Atlantic Gold

Appendix E.3

Beaver Dam Project - Geochemical Source Term Update –
January 20, 2021as
Completed for the Updated 2021 Beaver Dam Mine EIS

Beaver Dam Project:
Geochemical Source Term Update

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1. Introduction

1. Introduction

1.1 Project overview

The Beaver Dam project is a proposed gold mine owned by Atlantic Mining Nova Scotia Corporation (AMNS). As part of the regulatory requirements of for this project, AMNS submitted an Environmental Impact Statement (EIS) to the Canadian Environmental Assessment Agency (CEAA) and Nova Scotia Environment (NSE) in June 2017. In response to information requests made by these agencies, AMNS submitted a revised EIS in February 2019 in order to address information gaps and in consideration of a changed mine plan. The revised EIS included a site-wide water quality model to assess the impact of mine development on the downgradient aquatic environment. In support of the water quality model, Lorax Environmental Services Ltd. (Lorax) provided geochemical source terms of contaminant release from mine waste (waste rock, ore, tailings, overburden) facilities via drainage and seepage pathways. Since the original source term model described in Lorax (2018a), several changes have been made to the mine plan affecting the assumptions to this model. The most salient change is the planned segregation of waste rock into potentially acid generating (PAG) and non-acid generating (NAG) materials with storage in separate waste rock storage areas (WRSAs) which has a direct impact on the expected drainage qualities. Furthermore, additional data from kinetic testing (humidity cells) has become available since the 2019 EIS submission, providing an increased understanding of geochemical reaction rates over time. As a result, the geochemical source term model was updated on the basis of these new input parameters (Table 1-1).

This report is intended to provide an overview of the changes made during this model update as they apply to the Beaver Dam water quality predictions. A description of the general approach and rationale that apply to the source term model can be found in Lorax (2018a). Updated model assumptions and mine plan inputs are described in Section 2. The release of nitrogen species from waste rock, ore and pit wall surfaces in response to leaching of blast residues has been incorporated into the source term predictions (Section 3). The revised geochemical source term results are summarized in Section 4.

Table 1-1:
Overview of Beaver Dam Source Term Locations and Update Assumptions (Excluding N Source Terms)

Mine Component	Updated Assumptions Considered
Pit Walls	Additional kinetic test data, revised mine plan
NAG WRSA	Additional kinetic test data, revised mine plan
PAG WRSA	Additional kinetic test data, revised mine plan
Topsoil SP	New source term added
Till SP	New shake flask extraction data, revised mine plan

Notes: NAG = Non Acid Generating; PAG = Potentially Acid Generating; WRSA = Waste Rock Storage Area, SP = Stockpile

2. Updated Model Assumptions

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2. Updated Model Assumptions

In general, the development of geochemical source terms was conducted using the same approach as described in Lorax (2018a) and is primarily based on the upscaling of humidity cell leachate data. Exceptions to this approach are the overburden stockpiles (till, topsoil), the drainage chemistry of which was predicted using shake flask extraction (SFE) tests. An overview of the work steps involved in the humidity cell upscaling exercise is given in Figure 2-1.

In light of the additional leachate data that became available through the continued operation of the humidity cell test program, the calculation of loading rates as input for the source term model was revised to account for observed temporal geochemical trends. Loading rates from different test cycles were then assigned to the short-term (End of Mining = EOM; cycles 5-15) and long-term (Post-Closure = PC; last 5 cycles) scenarios.

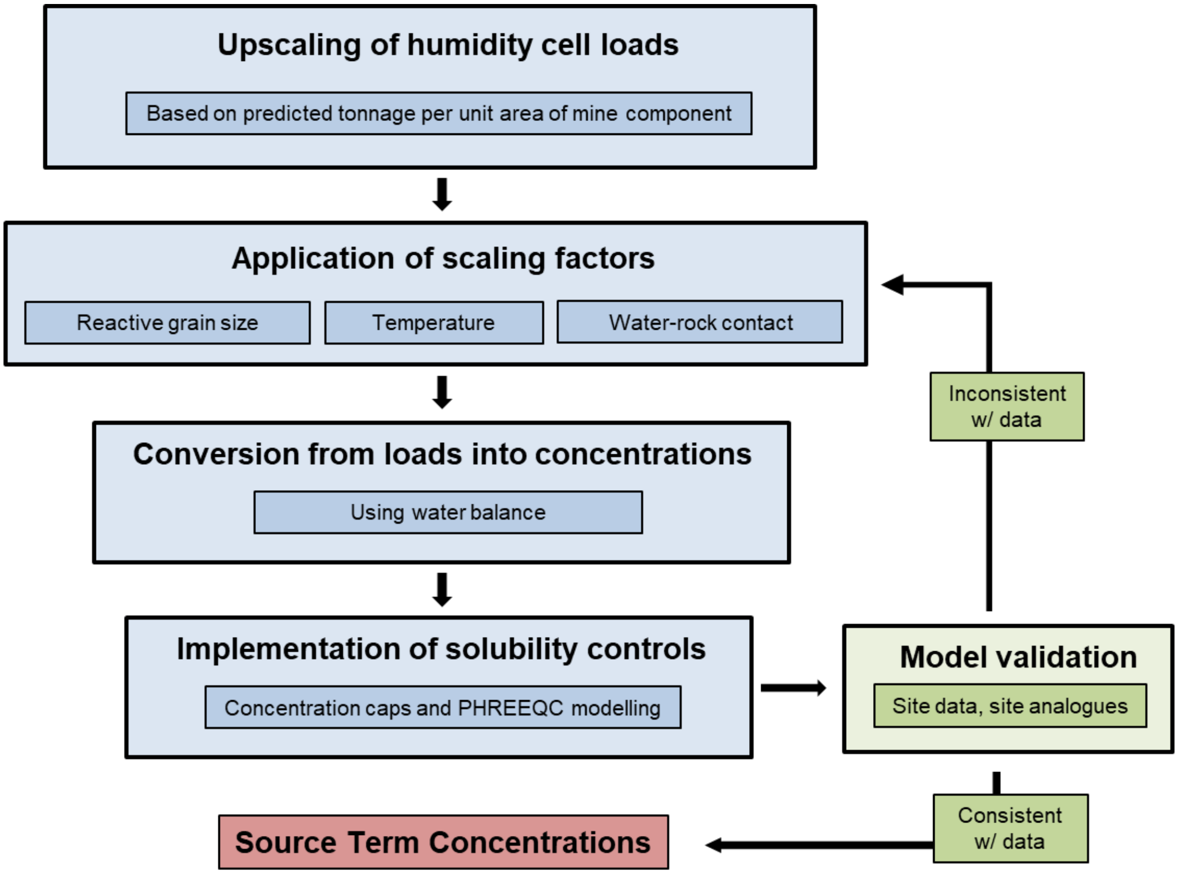

Figure 2-1: Work stages involved in the scaling of geochemical source terms.

Another key assumption that was adjusted since the original source term model is the "acid factor" which governs metal release rates from PAG mine rock in the long-term after acid rock drainage (ARD) is expected to develop. Previously, this acid factor was calculated based on humidity cell data from a BC gold mine which had produced both neutral and acidic leachates. Since this time, acidic and neutral leachate data from AMNS' Cochrane Hill mine has been observed as part of this project's kinetic test program. Although higher-grade metamorphic in nature, Cochrane Hill deposit lies within the same geologic formation (Meguma Terrane) as Beaver Dam mine and can therefore be considered a superior site analogue. Therefore, it was decided to use Cochrane Hill humidity cell data to calculate the acid factor (AF) as follows:

$$AF_i = L_{Ai}/L_{Ni}$$

where L_{Ai} is the loading rate of species i at low pH (~3.5-4) in the acidic Cochrane Hill humidity cell and L_{Ni} is the loading rate of species i in neutral humidity cells. The resulting AF was then multiplied with the Beaver Dam long-term (EOM) neutral source term in question to derive loading rates that are representative of long-term acidic conditions. Importantly, these loading rates were only applied in proportion to the estimated tonnage of PAG materials. An overview of the updated geochemical loading rates used for the EOM and PC model scenarios are given Table 2-1 through Table 2-3. Other changes made to assumptions specific to the individual source term locations are presented in the following subsections.

Table 2-1:
Neutral Short-Term (EOM) Loading Rates Used as Input for the Beaver Dam Source Term Model

Parameter	Unit	Argillite		Greywacke		Ore	
		Median	90th PCTL	Median	90th PCTL	Median	90th PCTL
Sulphate	mg/kg/wk	14	17	6.0	9.8	14	18
Al	mg/kg/wk	0.060	0.075	0.087	0.097	0.086	0.099
Ag	mg/kg/wk	0.000011	0.000011	0.000011	0.000011	0.000011	0.000011
As	mg/kg/wk	0.012	0.016	0.017	0.021	0.014	0.023
B	mg/kg/wk	0.0034	0.0050	0.0028	0.0039	0.0030	0.0044
Ca	mg/kg/wk	6.4	7.1	4.5	5.5	6.2	7.6
Cd	mg/kg/wk	0.0000025	0.0000073	0.0000012	0.0000042	0.0000025	0.0000056
Co	mg/kg/wk	0.000034	0.000046	0.000015	0.000025	0.000021	0.000028
Cr	mg/kg/wk	0.0000098	0.000018	0.000013	0.000017	0.0000092	0.000018
Cu	mg/kg/wk	0.00016	0.0014	0.00018	0.0017	0.00013	0.0015
Fe	mg/kg/wk	0.0028	0.0100	0.0018	0.0048	0.0020	0.0086
Hg	mg/kg/wk	0.0000022	0.0000022	0.0000022	0.0000022	0.0000022	0.0000022
K	mg/kg/wk	2.0	2.8	1.3	1.9	2.2	3.3
Mg	mg/kg/wk	0.57	0.70	0.40	0.50	0.55	0.69
Mn	mg/kg/wk	0.0039	0.0048	0.0029	0.0035	0.0051	0.0060
Mo	mg/kg/wk	0.00045	0.0011	0.00060	0.0013	0.00041	0.00095
Na	mg/kg/wk	0.33	0.66	0.39	0.82	0.23	0.45
Ni	mg/kg/wk	0.000088	0.00012	0.000041	0.000049	0.000059	0.000067
Pb	mg/kg/wk	0.000021	0.000049	0.000010	0.000029	0.000034	0.000067
Sb	mg/kg/wk	0.000056	0.00014	0.00011	0.00021	0.00013	0.00030
Se	mg/kg/wk	0.000055	0.000100	0.000055	0.000094	0.000072	0.000096
Tl	mg/kg/wk	0.0000062	0.0000069	0.0000039	0.0000046	0.0000048	0.0000057
U	mg/kg/wk	0.00029	0.00038	0.0012	0.0015	0.00044	0.00050
Zn	mg/kg/wk	0.00044	0.00046	0.00044	0.00055	0.00044	0.00087

Notes: EOM = End of Mining; Humidity cell cycles 5-15 were used for this scenario.

Table 2-2:
Neutral Long-Term (PC) Loading Rates Applied to NAG Materials in the Beaver Dam Source Term Model

Parameter	Unit	Argillite		Greywacke		Ore	
		Median	90th PCTL	Median	90th PCTL	Median	90th PCTL
Sulphate	mg/kg/wk	13	14	4.7	6.4	19	21
Al	mg/kg/wk	0.024	0.027	0.058	0.066	0.019	0.036
Ag	mg/kg/wk	0.000011	0.00027	0.000011	0.00022	0.000011	0.00025
As	mg/kg/wk	0.0050	0.0055	0.0064	0.0079	0.0034	0.0049
B	mg/kg/wk	0.0019	0.0028	0.0018	0.0020	0.0021	0.0031
Ca	mg/kg/wk	6.3	6.6	4.6	5.1	8.5	9.6
Cd	mg/kg/wk	0.0000029	0.0000038	0.0000022	0.0000030	0.0000044	0.0000050
Co	mg/kg/wk	0.000042	0.000052	0.000013	0.000020	0.000055	0.000051
Cr	mg/kg/wk	0.0000087	0.000020	0.000016	0.000039	0.0000093	0.000015
Cu	mg/kg/wk	0.00015	0.00023	0.00022	0.00089	0.00016	0.00021
Fe	mg/kg/wk	0.0029	0.0036	0.0015	0.0059	0.0015	0.0025
Hg	mg/kg/wk	0.0000021	0.0000021	0.0000021	0.0000021	0.0000021	0.0000021
K	mg/kg/wk	1.2	1.3	0.62	0.67	1.4	1.5
Mg	mg/kg/wk	0.27	0.28	0.21	0.20	0.36	0.29
Mn	mg/kg/wk	0.0063	0.0066	0.0022	0.0025	0.0087	0.0099
Mo	mg/kg/wk	0.00039	0.00059	0.0043	0.0045	0.00034	0.00026
Na	mg/kg/wk	0.13	0.23	0.14	0.15	0.13	0.20
Ni	mg/kg/wk	0.000058	0.000072	0.000031	0.000085	0.000086	0.000081
Pb	mg/kg/wk	0.000013	0.000021	0.0000072	0.000048	0.000014	0.000019
Sb	mg/kg/wk	0.000044	0.00011	0.000049	0.000070	0.000044	0.00010
Se	mg/kg/wk	0.000029	0.000038	0.000022	0.00012	0.000031	0.000040
Tl	mg/kg/wk	0.0000055	0.0000067	0.0000029	0.0000030	0.0000075	0.0000060
U	mg/kg/wk	0.00013	0.00014	0.00025	0.00028	0.00018	0.00020
Zn	mg/kg/wk	0.00044	0.00044	0.00044	0.0011	0.00044	0.00075

Notes: PC = Post-Closure; the last 5 humidity cell cycles (35-39) were used for this scenario.

Table 2-3:
Acid Factors and Acidic Long-Term (PC) Loading Rates Applied to PAG Materials in the Beaver Dam Source Term Model

Parameter	Unit	Argillite		Greywacke		Ore		Acid factor
		Median	90th PCTL	Median	90th PCTL	Median	90th PCTL	
Sulphate	mg/kg/wk	30	32	11	15	43	47	2.3
Al	mg/kg/wk	0.14	0.16	0.34	0.39	0.11	0.21	5.9
Ag	mg/kg/wk	0.000010	0.00025	0.000010	0.00021	0.000010	0.00024	0.95
As	mg/kg/wk	0.026	0.029	0.034	0.041	0.018	0.026	5.3
B	mg/kg/wk	0.0024	0.0035	0.0022	0.0025	0.0025	0.0038	1.2
Ca	mg/kg/wk	1.3	1.3	0.93	1.0	1.7	2.0	0.20
Cd	mg/kg/wk	0.00079	0.0010	0.00061	0.00081	0.0012	0.0014	273
Co	mg/kg/wk	0.0097	0.012	0.0030	0.0047	0.013	0.012	232
Cr	mg/kg/wk	0.0000082	0.000019	0.000015	0.000037	0.0000088	0.000014	0.95
Cu	mg/kg/wk	0.0020	0.0033	0.0031	0.012	0.0022	0.0030	14
Fe	mg/kg/wk	4.7	5.8	2.5	9.6	2.5	4.0	1618
Hg	mg/kg/wk	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.95
K	mg/kg/wk	1.1	1.2	0.59	0.64	1.3	1.4	0.95
Mg	mg/kg/wk	0.71	0.76	0.56	0.55	0.97	0.78	2.7
Mn	mg/kg/wk	0.055	0.058	0.019	0.022	0.077	0.087	8.8
Mo	mg/kg/wk	0.000029	0.000044	0.00032	0.00033	0.000025	0.000019	0.074
Na	mg/kg/wk	0.19	0.36	0.21	0.24	0.20	0.30	1.6
Ni	mg/kg/wk	0.018	0.022	0.0092	0.025	0.026	0.024	301
Pb	mg/kg/wk	0.0034	0.0052	0.0018	0.012	0.0035	0.0047	253
Sb	mg/kg/wk	0.000041	0.00011	0.000046	0.000066	0.000041	0.000097	0.95
Se	mg/kg/wk	0.00021	0.00028	0.00016	0.00092	0.00023	0.00030	7.4
Tl	mg/kg/wk	0.000034	0.000042	0.000018	0.000019	0.000047	0.000038	6.2
U	mg/kg/wk	0.0011	0.0012	0.0020	0.0022	0.0015	0.0016	8.1
Zn	mg/kg/wk	0.35	0.35	0.35	0.91	0.35	0.60	799

Notes: PC = Post-Closure; the last 5 humidity cell cycles (35-39) were used for this scenario.

2.1 Waste Rock Storage Areas

According to the revised mine plan (Schulte, pers. comm, 2019), waste rock will be stored in two facilities separated by PAG and NAG rock. This is in contrast to the single WRSA considered in the previous mine plan and will, by design, have a direct impact on the respective source term predictions.

In the previous study (Lorax, 2018a), the proportion of waste rock material considered to be PAG was calculated for argillite and greywacke units based on the proportion of PAG static test samples in relation to the total number of samples in the corresponding sample suite. This method of calculation does not take into account the spatial distribution of the samples and is prone to bias where there is spatial clustering of the data. For example, at Beaver Dam, there are twelve samples within the main argillite unit, seven of which have an NPR < 2, yielding 58% PAG. However, four of these samples were found to be in close proximity (within 20 m and in the same drill hole) whereas the other samples are more evenly distributed. Extrapolating this cluster across the entire deposit was found to produce an argillite PAG proportion that would overestimate the volumetric PAG tonnages.

To avoid this data bias, a distance-weighted geological model was created from the Beaver Dam drill hole database and interpreted geological cross sections, with solids produced for the main argillite- as well as greywacke-dominated units and the overburden material. This approach is more statistically robust and considers both the geometry of the geological units and the spatial distribution of the samples (Goodman, pers. comm., 2019). Leapfrog^{TM} software was used to produce an interpolated grade shell at the NPR=2 cutoff with an anisotropy determined by the geometry of the geological units. The tonnage of waste within the NPR=2 grade shell is reported as PAG waste, with argillite and greywacke solids used to subdivide the waste tonnage.

The revised tonnages for lithological and environmental units calculated using this updated geological model and used as input for the WRSA drainage predictions are shown in Table 2-4. Note that the derivation of WRSA scaling factors, based on kinetic test and operational data available for the Touquoy, remained unchanged.

Table 2-4:
Dimensions Assumed for the Beaver Dam WRSAs in the Updated Source Terms

	PAG WRSA	NAG WRSA
Tonnage		
Argillite (kt)	1,201	13,966
Greywacke (kt)	756	20,716
Total (kt)	1,958	34,683
Area		
Footprint (ha)	11	62

Notes: NAG = Non Acid Generating; PAG = Potentially Acid Generating; WRSA = Waste Rock Storage Area.

2.2 Pit Walls

As in the previous model, the Beaver Dam pit wall runoff predictions rely heavily on the data humidity cell and pit sump data available for the Touquoy mine for model calibration purposes. To account for the impact of groundwater inflow on the pit sump geochemistry, the geochemistry of groundwater from monitoring stations directly adjacent to the open pit (OPM1 through 7) was reviewed and included into the source term model (Table 2-5). Since groundwater concentrations are, for most parameters, lower than those observed in the pit sump, this approach led to a general increase in pit wall runoff source term concentrations, making these predictions more conservative and robust.

Proportions of pit wall lithologies (greywacke and argillite) and environmental classes (PAG and NAG) were re-calculated for the Beaver Dam pit walls using the geological model described for WRSA tonnages in Section 2.1. As for the WRSA, the model results yielded reduced PAG proportions thereby lowering the risk for acidic runoff into the pit sump (operations) and lake (closure). The relative proportions employed in the source term model update are given in Table 2-6.

Table 2-5:
Selected Median Concentrations in Touquoy Groundwater (OPM stations) Used in the Pit Wall Runoff Source Term Model

Parameter	Unit	Groundwater
Sulphate	*mg/L*	11
Al	*mg/L*	0.0099
Sb	*mg/L*	0.0010
As	*mg/L*	0.0086
Cd	*mg/L*	0.000010
Ca	*mg/L*	25
Cr	*mg/L*	0.0010
Co	*mg/L*	0.00040
Cu	*mg/L*	0.0020
Fe	*mg/L*	0.050
Pb	*mg/L*	0.00050
Mn	*mg/L*	0.31
Hg	*mg/L*	0.000013
Mo	*mg/L*	0.0020
Ni	*mg/L*	0.0020
Se	*mg/L*	0.0010
Ag	*mg/L*	0.00010
Tl	*mg/L*	0.00010
Sn	*mg/L*	0.0020
U	*mg/L*	0.00037
Zn	*mg/L*	0.0050

Table 2-6:
Proportions of Lithological and Environmental Units Assumed for Beaver Dam Pit Walls in the Updated Source Term Model

End of Mining	
Argillite	35%
Greywacke	61%
Ore	3.9%
Post-Closure	
Argillite	**28%**
NAG	*28%*
PAG	-
Greywacke	**71%**
NAG	*67%*
PAG	*3.7%*
Ore	**1.2%**
NAG	*1.2%*
PAG	-

Notes: NAG = Non Acid Generating; PAG = Potentially Acid Generating.

2.3 Overburden Stockpiles

Overburden will be stripped from the surface before mine development and stockpiled in a till and a topsoil stockpile. This material will later be used for reclamation purposes. Due to its deposition and formation environment and heavily weathered nature, overburden material is generally low in or devoid of sulphide minerals. Nevertheless, overburden contact water is expected to adopt a geochemical signature that will have an effect on the site-wide geochemical loading balance. Contrary to the previous mine plan which only included single overburden pile, the current mine plan provides for a topsoil (organics) and a till stockpile which are expected to have different drainage characteristics.

During a Lorax site visit in 2018, five overburden samples were retrieved from the Beaver Dam mine footprint via shallow (<1 m) test pitting. For the last model iteration, SFE data from these materials were reviewed and selectively used to derive source term predictions for the overburden stockpile. Due to the sampling depth, it is expected that these materials are more representative of Beaver Dam topsoil and therefore, these data were used for the topsoil stockpile drainage predictions in the current source term model. Further, in accordance with information request NSE 2-73, one sample (LX-BDT-03) that was previously considered a geochemical outlier, was included in the derivation of this source term to maintain conservatism.

In order to better understand the geochemistry of overburden material from below the topsoil horizon, data from till samples at site analogues (Touquoy and Fifteen Mile Stream projects) were utilized for the derivation of the till stockpile source term. Specifically, five till samples were recovered from Fifteen Mile Stream project site during a drilling program led by Golder Associates (2018). In addition, eight samples were collected from two existing Touquoy till piles during the 2018 Lorax site visit. All samples were characterized via acid-base accounting (ABA), metal content using aqua-regia digestion and shake flask extractions (SFE) to gain insight into the short-term leachability of this material type. SFE data from of these 13 till samples were used directly for the generation of geochemical source terms for the till stockpile.

Geochemical source terms for the two stockpiles were calculated as the median and 90th percentile SFE leachate values from the corresponding database for the Base and Upper Case scenarios, respectively.

3. Nitrogen Source Terms

3. Nitrogen Source Terms

This section describes the approach and rationale employed in the prediction of nitrogen (N) species, specifically ammonia, nitrate and nitrite in contact waters from the NAG WRSA, PAG WRSA, temporary Ore Stockpile, and Beaver Dam Pit Walls.

Nitrogen-based blasting reagents are typically the primary source of N compounds in pit walls and mine rock storage facilities at surface mining operations (Pommen, 1983). The nitrogen compounds ammonium (NH_4^+) and nitrate (NO_3^-) are the primary constituents of ammonium nitrate (AN) based explosives, while nitrite (NO_2^-) is typically formed during and after blasting. Under ideal blasting conditions the ammonium and nitrate are converted to nitrogen gas. However, in practice ideal blasting conditions are rarely if ever achieved and small proportions of the explosives remain as residue on blasted surfaces and are readily leached by infiltrating meteoric water.

For surface mining operations the export of N to the receiving environment is predominantly in the form of nitrate, and to a lesser extent, nitrite and ammonia (Ferguson and Leask, 1988). The N containing residues on pit walls and exposed blasted rock surfaces are rapidly flushed by contact water (Revey, 1996; Mueller *et al.,* 2015). However, in unsaturated waste rock piles preferential and capillary flow paths develop and can lead to variable and delayed flushing of N (Fala *et al.,* 2003; Fretz *et al.,* 2011; Baily *et al.*, 2013). The N available for leaching is limited to the wetted areas of the pile and the type of flow through the pile, therefore N release from a large rock piles can persist for years after rock placement (Lorax, 2017).

The approach used in the development of N species source terms for the EOM scenario is described below for the Beaver Dam WRSAs and temporary Ore Stockpile (Section 3.1), and pit walls (Section 3.2). The derivation of N depletion rates to be used in the Post-Closure scenario is described in Section 3.3.

3.1 WRSA N Source Term Model for EOM

The WRSA N source term model was developed from empirical observations at Touquoy Mine and is used to predict the concentration of N species in Beaver Dam WRSA and temporary Ore Stockpile drainage at EOM. The release of N from blasted rock placed in stockpiles is dependent on the mass of material placed and the physical characteristics of the blasted rock. The N loading to waste and ore at Beaver Dam is expected to be similar to Touquoy Mine which is located approximately 60 km northwest of Halifax, Nova Scotia, and 10 km southwest of the proposed Beaver Dam Mine. Touquoy Mine is considered a proxy site for Beaver Dam Mine due to its proximity, the similarities of the blasting methods, lithologies and physical rock properties, the scale of the WRSA and similar climate conditions. Therefore, as for other solutes, the WRSA N loading model is derived from empirical observations of water quality at the operating Touquoy Mine for the 2018 – 2020 period and the Beaver Dam mine plan. The N loading rates are applied to the Beaver Dam annual waste and ore schedules to calculate annual N loads. The highest derived annual N loads and estimated WRSA and Ore Stockpile runoff volumes are used to calculate Base Case and Upper Case concentrations for ammonia, nitrate and nitrite in Beaver Dam NAG WRSA, PAG WRSA and temporary Ore Stockpile drainage.

3.1.1 Empirical Observations of Nitrogen Export at Touquoy Mine

The climate at Touquoy Mine is temperate and a MAP of 1350 mm has been observed at the nearby Halifax Climate Station (Environment and Climate Change Canada Station No. 8202251). Mine development commenced in 2016 and the WRSA has been receiving waste rock since October 2017. Annual tonnages are presented in Table 3-1 and monthly cumulative totals are plotted in Figure 3-1. A cumulative total of 11.4 Mt waste was stockpiled in the WRSA at the end of October 2020.

The WRSA is in the catchment of collection ponds WRSP1 and WRSP2. Drainage from the WRSA accumulates within the ponds. Surplus water in the ponds is directed to the TMF by transferring water from WRSP1 to WRSP2, and then from WRSP2 to the TMF. Discharge from WRSP2 has been directed to the TMF since January 2018 and has been measured since April 2019. The measured monthly discharges ranged from 2,101 to 62,997 m^3 from April 2019 through October 2020 (Figure 3-1). Annualized discharge volumes, used for loading rate calculations, are derived by summing the observed flows and water balance modelled flows for the months when observed flows are not available (Table 3-1).

Table 3-1:
Touquoy WRSA Deposition Tonnages and WRSP2 Discharge Volume

Year	WRSA Deposition (t)	WRSP2 Discharge (measured) (m^3)	WRSP2 Discharge (annualized) (m^3)
2017	457,318	-	-
2018	2,464,794	-	-
2019	4,714,295	224,533 [2]	308,728 [4]
2020	3,798,050 [1]	230,675 [3]	306,222 [5]

Notes:
[1] Total deposition from January through October, 2020.
[2] Total measured discharge volume from April 2019 through December 2019.
[3] Total measured discharge volume from January 2020 through October 2020.
[4] The sum of the measured volume April – December 2019 and the water balance predicted volumes for January to March, 2019.
[5] The sum of the measured volume from January – October, 2020 and the water balance predicted volumes for November and December, 2020.

The total N (T-N) concentration in WRSP2 discharge has fluctuated since monitoring commenced July 2018, ranging from 1.7 to 17.1 mg N/L, with concentrations generally increasing from 2018 to 2020 (Figure 3-1). Expressed as an annual average, the T-N concentrations increased from 3.0 mg N/L in 2018, to 8.7 in 2019 and decreased slightly to 8.3 mg N/L in 2020 (Table 3-2).

The concentration and relative distribution of the individual N species (ammonia, nitrate and nitrite) measured at WRSP2 are plotted in Figure 3-2. During the monitoring period, nitrate concentrations ranged from 1.6 to 17.0 mg N/L and represented more than 90% of the T-N in the waters (Figure 3-2). Nitrite and ammonia constituted minor proportions of the T-N and concentrations were significantly lower ranging from <0.1 to 0.16 mg N/L (nitrite) and <0.05 to 0.40 mg N/L (ammonia). The proportion of ammonia, nitrate and nitrite to T-N ranged from 0.3 to 5.7%, 92.0 to 97% and 0.1 to 3.5%, respectively.

Table 3-2:
Touquoy WRSP2 Annual Average and Maximum T-N concentrations

Year	Number of Samples (n)	T-N Average (mg N/L)	T-N Maximum (mg N/L)
2018	4	3.0	4.1
2019	9	8.7	14.2
2020	9	8.3	17.1

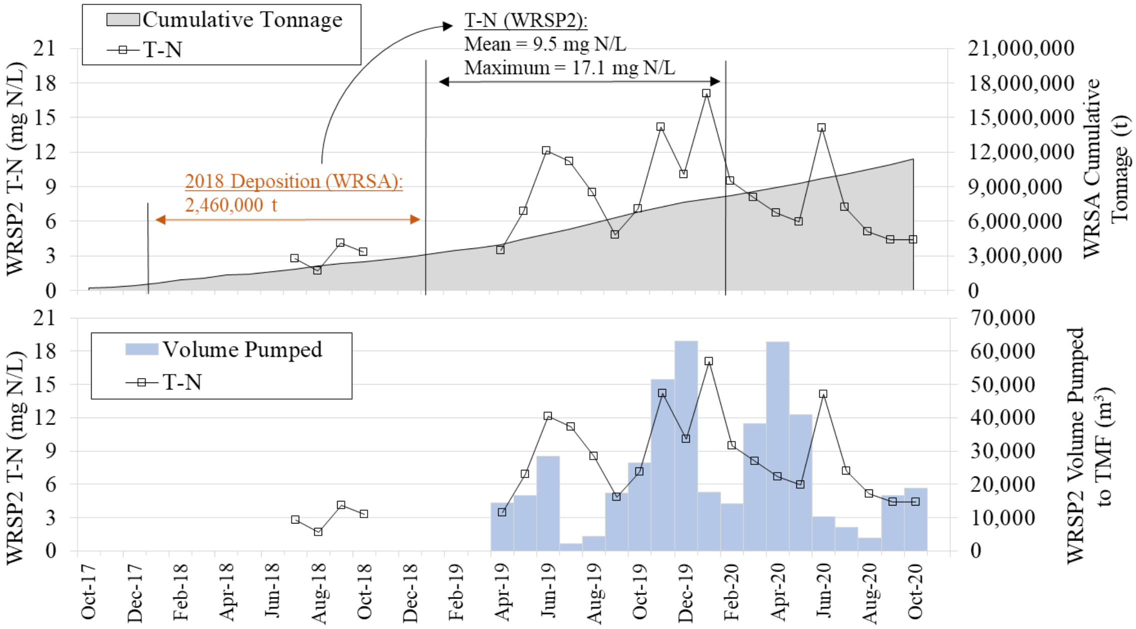

Figure 3-1: **Touquoy WRSA cumulative waste deposition and monthly T-N concentration (top plot) and WRSP2 measured monthly discharge volumes compared to T-N concentrations (bottom plot).**

Although the nitrogen in explosives is almost equally distributed between ammonia and nitrate, the N speciation in WRSA drainage may be influenced by blasting by-products as well as microbial and ion-exchange processes within the waste stockpile. The water quality observed in WRSP2 from April 2019 through October 2020, approximately 1.5 to 3 years after waste deposition in the WRSA commenced, is considered to represent steady-state conditions for the distribution of N species in the Touquoy WRSA drainage. The average N distributions for the April 2019 through October 2020 period are summarized in Table 3-3.

Observations of water quality in the Touquoy WRSP2 indicate the blasted rock N loads are released to contact water within one year of placement during the initial years of mining (Figure 3-1). The release of N from waste rock stockpiles has been observed to lag deposition by 2 to 3 years at mines with low MAP (*e.g.,* Diavik Mine) or large waste stockpiles (*e.g.,* Trend Mine) (Baily, 2013; Lorax, 2017). This may be partially attributable to water retention within the waste stockpile. At small mines in regions with higher MAP and smaller waste stockpiles (*e.g.,* Touquoy Mine), a shorter lag time early in mine life is likely and is consistent with the observations at Touquoy.

Table 3-3:
The Distribution of N Species in Touquoy WRSP2 Waters from April 2019 through October 2020 (Average Values).

Nitrogen Species	% of T-N
Nitrate	97.6%
Nitrite	0.84%
Ammonia	1.55%

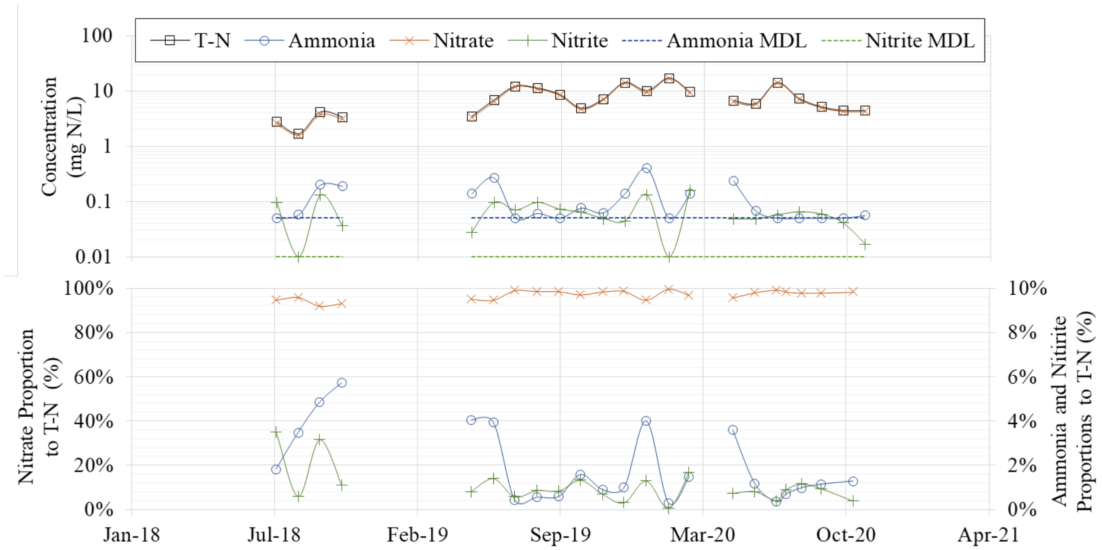

Figure 3-2: **Touquoy WRSP2 ammonia, nitrate, nitrite and T-N concentrations (top plot, logrithmic scale) and distibutions reltive to T-N (bottom plot, linear scale).**

To estimate the N loading rate at Touquoy Mine, the N load on waste rock deposited in 2018 (2,464,794 t) was assumed to yield the average and maximum T-N concentrations, 9.55 and 17.1 mg/L, respectively, that were observed April 2019 through January 2020 (Table 3-2). For blasting of the 2018 waste, the explosives use rate, referred to as the powder factor (PF), was 0.2 kg/t. It is likely that waste placed in 2019 also contributed N loads to the WRSP2 waters, however for the purpose of deriving a N loading rate for Beaver Dam, it is more conservative to assume the water quality observed April 2019 through January 2020 is only influenced by 2018 waste. Based on the 2018 WRSA tonnage, 2019 WRSP2 flows and the T-N concentrations, the Touquoy N loading rates were derived to be 1.20 and 2.14 g N/t, average and maximum, respectively

3.1.2 Scaling of Touquoy N Loading Rate to Beaver Dam

The N on blasted rock originates from the explosives used for blasting. The amount of N loaded to blasted rock is a function of the explosives quantities and the blasting practices that are used. The Beaver Dam Mine will use the same explosives and similar blasting practices as at Touquoy, however the Beaver Dam explosives use per tonne of rock, referred to as the powder factor (PF), is planned to be 0.29 kg/t for waste, higher than the Touquoy PF of 0.2 kg/t for waste mined in 2018. The increased explosives usage may elevate the N load on blasted rock at Beaver Dam relative to Touquoy, therefore, the Touquoy N loading rates are proportionally scaled to the Beaver Dam mine plan using the following equation:

$$r_{BD} = r_{TQ} \times PF_{BD}/PF_{TQ}$$

Where, r_{BD} is the Beaver Dam N loading rate (g N/t rock), r_{TQ} is Touquoy N loading rate, PF_{BD} is the planned Beaver Dam PF for waste rock (kg/t) and PF_{TQ} is the Touquoy PF for waste blasted in 2018.

The average and maximum Touquoy N loading rates are scaled to Beaver Dam to derive the Base Case and Upper Case model conditions for the Beaver Dam WRSA and temporary Ore Stockpile facilities. The N loading rates are calculated to be 1.73 and 3.11 g N/t of blasted rock, for Base Case and Upper Case, respectively (Table 3-4).

**Table 3-4:
Modeled Beaver Dam N Loading Rates for the NAG and PAG WRSAs and the Temporary Ore Stockpile.**

Model Scenario	N Loading Rate (g N/t)
Base Case	1.73
Upper Case	3.11

3.1.3 Beaver Dam Predicted WRSA and Ore Stockpile Annual N Load

The annual waste deposition schedule provided by AMNS (Halas, pers. comm., 2020; Schulte, pers. comm., 2021) is used to calculate Base and Upper Case N loads for each year of waste deposition to the WRSAs (Table 3-5). Note that the reported tonnages at EOM differ slightly from those presented in Table 2-4 due to updates to the mine plan. However, these changes are considered minor and a change in the source term model for species other than N was therefore not considered necessary at this time. The highest annual loads to the NAG and PAG WRSAs are predicted for 2023, the mine year with the highest planned waste deposition to the WRSAs as shown in Table 3-5. The annual N loads from to the Ore Stockpile are derived using the planned maximum 250,000 t of ore placed for temporary storage, yielding annual Base Case and Upper Case N loads of 433 and 778 kg.

For each annual waste rock quantity placed in the WRSAs and temporary Ore Stockpile, the N load released annually was calculated using the following equation:

$$N_{Load} = r_{BD}/1000 \times \ t$$

Where, N_{Load} is the nitrogen load (kg N), r_{BD} is the Beaver Dam N loading rate (g-N/t) and t is the annual tonnage of waste rock scheduled for deposition in the WRSA.

The N Loads derived using the Beaver Dam method were compared to loads predicted by the Ferguson and Leask (1988) methodology. Similar to the Beaver Dam approach, the Ferguson and Leask method is empirically derived from water quality monitoring and explosives use records from surface coal mines in British Columbia. Overall, the N loads predicted by the Beaver Dam method are 47% (Base Case) and 84% (Upper Case) of those derived using the Ferguson and Leask (1988) method. The differences between the two models are attributed to blasting practices and explosives types, explosives use rate (PF), mining rate, the scale of the WRSA facilities (*i.e.,* Beaver Dam is much smaller scale) and climate. The coal mines from which the Ferguson and Leask method was derived had a much higher mining and explosives use rates in comparison to Touquoy and Beaver Dam. It is therefore expected that the Ferguson and Leask model would result in a higher N loading rate in comparison to the Touquoy-based model. Despite these differences, the model results compare within a factor of ~2 and provide an expected point of comparison, lending confidence in the approach offered by the Beaver Dam method.

**Table 3-5:
Beaver Dam NAG and PAG WRSA Waste Depsition Schedule and Calculated Base Case and Upper Case N Loads.**

Mine Year	NAG WRSA			PAG WRSA		
	Waste Deposition (t)	N Load (kg)		Waste Deposition (t)	N Load (kg)	
		Base Case	Upper Case		Base Case	Upper Case
2022	5,539,000	9,607	17,202	487,000	845	1,512
2023	13,506,000	23,426	41,946	806,000	1,398	2,503
2024	10,009,000	17,360	31,085	346,000	600	1,075
2025	5,899,000	10,232	18,321	329,000	571	1,022
2026	1,758,000	3,049	5,460	134,000	232	416
2027	124,000	215	385	23,000	40	71
Total	36,835,000	63,889	114,399	2,125,000	3,686	6,599

3.1.4 Conversion of WRSA N Load to Drainage Concentration

Observations of water quality in the Touquoy WRSP2 indicate the blasted rock N loads are released to contact water within one year of placement during the initial years of mining. To conservatively account for uncertainties around the timing of N release, the highest predicted annual load (year 2023) is used to calculate WRSA drainage N species concentrations at EOM (Table 3-5). This conservative assumption addresses the uncertainty of the lag time between waste deposition and N release at later stages of mine life. A longer lag time will result in a longer delay between waste placement and the export of contact water to the WRSP which could increase the duration of elevated T-N concentrations in WRSA drainage waters.

The predicted Base Case and Upper Case N loads to the WRSA and temporary Ore stockpile are converted to T-N concentrations using the annual runoff volume derived from the estimated infiltration rate of precipitation (90% of the 1350 mm MAP; reported for Halifax Climate Station (Environment and Climate Change Canada Station No. 8202251) and the stockpile footprints at EOM (Table 3-6). The T-N concentrations are converted to ammonia, nitrate and nitrite concentrations based on the steady state proportional distributions observed at Touquoy from April 2019 through October 2020 (Table 3-3). The calculations are summarized by the following formulas:

**Table 3-6:
Beaver Dam NAG and PAG WRSA, and Ore Stockpile Footprints at EOM and the Esitmated Mean Annual Runoff from Each Facility.**

Parameter	NAG WRSA	PAG WRSA	Ore Stockpile
Mean annual precipitation (mm)	1,350		
Mean annual infiltration (mm)	1,215		
Footprint at EOM (m^2)	730,861	108,131	83,888
Mean annual runoff (m^3)	887,996	131,379	101,924

$$C_{T-N} = \frac{N_{Load} / 1000}{V}$$

Where, C_{T-N} is the concentration of T-N (mg/L), N_{Load} is the annual N load (kg) and V is the annual volume (m^3) of runoff predicted for the WRSA; and,

$$C_{N\ Species} = p_{N\ Species} \times C_{T-N}$$

Where, $C_{N\ Species}$ is the concentration of ammonia, nitrate or nitrite (mg N/L), $p_{N\ Species}$ is the proportional distribution of the N species compared to T-N and C_{T-N} is the T-N concentration (mg/L). The Base Case and Upper Case ammonia, nitrite and nitrate predictions for EOM are presented in Section 4.5.

3.2 Pit Wall Source Term Model Approach (EOM)

Operational monitoring data from the Touquoy site are available for the open pit and were used directly in the EOM prediction of nitrogen concentrations in pit wall runoff at Beaver Dam. The direct use of Touquoy operational monitoring data was selected based on the following rationale:

- The reactive rock mass that is available to leach residual nitrogen from blasting activities is much smaller in the pit walls versus the WRSAs and ore stockpiles. Therefore, the delay in the transport of stored nitrogen loads is expected to be much shorter from these facilities; and,
- Nitrogen loading to pit walls is dependent on explosives use and management. Explosives use is influenced by the physical rock properties. Lithologies and physical rock properties making up these mine components are considered sufficiently similar between Touquoy and Beaver Dam, therefore N loading to pit walls is expected to be similar between both sites.

The Touquoy open pit sump (SWOP) monitoring station was utilized to derive the pit wall nitrogen source term. The median and 90th percentile values from monitoring data from August 2017 to October 2020 were used for the Base Case and an Upper Case EOM source term for the pit wall runoff, respectively, and results are presented in Section 4.5.

3.3 Post-Closure N Source Term Derivation

The source of residual N is from explosives used for blasting and is therefore finite. Nitrogen concentrations will decrease once the addition of blasted material to a facility has ceased (*e.g.*, Pommen, 1983). The N depletion rates depend on a variety of factors including the amount of reactive rock surfaces as well as flushing rates. Long-term monitoring of waste rock drainage at the Roman-Trend Mine has shown that N depletion is not linear but rather can be expressed as a decay curve (Figure 3-3) with the highest absolute N reduction observed in the early years after closure (Lorax, 2017). It was found that, in the Post-Closure period, nitrogen concentrations were reduced annually by >10% of the previous year's concentration after correction for seasonal variability. Although the tonnage of the waste rock facility at the Trend-Roman Mine as well as its flushing rates differ markedly from those expected for the Beaver Dam WRSAs and ore stockpile, a conservative annual N depletion rate of 10% was applied to drainage from the Beaver Dam WRSAs (Table 3-7). The current mine plan indicates there will not be a temporary Ore Stockpile during Post-Closure, therefore the N species source terms for the Ore Stockpile are modelled to have an annual depletion rate of 100%. Note that it is herein assumed that nitrite and ammonia are depleted at the same rates as nitrate. The Post-Closure annual depletion rates are applied in the water quality model using the EOM N source terms as the initial concentrations.

For the pit walls, the depletion of nitrogen species is expected to occur significantly faster than in the blasted rock storage facilities due to the smaller size and higher water/rock surface ratios in this mine component. Therefore, data from two field bins constructed with freshly blasted Touquoy material (argillite and greywacke) were considered appropriate to estimate nitrogen depletion rate in the open pit. These field bins were initiated in fall of 2017 and consist of around 150-200 kg of material forming a 0.8 – 1 m thick reactive rock column. Leachate data showed that within one year of field bin operation, nitrate concentrations were reduced by > 90% in both field bins. In that year, both nitrite and ammonia were reduced to below detection limit. To account for uncertainties related to an experimental runtime of only one year and to maintain conservatism, the annual nitrogen depletion rate for the Beaver Dam pit walls was set to 80% (Table 3-7).

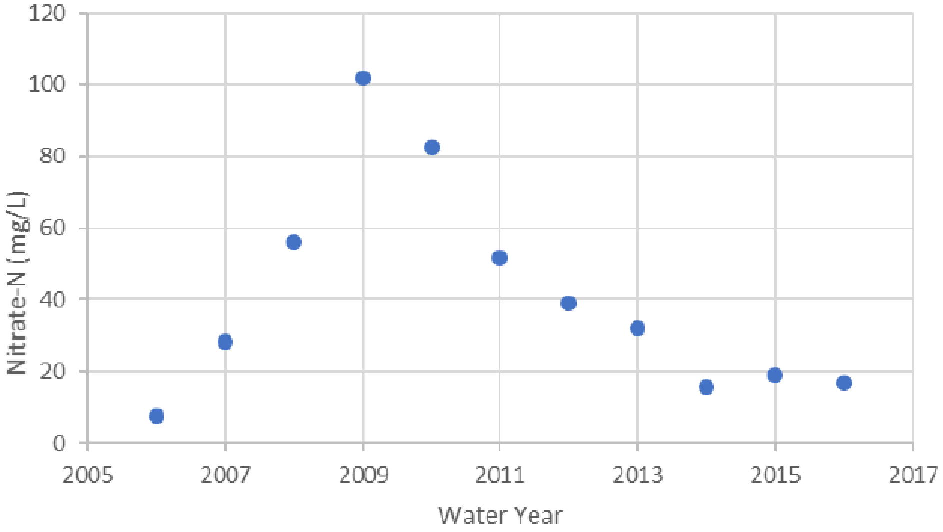

Figure 3-3: Nitrate Concentration Trends Observed in a Waste Rock Monitoring Station at the Roman-Trend Mine (from Lorax, 2017)

Table 3-7:
Annual Nitrogen Depletion Rates Derived in Post-Closure for the Various Beaver Dam Mine Components

NAG WRSA	
Nitrate	10%
Nitrite	
Ammonia	
PAG WRSA	
Nitrate	10%
Nitrite	
Ammonia	
Ore Stockpile	
Nitrate	100%
Nitrite	
Ammonia	
Pit Walls	
Nitrate	80%
Nitrite	
Ammonia	

Notes: NAG = Non-Acid Generating;
PAG = Potentially Acid Generating;
WRSA = Waste Rock Storage Area.

4. Model Results

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4. Model Results

4.1 Waste Rock Storage Areas

Geochemical source terms for the NAG and PAG WRSAs at Beaver Dam are given in Table 4-1 and Table 4-2, respectively.

Table 4-1:
Geochemical Source Term Predictions for the NAG WRSA

Parameter	Units	End of Mining		Post-Closure	
		Base Case	Upper Case	Base Case	Upper Case
pH	-	7.5	7.5	7.5	7.5
Sulphate	mg/L	631	873	414	445
Al	mg/L	0.0058	0.0059	0.0058	0.0058
Ag	mg/L	0.000050	0.00010	0.000050	0.00010
As	mg/L	0.018	0.023	0.0071	0.0083
B	mg/L	0.025	0.050	0.025	0.050
Ca	mg/L	70	61	86	82
Cd	mg/L	0.000030	0.000050	0.000040	0.000060
Co	mg/L	0.0026	0.0037	0.0029	0.0038
Cr	mg/L	0.00050	0.0010	0.00050	0.0010
Cu	mg/L	0.0010	0.0020	0.0010	0.0020
Fe	mg/L	0.0041	0.0042	0.0040	0.0040
Hg	mg/L	0.000010	0.000010	0.000010	0.000010
K	mg/L	45	63	25	27
Mg	mg/L	59	73	29	30
Mn	mg/L	0.085	0.10	0.11	0.12
Mo	mg/L	0.015	0.033	0.059	0.064
Na	mg/L	101	190	48	64
Ni	mg/L	0.035	0.046	0.024	0.040
Pb	mg/L	0.00025	0.00050	0.00025	0.00050
Sb	mg/L	0.00023	0.00049	0.00013	0.00027
Se	mg/L	0.0015	0.0027	0.00071	0.0021
Tl	mg/L	0.000050	0.00010	0.000050	0.00010
U	mg/L	0.026	0.033	0.0068	0.0075
Zn	mg/L	0.0077	0.0086	0.0076	0.013

Notes: NAG = Non-Acid Generating; WRSA = Waste Rock Storage Area.

Table 4-2:
Geochemical Source Term Predictions for the PAG WRSA

Parameter	**Units**	**End of Mining**		**Post-Closure**	
		Base Case	Upper Case	Base Case	Upper Case
pH	-	7.5	7.5	4.0	3.5
Sulphate	mg/L	638	872	701	856
Al	mg/L	0.0058	0.0059	0.13	0.14
Ag	mg/L	0.000050	0.00010	0.00012	0.00012
As	mg/L	0.017	0.022	0.035	0.041
B	mg/L	0.025	0.050	0.30	0.42
Ca	mg/L	70	61	67	62
Cd	mg/L	0.000030	0.000060	0.012	0.016
Co	mg/L	0.0029	0.0041	0.80	1.0
Cr	mg/L	0.00050	0.0010	0.0015	0.0034
Cu	mg/L	0.0010	0.0020	0.032	0.077
Fe	mg/L	0.0041	0.0042	13	46
Hg	mg/L	0.000010	0.000010	0.000010	0.000010
K	mg/L	48	67	27	28
Mg	mg/L	62	76	79	84
Mn	mg/L	0.088	0.11	1.1	1.2
Mo	mg/L	0.014	0.032	0.0028	0.0032
Na	mg/L	97	181	72	113
Ni	mg/L	0.039	0.052	8.0	12
Pb	mg/L	0.00025	0.00050	0.14	0.31
Sb	mg/L	0.00020	0.00044	0.00012	0.00028
Se	mg/L	0.0015	0.0027	0.0055	0.012
Tl	mg/L	0.000050	0.00010	0.00088	0.0011
U	mg/L	0.019	0.024	0.048	0.053
Zn	mg/L	0.0076	0.0082	6.0	8.4

Notes: PAG = Potentially Acid Generating; WRSA = Waste Rock Storage Area.

4.2 Pit Walls

Geochemical source term predictions for pit wall runoff at Beaver Dam are given in Table 4-3.

Table 4-3:
Geochemical Source Term Predictions for the Beaver Dam Pit Walls

Parameter	Units	End of Mining		Post-Closure	
		Base Case	Upper Case	Base Case	Upper Case
pH	-	7.5	7.5	7.5	7.5
Sulphate	mg/L	433	541	333	344
Al	mg/L	0.0058	0.0058	0.0058	0.0058
Ag	mg/L	0.000070	0.000080	0.000070	0.000070
As	mg/L	0.018	0.023	0.0074	0.0089
B	mg/L	0.15	0.22	0.086	0.11
Ca	mg/L	83	74	96	94
Cd	mg/L	0.000010	0.000020	0.000090	0.00012
Co	mg/L	0.0024	0.0034	0.0096	0.015
Cr	mg/L	0.00050	0.0010	0.00050	0.0010
Cu	mg/L	0.0010	0.0020	0.0010	0.0020
Fe	mg/L	0.0040	0.0041	0.0040	0.0040
Hg	mg/L	0.000010	0.000010	0.000010	0.000010
K	mg/L	41	57	20	21
Mg	mg/L	26	32	12	12
Mn	mg/L	0.035	0.042	0.043	0.046
Mo	mg/L	0.048	0.11	0.21	0.23
Na	mg/L	56	97	31	37
Ni	mg/L	0.039	0.050	0.17	0.44
Pb	mg/L	0.00045	0.0011	0.0016	0.0096
Sb	mg/L	0.00024	0.00052	0.00013	0.00024
Se	mg/L	0.00094	0.0016	0.00045	0.0017
Tl	mg/L	0.000050	0.00010	0.000050	0.000080
U	mg/L	0.049	0.063	0.016	0.018
Zn	mg/L	0.0044	0.0051	0.096	0.25

4.3 Ore Stockpile

Geochemical source term predictions for the Beaver Dam ore stockpile are given in Table 4-4.

Table 4-4:
Geochemical Source Term Predictions for the Beaver Dam Ore Stockpile

Parameter	**Units**	**End of Mining**		**Post-Closure**	
		Base Case	Upper Case	Base Case	Upper Case
pH	-	7.5	7.5	6.0	5.5
Sulphate	mg/L	582	758	565	564
Al	mg/L	0.0058	0.0058	0.027	0.051
Ag	mg/L	0.000050	0.00010	0.00014	0.00014
As	mg/L	0.016	0.027	0.0084	0.012
B	mg/L	0.025	0.050	0.31	0.47
Ca	mg/L	73	65	74	73
Cd	mg/L	0.000040	0.000071	0.0039	0.0045
Co	mg/L	0.0019	0.0026	0.25	0.24
Cr	mg/L	0.00050	0.0010	0.0015	0.0025
Cu	mg/L	0.0010	0.0020	0.0082	0.011
Fe	mg/L	0.0041	0.0041	0.13	0.40
Hg	mg/L	0.000010	0.000010	0.000020	0.000020
K	mg/L	53	82	40	44
Mg	mg/L	60	76	62	50
Mn	mg/L	0.11	0.13	0.56	0.64
Mo	mg/L	0.011	0.025	0.0090	0.0070
Na	mg/L	67	115	42	62
Ni	mg/L	0.028	0.032	2.7	2.5
Pb	mg/L	0.00025	0.00050	0.032	0.044
Sb	mg/L	0.00034	0.00081	0.00014	0.00033
Se	mg/L	0.0018	0.0025	0.0020	0.0026
Tl	mg/L	0.000050	0.00010	0.00047	0.00038
U	mg/L	0.015	0.017	0.017	0.019
Zn	mg/L	0.0070	0.014	1.2	2.1

4.4 Overburden Stockpiles

Geochemical source term predictions for the Beaver Dam topsoil and till stockpiles are given in Table 4-5. Note that these source terms apply for both the EOM and PC scenario.

Table 4-5:
Geochemical Source Term Predictions for the Beaver Dam Overburden Stockpiles

Parameter	**Units**	**Topsoil Stockpile**		**Till Stockpile**	
		Base Case	Upper Case	Base Case	Upper Case
pH	-	5.5	5.0	6.7	5.5
Sulphate	mg/L	9.0	33	65	127
Al	mg/L	0.081	0.83	0.0078	0.11
Ag	mg/L	0.000030	0.000030	0.000030	0.000030
As	mg/L	0.0038	0.19	0.0021	0.0076
B	mg/L	0.0050	0.011	0.0050	0.011
Ca	mg/L	1.0	5.7	22	41
Cd	mg/L	0.000030	0.00016	0.000030	0.000040
Co	mg/L	0.00084	0.0050	0.00019	0.00097
Cr	mg/L	0.00088	0.0012	0.00025	0.00098
Cu	mg/L	0.0014	0.0064	0.0020	0.0034
Fe	mg/L	0.26	0.46	0.023	0.16
Hg	mg/L	0.000030	0.000030	0.000030	0.000030
K	mg/L	0.79	2.4	0.81	1.3
Mg	mg/L	0.47	1.1	2.3	5.5
Mn	mg/L	0.11	0.12	0.11	0.30
Mo	mg/L	0.000050	0.00016	0.0027	0.012
Na	mg/L	1.6	3.3	3.6	2.4
Ni	mg/L	0.0015	0.022	0.00046	0.0015
Pb	mg/L	0.00013	0.0011	0.00010	0.00019
Sb	mg/L	0.000050	0.00011	0.00020	0.00051
Se	mg/L	0.00079	0.00095	0.00058	0.0014
Tl	mg/L	0.000050	0.000050	0.000050	0.000050
U	mg/L	0.000090	0.00010	0.000090	0.00099
Zn	mg/L	0.0050	0.032	0.0050	0.0050

4.5 Nitrogen Source Terms

End of mine nitrogen source terms for the blast-affected mine rock facilities are presented in Table 4-6. The nitrogen depletion rates to be applied in the water quality model for the Post-Closure scenario are discussed in Section 3.3.

Table 4-6:
Ammonia, Nitrate and Nitrite Source Term Predictions for the NAG WRSA, PAG WRSA, Ore Stockpile and Beaver Dam Pit Walls

Parameter	Units	End of Mining	
		Base Case	Upper Case
NAG WRSA			
Nitrate	mg N/L	25.7	46.1
Nitrite	mg N/L	0.22	0.40
Ammonia	mg N/L	0.41	0.73
PAG WRSA			
Nitrate	mg N/L	10.4	18.6
Nitrite	mg N/L	0.089	0.16
Ammonia	mg N/L	0.16	0.30
Ore Stockpile			
Nitrate	mg N/L	4.1	7.4
Nitrite	mg N/L	0.036	0.064
Ammonia	mg N/L	0.066	0.12
Pit Walls			
Nitrate	mg N/L	5.4	15.4
Nitrite	mg N/L	0.19	1.6
Ammonia	mg N/L	2.4	8.7

Notes: PAG = Potentially Acid Generating; NAG = Non-Acid Generating; WRSA = Waste Rock Storage Area.

5. Closure

5. Closure

This Lorax document was prepared for AMNS to provide a geochemical source term update for the Beaver Dam project.

Yours sincerely,
Lorax Environmental Services Ltd.

Prepared by:

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