed.
	Ore Processing	The activities associated with the processing of ore in and production of products, including: • milling/grinding;

Table 3.4.1 Description of Project Phases, Activities, and Physical Works

Project Phase	Activity Category	Project Activities and Physical Works
		• flotation; • concentrate dewatering; • tungsten refining; and • packaging.
	Mine Waste and Water Management	The activities associated with the supply of water for the process operation, and the management and storage of surplus water and byproducts from the process operation including: • dewatering of open pit; • tailings storage in TSF; • construction of TSF embankments over life of mine; • waste rock storage in TSF; • collection and management of on-site mine contact water; and • surplus water treatment, release, and monitoring.
	Linear Facilities Presence, Operation, and Maintenance	The physical presence, and operation and maintenance, of Project-related linear facilities, including the 138 kV transmission line, substation, and site roads.
	Emissions and Wastes	Emissions and wastes arising from Operation activities, including: • air contaminant emissions (*e.g.,* fugitive dust from mining and on-site vehicle movements, emissions from ore processing plants, combustion gas emissions from vehicles and heavy equipment); • sound emissions (*e.g.,* blasting, equipment operation, and vehicle movements); • vibration; • treated surplus water release (assessed under Mine Waste and Water Treatment above); • mining waste disposal (*e.g.,* tailings and waste rock, assessed under Mine Waste and Water Treatment above); and • non-mining solid waste disposal.
	Transportation	The activities associated with the transportation of goods, materials, and personnel to and from the Project site during Operation, including: • transportation of equipment, supplies and materials; • transportation of products; and • transportation of personnel to and from the site.
	Employment and Expenditure	The activities associated with Project-related employment and expenditures associated with Operation of the Project, including: • purchase of equipment, supplies and materials; • employment and incomes; and • taxation and royalties.
Decommissioning, Reclamation and Closure	Decommissioning	The activities associated with the decommissioning of Project components and facilities at the end of mine life, including: • decommissioning and removal of equipment; and • removal of buildings and structures.
	Reclamation	The activities associated with reclamation of the Project site at the end of mine life.
	Closure	The activities associated with closure of the mine, including the filling of the open pit with water from the TSF and precipitation.
	Post-Closure	The existence of the former TSF and open pit, now filled with water, in perpetuity, and the ongoing treatment and release of surplus water, as applicable.

Table 3.4.1 Description of Project Phases, Activities, and Physical Works

Project Phase	Activity Category	Project Activities and Physical Works
	Emissions and Wastes	Emissions and wastes arising from Decommissioning, Reclamation and Closure activities, including: • surplus water management, treatment, and release.
	Transportation	The activities associated with the transportation of goods, materials, and personnel to and from the Project site during Decommissioning, Reclamation and Closure, including: • transportation of equipment, supplies and materials; and • transportation of personnel.
	Employment and Expenditure	The activities associated with Project-related employment and expenditures associated with Decommissioning, Reclamation and Closure of the Project, including: • purchase of equipment, supplies and materials; and • employment and incomes.

Further details on these phases and activities are provided in the sub-sections that follow.

3.4.1 Construction

The Construction phase will begin immediately following government approval of the EIA and the receipt of all government approvals, permits and authorizations required to begin construction of the Project, as well as Project financing and a SML Board decision to proceed. Construction is expected to take place over a period of about 24 months, and will be completed by the initial start-up of the ore processing plant—marking the beginning of the Operation phase.

The following is a brief description of Construction activities that are typical for an open pit mine and associated infrastructure. All Construction activities will be managed by the Environmental Protection Plan for Construction as described in Chapter 2.

In general terms, once EIA approvals, the Approval to Construct and other necessary permits are in place, Construction will start over the first fall/winter period. The planned Construction sequence is as follows.

- Construction will start over the first fall/winter period following receipt of all approvals, with tree clearing for the plant site and road infrastructure (*e.g.,* Fire Road relocation, site access road to the Project, and main site roads), the TSF starter dams and the associated initial pond areas within the tailings basin, and the water management ponds.

- Construction of the ore processing plant, TSF starter dams, water management ponds, and road infrastructure will begin as soon as site conditions allow the following spring/summer. Clearing for the new and relocated transmission lines, the initial open pit, and other facilities will take place over the second fall/winter period, and construction/relocation of the transmission lines will start during that second winter period.

- Development of the initial open pit and construction of other facilities (*e.g.,* primary crusher, ore conveyors, and explosives facility) will begin as soon as site conditions allow early in the second spring/summer of Construction.

The Project site layout at the end of Construction is shown in Figure 3.4.1. Clearing of the rest of the TSF will take place in stages during Operation over the fall/winter periods before each major extension of the TSF footprint and embankment raises the following summer. Similarly, clearing of the rest of the open pit area will occur in stages during Operation in the fall/winter periods before major pit extensions the following summer.

3.4.1.1 Site Preparation of Open Pit, Tailings Storage Facility (TSF), and Buildings and Ancillary Facilities

During Year -2 (first year of Construction), the site will be prepared for development of the open pit, TSF, buildings and ancillary facilities. Site preparation will include clearing, grading, and leveling of the site as required in preparation for foundations and equipment.

Erosion and sedimentation control techniques will be employed throughout the site preparation activities as required to minimize erosion of exposed areas and sedimentation in site surface water. Dust suppression and water containment will also be employed during site preparation to minimize the potential environmental effects of fugitive dust to offsite locations.

3.4.1.1.1 Surveying

The Project site will be surveyed to accurately determine actual elevations and contours in order to optimize cut and fill operations consistent with layout requirements of the site components.

3.4.1.1.2 Geotechnical Investigations

Drilling and geotechnical investigations will be completed to establish the requirements to achieve stable foundations for Project infrastructure and to finalize the design of the open pit slopes. Geotechnical/hydrogeological data collection during the detailed design and construction stages, will focus on bench mapping, borehole hydrogeological testing, and piezometer instrumentation and monitoring.

3.4.1.1.3 Clearing

Clearing of the areas for the open pit, primary crusher and ore conveyor, ore processing plants, stockpiles, TSF, site access road, internal site roads, and ancillary facilities will be completed using forest harvesting machinery. Clearing near watercourses will be conducted manually. Clearing activities will be conducted outside of bird breeding season (May 1-August 31) to the extent possible, to prevent the undue disturbance of migratory birds or their nests. Should clearing be required within this season, these areas will be surveyed to determine if nesting is occurring within these areas. All cleared merchantable timber will be sold, and except for the TSF area, any remaining cleared vegetation will be stockpiled. Non-merchantable timber in the TSF area will simply be flooded when water begins to be impounded in the TSF.

The TSF embankment areas will be locally sub-excavated to remove unsuitable material (*e.g.,* soft, loose, or excessively wet soils). This material will be used to the extent possible as fill within the starter embankment shell zones, and unneeded material will be stockpiled for future use. The TSF embankment foundation areas will be dewatered and any natural streams will be diverted in engineered channels.

3.4.1.1.4 Grubbing

Grubbing includes the removal and disposal of stumps and roots remaining after clearing. Grubbing will be conducted using a root rake or similar equipment that is able to remove the roots and stumps of cleared vegetation and leaves the topsoil for salvage. The areas associated with the ore processing plant, the TSF embankments, and other surface facilities (*e.g.,* roadways) will be grubbed, whereas the TSF area itself will not be prepared further beyond clearing and removal of merchantable timber.

3.4.1.1.5 Removal and Stockpiling of Topsoil and Overburden

The overburden in the open pit area generally consists of a veneer of organic matting and topsoil over till. The overburden thicknesses generally range from 0.90 to 4.0 m in depth below ground surface. Topsoil will be an organic material, while overburden will typically be till (*i.e.,* silty sand and gravel).

This material will be removed with excavators from the area of the starter open pit and in the area where foundations will be laid. Topsoil and overburden will be stockpiled in various areas surrounding the TSF and other facilities, for reuse during re-vegetation activities associated with progressive reclamation of the site and ultimate site reclamation at the end of mine life. The amount of materials to be collected, construction and operation considerations, space availability, and future intended uses will determine the exact location and size of these stockpiles. The material will be used at closure to provide a growth medium on the tailings beach, TSF embankments, and any other appropriate areas. Sediment control fencing will be installed and maintained at all stockpiles that are up-gradient of a watercourse to prevent the down-slope transport of sediment into watercourses.

3.4.1.1.6 Grading and Leveling

Once clearing is completed, the Project site (including ore storage areas, ore processing plant and the TSF embankment foundations) will be prepared by grading and leveling of the areas using heavy equipment such as graders, dozers and scrapers.

The ore storage pads will be graded to create the desired grade for drainage capture. The foundation zone will be prepared, and drainage collection works will be installed.

3.4.1.2 Physical Construction and Installation of Project Facilities

3.4.1.2.1 Construction of Surface Facilities

Footings and foundations will be poured for buildings and structures associated with the ore processing plant and other buildings and structures. Pre-packaged and field-erected ancillary facilities, including the buildings, fuelling and processing equipment, will be delivered to the site and installed.

All buildings and ancillary facilities will be constructed using standard methods and built to all applicable safety codes, with reference to public health, fire protection, and structural sufficiency. The primary purpose of the codes is the promotion of worker and public safety through the application of appropriate uniform building standards. Equipment will be set up in their appropriate locations, electrical and mechanical connections will be established.

3.4.1.2.2 Quarrying, Aggregate Crushing, and Concrete Batch Plant

A quarry will be developed as shown in Figure 3.2.1 to supply coarse rock to be used in Project construction, particularly for the construction of the TSF embankments. Material from the quarry will be crushed as required using an aggregate crusher and used to develop the TSF starter embankments. Aggregate from the quarry will also be used to supply the on-site concrete batch plant during Construction.

3.4.1.2.3 Development of Starter Pit and Initial Ore Stockpile

Construction of the haul roads in the open pit will begin in Year -1 of Construction and will evolve as the pit is extended during each year of Operation. Following the removal of overburden, topsoil and waste rock in the pit, some initial ore will be blasted, excavated and stockpiled to prepare for operation of the ore processing plant.

3.4.1.2.4 Establishment of Stockpiles and Storage Areas

Stockpiles of cleared and grubbed soil, overburden and vegetation will be established at various locations around the open pit and TSF to store materials for use during re-vegetation activities at various times during the Project, and for use during reclamation activities. Stockpiles will not be located within 30 m of a watercourse or wetland within the Project site to minimize environmental effects through erosion and sedimentation. As an erosion and sedimentation control measure, stockpiles will be seeded after initial construction.

Storage areas for equipment, petroleum products (*e.g.,* petroleum, oils and lubricants) and explosives will be established. Proper storage and handling of petroleum products and explosives will prevent the chance of accidental spill or discharge. Temporary storage typically includes above-ground storage tanks and the use of portable tanks and containers for refueling and on-site maintenance activities. Permanent storage, including the establishment of above-ground storage tank systems, may be established within the Truck Maintenance facility for refueling and other maintenance activities.

All petroleum storage tank systems established for the Project will have an annual Petroleum Storage Site License and will be registered in compliance with the *Petroleum Product Storage and Handling Regulation – Clean Environment Act*. Petroleum storage areas will be inspected regularly and tanks will be inspected for stress or leaks. Storage areas will be sloped and will be directed to drain any spilled material to a safe collection area for clean-up. Storage areas and fuelling areas will not be located within 100 m of a watercourse, wetland, or groundwater supply well.

3.4.1.2.5 Construction of Engineered Drainage and Diversion Channels

Engineered drainage and diversion channels will be constructed to divert non-contact surface water and precipitation away from the Project site wherever possible. Water management during this phase will consist of establishing collection ponds, coffer dams, pumping systems, run-off collection ditches, and diversion channels. Some of the temporary works such as coffer dams and by pass diversion channels will be removed once the initial starter embankments have been constructed. Sediment collection ponds and collection ditches will remain in place throughout the life of the Project.

3.4.1.2.6 Loss of Bird and Sisson Brooks

Development of the Sisson Project will involve the creation of a TSF which will gradually inundate sections of Bird Brook, Sisson Brook, and an unnamed tributary (Tributary “A”) to West Branch Napadogan Brook, thus eliminating them as fish habitat. Sisson Brook is located atop the Sisson ore deposit, and Bird Brook and its tributaries pass directly through the location of the TSF. Since they cannot be diverted due to their position within the Project site, these brooks and associated fish habitat will be lost. Habitat loss will be authorized by DFO under the *Fisheries Act* and will be compensated accordingly.

3.4.1.2.7 TSF Preparation

In order to avoid the possibility of harming fish currently resident in the brook sections referred to above, SML intends to explore and, if possible, implement a program for removing fish from these brook sections before any tailings are deposited in them. Implementation of such a program depends upon the timing of EIA approvals, and the issuance of relevant permits and authorizations, since some of the required activities are seasonally restricted. Clearing activities are generally restricted to September through April, and electrofishing is limited to when weather and hydrological conditions allow for the safe and effective operation of the equipment. From a practical standpoint, implementation will also depend upon SML being able to accommodate such a program within the overall Project construction plan and schedule.

3.4.1.2.7.1 Overview of TSF Construction

Construction of the TSF will begin with the construction of small starter dams to collect the water required for the start of Operation. These dams will become encapsulated within the TSF embankments, and the embankments as well as the area inundated by water (and then tailings when operations begin) will grow over the life of the Project.

Construction of the TSF cannot begin before creating access to and clearing the dam construction sites. Coffer dams will then be installed just upstream of the starter dam locations, and stream flows from above the coffer dams will be pumped around the construction site for discharge downstream. The coffer dams will be sized to ensure that sediment generated upstream will settle out before the water is pumped around the construction sites. Construction of the starter dams, the downstream water management ponds, and then the initial TSF starter embankments, will follow. Within the TSF footprint, timber that is merchantable will be harvested and removed; timber that is not merchantable will be felled and gradually covered with water and then tailings. Other than for the construction of starter dams and embankments, no grubbing or other earth moving within the TSF footprint is required.

3.4.1.2.7.2 Fish Removal Strategy

Removal of fish from the relevant brook sections will be undertaken when weather and hydrological conditions allow for safe and effective operation of the equipment while avoiding peak salmonid spawning periods—likely over the June through September period. Captured fish will be released downstream of the starter dam and water management pond sites. To prevent fish from returning upstream, and if the coffer dams are not in place by late September, barrier nets or other suitable means will be established just downstream of the locations of the water management ponds. Once the coffer dams are in place and the upstream brooks are fish-free, the upstream brook beds within the TSF footprint will be filled in with non-deleterious materials such as local borrow or quarried material where access permits. Suitable means will be employed to allow groundwater discharge along the brook beds (*e.g.,* the bottom layer of fill will be coarse material and/or a drainage pipe will be laid in the bed). A detailed fish removal plan will be submitted for regulatory review and approval prior to the removal of fish.

3.4.1.2.7.3 Conceptual Fish Removal Plan

Preparatory Activities

Fish removal will likely be undertaken June through September and be preceded by a number of preparatory activities. These include primarily:

- during the year before fish removal, completion of test pitting in already identified areas of elevated archaeological potential wherever removal-related activities (*e.g.,* development of access roads) will disturb the ground surface;
- removal of beavers and beaver dams;
- clearing for, and development of, access roads to various points along the brooks; and
- clearing of woody debris and overhanging vegetation from the brook channels.

Various permits and authorizations will also be required before fish removal can be undertaken, the principal ones being the following.

- EIA approval of the Project under *CEAA* and the New Brunswick *Clean Environment Act* before any clearing or ground-breaking works can be initiated.
- A scientific collection permit for fish from DFO. Consultation with DFO and NBDNR will be required to determine suitable release locations for captured fish.
- Since the fish removal is in preparation for development of the TSF and consequent serious harm to fish, authorization of the serious harm to fish by DFO will be required under the *Fisheries Act*. That authorization will be contingent upon DFO approving a fish habitat offsetting plan.
- Provincially, an Approval to Construct will be required from NBDELG that will encompass specific permits (*e.g.,* Watercourse and Wetland Alteration (WAWA) permit).

Fish Removal

The following fish removal approach assumes that the coffer dams will not be in place at the time of initiating fish removal activities. Should these be in place, the fish removal process will follow the same general approach but the execution will be considerably simpler as fish will not be able to ascend past the coffer dams. Fish removal will be required in the TSF area, and to a lesser extent in the open pit area.

Fish removal will start in the headwaters of each watercourse and move in a downstream direction. Fish removal will entail isolating sections of watercourse using porous barriers (*e.g.,* dams made of sand bags and fitted with a screened PVC pipe) to allow for continuous flow of water and to prevent fish returning to areas already fished out. These porous barriers, and fish removal, will move sequentially downstream until each watercourse is determined to be free of fish.

It is anticipated that a minimum of three electrofishing passes will be required to remove fish from within each stretch of watercourse. Agreement will be required with DFO on what will be considered an acceptable "end point" (*i.e.,* after what type and level of effort a section of watercourse will be deemed to be "fish-free"). In fish-bearing waters where electrofishing is not possible (*e.g.,* flooded wetland), alternate methods of capture such as fyke nets and minnow traps will be used.

Captured fish will be placed in buckets of water for transfer to oxygenated tanks of water mounted on transport vehicles stationed at access points nearby. These vehicles will convey the captured fish to approved discharge points below the construction sites for release downstream.

Electrofishing will be conducted by crews consisting of a lead biologist, electrofishing technicians, and "porters" to carry fish in buckets to vehicle access points. Other crews will be responsible for porous barrier placement, for verifying that watercourse sections are free of fish, and for transporting captured fish to the discharge locations and releasing them.

The fish removal activities outlined above will be resourced and scheduled to be complete by the end of September. The porous barriers, barrier nets, or other suitable measures, may need to be kept in place until the coffer dams are installed to ensure that fish cannot return to the stretches of watercourses from which they have been removed. It is expected that installation of the coffer dams will be completed over the October-December period, and that the upstream, fish-free watercourses will be filled in during the winter months when flows are at a minimum and the ground is frozen enough that equipment can readily move around.

3.4.1.2.7.4 Alternatives

As an alternative to electrofishing, or as a complementary method, the use of an acoustic pressure cannon will be explored. This device releases a sonic boom to frighten fish from an area, and deters them from returning. It can be used in concert with electrical and/or physical barriers as approved by DFO and NBDNR. The currently available acoustic cannon requires a minimum of 1 m of water depth, is intended for use in large and deep waterbodies, and appears to be a relatively successful method. There is the potential to develop a smaller version of the acoustic cannon for use in the small watercourses found on the Sisson site.

If fish removal is not practical before construction of the coffer and starter dams, it may be possible to carry out such activities afterwards using the methods outlined above in the remaining upstream brooks, and various trap methods in the pond behind the dams.

Finally, since fish removal is a fish rescue activity that is generally permitted by DFO to be conducted at any time of year, it may be possible to carry out fish removals during the winter low flow period.

3.4.1.2.8 Construction of TSF Embankments, Water Management Ponds, and Ponding of Start-up Water

The land in the Project area is relatively low lying with gentle topography, which allows the TSF design to be relatively low and shallow given the storage capacity. Minimizing the depth of the TSF and the height of the embankments has several benefits, including:

- increased geotechnical stability,
- reduced seepage potential,
- operational efficiency, and
- advantages during reclamation and closure.

The TSF embankment foundation areas will be locally sub-excavated to remove unsuitable material (*e.g.,* soft, loose, or excessively wet). This material will be used to the extent possible as fill within the embankments. The foundation areas will be dewatered and any natural streams will be diverted away from the area using engineered channels. TSF filter sections will be developed using sand and/or crushed material produced from quarried rock. The TSF starter embankments will be lined so as to accumulate water from run-off and precipitation over one or two freshet periods prior to the start of mine operations to provide sufficient water for process start-up.

3.4.1.2.8.1 TSF Construction Methodology

The construction of the TSF is divided into the stages shown in Table 3.4.2.

Table 3.4.2 TSF Staging

TSF Stage	Embankment Crest Elevation (m above sea level)	End Year	Primary Construction By
Stage 1	318	-2	Contractor
Stage 2	338	7	Mine Fleet
Stage 3	362	19	Mine Fleet
Stage 4	376	27	Mine Fleet

The TSF starter embankments will be constructed by a contractor and ongoing embankment raises will be built by the mine fleet. Construction of the TSF has been divided into three phases, described below:

1. Site Establishment;
2. Starter Embankment Construction; and
3. Ongoing Embankment Construction.

Site Establishment

Site establishment consists of the activities required prior to beginning construction of the starter embankments:

- clearing the construction areas;
- upgrading existing forest resource roads to an access road sufficient for the contractor's equipment;
- establishing any maintenance shops, or other infrastructure that the contractor may require;
- preparing suitable laydown areas for equipment and cleared timber;
- construction of temporary by pass channels, or coffer dams (depending on contractor strategy); and
- best management practices for silt and sediment control (*e.g.,* sediment control ponds, silt fences, straw bales).

Starter Embankment Construction (Stage 1)

The Stage 1 starter embankments will be constructed by a contractor two years preceding mill start-up. The Stage 1 elevation was selected to provide sufficient capacity to store water for mill start-up and the first year of tailings storage. The major construction activities are:

- clearing and grubbing of the starter embankment footprints;
- excavation and re-compaction of overburden material for the Stage 1 embankment footprints;
- installation and operation of construction dewatering equipment (where required);
- overburden and topsoil stockpile development;
- development of local borrow sources; and
- coffer dam construction upstream of the embankments and installation and operation of dewatering systems (if required).

Construction of the Stage 1 embankments will require:

- installation of high density polyethylene (HDPE) upstream face liner (to prevent seepage and allow the collection of plant start-up water within the TSF starter pond) and placement of ice protection layer;
- removal of dewatering equipment;
- installation of tailings and reclaim pipework; and

- construction of water management ponds and pumping systems.

Ongoing Embankment Construction (Stage 2 and Onward)

Ongoing construction will include staged embankment raises and the installation of additional tailings and reclaim pipelines. Embankment raises will be completed using rock fill from the quarry located at the northwest corner of the TSF. The mine fleet will deliver quarried rock to the embankments, including processed filter and transition zone materials. A contractor may be used to spread and compact the filter and transition zones as they may be too narrow for the mine equipment to operate on efficiently. The major Stage 2 (and later stages) construction activities are:

- continued clearing of the impoundment, as required;
- continued grubbing, stripping, and excavation of unsuitable overburden beneath the expanded embankment footprints;
- modified centerline embankment raises using quarried rock fill delivered by the mine fleet;
- placement of processed filter and transition zones upstream of the coarse rock fill zone;
- hydraulic placement and compaction of deposited tailings in cells on the upstream side of the embankment; and
- installation of additional tailings pipelines to reach the full extent of the embankments.

3.4.1.2.9 Establishment of Water Management System

Overall, the water management system facilities to be installed during Construction include:

- diversion channels to divert clean (non-contact) water away from the site, with the objective of keeping clean water clean;
- the starter dams to establish the TSF as a collection point for all mine contact water, including from dewatering of the open pit, during Operation;
- lined water management ponds (WMPs) and pump-back equipment at the topographic low points downstream of the TSF embankments;
- groundwater monitoring wells below the WMPs; and
- tailings and reclaim water pipelines between the ore processing plant and the TSF.

3.4.1.2.10 Equipment Installation

Following the completion of physical construction of buildings and structures at the Project site, equipment for use in the ore processing plant and related facilities will be delivered to the site and installed at their intended location. The physical installation will be completed by anchoring the process units to the foundations at the appropriate location, and by completing all mechanical and electrical installations as required. Since most of these components are fabricated elsewhere and delivered to the site, the equipment installation will be relatively straightforward and result in minimal to no environmental effects.

3.4.1.3 Physical Construction of Transmission Lines and Associated Infrastructure

Relocation of the existing 345 kV transmission line, and construction of the new 138 kV transmission line, substation, and associated infrastructure will consist of activities described below. The transmission lines will be constructed and operated by NB Power, and the substation by SML.

Centreline Survey. A centerline survey will be conducted, consisting of a 1.2 m wide line cut, where required, to allow for a "line of sight" to obtain the necessary field information to finalize the design of the transmission lines. The vegetation is cut using chain saws and left on the ground parallel to the centerline. Data collected during the centerline survey includes, ground elevation, location of features such as roads, trails, stream crossings and wetlands, and other information which is vital to produce the plan and profile maps and to establish structure locations. The centerline survey may lead to minor modifications to the right-of-way as a result of previously unidentified constraints.

Access and Staging. Access is required to allow transportation of clearing and construction equipment, materials and personnel to the right-of-way. Access to the new transmission line will largely be provided through the adjacent existing 345 kV transmission line corridor. Access may be required along the right-of-way and deviate off right-of-way where watercourses and wetlands cannot be crossed with equipment. In all cases, use of existing access roads will be maximized. Temporary staging areas will be established for storage of equipment and material during Construction. These sites will be selected in close proximity to the new transmission line and away from developed areas in order to prevent noise and dust problems. Preferred new sites will be brownfield sites, such as forestry landings or abandoned quarries requiring little or no modification. An agreement will be signed with any landowners. Following Construction, the sites will be returned to their original condition.

Vegetation Clearing. Clearing will be conducted to remove from the right-of-way vegetation that may prohibit the construction and safe operation of transmission line. Clearing of vegetation will be conducted by mechanical means, except within 30 m of a watercourse or wetland where manual methods (*e.g.*, chain saws and other hand held equipment) will be used, leaving the under growth and duff layer undisturbed to prevent erosion. Trees will be felled, de-limbed, and piled at the edge of the right-of-way, and merchantable timber will be sold. The remaining slash and debris will be windrowed a few metres from the edge of the right-of-way and compacted to a height no greater than 0.5 m. The windrows will be broken (left open) at all roads or access trails, along property lines, and along watercourses, to provide access across the windrow for any wildlife not capable of crossing the low vegetation pile. The windrows will be allowed to decompose naturally. Burning of vegetation will not be undertaken. To the extent possible, clearing will be conducted outside of breeding bird season (May 1 – August 31). Should clearing be required within this season, these areas will be surveyed to determine if nesting is occurring within these areas.

Excavation and Structure Assembly. The assembly of structures involves the transportation of construction materials, the excavation for pole placement and the backfilling of excavated material. Excavations will be augured where possible. Excavation with backhoes and/or blasting will be used for larger foundations or in soils that cannot be efficiently augured. The assembly of structures will take place on-site at the structure locations. Depending on soil conditions, compacted native soil or imported backfill material will be used to fill the sides of the excavations and secure the poles in place. Guy wires will be used as necessary.

Conductors Stringing. Large reels of wire (conductor) will be delivered to selected areas along the right-of-way. The wire will be subsequently strung using a tension-pulling machine and attached to the insulators by hand while pulling lines between structures. Once the conductors are in place, they will be correctly sagged and tensioned, then permanently clipped into the clamps at each structure. Hardware such as marking, vibration damping devices, or air flow spoilers may also be installed, as required. In areas where the transmission lines cross a road, rider poles will be installed on either side of the roadway to support conductors and prevent the conductor from sagging.

Inspection and Energization. Upon completion of construction, ground and air acceptance patrols will be conducted by staff to ensure that the lines are ready for service. Any deficiencies discovered during these patrols will be corrected prior to energizing the line. NB Power will complete the connection of the new transmission line at the Keswick Terminal.

Clean-up and Re-vegetation. Site clean-up and re-vegetation to stabilize disturbed areas will complete the construction of the transmission lines. In areas where the disturbance of soil may cause erosion, measures will be taken to stabilize the affected area. Such measures include trimming and back-blading, mulching, seeding and fabric placement. Erosion control used during construction will be maintained until such time the disturbed ground has been adequately stabilized with vegetation, and will then be removed.

Construction of Sisson Electrical Substation. SML will construct the new electrical substation at the Sisson mine site. This will involve clearing, pouring of concrete foundations for switchgear and transformers, installation of equipment, inspection, energization, erection of a fence surrounding the substation for security purposes, and clean-up and landscaping of the area following construction.

Removal of By-passed 345 kV Transmission Line. NB Power will be responsible for removal of the former line and by-passed line towers and conductors, and for reclaiming the abandoned right-of-way.

3.4.1.4 Physical Construction of Realigned Fire Road, New Site Access Road, and Internal Site Roads

Construction will be conducted of the realigned Fire Road, a new site access road to access the Project site from the Fire Road, and internal site roads within the PDA to connect the Project facilities. All roads will be unpaved.

Road construction requires the creation of a continuous right-of-way through clearing and grubbing of existing forested areas (as shown in Figure 3.2.14), and cutting, filling and grading to overcome geographic obstacles and provide grades low enough to permit vehicle travel. Right-of-ways will be cleared as required in accordance with guidelines, standards and best practices for developing forest resource roads. Leveling and excavation will be conducted as necessary. Some blasting may be required. The completed roadways will be finished by preparing a stabilized sub-grade with a gravel surface. Fill, gravel, and rock will also be sourced as needed from local sources or the site quarry.

Erosion control and dust suppression measures will be implemented to reduce the potential environmental effects of activities on neighbouring watercourses and surrounding properties.

All site access and internal site roads will be designed based on loadings, vehicle dimensions, travel speeds, sight distances, and traffic densities that are required during the life of the road according to forest resource road specifications. All site access roads and site roads will be refurbished or constructed in accordance with the Forest Management Manual (NBDNR 2004a, Section 4.4 “Roads and Watercourse Crossings”) and have approval from NBDNR. Best management practices for the use of forest roads in New Brunswick will be implemented and a Traffic Plan developed in consultation with the Crown Timber Licence Holders and NBDNR.

3.4.1.4.1 Construction of Watercourse Crossings

No watercourse crossings on the existing forest resource road network require refurbishment or replacement to access the Project.

Within the planned realignment of the Fire Road, six new watercourse crossings (including wetlands) are required. All new watercourse crossings structures installed as part of the Project will be designed, installed, and maintained to support design loadings, and will be presented to NBDNR for approval prior to construction. These watercourse crossings will be pre-constructed single-span bridges that avoid construction activity in the watercourse bed and disturbance of its embankments. The bridges will span the width of the watercourse from bank to bank, such that no disturbance of the stream bed or its banks (up to the ordinary high water mark) is required. Concrete culverts may be used in place of bridges for small watercourse crossings.

The construction activities conducted within 30 m of a watercourse or wetland will require a permit under the New Brunswick *Watercourse and Wetland Alteration Regulation–Clean Water Act* (WAWA Regulation). However, with the construction methods identified, it is not expected that any further approvals, permits, or other forms of authorization (*e.g.*, *Fisheries Act* authorization) will be required.

3.4.1.5 Implementation of Fish Habitat Offsetting/Compensation Plan

Subject to regulatory approval, the implementation of fish habitat offsetting/compensation plan will involve replacing an old water-level control dam and road culvert on the Nashwaak River just below its exit from Nashwaak Lake with a woods road bridge (see Section 7.4 for details).

Construction will be carried out during the low-flow summer period. A coffer dam will be installed upstream of the site, and flow pumped around the site, to provide a dry working area. Any fish in the working area will be moved downstream. The existing timber box culvert and abutments will be removed and disposed of offsite. Once the existing structure is removed, the stream bed will be inspected for barriers to fish passage and modifications will be made as required to allow for suitable flow conditions under the new bridge. The new bridge abutments and deck will then be built, and rip rap or other armouring will be installed to prevent erosion. Once construction is complete, the coffer dam will be removed and disturbed areas will be reclaimed as required to ensure bank and shoreline stability.

3.4.1.6 Emissions and Wastes

3.4.1.6.1 Air Contaminant Emissions

Air contaminant emissions during Construction will not be substantial. Emissions will consist mainly of combustion gas emissions from heavy equipment on-site and the heavy-duty trucks used to deliver equipment to the site, as well as fugitive dust emissions resulting from on-site activities. The only sources of greenhouse gas (GHG) emissions will be from fuel combustion in heavy equipment and trucks. During Construction, air contaminants may be released from the following activities:

- fuel combustion in heavy equipment during clearing and site preparation (*e.g.*, excavators, dozers);
- fuel combustion in passenger vehicles moving to and from the site, as well as on-site;
- fuel combustion in trucks transporting equipment and material;
- dust from site preparation activities (*e.g.*, land clearing);
- dust from vehicle and equipment movements on unpaved roads;
- combustion emissions from detonated explosives in the quarry;
- dust from drilling and blasting events in the quarry;
- dust from loading and unloading of overburden, topsoil, and quarry rock; and
- dust from stockpiling of overburden and topsoil.

Emissions inventories for air contaminant and GHG emissions for Construction were developed based on information provided by Northcliff, published emission factors, and engineering judgment, as detailed below.

Emissions of air contaminants and GHGs from diesel fuel combustion in typical construction equipment were estimated using emission factors from the USEPA NONROAD program (USEPA 2008), with assumed horsepower and operating hours of each unit. The equipment types are provided in Table 3.4.3.

Table 3.4.3 Heavy Equipment Used – Construction

Equipment	Number of Units	Horsepower (hp)	Operating Hours (h/d)
Scraper	2	300	12
Excavator	2	300	12
Crane	1	300	6
Bulldozer	2	300	12
Generators	5	175	12
Dump Truck	5	475	12
Concrete Truck	1	475	12

The estimated emissions of air contaminants and GHGs during Construction are provided in Tables 3.4.4 and 3.4.5, respectively.

Table 3.4.4 Criteria Air Contaminant (CAC) Emissions – Fuel Combustion in On-site Construction Equipment – Construction

Equipment	Emissions (t/a)				
	Carbon Monoxide (CO)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)	Volatile Organic Compounds (VOCs)	Total Particulate Matter (PM)
Scraper	3.22	6.80	0.01	0.50	0.59
Excavator	3.27	6.81	0.01	0.50	0.62
Crane	0.57	1.63	0.00	0.11	0.08
Bulldozer	3.22	6.80	0.01	0.50	0.59
Generators	3.37	9.47	0.02	0.68	0.70
Dump Truck	14.63	26.95	0.05	1.78	2.46
Concrete Truck	2.93	5.39	0.01	0.36	0.49
Total	**31.20**	**63.85**	**0.12**	**4.43**	**5.54**

Notes:
t/a = tonnes per year.
1) Numbers may not add up due to rounding.

Table 3.4.5 Greenhouse Gas (GHG) Emissions – Fuel Combustion in On-site Construction Equipment – Construction

Equipment	Emissions (t/a) [a]
	Carbon Dioxide (CO_2)
Scraper	1,391
Excavator	1,391
Crane	344
Bulldozer	1,391
Generators	2,007
Dump Truck	5,507
Concrete Truck	1,101
Total	**13,133**

Notes:
[a] Emission CH_4 and N_2O were not estimated as these are minor contributions to total GHG emissions.
t/a = tonnes per year.
1) Numbers may not add up due to rounding.

Fuel combustion emissions were estimated for passenger vehicles and vehicles used to transport materials and equipment to and from the Project site as well as on-site vehicle traffic. Northcliff provided some information on vehicle movements; conservative assumptions were made for the remainder, including distances travelled. Emission factors and default fuel efficiency values from the Transport Canada Urban Transportation Emissions Calculator (Transport Canada 2012) were used. Air contaminant and GHG emissions from vehicle operation during Construction are provided in Tables 3.4.6 and 3.4.7, respectively.

Table 3.4.6 Criteria Air Contaminant (CAC) Emissions – Vehicle Fuel Combustion – Construction

	Emissions (t/a)						
	Carbon Monoxide (CO)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)	Volatile Organic Compounds (VOCs)	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Personal vehicles (includes on-site traffic)	7.06	0.56	0.004	0.35	0.02	0.02	0.01
Equipment and Materials	0.22	1.11	0.004	0.05	0.03	0.03	0.02
Total	**7.28**	**1.67**	**0.01**	**0.40**	**0.05**	**0.05**	**0.03**

Assumptions:
- Personnel travel by bus (6 roundtrips/day) and by light duty passenger trucks (50 roundtrips per day), 6 days per week.
- Buses travel from Nackawic assumed to be 2/3 of the trips, and from Napadogan 1/3 of the trips.
- Light duty passenger trucks travel equally from Nackawic and Napadogan.

Notes:
t/a = tonnes per year.
1) Numbers may not add up due to rounding.

Table 3.4.7 Greenhouse Gas (GHG) Emissions – Vehicles Fuel Combustion – Construction

	Emissions (t/a)			
	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Total Greenhouse Gases (CO_2e)
Personnel (includes on-site traffic)	290	0.003	0.03	300
Equipment and Materials	213	0.01	0.01	215
Total	**503**	**0.01**	**0.04**	**515**

Assumptions:
- Personnel travel by bus (6 round trips/day) and by light duty passenger trucks (50 round trips per day), 6 days per week.
- Buses travel from Nackawic assumed to be 2/3 of the trips, and from Napadogan 1/3 of the trips.
- Light duty passenger trucks travel equally from Nackawic and Napadogan.

Notes:
t/a = tonnes per year.
CO_2e = carbon dioxide equivalent.
1) Numbers may not add up due to rounding.

Dust emissions from site preparation were estimated using a United States Environmental Protection Agency (USEPA) emission factor (USEPA 1995a) and a conservative estimate of the area of site disturbance (1,253 ha). Application of water sprays during site preparation will reduce dust emissions by approximately 70% (NIOSH 2012). Particulate matter emissions for site preparation activities are estimated to be approximately 13.2 tonnes, 2.49 tonnes, and 1.39 tonnes for PM, PM_{10}, and $PM_{2.5}$, respectively, for the Project (estimate covers total site preparation which is spread over the life of the Project).

Dust lifted by blasting activities in the quarry during Construction may be estimated using a USEPA emission factor (USEPA 1998) and the area of land subjected to the blast. Blasting in the quarry is anticipated to occur once per week for 3 months of the year. An average blast area of 2,150 m^2 per blast was used to estimate fugitive dust emissions (NIOSH 2012). Particulate matter emissions (PM) from blasting were estimated to be approximately 0.07 tonnes per year.

The movement of vehicles and equipment on unpaved roads during Construction may cause particulate matter emission (PM, PM_{10}, $PM_{2.5}$). The USEPA methodology to estimate emissions is based on silt content of the road material and vehicle tonnage. Northcliff provided information on vehicle and equipment movements, and Stantec made conservative assumptions regarding the silt content and vehicle tonnage. It was assumed that the site access road and internal site roads are watered for dust suppression, and this gives a 80% reduction in dust generation; no dust suppression was assumed for the unpaved forest resource roads (*i.e.,* the PSA Route via Nackawic and the SSA Route via Napadogan). The estimated fugitive emissions from vehicles movements on unpaved roads are provided in Table 3.4.8.

Table 3.4.8 Particulate Matter from Unpaved Roads – Construction

	Emissions (t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Forest Resource Roads (PSA and SSA Routes, for transporting materials, equipment, and personnel)	515	136	13.6
Site access road and internal site roads (on-site heavy equipment and passenger vehicles)	93.1	24.7	2.47
Total	**608**	**161**	**16.1**

Notes:
t/a = Tonnes per year.
1) Numbers may not add up due to rounding.

Topsoil and overburden stockpiled during Construction will be seeded and re-vegetated periodically. Emissions of dust from these sources are therefore considered to be negligible (essentially zero).

Stantec estimated fugitive dust emissions for material transfer activities during Construction. Topsoil and overburden are transferred by trucks to stockpiles. While material handling may generate dust, it is assumed that the material is wet and that minimal dust is generated.

A concrete plant will be used during Construction to provide concrete for foundations. Stantec estimated particulate matter emissions from the concrete plant using the total anticipated concrete production and emission factors from USEPA (2006c). The analysis assumed the use of best practice dust control. The estimated emissions of PM and PM_{10} per year are 3.3 tonnes and 0.98 tonnes, respectively, over the entire period of Construction.

3.4.1.6.2 Sound and Vibration Emissions

Some noise will be generated during Construction and is expected to be typical of that associated with construction projects involving the movement of heavy equipment.

To estimate emissions of sound, Stantec developed an inventory of sound emission sources from heavy equipment during Construction activities. The number and types of equipment, as well as hours of operation, were estimated based on experience and professional judgment. Equipment sound power levels for each equipment type were assigned based on information for the various equipment in the United States Federal Highway Administration's "Roadway Construction Noise Model User's Guide" (FHWA 2006).

The activity data and sound power levels associated with Construction are presented in Table 3.4.9.

Table 3.4.9 Sound Inventory – Construction

Equipment Type	Number of Equipment	Operation Hours per Day	Sound Pressure Level (dB_A) at 15 m	Sound Power Level (dB_A)
Scraper	2	12	84	115
Excavator	2	12	81	112
Crane	1	6	81	112
Wheeled Bulldozer	2	12	82	113
Generators	5	12	81	112
Dump Truck	5	12	76	107
Concrete Truck	1	12	76	107
Crusher	1	12	84	116

The contribution of the movement from on-site light duty truck traffic is assumed to be negligible in comparison with heavy equipment operation on-site (only on-site roads were not included in the noise model). There will be sound emissions from transportation vehicles on Project access roads. The number and types of transportation vehicles accessing the site on a daily basis were provided by Northcliff, based on the planned activities. The traffic information entered into the acoustic model is provided in Table 3.4.10.

Table 3.4.10 Project Traffic – Construction

Vehicle Type	Vehicles per Hour	Starting Point
Buses	6	Through Nackawic
Heavy trucks	1	Through Napadogan
Passenger trucks/vehicles	19	Through Napadogan

Notes:
For modelling of traffic noise the change through Napadogan was the focus as this represents the largest change from existing traffic. 19 vehicles through Napadogan based on estimate of 76 per day from Route 8 to SSA, with 4 peak hours per day assumed (shift changes). Buses all assumed to originate in Nackawic.

A review of available literature on vibration emitted from construction activities was conducted to assess the distance from the PDA that vibration may be perceptible. In the US Federal Transit Administration (FTA) document "Noise and Vibration Manual" (FTA 2006), average peak particle velocities (PPVs) at 7.6 m (25 feet) for various equipment types and activities are presented. Reference PPVs for common construction equipment types are provided in Table 3.4.11.

Table 3.4.11 Typical Equipment Vibration (Peak Particle Velocity) – Construction

Equipment	Reference Peak Particle Velocity (PPV) at 7.6 m (mm/s)
Pile Driver (impact)	16.4
Vibratory roller	5.3
Caisson drilling rig	2.3
Large bulldozer	2.3
Loaded trucks	1.9
Jackhammer	0.9
Small bulldozer	0.1

Source: FTA (2006).

The largest piece of mobile construction equipment on-site is likely to be a large bulldozer.

Some blasting and crushing of rocky material may occur in the quarry area during Construction, and blasting will also be required during leveling and preparation of the PDA for building construction.

3.4.1.6.3 Surface Run-Off

Site run-off from precipitation events will be carefully managed, and there are no other activities during Construction of the Project that will result in the generation of wastewater. Engineered drainage diversion channels constructed early in the Construction period will limit the amount of off-site surface run-off from entering the site.

Watercourse and wetland alteration mitigation measures (*e.g.,* erosion and sedimentation control measures) will be employed during Construction, and ground disturbance will be held to a minimum outside the required construction zones. Management of site run-off will employ best practices such as containment ditches, sediment settling ponds and silt curtains to avoid or mitigate potential environmental effects to watercourses.

Any liquid hazardous materials (*e.g.*, waste oils and lubricants) generated by contractors on-site will be collected and disposed of using approved hazardous materials collectors.

3.4.1.6.4 Solid Waste Disposal

During Construction, there will be a need to dispose of some general construction wastes such as wood, steel, cardboard or other packaging, and other construction wastes. All merchantable timber from site clearing will be sold, and remaining brush will be stockpiled or be covered by fill or Project facilities (*e.g.,* by water and then tailings in the TSF area). No burning will be carried out during Construction. Soil and overburden will be stockpiled for future use in reclamation activities. SML or its contractors will re-use or recycle waste materials where possible, and dispose of other wastes at approved facilities.

3.4.1.7 Transportation

Construction and trucking activities will vary from month to month during Construction, depending on what components are being constructed and the stage of construction. During Construction, contractors will be encouraged to bus their crews to the Project site. For the purpose of this EIA, it is assumed that Project workers will be collected at two parking lots, one located near Route 2 at Nackawic and the other located near the Napadogan rail siding, and travel by bus from those parking lots to the Project location. The precise location of the parking lots to be used for such purposes will be confirmed as further Project planning and contracting is conducted.

Road traffic generated during Construction will comprise:

- passenger vehicles (construction workers' automobiles, SUVs, vans and pick-ups);
- buses (construction workers); and
- trucks (for transport of construction equipment and materials, and various services).

The traffic generated by the Project during Construction will accumulate as it approaches the Project site. All Project generated traffic volumes were converted to one-way daily (ADT) volumes. A summary of the average daily traffic that will be generated by the construction activities associated with the Project is presented in Table 3.4.12.

Table 3.4.12 Average Daily Traffic (ADT) Generated During Construction

Traffic Components	Round Trips Per Day	Average Daily Traffic (ADT) (one-way)
Vehicles to/from Project Site		
Trucks (at highest month of Project construction activity to Site)	12	24
Construction Workers' Buses (75% of workers, between parking lots and Site)	6	12
Construction Workers' Autos (25% of total workers, direct to Site, two per vehicle)	50	100
Total	**68**	**136**

Source: exp Services Inc. (2013a, 2013b).

The Project-generated traffic volumes reflect the maximum volumes expected during the highest month of construction activity. The additional traffic volumes predicted to be generated by the Project total 136 ADT.

3.4.1.8 Employment and Expenditure

A variety of construction personnel will be required to complete various construction activities, including but not limited to heavy equipment operators, millwrights, welders, and other specialized trades. It is expected that the Project will generate direct employment for up to approximately 500 workers at the peak of Construction activity. These workers may be working for New Brunswick based construction firms, working for firms from outside the province coming to deal with specific aspects of the construction or provide engineering supervision, or employees of the mine owner or engineering firms associated with the Project but working outside New Brunswick.

Total capital expenditures (construction costs) for the Project are expected to reach $578.8 million over an estimated 24 month construction period. About 38% of the expenditures will occur during the first year of construction, with most of the remainder spent during the second year. Table 3.4.13 provides a summary of expenditures during Construction.

Table 3.4.13 Construction Expenditures

Description	Construction Expenditures (Millions of Canadian dollars)						
	Mine (including SME Facility)	Concentrator (including Clarification Plant)	APT Plant	TSF and Environmental	Infrastructure	Owner's Cost	Total
Earthwork	$8.3	$6.2	$0.1	$14.1	$3.5	-	$32.1
Buildings	$1.2	$32.2	$2.7	-	$6.9	-	$43.0
Concrete	-	$14.6	$1.9	-	$3.7	-	$20.2
Steel	-	$20.7	$0.5	-	$0.2	-	$21.4
Equipment	$24.5	$105.5	$21.0	$11.2	$0.9	-	$163.2
Piping	-	$13.5	$4.9	-	$0.2	-	$18.6
Electrical	-	$13.4	$1.1	-	$14.2	-	$28.6
Instrumentation	-	$7.3	$2.6	-	$0.4	-	$10.4
Direct Cost	$34.0	$213.3	$34.6	$25.3	$30.1	-	$337.4

Table 3.4.13 Construction Expenditures

Description	Construction Expenditures (Millions of Canadian dollars)						
	Mine (including SME Facility)	Concentrator (including Clarification Plant)	APT Plant	TSF and Environmental	Infrastructure	Owner's Cost	Total
Contractor Indirects	$1.2	$43.8	$8.3	$2.0	$4.9	-	$60.2
Contracted Indirects	-	$36.6	$6.0	$0.8	$4.1	-	$47.4
Spares	$0.7	$1.3	$0.2	-	-	-	$2.2
Initial Fills	-	$4.1	$0.9	-	-	-	$5.0
Owner's Cost	-	-	-	-	-	$36.0	$36.0
Indirect Cost	$1.9	$85.9	$15.3	$2.8	$8.9	$36.0	$150.8
Other Expenditures and Contingency	$3.2	$58.6	$11.9	$3.4	$7.1	$6.4	$90.6
Total Cost (millions, CAD$)	**$39.1**	**$357.8**	**$61.9**	**$31.5**	**$46.1**	**$42.4**	**$578.8**

Source: Samuel Engineering (2013)

3.4.2 Operation

Operation begins at Year 1 with the commissioning of the ore processing plants and extends to completion of mining and ore processing at approximately Year 27. Details of activities to be conducted during Operation are provided below. The site layout will evolve as the Project proceeds through various stages of Operation with the most substantive evolution occurring in the extent of the open pit and the TSF.

In addition to the routine inspections carried out by mine personnel on a shift/daily/weekly/monthly basis, the Project and facilities will be audited regularly by a suitably qualified professional engineer to ensure it is operating in a safe and efficient manner. A dam safety review will be conducted every five years by a qualified geotechnical engineer.

The following is a brief description of activities that will be carried out during Operation of the Project.

3.4.2.1 Mining

3.4.2.1.1 Open Pit Mine Operation

Operation of the open pit mine will involve drilling, blasting, loading and hauling of ore and waste rock, primary crushing, and conveyance to the ore processing plant.

Open pit mining will be carried out year-round on a 24 hour per day, seven day per week schedule, for approximately 360 days per year. Following clearing, and removal and stockpiling of overburden in the pit area during Project construction, the pit will be excavated by drilling and blasting successive benches and removing the broken rock with a hydraulic shovel and/or wheeled loaders. Blasting will occur approximately every two days using emulsion explosives. The broken rock will be hauled out of the pit by truck, and run-of-mine (ROM) ore will be delivered to the primary crusher or to the temporary ore stockpile nearby. Waste rock will be trucked to the TSF and stored under water in the TSF. As the pit expands over time, there will be successive “push backs” of the pit rim with associated vegetative clearing and overburden removal and storage. Further details on the operation of the open pit are provided below.

3.4.2.1.2 Drilling

In-situ rock will require drilling and blasting to create suitable fragmentation for efficient loading and hauling of both ore and waste rock. Ore limits will be defined in the blasted muck pile through blast hole, assays and grade control technicians. Support personnel and equipment will be required to maintain the mining area, ensuring the operation runs safely and efficiently.

Primary production drilling at the Sisson Project uses diesel hydraulic rotary drills outfitted with high precision drill positioning or GPS systems for efficient and accurate positioning, and superior data collection from each drill unit and drill hole.

Areas will be prepared on the bench floor for blast patterns in the *in-situ* rock. The spacing and burden between blast holes will be varied as required to meet the specified powder factor for the various rock types. The drill operators will be responsible for blast hole sampling for the ore control system (OCS).

Controlled blasting techniques will be used for high wall rows, pioneering drilling during pre-production, and development of initial upper benches. Where required, dozers will be used to establish initial drilling benches for the upper portions of each phase.

3.4.2.1.2.1 Blasting

A contract explosives supplier will provide the blasting materials and technology for the mine, as well as manufacture bulk emulsion-type explosives on-site at the site mixed explosives (SME) plant. The nature of the business relationship between the explosives supplier and the mining operator will determine who is responsible for obtaining the various manufacture, storage and transportation permits, as well as any necessary licenses for blasting operations. This will be established during commercial negotiations. For the feasibility study, the explosives contractor delivers the prescribed explosives to the blast holes and supplies all blasting accessories. Different contractors have various explosives products and specifications. The chosen contractor will be responsible for providing all material safety data sheets (MSDS) and product fact sheets as applicable. For the feasibility study, all contract explosives providers recommended 100% emulsion products.

Loading of the explosives will be done with bulk explosives loading trucks provided by the explosives supplier. The trucks will be equipped with global positioning system (GPS) guidance or otherwise tied into the in-pit data network, and will be able to receive automatic loading instructions for each hole from the engineering office.

The blast holes will be stemmed to avoid fly-rock and excessive air blasts. Any crushed rock required for blast hole stemming will be provided by the onsite rock crusher specified for mine roads and quarrying operations.

The SME facility will be equipped to deal with spills of hazardous materials, coming under the responsibility of the explosives contractor operating the SME facility. The spill prevention and contingency plan typically developed for such facilities is as follows.

Prevention

- Double-walled diesel and fuel phase tanks.
- Ammonium nitrate solution tank containment system.
- Trace chemicals stored in sea-can containers.
- Closed systems in emulsion plant and parking garage.
- Drip trays at transfer points.
- Water recycling system in ammonium nitrate solution.

Contingency

- Spills recovery and clean-up procedures.
- Standard operating procedures for waste and wastewater management.
- Off-site disposal of sanitary waste and hazardous wastes.
- Internal HSE audit program and inspections.
- Emergency plan for transportation incidents off-site.

The SME facility will be a zero discharge plant. The wastewater from SME plant will be treated (through settling, oil separation and filtration) and will be re-introduced into the process. Wastewater will also be treated and re-introduced into the water injection systems of the trucks.

3.4.2.1.3 Loading

Production loading will be performed by electric hydraulic shovel units, sized according to the feed rate and waste rock volume per day or per year. Using 30,000 t/d mill feed and 30,000 t/d waste rock, the 16.5 m^3 class of hydraulic shovel paired with the 136 t haul truck is the most cost effective combination. Using this match, and with the addition of the quarry and machine availability, three shovel units are specified, with one shovel being under-used. The 136 t truck is the largest payload to efficiently match the shovel production rate with four-pass loading.

A 433 kW dozer will be stationed in the pit. This dozer is larger than others on-site and is included for heavy ripping and in-pit ramp and road cuts. A 372 kW wheel dozer is included for cleaning up spilled rock at the shovel face.

Bench widths are designed to ensure operating room is suitable for efficient double-sided loading of trucks at the shovels. Where double-sided loading is not possible, *i.e.,* the upper benches of the pit phases where the end of the bench meets topography, ancillary equipment will be deployed in non-productive operating areas, to prepare the digging areas for higher shovel productivity.

After mill start-up, there will be a requirement each year to mine a given quantity of quarried rock. The intention is to campaign mine the required quarry tonnes for one or two months each year. During these months, it is intended to relocate a single shovel and matching truck fleet to the quarry area for the required length of time.

3.4.2.1.3.1 Hauling

The hauler selected to match the 16.5 m^3 shovels is the 136 t payload class diesel haul truck. The size of the haul fleet is determined by the production schedule and required truck operating hours to meet the scheduled tonnage over the haul road network for each operating period. The life-of-mine (LOM) maximum haul fleet is 14 units. All haul trucks are fitted with fleet management systems, state-of-the-art data centres that report on all facets of machine health.

Pit maintenance activities include haul road maintenance, mine dewatering, transporting operating supplies, relocating equipment, snow removal, and pit floor clean-up.

3.4.2.1.3.2 Ore Crushing and Conveyance

To minimize dust, the blasted ore is wetted down as it passes through the primary crusher and conveyor to the ore processing plant. The primary crusher will be a gyratory cone crusher and process approximately 30,000 t per day of ore. The ore will be crushed to approximately 150 mm, conveyed and deposited into the crushed ore stockpile at the plant site. The stockpile will have approximately 30,000 t storage capacity.

Potential noise and dust generating parts of the primary crusher are below ground with water sprays are applied as needed to control dust. The conveyor from the primary crusher to the coarse ore stockpile at the ore processing plant is enclosed from weather as the damp ore will produce very little dust (though the conveyor is not air tight or does not provide a full enclosure for dust control).

At the plant, the coarse ore stockpile is uncovered. Water sprays can be used as needed to wet the ore stockpile in dry conditions.

3.4.2.1.3.3 Rock Quarrying, Trucking and Crushing

Throughout Operation of the Project, the quarry will be used to provide NPAG rock for construction of the TSF embankments and internal haul roads. The location of the quarry is shown in Figure 3.2.1. Rock will be quarried and trucked from the quarry to locations surrounding the TSF as required. The rock will be crushed using the on-site mobile aggregate crusher and placed using mobile mining equipment.

3.4.2.1.4 Mining Schedule

The overall mine production is scheduled by pit phase and bench on an annual basis. The activities in the pre-production periods are mainly related to construction of the facilities and the TSF dams. The first pit phase provides continuous mill feed after start-up with minimal pre-stripping in the last half of Year -1. Full mill feed production capacity is expected in Year 2. The production schedule specifies:

- pre-production (Construction) in Years -2 and -1;

- pre-stripping in second half of Year -1; and
- life-of-mine (LOM) operations starting in Year 1 and onward.

The general schedule of mining by pit phase, year, and kilotonnes (kt) mined, is summarized in Table 3.4.14.

Table 3.4.14 Mining Schedule by Phase and Year, and Total Kilotonnes (kt) Mined

Year	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Total
	kt	kt	kt	kt	kt	kt	kt
-1	2,648	-	-	-	-	-	2,648
1	19,505	-	-	-	-	-	19,505
2	12,398	8,959	-	-	-	-	21,358
3	911	17,329	3,896	-	-	-	22,136
4	379	13,072	8,296	-	-	-	21,747
5	-	9,148	12,410	-	-	-	21,557
6	-	828	22,102	-	-	-	22,929
7	-	770	20,188	-	-	-	20,957
8	-	-	17,196	3,002	-	-	20,198
9	-	-	11,923	8,275	-	-	20,198
10	-	-	2,096	21,214	-	-	23,310
11	-	-	1,574	23,787	-	-	25,360
12	-	-	457	23,458	-	-	23,915
13	-	-	-	20,646	-	-	20,646
14	-	-	-	19,301	-	-	19,301
15	-	-	-	19,635	-	-	19,635
16	-	-	-	18,523	-	-	18,523
17	-	-	-	17,293	1,203	-	18,496
18	-	-	-	14,244	4,438	314	18,996
19	-	-	-	12,553	3,649	2,538	18,741
20	-	-	-	12,963	-	5,053	18,016
21	-	-	-	2,603	19,960	-	22,563
22	-	-	-	-	18,027	1,143	19,170
23	-	-	-	-	8,297	17,175	25,472
24	-	-	-	-	4,703	21,628	26,332
25	-	-	-	-	-	23,740	23,740
26	-	-	-	-	-	18,067	18,067
27	-	-	-	-	-	15,130	15,130
Total Life-of-Mine (LOM) (kt)	**35,840**	**50,105**	**100,137**	**217,498**	**60,278**	**104,789**	**568,647**

Source: Samuel Engineering (2013).

3.4.2.1.5 Detailed Mine Plan

The description of the detailed mine plan, for both the open pit and quarry operation, is based on the production schedule. End of period (EoP) maps were generated from the production schedule, to depict what the Project site may look like at the end of the year listed. EoP maps were generated for pre-production (Year -1) and production years 1, 5, 10, 20, and 27, where Year 27 represents the life-of-mine (LOM). EoP maps are shown in Figures 3.4.1 to 3.4.6, starting at mill start-up (Year -1) and culminating at end of life-of mine (Year 27).

3.4.2.2 Ore Processing

The ore processing will take the mined ore produce final products of dried molybdenum concentrate and 96.7% pure ammonium paratungstate (APT) in crystallized form.

A simplified flowsheet for the ore concentrator process is provided in Figure 3.4.7. The operation of the major processes is described below.

3.4.2.2.1 Milling/Grinding

From the coarse ore stock pile, the ore is transported via covered apron feeders and conveyors to the secondary screening process. These conveyors have a dust collector. All dust collectors in the ore processing plant will discharge collected particles into bags and will not discharge to atmosphere.

The secondary screens separate the ore stream based on size, with larger particles being conveyed to the secondary crusher and smaller particles being conveyed to the tertiary (high pressure grinding roll or HPGR) crusher for further size reduction. Material out of the secondary crusher is then conveyed back to the secondary screens for rescreening and sorting to the secondary and tertiary crusher.

Following tertiary HPGR crushing, the ore is screened again with particles larger than 4 mm being conveyed back to the tertiary crusher for additional size reduction. Dust is controlled through the secondary and tertiary screening process via a dust collector, with dust being routed back to the secondary screens surge bin and minimal emissions of dust to atmosphere via the air exhaust fan. A process water fed scrubber will also be used to control atmospheric emissions from the secondary and tertiary crushers.

Particles less than 4 mm will pass through the screens and into the primary cyclone feed pump box where filtered water is added to the ore particles to allow pumping into the primary cyclones for further size classification. Larger particles exit the cyclone and into the primary ball mill for further size reduction, while smaller particles are transported to the flotation process tanks. The slurry exiting the ball mill is pumped back through the cyclones.

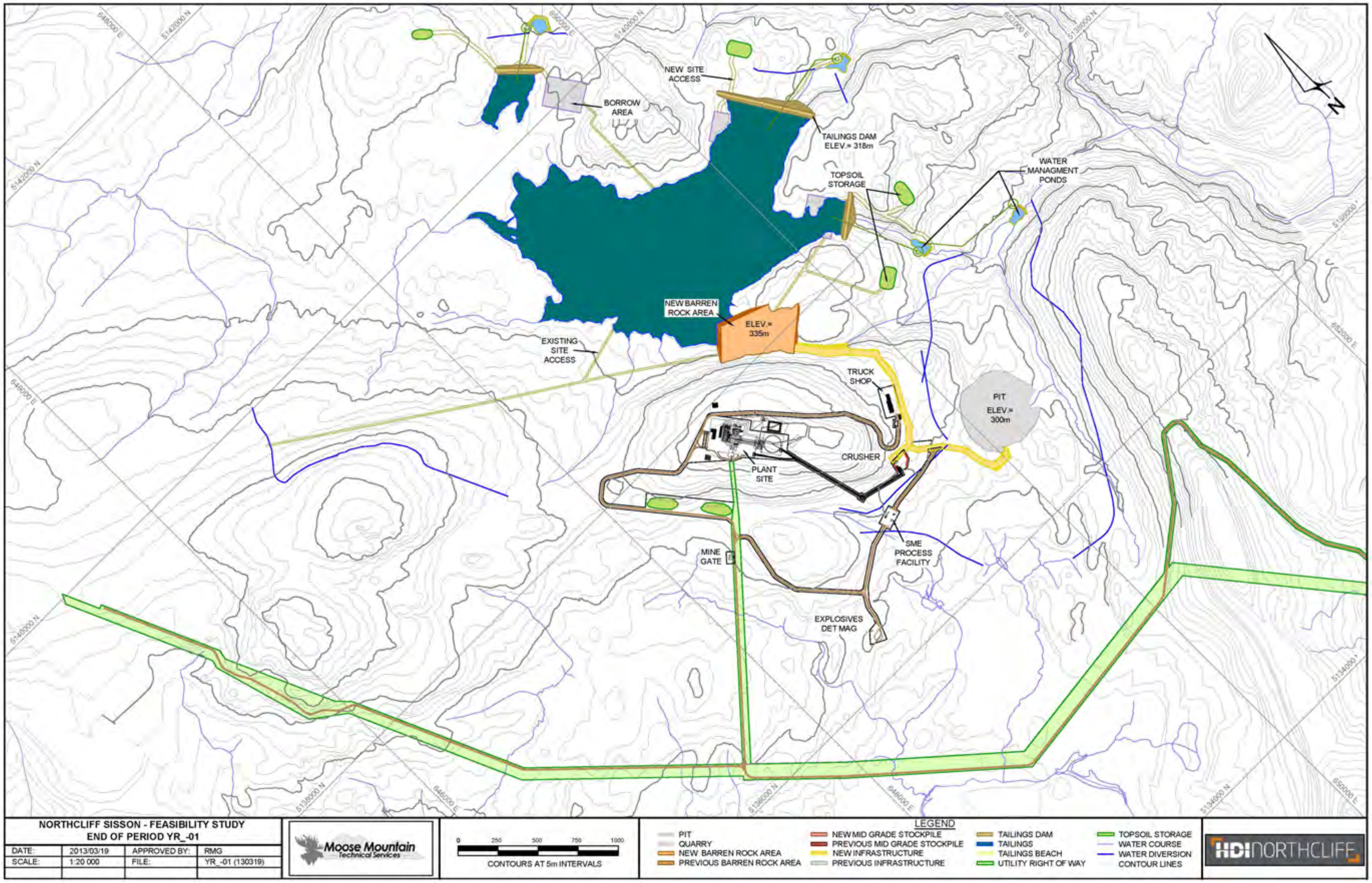


Figure 3.4.1 End of Period (EoP) Map, Pre-production Year -1 (Mill Start-up)

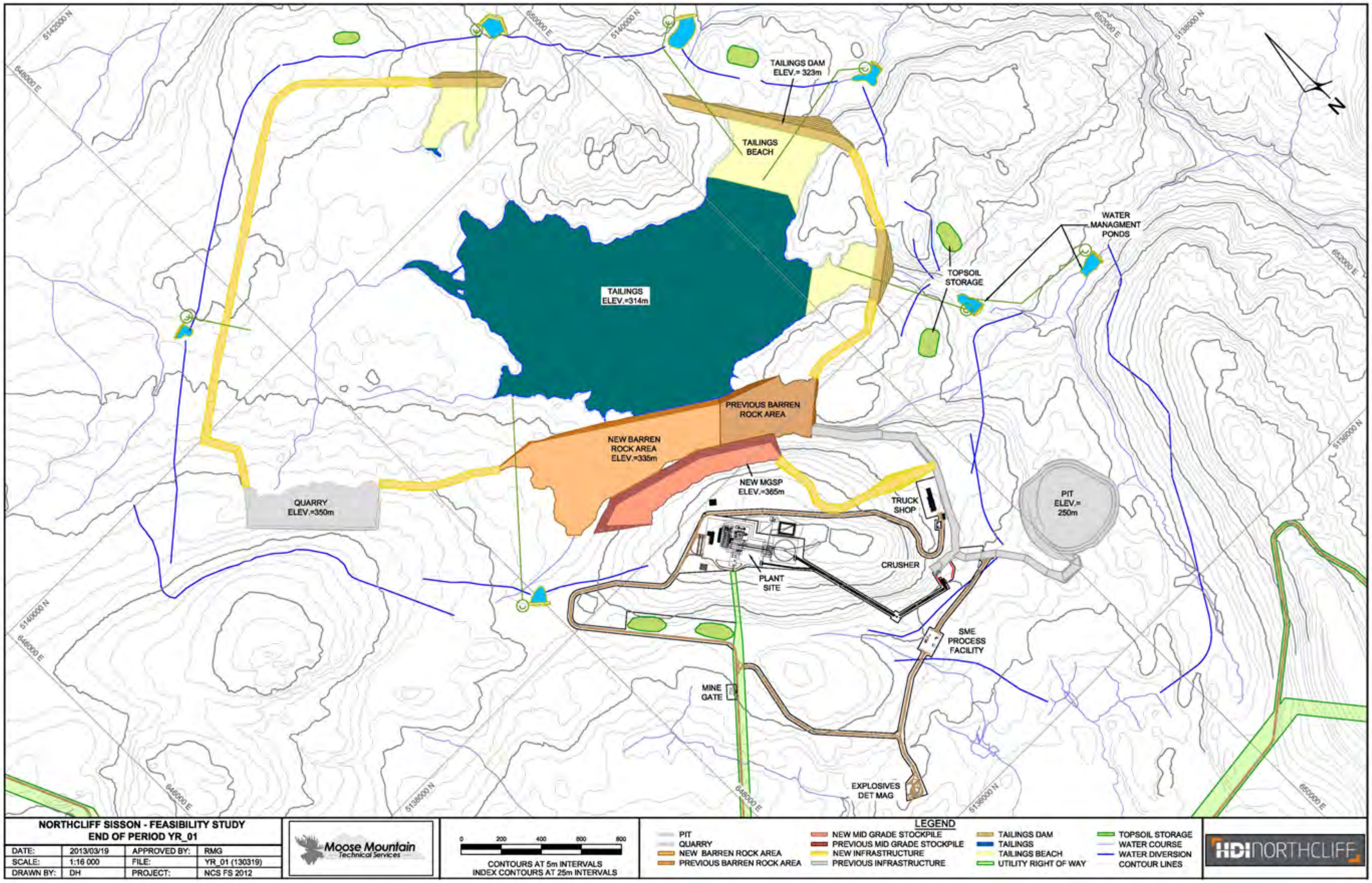


Figure 3.4.2 End of Period (EoP) Map, Production Year 1

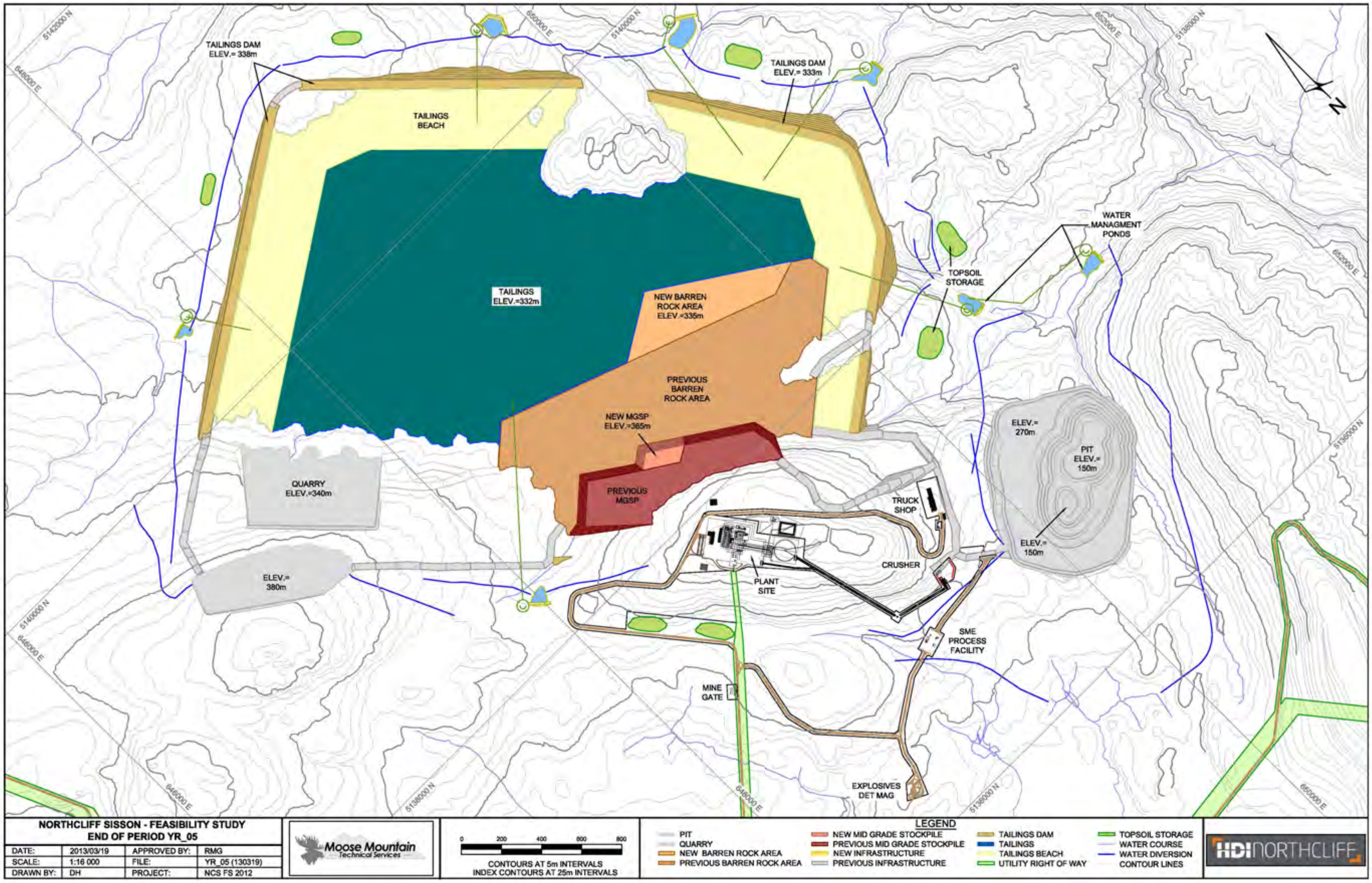


Figure 3.4.3 End of Period (EoP) Map, Production Year 5

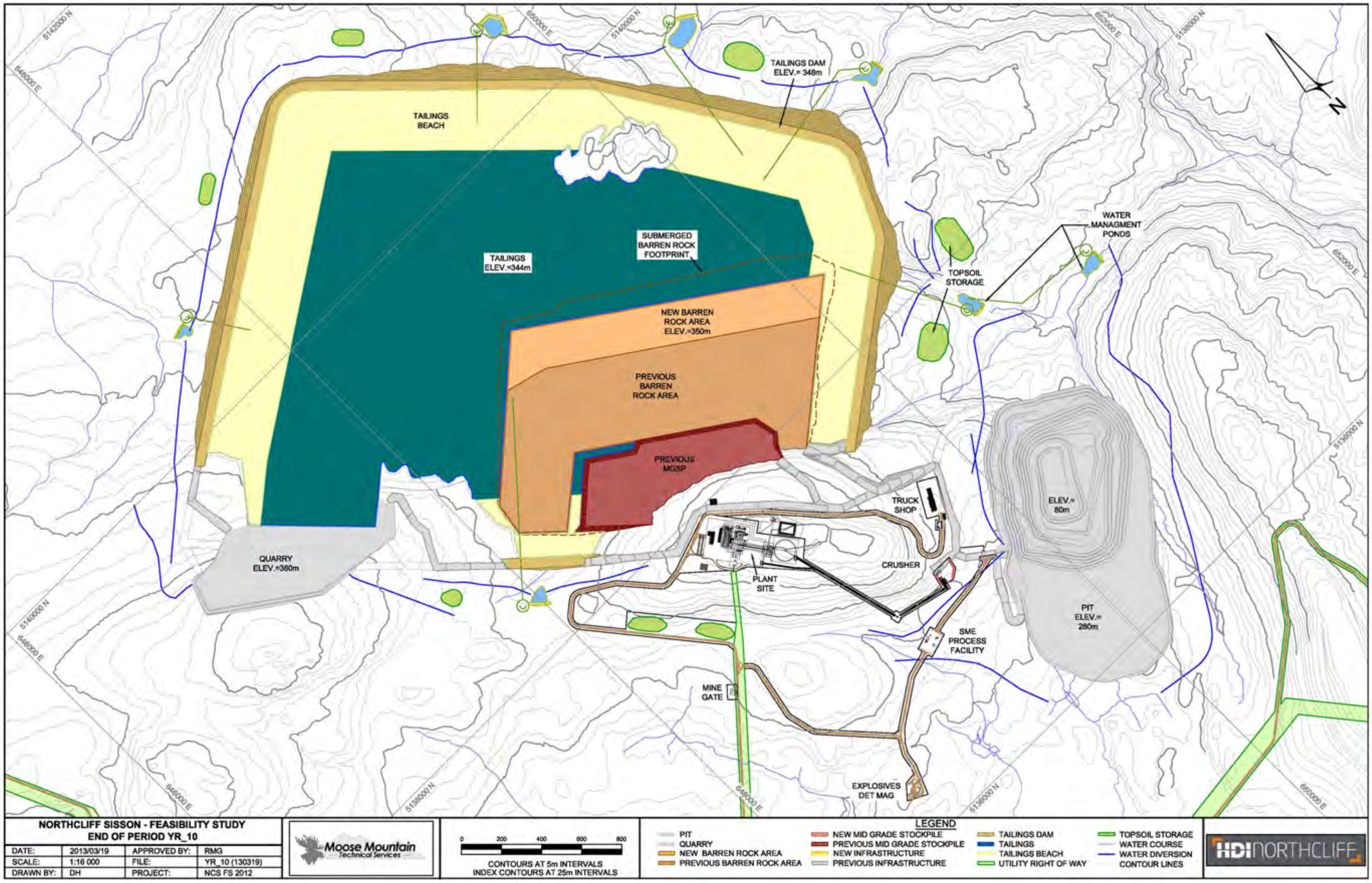


Figure 3.4.4 End of Period (EoP) Map, Production Year 10

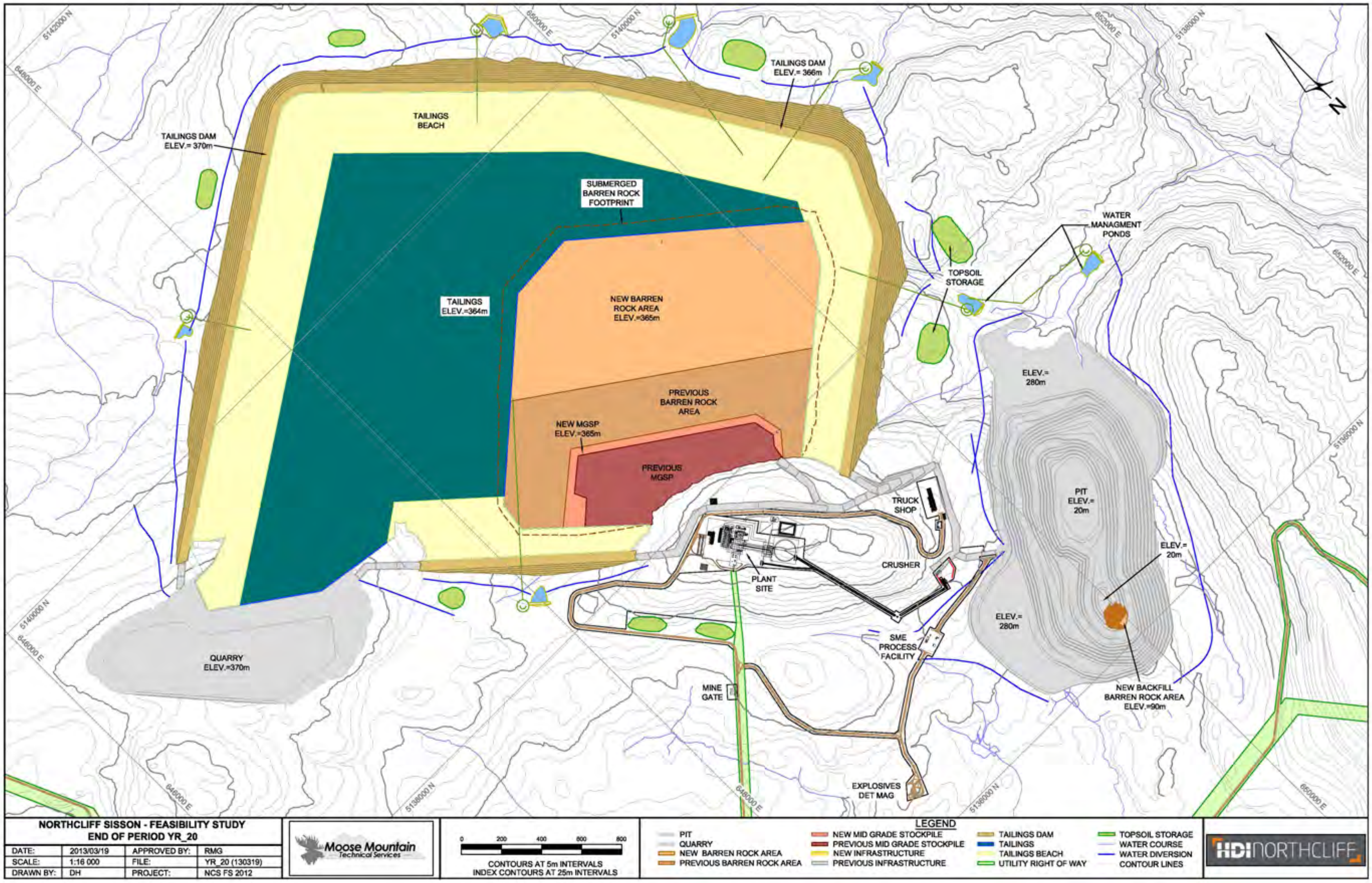


Figure 3.4.5 End of Period (EoP) Map, Production Year 20

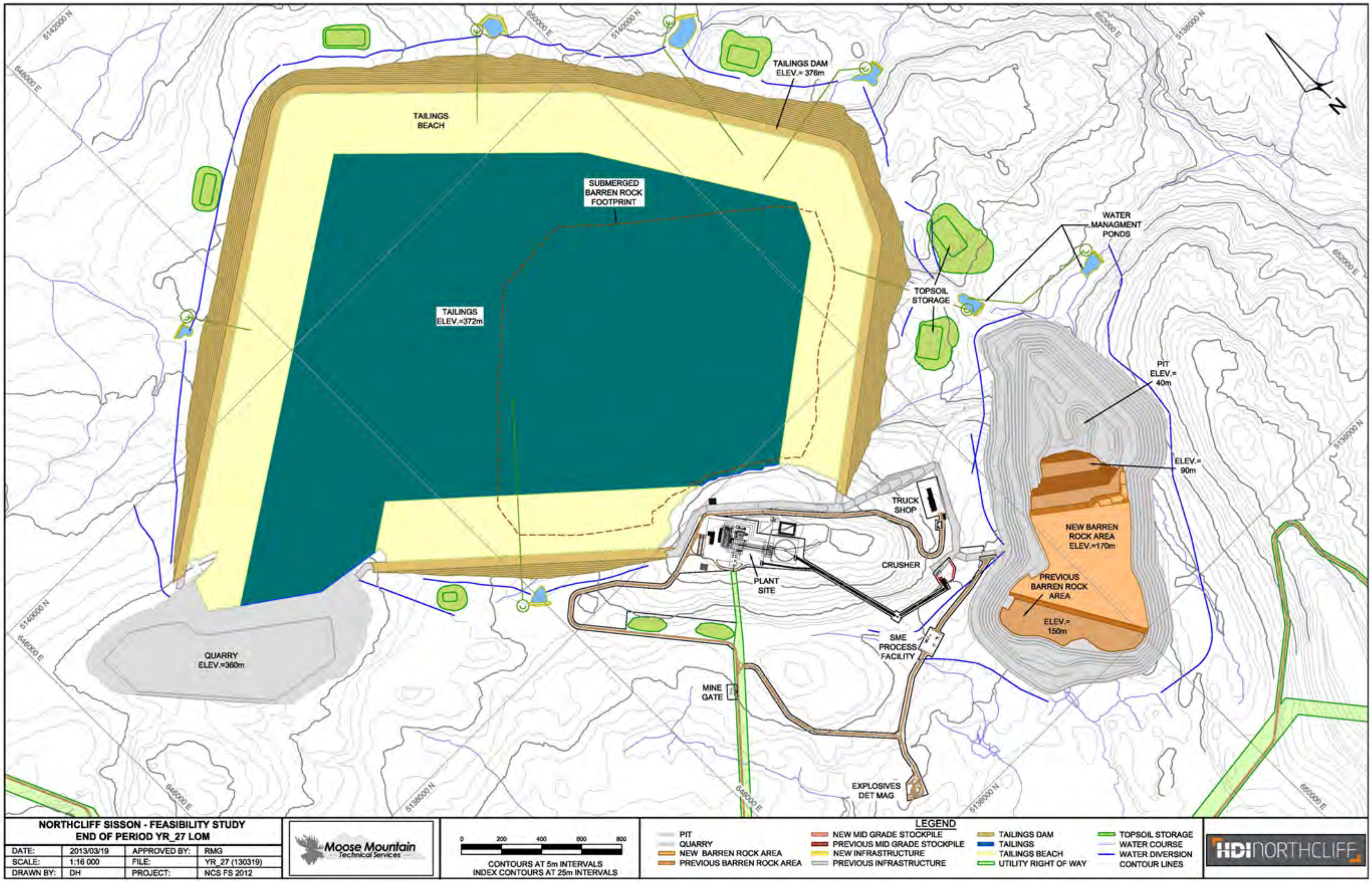
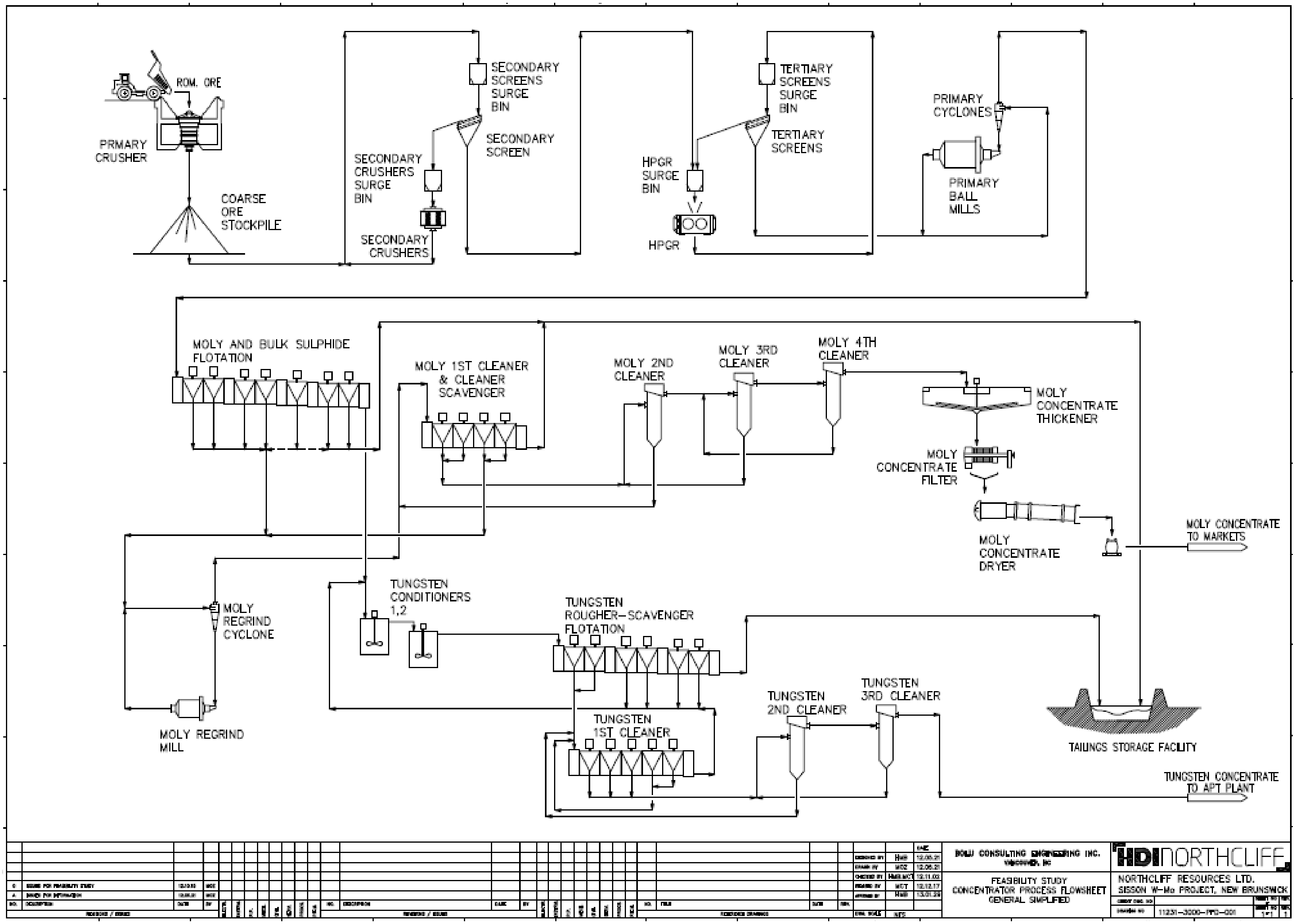


Figure 3.4.6 End of Period (EoP) Map, Production Year 27 (Life-of-Mine)



Source: Samuel Engineering (2013).

Figure 3.4.7 Simplified Concentrator Process Flowsheet

3.4.2.2.2 Flotation

The flotation process consists of a series of cells to allow for multiple stages of separation of the various ore constituents. The use of a multistage circuit for froth flotation allows for flexibility as the concentrates (and tailings wastes) can be monitored at the various tank outlets and the amount of recirculation of material between cells can be adjusted accordingly to optimize recoveries of the overall process.

Molybdenum and Bulk Sulphide Rougher Flotation

The molybdenum and bulk sulphide flotation circuit comprises seven 250 m^3 tank cells in series, of which the first four cells will float a molybdenite rougher concentrate and the remaining three a bulk sulphide concentrate. The molybdenite rougher concentrate will be sent to a regrind circuit for further liberation and upgraded in four stages as described below. The Bulk Sulphide Flotation (BSF) concentrate stream will join the molybdenum cleaner scavenger tailings and will be discharged for disposal to the TSF through a dedicated submerged pipeline. The BSF tailings stream will proceed to the tungsten flotation circuit.

Reagent addition will include fuel oil, pine oil and methyl isobutyl carbinol (MIBC) frother for the molybdenum circuit, and a sulphide collector PAX (potassium amyl xanthate) and MIBC frother to aggressively float the remaining sulphides in the BSF circuit.

Molybdenum Cleaner Flotation

The molybdenum cleaner circuit is based on single stage cleaner and cleaner scavenger flotation using tank cells, and three subsequent stages of cleaners using industry standard column flotation cells resulting in a total of four stage of cleaning plus a cleaner scavenger stage for recycling of oversize material back to regrinding. The regrinding and the four-stage cleaner and cleaner scavenger flotation circuit is designed to operate in counter current configuration.

The rougher molybdenite concentrate flows to a regrind cyclone feed pump which pumps the combined regrind mill discharge and rougher concentrate to regrind cyclones. Regrinding is accomplished in a ball mill operating in closed circuit with the cyclone pack. The cyclone underflow discharges to the regrind mill feed inlet accompanied with iron sulphide depressants and sodium sulphide.

The regrind circuit finished product, the cyclone overflow, flows by gravity to a bank of four cleaner and cleaner scavenger flotation tank cells for upgrading. Fuel oil is added to the tank cells to facilitate flotation. A cleaner concentrate is collected from the first two cells and a cleaner scavenger concentrate from the remaining two cells. The cleaner scavenger concentrate is returned to the molybdenite regrind circuit, and the cleaner scavenger tailings (which are PAG) are pumped to the TSF for storage.

The first cleaner concentrate is further upgraded in the subsequent cleaner flotation stages employing column cells.

Molybdenum Concentrate Dewatering

The concentrated slurry from the molybdenum cleaner circuit is pumped to a concentrate thickener where flocculant is added to assist in settling out the heavier particles (including the molybdenum). The thickened underflow is pumped through a pressure filter to further dewater, and then to a concentrate dryer. Removed water is recycled, and the dried molybdenum concentrate is bagged for shipment.

Tungsten Rougher-Scavenger Flotation

The tungsten flotation is accomplished by conventional techniques involving conditioning, rougher and scavenger flotation, and three stages of cleaning to produce a final tungsten concentrate.

A series of two agitated conditioning tanks will sequentially adjust the pH of the incoming slurry, and progressively condition the feed with dispersants, gangue depressants, collectors, and frothers. These will include sodium hydroxide, sodium carbonate, sodium silicate, quebracho, and fatty acids. The overflow from the second conditioner will report to the rougher flotation bank.

Six tank cells will be used to recover the tungsten. The first two cells will float a rougher concentrate which will be sent to cleaning. The remaining four cells will produce a scavenger concentrate which is pumped back to the second conditioner. Supplementary collector and frother are added to the scavenger cells.

The tungsten scavenger tailings will be discharged to the TSF through a dedicated pipeline as NPAG tailings.

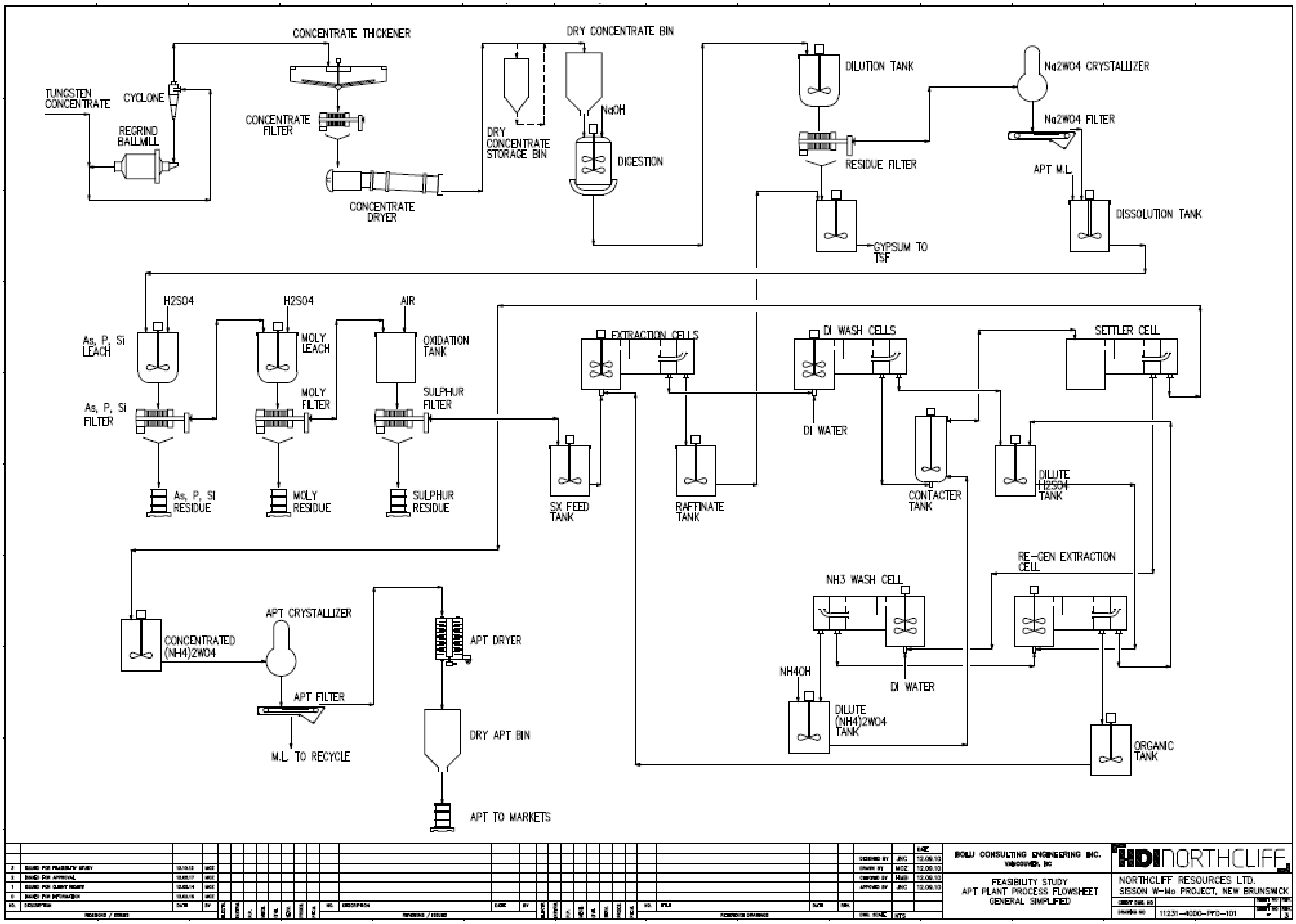
Tungsten Cleaner Flotation

The rougher concentrate is cleaned in three stages. The first stage consists of five tank cells. The first two cells produce Cleaner 1 concentrate, and the remaining three cells produce a cleaner scavenger concentrate which is recycled to the head end of the cleaner circuit. Supplementary frothers and depressants are added as needed to the first stage of cleaning. The Cleaner 1 concentrate is cleaned two more times using two column cells in series operating on forced air. The final concentrate of approximately 30% tungsten trioxide (WO_3) is thickened, filtered, and dried. The final tungsten concentrate is then pumped to the APT plant for further refining.

3.4.2.2.3 Tungsten Concentrate Refining to APT

The tungsten concentrate produced in the flotation process is thickened, dewatered and further refined in the ammonium paratungstate (APT) plant. The APT plant will operate year-round, with two 12-hour shifts per day, processing approximately 2 to 3 tonnes per hour of WO_3 concentrate. A simplified process flowsheet for the APT plant is provided in Figure 3.4.8. The process in the APT plant consists of the following major steps:

- feed preparation;
- digestion and residue filtration;



Source: Samuel Engineering (2013).

Figure 3.4.8 Simplified Ammonium Paratungstate (APT) Plant Flowsheet

- alkali recovery and solution purification;
- conversion to ammonium tungstate;
- APT crystallization;
- APT drying and packaging; and
- reagent preparation and utilities.

Tungsten concentrates will first be reground and dewatered in the feed preparation circuit in order to allow a uniform feed ahead of digestion. Tungsten in the concentrates will be digested using an alkali leach system and the sodium tungstate solution will be filtered from the undigested leach residue. The gypsum residue will be stored in a lined containment pond within the TSF, while the sodium tungstate solution will be processed through an alkali recovery and purification process. Common impurities will be removed and stored for disposal at an approved off-site facility. The resulting sodium tungstate solution will be converted to ammonium tungstate and subsequently to APT crystals.

The aqueous solution effluent from the ammonium tungstate conversion will be stored in a lined containment pond within the TSF after pH adjustment. The dried and screened APT will be packaged for markets. Vapours from the crystallizer and other process vessels and processes in the plant will be sent to their respective scrubbers and stripping systems for reclaim and re-use before release to atmosphere. The main reagents used in the process are sodium hydroxide, sulphuric acid, anhydrous ammonia, ammonium hydroxide, sodium sulphahydrate, lime, and organic exchange media.

Feed Preparation

Tungsten concentrate slurry from the concentrator plant will be processed through a wet grinding mill to facilitate size reduction and further exposure of tungsten mineral grains. The mill will operate in closed circuit with a hydrocyclone and the finished product, the cyclone overflow, is fed to a thickener for dewatering and density adjustment prior to filtering. The filter cake discharge is fed to continuous dryer to further reduce moisture. The ground and dried concentrate is stored in a hopper for feed to the digesters.

Digestion and Residue Filtration

The digestion section of the plant consists of digesters, dilution tanks, filter presses, residue processing equipment, and storage tanks.

The three digesters are nickel-lined jacketed vessels, and will process seven digestions per day using an alkali solution. After digestion, the digested slurry is transferred for filtration of the gangue from the sodium tungsten solution to agitated steel vessels. After transfer, the slurry is diluted with raw and recovered condensate water and then filtered to separate the sodium tungstate solution from the residue. The undigested residue is washed with recovered condensate for maximum tungsten recovery. The sodium tungstate solution and wash are pumped to steel storage tanks before further processing. Filter cake, the undigested residue, is hauled for storage in a lined containment pond within the TSF (separate from tailings).

Alkali Recovery and Solution Purification

The sodium tungstate solution is next processed through a purification process where impurities are removed from the solution. The first step is alkali recovery where the products are alkali and sodium tungstate crystals. This is accomplished in an evaporator crystallizer which yields sodium tungstate crystals, alkali, the bottoms and condensate (pure water) vapours. The bottoms are separated using a horizontal belt vacuum filter, the alkali is reused in the digestion step, and the recovered condensate is recycled within the plant.

The sodium tungstate crystals are then re-dissolved in condensate to remove impurities such as aluminum (Al), molybdenum (Mo), and silicon (Si). This is accomplished by pH adjustment of the re-dissolved crystal solution and addition of ammonium hydroxide and magnesium sulphate to precipitate aluminum and silicon. This solution is then agitated, settled and filtered to remove the impurities. The solution from the Al/Si removal step is then treated with sodium sulphahydrate and pH adjusted to precipitate the molybdenum, agitated, settled and filtered. The hydrogen sulphide generated in this step is scrubbed with sodium hydroxide and converted to sodium sulphide for reuse in the process. The resulting solution is oxidized with air to convert the excess sulphide to sulphur, and filtered to remove the sulphur as it is transferred to the solvent extraction section. At this point, the solution is ready for conversion to ammonium tungstate.

Conversion to Ammonium Tungstate

The conversion of sodium tungstate to ammonium tungstate is accomplished in a continuous solvent extraction process. The feeds to the solvent extraction process are the sodium tungstate solution, an amine organic solution, sulphuric acid, ammonia, and deionized water. There are three extraction cells, two low pH wash cells, a product separation cell, a high pH wash cell, and an organic regeneration cell, plus supporting feed and storage tanks used in the conversion process.

The extraction cells produce a sodium sulphate waste solution (raffinate) that is mixed with lime and pH adjusted in an agitated treatment tank to stabilize the calcium sulphate. The resulting slurry is stored with the earlier gypsum waste in a lined containment cell within the TSF, separate from tailings. Sulphuric acid, ammonium hydroxide and an organic solvent are used in the extraction, and these reagents are recovered and recycled in the process.

Ammonium Paratungstate (APT) Crystallization and Drying

The APT is crystallized in a continuous evaporator crystallizer. The concentrated ammonium tungstate solution is pumped to the crystallizer and, as formed, the crystals are continuously removed from the mother liquor by use of a belt filter. Mother liquor is returned to the crystallizer. The crystals are then washed on the belt filter, dried and stored for packaging.

Ammonia (NH_3) Scrubber and Stripper

The ammonia scrubber will consist of a scrubber, a steam stripper and an ammonia absorption tower. Fumes containing ammonia will be scrubbed using sulphuric acid from the solvent extraction circuit and concentrated sulphuric acid. The resulting ammonium sulphate will be sent to the steam stripper, and then the resulting ammonia and water vapour will be absorbed in the absorption tower for reuse as ammonium hydroxide in the solvent extraction circuit.

3.4.2.2.4 Packaging

The dried molybdenum concentrate will be placed in bags for shipment off-site. The design capacity for production of molybdenum concentrate is 1 tonne per hour.

The dried APT is stored in dry APT bins prior to being packaged in drums for shipment. Standard packaging is 150 kg of APT in polyethylene bags inside 60 litre drums. The design capacity for production of the APT crystals is 1.7 tonnes per hour.

3.4.2.2.5 Reagents

Reagents and chemicals for the process plants will be used in flotation, dewatering, reclaim water clarification and APT conversion circuits. Reagents will be delivered in bulk or by specific container and stored onsite in separate, secure, designated areas near or attached to process plant buildings. Covered and open storage areas for all reagents will be self-contained and equipped with spill recovery sump pumps as needed. Reagents will be mixed with filtered process water where necessary and pumped to day-tanks for use. Some select reagents such as flocculants will use fresh water for mixing.

A listing of reagents used in the ore processing plant and APT plant is provided in Table 3.4.15.

Table 3.4.15 Ore Processing Reagents

Reagent	For Use In
Fuel Oil	Molybdenum Flotation
Pine Oil	
Sodium Hydrosulphide (NaHS)	Molybdenum Cleaner Flotation, APT Plant
Potassium Amyl Xanthate (PAX)	Bulk Sulphide Flotation
Methyl Isobutyl Carbinol (MIBC)	Molybdenum and Bulk Sulphide Flotation
Sodium Hydroxide	Tungsten Flotation, APT Plant
Sodium Silicate	
Sodium Carbonate	Tungsten Flotation
Quebracho	
Fatty Acid	
Frother	
Lime	Water Clarification, APT Plant
Liquid Carbon Dioxide	Water Clarification
Flocculant	Concentrate Thickening, Water Clarification
Ammonium Hydroxide	
Sulphuric Acid	
Liquid Nitrogen	APT Plant
Magnesium Chloride	
Ammonia	
Amine	

Fuel oil, pine oil, MIBC, fatty acid, and tungsten flotation frother will be shipped to site in tanker trucks and stored in environmentally-safe tanks where they will be transferred, as required, into day tanks for use. PAX, quebracho and flocculant will be shipped to site in dry solid flakes or pellet form in bags or drums. These will be stored in the reagent storage area next to the reagent preparation building. Bulk reagents such as sodium hydroxide, sodium carbonate, and lime will be shipped to site in tanker trucks and pneumatically unloaded into their dedicated on-site storage bins. Sodium silicate and sodium hydrosulphide will be delivered to the site in liquid form to their storage tanks.

3.4.2.3 Mine Waste and Water Management

Mine waste will include tailings (*i.e.,* residual rock after mineral processing which is fine sand and silt material in a slurry with process liquids) and waste rock (*i.e.,* rock mined from the pit that is uneconomical to process). Mine contact water (*i.e.,* precipitation, groundwater, or surface water that comes in contact with site activities) and water that will accumulate in the open pit will also need to be managed throughout the life of the mine. The primary waste and water management system component is the TSF, where tailings, waste rock, all mine contact water, and process water will be stored and managed. Water within the TSF will be reclaimed, treated, and used in the ore processing plant, then discharged back to the TSF in a closed loop. At approximately Year 8, water will be in surplus within the TSF, thereby necessitating the treatment of water to meet water quality discharge standards (to be defined by permit requirements) before being released to the environment.

Further details on the mine waste and water management activities associated with the Project are provided below.

3.4.2.3.1 Tailings Storage Facility

The TSF is designed to contain approximately 282 Mt of tailings, 17 Mt of mid-grade ore, 270 Mt of waste rock from the open pit, water contained within the tailings and waste rock voids, as well as mine contact water from the entire Project site. Approximately 650 kt of APT process residue will also be stored in lined cells within the TSF over the mine life.

Tailings from the ore processing plant will be pumped to the TSF and stored there in perpetuity, as will be the waste rock trucked from the open pit (until Year 21). Reclaim water will be recycled back to the ore processing plant from a floating barge and pipeline for use as process water.

The TSF inflows are:

- tailings slurry pumped to the TSF from the ore processing plant;
- open pit dewatering;
- pump-back water from the water management ponds (WMPs) around the TSF;
- direct precipitation into the TSF; and
- other mine contact water collected throughout the PDA.

The TSF outflows and losses are:

- water retained within in the tailings and waste rock voids;
- water recycled back to the ore processing plant;
- seepage under and through the embankments; and
- evaporation.

The majority of the process water for the ore processing operation will be supplied by the TSF reclaim water system. This will be supplemented by a fresh water make-up for the processing plants supplied from groundwater wells on the Project site.

The TSF will be designed and operated to prevent fugitive dust emissions. Rotational deposition of tailings will keep exposed tailings beaches wet during operations to prevent dusting.

The TSF embankments will be constructed as required through the life of the mine to maintain containment of the contents of the TSF. The evolution of the TSF embankments throughout the various Operation stages was shown in Figures 3.4.1 to 3.4.6.

SML plans to use the centerline construction method for tailings embankments at the Sisson Project because of its superior seismic resistance, reduced foundation footprint when compared to downstream construction, and efficient use of non-mineralized mine rock for construction. The TSF embankments and foundations will be designed to minimize the seepage of water, and collection systems and monitoring wells designed to gather run-off and seepage from the embankments for recycle into the TSF.

The embankments will be engineered for stability and containment. As embankment construction will continue throughout the active life of the mine, experience gained from ongoing monitoring and analysis will allow for changes and improvements in the design if required.

3.4.2.3.2 Tailings Storage in TSF

Tailings from the ore processing plant will be pumped as a slurry to the TSF and stored there in perpetuity. Tungsten tailings are NPAG and will be discharged via a pipeline that will surround the perimeter of the TSF; molybdenum tailings are considered PAG and will be discharged to the TSF subaqueously using a separate pipeline. The NPAG slurry (approximately 30% solids) pumped into the TSF will discharge from the top of the TSF embankments, with larger solid particles settling out by gravity closer to the embankment and finer particles travelling further toward the centre of the TSF. The solids will settle to form a solid beach type surface. The water from the TSF supernatant pond will be reclaimed by the moveable barge and pumped back to the ore processing plant. Water levels in the TSF will be managed to keep water away from embankments as well as to ensure sub-aqueous disposal of PAG tailings and waste rock.

3.4.2.3.3 Waste Rock Storage in TSF

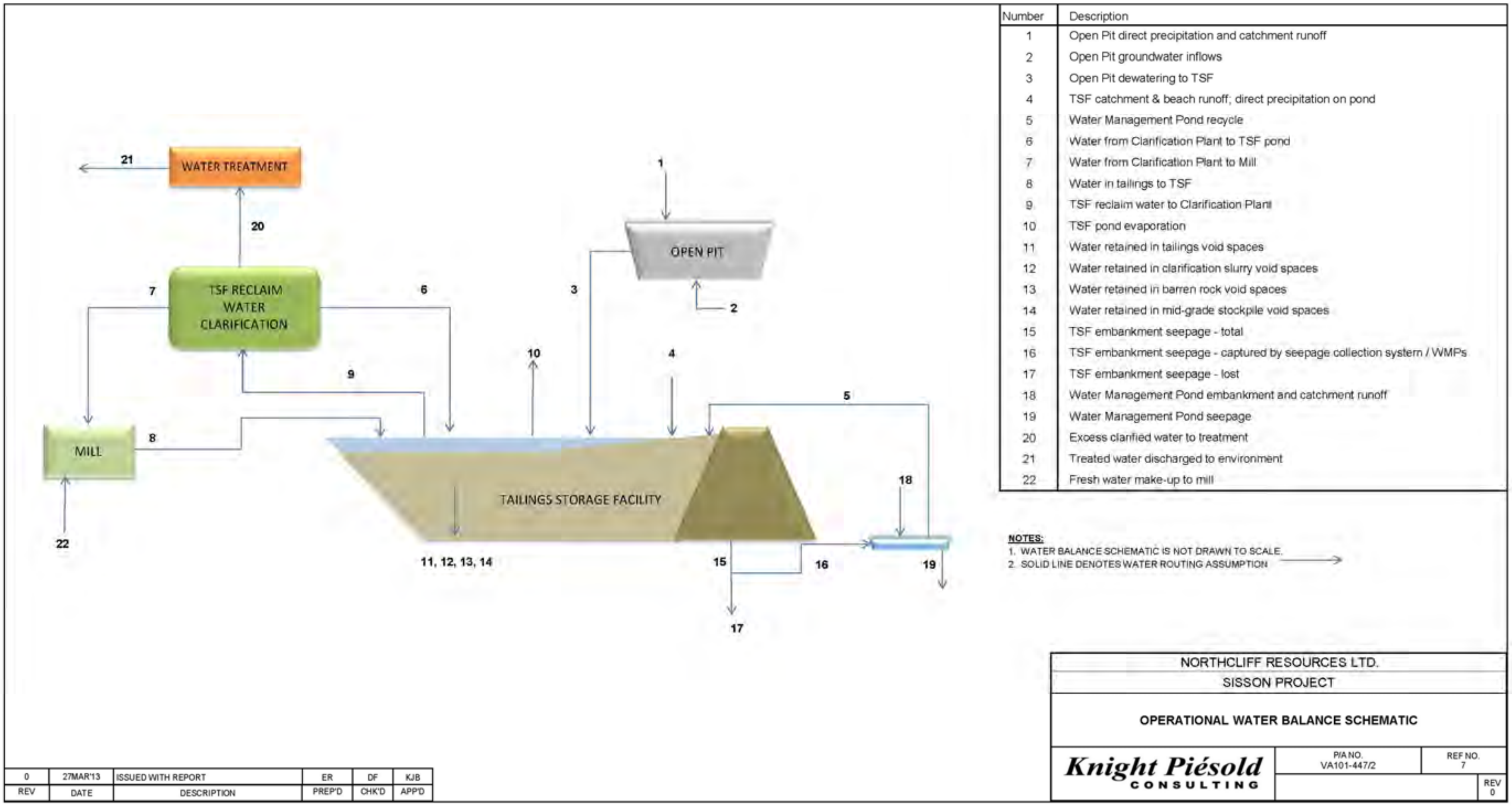
All waste rock from the open pit will be stored under water and NPAG tailings in the TSF. By containing all waste rock within the TSF as opposed to a separate storage pad, environmental benefits are achieved by avoidance of ML/ARD generation, despite the increased short-term cost of waste disposal due to hauling of waste rock to the TSF as opposed to storing it near the pit.

Waste rock will be hauled from the open pit to the TSF. At approximately Year 21, waste rock will remain stored in an inactive area of the open pit, to be later flooded by water during Closure.

3.4.2.3.4 Water Management in the TSF

The operational water balance model for the Project is discussed in Section 7.6 of this EIA Report, and is shown schematically in Figure 3.4.9. The operational water management plan for the TSF includes the following.

- All un-diverted run-off from within the TSF catchment will report to the TSF.
- Process slurry water contained in the tungsten and molybdenum tailings streams will be discharged into the TSF with the tailings solids at an average rate of approximately 2,022 m^3/h at full production.
- Tailings supernatant pond water will be reclaimed and pumped back to the process plant to meet the average process water requirement of approximately 2,003 m^3/h at full production.
- The TSF will have approximately 6 million m^3/year of surplus water (including surplus precipitation from the TSF area as well as water from dewatering of the open pit) starting at about Year 8. After treatment in the clarifier and water treatment plant at the ore processing plant to meet water quality discharge standards, this surplus will be discharged to Sisson Brook in order to maintain an acceptable operating pond volume in the TSF and to supplement the downstream flows affected by the Project. The reclaim barge has been sized to accommodate this additional flow rate.
- NPAG tailings will be selectively deposited from along the top of the embankments to develop stable beaches around the inside of the embankments. The operational supernatant pond volume will be managed to ensure that sufficient storage exists for operational flexibility and storm inflow storage.
- Engineered drainage diversion channels will divert non-contact water away from the TSF and quarry, to the extent possible.
- Water management ponds (WMPs) at low points around the TSF embankment perimeter will collect seepage and run-off from the TSF embankments. This water will be pumped back to the TSF unless the water quality is suitable for direct release to the environment.
- Groundwater monitoring wells will be located below the WMPs to monitor water quality. Groundwater pump-back wells will be developed as necessary if the groundwater quality may jeopardize downstream water quality; this groundwater will be pumped to the WMPs.



Number	Description
1	Open Pit direct precipitation and catchment runoff
2	Open Pit groundwater inflows
3	Open Pit dewatering to TSF
4	TSF catchment & beach runoff; direct precipitation on pond
5	Water Management Pond recycle
6	Water from Clarification Plant to TSF pond
7	Water from Clarification Plant to Mill
8	Water in tailings to TSF
9	TSF reclaim water to Clarification Plant
10	TSF pond evaporation
11	Water retained in tailings void spaces
12	Water retained in clarification slurry void spaces
13	Water retained in barren rock void spaces
14	Water retained in mid-grade stockpile void spaces
15	TSF embankment seepage - total
16	TSF embankment seepage - captured by seepage collection system / WMPs
17	TSF embankment seepage - lost
18	Water Management Pond embankment and catchment runoff
19	Water Management Pond seepage
20	Excess clarified water to treatment
21	Treated water discharged to environment
22	Fresh water make-up to mill

Source: Samuel Engineering (2013).

Figure 3.4.9 Schematic of Mine Operational Water Balance

- Water from the open pit will be pumped to a WMP near the pit rim and then to the TSF.

The water balance model results were used to estimate the likelihood of having a surplus or deficit of water in the TSF. The TSF pond is predicted to be in a surplus condition for the entire operating life of the mine, indicating that the system (including the TSF and contributing catchments) is able to supply more than enough water to meet the mill process water requirements, even under dry conditions. This surplus will accumulate in the TSF until it is excessive (starting about Year 8 as noted above) and needs to be discharged.

3.4.2.3.5 Dewatering of the Open Pit

The water pumped from the open pit by the dewatering system includes direct precipitation onto the pit, undisturbed pit catchment surface run-off entering the pit, and groundwater inflows. Water collected in the open pit will be periodically pumped from a pit sump and report to the TSF via an intermediary WMP.

3.4.2.3.6 Collection and Management of Mine Contact Water

Precipitation and surface water run-off onto the site will be directed away from Project facilities with engineered diversion channels wherever possible to minimize the creation of mine-contact water. Mine- contact water from throughout the PDA will be sent to the TSF for storage and use.

Water management ponds constructed at the topographic low points downstream of the embankments will collect water that may seep through the TSF embankment as well as run-off from the embankments. Embankment foundation drains will be piped to these ponds and water from the ponds will be pumped back to the TSF for containment and use.

3.4.2.3.7 Surplus Water Treatment, Release and Monitoring

The conceptual water treatment process for the Project is described in Appendix I of SRK (2013). *Sisson Project: Metal Leaching and Acid Rock Drainage Characterization. August 2013.* The process is conceptual since it was developed for feasibility study purposes. This is normal practice at the environmental assessment stage of a project, which is intended to be a planning process rather than a detailed engineering review for the purposes of permitting. Further refinement of the water treatment process will be carried out during Basic Engineering, with input from regulatory agencies regarding expected effluent standards, and will be described fully in subsequent permit applications for the Project.

Table 3.4.16 presents the predicted TSF water quality data for Operation, as well as any water quality discharge limits set by the federal *Metal Mining Effluent Regulations* (*MMER*). It is the TSF water that is treated for use in the ore concentrator. Starting about Year 8, water surplus to Project requirements will need to be discharged to Sisson Brook.

Table 3.4.16 TSF Water Quality Predictions - Operation

Parameter	Average Concentration in TSF Water (mg/L)	Maximum Concentration in TSF Water (mg/L)	Discharge Limits (maximum authorized monthly mean concentration, column 2) (mg/L)
Aluminum (dissolved)	0.6	0.9	---
Antimony (total)	0.012	0.019	---
Arsenic (total)	0.08	0.13	0.5
Cadmium (total)	0.00058	0.00084	---
Chromium (total)	0.012	0.017	---
Copper (total)	0.026	0.036	0.3
Cyanide	N/A	N/A	1.00
Lead (total)	0.0016	0.0022	0.2
Manganese (total)	0.64	0.94	---
Molybdenum (total)	0.081	0.13	---
Nickel (total)	0.0079	0.012	0.50
Selenium (total)	0.0026	0.0034	---
Zinc (total)	0.044	0.068	0.50

During the feasibility study, the water quality predictions presented in Table 3.4.16, and the preliminary environmental effects assessments based on them, indicated that water treatment for arsenic (and antimony) was likely to be required before the surplus TSF water can be discharged to Sisson Brook. Thus, this capability was added to the conceptual design of the water treatment process.

During Operation, water recycled from the TSF pond will be clarified with lime and then carbon dioxide to settle fine tailings solids and silica minerals before the water is used in the concentrator plant. The solids from the clarifier will comprise two streams: a lime underflow at approximately 28 tonnes per hour; and a calcium carbonate precipitate (from the CO_2 treatment) at approximately 67 tonnes per hour. These two streams will be pumped into the TSF for permanent storage. For the purposes of the TSF capacity calculations, both these waste streams are assumed to settle to a final dry density of 0.5 tonnes/m^3. However, to be conservative, the predictive water quality modelling assumed that the elements in these solids would re-mobilize in the tailings water; this assumption is currently being refined through additional test work.

Starting in about Year 8 of Operation, water surplus to Project needs will be released (following treatment as necessary) into Sisson Brook at between about 5,000 and 55,000 m^3/day (average of 16,500 m^3/day) to mimic the Napadogan Brook hydrograph as close as possible. Before discharge, and after it is clarified with lime and carbon dioxide, the water will be treated in a ferric co-precipitation process[1] (shown in Figure 3.4.10 targeted to remove arsenic and antimony; the process is expected to beneficially remove the other elements listed in Table 3.4.16 but, to be conservative, these benefits have not been assumed at this stage of Project planning. This treatment entails feed water entering Reactor 1 where ferric sulphate and sulphuric acid are added and the pH drops to approximately 5 or 6. In the reactor, ferric hydroxide precipitates are formed, which adsorb and co-precipitate arsenic,

[1] The USEPA (United States Environmental Protection Agency. 2005. Treatment Technologies for Arsenic Removal. Cincinatti (OH). Reference No.: EPA/600/S-5/006) recognizes ferric treatment as an effective method for arsenic and antimony removal.

antimony and other metals. A second reaction tank (Reactor 2 in Figure 3.4.10) extends the retention/reaction time to ensure that the adsorption reaction is complete. The ferric sludge produced in the process will be collected and removed in a clarifier. A portion of the produced solids from the clarifier underflow will be recycled back to the reactor tanks to provide seed for the ongoing precipitation process. The balance of the ferric sludge, approximately 650 tonnes/year of solids, will be pumped for disposal in the TSF. This sludge is expected to be stable (*i.e.*, will not dissolve) and to thus not affect TSF water quality.

The final effluent will flow from the clarifier overflow to a sand filtration unit before it is released to Sisson Brook. The predicted quality of water discharged to Sisson Brook is given in Table 3.4.17 below.

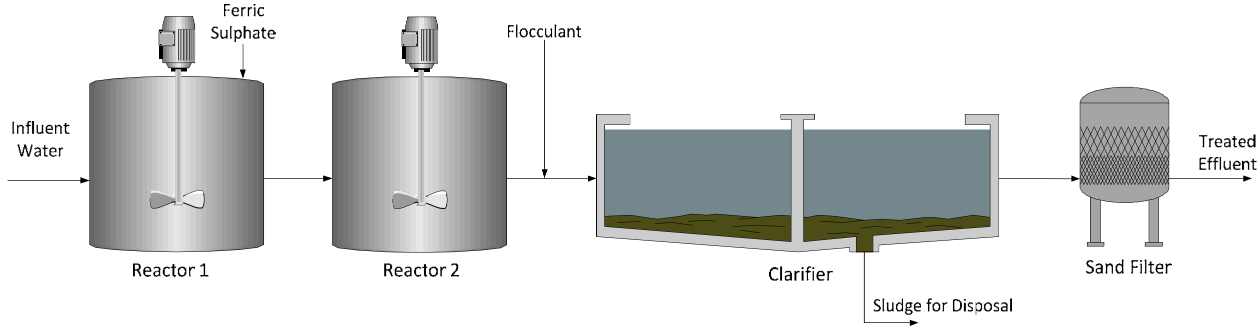


Figure 3.4.10 Ferric Co-precipitation Process Flow Diagram

Table 3.4.17 Predicted Discharge Water Quality to Sisson Brook for Treated Parameters – Operation

Parameter	Average Expected Final Effluent Water Quality-Concentration of Trace Metal in Water (mg/L)	Maximum Expected Final Effluent Water Quality – Concentration of Trace Metal in Water (mg/L)	*MMER* Discharge Limits (maximum authorized monthly mean concentration, column 2) (mg/L)
Aluminum (dissolved)	0.2	0.2	---
Antimony (total)	0.01	0.01	---
Arsenic (total)	0.01	0.01	0.50
Cadmium (total)	*<u>0.0004 (0.0005)</u>*	0.0005	---
Chromium (total)	0.01	0.01	---
Copper (total)	0.002	0.002	0.30
Cyanide	N/A	N/A	1.00
Lead (total)	0.0005	0.0005	0.20
Manganese (total)	0.1	0.1	---
Molybdenum (total)	0.05	0.05	---
Nickel (total)[2]	0.0084	0.012	0.50
Selenium (total)	*<u>0.0027 (0.015)</u>*	*<u>0.0034 (0.015)</u>*	---
Zinc (total)[2]	0.047	0.068	0.50
TSS	< 15.00	< 15.00	15.00

Notes:
1. The numbers in *<u>underlined italics</u>* indicate that concentration is lower than the WTP threshold removal. The threshold values are given in brackets.
2. Nickel and Zinc are not targeted for removal in the WTP, but are shown for comparison with *MMER* Discharge Limits.

3.4.2.3.8 Fresh Water Supply

Fresh water for the Project will be pumped from the fresh water wells developed for the Project. This will include water for use as drinking water (treated as necessary to ensure potability), for sanitary facilities, for fire protection, for dust suppression, and as fresh water make-up for the ore processing plant. The requirement is about 21 m^3/h of fresh water for all uses.

3.4.2.4 Linear Facilities Presence, Operation and Maintenance

Linear facilities, including the transmission lines and access roads, will be operated and maintained throughout the Project life.

3.4.2.4.1 Operation and Maintenance of the Transmission Lines

NB Power will conduct the required maintenance of the transmission line so that it operates in a safe and reliable manner according to the Canadian Electrical Code. The electrical code clearances were developed for safe and reliable operation of high-voltage lines. NB Power will also be responsible for maintaining the right-of-way for vegetation control and to permit suitable access to the transmission line during emergencies and for regularly scheduled inspections and maintenance. Routine inspections will be conducted to facilitate the safe and reliable operation of the transmission line, and to minimize the risk of potential hazards such as fires or electrocution caused when trees grow too close to energized power lines.

In order to avoid interruptions to electric service caused by overgrown or fallen vegetation, NB Power restricts the growth of trees and brush along the lines through its vegetation management program. Manual and mechanical methods will be used to control vegetation along right-of-way. The frequency of vegetation management depends upon the growth rate, but is normally carried out every five to seven years.

3.4.2.4.2 Operation and Maintenance of Site Access Road and Internal Site Roads

The forest resource roads will be used by personnel and for delivery and product vehicles as well as by existing users (mainly for forestry operations). General forest road maintenance activities will be carried out by third parties (*e.g.,* the Crown timber license holder or contractors) during the summer months, with the assistance of SML. The site access road and internal site roads will be maintained by SML.

Detailed maintenance procedures will be developed during later planning stages; however, maintenance of the roads may include:

- bridge or culvert maintenance;
- litter pick-up;
- road repairs;
- snow removal and ice control;

- traffic sign installation and repairs;
- traffic signal maintenance; and
- vegetation control.

Periodic maintenance of roadway drainage systems may be required, including the replacement or repair of culverts, re-establishment of the drainage ditches and clearing of brush and trimming of overhanging vegetation to re-establish sight lines. Repairs will be conducted as necessary and may involve occasional excavation or removal of the existing cover and subgrade, leveling, grading, and gravelling. Traffic disruption from these repairs will be temporary and infrequent in nature.

Winter operation activities generally involve snow removal and ice control to reduce traffic disruptions and safety hazards. Snow removal will be accomplished by plow. Road ice will be managed through the application of sand to icy or snow-packed road surfaces, to provide traction.

Growth of vegetation may interfere with the lines of sight required for safe use of the roads. Clearing and trimming along the roadways will be necessary and will part of regular maintenance routines for access roads and may involve both manual and mechanized cutting. There will be no herbicide application for the control of vegetation.

3.4.2.5 Emissions and Wastes

3.4.2.5.1 Air Contaminant Emissions

During Operation, emissions of air contaminants may be released from the following activities:

- fuel combustion in mobile mining equipment;
- fuel combustion in passenger vehicles to and from the site, as well as on-site;
- fuel combustion in trucks bringing in materials and transporting products out;
- dust from drilling and blasting events;
- combustion emissions from detonated explosives;
- dust from loading and unloading of run-of-mine ore;
- dust from the operation of the primary crusher;
- dust from the conveying of crushed ore to the ore processing plant (at material transfer points);
- dust from the movement of vehicles and equipment on unpaved roads;

- dust from wind erosion of the crushed ore stockpile;
- dust from wind erosion of the TSF beaches; and
- air contaminants and odourous compounds from the ore concentrator building and the APT plant.

Emissions inventories for air contaminant and GHG emissions for Operation were developed based on information provided by Northcliff, published emission factors, and engineering judgment, as detailed below.

Emissions of air contaminants and GHGs from the combustion of diesel in heavy mining equipment during Operation were estimated using USEPA NONROAD program (USEPA 2008) based on the list of equipment provided by Northcliff. Indirect emissions of GHGs from electric equipment were estimated using the New Brunswick grid emission factor from the most recent National Inventory Report (Environment Canada 2012d). A list of mining and support equipment for Operation is provided in Table 3.4.18.

Table 3.4.18 Heavy Equipment Used – Operation

Equipment	Number of Units	Horsepower (hp)	Fuel
Electric Drill	2	700	Electric
Blasthole Loader	1	110	Diesel
Hydraulic Shovel	3	1,200	Electric
Bulldozer	1	580	Diesel
Wheeled Bulldozer	1	500	Diesel
Haul Truck	11	1,450	Diesel
Water Truck	1	1,000	Diesel
Bulldozer	3	410	Diesel
Grader	1	300	Diesel
Multi-tool	1	390	Diesel
Excavator	1	380	Diesel
Mobile Screening Plant	1	100	Diesel
Light Plant	4	30	Diesel
Forklift – 10 t	1	150	Diesel
Forklift – 30 t	1	230	Diesel
Fuel/Lube Truck	1	375	Diesel
Jaw Crusher	1	400	Diesel
Warehouse Truck	1	375	Diesel
Mine Rescue Truck	1	375	Diesel
Service Truck	2	375	Diesel
Welding Truck	1	375	Diesel
Picker Truck	1	375	Diesel

In addition to the equipment in Table 3.4.18, it is estimated that there are 8 personnel gasoline vehicles on-site. Emissions from these equipment are included in the estimates of on-site vehicles (below).

The releases of criteria air contaminants (CAC) and greenhouse gases (GHG) are shown in Tables 3.4.19 and 3.4.20.

Table 3.4.19 Criteria Air Contaminant (CAC) Emissions – Fuel Combustion in Mining and Support Equipment – Operation

	Average Annual Emissions (t/a)						
	Carbon Monoxide (CO)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)	Volatile Organic Compounds (VOCs)	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Mining and Support Equipment	104	318	0.29	32.8	20.2	20.2	20.2

Notes:
t/a = tonnes per year.

Table 3.4.20 Greenhouse Gas (GHG) Emissions – Fuel Combustion in Mining and Support Equipment – Operation

	Average Annual Emissions (t/a)			
	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Total Greenhouse Gases (CO_2e)
Mining and Support Equipment	30,867	1.72	12.7	34,852

Notes:
t/a = tonnes per year.
CO_2e = carbon dioxide equivalent.

Indirect GHG emissions from the use of electricity in mobile mining equipment and facility operations are estimated to be 183,600 t CO_2e per year.

Fuel combustion emissions were estimated for passenger vehicles and vehicles transporting materials, equipment, and product. Northcliff provided some information on vehicle movements and Stantec made conservative assumptions for the remainder, including distances travelled. It is assumed that heavy trucks transport the product from the site to the rail siding in Napadogan; from there, the product is transported to port(s) by rail and loaded onto existing trains. Stantec assumed the train transporting product is travelling regardless of whether the Project existed due to existing transportation needs in New Brunswick; therefore emissions from locomotive transportation have not been estimated.

For vehicles, emission factors and default fuel efficiency values from the Transport Canada Urban Transportation Emissions Calculator (Transport Canada 2012) were used to estimate emissions.

The estimated emissions from vehicle travel during Operation are presented in Tables 3.4.21 and 3.4.22.

Table 3.4.21 Criteria Air Contaminant (CAC) Emissions – Vehicle Fuel Combustion – Operation

	Average Annual Emissions (t/a)						
	Carbon Monoxide (CO)	Volatile Organic Compounds (VOCs)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Personnel	17.8	0.86	0.92	0.01	0.03	0.03	0.01
Deliveries	0.30	0.08	1.31	0.01	0.04	0.04	0.03
Total	**18.1**	**0.94**	**2.23**	**0.02**	**0.07**	**0.07**	**0.04**

Assumptions:
- Personnel travel by light duty passenger trucks (100) for 30 days per month. Personnel category includes 8 on-site gasoline vehicles.
- Light duty passenger trucks travel from Napadogan and Nackawic (50:50 split).

Notes:
t/a = tonnes per year.

Table 3.4.22 Greenhouse Gas (GHG) Emissions – Vehicle Fuel Combustion – Operation

	Average Annual Emissions (t/a)			
	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Total Greenhouse Gases (CO_2e)
Personnel (includes on-site traffic)	580	0.04	0.08	605
Deliveries	401	0.02	0.01	405
Total	**981**	**0.06**	**0.09**	**1,010**

Assumptions:
- Personnel travel by light duty passenger trucks (100) for 30 days per month. Personnel category includes 8 on-site gasoline vehicles.
- Light duty passenger trucks travel from Napadogan and Nackawic (50:50 split).

Notes:
t/a = tonnes per year.
CO_2e = carbon dioxide equivalent.

Stationary point sources of air contaminants include the exhaust of the primary crusher, as well as exhaust points from the ore concentrator building and APT plant.

Emissions from the crusher were estimated using the anticipated throughput of material and USEPA emission factors (USEPA 1995b). A dust collector and wet sprays will minimize emissions of dust from Operation; a control efficiency of 95% was applied to account for these controls. The estimated particulate matter emissions from the primary crusher are presented in Table 3.4.23.

Table 3.4.23 Particulate Matter Emissions – Primary Crusher – Operation

	Average Annual Emissions t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Primary Crusher	32.0	3.24	0.49

Notes:
t/a = tonnes per year.

There are exhaust vents equipped with dust collectors on the ore concentrator plant building to collect particulate matter from exhaust air streams and from building ventilation. Each dust collector releases exhaust gases and a negligible amount of particulate matter into the atmosphere. No emissions were therefore estimated from this source.

There are three exhaust points at the APT plant: the H_2S scrubber exhaust, the NH_3 scrubber exhaust, and the package boiler exhaust. The air contaminants released from these exhaust points include combustion gases, H_2S, NH_3, decane, ethylbenzene, naphthalene, tri-isooctylamine (TIA), and particulate matter. Northcliff provided the concentrations of the air contaminants for the H_2S and NH_3 scrubbers. Stantec estimated air contaminant emissions from the combustion of diesel fuel in the package boiler.

The estimated emissions from the H_2S and NH_3 scrubber are provided in Table 3.4.24.

Table 3.4.24 Point Source Emissions – APT Plant – Operation

	Average Annual Emissions (t/a)					
	Hydrogen Sulphide (H_2S)	Ammonia (NH_3)	Decane	Ethylbenzene	Naphthalene	Tri-isooctylamine (TIA)
H_2S Scrubber	1.65	-	42.6	33.8	0.26	0.95
NH_3 Scrubber	-	0.64	42.6	33.8	0.26	0.95

Notes:
t/a = tonnes per year.
- = not released from this source.

The estimated emissions of CACs and selected trace metals from the diesel package boiler are presented in Tables 3.4.25 and 3.4.26, respectively.

Table 3.4.25 Point Source Criteria Air Contaminant (CAC) Emissions – Package Boiler - Operation

	Average Annual Emissions (t/a)						
	Carbon Monoxide (CO)	Volatile Organic Compounds (VOCs)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Package Boiler (Diesel Fuelled)	2.52	0.13	10.1	0.11	1.0	0.65	0.65

Notes:
t/a = tonnes per year.

Table 3.4.26 Point Source Metals Emissions – Package Boiler – Operation

	Average Annual Emissions (kg/a)							
	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Selenium (Se)
Package Boiler (Diesel Fuelled)	0.28	0.21	0.21	0.42	0.64	0.21	0.21	1.1

Notes:
kg/a = kilograms per year.

The estimated emissions of GHGs from the diesel package boiler are presented in Table 3.4.27.

Table 3.4.27 Point Source Greenhouse Gas (GHG) Emissions – Package Boiler – Operation

	Average Annual Emissions (t/a)			
	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Total Greenhouse Gases (CO_2e)
Package Boiler (Diesel Fuelled)	11,296	0.56	1.68	11,829

Notes:
t/a = tonnes per year.
CO_2e = carbon dioxide equivalent.

Prior to blasting, holes are drilled into the rock to place explosive charges. The drilling may generate some dust; however, based on the number of holes drilled per blast (estimated at 40), an estimated density of the rock, and controls by wet drilling, the amount of dust that may be generated is less than 1 kg per year for all blasting events. Therefore, a negligible amount of dust is generated from drilling activities in the quarry and open pit.

Fugitive particulate matter caused by blasting activities during Operation was estimated using an USEPA emission factor (USEPA 1998) and the area of land subjected to a blast. Blasting in the open pit is expected to occur approximately every two days throughout the year (approximately 178 events per year), and blasting in the quarry is expected to occur once per week for three weeks in a year (three events per year). Stantec used the average blast area of 2,150 m^2 per blast to estimate fugitive dust emissions. Particulate matter (PM) emissions from blasting were estimated to be approximately 3.89 tonnes per year. Emissions of PM_{10} and $PM_{2.5}$ were estimated to be approximately 2.02 tonnes per year and 0.12 tonnes per year, respectively.

The detonation of explosives during blasting releases combustion gases into the atmosphere. The releases of these gases based on the amount of explosive, the number of blast events per year, and USEPA emission factors (USEPA 1980). The estimated air contaminant emissions are presented in Table 3.4.28.

Table 3.4.28 Criteria Air Contaminant (CAC) Emissions – Explosive Detonation – Operation

	Average Annual Emissions (t/a)		
	Carbon Monoxide (CO)	Nitrogen Oxides (NO_X)	Sulphur Dioxide (SO_2)
Explosives Detonation	35.1	8.26	1.03

Notes:
t/a = tonnes per year.

During Operation, run-of-mine material is transferred from the pit to the primary crusher and crushed ore is transferred with a conveyor belt onto the crushed ore stockpile. Points in the process where material is transferred are known as transfer points. Fugitive emissions from material handling were estimated based on emission factors and equations from USEPA (USEPA 2006b; 2004; 1995b), and using average wind speed and material moisture content. The estimated emissions are presented in Table 3.4.29.

Table 3.4.29 Particulate Matter Emissions – Material Handling and Transfer Points – Operation

	Average Annual Emissions (t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Loading in Pit	0.32	0.15	0.02
Unloading at Crusher	0.32	0.15	0.02
Loading onto Stockpile	16.3	7.72	1.17
Total	**16.9**	**8.02**	**1.21**

Notes:
t/a = tonnes per year.

The movements of vehicles and equipment on unpaved roads during Operation cause emissions of fugitive particulate matter (PM, PM_{10}, $PM_{2.5}$). The USEPA methodology to estimate emissions is based on silt content of the road material and vehicle tonnage. Northcliff provided information on vehicle and equipment movements, and Stantec made conservative assumptions regarding the silt content and vehicle tonnage. It was assumed that the site access road and internal site roads are watered for dust suppression, and this gives a 80% reduction in dust generation (NIOSH 2012); no dust suppression was assumed for the unpaved forest resource roads (*i.e.,* PSA Route via Nackawic or SSA Route via Napadogan). The estimated fugitive emissions from vehicle activity on unpaved roads are provided in Table 3.4.30.

Table 3.4.30 Particulate Matter from Unpaved Roads – Operation

Operation	Average Annual Emissions (t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Forest Resource Roads (PSA and SSA Routes)	986	261	26.1
Site Access Road and Internal Site Roads	412	109	10.9
Total	**1,397**	**370**	**37.0**

Assumptions:
- On-site roads have a silt content of 8.3% and access roads have a silt content of 10% (default values from USEPA 2006a).
- Heavy mobile equipment is assumed to have a mass of 263 tonnes (290 tons) (upper range from USEPA 2006a).
- Passenger vehicles are conservatively assumed to have a mass of 1.8 tonnes (2 tons) (lower range from USEPA 2006a).
- Water is applied to site roads to control fugitive emissions. An 80% reduction was applied to emissions (NIOSH 2012).
- It is assumed that fugitive emissions will not occur during days with precipitation or snow cover. Based on local weather data, Stantec assumed that 176 days per year will not be capable of generating dust.

Notes:
t/a = tonnes per year.

Topsoil and overburden will be stockpiled periodically throughout Operation as land is cleared for the open pit and quarry. To minimize dust emissions, each pile will be seeded and re-vegetated periodically. Emissions of dust from these sources are therefore considered to be negligible.

During Operation, crushed run-of-mine ore is stockpiled near the ore processing building. As addition of material to the stockpile and reclaiming ore from the stockpile will be frequent, there is potential for dust generation from wind erosion. Stantec estimated hourly particulate matter emissions using wind speed and precipitation data for six years from the Fredericton weather station (Environment Canada 2012c). The steady-state dimensions of the pile were provided by Northcliff. The yearly average emission rates of particulate matter, considering hours with precipitation (with no emissions during precipitation events), are provided in Table 3.4.31.

Table 3.4.31 Particulate Matter Emissions – Crushed Ore Stockpile – Operation

	Average Annual Emissions (t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Crushed Ore Stockpile	0.013	0.012	0.002

Notes:
t/a = tonnes per year.

Fugitive emissions of particulate matter from the TSF beaches may be generated from wind erosion of dry surfaces, on dry windy days. Stantec estimated hourly particulate matter emissions using wind speed and precipitation data for six years from the Fredericton weather station and the area of the TSF beaches. It was assumed that of the total area of the beaches (20 km^2), approximately 1/3 of the beach is active (*i.e.*, wetted by new material addition). The yearly average emission rates of particulate matter, considering hours with precipitation (with no emissions during precipitation events), are provided in Table 3.4.32.

Table 3.4.32 Particulate Matter Emissions – TSF Beaches – Operation

	Average Annual Emissions (t/a)		
	Total Particulate Matter (PM)	Particulate Matter less than 10 µm (PM_{10})	Particulate Matter less than 2.5 µm ($PM_{2.5}$)
TSF Beaches	89.7	1.35E-4	2.02E-5

Notes:
t/a = tonnes per year.

Stantec applied the metal concentrations in the ore to estimate fugitive emissions of specific metals from truck unloading at the crusher, primary crusher operation, material transfer onto the conveyor, material transfer onto the crushed ore stockpile, and stockpile wind erosion fugitive dust. An adjusted breakdown was applied to wind erosion fugitive dust emissions from the TSF beaches; for these, it was assumed that the tailings will not contain any molybdenum or tungsten. The average concentration of trace metals in the ore as supplied by SRK Consulting is provided in Table 3.4.33.

Table 3.4.33 Average Trace Metals Concentration in the Ore

Metal	Units	Value (Average)
Aluminium (Al)	%	1.8
Arsenic (As)	mg/kg	41
Boron (B)	mg/kg	<20
Cadmium (Cd)	mg/kg	1
Cobalt (Co)	mg/kg	13
Total Chromium (Cr)	mg/kg	67
Copper (Cu)	mg/kg	180
Lead (Pb)	mg/kg	45
Lithium (Li)	mg/kg	43
Manganese (Mn)	mg/kg	720
Total Mercury (Hg)	mg/kg	0.01
Molybdenum (Mo)	mg/kg	300
Nickel (Ni)	mg/kg	20

Table 3.4.33 Average Trace Metals Concentration in the Ore

Metal	Units	Value (Average)
Selenium (Se)	mg/kg	0.8
Thallium (Tl)	mg/kg	0.97
Tungsten (W)	mg/kg	530
Uranium (U)	mg/kg	2.8
Vanadium (V)	mg/kg	80
Zinc (Zn)	mg/kg	150

3.4.2.5.2 Sound and Vibration Emissions

To estimate emissions of sound during Operation, Stantec developed a sound emissions inventory for based on the Project activities. The sources of sound included in the inventory are:

- operation of heavy mining equipment;
- transportation of personnel, material, and product;
- crushing/processing equipment; and
- intermittent drilling and blasting activities.

Similar to Construction, Stantec estimated sound emissions from heavy equipment and drilling activities based on publically available literature (FHWA 2006).

The activity data and sound power levels associated with Operation are presented in Table 3.4.34.

Table 3.4.34 Sound Inventory – Operation

Equipment Type	Number of Units	Sound Pressure Level (dB_A) at 15 m	Sound Power Level (dB_A)
Electric Drill	2	81	112
Blasthole Loader	1	79	110
Hydraulic Shovel	3	79	110
Bulldozer (580 hp)	1	82	113
Wheeled Bulldozer	1	82	113
Haul Truck	11	76	107
Water Truck	1	75	106
Bulldozer (410 hp)	3	82	113
Grader	1	85	116
Multi-tool	1	74	105
Excavator	1	81	112
Mobile Screening Plant	1	87	118
Light Plant	4	81	112
Forklift – 10 t	1	75	106
Forklift – 30 t	1	75	106
Fuel/Lube Truck	1	75	106

Primary crushing equipment is located within a three-sided structure to reduce noise. Rock is dumped into the crushing equipment by haul trucks. Northcliff provided sound measurements for the operation of a similar crusher at the Gibraltar Mine in British Columbia; the maximum measured sound pressure level was 85 dB_A at 15 m while a haul truck was dumping ore.

The sound power level associated with the conveyor belt was calculated from the maximum measured sound pressure level for a similar conveyor belt at the Gibraltar Mine in British Columbia. The measured sound pressure level was 70 dB_A at 15 m.

The ore processing plant is enclosed to protect the equipment from the weather. Northcliff provided sound measurements for the operation of a similar ore processing facility at the Gibraltar Mine in British Columbia; the maximum measured sound pressure level was 74 dB_A at 15 m.

The contribution of the movement of on-site light duty truck traffic is assumed to be negligible in comparison with heavy equipment operation on-site. There will be sound emissions from transportation vehicles on the site access road and internal site roads. The number and types of transportation vehicles accessing the site on a daily basis was provided by Northcliff, based on the planned activities. The traffic information entered into the model is provided in Table 3.4.35.

Table 3.4.35 Project Traffic – Operation

Vehicle Type	Vehicles per Hour	Starting Point
Heavy Trucks	2	Through Napadogan
Passenger Trucks/Vehicles	15	Through Napadogan

Notes:
For modelling of traffic noise the change through Napadogan was the focus as this represents the largest change from existing traffic. 15 vehicles through Napadogan based on estimate of 60 per day from Route 8 to SSA, with 4 peak hours per day assumed (shift changes).

The main sources of vibration during Operation are the movement of the loaded trucks from the pit to the crushing equipment and the crushing equipment itself. Similar to the assessment of vibration from construction equipment, reference PPVs from loaded trucks were found and are provided in Table 3.4.11 (above).

3.4.2.5.3 Treated Surplus Water Release

As discussed in Section 3.4.2.3.4, all non-contact water will be diverted away from the Project site, and all mine contact water within the PDA will be collected in the TSF. Starting in approximately Year 8 of Operation, and as discussed in Section 3.4.2.3.7 above, surplus water from the TSF will be treated as necessary, and monitored, to ensure acceptable water quality, and released to the former Sisson Brook channel. In the remainder of this EIA Report, this surplus water treatment and release during Operation is assessed under the activity “Mine Waste and Water Management”, to avoid duplication.

Liquid wastes (containing suspended solids) from the ore processing will be minimized by recycling reagents and water wherever feasible. Sumps in each process area are fed back into the process where feasible or directed to the TSF for settling and reuse of water. Liquids and slurries that cannot be reasonably recycled back into the process will be safely stored in the TSF with pond water being recirculated to the ore processing plant.

3.4.2.5.4 Mining Waste Disposal

As discussed in Sections 3.4.2.3.2 and 3.4.3.2.3, tailings and waste rock from the Operation of the Project will be stored permanently in the TSF, as previously described. PAG waste rock (and tailings) will be stored subaqueously to effectively inhibit the potential generation of acid and metal leaching. This avoids the potential for ML/ARD from the waste rock if stored in land-based piles. In the remainder of this EIA Report, the disposal of tailings and waste rock in the TSF during Operation is assessed under the activity “Mine Waste and Water Management”, to avoid duplication.

The process of refining tungsten concentrate to ammonium paratungstate (APT) is summarized above in Section 3.4.2.2.3 and in Figure 3.4.8. This process generates two waste streams that will be disposed of within the TSF:

1. The first waste stream is undigested residue from the concentrate digestion process. It is generated as a filter cake (about 25% water, by weight), containing calcium hydroxide with trace minerals and oxides, at a rate of approximately 68 tonnes/day.

2. The second waste stream is raffinate[2] generated during the solvent extraction process that converts sodium tungstate to ammonium tungstate. The raffinate consists of 10% to 15% sodium sulfate in a sulphuric acid solution with minor concentrations of molybdenum, silicates and aluminum, and likely some trace metals. The raffinate will be mixed with lime and pH adjusted in an agitation tank, and will then be passed through a crystallizer to remove the metals and other constituents as a dry product at a rate of approximately 0.8 tonnes per day. The product is primarily sodium sulphate, with minor components of calcium sulphate (gypsum) and trace metals.

These two waste streams cannot be stored directly in the TSF because their effects on TSF water quality would reduce the ore concentrator efficiency (*e.g.*, calcium ions would adversely affect tungsten flotation recoveries) and seepage water quality (notably regarding sodium and sulphate). Therefore, they will be placed in storage cells within the TSF basin, but above the active TSF pond level during Operation. The cells will be double-lined with HDPE, and also equipped with a leak detection and recovery system, to ensure they will not leak to the TSF during Operation. During Operation, precipitation recovered from an open cell will be pumped to treatment before reuse or discharge. Fences or other suitable safety measures will be used as needed to limit access by people or animals to the cells during Operation.

Over the life of the Project, there may be up to six of these cells, staged consecutively from the northwest to the northeast of the plant site between the elevations of approximately 335 masl and 370 masl within the TSF. Only three cells are required to contain the estimated volume of solids described above: 400,000 m^3, 300,000 m^3 and 650,000 m^3 for Cells 1, 2 and 3, respectively. Figures 3.4.11 through 3.4.13 below depict the cells at the end of each period. Additional cells have been considered as a contingency measure in the event that the actual quantity or density of the wastes varies from the current estimate.

2 In solvent extraction, a “raffinate” is the liquid stream which remains after solutes from the original liquid are removed through contact with an immiscible liquid.

Cell 1 will be built and operated first (Figure 3.4.11) and, as it fills and the level of tailings, waste rock and water rises in the TSF, it will be capped and closed and Cell 2 will go into operation at a higher elevation (Figure 3.4.12). Similarly, Cell 2 will be operated, closed and superseded by Cell 3 at a higher elevation (Figure 3.4.13). The crest elevation of the Cell 3 embankments will be about 370 masl; at Closure the TSF pond elevation is at about 376 masl, so Cell 3 will be submerged under about 6 m of tailings and water.

The solids stored in each cell will be allowed to consolidate to the extent possible prior to closure of the cell. Methods that may be used to enhance consolidation include allowing the solids to air dry during the dry summer months prior to closure, or the use of wick drains and strip drains. Closure of a cell will involve capping it with a HDPE top liner before it becomes encapsulated by tailings within the TSF.

Once the cells are encapsulated within the TSF, it is highly unlikely that pore water in the tailings would interact with the material in the cells. The HDPE top and bottom liners present a very low permeability barrier to groundwater flow; therefore, seepage between the TSF and the groundwater beneath it would flow preferentially around the cells, rather than through them. Furthermore, when the cells are closed and encapsulated, the groundwater conditions within the TSF will be such that seepage into or out of the cells is improbable.

The size, number and location of the cells will be confirmed during the Basic and Detailed Engineering design phases of the Project.

The cells will be designed to be stable, self-contained structures within the TSF, and gradually covered with tailings, so that their contents are securely isolated. Thus, in the highly unlikely event of a failure of TSF containment, the cells and their contents would remain intact.

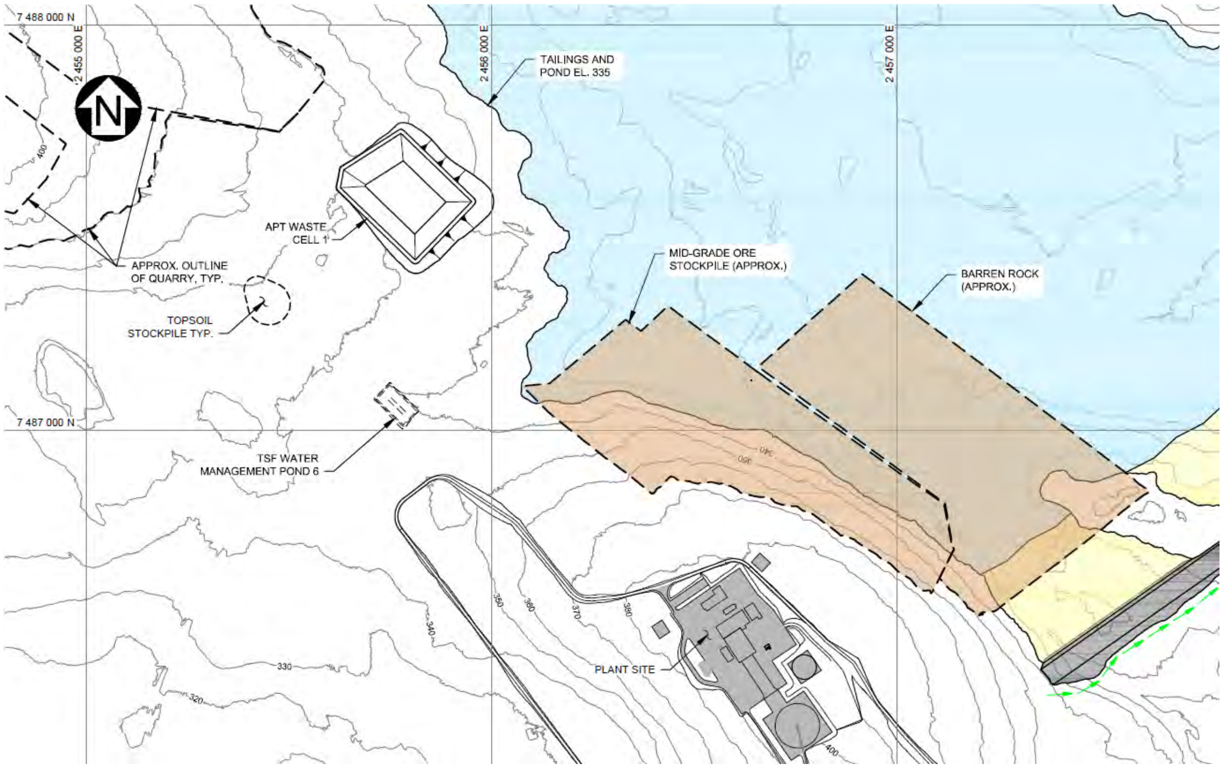


Figure 3.4.11 APT Waste Cell 1 – Years 1 to 8

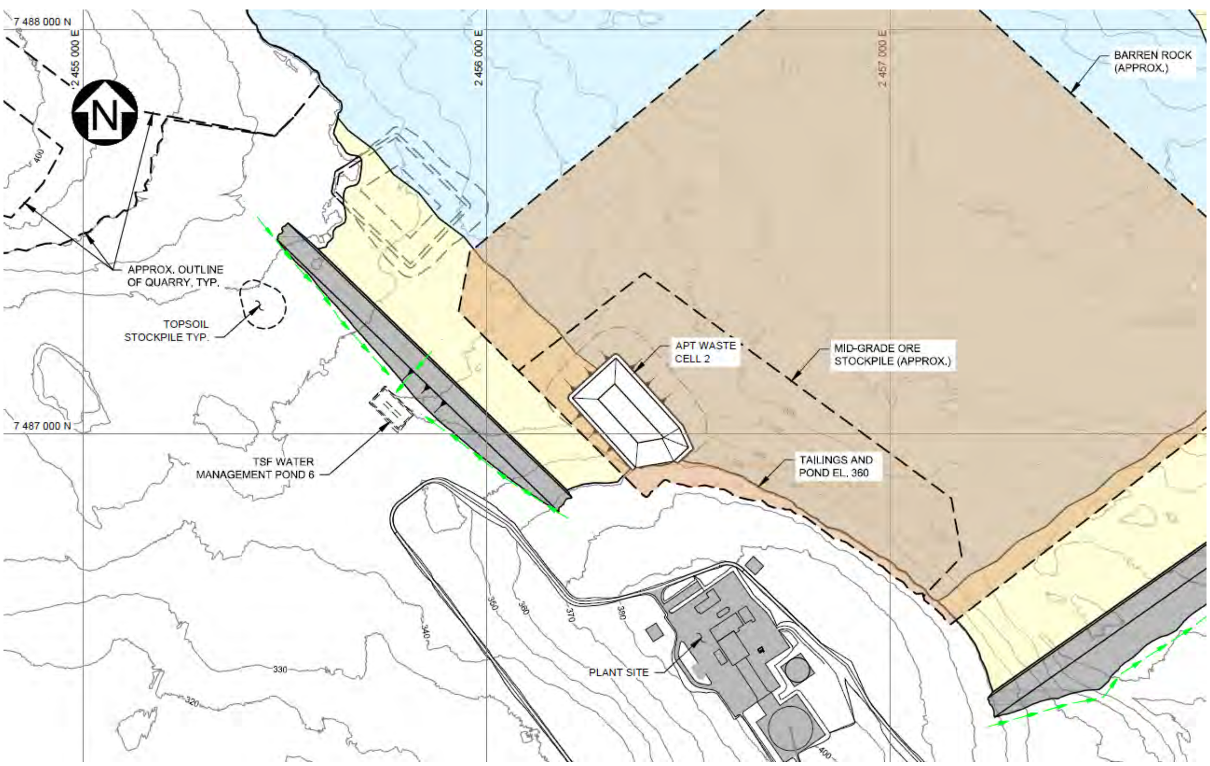


Figure 3.4.12 APT Waste Cell 2 – Years 9 to 14

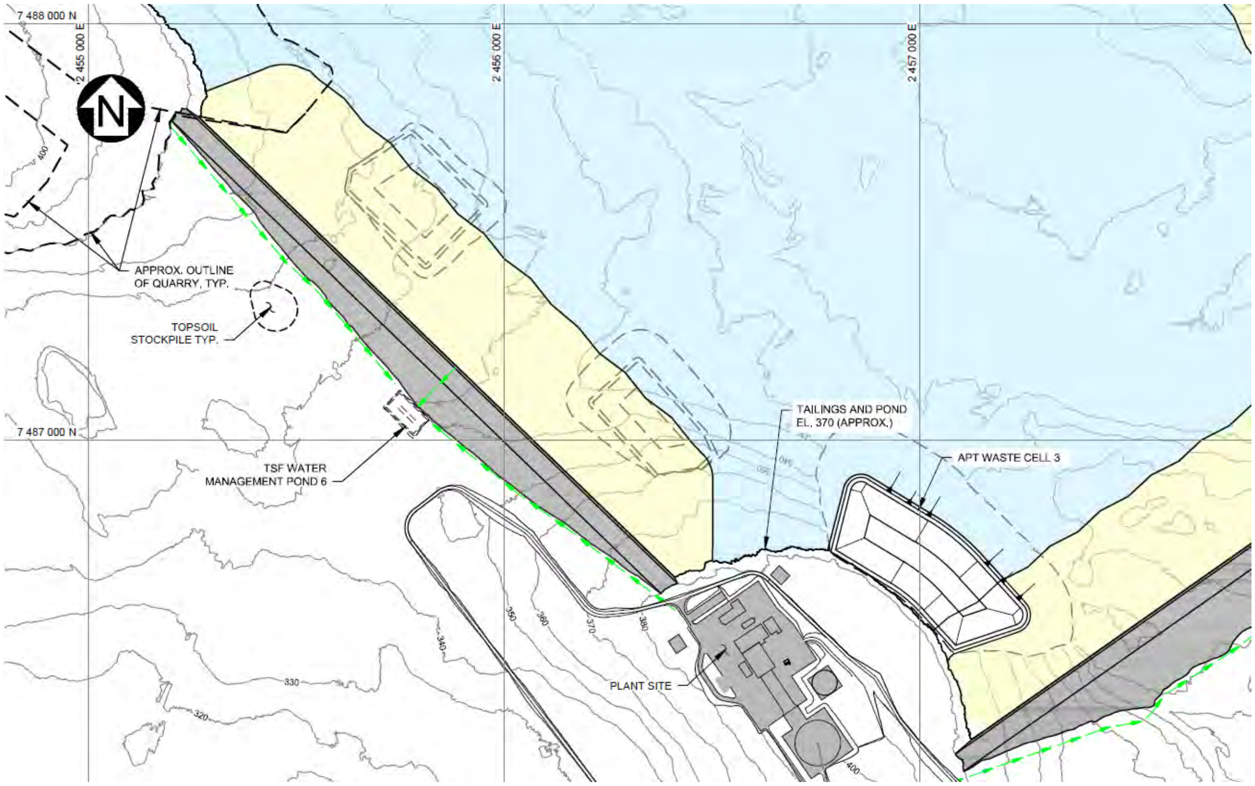


Figure 3.4.13 APT Waste Cell 3 – Years 15 to 27

3.4.2.5.5 Non-Mining Solid Waste Disposal

Non-mining waste refers to wastes generated beyond the open pit mining operation including in the ore processing plant (concentration and APT processes) as well as other site buildings (such as the administration and maintenance buildings). SML will re-use or recycle waste materials where possible, and dispose of other wastes at approved facilities.

3.4.2.6 Transportation

Once commissioning activities are completed, the Project Operation and the traffic generated will be fairly uniform. Estimates of the truck trips per month have been broken down by inbound shipments of production input materials and outbound product, as well as various services used during the Operation phase. The estimated daily average number of mine workers that will be employed in the Project Operation will drive into the site in their own vehicles.

Road traffic generated during the Operation phase of the Project will be comprised of:

- Passenger vehicles (mine workers' automobiles, SUVs, vans and pick-ups); and
- Trucks (for transport of inbound shipments of production input materials and outbound product, and various services for mine operations).

Truck traffic generated by the Project during its Operation will travel over segments of the public Provincial highway network and PSA/SSA Routes within the Project area to the site access road.

The Operation phase traffic generated by the Project will accumulate as it approaches the Project site. All Project generated traffic volumes were converted to one-way daily (ADT) volumes to correspond with the existing AADT traffic. A summary of the average daily traffic that will be generated during Operation of the Project is presented in Table 3.4.36.

Table 3.4.36 Average Daily Traffic (ADT) Generated During Operation

Traffic Components	Round Trips per day	Average Daily Traffic (ADT) (one-way)
Vehicles To/From Project Site		
Trucks (at highest month of Project Operation activity to site)	14	28
Mine Workers' Autos (direct to site, two per vehicle)	100	200
Total	**114**	**228**

Source: exp Services Inc. (2013a; 2013b).

The Project-generated traffic volumes reflect the maximum volumes generated at the site once the mining operation is at its full level of activity, and a steady state mining operation will continue from that point forward at this average daily traffic generation level. The additional traffic volumes predicted to be generated by the Project operation total 228 ADT.

3.4.2.7 Employment and Expenditure

Mining operations will require various types of workers on-site, including but not limited to management personnel, heavy equipment operators, contractors, process operators, and maintenance personnel. It is expected that the Project will generate direct employment for up to 300 workers during the Operation phase of the Project, generally split between two 12-hour shifts per day.

Table 3.4.37 shows the total operating expenditures by main component of the Project over its life. At present, the projected expenditures for the Operation phase total $4.09 billion, including $3.9 billion in operating expenditures and $195.8 million in sustaining capital, over the life of the Project.

Table 3.4.37 Total Operating Expenditures

Component	Total Operating Expenditures	
	Millions of Canadian dollars	% of total expenditure
Milling	$2,001.3	48.9%
Mining	$1,168.1	28.5%
APT Plant	$428.3	10.5%
Tailings	$167.1	4.1%
Administration	$132.3	3.2%
Sustaining Capital	$195.8	4.8%
Total (millions, CAD$)	**$4,092.9**	**100.0%**

Source: EcoTec (2013).

Table 3.4.38 shows the expected breakdown of expenditures by year.

Table 3.4.38 Operating Expenditures by Year

Year during Operation Phase	Annual Operating Expenditures (Millions of Canadian dollars)	Year during Operation Phase	Annual Operating Expenditures (Millions of Canadian dollars)
1	$152.9	15	$159.6
2	$157.0	16	$161.5
3	$147.1	17	$151.4
4	$149.0	18	$155.3
5	$152.8	19	$155.1
6	$152.7	20	$153.4
7	$152.1	21	$162.2
8	$150.8	22	$149.8
9	$150.4	23	$148.1
10	$164.0	24	$147.6
11	$159.3	25	$142.9
12	$155.3	26	$138.5
13	$151.1	27	$126.5
14	$146.6		
Total			**$4,092.9**

Source: EcoTec (2013).

3.4.3 Decommissioning, Reclamation and Closure

The Decommissioning, Reclamation and Closure phase extends from completion of mining and ore processing activities during Operation to Post-Closure of the facilities. Activities in this phase will be focused on the decommissioning, land reclamation, and closure of the Project site. All mining facilities not needed post-Operation will be decommissioned at the end of the Project Operation, and the mine site will be restored to meet desired end land uses and as required under provincial and federal legislation and regulations.

In general, all facilities, buildings and other infrastructure will be removed and the sites reclaimed except for those that will be used for ongoing care and maintenance of the site (*e.g.,* water treatment, TSF inspections). The water management system will be reconfigured as needed to ensure the long-term stability of the site. The TSF embankments and beaches will be capped and re-vegetated, and a spillway will direct run-off to the open pit. The open pit is estimate to take approximately 12 years to fill during Closure, between Years 28-39. Once the pit is completely full (at approximately Year 40), Post-Closure begins and water (treated, if necessary, until it meets regulatory requirements) will discharge to the former Sisson Brook channel.

A description of the current plans for Decommissioning, Reclamation and Closure of the Project is provided in the document entitled “Sisson Project: Conceptual Decommissioning, Reclamation, and Closure Plan” (EvEco 2013) prepared for SML. These Plans are based on best professional judgment regarding the desired end land uses of the site as conceived at this time. These end land uses will need to be discussed and confirmed by the Government of New Brunswick in consultation with stakeholders, First Nations, and other interested parties, at the appropriate time over the life of the Project. Further reclamation information is presented in Section 3.4.3.6 and Appendix H.

3.4.3.1 Site Description at Closure

The site will include the following elements at Closure:

- the open pit will be flooded to create an aquatic feature;
- permanent submersion of waste rock within the TSF and at the bottom of the open pit;
- TSF embankments and beaches will be undergoing re-vegetation with suitable species to provide forested, wetland, and open water habitats suitable for wildlife;
- engineered channels connecting the quarry to the TSF pond, and the TSF pond to the open pit to manage the collection, treatment if necessary, and discharge of on-site water to the environment;
- disturbed areas around the open pit, TSF, the former ore processing plant area, and most of the plant site will be decommissioned and reclaimed to forested, wetland and shrub-riparian habitats primarily suitable for wildlife use with potential for traditional, recreational and commercial forestry use;
- appropriate surface and groundwater drainages from the site and the ongoing restoration of constructed drainages to open water will be established, with shrub-riparian and aquatic habitats suitable for use by wildlife and fish; and
- site buildings, equipment, roads and power supply needed for care and maintenance of the site after operations cease.

The general strategies for Decommissioning, Reclamation and Closure are to:

- decommission and remove all buildings, equipment and infrastructure not required for future care and maintenance of the site;
- stabilize terrestrial and aquatic environments;
- remediate disturbed areas using passive natural systems;
- recreate a natural environment dominated by native vegetation;
- restore visual aesthetics; and
- restore land use potential and possibly create new opportunities.

3.4.3.2 Activities during Decommissioning, Reclamation and Closure

In the short-term and conceptually, Reclamation and Closure activities will focus on site restoration (*i.e.,* beginning the process of re-establishing existing vegetation communities) as much as rehabilitation (*i.e.,* re-establishing ecosystem processes and capability). The short-term objective will be to establish a stable growing medium to support pioneer vegetative species as soon as possible.

Activities will include removing buildings, equipment and unneeded roads, preparing new landforms and covering them with overburden and soil, ensuring stable site drainage, and planting prepared areas with native plant species. New channels to direct run-off from the quarry and TSF into the open pit to accelerate its filling will also be constructed at this time.

3.4.3.2.1 Decommissioning

Most of the site infrastructure will be decommissioned and removed. Plant site buildings and equipment no longer required include the primary ore crusher, ore concentrator, APT plant, the SME process facility, conveyors, warehouse, truck service bays, the laboratory and the vehicle fueling stations. The administration office and its fresh water supply and sanitation system, the site water management and treatment system, and one or two small buildings for housing equipment or supplies will be retained until no longer needed. All of the removable assets, which include everything except the buildings, will be removed and sold or disposed of prior to or concurrent with their dismantling.

All access roads, power supplies, sanitation infrastructure, fresh water supplies, water management structures, and other utilities, will be decommissioned unless required for care and maintenance of the site during Closure and Post-Closure. All on-site power supplies and utility poles no longer needed will be decommissioned and removed from the site to approved off-site facilities. The main electrical transmission line supplying power to the site will be retained until the site is fully reclaimed, capability goals for each end land use objective have been achieved, and water resources have been restored to sustainable levels. At this point, this line may also be decommissioned and reclaimed. The electrical transmission line will remain the property of NB Power who will be responsible for planning and executing any decommissioning and subsequent reclamation activities of all aspects of the electrical transmission line.

Sanitation infrastructure and fresh water supplies not required for post-Operation work will be decommissioned. Above-ground structures, pumps, and pipes will be removed, sold or recycled to an approved off-site facility. All below-ground structures will remain in place and reclaimed as part of the plant site reclamation.

Following removal of the assets, most buildings will be either dismantled for re-use at another site or cut into pieces and sold or recycled as steel scrap. Foundations will be broken or blasted down to or below ground level, where possible, and then backfilled to create natural-looking landforms. Other surplus materials (*e.g.,* sheet metal, insulation, roofing material, and other waste industrial construction materials) will be recycled or disposed of at an approved off-site facility. Chemicals, waste products and potentially hazardous materials will be disposed of according to local requirements.

During the decommissioning work, an investigation will be conducted to determine the presence, if any, of contamination from accidental spills and long-term use of hazardous materials. Any incidents identified will be remediated according to practices approved by NBDELG.

3.4.3.2.2 Reclamation

Reclamation will involve the restoration of the Project site to as near natural conditions as possible. In general, disturbed areas of the site including the former ore processing plant areas and other active areas of the site will be graded and shaped. Slopes will be graded to merge naturally into adjacent undisturbed areas. Grading may include decommissioning ditches and other water management structures that are no longer needed, or enhancing them to provide natural swales for channelling surface water into nearby watercourses. Former building sites, foundations and laydown areas will be capped with overburden.

It will not be possible to reclaim the open pit other than as an open-water landscape feature once a pit lake with acceptable water quality has been established Post-Closure. There are no reclamation options for the bare rock faces that will not require intensive intervention and the potential benefits likely outweigh the level of effort given safety concerns and that success will be uncertain. The benches that may remain exposed above the pit lake level will likely be subject to wide temporal and spatial variability in moisture availability, depending on run-off from surrounding slopes, seepages from surrounding pit walls, and seasonal changes. The focus for reclamation will therefore be to encourage natural re-vegetation, with limited intervention. Over time, some natural habitats will emerge, such as rock outcrop on the pit rim and walls, possibly wetland habitat on shallow, submerged rock terraces, and upland forest in areas surrounding the pit. The main end land use objectives for the open pit will thus be open water feature with some use by terrestrial wildlife such as birds, waterfowl, amphibians, reptiles and small mammals. Large mammals will be excluded from the pit rim by security fencing.

Specifically for the TSF embankments and exposed TSF beaches, reclamation may include the following.

- The open water of the TSF pond will be an aquatic feature, used for resting and escape terrain by waterfowl.

- The beaches adjacent to the open water will be flat to gently sloping shorelines, reclaimed as shrub-riparian or open water wetland to provide forage, cover and nesting habitat for waterfowl and shorebirds.

- The top of the TSF embankment will be maintained as an access road.

- The downstream slopes of the TSF embankments may be reclaimed to grassland and forest cover of varying composition depending on aspect and moisture regime. Upper and south-facing slopes of the embankments will likely be subject to summer drought, so may be reclaimed to an upland forest habitat such as tolerant hardwood or intolerant hardwood habitats. The lower and north-facing slopes may be wetter, so may be reclaimed to spruce-balsam fir or rich softwood habitats. Areas subject to surface erosion may need to be treated with coarse quarry rock, and thus remain exposed as rock outcrop.

Although reclamation of the TSF will focus on forested habitats, the end land use objective will remain primarily wildlife use by mammals, birds, reptiles, amphibians and insects. Commercial forestry use will be discouraged because the TSF is an engineered facility unsuited to logging activity. Over the long term, some of the reclaimed footprint may become suitable for traditional or recreational end land uses.

Exposed areas will be re-vegetated in accordance with the end land use objectives for upland and wetland forests. Areas will be hydroseeded to help accelerate the establishment of a vegetative cover. Hydroseed mixes should include species that are tolerant of drought and infertile conditions, with an emphasis on native species. Although this type of seed blend may not be appropriate to wetter areas, wetter areas can be expected to naturally re-vegetate to full cover within approximately three years.

Once the areas are stable, native shrubs and trees such as speckled alder, grey birch, trembling aspen, and pin cherry will quickly invade within two decades. Except for the area of the TSF within which commercial forestry will be discouraged, spot planting of black spruce, balsam fir, hardwoods or other locally occurring commercial tree species may be appropriate on sites where adequate moisture and mineral soil is present. Where commercial forestry is agreed as an end land use objective in the final, approved Decommissioning, Reclamation and Closure Plan, reforestation of the PDA for future commercial forestry will be undertaken.

3.4.3.2.3 Closure

During Closure, the non-contact surface water diversion channels outside the PDA will be maintained. Engineered channels will be established between the quarry and the TSF, and between the TSF and the open pit, to direct run-off to the open pit and accelerate its filling with water.

The water management ponds around the TSF will be maintained to collect TSF embankment run-off and seepage, and to pump it to the TSF until it becomes of sufficient quality to allow its discharge into downstream drainages.

The open pit will take up to about 12 years to fill (approximately Years 28-39), and until it does there will be no discharge of mine contact water from the site, with the possible exception of water within the water management ponds as just discussed. The open pit will be allowed to fill to an elevation that ensures it is a groundwater sink (*i.e.,* groundwater around the pit will only flow into it); this elevation will be maintained by pumping the lake water to a reactivated or new water treatment plant. Filling of the open pit to this elevation will mark the end of the Closure period and the beginning of Post-Closure.

The Site will include the following elements at Closure:

- the open pit that will be flooded to create an aquatic feature;
- permanent submersion of barren rock and mid-grade ore within the TSF and at the bottom of the open pit;
- TSF embankments and beaches that will be undergoing re-vegetation with suitable species to provide forested, wetland, and open water habitats suitable for wildlife;
- engineered channels connecting the quarry to the tailings pond and the tailings pond to the open pit, to manage the collection, treatment and discharge, as necessary, of on-site water;
- disturbed areas around the open pit, TSF, the former ore processing area (*i.e*., primary crusher), and most of the plant site that will be decommissioned and reclaimed to forested, wetland and/or shrub-riparian habitats primarily suitable for wildlife use with potential for traditional, recreational and commercial forestry use;

- appropriate surface and groundwater drainages in and around the site and the ongoing restoration of all surrounding watercourses to open water, shrub-riparian and aquatic habitats suitable for use by wildlife and fish; and
- site buildings, equipment, roads and power supply needed for care and maintenance of the site after Operations cease.

The conceptual closure and reclamation plan that would be implemented at various stages of the mine development is presented on Figure 3.4.14 to Figure 3.4.17. The plan has been divided into the following areas:

- TSF Reclamation;
- Open Pit Reclamation;
- Barren Rock and Mid-Grade Ore Reclamation;
- Decommissioning of Mine Site Infrastructure; and
- Ongoing Post-Closure Monitoring and Reclamation.

A description of the scope of work for each of the areas is presented below.

TSF Reclamation

- Selective discharge of tailings around the TSF during the final years of plant operations to establish a final tailings beach that will facilitate surface water management and reclamation. A surface pond will be maintained at the centre of the TSF.
- Tailings beaches will be capped with a layer of barren rock and topsoil from the topsoil stockpiles.
- Swales will be excavated in the beaches to make the grade less uniform and promote drainage. The beaches will then be hydroseeded and planted with appropriate vegetation.
- Downstream tailings embankment slopes will be capped with a layer of topsoil and hydroseeded, wherever possible.
- Removal of surface water diversion channels and access roads not required for long term monitoring.
- Construction of a permanent outlet channel and spillway from the TSF to the open pit. The TSF and surface pond will be designed to attenuate storm inflows to minimize the magnitude of spillway discharge flows and hence the size of the outlet channel.

- Removal of the water management ponds and collection systems at such time that suitable water quality for direct release is achieved.

Open Pit Reclamation

- A perimeter fence will be installed around the open pit.
- The pit will fill naturally with groundwater, precipitation and TSF discharge.
- Construction of a permanent outlet channel and spillway from the open pit to Sisson Brook.
- Open pit discharge will require water treatment prior to downstream release.

Barren Rock and Mid-Grade Ore Reclamation

- Re-grading of the barren rock dump and mid-grade ore stockpile within the TSF to ensure permanent submersion below the final TSF elevation to mitigate potential onset of acid generation.

Decommissioning of Mine Site Infrastructure

- Decommissioning and removal of all surface facilities and buildings.
- Building materials, pipelines, pumps, electrical equipment, septic systems, and machinery will be trucked to the nearest acceptable disposal facility and/or will be sold (if possible).
- Concrete foundations will be demolished and buried on site.

Ongoing Post-Closure Monitoring and Reclamation

Certain aspects of the Reclamation Plan will require an ongoing commitment beyond the initial closure and active reclamation period. This generally includes engineering support, reclamation and water quality monitoring, and site maintenance.

Specific activities for the Site will include:

- maintenance of electrical infrastructure to ensure available power for needed Site equipment;
- maintenance of geotechnical instrumentation for long-term monitoring of the stability of the TSF;
- operation of the water treatment facility, as needed, to treat all surplus site water for discharge to ensure it will meet the Project's permit conditions for discharge water quality;
- upkeep of water management infrastructure as needed, including ditches, engineered channels, WMPs, and groundwater monitoring and pump-back wells, to monitor, capture and pump runoff and seepage, if any, back to the TSF;

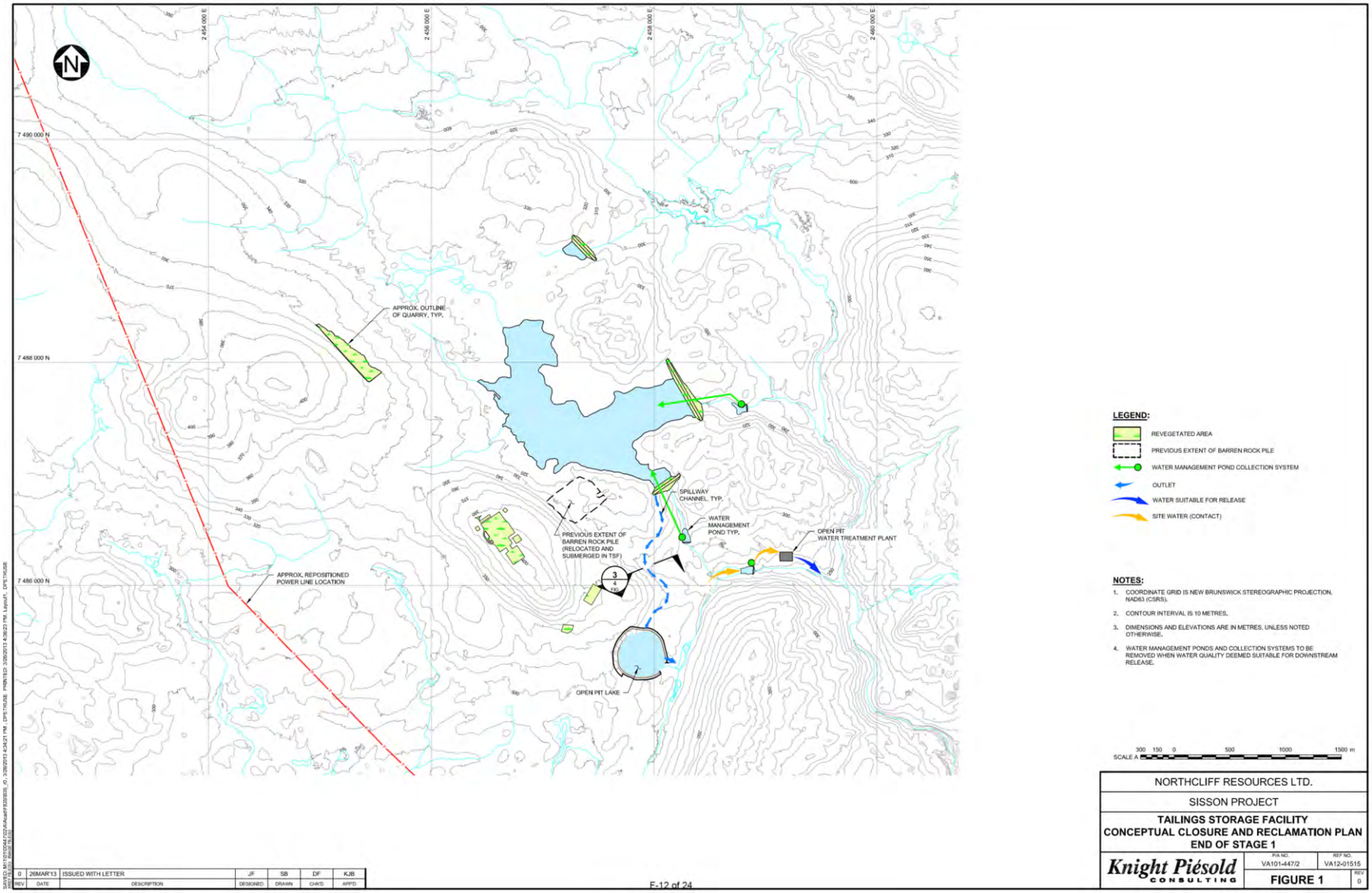


Figure 3.4.14 Conceptual Closure and Reclamation Plan - End of Stage 1

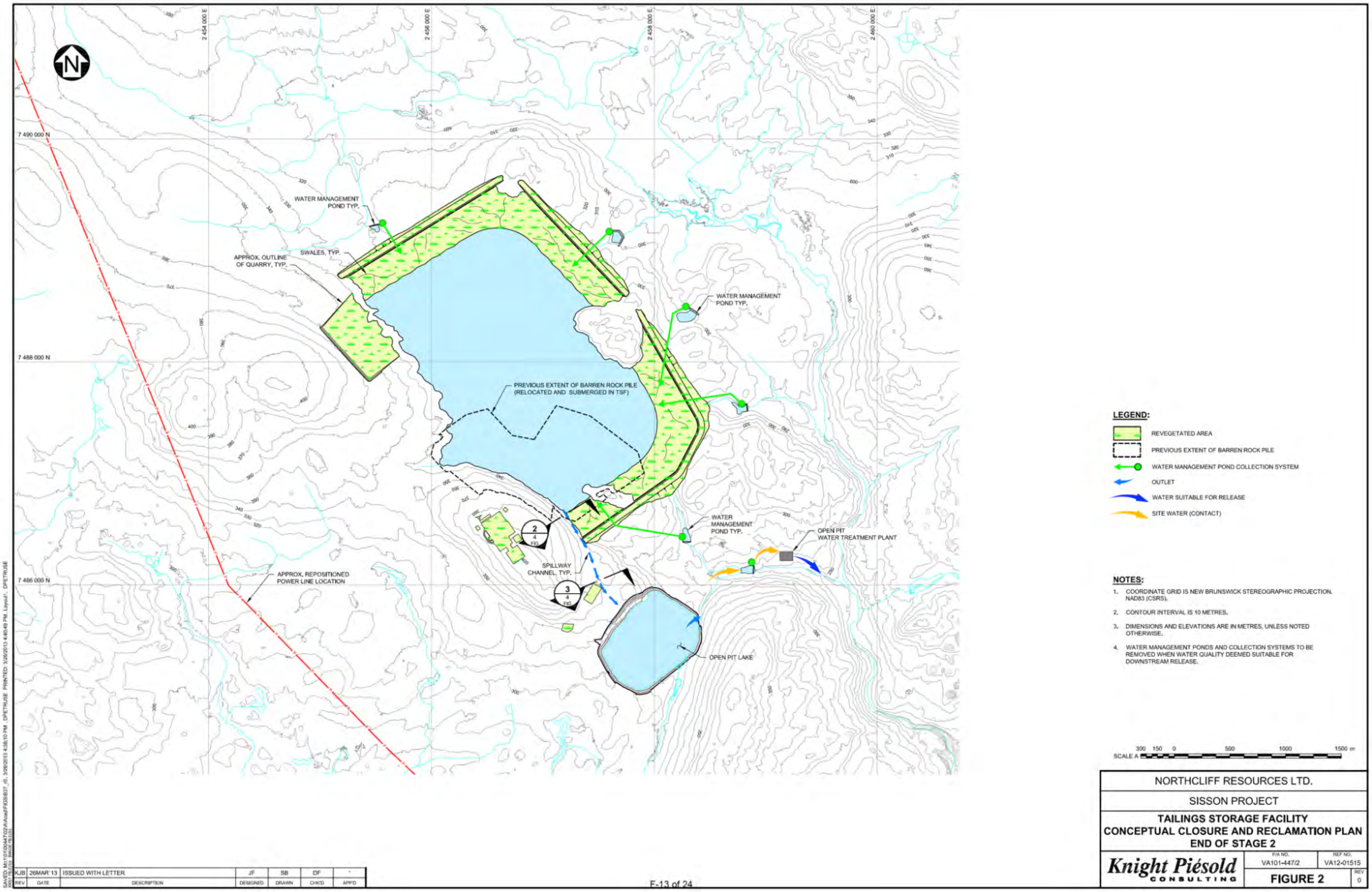


Figure 3.4.15 Conceptual Closure and Reclamation Plan - End of Stage 2

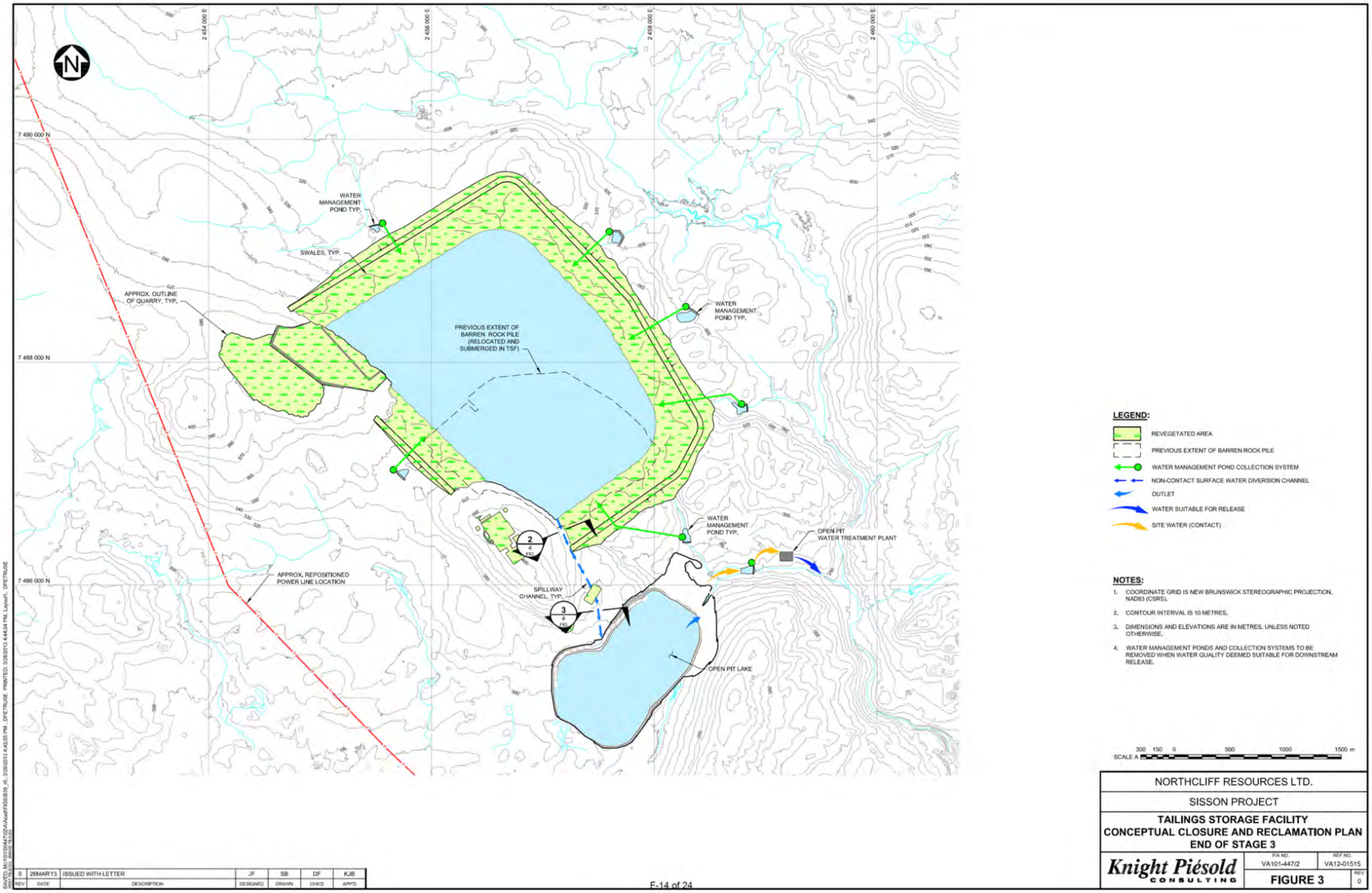


Figure 3.4.16 Conceptual Closure and Reclamation Plan - End of Stage 3

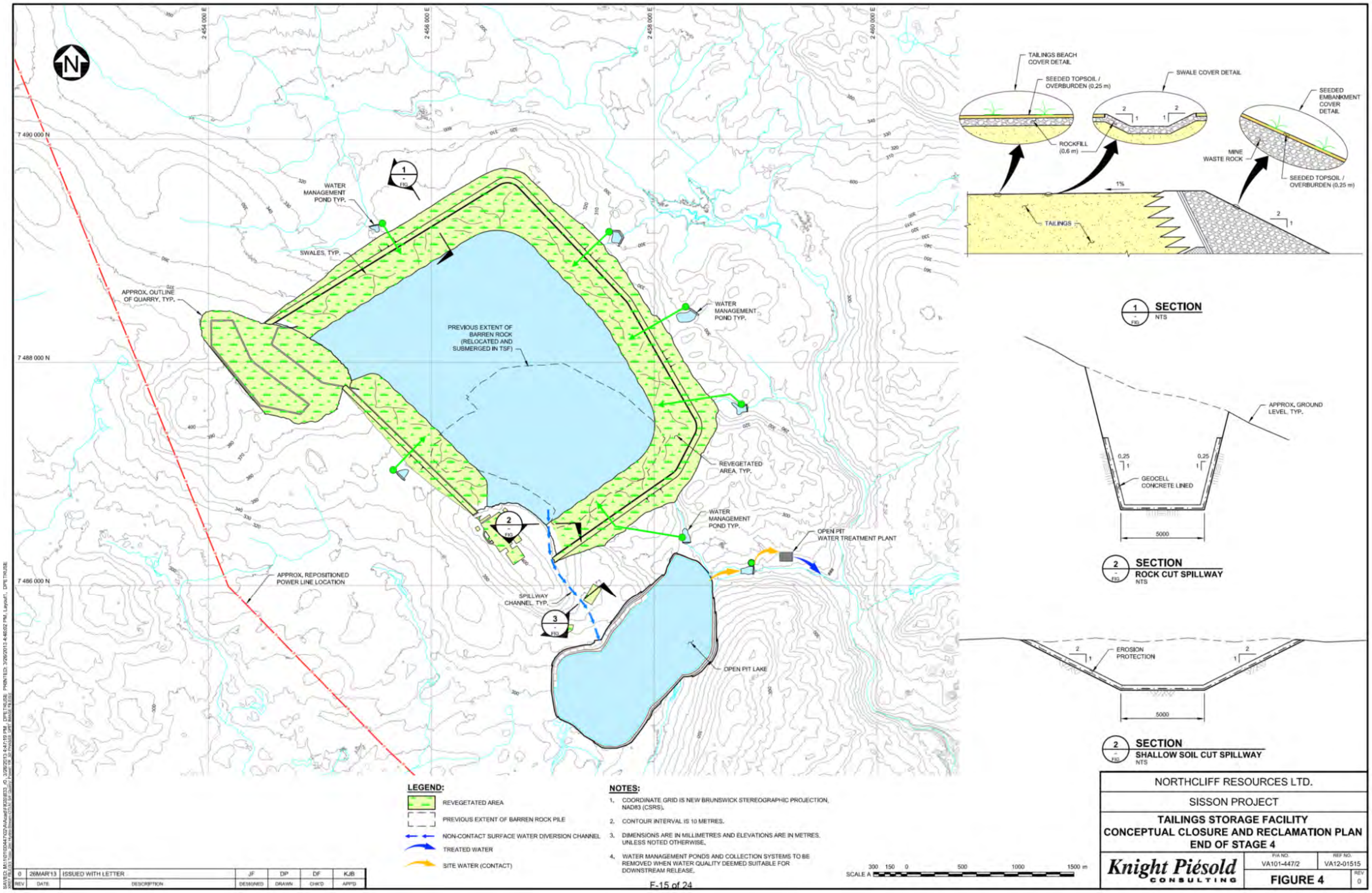


Figure 3.4.17 Conceptual Closure and Reclamation Plan - End of Stage 4

- water quality monitoring around the Site to support the effective collection and treatment of water, as required, before discharge to nearby watercourses; and
- upkeep of site roads and buildings that are kept active to support ongoing inspection, monitoring, and maintenance.

3.4.3.2.4 Post-Closure

Post-Closure (starting when the open pit is completely full, estimated to be about Year 40), all contact water that needs to be discharged will be treated for as long as is necessary to meet discharge permit conditions, as described above during the Closure period. When the pit lake water quality becomes of sufficient quality to allow its discharge into downstream drainages, it will be allowed to fill and discharge to the former Sisson Brook channel through an engineered channel.

During Closure and Post-Closure, all on-site and downgradient water management features will be reclaimed as open water features, wetlands and/or other appropriate end land uses when no longer needed.

During Post-Closure, when the pit has been filled, the combined water from the TSF and open pit will be treated before discharge to Sisson Brook. Tailings will no longer be deposited in the TSF and it is expected that the water quality in the TSF pond will gradually improve. However, for the purpose of assessing treatment needs Post-Closure, it was conservatively assumed that TSF water quality would remain the same as during Operation (see Section 3.4.2.3.7).

Water treatment will occur during the open water season at between about 12,000 and 97,000 m^3/day (average of 30,000 m^3/day), and it is expected that treatment for arsenic, antimony and dissolved metals will be required. Treatment is planned to include in-pit ferric co-precipitation followed, if required, by in-plant lime treatment for pH adjustment and dissolved metals removal.

In-pit water treatment will be implemented after the spring melt each year. Pit water will be pumped to a mixing tank onshore where ferric sulphate will be added. After reacting with ferric sulphate, the process water will flow to a section of the pit lake that is enclosed with an open-bottom floating baffle curtain made of impermeable liner material (*e.g.*, HDPE). The enclosed section of the pit lake will allow ferric solids to settle to the bottom for permanent disposal. A photograph of such a floating baffle system in a pit lake at a Canadian mine is shown in Photo 3.4.1 below.

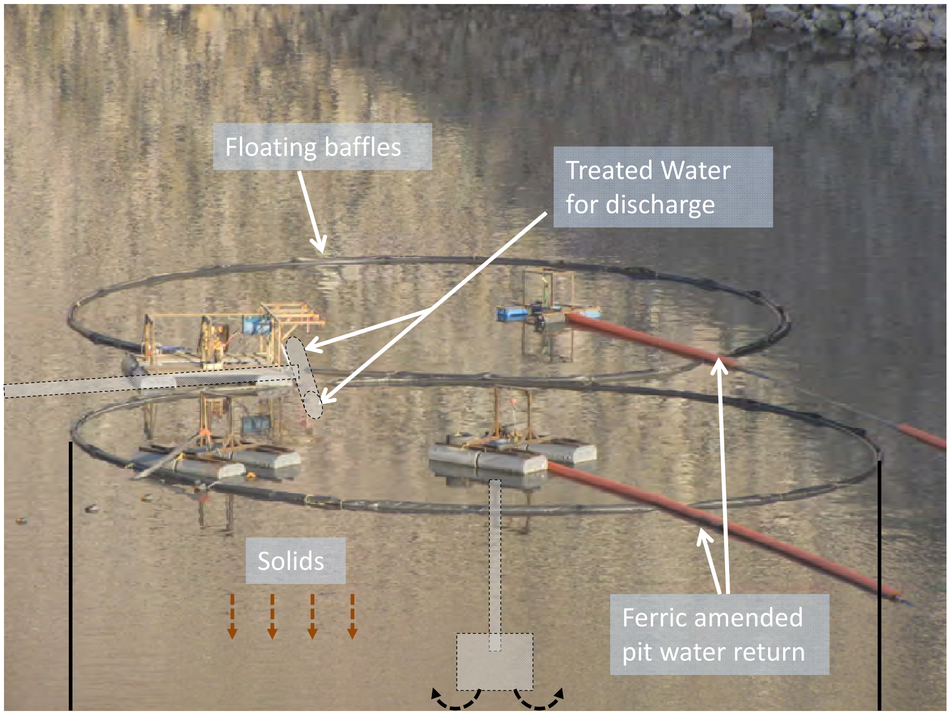


Photo 3.4.1 Example of in-pit floating baffle for water treatment.

If required, lime treatment will consist of pumping metal-depleted water from within the in-pit floating baffle curtain to a pair of reactor vessels onshore. Lime will be added to the first of the reactors in order to raise the pH to a level suitable for discharge. The elevated pH will also cause dissolved metals (such as iron and copper) to precipitate as hydroxide solids. The precipitates will be recovered as lime sludge in the clarifier, and then pumped for disposal in a purpose-built storage cell on-site.

The predicted Post-Closure discharge water quality is provided in Table 3.4.39. The post-water treatment plant (post-WTP) discharge values assume that lime treatment will be implemented.

Table 3.4.39 Predicted Post-Closure Water Quality for Treated Parameters

Parameter	Pit Lake		Post-Ferric Treatment (baffled section of lake)		Post-WTP Discharge		Water Treatment Threshold (mg/L)	*MMER* Discharge Limit (maximum authorized monthly mean concentration, column 2) (mg/L)
	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)		
Aluminum (dissolved)	0.16	0.20	0.16	0.20	*0.16*	0.2	0.2	-
Antimony (total)	0.011	0.011	0.01	0.01	0.01	0.01	0.01	-
Arsenic (total)	0.078	0.079	0.01	0.01	0.01	0.01	0.01	0.50
Cadmium (total)	0.00018	0.00020	0.00018	0.00020	*0.00018*	*0.00020*	0.0005	-

Table 3.4.39 Predicted Post-Closure Water Quality for Treated Parameters

Parameter	Pit Lake		Post-Ferric Treatment (baffled section of lake)		Post-WTP Discharge		Water Treatment Threshold (mg/L)	*MMER* Discharge Limit (maximum authorized monthly mean concentration, column 2) (mg/L)
	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)	Seasonal Average (mg/L)	Seasonal Maximum (mg/L)		
Chromium (total)	0.0069	0.0076	0.0069	0.0076	*0.0069*	*0.0076*	0.01	-
Copper (total)	0.022	0.022	0.022	0.022	0.002	0.002	0.002	0.30
Lead (total)	0.0015	0.0015	0.0015	0.0015	0.0005	0.0005	0.0005	0.20
Manganese (total)	0.16	0.19	0.16	0.19	0.1	0.1	0.1	-
Molybdenum (total)	0.081	0.081	0.05	0.05	0.05	0.05	0.05	-
Nickel (total)[2]	0.0032	0.0036	0.0032	0.0036	0.0032	0.0036	-	0.50
Selenium (total)	0.0009	0.0011	0.0009	0.0011	*0.0009*	*0.0011*	0.015	-
Zinc (total)[2]	0.022	0.023	0.022	0.023	0.022	0.023	-	0.50

Notes:

1. The numbers in *underlined italics* indicate that concentration is lower than the WTP threshold removal.
2. Nickel and Zinc are not targeted for removal in the WTP, but are shown for comparison with *MMER* Discharge Limits.

3.4.3.3 Emissions and Wastes

Emissions and wastes during Decommissioning, Reclamation and Closure are expected to be relatively modest in comparison to those that will occur during Construction or Operation of the Project. Emissions of air contaminants and noise may occur during Decommissioning and Reclamation activities from the movement of heavy equipment and vehicles on-site as demolition occurs and as materials are hauled to and from the Project site, as well as from reshaping of the landscape. These are not expected to be substantive. There are no known solid waste materials expected from the Decommissioning, Reclamation and Closure phase beyond disposal of decommissioning materials as discussed above.

As discussed above in Section 3.4.3.2.3, no water will be discharged from the Project during Closure with the possible exception of water in the water management ponds (WMPs) if it is of suitable quality for direct discharge; water from the WMPs will otherwise be pumped to the TSF. During Post-Closure, and as discussed above in Section 3.4.3.2.4, water from the pit lake will be treated before discharge until it is of suitable quality for direct discharge.

3.4.3.4 Transportation

Transportation needs during Decommissioning, Reclamation and Closure will be modest and will vary depending on the activity being carried out at the time. Although specific details of the Decommissioning phase and associated transportation requirements are not fully defined at this time, it is expected Project activities and requirements during this phase will be similar to or less than those during the Construction phase. This is a conservative assumption.

3.4.3.5 Employment and Expenditure

Employment and expenditure during Decommissioning, Reclamation and Closure will be modest and will vary depending on the activity being carried out at the time. Decommissioning will require limited contractor and project personnel to dismantle all equipment and facilities associated with the Project. Reclamation will see limited contractor and project personnel to restore areas of the site to near pre-Project conditions. Closure will involve limited Project personnel to carry out care, maintenance and monitoring activities, and to maintain and operate the limited equipment remaining on-site (*e.g.,* water treatment plant). Expenditure associated with all these activities will be relatively limited in comparison to that occurring annually during Operation. Once surplus water no longer needs to be treated to meet discharge standards at Post-Closure, employment and expenditure activities will cease.

3.4.3.6 Estimated Decommissioning, Reclamation and Closure Costs

3.4.3.6.1 Capital Construction Costs, Long-Term Maintenance, Monitoring and Water Treatment

A cost estimate for the conceptual closure and reclamation plan for the Project was developed based on a plan to achieve the following objectives:

- minimize or eliminate residual environmental effects following closure;
- establish conditions that allow the natural environment to recover from mining activities; and
- establish long-term physical, chemical, and ecological stability in the disturbed area.

A number of assumptions were made about the end-use plan for the Site, including:

- flooding of the open pit to create a lake;
- permanent encapsulation of barren rock within the TSF;
- TSF embankments will be vegetated with suitable species;
- TSF impoundment area will include wildlife habitat such as littoral, wetland, and a lake area; and
- appropriate drainage for surface and groundwater from the new landforms will be ensured.

Closure is defined as the time period between when the mine ceases operation and when the open pit has filled with water. The Post-Closure period is defined as the time after which the open pit has been flooded and begins discharging water, which is estimated to occur approximately 10 years after Closure.

The closure and reclamation plans will be updated throughout design, construction, and operation of the Project to help ensure that the objectives can be successfully achieved; the cost estimate and subsequent bonding requirements may also require adjustment as the Project evolves through the EIA process, permitting, and operations.

3.4.3.6.2 Ongoing Post-Closure Expenses

Certain aspects of the closure and reclamation plan will require ongoing commitment beyond the initial closure and active reclamation period. These generally include environmental monitoring, engineering support, and site maintenance; specific Post-Closure activities included in the cost estimate are:

- upkeep of water management ponds and recycle pumps being used to collect seepage and embankment runoff, which will be retained until monitoring results indicate that runoff and seepage from the TSF is of suitable quality for untreated discharge;
- groundwater monitoring wells and geotechnical instrumentation will be retained for long-term monitoring. Water quality will be assessed on a schedule defined in the detailed closure plan;
- annual inspection of the TSF and an ongoing evaluation of water quality, flow rates, and instrumentation records will be performed;
- maintenance of site roads that are kept active beyond closure to support ongoing monitoring and inspection requirements;
- maintenance of electrical infrastructure to ensure that power is available for pumps where applicable; and
- water treatment at the open pit discharge point to Sisson Brook until water quality is deemed acceptable for direct release.

3.4.3.6.3 Cost Estimate Methodology

The reclamation cost estimate was developed by identifying the tasks required to achieve the defined closure and reclamation objectives. The quantities used for the cost estimate were based on neat-line take-offs from the design figures with allowances for construction variances. Lump sum or provisional sum allowances were based on similar projects and estimates where sufficient detail did not exist to develop quantities for a particular line item.

The unit rates were developed using production rates, material costs, and contractor equipment rentals rates from the following sources:

- Caterpillar Performance Handbook (Edition 40);
- 2011-2012 BC Blue Book - Equipment Rental Rate Guide - BC Road Builders and Heavy Construction Association (July 2011); and
- 2010 RS Means Heavy Construction Cost Data (2010).

Assumptions

The following assumptions were used to develop the reclamation cost estimate.

- The work would be performed by a contractor using contractor equipment. The cost estimate assumes a worst case scenario that the mine equipment is not available to perform the closure and reclamation work.
- Surface reclamation areas as shown on Figures 13.4.14 to 13.4.17.
- Tailings beaches capped with a 60 cm thick layer of rockfill from the quarry to provide a trafficable surface for topsoil and overburden placement.
- Disturbed areas will first be shaped, resurfaced with an average topsoil and overburden layer 25 cm thick, and then re-vegetated.
- Topsoil and overburden for resurfacing will be located in a stockpile within 2 km of the final destination.
- The open pit will fill naturally with precipitation, groundwater inflow, and TSF discharge (*i.e*. no pumping required).
- Demolished concrete can be disposed of on-site (*i.e*. buried).
- Salvage value of materials transported to a disposal site will cover any disposal fees (*i.e*. net zero disposal fees).
- The TSF spillway will be constructed as a rock cut in the south abutment of the TSF embankment near the plant site.
- An open pit spillway to Sisson Brook will be constructed as a rock cut at the northeast side of the open pit.
- Water treatment will be bonded for assuming that it is required in perpetuity.
- Operating expenditures for water treatment can be scaled based on plant design flow (reduced operating expenditures if the mine closes prematurely, due to a smaller catchment area of the facilities and hence leading to lower design flows).
- Infrastructure from the plant clarification system used during mine operations can be partially utilized for the post-closure water treatment plant. A 50% reduction for the water treatment plant capital cost was assumed. This assumption for costing is based upon determination that the process water clarifier will be large enough to handle the mill reclaim flow rate combined with the surplus water sent to the Water Treatment Plant during operations, and should therefore be suitable for use Post-Closure when only surplus water needs treatment. The design of the clarifier and Water Treatment Plant will be reviewed during Basic Engineering to determine their suitability for both Operation and Post-Closure. If necessary, the cost estimate for Post-Closure water treatment equipment and operation can be revised for bonding

calculation purposes. At Closure, as the actual environmental conditions become more clear, a water treatment plant may need to be custom built for flow sizing, water quality objectives, power requirements, *etc*. and any pre-existing equipment should not be assumed to be suitable for use, at least not for bonding calculation purposes. This rationale can be integrated into the 5 year bond review process as the Project advances.

Exclusions

The closure and reclamation cost estimate currently excludes costs for dump disposal fees for structures, pipelines, pumps, and foundations.

3.4.3.6.4 Estimate Breakdown

The closure and reclamation cost estimate is divided into the following sections:

- Direct Costs;
- Indirect Costs;
- Ongoing Post-Closure Expenses; and
- Allowances and Contingency.

Direct Costs

The direct costs include:

- TSF Reclamation;
- Open Pit Reclamation;
- Barren Rock and Mid-Grade Ore Reclamation;
- Decommissioning of Mine Site Infrastructure; and
- Miscellaneous Allowances (Environmental Monitoring and Best Management Practices).

Indirect Costs

The indirect costs were estimated as a fixed percentage of the direct costs. Materials, services, and engineering/specialist input were estimated as lump sums.

The indirect costs included in the estimate are:

- Contractor mobilization and demobilization at 5% of estimated direct costs;
- Construction management and indirects at 12% of estimated direct costs;

- Materials and services such as power and insurance; and
- Engineering and specialist input.

Ongoing Post-Closure Expenses

Annual Post-Closure expenses will be incurred beyond the active reclamation period. A bond will need to be posted such that interest gained on the initial investment will cover the estimated annual expenses in perpetuity. The on-going Post-Closure expenses are attributed to water treatment, and monitoring and maintenance of equipment.

The water treatment costs (SRK 2013) include capital costs and fixed and variable operating costs.

The costs represent Post-Closure water treatment at full mine development (*i.e.,* at the end of the projected mine life at 27 years). Water treatment costs for premature mine closure will be estimated using a water treatment design flow factor, which is based on the catchment area reporting to the TSF that cannot be practically diverted around the facility and the approximate size of the open pit at each stage of the mine life.

The capital costs (SRK 2013) are for a standalone, newly constructed water treatment plant. However, based on the current mine design and feasibility study results, cost savings may be available by utilizing the clarification plant that would be built as part of the processing facilities. The closure and reclamation cost estimate assumes that 50% of the estimated capital cost of the water treatment plant will be required to upgrade the clarification plant for use as the Post-Closure water treatment plant. In addition to the clarification plant, a stand-alone water treatment plant will be required for Operations in Year 8; it is assumed that this plant can be used as the post-closure treatment plant at no additional cost.

For simplicity, no interest rate was utilized for estimating the bonding requirements, and hence no interest is gained on the bonding investments nor was any bond credit applied in subsequent years once the water treatment plant is built.

Allowances and Contingency

The following allowances will be included in the direct costs for items with limited design information:

- A $500,000 allowance to cover best management practices during the active reclamation period; and
- A $1,000,000 allowance for monitoring (environmental and geotechnical).

A contingency of 25% was allotted for the direct costs.

3.4.3.6.5 Description of Bonds

Based on input from the New Brunswick Department of Energy and Mines (NBDEM) and the New Brunswick Department of the Environment and Local Government (NBDELG), there are three, distinct bonds that will be posted and maintained over the 27 year life of the Project to mitigate liability to the Province for:

- Reclamation;
- Environmental Protection; and
- Post-Closure Water Treatment.

Reclamation Bonding

Reclamation bonding will be initiated at the onset of construction and will cover a period of three years (Year -2 to Year +1, inclusive), which will span the two-year construction period plus the initial year for commissioning and start-up. Potential reclamation efforts over this period would be the least significant during the mine life as construction of the Project will have been completed and commissioning of the plant will have been fully achieved such that it can operate at 100% of its capacity.

For this period, there will be fresh water (from precipitation) stored behind the tailings embankment (up to 8 million m^3), a minimum amount of tailings discharges into the TSF from commissioning activities (up to approximately 4 million m^3 or 1% of the total tailings volume), overburden piles developed from pre-stripping activities in the open pit (5.3 million tonnes or 2% of the total waste tonnes), and quantities of waste rock stored in the TSF basin (up to 13.0 million tones or 5% of the total waste tonnes) from initial mining activities.

The bond for this period has been calculated based on an initial bond amount, which would increase in value over the three years to a fully matured amount based on a 0% net interest rate for simplicity in presenting the calculations. This bond would be posted to NBDEM when construction of the Project begins at the beginning of Year -2.

After this initial, three year period, a second bond would be posted for a five year period (Year 2 to 6, inclusive) at the beginning of Year 2. Since the Project will be in full operation by this time, the value of the new bond will be substantially greater than the previous bond to cover the reclamation cost associated with significantly more tailings and waste rock stored in the TSF as well as more process water mixed with fresh water in the TSF pond. For calculation simplicity, it has been assumed that the original bond will continue to be reinvested at the nominal interest rate (assumed to be 0% for simplicity), and a new, second bond to be made at the beginning of Year 2 will be provided to NBDEM for the difference.

Subsequently, a third bond would be posted for another five year period (Year 7 to 11, inclusive) at the beginning of Year 7.

After this period, there will be sufficient bond value to cover the next five year period's liability amount based on the gain in the accumulated interest on the three bonds. In fact, all periods after this will be fully covered with these bonds.

The bond values will vary based on the effective interest rate at the time of the bond placements. For simplicity, the values presented assume a 0% interest rate; however, the interest rate at the time of bond placement will change the bond values as interest will allow the bonds to grow in value over time while they are held by the regulatory agency.

Environment Protection Bonding

The environment protection bonding would be established in a progressive manner starting prior to construction and continuing for three years (i.e. two years of construction plus a year for commissioning and startup) up to the end of the commissioning period. An initial contribution at the commencement of construction would be provided. An annual contribution for the three year period of construction would be provided to ensure sufficient bond prior to the start of full production at the mine at the beginning of Year 2.

This bond would be established to accommodate the cost of monitoring during the active reclamation period (one year) and for a subsequent two-year mine Closure period. The value of the bond account at the end of the 27 year mine life would be calculated using the same interest rate (assumed to be 0% for simplicity) for the other bonding instruments.

Post Closure Water Treatment Bonding

The period of Post Closure water treatment would commence once the open pit has filled, approximately 12 years after the end of Operation. This bonding would be in place at the commencement of the Post Closure period to cover the cost of water treatment in perpetuity.

Bond contributions would be made at the beginning of Year 2, once full production has started, and would be placed as a separate capital cost (CAPEX) amount and an operating cost (OPEX) amount. As per the bonding placement procedure described for reclamation bonding, subsequent bonds for CAPEX and OPEX would be posted for each five year period thereafter at the beginning of each of these periods to cover the liability associated with each period. However, the CAPEX bond placement would end at Year 7 as the total CAPEX bond value would match the CAPEX value for the water treatment plant that would be built and operating by Year 10; hence no further bonding contributions to CAPEX would be necessary. Similarly, the OPEX bond placement would end at Year 17 as the total OPEX bond value would match the OPEX value for water treatment throughout the remaining 27 years of the mine life.

The bond values will vary based on the effective interest rate at the time of the bond placements. For simplicity, the values presented assume a 0% interest rate; however, the interest rate at the time of bond placement will change the bond values as interest will allow the bonds to grow in value over time while they are held by the regulatory agency.

Summary of Bonding Requirements

The estimated costs for closure and reclamation throughout the mine life will increase over time. It is proposed that the bonding requirement shall be reviewed on a five-year "look forward" basis once the mill reaches full production and adjusted as required. The estimated maximum bonding requirement is presented in Table 3.4.40 below at the start of construction, at the commencement of full production (beginning of Year 2) and at the end of the estimated life of the mine after 27 years.

Table 3.4.40 Bonding Summary

No.	Bond Description	Estimated Bond Requirement Start of Construction (Year -2)	Estimated Bond Requirement Full Production (Year 2)	Estimated Bond Requirement End of Life of Mine (Year 27)
1.	Reclamation	$7,500,000	$24,000,000	$41,800,000
2.	Environmental Protection	$1,500,000	$1,500,000	$1,500,000
3.	Post-Closure Water Treatment			
3a.	CAPEX Bond value	Nil	$4,600,000	Nil
3b.	OPEX Bond Value	Nil	$19,700,000	$22,000,000
	Totals	**$9,000,000**	**$49,800,000**	**$65,300,000**

Note:
No discount or interest rate was utilized for estimating the bonding requirements for each of these periods. This table assumes that the CAPEX bond for Post-Closure Water Treatment has been withdrawn once the water treatment plant has been built (Year 8), and hence this amount is shown as "Nil" at the End of Life of Mine (Year 27).

The closure bonding requirement generally increases over the mine life as additional development takes place and the Project footprint expands, which requires additional reclamation work and greater water treatment capacity.

The closure plan has been developed to a conceptual level and the cost estimate will require adjustment to account for changes in the scope, design, and permitting requirements as the Project is developed further. Studies carried out as part of the EIA process and information received from this process will solidify decisions about the preferred end-use for the site after Closure. For example, ongoing soil and vegetation studies will better define the soil replacement and re-vegetation strategy.

Further details of the reclamation plan for the Project can be found in Appendix H.

3.4.3.7 Site Safety and Security

Because the open pit and quarry at Closure will remain as open water features with abrupt, steep, and sometimes unstable edges, they will present potential safety issues and liabilities. They thus warrant exclusion of both people and terrestrial wildlife, and will be fenced around the edges to prevent access. No other continuous fencing is planned.

Much of the remaining area will be accessible (particularly during the winter), so fencing, berms, rock barriers, or warning signs discouraging public access may be employed in target areas to prevent accidents and minimize exposure to potentially harmful conditions. Warning signs will be posted at regular intervals along fenced areas and along the base of the TSF, on posts of sufficient height so the signs will be visible during winter conditions.

The main access to the site and the on-site access roads to the open pit and quarry will be restricted with locked gates. Locked gates will be accessible to mine personnel and contractors only. Any remaining buildings will be secured.

On-site roads required for Closure and Post-Closure maintenance will not be secured. Those required for water quality monitoring or vegetation surveys will be partially decommissioned with water bars and berms to discourage all traffic use, except by ATV or snow machines. All other on-site roads no longer required will be permanently decommissioned.