Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration

Response to Ministerial Request for Additional Information

March 2022

Prepared for:

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File: 121619250

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Abbreviations

AMNS	Atlantic Mining NS Corp
BFL	Boreal Felt Lichen
CN	Cyanide
CRA	Conestoga Rovers and Associates
EA	Environmental Assessment
EARD	Environmental Assessment Registration Document
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
ETP	Effluent Treatment Plant
FBR	Fluidized Bed Reactor
FDP	Final Discharge Point
FEC	Forest Ecosystem Classification
GBR	Gravel Bed Reactor
GFH	Granular Ferric Hydroxide
GWCP	Groundwater Contingency Plan
IA	Industrial Approval
MAD	Mean Annual Discharge
MBBR	Moving Bed Biofilm Reactor
MDMER	Metal and Diamond Mine Effluent Regulations
MMMP	Mainland Moose Management Plan
NCE	Natural Communities and Ecosystems
NRR	Nova Scotia Natural Resources and Renewables
NSDNR	Nova Scotia Department of Natural Resources
NS ECC	Nova Scotia Environment and Climate Change
RO	Reverse Osmosis
TMF	Tailings Management Facility
WESP – AC	Wetland Ecosystem Services Protocol – Atlantic Canada
WL	Wetland
WMP	Wildlife Management Plan
WRSA	Waste Rock Storage Area

1.0 INTRODUCTION

The Touquoy Gold Project (also referred to as the Approved Project) is an open pit gold mine operated by Atlantic Mining NS Inc (AMNS) under Industrial Approval (IA) No. 2012-0824244-11. AMNS is a wholly owned subsidiary of the Australian-based St. Barbara Limited. The Touquoy Gold Project is located in Moose River, Nova Scotia, approximately 63 km northeast of Halifax and 19 km southeast of Middle Musquodoboit. The Touquoy Gold Project started mining operations in 2017 and attained commercial production in March 2018, with an estimated life of four to six years.

AMNS is proposing modifications to the Approved Project that are required to support ongoing operation. These modifications include: use of the exhausted Open Pit for tailings disposal; expansion of the Waste Rock Storage Area (WRSA); expansion of the Clay Borrow Area; and realignment of the Plant Access Road used to access the Plant Site.

Upon review of these proposed modifications to the Approved Project, the Minister of Environment determined that a Class I EA (Environmental Assessment) registration under the *Environment Act* and Environmental Assessment Regulations was required. On July 16, 2021 AMNS registered the Touquoy Gold Project Site Modifications (the Project) for environmental assessment with the submission of an Environmental Assessment Registration Document (EARD) to Nova Scotia Environment and Climate Change (NSECC).

On September 8, 2021, following regulatory, Indigenous and public review of the EARD, the Minister of Environment determined that the information in the EARD was insufficient to make a decision on the Project and that additional information is required regarding in-pit mine tailings disposal, ground and surface water, fish and fish habitat, protected areas, wildlife, wetlands and historical mine tailings. This Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration (the Addendum) presents AMNS' response to the additional information requested.

1.1 PROPONENT INFORMATION

The proponent is Atlantic Mining NS Corp (AMNS), a wholly owned subsidiary of the Australian based St. Barbara Limited. In addition to the Touquoy Gold Project, AMNS holds three other gold development projects in Nova Scotia which are at various stages of planning and regulatory review. These are the Beaver Dam Mine Project, Fifteen Mile Stream Gold Project, and the Cochrane Hill Gold Project.

Project Name: Touquoy Gold Project Modifications

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1.2 DOCUMENT STRUCTURE

This document has been prepared to fulfill additional information requirements as requested by the Minister of Environment. Table 1.1 is a concordance table which relates each information request with the relevant report section.

Table 1.1 Concordance of Ministerial Information Requests

IR No. (assigned)	Ministerial Request for Additional Information	Relevant Report Section
In-pit Tailings Disposal		
1	Describe mine pit permeability and detail mitigation measures to decrease pit permeability	2.1
2	Clarify the mine pit capacity for project tailings and future proposed tailings deposition	2.2
3	Describe proposed in-situ water treatment plan and schedule.	2.3
4	Describe how the pit and Waste Rock Storage Area discharge points will meet Metal and Diamond Mining Effluent Regulations and Fisheries Act requirements.	2.4
Ground and Surface Water		
5	Provide a third-party expert review of the ground and surface water modelling presented and referenced in the Environmental Assessment Registration Document (EARD)	3.1
6	Describe current and potential impacts to Watercourse #4 in the EARD including any monitoring data not included in the EARD submission.	3.2
7	Provide a more detailed analysis and clarify the impacts to Moose River currently, and as a result of the proposed project.	3.3
8	In consultation with the Inspection and Compliance Division and Water Resources Branch at ECC, clarify or provide information related to water quality and quantity analysis inconsistencies	3.4 Appendix A
Wildlife		
9	Provide all flora and fauna survey data referenced in the EARD with corresponding analysis.	4.1
Wetlands and the Ship Harbour Long Lake Wilderness Area		
10	Provide additional analysis for avoidance of Wetland #15, a Wetland of Special Significance under the ECC Wetland Policy	5.1
11	Provide an analysis of potential impacts to the Ship Harbour Long Lake Wilderness Area and proposed mitigations.	5.2
Historic Tailings		
12	Provide a description and map of historic mine tailings within or near the proposed project footprint. Provide a plan to manage the historic tailings	6.0

Table 1.1 Concordance of Ministerial Information Requests

IR No. (assigned)	Ministerial Request for Additional Information	Relevant Report Section
Fish and Fish Habitat		
13	Provide all fish surveys and relevant data that has been completed at or near the Touquoy site.	7.1
14	Conduct fish and fish habitat surveys in Square Lake and provide analysis.	7.2
15	Conduct fish sampling in Moose River	7.3
16	Provide information to support statements in the EARD indicating there are no or limited impacts to fish and fish habitat in Watercourses: Square Lake, Upper Fish River, Watercourse #14, Watercourse #13, Watercourse #3	7.4

2.0 IN-PIT TAILINGS DISPOSAL

2.1 MINE PIT PERMEABILITY (IR 1)

Describe mine pit permeability and detail mitigation measures to decrease pit permeability

2.1.1 Background

The EARD acknowledges the potential for groundwater flow pathways between the Open Pit and Moose River during the post-closure phase of the project (Section 6.5.1).

Appendix D.1 (Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit) provided further discussion of what is known about the bedrock hydrostratigraphic units (Section 3.3.2). Hydraulic conductivity testing was conducted in bedrock at the Mine Site, both in the weathered fractured bedrock and the competent fractured bedrock; however, faults in the bedrock were not specifically tested to assess hydraulic conductivity in advance of modelling. Regular observations of the fault traces on the pit walls have identified some discrete areas of seepage, with total flow from the exposed faults being generally very low.

As identified in the EARD, work was planned to supplement the data used in the Pit design and associated groundwater modelling and assessment of potential environmental effects. This work was initiated in Fall 2021 and has been used to support groundwater modelling updates, pit design and mitigation.

The following information serves to describe the additional work undertaken, and to relate any new findings to the assessment of environmental effects. This information, and the supporting technical reports which are attached also address issues raised in the Third Party Review (Appendix C.1).

Work undertaken to characterize mine pit permeability is described in the following attached reports and attachments:

- Appendix B.1 Factual Data Report. Hydrogeological Site Investigation, Touquoy In-Pit Tailings Disposal
- Appendix B.2 Touquoy In-Pit Disposal - Seepage Mitigation Measures

2.1.2 Summary of Assessment – EARD

The groundwater flow model (Appendix D.1 to the EARD) was used to predict the groundwater inflow rates to the Open Pit during the filling of the Open Pit with tailings and water. The filling of the Open Pit was simulated by adding tailings to the model, and then predicting the groundwater inflow rates to the pit over time.

The potential impacts to groundwater quality associated with in-pit tailings disposal during filling were predicted to be minor in nature and localized to within a short radius of the flooded Open Pit. During the post-closure period, the deposition of tailings in the Open Pit will affect the water quality in the pit, primarily the pore water quality in the tailings within the Open Pit. This lower quality water has the potential to migrate toward Moose River via groundwater. The Touquoy groundwater model was used to simulate the migration of solutes from the Open Pit to Moose River. As described in the Touquoy groundwater modelling report (Appendix D.1 to the EARD), the model simulated the release of water from the pore spaces in the deposited tailings, and the pit lake quality based on a relative contribution basis. The total groundwater seepage rate was simulated to contribute approximately 0.6% of the flow in Moose River; therefore, the mass loading of the primary compounds of concern were predicted to be low and not anticipated to adversely affect the water quality in Moose River.

In addition to the standard management and monitoring measures to be implemented for the Project the following specific measures related to in-pit tailings storage were recommended to reduce adverse effects on groundwater resources:

- Limit construction footprint (i.e., PDA) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the PDA.
- Use standard construction methods, such as seepage cutoff collars, where trenches extend below the water table to mitigate preferential flow paths.
- Use standard bedrock grouting methods on high permeability fractures along the wall of the Open Pit to prevent migration of groundwater.
- Use standard management practices throughout the Project, including drainage control and excavation dewatering.
- Maintain existing non-contact water diversion berms around the perimeter of the Open Pit to prevent the migration of clean runoff from the Open Pit during Project operation.
- Implement the Project-specific GWCP (Stantec 2019a).
- Additional characterization of the hydrogeological parameters in the vicinity of the Touquoy Open Pit, to confirm the properties of the faults and identify potential high permeability fractures.

The conclusion of the assessment of potential environmental effects on groundwater quantity and quality were as follows:

- With mitigation and environmental protection measures, the residual effect of a change in groundwater quantity is predicted to be not significant, because the extent of groundwater drawdowns during operation and closure of the Project components are located within the development area of the site, and will not result in changes to well yields at existing or future groundwater users.
- With mitigation and environmental protection measures, the residual effect of a change in groundwater quality was predicted to be not significant, because the extent of changes in groundwater quality resulting from the WRSA expansion, or the in-pit disposal of tailings will not result in groundwater quality that exceeds the GCDWQ for a consecutive period of 30 days or more for existing or future groundwater users located outside of the PDA.

The following information summarizes the results of the hydrogeological site investigation and includes an overview of the studies undertaken, revised groundwater modelling results, and additional details on planned mitigation

2.1.3 Hydrogeological Site Investigation

Appendix B.1 provides a full report and discussion of the hydrogeological site investigation.

A site investigation was initiated to collect additional data required to support the detailed design for planned in-pit tailings disposal at the Touquoy Mine site. The investigation is part of the overall hydrogeological characterization work with the objective of advancing the knowledge of the bedrock and overburden soils conditions around the open pit to and to better define the hydrogeological conditions of the site. Specifically, the investigation program was designed to investigate the presence of preferential pathways, such as fractures and faults not characterized in previous investigations/field assessments that was identified as a data gap in the earlier in-pit disposal groundwater modeling.

To identify the data gaps and define the site investigation requirements, a comprehensive review of available historical information was completed. Based on this review an investigation program consisting of borehole drilling, in-situ hydraulic conductivity testing, downhole geophysical surveys and monitor well installations was implemented. Twelve boreholes with drill depths ranging from approximately 40 meters to 120 meters were completed around the pit with each borehole targeting the presence of potential preferential seepage pathways, such as fractures and faults. The locations of the boreholes are shown on Figure 2-1. In addition, to help confirm and delineate the extent of historical underground workings in the southwest corner of the Open Pit, a ground penetrating radar (GPR) surface geophysical survey was completed.

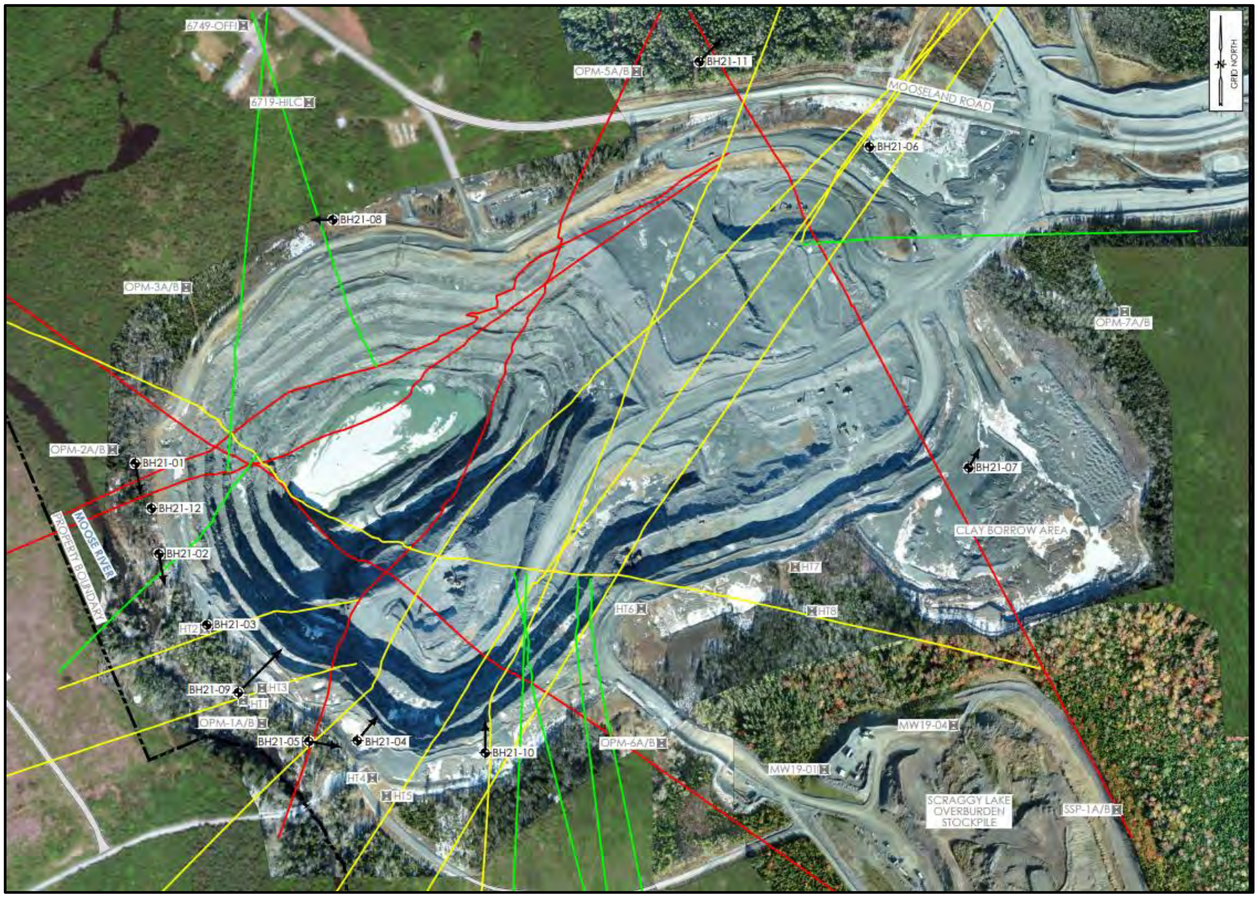


Figure 2.1 Drilling Locations Showing Structural Faults

The bedrock hydraulic conductivities obtained from the new 2021 investigations are generally within or below the historical ranges used for the previous modelling, as shown on Figure 2.2. In addition, a review of the 2021 data shows there was no significant variation of hydraulic conductivity associated with fault zones identified in the pit area. This indicates that despite structural features logged within the tested intervals, those features appear to be hydraulically isolated and/or localized such that they are not increasing the overall hydraulic conductivity within the bedrock immediately surrounding boreholes. These results are consistent with regular observations of the faults exposed in the Open Pit which have identified some discrete seepage but generally total flow from these exposed faults is very low.

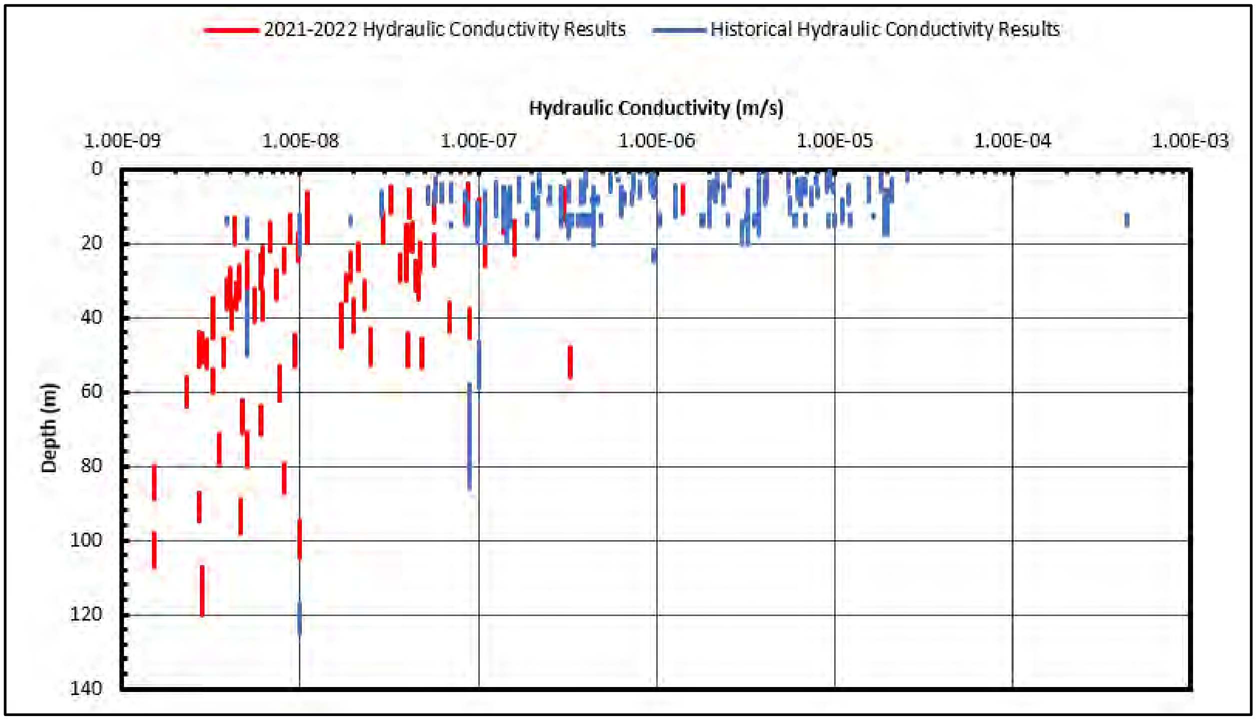


Figure 2.2 Compilation of Bedrock Hydraulic Conductivity (Historical and 2021 Investigation)

Based on the findings of the 2021 investigation, the structural geology (fault) model provided by Atlantic Gold appears representative of the actual site conditions. The 3D structural model which incorporates the AMNS structural model and the results of the 2021 hydrogeological study show that geological faults zones are located within the areas as anticipated.

The knowledge of the underground workings at the site has been advanced based on the work described herein, review and integration of available historical records, the geological model prepared by AMNS, and documented observations of the pit wall during construction. GPR surveys have provided additional data related to underground workings outside of the pit shell. This information has been cross-validated and combined to develop a detailed understanding of the geological environment proximate to the Open Pit. All available location information related to the underground workings is shown on drawings attached to Appendix B.1. Three-Dimensional views of the underground workings are presented in Figure 2.3, and show that the workings that intersect the pit wall are generally located in the western area of the pit.

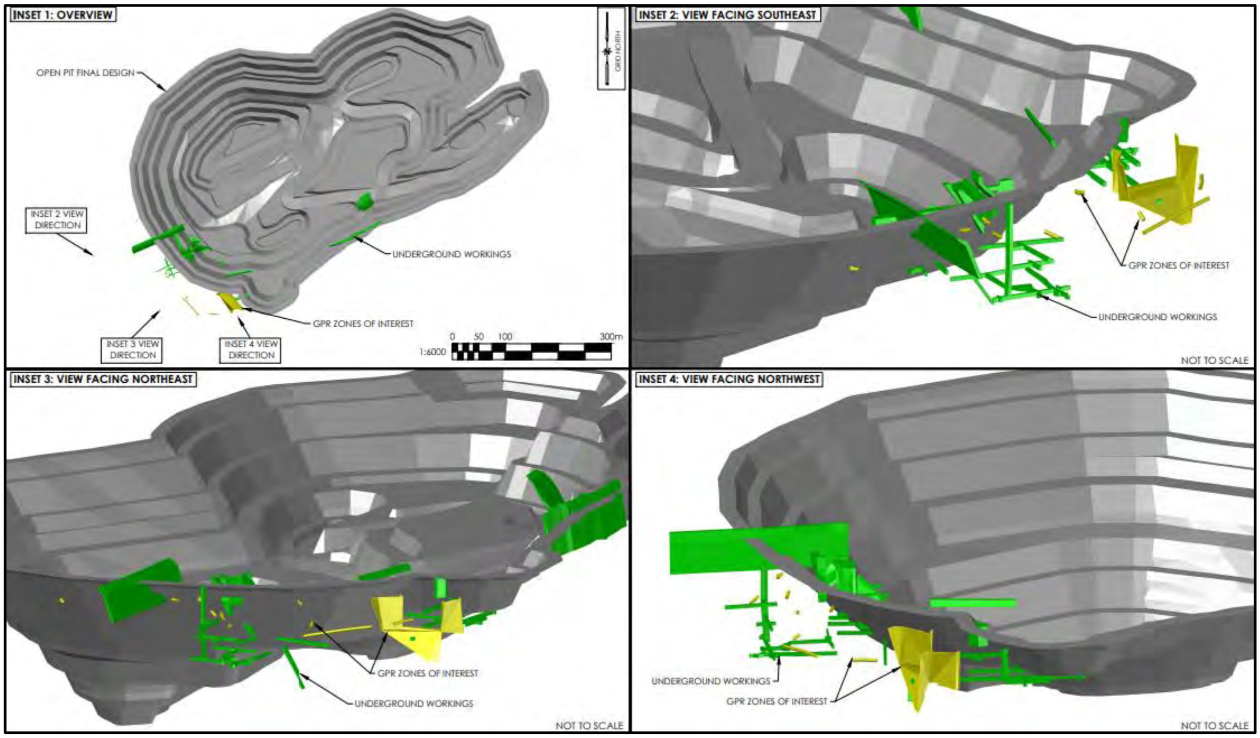


Figure 2.3 3D Model Showing Underground Workings and GPR Zones of Interest

Taken together, previous site investigations, the structural geological model, and the site investigations undertaken in 2021/2022, the findings of this work:

- Validate the geological model developed by AMNS (July 2020, updated February 2022, Appendix E)
- Provide confidence in the understanding of the location and lateral extent of the underground workings
- Confirm that the data used in the original groundwater flow and solute transport model (Appendix D.1 in the EARD) were conservative; with the new data demonstrating generally lower permeability in bedrock around the Open Pit.

2.1.4 Updated Groundwater Modelling Results

The results of the update to the groundwater flow and solute transport model are provided in Appendix B.2.

The original numerical groundwater flow model (Appendix D.2 of the EARD) was revised to incorporate additional data collected from the hydrogeological site investigation. The model was updated and recalibrated to incorporate data from drilling, packer testing, and geophysics investigations performed in 2021 and early 2022 as reported in Appendix B.1.

Specific changes made to the groundwater flow model include:

- Incorporating new estimates of hydraulic conductivity in the bedrock units and selected fault zones
- Refining the locations of underground mine workings based on additional information from AMNS and a surface geophysical investigation
- Recalibrating the groundwater flow model to reflect the new field data
- Re-running the groundwater flow and transport model to update the predicted mass fluxes of dissolved constituents from the Open Pit that have the potential to affect Moose River.

Other than the changes above, the groundwater flow and transport model was unchanged from that submitted in support of the EARD. The modelling presented in the EARD and described in Appendix B.2 was conducted using the Groundwater Vistas (Environmental Simulations, Inc. 2017) graphical user interface (GUI) for MODFLOW-NWT (Niswonger et al. 2011) as the groundwater flow code, and MT3D-USGS (Bedekar et al. 2016) as the numerical solute transport code. MT3D-USGS is a modular three-dimensional multispecies transport code for simulation of advection, dispersion and chemical reactions of contaminants in groundwater systems.

The hydrogeological site investigation (Appendix B.1) resulted in additional data regarding aquifer parameters and the potential extent of historic underground workings on the west side of the Open Pit, between the pit and Moose River. The field investigations included drilling and coring, packer testing, downhole geophysics, and surface geophysics. Details of the investigation methods and results are presented in Appendix B.1 to the Main Addendum Report.

Results of the field investigations were used in three ways:

- boring logs and surface geophysics were used to evaluate the nature and potential extent of underground workings and to characterize the flow characteristics of natural fault zones
- packer test data were used to characterize hydraulic conductivity of the hydrostratigraphic units identified in the original EARD model
- new groundwater elevation data were combined with the stream elevation of Moose River to provide updated groundwater elevation contours and calibration targets

The recalibrated groundwater flow model included water level measurements at 17 additional locations around the Open Pit. These 17 additional calibration targets included water level measurements at various levels in the competent bedrock.

The calibration quality of the updated model is similar to the calibration quality of the original EARD model. Additional details and model output are presented in Appendix B.2. The updated model results are similar to the results from the original EARD model.

2.1.5 Mitigation

Based on the available information and analysis completed, the hydraulic conductivity for the bedrock in the pit area does not indicate additional seepage mitigation is required to avoid environmental interactions. However, to address any uncertainty related to the presence and interconnectivity of the underground workings, a low permeability liner is proposed on the western side of the Open Pit. In addition, there are localized fault zones where concentrated grouting may be required. Seepage mitigation measures are described in full in the attached Memo, Appendix B.2.

<u>Seepage Mitigation – Pit Wall Liner</u>

The concept for the seepage mitigation includes placement of a clay till liner between the tailings and the pit wall. For the purposes of this discussion, the terms upstream and interior are used to describe areas towards the middle of the Open Pit and the terms downstream or exterior are used to describe areas towards the outside of the Open Pit or the surrounding environment.

A typical cross section of the concept is shown on Figure 2.4, and includes the following components:

- **Low Permeability Layer (Clay Till Liner)** – A low permeability element will be constructed of locally sourced clay till. The total normal thickness of the clay till liner (the liner) will be 3 m to 5 m wide.
- **Drainage/Filter layer** – A drainage/filter layer will be placed to the exterior of the liner to provide drainage control of effluent seeping through the liner from the Open Pit as well as groundwater flowing into the Open Pit. This layer will also mitigate the migration of fines from the clay till to the downstream. Additional drainage elements may be required near the base of the liner to accommodate seepage quantities, and this will be determined during detailed design.
- **Upstream Filter (if required)** – A filter layer may also be placed on the interior of the clay till to prevent the migration of fines into the rockfill layer caused by any groundwater seepage into the Pit, particularly during early stages of pit filling. Seepage from the exterior through the liner is expected to be minimal due to the exterior drainage layer discussed above. This could be a granular filter or a geotextile and will be determined during detailed design.
- **Upstream Protection / Stabilization Layer** – A rockfill protection/stabilization zone on the interior of the liner and upstream filter layer will provide overall slope stability of the fill and erosion protection from surface water and wave runup.

The vertical extent of the clay layer is from the crest of the pit to the rock bench at approximate elevation 60 m, which is below the majority of the underground workings.

Construction sequencing will consist of rockfill placement to the elevation 60 m bench at a slope of 1.5 Horizontal to 1.0 Vertical as shown in Figure 2.4. Placement of the exterior drainage/filter layer, clay till liner, interior filter and rockfill will then be placed and compacted in horizontal lifts using conventional construction practices to bring the elevation of the liner to the top of the pit. Additional rockfill width was included on the upstream side of the slope to allow for a safety berm and hauling surface to reduce traffic on the clay till and filter layers.

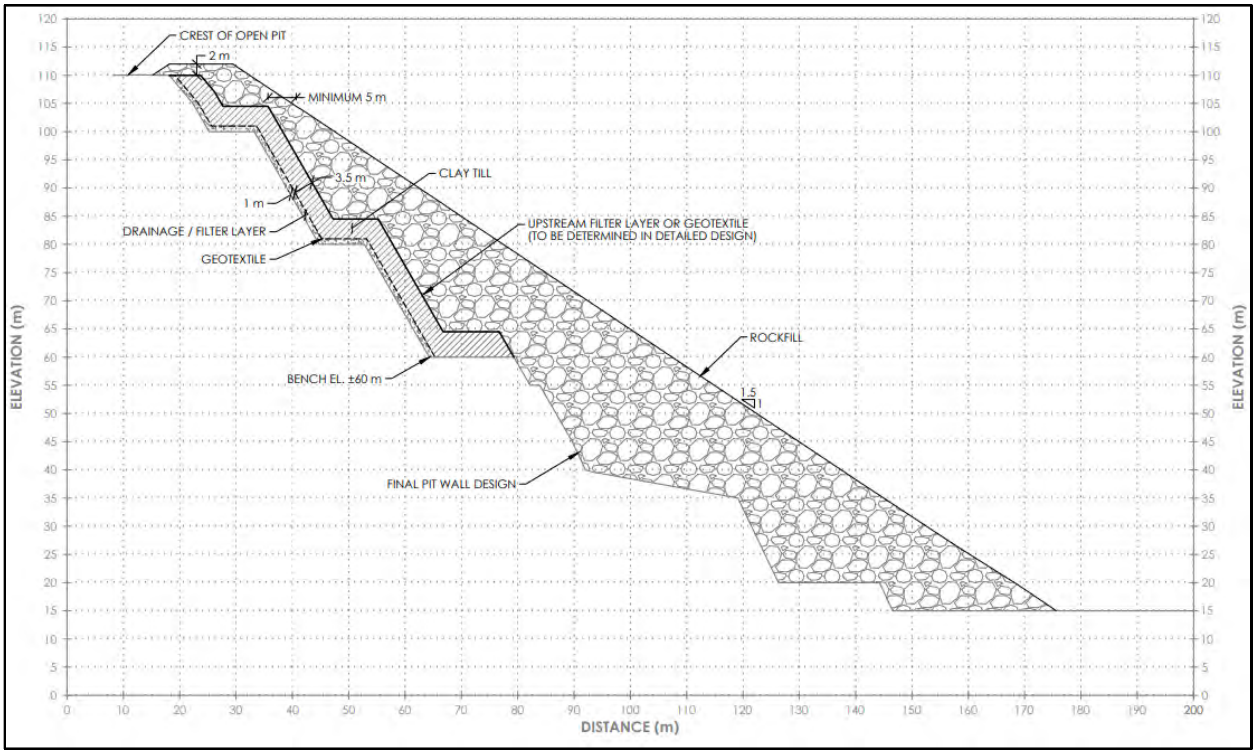


Figure 2.4 Typical Mitigation Section

A conceptual drawing of the planned mitigation, showing the area of underground workings, and stages of mitigation treatment is shown on Figure 2.5.

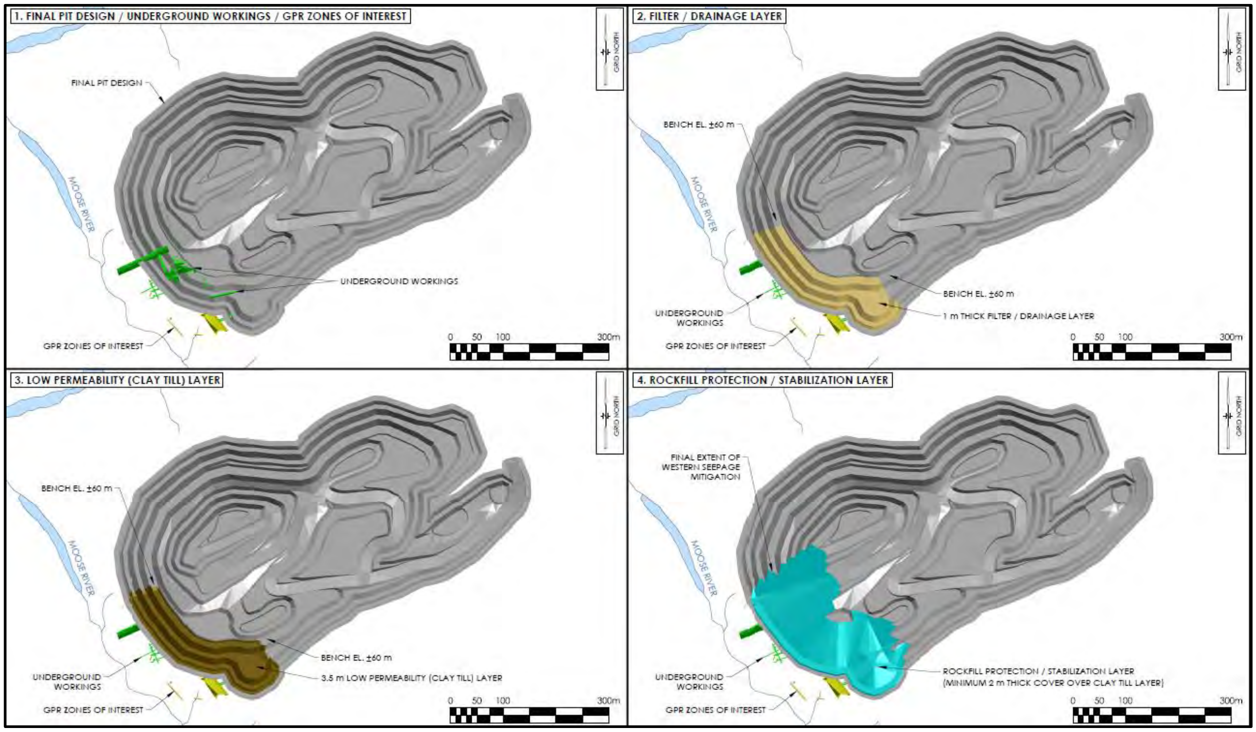


Figure 2.5 Seepage Mitigation Overview

Seepage Mitigation – Fracture Grouting (If required)

Although the permeability has been shown to be low, an additional layer of conservatism in mitigation design will be applied to increase confidence in integrity of the localized fracture zones (faults). During detailed design, location specific plans will be developed, focusing on the primary and secondary facture zones. Mitigation zones will be identified based on the location, characteristics, and permeability ratings of the faults. These will be sealed by downhole pressure grouting, which involves drilling borehole(s) near the zone of interest and pumping pressurized grout to infill the fractures to decrease the overall permeability of the zone. Details of the grout hole depths, locations, orientations, grouting materials and pumping pressures will be assessed for each specific location during detailed design.

2.1.6 Conclusion

The results from updated groundwater flow and transport modelling do not substantively change the predicted groundwater contributions to the assimilative capacity modelling performed for the EARD. In the water balance/water quality models, groundwater flows are added to the calculated surface water flows in Moose River. Since the predicted groundwater seepage quality and mass loading would not be changed based on these results, the predicted overall water quality in Moose River would not be affected by the relatively minor reductions to groundwater seepage rates. Therefore, the assessment of potential environmental effects on groundwater presented in the EARD is considered to be conservative. With mitigation and environmental protection measures, the residual environmental effects of a change on groundwater quantity or quality are considered not significant.

2.2 MINE PIT CAPACITY (IR 2)

Clarify the mine pit capacity for project tailings and future proposed tailings deposition

AMNS acknowledges that there have been differences in values between those presented in the individual project EAs and that have been presented in the Touquoy EA. These differences are due to ongoing mine planning and optimization, in which resource and waste estimates are updated on an almost continual basis. Going forward, when mass-balance estimates are provided, the dates of those estimate will also be given to allow for future comparison.

Table 2.1 Touquoy Pit Estimate of Tailings Capacity [1]

	% of Tailings Volume to be stored in the Touquoy Pit	Tailings Vol (m3) for Deposition at Touquoy	Touquoy Pit Capacity Remaining (estimated)
Estimated Total Pit Capacity			11,458,669
Touquoy	100%	6,030,769	5,427,900
Beaver Dam	100%	4,738,462	689,438
Fifteen Mile Stream	2.85%	367,913	321,525
Cochrane Hill	TBD[2]		

1. Calculations based on tailings density of 1.3 t/m³; Estimates current as of December 2021
2. Planning and permitting for Cochrane Hill is ongoing

The total volume of tailings that is proposed to be deposited in the exhausted pit will depend on several factors: the final capacity of the pit while maintaining a minimum of 1.75 m to 2 m of cover (water), the final density factor of the tailings (currently assumed to be 1.3 t/m³), and the volumes of tailings produced at each of the mines proposed to deposit tailings in the Touquoy pit. The deposition density in particular is subject to change, for example through compaction over time. Additionally, there are mechanical options to increase deposition density such as thickening, which may be applied. Actual density will be monitored during deposition, and will be used to inform ongoing adaptive management. This approach follows best management practices and is consistent with Touquoy TMF operation.

Assuming a future discharge elevation of 108 masl, tailings could be deposited up to elevation 106 masl. Beaver Dam and Fifteen Mile Stream are relatively early in the planning stage, so ore production estimates are subject to change; estimates for Cochrane Hill is not included at this time as planning, permitting, and assessment of this Project is not active and may be undertaken in the future. What is important to note is that there are potentially enough tailings to fill the pit to capacity, and that the pit will not be filled beyond its capacity. Also, the total water in the pit will not be allowed to be drawn down (i.e. when used for mill process) to below 1.75 m of cover, and water will not be released to Moose River unless it has met approved water quality.

The Touquoy ore identified for processing and ultimate disposal in the Touquoy pit are medium grade and low grade. Higher-grade ore from Beaver Dam would be processed on a priority basis before the low-grade ore from Touquoy. There are no plans or scenarios where the pit would be filled to overcapacity. Should economics warrant, the processing of the remaining low-grade ore in this scenario would require the development and permitting of an alternate storage facility at that time.

2.3 IN-SITU WATER TREATMENT (IR 3)

Describe proposed in-situ water treatment plan and schedule.

Contact water (effluent) that is composed of inflows and runoff from the Open Pit walls, runoff, and seepage from the WRSA, and runoff and seepage from the TMF will be collected and treated, if determined to be required, prior to discharge to the environment during the operation and reclamation phases. Effluent from the WRSA will be discharged through a *Metal and Diamond Mine Effluent Regulations* (MDMER) regulated final discharge point (FDP) to Watercourse #4. Similarly, the Open Pit effluent will also be discharged through an MDMER regulated FDP to Moose River.

The existing Touquoy water treatment operation is described below to provide context to the Open Pit treatment approach described later in the text.

Existing Touquoy Operation Water Treatment

The effluent quality treatment chain involves the cyanide (CN) destruction process in the tailings pond, Effluent Treatment Plant (ETP), and the polishing pond, which is designed to provide a final effluent that meets MDMER effluent water quality criteria.

Water quality treatment involves the following:

- Mill whole tailings cyanide destruction at the mill using the air/SO_2 process
- Sedimentation of mill tailings suspended solids, and supplemental natural degradation of cyanide, cyanate, and ammonia in the mill tailings solution in the TMF, with discharge to the effluent treatment facility as needed to maintain operating water levels within the tailings pond
- Metal removal, solids precipitation, and pH adjustment in the effluent treatment facility
- Sludge removal and storage within the geobags
- Effluent equalization and sedimentation in the polishing pond

The existing effluent treatment involves both a passive and active treatment processes. The tailings pond is designed to facilitate the sedimentation processes, precipitation of dissolved and suspended metal solids, and co-precipitation of cyanide-metal complexes. Water is stored in the TMF during open water conditions to promote natural degradation of residual cyanide, cyanate, and ammonia, when possible. The degradation process in the tailings pond is primarily composed of natural biodegradation, hydrolyzation and UV light degradation.

The existing Touquoy effluent treatment plant receives decanted water from the TMF, treats the water, and discharges it through the polishing pond. The plant has a maximum design capacity of 450 m^3/hr, and operates at an average rate of 350 m^3/hr (CRA 2012). The treatment plant operates based on TMF water level requirements.

The ETP is designed to precipitate and remove dissolved metal contaminants (chiefly arsenic), remove suspended solids, and adjust pH. Decant water for treatment enters several reaction tanks where it is dosed with ferric sulphate (for precipitation of ferric arsenate). pH is adjusted using slaked lime, and a coagulant added to help form settleable solids. Hydrogen peroxide may be added to oxidize arsenite to arsenate to provide additional ferric precipitation efficiencies. Treated water is coagulated and flocculated using polymers and flows through large Geotube™ filtration bags to filter formed metal hydroxides. The filtrate proceeds to a polishing pond, where any final solids may precipitate and settle and natural degradation of cyanate and ammonia (photolysis and biological activity) may occur.

Treated effluent is stored in the polishing pond prior to discharge. The final discharge point (N44.973610 W62.919088) is located at the outlet of the polishing pond and discharge is controlled by a valve. Treated effluent flows through a constructed wetland prior to seeping through the embankment into Scraggy Lake at the southern end of the Touquoy Mine Site (Figure 2.2). Treated effluent has been discharged since July 2018 with flow rate based on TMF water level requirements (typically seven to eight months per year).

Waste Rock Storage Area Treatment for Nitrates/Nitrites

As described in the Touquoy EA registration document, a new WRSA sediment pond and treatment system designed for nitrate/nitrite removal will be constructed at the water return location in Watercourse #4 to provide treatment for the portion of WRSA runoff returned to the watercourse.

Effluent from the WRSA will be treated to meet regulatory discharge criteria. The engineered treatment options considered include the continuous treatment by:

- Biological treatment of nitrate and nitrite using bacteria and other microorganisms. This can include a number of alternative active biological treatment technologies. All typical processes are biological fixed film type and include the need to add substrate (food source for biomass that drive the process to anoxic conditions) and may include the need for phosphorus and/or micronutrients:
    - Moving bed biofilm reactor (MBBR) consisting of plastic media that support fixed-film growth that are agitated under anoxic conditions.
    - Fluidized bed reactor (FBR), which is a fixed-film bioreactor where the media (carbon or sand) is suspended by upward flow.

  - Gravel bed reactor (GBR) is a coarse and fixed packed bed reactor that is typically constructed to facilitate horizontal flow.
- Reverse osmosis (RO) that uses a permeable membrane to partially reject ions (including nitrite/nitrate) and provide a desalinated permeate
- Ion exchange process that uses a strong base anion exchange resin, which is brine regenerated (*e.g.,* high sodium chloride).

An additional MDMER regulated FDP will be established in Watercourse #4.

<u>In-Pit Tailings Water Treatment for Arsenic & Ammonia</u>

Treatment of effluent from the pit will be required to meet MDMER limits during reclamation. The pit was modelled to fill by Year 9 and treatment of effluent required until Year 30; the reclamation phase was simulated to occur in Year 3 -30. Water will be continuously treated from Year 9.

As the pit will be prepared for closure throughout operation (*e.g.,* the banks will be sloped back and stabilized), the project will submit for closure once water quality meets discharge criteria. Closure is subject to MDMER Environmental Effects Monitoring (EEM) requirements that must occur 3 years post-closure.

Proposed water quality treatment involves the following:

1. Mill cyanide destruction is ongoing from the existing operation using the air/SO_2 process.
2. Sedimentation in-pit facilitates sedimentation of mill tailings suspended solids, and supplemental natural CN degradation of mill tailings solution in the Open Pit, with seasonal discharge to the effluent treatment facility.
3. Metals removal, solids precipitation, and pH adjustment as batch treatment in the pit and/or in the effluent treatment facility. A number of treatment approaches are being considered, the in-situ batch treatment of the Open Pit water and treatment with a dedicated treatment plant, and a combination of the two.
   a. Batch Treatment

      As part of the treatment circuit, metals removal, solids precipitation and pH adjustment will be achieved through batch treatment of the pit lake once operation has ceased. Batch treatment will increase the pH to induce precipitation of minerals and remove metals by enhancing natural oxidation and precipitation followed by precipitate sedimentation. Arsenic co-precipitates with iron when iron is oxidized from the ferrous to ferric iron form. A lime mixing stations will be installed near the Open Pit and pit water will be pumped from the pond for mixing. The lime will be applied to the Open Pit as a slurry. Air injection and/or aerators will be installed in the pond for mixing.

   b. Treatment Plant of Surplus Flows

      In-situ treatment of surplus water in the Open Pit will be applied once the Open Pit is full, as required, or integrated into the batch treatment circuit while the Open Pit is filling. A packaged treatment plant will be installed adjacent to the Open Pit. This treatment will be comparable to the existing plant that provides pH adjustment through liming for metals precipitation, and coagulation/flocculation or filtering to remove sediment. In addition, ammonia treatment may be required. The engineered treatment options for ammonia removal that are considered include:

      - Naturally occurring and enhanced biological processes that converts ammonia to nitrate and nitrite (*i.e.,* nitrification).
      - Natural volatilization and enhanced volatilization

- Break-point chlorination with post oxidation quenching (to remove chlorine residual)
- Adsorption columns

The treatment options that are being considered for arsenic removal consist of the following:

- Co-precipitation with ferric iron or aluminum (to a lesser degree), which may require pre-oxidation to convert arsenic from the arsenite to arsenate form, followed by liquid-solids separation to return the solids to the Open Pit.
- RO membrane treatment where the concentrate is either returned to the Open Pit and the permeate discharged, or the concentrate is treated for arsenic and the blended with the permeate for discharge.
- Adsorption using engineered adsorbants such as ion exchange resins, zeolite, activated alumina, iron or titanium based sorbents, and granular ferric hydroxide (GFH).

Modelling has shown that the future water quality parameters of concern in the Open Pit water would be similar to the TMF effluent that is being treated by the Touquoy ETP. However, as natural degradation takes place during the 9 years of Open Pit filling, the required treatment will be reduced, and some aspects may no longer be required. The Open Pit filling time provides opportunity to monitor the Open Pit water quality and conduct additional modelling and bench-scale level work.

The details of the treatment plant are undergoing design. The footprint of the water treatment plant will be sited during design.

Tailings Management Facility Continued Treatment

The drawdown of ponded water in the TMF and polishing ponds and the pumping of ongoing runoff and seepage to the Open Pit will create a "near-zero discharge" environment from the TMF. During in-pit tailings deposition, excess water from the TMF will be pumped to the Open Pit.

2.4 DISCHARGE POINTS AND REGULATORY REQUIREMENTS (IR 4)

Describe how the pit and Waste Rock Storage Area discharge points will meet Metal and Diamond Mining Effluent Regulations and Fisheries Act requirements.

The in-pit disposal area and WRSA discharge points will meet the MDMER and *Fisheries Act* requirements through designation as a final discharge point, water treatment and compliance testing (*i.e.,* acute lethality testing).

The in-pit disposal area and WRSA discharge points will meet the MDMER and *Fisheries Act* requirements though a submission, documenting the location of each final discharge point, plan specifications, design, and general description, maintenance in respect to the deposit of deleterious substances and the name of the receiving body of water (MDMER Part 2, Division 1, Section 9).

The new WRSA sediment pond will capture and treat water through settling to meet the applicable MDMER limits as described in Section 7.7.2 of the EARD. Effluent will be treated to MDMER limits prior to discharge as described above in Section 2.3. Engineered wetland(s) may be used as required in addition to conventional treatment methods to further treat WRSA effluent.

Effluent from the final discharge point for in-pit disposal of tailings will only be discharged provided the water quality is suitable for discharge in that it meets applicable MDMER and provincially applicable limits. A water cover over the deposited tailings within the Open Pit will limit sulphide oxidation thus reducing metal leaching from sulphides. A passive treatment system with adequate carbon substrate could potentially treat in-pit overflow to closure regulatory criteria long enough for Open Pit water quality concentrations to stabilize at closure regulatory criteria. AMNS will explore this alternative via its closure planning activities.

Finally, the Open Pit and WRSA discharge points will meet *Fisheries Act* requirements for monitoring through compliance (*i.e.,* acute lethality testing) testing to confirm effluent is not acutely lethal as required by MDMER (Part 2, Division 2, Section 14).

3.0 GROUND AND SURFACE WATER

3.1 THIRD PARTY EXPERT REVIEW OF GROUND AND SURFACE WATER MODELLING (IR 5)

Provide a third-party expert review of the ground and surface water modelling presented and referenced in the EARD

As part of the Ministerial Response to the EARD received September 8, 2021, additional information was requested to, "Provide a third-party expert review of the ground and surface water modelling presented and referenced in the EARD". AMNS worked with NSECC to identify an appropriate Third Party to undertake this review (Wood), and NSECC provided a scope of work to guide the review. Through the review period, the consultants responsible for the technical reports which were subject to the Third Party Review (Stantec Consulting Ltd., Lorax Environmental Service Ltd., and Minnow Aquatic Environmental Services) were available to provide documentation and answer any technical questions that arose during the period of the review. Meetings were held between AMNS, Wood, Stantec, Lorax, and Minnow on November 1 and December 9, 2021.

The Third Party Review Memo, Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications – Environmental Assessment Registration, is included as Appendix C.1.

The primary issues identified during the Third Party Review are addressed in the following documents and sections:

- Response to Ministerial IR 1
- Appendix B.1 – Touquoy In Pit Disposal Factual Data Report
- Appendix B.2 – Touquoy In-Pit Disposal - Seepage Mitigation Measures
- Appendix B.3 – Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit
- Appendix D – Touquoy Gold Project Assimilative Capacity Study of Moose River Touquoy Pit Discharge (Updated)

The following information addresses some issues not explicitly addressed by the documentation above.

Waste Rock Storage Area

Investigation/Remediation of the Drainage Ditch

The primary recommendations related to the assessment of the WRSA expansion focused on the planned remediation work, currently in progress, for the WRSA ditch. Additional information pertaining to this is provided below. The Third Party Review indicated that the small expansion to the WRSA would not likely result in a significant change in the related environmental effects.

Water quality results reported in the 2020 Annual report (Attached to EARD as SD 19) indicated that there may be a design/construction issue with the WRSA ditch on the western side of the WRSA, contributing to observed changes in water quality. Reference to this is made throughout the Third Party Review, including that this is an ongoing operational issue that is being addressed. The following provides an update on the requirements and progress of the investigations and proposed remediation for the WRSA ditch and related water management. Although this is an issue related to current operations it is relevant to the modifications insofar as it relates to management of the WRSA and demonstrates AMNS' commitment to adaptive management.

As proposed by AMNS in the Annual Report and various communications subsequent to that (i.e., Information Requests related to the WRSA Raise Industrial Approval Amendment request), and as required based on new Terms and Conditions issued with the Certificate of Variance for the WRSA Raise (File No. 92100-30-BED-2012-084244), specifically Condition 8.i, AMNS has undertaken the following:

As reported to NSECC January 17 (Appendix C.2): Test pit investigations and survey data indicate that a portion of the west side of the existing WRSA drainage ditch was constructed above the original ground surface with a clay liner placed over a rockfill base. The ditch invert gradient is relatively flat and somewhat uneven resulting in areas of ponding which could result in possible leakage from the ditch. The water quality results downstream of the ditch indicate that this configuration may allow some of the runoff and shallow groundwater below the stockpile to flow under the ditch through the rockfill and into the receiving environment. Based on observations and discussions with AMNS staff, the Phase I design is functioning adequately as it relates to conveying collected water flows through the ditch with no evidence of overtopping. Therefore, the same general design criteria, concepts and methodology used for the Phase I design have been used or made more stringent for the west ditch updated design. The remedial work proposed will accomplish the following:

- Increasing the minimum invert slope gradient to at least 0.6%.
- Replacing the existing rockfill below the ditch with clay till borrow to form a cutoff of westward subsurface flow, directing it into the ditch and ultimately to the WRSA West Pond for subsequent treatment
- Replacing the existing rockfill berm with a clay till borrow berm protected by rockfill

Due to winter-construction constraints, the original timeline for completion of this work (February 17, 2022) and reporting (March 3, 2022) have been revised to May 16 and May 30, 2022 respectively (Appendix C.3).

As required by Condition 7.d.v, and in consultation with NSECC, AMNS is developing a site-specific sulphate limit for the Touquoy Mine.

An exceedance of the stipulated dissolved sulphate surface water limit was identified on November 12, 2021, and NSECC was notified as required. As per the Condition 7.d.viii, water sampling was required at a minimum of 5 time-intervals over a 30-day period and these results were provided to independent aquatic toxicologists for analysis and recommendations (Appendix C.1, Independent Aquatic Toxicology Opinion re: Sulphate Exceedance at SW 15 – Touquoy Gold Mine (Industrial Approval Condition 7.d.viii). Based on the analysis presented in Appendix C.1, adverse effects to aquatic life, attributable to high concentrations of sulphate, are not likely to have occurred at Stations SW-15 or SW-15C during the evaluation period: December 20, 2021 to January 18, 2022, and based on this finding it was determined that additional measures to protect aquatic life are not required at this time.

As outlined in the memo (Appendix C.1), AMNS is developing a site-specific limit for dissolved sulphate for freshwater aquatic life for surface waters with hardness greater than 250 mg/L in part because the existing regulatory guidance referenced by the NSECC (i.e., British Columbia Ministry of Environment, Meays and Nordin, 2013) may be biased low, owing to its reliance on tests conducted in synthetic dilution waters that would lead to ion imbalances or deficiencies at high added concentrations of sodium sulphate, or where the dilution water appears to be contaminated with copper (i.e., certain of the PESC data). Total copper concentrations at the referenced stations during the period of record were generally <1 µg/L.

<u>Watercourse #4 Time Series Data</u>

Questions were raised regarding the time series data for modelling at Watercourse #4. Time series data of modelled (base case condition) and measured concentrations of sulphate and other major ions (calcium, sodium, potassium, and strontium) in Watercourse #4 are presented in Figure 3.1. The model results for the base case condition are compared to the measured data as the key purpose of the base case scenario is to simulate concentrations in Watercourse #4 under the current conditions to allow for model verification. The proposed new case condition, or the assessment case that simulates the proposed changes to the Touquoy operations, was then simulated after the completion of the model verification step. Predicted and measured time series data for Watercourse #4 were not originally provided in Appendix D.3. However, this data is now available and has been provided in Figure 2.1. Results for both the base case condition and the proposed new case condition for Watercourse #4 are presented in Table 4.3 in Appendix D.3.

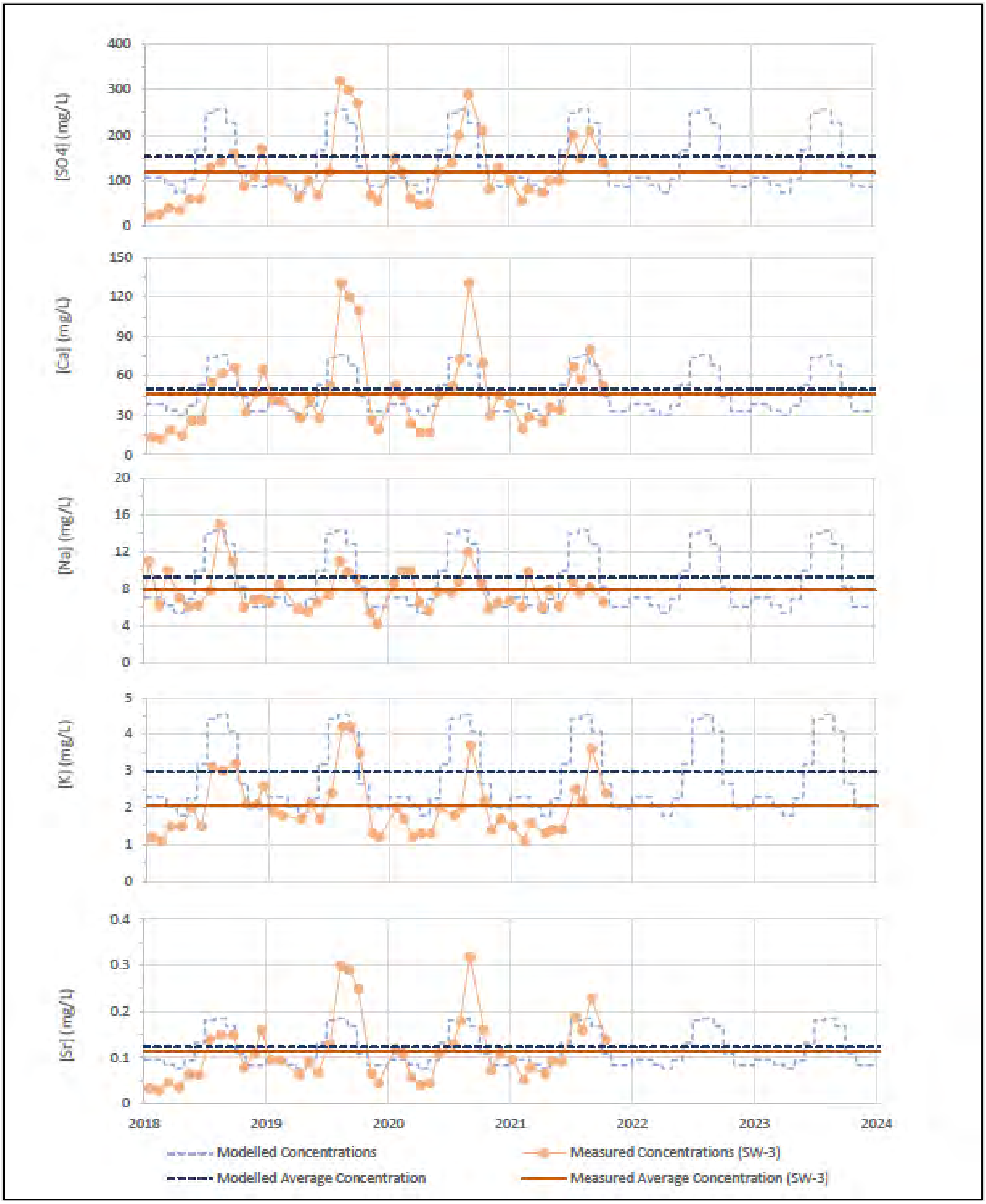


Figure 3.1 Comparison of Modelled versus Measured Major Ion Concentrations in Watercourse #4 for the Base Case Scenario

As shown in Figure 2.1, the modelled concentrations compare well with the measured concentrations both in terms of the range of concentrations and also with respect to the inter-year seasonal trends. In addition, the average modelled concentrations for sulphate and each of the major ions are compared to the average measured concentrations at SW-3. The modelled average concentrations are slightly greater than the average measured concentrations, which indicates that the model is providing relatively conservative estimates of average concentrations over the longer term. Based on these comparisons, the water quality model clearly provides reasonably accurate predictions of sulphate and other major ions in Watercourse #4. Therefore, these comparisons validate the predictive capabilities of the water quality model and confirm its usefulness to assess the potential effects to the water quality of Watercourse #4 as a result of the proposed changes to the Touquoy operations.

Geochemical Source Term/Sulphate

The Third Party Review raised questions pertaining to the Annual Report, indicating that the source predictions were not supported by the geochemical data.

A geochemical source term was applied in the water quality model to account for the mass loading of sulphate into Watercourse #4 via WRSA seepage. The sulphate concentrations for this geochemical source term range from 1,029 to 1,312 mg/L (Appendix D.4). This range of concentrations is greater than the maximum sulphate concentration observed in Watercourse #4 as part of the sulphate source investigation (Stantec 2021, Attached), which was less than 1,000 mg/L directly beside the WRSA. Therefore, the source term predictions for sulphate in the WRSA seepage are considered to be reasonable and align with the current knowledge base on the water quality of Watercourse #4.

Reference: Stantec (2021). Investigation of Potential Source of Sulphate in Groundwater and Surface Water. April 30, 2021.

Model results for SW-3/Watercourse #4 – Sulphate Anomaly

It is acknowledged that the water quality model can provide assistance with predicting sulphate concentrations in Watercourse #4. As discussed above, the water quality model has been validated and provides reasonably accurate predictions of sulphate concentrations in Watercourse #4 (Figure 3.1). For information on the next steps regarding the occurrence of sulphate in Watercourse #4, please refer to the discussion of investigating and remediating the WRSA drainage ditch, above.

Sulphate as a Tracer Element

The Third Party Review noted that when basing the transport of other POPCs on the measurements of sulphate, consideration it is required to evaluate whether the sulphate transport rate has been affected by additional reactions, which could decrease its transport rate. In most groundwater and surface water environments sulphate is less reactive, and its transport is more conservative than other parameters of interest such as nutrients and metals. For this reason, sulphate is commonly used a tracer parameter in mining environments. Under oxic conditions, the transport of sulphate becomes controlled by solubility constraints at concentrations typically above 1500 mg/L. Furthermore, if the redox conditions in the groundwater or surface water environment are sulphate reducing, the sulphate can be controlled by reduction reactions and subsequent precipitation of secondary sulphide minerals. In the case of Touquoy, the sulphate concentrations that are being modelled are below solubility thresholds in the receiving environment and the redox conditions are not sulphate reducing.

Modelled and Measured Solubility Constraints

The Third Party Review questioned whether the modelled (PHREEQC) and measured solubility constraints were compared to verify findings.

The two species that were modelled using PHREEQC (a computer program for speciation, reaction-path, advective transport, and inverse geochemical calculations) are iron (Fe) and aluminium (Al) due to their well-established solubility limits under neutral conditions. In the WRSA drainage and pit sump water, dissolved Fe typically falls below the analytical detection limit of 0.05 mg/L which prevents a direct comparison of the source term (0.0015 mg/L) with site water quality data. It is however assumed that any temporarily soluble Fe precipitates in the form of Fe-hydroxides relatively rapidly after contact with waste rock. The relatively high sulphate values (~1000 mg/L), which are inferred to be mobilized from Fe-sulphide oxidation, combined with the low measured Fe concentrations in WRSA drainage supports this hypothesis.

Aluminum is expected to be solubility-limited by the precipitation of gibbsite or other Al-hydroxides. Median and maximum dissolved Al concentrations measured in Touquoy WRSA drainage to date are 0.012 and 0.032 mg/L, respectively, suggesting relatively little variability. These values are somewhat higher than (but within a factor of 4) of the PHREEQC output used as the final source term (0.0087 mg/L). Dissolved species in water samples are measured on a subsample that was filtered with a standard 0.45 micron (µm) filter through which some colloidal (non-toxic) forms of Al may pass (e.g., Lin & Coller, 1998). It is therefore assumed that the measured concentrations of Al in the pH-neutral drainage are somewhat conservative. Regardless, the baseline total Al concentration assumed for Watercourse No. 4 in the water quality model is 0.43 mg/L and, even if dissolved Al is lower by an order of magnitude, it can be said with some certainty that flow contributions from WRSA drainage are likely to dilute the background concentrations for dissolved Al rather than exceed them in Watercourse #4. Since pH is expected to remain circum-neutral in WRSA drainage in the long term, significant increases in Al concentrations over time are not expected.

In Pit Tailings Management

Issues identified by the Third Party Review related to the assessment of in-pit tailings storage were more detailed and concluded, in part, that additional work be undertaken to support the proposal. As stated in Section 6.6. of the EARD, AMNS had planned for additional surveys: “Additional characterization of the hydrogeological parameters in the vicinity of the Touquoy Open Pit are currently planned for the summer of 2021, to confirm the properties of the faults and identify potential high permeability fractures.” A full geotechnical and geophysical program was undertaken beginning in the Fall 2021 to provide additional characterization of the pit walls, permeability of the surrounding bedrock, location of historic mine workings, and naturally occurring fractures. The results of this work were used to update the hydrogeologic model. This work is fully described as part of the Main Addendum Report (Section 2.1), including the technical reports listed above.

<u>Concentration Gradient</u>

The Third Party Review noted that the predicted concentration gradients were steep between the open pit and the Moose River, and changed relatively little between 5 and 500 years after pit-filling. The model results represent predicted concentrations of a conservative, non-reactive solute species with a source concentration of 1 mg/L. As described in Section 5.4.1 of the modeling report (Appendix D.1 of the EARD), the diffusion coefficient of chloride, a conservative species under most natural conditions, was used to represent the diffusion characteristics of the generic solute in the transport model. The model results can be scaled by the estimated source concentration of each constituent of interest relative to 1 mg/L to arrive at predicted concentrations away from the open pit. Estimated source concentrations for the tailings pore water within the pit after closure are shown in Table 5.3 of Appendix D.1 of the EARD, Table 5.3. The Third Party Review indicated this was an acceptable approach to evaluate potential groundwater transport of dissolved constituents from the open pit.

There is limited opportunity for transport through the overburden with the pit lake at elevation 108 m amsl or lower. As shown in the geologic cross-section (Figure 4.3 of Appendix D.1) the elevation of the contact between overburden and weathered bedrock at the location of the anticipated pit wall would be at about 108 m amsl or above. Additional drilling conducted in the fall of 2021, as reported in Appendix B.1 confirmed this relationship. Therefore potential transport would occur primarily through the weathered bedrock units in the immediate vicinity of the pit.

The hydraulic gradient between the pit and the Moose River is predicted to be low based on the relative elevation of the pit lake and the Moose River. The gradient would be from the Moose River toward the pit in the northern portion of the area where the Moose River flows past the pit, and from the pit toward the Moose River only in the southern portion of that area. The combination of low hydraulic gradient and low hydraulic conductivity results in predictions of limited transport from the pit to the Moose River where the gradient is in that direction.

<u>Regional Runoff Regression</u>

The third party review stated that regional runoff regression relationships are acceptable to use when recorded streamflow data is not available, and asked about uncertainty/sensitivity analysis. Regional regression analysis is a single variant analysis, which is inherently sensitive to changes. Regional regression analysis is discussed in more detail in Appendix A (Section 2 – Group B Regional Regression Analysis).

References

Lin, J., & Coller, B.A. (1998). Measurement of dissolved aluminium in waters: Use of the tangential flow filtration technology. Water Research, 32, 1019-1026.

Regional Regression Analysis

The third party review stated that regional runoff regression relationships are acceptable to use when recorded streamflow data is not available, and asked about uncertainty/sensitivity analysis. Regional regression analysis is a single variant analysis, which is inherently sensitive to changes. Regional regression analysis is discussed in more detail in Appendix A (Section 2 – Group B Regional Regression Analysis).

3.2 WATERCOURSE #4 (IR 6)

Describe current and potential impacts to Watercourse #4 in the EARD including any monitoring data not included in the EARD submission.

Stage discharge relationships (Table 3.1) were developed for hydrometric stations on Watercourse #4 for the period of May to October 2021. The hydrometric stations were instrumented with pressure transducers to record hourly water level. Flow cross sections were measured at minimum of 10 site visits. The methodology used to conduct stream flow monitoring was in accordance with ISO 748:2007E Hydrometry – Measurements of liquid flow in open channels using current meters or floats and consistent with the hydrometric monitoring program for Moose River. The 2021 hydrometric program are presented as single page station summaries in Appendix E.

Table 3.1 Watercourse #4 Stage-Discharge Equations

Location on Watercourse #4	Stage - Discharge Equation	Regression Coefficient (R^2)
SW-23	Q = 843.81x^14.62	0.9304
SW-19	Q = 4.4932x^4.5073	0.9352
SW-3	Q = 55.276x^7.4948	0.9876
Note: Stage, X in meters, Discharge Q (m^3/s)		

Mean monthly flows at Watercourse #4 surface water monitoring locations are presented in Table 3.2 below, as instantaneous flow rates over the 2021 monitoring period of record. The highest flows were in September.

Table 3.2 Mean Monthly Flow at Watercourse #4 from Upstream to Downstream

Month	Mean Monthly Flow from Measured Data (2021) in (L/s)		
	SW-23	SW-19	SW-3
May	4.73	9.26	11.50
June	8.40	9.85	14.60
July	3.10	8.21	6.90
August	7.20	8.18	14.40
September	13.80	10.39	29.90

As noted in the EARD Section 7.5.2 and 7.5.3., expansion of the WRSA and the Clay Borrow Area will alter the topography and cover of the drainage areas associated with Watercourse #4, reducing surface water quantity. The WRSA will result in a reduction of 5.1 ha draining to the Watercourse #4 catchment and another 1.2 ha in the Scraggy Lake catchment (reporting specifically to Square Lake which drains via the Fish River to Scraggy Lake) and the clay borrow reduction of 5.9 ha draining to the Watercourse #4. Changes to flow to Square Lake are perceived as negligible with respect to the total catchment area draining to the Lake. As changes in flows to Watercourse #4 would be reduced by 8% (i.e. 5.1 ha of 61.3 ha) of the upstream catchment area at SW-19 as indicated in Figure 3.2, Watercourse #4 will be supplemented from WRSA runoff.

Runoff from WRSA will be collected in a sedimentation pond for treatment and drained to Watercourse #4 to supplement flow to near existing conditions while meeting regulatory water quality objectives. The following presents an empirically-based estimate of anticipated instantaneous flow changes in Watercourse #4 at the new sedimentation pond FDP. Detailed design of the WRSA new sedimentation pond and the associated hydrologic and hydraulic modeling will be provided as part of the IA amendment process, ahead of construction.

As also summarized in IR E.5 (Appendix A), local flow station SW-19 was established on Watercourse #4 upstream of Mooseland Road in sub-catchment 1. The hydrograph for the 2021 flow monitoring period at SW-19 is presented in Figure 3.2. To estimate and present the anticipated effect of the WRSA expansion new sedimentation pond on flows at SW-19 a short distance downstream from the proposed new FDP, hydrograph separation was conducted. The residual unaffected upstream catchment of SW-19 would produce flows as per the “without flow supplementation” hydrograph. To estimate runoff and seepage to the WRSA new sedimentation pond and then to the FDP, hydrograph simulation was conducted based on a total proposed WRSA contributing area of 20.4 ha and then the hydrograph was reduced to account for the reduction in runoff coefficient observed between natural ground (0.67) and the existing WRSA (0.43). Subsequently, to account for runoff and seepage lag and detention time in the pond the WRSA 20.4 ha contributing hydrograph was adjusted using a moving average which attenuates peaks and extends its baseflows. The results of the estimated resulting flows at SW-19 are presented in Figure 3.2 j-1 and will be confirmed by the modeling proposed in IR C.5 (Appendix A).

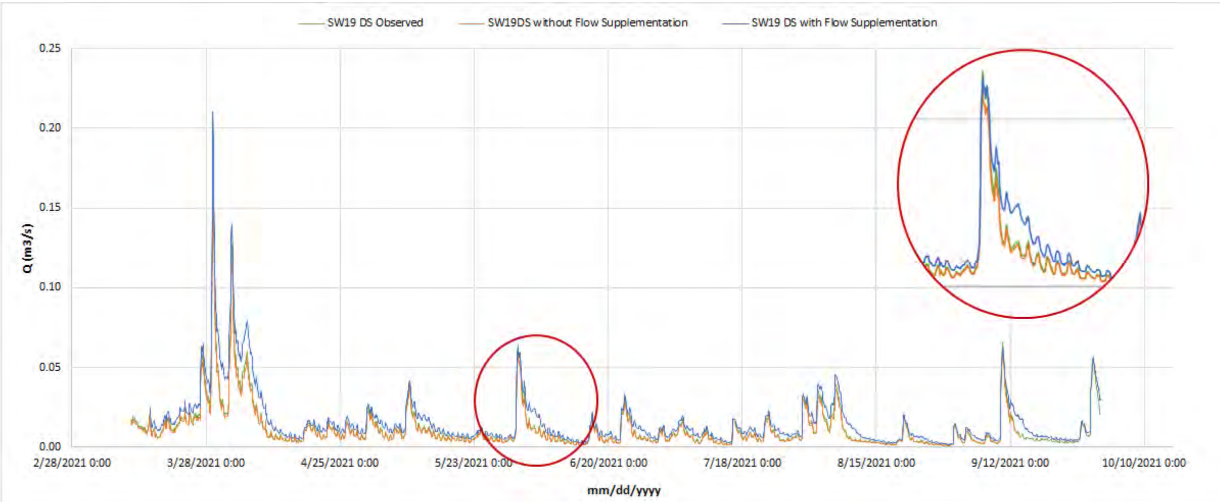


Figure 3.2 2021 SW-19 Hydrograph and Estimated Hydrographs with and without Flow Supplementation from the New WRSA Sedimentation Pond

As the predominant groundwater flow direction is toward the southwest and Watercourse #4 is outside the modelled zone of depression from Open Pit dewatering, effects to flow quantity to Watercourse #4 from Open Pit dewatering or filling during operation are not anticipated.

3.3 MOOSE RIVER IMPACTS (IR 7)

Provide a more detailed analysis and clarify the impacts to Moose River currently, and as a result of the proposed project.

As described in Section 7.2.2 of the EARD, water quality in Moose River is consistent with background water quality and does not appear to be affected by site operation. This is consistent with predictions in the original EA (CRA 2007), and as reflected in the Annual Monitoring Report (included as SD 19a to the EARD).

With respect to water quantity, a depressed groundwater table was observed at OPM-2A/B in 2019 and continued in 2020. This triggered further review via the project Groundwater Contingency Plan (GWCP, Attached to the EARD as SD 03) based on the drop between consecutive monthly readings being greater than the 2016 baseline annual range of water levels.

Upon further investigation, seepage into the Open Pit appears to have a minor influence on stream flows in Moose River during low-flow. This is attributable to the diversion of groundwater to the Open Pit that would have otherwise discharged to Moose River. It is not considered to be baseflow seepage from Moose River to the Open Pit. Per Section 5.5.2 of Appendix D.1 in the EARD, at baseline, the Open Pit will be fully dewatered, and is simulated to intercept groundwater seepage at a rate of 768 m^3/d. The extent of the corresponding drawdown cone, as delineated by the 0.5 m drawdown contour, extends approximately 600 m south of the site and about 50 m west of the site toward Moose River. The inflow to the Open Pit decreases as it is filled with tailings and water, until the Open Pit stage reaches the maximum level of 108 m relative to CGVD2013 (vertical datum). At this stage, the groundwater seepage decreases to 373 m^3/d, and the corresponding drawdown cone is comparable to the baseline condition.

The net pre-development baseflow to Moose River at SW-2 is simulated to be 29,845 m^3/d under average annual conditions, and 9,689 m^3/d under summer conditions, as reflected in Appendix D.1 of the EARD. Dewatering of the fully-developed Open Pit is anticipated to reduce the baseflow in Moose River at SW-2 by 49 m3/d on a mean annual basis, and 29 m^3/d on a summer flow basis.

Initial comparison between estimated and observed flow in Moose River is provided in Section 7.4.7.1 of the EARD for the monitoring period including 2020; this is further discussed in Section 3.1.2 of 2020 Annual Report (SD 19a, attached to the EARD). The reductions in flow rates in Moose River are greater than the dewatering rates from the Open Pit, and therefore cannot be solely attributed to baseflow reductions to Moose River associated with the Open Pit. This is further described in the attached memo: Response to DFO Request 20-HMAR-00531 – Moose River Request for Studies Halifax County, Nova Scotia (Appendix F).

Hydrometric monitoring has been undertaken at select locations in Moose River (Table 3.3). A more detailed analysis of estimated and observed flow is provided for Moose River using data from the 2021 monitoring period, included below.

Table 3.3 Details of Hydrometric Monitoring Locations on Moose River

Station	CGVD2013 Zone 20T Coordinates	Date of Installation	Watercourse	Location
SW-11	504126 E 4982555 N	April 25 2018	Moose River	Most upstream station
SW-11B	504140 E 4982526 N	July 14, 2021	Moose River	Approximately 60 m downstream of SW-11 on Moose River
HM-3	504288 E, 4981604 N	June 29, 2021	Moose River	Upstream of Open Pit
HM-1	503924 E, 4981232 N	August 17, 2018	Long Lake Tributary to Moose River	Near confluence with Moose River
HM-4*	504158 E, 4981032 N	June 29, 2021	Moose River	Upstream of Open Pit, 20 m upstream of old wooden weir in river
SW-2	504306 E, 4980726 N	April 25 2018	Moose River	Downstream of Open Pit ,15 m upstream of the Western Diversion Rd bridge crossing

Table 3.3 provides a characterization of the monitoring stations. Moose River is located west of the existing Open Pit and drains to Lower Fish River. Long Lake tributary confluences with Moose River upstream of the Open Pit between hydrometric stations HM-3 and HM-4. Station HM-4 is a low gradient wide reach with a contiguous wetland (Wetland 22) and a remnant wooden structure 20 m downstream. The majority of Moose River catchment area is forested with waterbodies and wetlands. A portion of the Touquoy project footprint reduces the predevelopment watershed of Moose River. Moose River is generally a meandering low-gradient watercourse with defined banks.

Table 3.4 2021 Moose River Hydrometric Station Field Observations

Station	Catchment Area (km^2)	Range of Average of 2021 Field Visits			Substrate	Floodplain
		Wetted Width (m)	Depth (m)	Velocity (m/s)		
SW-11	25.08	7.1-9.2	0.104-0.355	0.065-0.467	Fines, gravel, cobbles and few boulders, grassy vegetation	Grasses, shrubs, and low-cut banks
SW-11B	25.75	4.4-9.4	0.164-0.331	0.074-0.456	Fines, gravel, cobbles and few boulders near the channel edges	Mixed wood floodplain with low cut banks on both sides of the channel
HM-3	26.78	7.1 -7.9	0.278-0.486	0.026-0.416	Exposed bedrock, boulders, cobbles, and gravel	High rock cuts, tall grass, medium shrubs
HM-1	12.02	3.0-4.8	0.100-0.194	0.112-0.431	Gravel and cobbles	Tall grasses, mosses, ferns, and hardwood species; the banks were low-cut
HM-4*	38.82	13.3-14.3	0.451-0.726	0.014-0.170	Soft organic, with some boulders	Contiguous wetland (Wetland 22) features such as hydrophytic vegetation
SW-2	39.03	7.5-9.4	0.557-0.743	0.022-0.099	Fine material and few cobbles. During low flows, boulders are exposed on either side of the cross section.	Wide, low-cut banks, boulders, and grasses which transition into a mixed wood forest

* Moose River reach identified in the ministerial request is not an optimal hydrometric station location as flow accuracy may be reduced due to the presence of Wetland 22 and/or wooden bridge structure, see Section 4.3 for further discussion.

Figure 3.3 presents the observed average daily flow in m^3/s over the monitoring period between June 1 and the end of September 2021 on the primary x-axis and the Halifax Stanfield International Airport climate station (Environment and Climate Change Canada 2021) on the secondary x-axis. The flow is presented to 2.0 m^3/s, associated with the applicability of the developed rating curves.

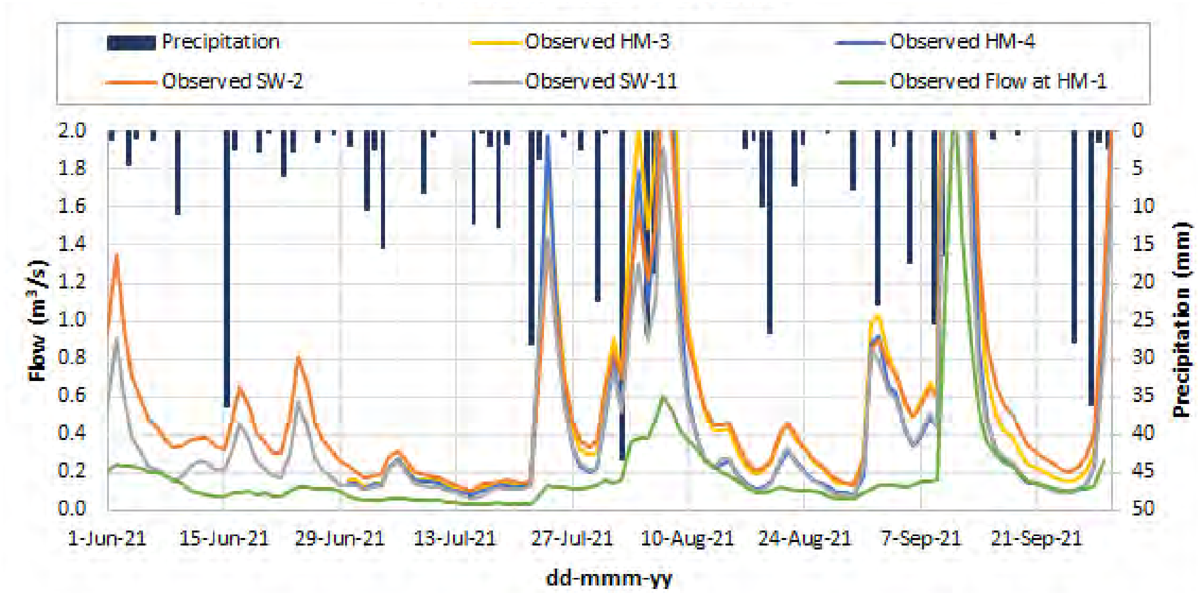


Figure 3.3 Average Daily Flow and Total Precipitation Over Time for All Stations

As shown in Figure 3.3, the flow response to precipitation events at the Long Lake tributary to Moose River HM-1 is attenuated compared to the response in the Moose River main branch. For the most part, flow show increase with progression downstream in Moose River due to an increase in catchment area. Generally, flows at SW-2 observed in 2021 were slightly higher than flows observed in 2019 and 2020 and had a similar response to precipitation events.

The observed flows at stations HM-3, HM-4, and SW-2 were compared to the calculated flows at the associated stations based on area pro-rating (also referred to as regional extrapolation) flow measurements at SW-11 and HM-1, as these stations are outside of the drawdown cone of depression of the Open Pit developed in groundwater modeling.

Calculated flows (Q) and HM-3 are prorated based on catchment area (A, km^2) from SW-11, for example:

QHM-3 = Q SW-11 *(AHM-3/ ASW-11)

When calculating flow downstream of the Long Lake tributary at HM-1 calculated flows sum the tributary flow and main branch, for example:

QHM-4 = Q HM-1 + Q SW-11 *(AHM-4/ (ASW-11+AHM-1)

Flow hydrographs overtime are depicted in Figures 3.4 to Figure 3.6, for flows up to 2.0 m^3/s; corresponding to the maximum flows measured during the in-situ flow monitoring events and the resultant applicability of the stage discharge curve. There are periods when these observed streamflows were lower than the calculated (prorated) streamflows, indicating a potential loss to Moose River, particularly in mid-September observed at HM-3, HM-4 and SW-2. Potential losses to Moose River were calculated from the difference of calculated (prorated) from observed as shown in Figure 3.6.

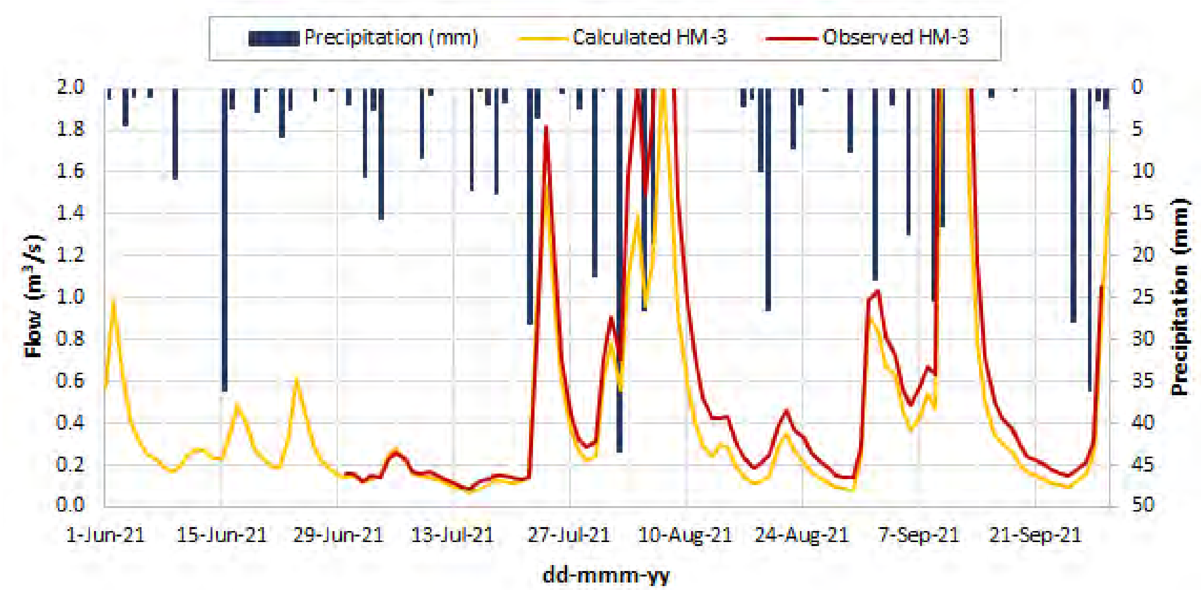


Figure 3.4 Moose River Average Daily Flow, Prorated to HM-3

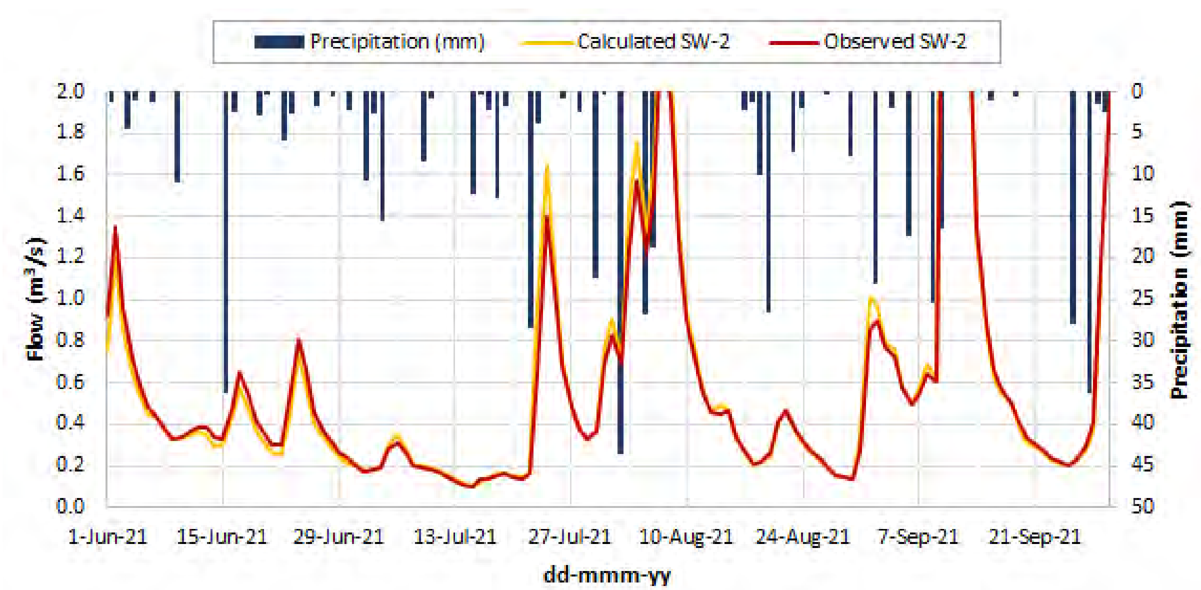


Figure 3.5 Moose River Average Daily Flow, Prorated to SW-2

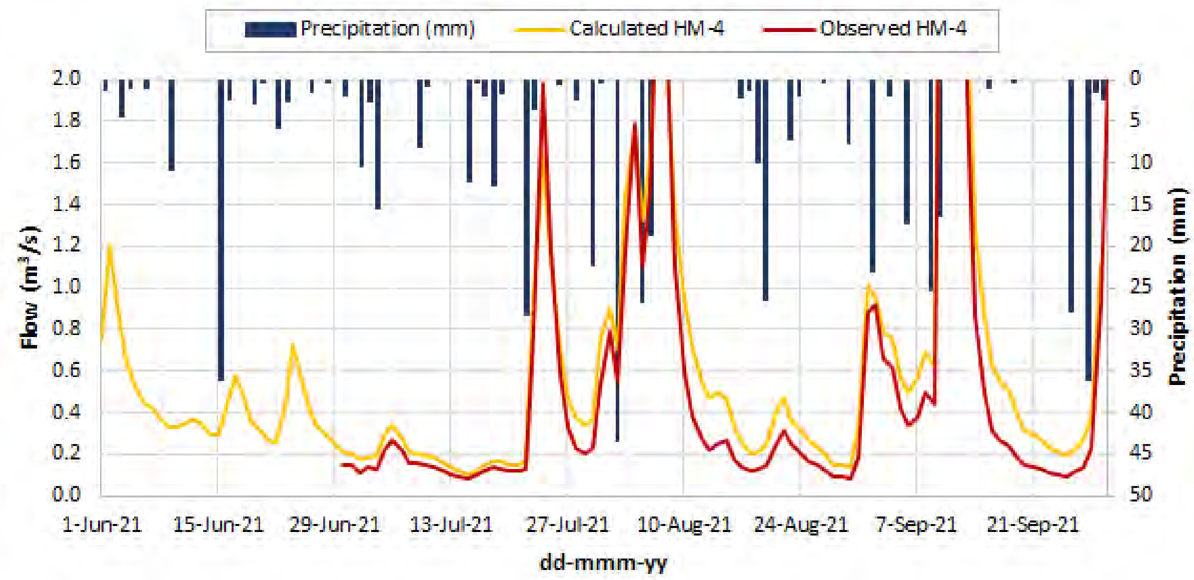


Figure 3.6 Moose River Average Daily Flow, Prorated to HM-4

The potential for environmental effects of the project are assessed based on the two criteria outlined in the “Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada” (DFO 2013) are summarized in the Table 3.5. These criteria were used as guidance to review the potential for an environmental effect.

Alterations in flow in excess of these criteria may result in potential effects to fish and fish habitat, including decreases in wetted perimeter and physical area of fish habitat available, and the creation of barriers to fish passage and changes to water temperature during periods of low flow.

Table 3.5 Ecological Flow Metrics

Criterion No.	Ecological Flow Criteria	Reduction Threshold
1	*Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a "natural flow regime" have a low probability of detectable impacts to ecosystems that support commercial, recreational or Aboriginal fisheries. Such projects can be assessed with "desktop" methodologies.*[1]	0.0057 m^3/s of mean annual baseflow & 0.0035 m^3/s of mean summer baseflow from pre-development conditions
2	*Cumulative flow alterations that result in instantaneous flows < 30% of the mean annual discharge (MAD) have a heightened risk of impacts to fisheries.*	30% of MAD = 0.345 m^3/s.
Source 1: Mean annual discharge at SW-2 is estimated to be 1.15 m^3/s. Therefore, to meet the first ecological flow criterion, alterations to mean annual baseflow in Moose River related to mining operation should not decrease by ≥0.0057 m^3/s, and summer baseflow by ≥0.0035 m^3/s from pre-development conditions, as described in the response to 20-MAR-00531-02 (Stantec 2021[2]), based on the extent of the August 2019 Open Pit shell.		
Source 2: Mean annual discharge at SW-2 is estimated to be 1.15 m^3/s. Therefore, to meet the second ecological flow criterion, alterations to instantaneous flows related to mining operation should not result in flows less than 30% of mean annual discharge, equivalent to below 0.345 m^3/s at SW-2.		

The reduction threshold for Ecological Flow Criterion 1 is 0.0057 m^3/s of mean annual baseflow and/or 0.0035 m^3/s of mean summer baseflow from pre-development conditions (Table 3.6) and is based on cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a "natural flow regime".

There are periods for which calculated potential losses amount to more than 10% of the instantaneous stream flow (Criterion 1). Consistent to what was observed in past years, particularly in September and October 2019; these losses greater than 10% occur throughout the low flow period as shown in Figure 3.7, and Table 3.6.

As illustrated in Figure 3.7 and 3.9 generally, the volume of water removed from the Open Pit is up to an order of magnitude less than the corresponding calculated potential streamflow reduction in Moose River. Based on this assessment, streamflow reductions in Moose River would normally occur without the consideration of Open Pit dewatering. As noted earlier, water that is removed from the Open Pit is contributed from direct precipitation to the Open Pit and groundwater seepage. Given that the metered Open Pit dewatering rates are lower than the streamflow reductions, the streamflow reductions in Moose River cannot be wholly attributed to pit dewatering. The upper bound of the proportion of potential calculated losses which could result from dewatering of the open pit on days with more than 10% decrease in instantaneous stream flows, averaged over the monitoring period between June 1 and September 30, 2021 is summarized in Table 3.8. In 2021, pit dewatering can only account for up to 15% of the total potential losses in stream flow on days where a more than 10% decrease in instantaneous stream flow was observed.

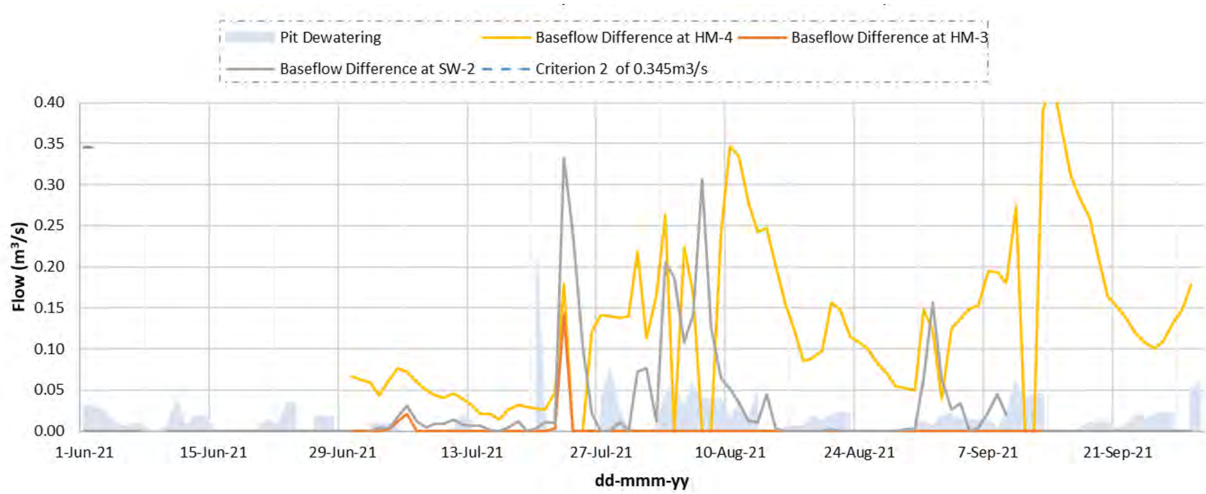


Figure 3.7 Difference Between Estimated and Observed Flows on Moose River

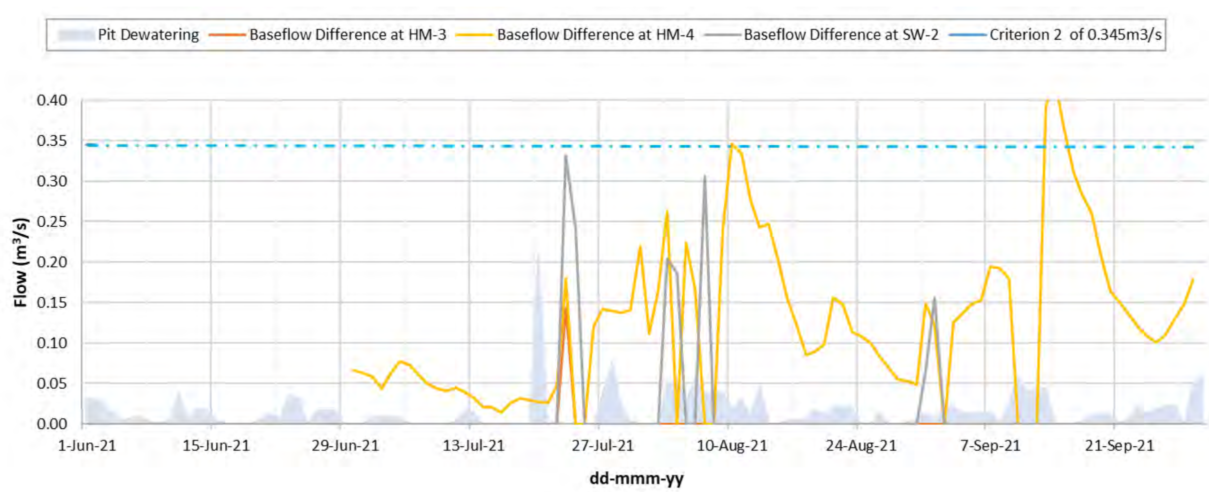


Figure 3.8 Flow Losses to Moose River, >10% of Calculated Flows

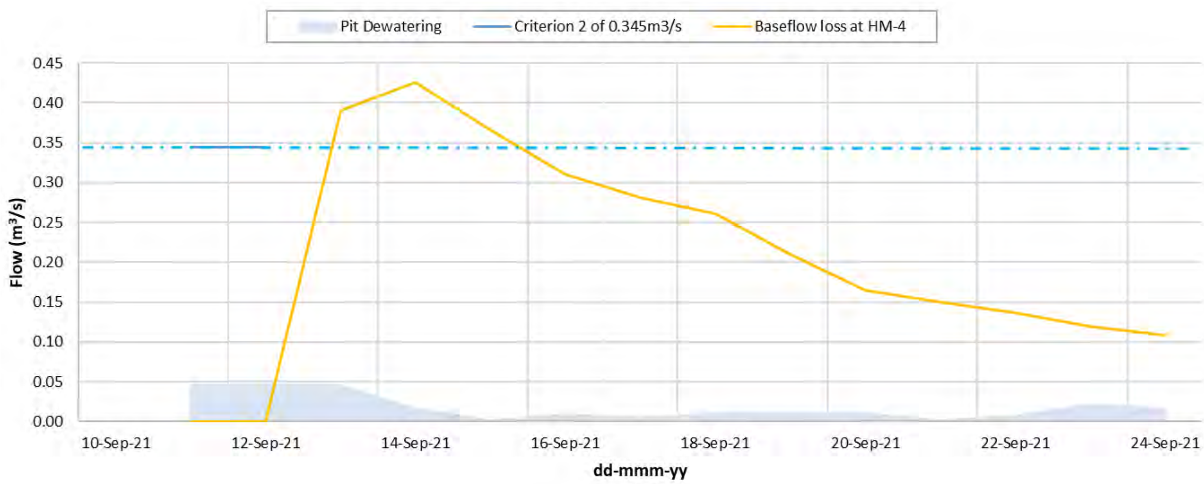


Figure 3.9 Flow Losses to Moose River at HM-4

The project effect of Open Pit dewatering does not exceed Criterion 1, calculated potential flow losses that exceeds Criterion 1 would occur if no Open Pit dewatering occurred. The evaluation of the flow assessment to Criterion 1 is summarized in Table 3.6.

Table 3.6 Evaluation of the Flow Assessment to Criterion 1

<table>
<tr><th>Station</th><th colspan="2">Ecological Flow Criterion 1 Exceeded</th><th colspan="2">Project Effect Exceeding Criterion 1</th></tr>
<tr><td>HM-3</td><td>Yes</td><td>Single occurrence on Jul 24,2021 of potential calculated losses >10%
Upper bound of proportion of total decrease in instantaneous streamflow attributed to Open Pit is 15%</td><td>No</td><td rowspan="3">The modelled project-related reduction in baseflow of 4.5% in relation to the Open Pit does not exceed Criterion 1.
In addition, the Open Pit dewatering rates (negating the fact that dewatering rates are also attributed to direct precipitation) are lower than observed flow reductions and therefore flow reductions can only be partially attributable to pit dewatering.</td></tr>
<tr><td>HM-4</td><td>Yes</td><td>Intermittently throughout 2021 monitoring period
Upper bound of proportion of total decrease in instantaneous streamflow attributed to Open Pit is 15%</td><td>No</td></tr>
<tr><td>SW-2</td><td>Yes</td><td>Occurrences on Jul 24, Aug 3, Aug 7, Sep 1, 2021, of potential calculated losses >10%
Upper bound of proportion of total decrease in instantaneous streamflow attributed to Open Pit is 9%</td><td>No</td></tr>
</table>

The reduction threshold for Ecological Flow Criterion 1 is 0.345 m^3/s (Table 3.6) and is based on cumulative flow alterations that result in instantaneous flows < 30% of the mean annual discharge (MAD).

As noted in Figure 3.9, a calculated potential loss to Moose River at HM-4 exceeding Criterion 2 was observed for approximately three days (September 13, 14, 15, 2021) of the 122-day monitoring period. The cumulative calculated potential flow loss over the three days amounts to 1.183 m^3/s, as presented in Figure 3.8, showing the losses to Moose River at a higher resolution scale. This loss in flow resulted in a temporary reduction of water depth of 0.389 m, occurred during a dry period without rain for several days, and was not observed downstream at SW-2 nor upstream at HM-3. An explanation for the temporary potential loss at HM-4 is that flow in Moose River is expanding into the adjacent wetland (Wetland 22) as “interflow” and coming back into the stream around the bend. This is likely occurring more predominately during low flow periods. This inaccessible portion of the river flow that may be stored in Wetland 22 would not be captured in flow monitoring and therefore the lower portion of the stage discharge curve may be biased low. In addition, there is an inundated remnant wooden plank structure located 30 m downstream of the station that likely results in some backwater during lower flows and may influence the stage discharge relationship at this station. At the lowest observed water level during the 2021 monitoring program, the water level in the river was cresting the top of the remnant wooden plank structure.

The upper bound of the proportion of potential calculated losses of Open Pit dewatering flows, averaged over the monitoring period between Jun 1 and Sep 30, 2021, is summarized in Table 3.4. In 2021, pit dewatering can only account for up to 0.05% of the potential losses at HM-4. Observed pit dewatering average rates over the monitoring period amounts to less than 1% of the flow losses to Moose River at both HM-4 or SW-2.

The project effect of Open Pit dewatering does not exceed Criterion 2. The evaluation of the flow assessment to Criterion 2 is summarized in Table 3.7.

Table 3.7 Evaluation of the Flow Assessment to Criterion 2

Station	Ecological Flow Criterion 2 Exceeded		Project Effect Exceeding Criterion 2	
HM-3	No	No exceedances	No	The modelled project-related reduction in baseflow of 4.5% in relation to the Touquoy Open Pit does not exceed Criterion 2. In addition, the pit dewatering rates (negating the fact that dewatering rates are also attributed to direct precipitation) is lower than observed flow reductions and cannot be wholly attributable to pit dewatering.

The modelled project-related reduction in baseflow of 4.5% in relation to the Open Pit does not exceed either of the two ecological flow criteria and is below a 10% alteration in magnitude of instantaneous flow in Moose River, including during low flow periods in the summer months.

In addition, Open Pit dewatering is not attributed to the calculated potential losses to Moose River as a whole. The metered Open Pit dewatering rates, which also include direct precipitation to the Open Pit are up to an order of magnitude lower than the calculated potential losses to Moose River. The remaining portion of the calculated potential flow losses to Moose River may be attributed to a combination of factors that are not related to Touquoy Mine Site operation, including:

- Evapotranspiration losses, as indicated in correspondence from NRCan (2020) that flow observed in rivers during the warm summer months is subject to heavy evapotranspiration losses (20-50% of the flow)
- Interflow losses through adjacent hydrophytic vegetation (*i.e.,* Wetland 22) at HM-4; thus, streamflow monitoring data at this monitoring location may not be representing all the flow in Moose River at this location.
- The presence of a remnant wooden structure with the potential to influence the rating curve more pronouncedly in lower flows
- The flow response from precipitation events at HM-1 Long Lake tributary varying from the response in Moose River; thus, showing a delay in discharge from rainfall events
- Natural characteristics of the river and watershed

Although quality control and accuracy of the 2021 hydrometric monitoring program was high, there are limitations in the data collection and methodology that cannot be avoided, including the following:

- limitation of instrument accuracy in the water level and flow monitoring data, compensation, and correction
- inherent method error associated with any aerial pro-rating upstream hydrometric stations to downstream stations adjacent to the Open Pit. Natural variation in the watercourse over time, subtle changes to the watercourse as a result of a mobile bed layer

Substantive residual effects to fish habitat as a result of the Open Pit are not anticipated, and no mitigation measures are proposed.

3.4 WATER QUALITY AND QUANTITY ANALYSIS (IR 8)

In consultation with the Inspection and Compliance Division and Water Resources Branch at ECC, clarify or provide information related to water quality and quantity analysis inconsistencies

This Additional Information is provided as Appendix A.

Comments received from the following groups were reviewed, to identify where inconsistencies were noted:

- Surface Water Quality Specialist
- ICE Division
- Senior Hydrogeologist, Sustainable and Applied Science Division
- Water Resources Engineer, Sustainability and Applied Science Division

These have been organized into themes, and clarification or additional information is provided in response.

3.5 REFERENCES

CRA (Conestoga-Rovers and Associates). 2007. Environmental Assessment Registration Document for the Touquoy Gold Project. Prepared for DDV Gold Limited.

DFO. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/017.

4.0 WILDLIFE

4.1 FLORA AND FAUNA SURVEY DATA (IR 9)

Provide all flora and fauna survey data referenced in the EARD with corresponding analysis.

This response is provided in Appendix G.

4.1.1 Vegetation Community Assessments 2020 and 2021 Methodology

Vegetation community surveys originally took place outside the growing season in October 21-22, 2020 to support the 2021 EARD submission. Although many communities can be confidently identified out of season, a follow up visit in-season occurred on September 30, 2021 in snow-free conditions. These follow up surveys determined the results in 2020 are reflective of what was observed in 2021.

Surveys were completed by terrestrial ecologist John R. Gallop by walking meandering transects during biophysical assessments. The objective of these surveys was to document the key forested and non-forested vegetative plant communities within the LAA and determine if any uncommon communities or SAR/SOCI habitat exist.

Classification of forested and non-forested community types were completed by merging two existing classification systems. For forested community types, the Nova Scotia Department of Natural Resources (NSDNR) Forest Ecosystem Classification (FEC) (Neily et al. 2010) was used. In the event surveyors encountered non-forested community types which were not defined by the FEC system, the *Maine Natural Areas Program - Natural Communities and Ecosystems* (NCE) (Gawler & Cutko, 2018) classification system was used.

The NCE was selected as an alternative guide because the FEC only describes forested landscapes, many of which are found in upland communities. Use of only the FEC would cause a bias in the survey results and would not be an accurate representation of all the vegetation community types within the LAA. the NCE classification system describes non-forested communities such as barrens, bogs, fens, and regenerative stands. Using this classification system in conjunction with the FEC provides a more detailed overview of the vegetation types found within the LAA.

The Maine NCE classification was referenced and used as a guideline because Nova Scotia does not have any published non-forested classification systems available with the exception to the *Barrens Ecosystems in Nova Scotia: Classification of Heathlands and Related Plant Communities* (Porter et. al. 2020) which is not applicable to the communities observed within the LAA. Due to the geographical location of Maine and its proximity to Nova Scotia, many habitat similarities exist between the two locations. Nova Scotia and Maine are both within the Acadian Forest region which is characterized by temperate broadleaf and mixedwood forests which are subject to coastal influences. As a result, many of the community types described in the NCE are directly applicable to Nova Scotia, and therefore, it is a suitable classification system to use for these surveys.

All vegetation community types encountered within the LAA were georeferenced using a handheld Garmin and the following information was collected:

1. Dominant tree, shrub and herbaceous species;
2. Presence of a disturbance;
    a. Anthropogenic (e.g. cutblock)
    b. Natural (e.g. windthrow)
    c. None
3. Approximate stand age;
    a. Regenerative
    b. Mature
4. Representative photographs;
5. Approximate boundary of the habitat types (if not clearly visible from aerial imagery); and
6. Vegetation community and classification.

Both wetland and upland vegetation communities were documented during the surveys.

The data collected in the field was then processed and the approximate boundaries of the vegetation types within the LAA were interpreted by the use of aerial imagery.

4.1.2 2021 Flora Surveys Methodology

Field surveys took place on September 30, 2021, by John R. Gallop by walking meandering transects through all habitat types to create a species list of the general vascular species and communities present within the LAA (Figure 4.1). Survey efforts were focused on wetlands and riparian habitats as they often have an increased potential for rarities due to richer and unique conditions.

If a species could not be identified in the field, detailed photographs were taken to capture diagnostic features, and, if possible, specimens were collected and preserved for identification at a later time. All priority species observed were georeferenced, counted (when possible), photographed, and their habitat was recorded. When specimens were present in tufts or in large numbers and counting the individuals became a challenge, the areas of these clumps were measured (e.g. 10 m x 10 m). The following literature are the primary references used during the field surveys and identification process:

4.1.2.1 Vascular Flora

- Roland's Flora of Nova Scotia (Zinck, 1998)
- Nova Scotia Plants (Munro, Newell, & Hill, 2014)
- Flora of New Brunswick (Hinds, 2000)
- Go Botany (Native Plant Trust, 2020)
- Field Manual of Michigan Flora (Voss & Reznicek, 2012)
- Sedges of Maine (Matt Arsenault, 2013)
- Grasses and Rushes of Maine (Glen H. Mittelhauser, 2019)

4.1.2.2 Bryophytes

- Mosses of Eastern North America Vol. 1 & 2 (Crum & Anderson, 1981)
- Mosses and Liverworts of Britain and Ireland – a Field Guide (British Bryological Society, 2010)
- Common Mosses of the Northeast and Appalachians (McKnight., Rohrer, Ward, & Perdrizet, 2013)

4.1.3 Flora 2021 Survey Results

Seventy-four flora species were observed during the in-season surveys which took place in September 2021 within the LAA. See Table 4.1 for the species observed.

Table 4.1 Vascular flora and Bryophyte list observed within the LAA in 2021

Scientific Name	Common Name	S Rank
Cornus canadensis	Cana bunchberry	S5
Hylocomium splendens	Stairstep moss	S5
Picea rubens	Red spruce	S5
Abies balsamea	Balsam fir	S5
Kalmia angustifolia	Sheep laurel	S5
Gaultheria hispidula	Creeping snowberry	S5
Sphagnum girgensohnii	Green peatmoss	S5
Vaccinium angustifolium	Late lowbush blueberry	S5
Dicranum scoparium	Common broom moss	S5
Sphagnum capillifolium	Northern peatmoss	S5
Hypopitys monotropa	Pinesap	S4
Monotropa uniflora	Convulsion-root	S5
Coptis trifolia	Gold thread	S5

Table 4.1 Vascular flora and Bryophyte list observed within the LAA in 2021

Scientific Name	Common Name	S Rank
Osmunda cinnamomea	Cinnamon fern	S5
Ulota crispa	Crisped Pincushion Moss	S5
Thuidium delicatum	Delicate fern moss	S5
Chaenotheca balsamconensis	A lichen	-
Platismatia glauca	Varied rag lichen	S5
Pinus strobus	White pine	S5
Acer rubrum	Red maple	S5
Usnea longissima	Methuselah's Beard Lichen	S4
Platismatia tuckermanii	Crumpled Rag Lichen	S5
Solidago rugosa	Rough goldenrod	S5
Dryopteris carthusiana	Spinulose Wood Fern	S5
Brachyelytrum aristosum	Northern shorthusk	S5
Mnium hornum	Swan's neck Leafy moss	S5
Betula papyrifera	Paper Birch	S5
Pteridium aquilinum	Bracken fern	S5
Scirpus cyperinus	Common Woolly Bulrush	S5
Pleurozium schreberi	Red-stemmed Feather Moss	S5
Ledum groenlandicum	Labrador tea	S5
Thalictrum pubescens	Tall meadown rue	S5
Rubus hispidus	Bristly dewberry	S5
Iris versicolor	Blue flag	S5
Polytrichum commune	Common haircap moss	S5
Vaccinium vitis-idaea	Mountain cranberry	S5
Onoclea sensibilis	Sensitive fern	S5
Usnea strigosa	Bushy beard lichen	S3
Osmunda regalis	Royal fern	S5
Sorbus americana	American mountain ash	S5
Viola cucullata	Marsh blue violet	S5
Calamagrostis canadensis	Bluejoint reed grass	S5
Alnus incana	Speckled alder	S5
Spiraea alba	White Meadowsweet	S5
Chamaedaphne calyculata	Leather leaf	S5
Juncus canadensis	Soft rush	S5
Nymphaea odorata	Fragrant water-lily	S5
Sphagnum paluste	blunt leaved sphagnum moss	S5

Table 4.1 Vascular flora and Bryophyte list observed within the LAA in 2021

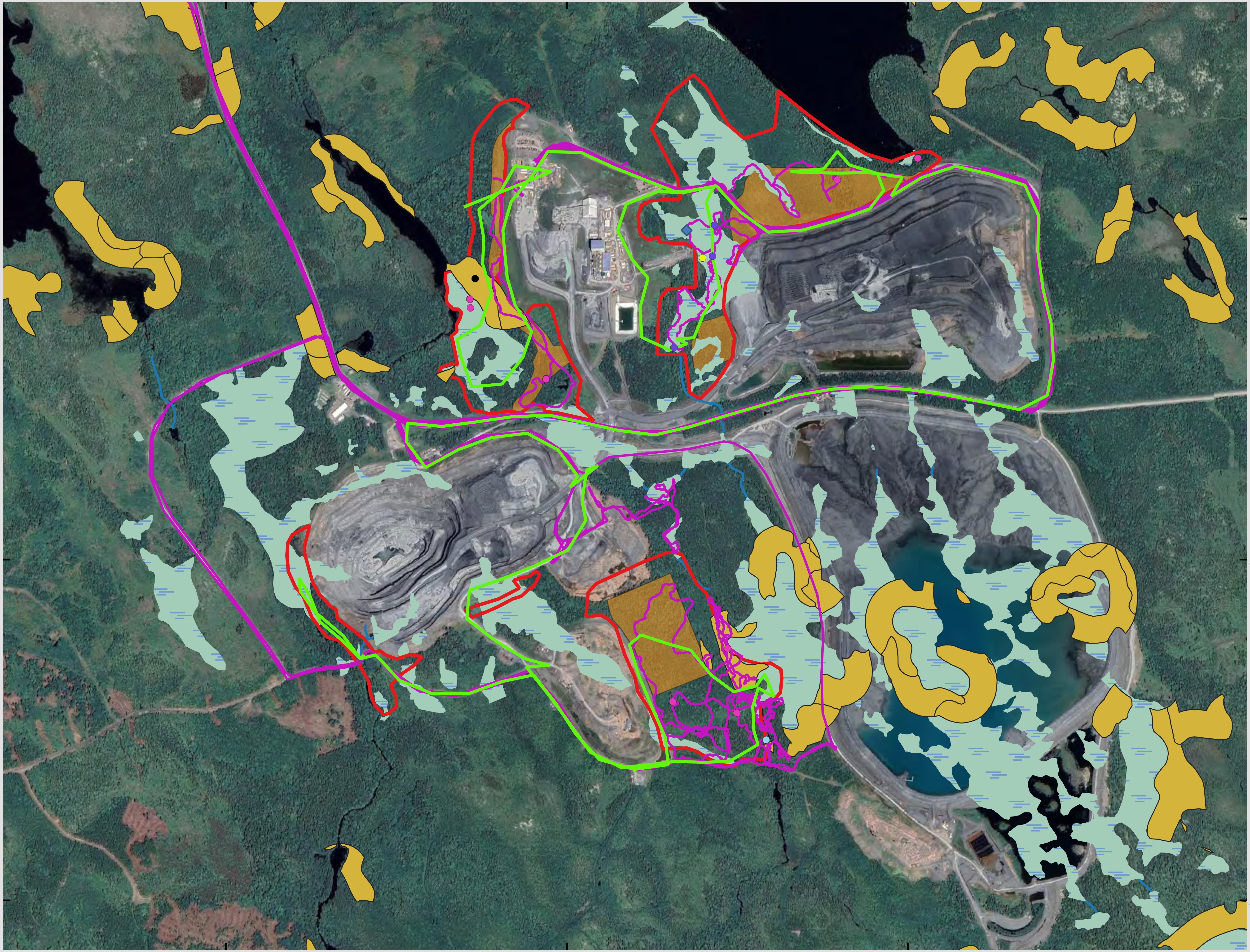
Scientific Name	Common Name	S Rank
Sphagnum magellanicum s.l.	Magellan's peatmoss	S5
Sphagnum angustifolium	Narrowleaf peatmoss	S5
Carex trisperma	Three-seeded sedge	S5
Larix laricina	Tamarack	S5
Epilobium leptophyllum	Bog willow herb	S5
Dryopteris cristata	Crested wood fern	S5
Peltigera aphthosa	Common freckle pelt lichen	S5
Lobaria quercizans	Smooth lung lichen	S5
Phegopteris connectilis	Northern beach fern	S5
Fontinalis antipyretica	Greater water moss	S5
Sarracenia purpurea	Northern pitcher plant	S5
Andromeda polifolia	Bog rosemary	S5
Thelypteris noveboracensis	New York fern	S5
Dicranum polysetum	Wavy-leaved Broom Moss	S5
Nephroma helveticum	Fringed Kidney Lichen	S4
Linea borealis	Twin flower	S5
Polytricum juniperum	Juniper Haircap Moss	S5
Doellingeria umbellata	Hairy flat-top white aster	S5
Epigaea repens	Trailing arbutus	S5
Calicium sp.	A lichen	-
Pannaria rubiginosa	Browned-eyed shingle lichen	S5
Glyceria canadensis	Canada manna grass	S5
Oclemena x blakei	An aster hybrid	S5
Vaccinium myrtilloides	Velvet-leaved Blueberry	S5
Euthamia graminifolia	Grass-leaved Goldenrod	S5
Solidago puberula	Downy Goldenrod	S5

4.1.4 Lichen Survey 2020 and 2021 Methodology

Surveys were completed by lichen surveyor Mr. John R. Gallop concurrently with the full suite of biophysical surveys on October 21st – 22nd, 2020 and September 30, 2021, in snow-free conditions. All habitat types were visited and inspected for lichens; however, efforts were focused on surveying mature trees that are appropriate for hosting priority lichen species. The trunks and branches were surveyed for lichens. Boreal felt lichen (BFL), which is a globally rare lichen listed as Endangered by SARA and NSESA, was one of the targeted species during the surveys and predictive habitat polygons were visited to determine BFL presence and/or habitat suitability.

The following information was collected for any priority lichen species identified during field surveys: site location, date, scientific name, count, size, habitat (substrate, general habitat), location (waypoint in UTM NAD83), along with a photograph and any relevant comments. In the event lichen specimens could not be identified in the field, lichen samples were collected (when in abundance on site) in paper bags and stored for future identification. Chemical spot tests were used when necessary for identification and were completed as per methodologies described in Lichen of North America (Brodo, Sharnoff, & Sharnoff, 2001). The following literature are the primary references used during the field surveys and identification process:

- The Macrolichens of New England (Hinds & Hinds, 2007)
- Lichens of North America (Brodo, Sharnoff, & Sharnoff, 2001)



Prepared for:

Atlantic Gold

FIGURE 4.1

2021 Lichen and Rare Plant Survey Tracks and Results

Moose River, Nova Scotia

- Field Delineated Wetlands
- Predicted Boreal Felt Lichen Habitat
- 2021 In-season Rare plant surveys
- LAA
- Lichen Surveys
- Field Delineated Watercourses
- Blue felt Lichen (SAR)

SOCI Lichens
- Collema leptaleum
- Fuscopannaria ahlneri
- Fuscopannaria leucosticta
- Leptogium corticola
- Usnea rubicunda

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 200 400 600 m

Scale: 1:10,490

Scale when printed @ 11" x 17"

2021-11-1

McCallum Environmental Ltd.

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5.0 WETLANDS AND SHIP HARBOUR LONG LAKE WILDERNESS AREA

5.1 WETLAND #15 (IR 10)

Provide additional analysis for avoidance of Wetland #15, a Wetland of Special Significance under the ECC Wetland Policy

Wetland 15 was identified as a Wetland of Special Significance due to the presence of an occurrence of blue felt lichen (COSEWIC & SARA: Special Concern; NSESA: Vulnerable, S3), as per the criteria specified in the Nova Scotia Wetland Conservation Policy (NSE, 2011): "wetlands known to support at-risk species as designated under the federal Species At Risk Act or the Nova Scotia Endangered Species Act".

Wetland 15 is proposed to be partially altered (6.5% of the total wetland area) by the WRSA expansion development. The original WRSA size was reduced due to engineering and environmental (wetland) constraints (Section 1.4.2 of the 2021 EARD). The WRSA expansion has been micro-sited to the extent practicable, due to additional direct habitat impacts, including Wetland 15. The placement of the WRSA expansion uses infrastructure currently in place for the existing WRSA to optimize mining activities, reduces the potential for direct and indirect effects of the expansion and focuses new development to previously impacted areas (*i.e.,* historically cutover). The WRSA expansion is located on 1.3 ha of previously cutover forest (Figure 9.3 of the 2021 EARD).

Presently, 0.60 ha of Wetland 15 is altered by the existing WRSA. Wetland 15 is also bisected by a mine road from the Plant Site to the WRSA. Wetland 15 has been permitted for a total of 4.12 ha of alteration area under previous wetland alteration approvals (see Figure 2.1 of the EARD and Figure 5.1 below), some of which overlaps with the areas proposed in this EARD. Under this EARD only 0.62 ha of Wetland 15 is proposed for alteration, 15% of the previously approved alteration area. The proposed alteration area has been confined to the northeast lobe and to a small 0.1 ha area next to the existing WRSA impact area. The northeast lobe is dominated by the M1 – Mountain Holly – Alder Shrub Swamp vegetation community, which has low potential to support blue felt lichen. There is currently no request to develop within remaining approved alteration areas in Wetland 15.

In consideration of landbird SAR habitat, a portion of Wetland 15 proposed for direct impact (~0.2 ha or 1% of the Wetland 15 area) contains the M1 – Mountain Holly – Alder Shrub Swamp vegetation community, which has potential to support Canada Warbler (COSEWIC & SARA: Threatened; NSESA: Endangered, S3B). The other wetland areas proposed for direct impact, in Wetland 15 and 17, contain the WC6 – Balsam Fir/Cinnamon Fern – Three Seeded Sedge/Sphagnum Moss vegetation community. This community has low potential to support landbird SAR critical life functions.

Potential indirect wetland impacts through changes to hydrology associated with the PDAs (*e.g.,* drainage patterns, surface water management) are presented in the EARD. Wetland 15 is located between the existing Plant Site and WRSA in the WRSA expansion PDA. The wetland receives water through a drainage inlet to the north of the wetland and passive overland/throughflow drainage from adjacent uplands. The primary flow path within Wetland 15 is north-south, via Watercourse 4. No impacts are proposed in the contributing catchment area north of Wetland 15. Existing infrastructure is located in the upland areas east (WRSA) and west (Plant Site) of Wetland 15. No hydrological impacts have been observed to date in Wetland 15 through the wetland monitoring program (Table 14 of the EARD). As a result, it is not expected that the WRSA expansion footprint proposed in this EARD will cause new hydrological (*i.e.,* flow) impacts to Wetland 15.

As presented in the EARD, there exists potential for groundwater seepage from the Project (*e.g.,* the pit and WRSA) to indirectly impact wetlands through potential changes in water quality. The quality of this groundwater seepage as a result of modifications has been predicted to support this EARD, and is presented in Appendix D.1 of the EARD. The predicted water quality of seepage is at concentrations that comply with regulatory guidelines for the protection of aquatic health (NSE Tier II Pathway Specific PSSLs) and thus, there is no predicted residual impact to wetlands. A groundwater monitoring plan is in place for the project.

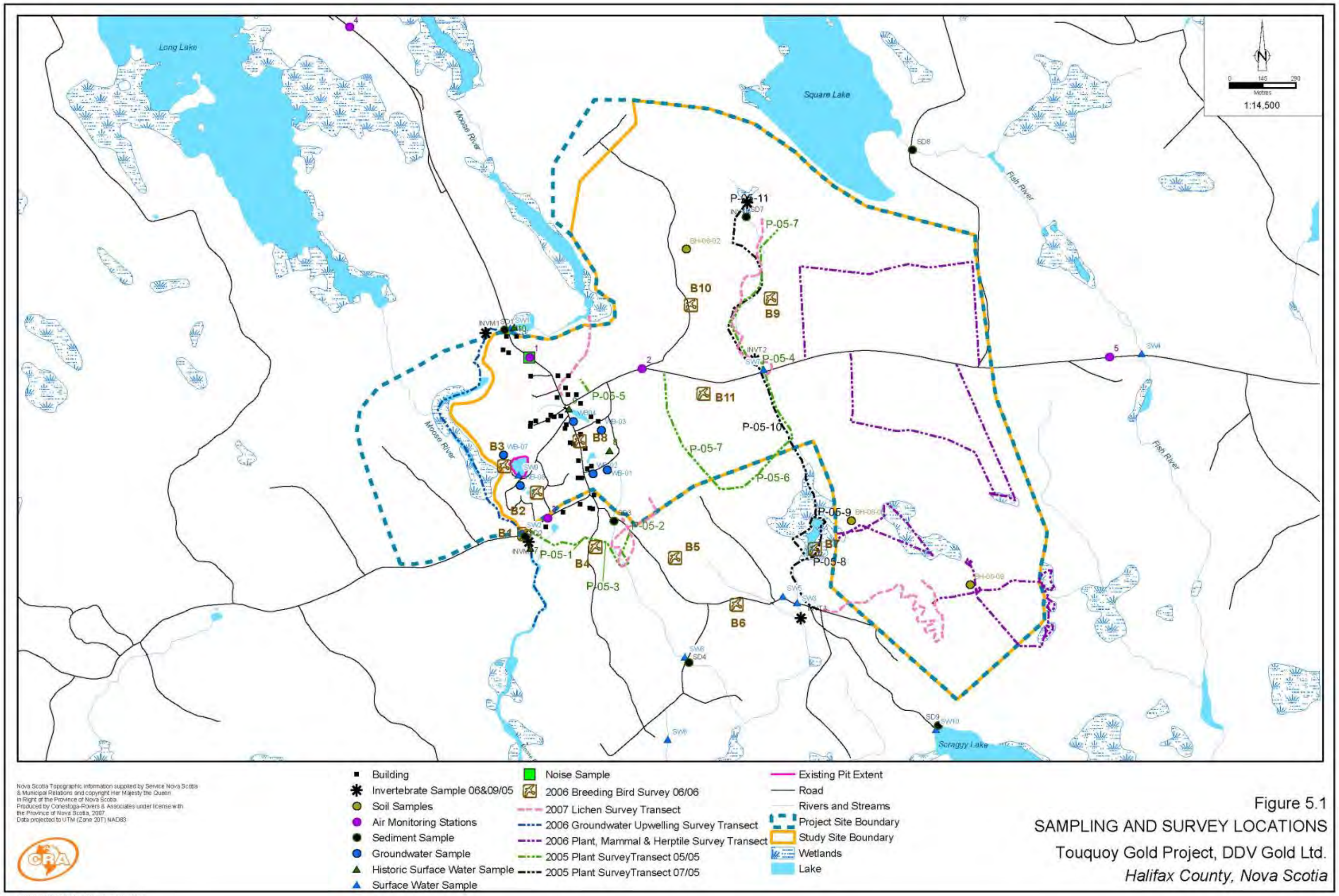

Figure 5.1 Approved and Proposed Wetland Impact Areas

5.2 SHIP HARBOUR LONG LAKE WILDERNESS AREA (IR 11)

Provide an analysis of potential impacts to the Ship Harbour Long Lake Wilderness Area and proposed mitigations.

As part of their protected areas program, in 2009, the Province of Nova Scotia designated approximately 14,700 ha of crown land as the Ship Harbour Long Lake Wilderness Area under the Wilderness Areas Protection Act. The Wilderness Areas Protection Act is administered by NSECC and is intended to "provide for the establishment, management, protection and use of wilderness areas, in perpetuity, for present and future generations, to achieve the following objectives:

- maintain and restore the integrity of natural processes and biodiversity;
- protect representative examples of natural landscapes and ecosystems;
- protect outstanding, unique, rare and vulnerable natural features and phenomena;
- provide reference points for determining the effects of human activity on the natural environment;
- protect and provide opportunities for scientific research, environmental education and wilderness recreation;
- promote public consultation and community stewardship in the establishment and management of wilderness areas;
- provide opportunities for public access for sport fishing and traditional patterns of hunting and trapping.

The Ship Harbour Long Lake Wilderness Area was expanded by 332 ha in 2012; by 929 ha in 2015; and by 521 ha in 2020 with the addition of lands owned by the Nature Conservancy of Canada and a private land donation. The Ship Harbour Long Lake Wilderness Area now extends over 30 km between Musquodoboit Harbour and Mooseland, and protects more than 16,500 ha of rugged woodlands, lakes, and waterways of the Eastern Shore interior (Province of Nova Scotia 2020).

The Ship Harbour Long Lake Wilderness Area is the largest protected area in the Halifax Regional Municipality and is located immediately south of the Touquoy Mine, encompassing a substantial part of Fish River and Scraggy Lake watersheds. This wilderness area includes stands of old forest, large wetland complexes and numerous wilderness lakes and waterways and offers opportunities for wilderness recreation and nature tourism, including angling, hunting, canoeing, and hiking (Province of Nova Scotia 2020).

A preliminary assessment of protection-oriented values of the *proposed* Ship Harbour Long Lake Wilderness Area was commissioned by the Eastern Shore Forest Watch in May 2006 prior to the site's official designation in 2009 (deGooyer 2006). deGooyer (2006) described the natural features of the area which contribute to the ecological value of the area and corresponding rationale for protection under the *Wilderness Areas Protection Act* including: large natural patches of interior habitat (particularly relevant for the endangered mainland moose); diverse landscape representation; old forests; significant ecosites (relatively small landform vegetation complexes that are often biologically rich and/or can provide habitat for rare or vulnerable species); and wilderness recreation opportunities (*e.g.,* (canoeing, hiking, hunting, fishing). The need for protection from landscape fragmentation (primarily associated with forestry operations and road presence and use) was recognized as important rationale for designating this area under the Act. The Proposed Ship Harbour Long Lake Wilderness Area Assessment of Protected Areas Values (deGooyer 2006) was appended to the 2007 Focus Report (CRA 2007) to supplement an assessment of potential effects of the Touquoy Gold Project on wilderness recreational aspects of the Focus Report study area.

The Touquoy Mine Site lies within the Fish River-Lake Charlotte secondary watershed (1EL-5) and is immediately adjacent to the Ship Harbour Long Lake Wilderness Area, with active operations occurring approximately 100 m north of the wilderness area boundary (Figure 5.2). The Fish River-Lake Charlotte watershed includes Fish River, Moose River, and other smaller tributaries within the immediate vicinity of the Touquoy Mine Site. Several watercourses and waterbodies located immediately adjacent to or within the development area of the existing Touquoy Mine Site are associated with the Ship Harbour Long Lake Wilderness Area. Moose River is located to the west of the existing Open Pit with the riverbank located approximately 65 m from the Open Pit at the closest location. Watercourse #4, a tributary to Moose River, flows north to south through the site between the Open Pit and TMF. The Fish River headwaters flow adjacent to the site to the east. There is an unnamed tributary to Fish River which flows approximately 1,450 m before the confluence with Fish River adjacent to the eastern side of the TMF. Square Lake is located directly to the north of the WRSA. Scraggy Lake is downstream of the Touquoy Mine Site and is both a source of water for the site as well as the receiving body for treated effluent discharge from the TMF. A large portion of the land surrounding Scraggy Lake falls within the Ship Harbour Long Lake Wilderness Area. The final discharge point from the TMF is located just outside the wilderness area boundaries.

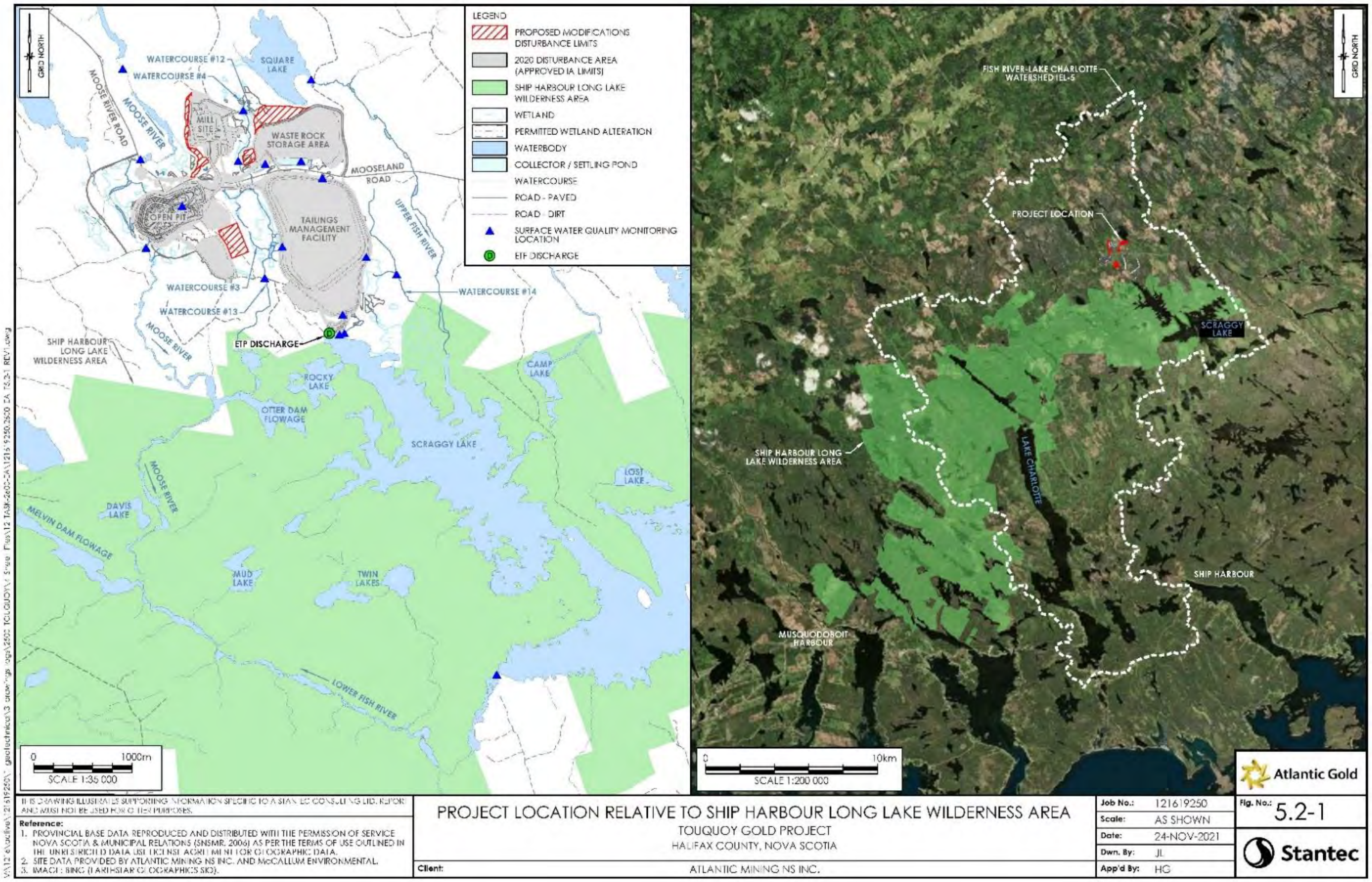

Figure 5.2 Project Location Relative to Ship Harbour Long Lake Wilderness Area

Potential Project Interactions

In consideration of the proximity of the wilderness area to the Touquoy Mine Site and potential Project interactions with Fish River, Moose River and Scraggy Lake, there could potentially be Project-related effects on the Ship Harbour Long Lake Wilderness Area. Project activities could result in direct and/or indirect loss or alteration of wildlife habitat (*e.g.,* through light, noise, air emissions) and/or through physical or chemical changes in fish and fish habitat, including wetland habitat. It is also possible that Project activities could potentially result in direct and/or indirect effects on the use and enjoyment of the wilderness area, particularly if there are changes in ambient light, noise and/or air quality in the wilderness area, and/or if there are Project effects on fish and fish habitat which could indirectly affecting angling activities.

Key Mitigation

Project planning and design and the application of proven mitigation measures will be used to reduce adverse environmental effects. As a priority mitigation measure, AMNS has designed the WRSA expansion, new Clay Borrow Area, and Plant Access Road to reduce impacts on terrestrial and wetland habitat and avoid fish habitat. Where potential interactions cannot be avoided, measures to mitigate and reduce adverse effects are proposed.

The following mitigation measures will be implemented to reduce or avoid adverse effects on the Ship Harbour Long Lake Wilderness Area:

- No work is to be done within 30 m of a watercourse or wetland, or within 30 m of the property boundaries without the necessary permits.
- The limits for approved clearing, grubbing and topsoil overburden removal will be clearly identified (flagging/survey stakes) in the field prior to the commencement of any work.
- Areas to be cleared will have sediment and erosion control measures implemented prior to the initiation of any clearing activities. The sediment and erosion control measures will be adapted to suit the field conditions associated with the specific construction activities as construction proceeds.
- Work operation will be conducted at a time and in a manner to protect watercourses from siltation and disturbance. Sediment control measures will be installed prior to construction and properly maintained until erodible material is stabilized.
- Refueling will not occur within 30 m of a watercourse or waterbody.
- Work will be performed in such a way as to prevent materials such as sediment, fuel or any other hazardous materials from entering watercourses and waterbodies through the implementation of sediment control measures and proper hazardous materials management practices. In the event of a release to the environment, it will be reported in accordance with the Environmental Emergency Regulations and the Emergency Response Plan and Spill Contingency Plan will be implemented.
- The duration of work below the ordinary high-water mark will be planned to respect the DFO timing windows, as required.
- Work will be scheduled to avoid high precipitation and runoff events or periods that could increase the potential for erosion and sedimentation.
- No debris or other construction material will be allowed to enter watercourses.
- Fish screens and/or other barriers will be installed and maintained to prevent fish from entering the in-pit disposal area, as is practically feasible.
- If explosives are required, use of explosives will follow DFO blasting guidelines.

- Water management infrastructure will be used to maintain flows in Watercourse #4 and will be located as far upstream as is practically feasible.
- Water will be discharged via subsurface discharges where practicable/feasible on water management ponds which flow into fish-bearing waters.
- Effluent will be treated as required to applicable regulatory limits prior to discharge.
- Blasting (if required) will be conducted as per the Pit and Quarry Guidelines to reduce the impact of noise and vibration on wildlife.
- The use of lighting will be reduced to the amount necessary for safe operation within the Touquoy Mine Site, with the recognition that excessive lighting can be disruptive to wildlife. Additional lighting will be installed facing downward and wherever practicable using motion-sensing lights.

The Surface Water Management Plan (Attached to EARD as SD 05) and Erosion and Sediment Control Plan (Stantec 2010, 2020, X) developed for the Touquoy Gold Project will be updated to reflect proposed modifications to the Touquoy Gold Project and will incorporate engineered water management systems that will be constructed to collect runoff and seepage from the WRSA, Clay Borrow Area, and Plant Access Road during the operational phase and closure phases.

The Mainland Moose Management Plan (MMMP, X) (McCallum Environmental Ltd. 2017a) and the Wildlife Management Plan (WMP, X) (McCallum Environmental Ltd. 2017b) will be updated to account for proposed modifications to the Touquoy Gold Project and potential interactions with the Ship Harbour Long Lake Wilderness Area. The MMMP outlines protocols to monitor usage of the Touquoy Mine Site and surrounding landscape by mainland moose, minimization of moose-human interaction, and support research, education and stewardship related to mainland moose recovery. The WMP outlines protocols to reduce interactions between terrestrial wildlife and Project activities.

Residual Effects Analysis

As assessed in Sections 6 to 8 of the EARD, changes in surface water and groundwater quality and quantity could potentially affect fish and fish habitat including in Moose River, Fish River and Scraggy Lake. Potential reductions in fish habitat quantity and quality associated with Project-related changes in watershed area and streamflow, groundwater seepage, and effluent discharges will be mitigated through the installation of various water management features which will be incorporated into an updated Surface Water Management Plan for the Touquoy Gold Project. As described in Section 7.6 of the EARD, this includes engineered features to treat and return surface water flow to Watercourse #4 to compensate for potential water quality changes and loss of catchment area associated with WRSA and Clay Borrow Area modifications. Effluent will be treated to meet MDMER authorized limits or site-specific water quality objectives prior to being discharged to the environment.

During the post-closure period, the deposition of tailings in the Open Pit will affect the water quality in the pit, including the pore water quality in the tailings within the Open Pit. This lower quality water has the potential to migrate toward Moose River via groundwater. However, as described in Section 6.7.2 of the EARD, groundwater seepage from the Open Pit is predicted to contribute approximately 0.6% of the flow in Moose River; therefore, the mass loading of the primary compounds of concern are predicted to be low and are not anticipated to adversely affect the water quality in Moose River, including downstream reaches of Moose River within the Ship Harbour Long Lake Wilderness Area.

As described in Section 9.7.2 of the EARD, riparian wetlands along the Moose River west of the Open Pit, and wetlands located south of the Open Pit may also be affected by groundwater seepage from the Open Pit (*i.e.,* WL22, WL27, WL40, WL49 and WL56). The predicted increase in flow from both the Open Pit overflow via the spillway at post-closure and groundwater seepage (described above) is expected to be low – collectively less than 4% of the average Moose River August flow (when flows are lowest). Therefore, the Project is not anticipated to adversely affect the water quantity or quality in adjacent wetlands (within ~100 m of the Open Pit), or wetland habitat downstream within the Ship Harbour Long Lake Wilderness Area.

Although some changes in fish habitat quality are predicted within localized reaches of watercourses and waterbodies associated with the Touquoy Mine Site, no measurable effects are predicted further downstream or within the Ship Harbour Long Lake Wilderness Area. Changes in water quality will be monitored and water will be treated as required to avoid or reduce adverse effects on fish habitat quality.

Based on the effects assessment for groundwater resources, surface water resources, wetlands, and fish and fish habitat, with avoidance, mitigation and environmental protection measures, effects on fish and fish habitat in the Ship Harbour Long Lake Wilderness Area are not anticipated.

The Project will result in a small additional loss of habitat that supports moose foraging activities. However, these areas exist within the operational Touquoy Mine Site and as a result of the presence of the operating mine, impacts to these areas are not expected to result in further changes to moose habitat use and patterns. Project activities will result in direct loss of habitat within Mine Site boundaries for avian species, including priority species such as common nighthawk, Canada warbler, barn swallow, olive-sided flycatcher, and eastern wood-pewee. However, due to the abundance of these habitats regionally and the likely decreased quality of the impacted habitats because of their proximity to the operating Touquoy Mine Site, it is not expected that this Project will further impact avian species. Indirect effects to wildlife (*i.e.,* vehicle interactions, edge effects, sensory disturbance) are not expected to increase beyond those associated with the current operation of the Touquoy Mine Site. Based on the effects analysis for the terrestrial environment (Section 9 of the EARD), with effects avoidance, mitigation and environmental protection measures, effects on wildlife and wildlife habitat associated with the Ship Harbour Long Lake Wilderness Area are expected to be negligible.

For recreational users of the Ship Harbour Long Lake Wilderness Area, the Project will not result in any substantial additional traffic and there are no new atmospheric emissions (*e.g.,* air, dust, noise, lights) predicted from Project activities that would affect the use and enjoyment of the Area.

Monitoring

AMNS has designed and implemented a series of management procedures and monitoring programs that integrate engineering design and environmental planning to avoid or reduce environmental effects of the Touquoy Gold Project to the greatest extent practicable. Various monitoring programs are already in place to monitor environmental performance of the Touquoy Gold Project, including surface water and groundwater monitoring, wetland monitoring, ambient air quality monitoring, environmental effects monitoring, and mainland moose monitoring. Section 3.3 of the EARD provides additional information on monitoring programs.

Existing monitoring programs will be reviewed to determine what, if any, changes are required to capture potential environmental effects associated with the proposed modifications to the Approved Project. This may include, but not be limited to the addition of water quality monitoring sites such as a new monitoring location proposed for Moose River downstream of the Open Pit spillway discharge location once the spillway becomes active (Year 9).

As no significant residual indirect effects to wetlands along the Moose River and within the Ship Harbour Long Lake Wilderness Area are expected, additional wetland monitoring within these wetlands is not proposed. Wetland monitoring will continue through the existing wetland monitoring program and as proposed in Table 9.14 of the EARD, based on predicted or observed direct and indirect effects. Water quality will be monitoring through the existing and/or proposed surface water and groundwater monitoring programs.

Current surface water quality monitoring locations are shown on Figure 5.2. No additional monitoring programs or surface water quality monitoring sites are proposed to specifically monitor effects on the Ship Harbour Long Lake Wilderness Area. However, should changes to predicted water quality and quantity be observed, the monitoring programs will be revisited in consultation with applicable regulatory agencies.

Summary

In summary, in consideration of effects avoidance, mitigation and environmental protection measures, Project effects on Ship Harbour Long Lake Wilderness Area, including ground and surface water resources, wetlands, fish and fish habitat, wildlife and wildlife habitat, and recreational use, are expected to be negligible.

5.3 REFERENCES

CRA. 2007. Focus Report Touqouy Gold Project Moose River Gold Mines, Nova Scotia. Prepared for: DDV Gold Limited. November 2007.

deGooyer, K. 2006. Proposed Ship Harbour Long Lake Wilderness Area Assessment of Protected Area Values. Prepared for Eastern Shore Forest Watch. May 2006.

McCallum Environmental Ltd. 2017a. Touquoy Gold Project Mainland Moose Management Plan. Prepared for Atlantic Gold. January 2017.

McCallum Environmental Ltd. 2017b. Touquoy Gold Project Wildlife Management Plan. Prepared for Atlantic Gold. January 2017.

Province of Nova Scotia. 2020. Ship Harbour Long Lake Wilderness Area. Available at: Ship Harbour Long Lake Wilderness Area | Protected Areas | Nova Scotia Environment.

Stantec (Stantec Consulting Ltd.). 2010. Erosion and Sediment Control Plan for the Development of the Touquoy Gold Project, Moose River Gold Mines, Nova Scotia. March 2010.

Stantec (Stantec Consulting Ltd.). 2017. Water Management Plan, Touquoy Gold Project. Version 1. Prepared for Atlantic Mining NS Inc. February 2017.

Stantec (Stantec Consulting Ltd.). 2020. Erosion and Sediment Control Plan Update. Touquoy Gold Project. Prepared for Atlantic Mining NS Inc.

Wright, D.G. and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Fisheries and Oceans Canada.

6.0 HISTORIC TAILINGS (IR 12)

Provide a description and map of historic mine tailings within or near the proposed project footprint. Provide a plan to manage the historic tailings.

A Historic Tailings Management Plan (HTMP) has been in place for the Touquoy Mine Site since July 2018 and is being updated and maintained as part of site operations. Given the project site changes since the HTMP was approved, AECOM Canada Ltd. (AECOM) was retained by Atlantic Mining NS (AMNS) to review and suggest modifications to the HTMP to be reflective of current site conditions – these are provided as Appendix H.

7.0 FISH AND FISH HABITAT

7.1 FISH SURVEY DATA (IR 13)

Please refer to Appendix I.

7.2 SQUARE LAKE FISH SURVEYS (IR 14)

Conduct fish and fish habitat surveys in Square Lake and provide analysis.

Stantec conducted fish and fish habitat surveys in Square Lake on October 13 and 14, 2021. The fish habitat consisted of a survey of the littoral zone and bathymetric mapping. The fish survey consisted of deployment of a fyke net and minnow traps in the littoral zone as well as two gill nets in littoral areas and two gill nets in deeper water habitat to document the existing fish community. Fish were measured and weighed. The methods and results are described in Appendix I.

7.3 MOOSE RIVER FISH SURVEYS (IR 15)

Conduct fish sampling in Moose River

Stantec conducted fish sampling in Moose River on September 14, 2021. A qualitative survey was conducted involving 500 seconds of electrofishing at two locations on Moose River. A juvenile white sucker (*Catostomus commersoni*) and an American eel (*Anguilla rostrata*) were captured. The methods and results are described in Appendix I.

7.4 FISH AND FISH HABITAT IMPACTS (IR 16)

Provide information to support statements in the EARD indicating there are no or limited impacts to fish and fish habitat in Watercourses: Square Lake, Upper Fish River, Watercourse #14, Watercourse #13, Watercourse #3.

The EARD indicated there were no noted changes associated with fish or fish habitat in Square Lake, upper Fish River, Watercourse #14, Watercourse #13, and Watercourse #3 following the development of the Touquoy Mine from pre-development conditions to existing conditions. The Proponent acknowledges that the information about pre-development conditions is limited for comparison purposes.

A fish survey was conducted in Square Lake to support the original EA (CRA 2007) however no fish were captured for comparison with existing information. Square Lake is located approximately 60 m from the existing WRSA and no direct interactions were identified which could result in a measurable change in fish or fish habitat in Square Lake. There is the potential of indirect effects to Square Lake (*e.g.,* groundwater seepage) however water quality monitoring information collected at the outflow of Square Lake (SW-12) has not changed notably following mine development. The fish habitat survey of Square Lake undertaken on October 13 and 14th, 2021 did not observe any evidence of effects of the mine (*e.g.,* precipitate, staining) to fish habitat near the existing WRSA or within Square Lake (Appendix I). These observations support the EARD conclusion of no measurable changes to fish and fish habitat from pre-development to existing conditions.

Similarly, the closest Project component (*i.e.,* WRSA) to upper Fish River is located approximately 200 m away. No direct interactions with the existing Project were identified which may result in a measurable change in fish or fish habitat in upper Fish River. There is the potential of indirect effects to upper Fish River (*e.g.,* groundwater seepage) however water quality monitoring information collected at SW-12 has not changed notably following mine development supporting the EARD conclusion of no measurable changes to fish and fish habitat.

Watercourses #13 and #3 are small headwater streams, which do not extend the length of what is shown on available maps (Stantec 2021). There have been reductions in watershed area and associated flow greater than 10% from the pre-development condition to existing conditions which may result in detectable effects to fish habitat based on the instantaneous and mean annual discharge thresholds established in DFO (20 13). While there was no pre-development data for comparison, it is anticipated that there would have been potential reductions in water velocity, wetted channel perimeter, modification of fish habitat types (*e.g.,* changes from runs to glides) or changes in primary or secondary productivity. Surveys conducted in 2021 to support the EARD did not observe any direct changes to fish habitat (*i.e.,* changes in channel morphology, precipitate, staining) between the pre-existing and existing conditions (Appendix I). Fish were confirmed present in Watercourse #3 in 2021 providing evidence that these watercourses still support fish populations.

The headwaters of Watercourse #14 run adjacent to and flow away from the TMF. The aerial imagery indicates there is a riparian buffer around Watercourse #14, and therefore no direct interactions were identified which may result in a measurable change in fish or fish habitat. There is the potential for indirect effects to Watercourse #14 (*e.g.,* groundwater seepage, loss in flow) however water quality monitoring information collected at two sampling locations (*i.e.,* SW-20) has not changed notably following mine development, supporting the conclusion of no measurable changes to fish and fish habitat.

Following additional clarification from DFO regarding the determination of harmful alteration, disruption and destruction (HADD) associated with flow reductions following submission of the EARD, the Project as proposed will result in the HADD to fish habitat (approximately 2,941 m2) as a result of reductions in flow to Watercourse #3, #4 (upstream of the proposed water management pond), #12 and #13. AMNS is continuing to consider options to avoid or mitigate effects to fish and fish habitat.

If avoidance or mitigation is not practically feasible, the reductions in flow are such that streams will continue to support fisheries at a reduced level of productivity for the duration of the Project. These streams will likely be less productive and have lower primary (*e.g.,* periphyton) and secondary (*e.g.,* benthic invertebrates) production as a result of reductions in water velocity, channel wetted perimeter, and modification of fish habitat types (*e.g.,* changes from runs to glides). The potential cumulative effects may also include reach level changes in headwater areas associated with stream class (*i.e.,* ephemeral, intermittent or perennial) depending on the watercourse and associated flow reduction. It should be noted, that Watercourse #3, #4 (upstream of the proposed water management pond), #12 and #13 are small headwater streams and may have had intermittent flows during the low flow periods of the year as an pre-development condition.

Residual adverse effects to fish habitat resulting from habitat loss will be counterbalanced by offsetting through an authorization pursuant to the Fisheries Act. A Fish Habitat Offsetting Plan will be developed and implemented in consultation with DFO and in consideration of the “Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act” (DFO 2019) to result in a net gain of fish habitat.

7.5 REFERENCES

DFO (Fisheries and Oceans Canada). 2019. Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act. Available Online: https://waves-vagues.dfo-mpo.gc.ca/Library/40939698.pdf