Atlantic Gold

Appendix P.6

Preliminary Lichen Mitigation and Monitoring Plan
Completed for the Updated 2021 Beaver Dam Mine EIS

Lichen SAR Translocation and Monitoring Plan
Beaver Dam Mine Project

Beaver Dam Mine Project
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1.0 Introduction

Atlantic Mining NS Inc. (AMNS) is proposing the construction, operation, decommissioning, and reclamation of an open pit gold mine in Marinette, Nova Scotia. The Beaver Dam Mine Project (the Project) would have an ore production rate of approximately 6,000 tonnes per day, over a five-year period. Ore from the Project would be crushed and transported approximately 31 km by road to the Moose River (Touquoy) mine for processing. Components of the Project include an open pit, material storage facilities (i.e., waste rock, topsoil and organic materials), mine haul roads, mine infrastructure for crushing, water management, hauling, truck maintenance, administration, and road upgrades.

McCallum Environmental Ltd. (MEL) has been retained by AMNS to support in the responses to the Round 2 of Information Requests (IR2) from the Canadian Environmental Assessment Agency (CEAA) and Nova Scotia Environment (NSE) (CEAA 2019) in response from the review of the Revised 2019 Environmental Impact Statement (EIS) for the proposed Project (AGC 2019). Lichen species at risk (SAR) monitoring, translocation and mitigations were requested to support the Updated 2021 EIS (AMNS 2021a) and in response to IR2 CEAA-2-26 (AMNS 2021b):

> *ii. Provide details regarding the technical feasibility of transplantation of directly affected blue felt lichen as a proposed mitigation.*
>
> *iii. Confirm that 100 m setback would be maintained for all blue felt lichens and frosted glass whiskers that would not be directly affected by the Project. For any individuals where a 100 m setback would not be implemented, identify measures to avoid/minimize the effects.*
>
> *iv. Provide a lichen Species at Risk (SAR) monitoring program that would include all sites where lichen SAR have been detected in the Local Assessment Area (LAA). Explain how adaptive management measures would be proposed and implemented in a timely manner in the event that adverse effects to SAR are detected.*

This plan has been developed in consultation with NSE, Nova Scotia Lands and Forestry (NSLF) and Environment and Climate Change Canada (ECCC), as per meetings held on October 10, 2020 (NSE), December 2, 2020 (NSE and NSLF) and April 6, 2021 (ECCC, NSE and NSLF).

1.1 Purpose, Objectives and Scope

The purpose of this plan is to monitor the direct and indirect effects of the Project on lichen SAR, validate Project effect predictions and to present translocation as a form of mitigation against potential Project impacts. The general objectives of this plan are to:

1. Provide a monitoring program for lichen SAR occurrences evaluated to be directly or indirectly impacted by the Project and outline planned mitigations and adaptive management strategies;

2. Propose a Project-specific lichen SAR translocation plan for occurrences that will be directly lost or will experience unmitigable impacts from Project development; and,

3. Discuss the feasibility and effectiveness of lichen SAR translocation as a mitigation where Project impacts cannot be avoided, including related studies and limitations.

Baseline lichen surveys were conducted within a defined Study Area, inclusive of a focused lichen study area (LSA) surrounding the Beaver Dam Mine Site and along the proposed Haul Road (Figure 1). The LAA was established to define the maximum potential spatial extent of Project indirect impacts and are described in Section XX of the Updated 2021 EIS (AMNS, 2021a).

The monitoring plan will include all lichens within the predicted maximum expected indirect impact area, based on the available literature and the Project-specific effects assessment (AMNS 2021a, Section 6.13). A conservative approach has been taken to determine the expected extent of Project-related impacts to lichen (i.e., upper thresholds and worst-case modeling scenarios). The monitoring plan also includes lichens beyond the predicted maximum expected indirect impact area as control sites.

2.0 Project Background

AMNS is proposing the construction, operation, and closure of an open pit gold mine located near Marinette, Nova Scotia. The Project Area (PA) consists of the three project components; Beaver Dam Mine Site, Touquoy Mine Site, and the Haul Road, and extends from Marinette to Moose River Gold Mines, Halifax County, NS. The ore from the Beaver Dam Mine Site is proposed to be transported by truck via the Haul Road to the existing Touquoy Mine Site, for processing.

During the suite of biophysical surveys, including dedicated lichen surveys, which occurred in 2015, 2016, 2018, and 2019 to support the Updated 2021 EIS (AMNS 2021a), several lichen SAR and species of conservation interest (SOCI) were observed. A total of 44 lichen SAR occurrences were observed during within the defined Study Area (Figure 2a and b). The following sections present the observed lichen SAR, their biology/ecology and the proposed translocation and monitoring plan. Varying levels of monitoring intensity are proposed on an occurrence-specific basis, depending on their interactions with the Project (Section 5.2).

3.0 Lichen Biological Requirements

Understanding species-specific lichen biology and habitat requirements is important to develop a lichen translocation and monitoring plan.

Lichens are symbiotic organisms which consist of a fungal partner (mycobiont) and one or more photosynthetic partners (photobiont) which is either a green alga or cyanobacterium (Nash III 2008). Lichens, unlike most vascular plants, are poikilohydric organisms, meaning they do not have the ability to maintain and regulate water content (Nash III 2008). The result of this inability to maintain homeostasis means these organisms are prone to desiccation. This explains why water availability is a prime factor in their survival and many lichen SAR are found in humid/wet environments.

Lichens, in general, are slow growing and can vary between 0.5 to 11 mm per year (Csanyi 2020). Lichens reproduce primarily through sexual reproductive structures (apothecia or basidia in some species) and by vegetative propagules (Brodo et al. 2001). Apothecia create ascospores and when at maturity are ejected (often referred to as ‘gun’ fired) into the atmosphere where they are carried by wind (Brodo, et al. 2001). The limitation of this method of reproduction is a suitable photobiont must be present for a new lichen to form (Cameron and McMullin 2010). To overcome this limitation many lichen species have evolved the ability to reproduce through vegetative propagules which can serve as an advantage in situations where the free-living photobionts are limited.

Air-born contaminants (e.g., SO_2/NO_x, dust/particulates), climate change and habitat loss/fragmentation are some of the major concerns in lichen conservation and diversity (Boudreault et al. 2008; COSEWIC 2002). Edge effects, which are a result of fragmented habitats, are viewed as a major impact to lichen diversity and health (Rheault et al. 2002). Edge effects include alteration of humidity, higher wind velocity, increase solar radiation often resulting in vegetation, and community structure changes (Rheault et al. 2002). Poikilohydric organisms (such as lichens) which have the inability to regulate and maintain their water content are often sensitive to these effects (Rheault et al. 2002).

The distance in which lichen individuals and populations are affected by edge effects (referred to as depth of edge-influence) have been well studied (Moen & Jonsson, 2002). Studies have shown that the depth of influence on pendent fruticose lichens (Esseen and Renhorn 1997) and diversity of cyanolichens (Haughian and Harper 2020) range from 60 to 80 m, respectively. However, studies by Gauslaa et al. (2018) recommend setbacks of greater than 240 m for three *Lobaria* species studied in temperate rainforests of British Columbia. These results show edge effects, and the depth of influence, is species and context-dependent (e.g. dependent on size of the clearings, substrate, type of climate etc.). Additionally, changes in vegetation communities that support lichen species could affect lichen community, health and abundance (Cornelission et al. 2001).

Naeth and Wilkinson (2008) present the primary drivers of atmospheric impacts to lichens from mine operations: sulfur dioxide (SO_2) and nitrous oxide (NO_x) emissions, metal mobilization and dust generation. Dust deposition can result in smothering, increased alkalinity in substrate pH composition (e.g.. bark of host tree) and bioaccumulation in lichen tissue which can impact lichen health and species richness (Degtjarenko, 2016; Naeth and Wilkinson 2008; Farmer, 1993).SO_2 and NO_x emissions are toxic to lichens when bioavailable (dissolved or acid state) due to their ability to acidify the lichen's substrate, affect cell membranes and leach metals (i.e., metals are no longer available as nutrients or a buffering agent; Naeth & Wilkinson, 2008; Richardson & Cameron, 2004, Maass & Yetman, 2002). Studies such as Geiser et al. (2019), Cameron et al. (2007) and Richardson (1992) present lichen critical load thresholds for atmospheric deposition of sulphur and nitrogen, which is defined as "the low-risk threshold".

As a result of the Project's lichen SAR effects assessment (AMNS 2021a), this monitoring plan considers the impacts of edge effects and dust/particulate deposition. Edge effects are expected through habitat disturbance and fragmentation as a result of construction activities. Dust/particulate generation is expected as a result of Project construction and operations, particularly along the Haul Road due to mobile vehicle use to transport ore (AMNS 2021a). The Project's predicted emissions of SO_2 or NO_x are below harmful critical load thresholds for lichen (AMNS 2021a) and therefore were not considered as part of the monitoring plan.

4.0 Observed Lichen SAR

Three lichen SAR species were identified within the defined Study Area (Section 2.0), all of which have been included in the monitoring plan. Within this section, a brief description on the distribution, biology and ecology of each species is described. Monitoring methodologies will be tailored to the lichen species observed (i.e.. foliose vs. calicioid).

The lichen SAR observed include:

1. Boreal felt lichen (*Erioderma pedicellatum*; SARA/COSEWIC/NSESA: Endangered; ACCDC: S1)
2. Blue felt lichen (*Pectenia plumbea*; SARA/COSEWIC: Species Concern; NSESA: Vulnerable; ACCDC: S3)
3. Frosted glass-whiskers (*Sclerophora peronella*; SARA/COSEWIC: Special Concern; ACCDC: S1)

<u>Boreal felt lichen</u>

Boreal felt lichen is a small to medium foiliose cyanolichen with tomentose upturned lobe tips (COSEWIC 2002) and photobiont belonging to the genus *Scytonema* (Brodo et al. 2002). This species has a patchy circumpolar disturbution with an affinity to coastal/near coastal forests (COSEWIC 2002). Within Canada, boreal felt lichen populations are devided into two separate populations: the boreal population (found in Newfoundland) and Atlantic population found in Nova Scotia (COSEWIC 2002). In 2014, COSEWIC estimated this species would decline by 34% in a 10 year period.

Boreal felt lichen requires humid forested wetlands often dominated by balsam fir (*Abies balsamea*). Historically, occurrences have also been recorded on black spruce (*Picea mariana*), white birch (*Betula papyrifera*) white spruce (*Picea glauca*) and red maple (*Acer rubrum*). Some of the biggest threats to boreal felt lichen are acid rain, ari-born contaminats and timber harvesting (COSEWIC 2002) . Being a cyanolichen, this species is inherently vulnerable to chances to air quality (COSEWIC 2002). The lack of vegetative propagules and requirement for ascospores to be present with a compatible photobiont is a limitation for this species. The boreal felt lichen occurrences within the LSA were observed by MEL and historically identified by ACCDC will need to be revisited to confirm if extant.

No occurrences of boreal felt lichen were observed within the Beaver Dam Mine Site, along the Haul Road or within the Touquoy Mine Site. MEL observed three occurrences of boreal felt lichen south of the Beaver Dam Mine Site, within the LSA, during initial surveys in 2015 (Figure 2a). However, upon return in 2016 and 2017, the three observations were no longer present (potential impacts from adjacent non-Project related activities).

Blue felt lichen

Blue felt lichen is a large blue-grey foliose lichen typically with a thick thallus with a prominent dark blue hypothallus (Cameron and McMullin 2010). This species has apothecia which typically lack margins and vegetative propagules are lacking. The photobiont is a cyanobacteria belonging to the genus *Nostoc* (Cameron and McMullin 2010).

In Canada, blue felt lichen is an eastern species found only in Nova Scotia, New Brunswick and Newfoundland. Outside of Canada it is found in western Europe and a few occurrences within Maine, U.S. (Cameron and McMullin 2010). Blue felt lichen is often associated with humid tree swamps found growing on mature broad-leaf trees such as red maple (*Acer rubrum*), ash (*Fraxinus spp*.) and yellow birch (*Betula alleghaniensis*).

Thirty-three occurrences of blue felt lichen were observed within the LSA and within the proposed new construction section of the Haul Road (Figure 1). This species was often found within tree swamps or in upland habitat in proximity to wetlands. Twenty-nine of these occurrences are within the Beaver Dam Mine Site or in the surrounding LSA. Four occurrences are along the Haul Road. Figure 2a and b presents these occurrences and their Project interactions.

Frosted glass-whiskers

Frosted glass-whiskers is a small lichen belonging to the Caliciaceae family (or often referred to as calicioids). This lichen has a very thin endosubstratic thallus, with apothecia on small stalks. Like many calicioids, frosted glass whiskers produce a powdery mass on the apothecia, which primarily consists of spores (mazaedium) (COSEWIC 2016). Frosted glass-whiskers is found on tree species such as maples (*Acer spp*.), birch (*Betula spp.)* and other hardwood species. Typically, frosted glass-whiskers is found on heartwood in hollows in tree trunks and more rarely so on bark (COSEWIC 2016). Like many calicioids, frosted glass-whiskers is associated with mature hardwood forests occurring in upland and wetland habitats.

Frosted glass-whiskers is found in several European countries and in North America. In Canada, frosted glass-whiskers has a disjunct distribution where it is found on the east coast (Nova Scotia) and west coast (British Columbia) (COSEWIC 2016). Since the last COSEWIC report for this species, new localities of frosted glass-whiskers have occurred in Nova Scotia, with observations located in Shelburne, Halifax and Richmond county (INaturalist 2020).

Eight occurrences of frosted glass-whiskers were observed within the Beaver Dam Mine Site. No occurrences of frosted glass-whiskers were observed within the broader LSA or along the Haul Road. Figure 2a presents these occurrences and their Project interactions.

5.0 Lichen Translocation and Monitoring Plan

The following sections present the detailed objectives and methodologies of the proposed translocation and monitoring plan. These plans have been developed with considerations from studies completed by Jones and Goudie (2018) and Gustafsson et al. (2012). In addition, several other studies and methods were considered to develop this plan.

5.1 Lichen Translocation Plan

The following lichen translocation plan has been developed as a proposed mitigation measure for lichen SAR that will be directly lost or experience unmitigable indirect impacts from Project development. This plan recognizes that translocation should not be considered a standard mitigation and only applied when other mitigation measures are not possible or sufficient. All lichen proposed for translocation are blue felt lichen. Frosted glass-whiskers is not proposed for translocation, due to its small size, endosubstratic thallus and limited translocation information. No frosted glass-whicker occurrences will be directly lost to Project development (Figure 2a). The 100 m buffer of one frosted glass-whisker occurrence will be impacted by a surface water management ditch and topsoil stockpile. The ditch is an outflow to Cameron Flowage, which has been micro-sited in consideration of other biophysical constraints (i.e., fish and fish habitat, hydrology) to mitigate impacts to baseflow reduction in Cameron Flowage. Based on the effects assessment, the construction and maintenance of this ditch is not expected to have significant adverse effects on the forested glass-whisker occurrence. AMNS will endeavour to further microsite the topsoil stockpile beyond 100 m of the frosted glass-whisker occurrence during the detailed design.

All occurrences of boreal felt lichen are beyond the PA within the boreal felt lichen critical habitat areas, within which no development is proposed and will, therefore, not experience unmitigable impacts from the Project (Figure 2a).

The specific objectives of this plan are to:

1. Translocate blue felt lichen that will be directly lost to the Project; and,
2. Assess the necessity for translocation of blue felt lichen occurrences within 60 m of Project infrastructure on an occurrence-specific basis

The proposed translocation plan is primarily based on the known impacts of edge effects, as this has been the focus of many studies and management policies (i.e., *At-Risk Lichens – Special Management Practices*, NSL&F 2018). Esseen and Renhorn (1998) observed adverse impacts to lichen within 60 m of edge clearings. As a result, blue felt lichen within this distance of Project infrastructure are considered for potential translocation, as it has been determined that mitigation measures may not be effective within this proximity. This includes three of the blue felt lichen occurrences within Wetland 17, a potential WSS.. Occurrences of blue felt lichen where a 100 m setback is maintained will not be assessed for translocation feasibility. In these instances, the risk of translocating the occurrences is determined to be greater than leaving them in-situ and monitoring.

5.1.1 Lichen Translocation Feasibility

Lichen translocation is a technique that has been used to support the conservation of species since the 20th century (Smith, 2014). A study conducted by Jones and Goudie (2018) involved the translocation of boreal felt lichen in Newfoundland, In this study 544 thalli were translocated to host trees. After one year of post translocation efforts the survival rate (referred to as return rates in the study) was 95.1%. Smith (2014) highlights the successes of many different translocation experiments with lichens of different habitats and habits.

Due to the limited data on translocation of calicioid lichen species and the inherent risk that translocation of this group of species will not be successful (e.g., small size, endosubstratic thallus), frosted glass-whiskers are not proposed to be translocated. One occurrence of frosted glass-whiskers is within 60 m of Project infrastructure (surface water management ditch and topsoil stockpile). None are proposed to be directly impacted (Figure 2b).

Table 1 provides a list of translocation experiments involving lichens and their successes.

Table 1: Lichen translocation Experiments and Results

Lichen Species	Habit	Habitat	Experiment Summary	Results	Author(s)
Nephroma arcticum	Foliose	Terricolous	Thalli were transplanted in various locations within alpine heath and subalpine birch forests in Lapland and harvested 8 years after.	All transplants survived after an 8-year study.	Sonesson M., Sveinbjornsson B., Tehler A, Carlsson BA (2007)
Lobaria scrobiculata, Platismatia glauca and *P. norvegica*	Foliose	Epiphytic (corticolous)	A study was conducted to determine growth and morphological response of old-forest lichens transplanted into old *Picea abies* and young forests.	120 thalli were transplanted and 5 were lost in a 14 year study.	Hilmo (2002)
Lobaria pulmonaria	Foliose	Epiphytic (corticolous)	2240 transplants were placed on *Populus tremula* in Sweden. Transplants were placed in various woodland regimes and were observed 20 to 25 months after translocating efforts.	89% of transplants remained.	Hazell and Gustafsson (1999)
Lobaria oregana and *Pseudocyphellaria rainerensis*	Foliose	Epiphytic (corticolous)	+1,000 thalli were transplanted in Douglas-fir trees in 13 forest stands within four age classes.	Results show that growth rates in transplants were faster than in clear-cuts. In all stands, lichen growth was observed in all transplant	Sillett and McCune (1998)

5.1.2 Lichen Translocation Methodology

As presented in Figure 2a, two blue felt lichen occurrences could not be avoided by the Project due to consideration of mine development, safety and other biophysical constraints. Translocation is proposed for these occurrences. Five other blue felt lichen occurrences where a 60 m setback could not be maintained are considered for translocation (Figure 3a). The final translocation plan will be developed in consideration of the detailed Project design, site-specific conditions and in consultation with NSE, NSLF and ECCC.

The following proposed translocation methods were adapted from studies completed by Jones and Goudie (2018) and Gustafsson et al. (2012). The studies conducted by Jones and Goudie (2018) involved the translocation of boreal felt lichen. These methods were primarily referenced for the proposed translocation of blue felt lichen because of the similarities in habit and habitat between the two species. In this report, the thallus which is proposed to be translocated is termed 'the transplant'. The location where the transplant is proposed to be removed from is termed 'the donor site' and where it is proposed to be placed is termed 'the recipient site'.

5.1.2.1 Donor Sites

As described above, translocation is proposed for two blue felt lichen occurrences and will be further assessed for another five blue felt lichen occurrences, which are presented as possible donor sites in Figure 3a. Table 3 describes the possible donor site locations.

Table 1: Proposed Donor Sites

Donor Site ID#	Species	NAD 83 UTM		Distance from Proposed Infrastructure	Wetland ID#
		Easting	Northing		
DS1	Blue felt lichen	520186	4989959	Within the non-acid generating (NAG) stockpile	Wetland 205
DS2	Blue felt lichen	522757	4989497	Within the crusher pad	N/A
DS3	Blue felt lichen	521270	4990507	Within 54 m of the proposed water management infrastructure	N/A
DS4	Blue felt lichen	522647	4990326	Within 23 m of the open pit perimeter road	N/A
DS5	Blue felt lichen	521962	4990607	Within 8 m of proposed water management infrastructure	Wetland 17
DS6	Blue felt lichen	521978	4990659	Within 30 m of proposed water management infrastructure	Wetland 17
DS7	Blue felt lichen	521937	4990725	Within 60 m of proposed water management infrastructure and mine road	Wetland 17

5.1.2.2 Recipient Site Location Selection

A desktop screening exercise, followed by verification by a field assessment, will be undertaken to determine suitable recipient sites for the seven transplants.

5.1.2.2.1 *Desktop Review*

Baseline wetland, watercourse and lichen occurrence data collected to support the Updated 2021 EIS (AMNS 2021a) will be reviewed. Candidate recipient sites for the transplants will focus on locations within defined boreal felt lichen critical habitat areas. These are protected areas with known occurrences of boreal felt lichen (i.e., ACCDC), mature forested wetland communities suitable to support blue felt lichen and offer opportunities for long-term studies (Figure 3a). Two boreal felt lichen critical habitat areas exist within the LAA, and will both be targeted for suitable recipient sites using the following criteria:

1. Documented blue felt lichen occurrences within the wetland or directly adjacent;
2. Classified as tree swamp;
3. No history of recent or planned timber harvesting; and
4. Recipient sites will be no closer than 100 m (as specified in the *At-Risk Lichens – Special Management Practices*, NSL&F 2018), and ideally >500 m, from to proposed Project development or existing clearings/roads.
5. Target Crown land portions of these areas.

Priority will be given to sites within both boreal felt lichen critical habitat areas adjacent to the Beaver Dam Mine Site (Figure 3a) that have an existing occurrence(s) of blue felt lichen. However, if historical blue felt lichen observations and/or if suitable conditions for the blue felt lichen transplants are no longer present, additional locations within the defined boreal felt lichen critical habitat areas will be considered. While the At-Risk Lichens – Special Management Practices (NSL&F 2018) proposes a 100 m setback, prefered recipient sites will be further away from development (Project related and unrelated) to mitigate against potential effects of air-born dust/particulates.

5.1.2.2.2 *Field Verification of Candidate Recipient Sites*

All wetlands within the boreal felt lichen critical habitat areas that meet the criteria described in Section 5.1.2.2.1 will be considered for candidate recipient sites. These sites will be visited to confirm habitat suitability, presence of suitable host trees and that available aerial imagery is reflective of current conditions (e.g., the wetland has not been impacted, nearest development, etc.).

A scoring system has been developed to aid in selecting a recipient site. Scores will be out of eight and each of the criteria listed below will have a score of one. The following criteria will be collected at each potential recipient site and scores will be tallied.

1. Swamp (within the Wet Coniferous or Wet Deciduous group as per Forest Ecosystem Classification (FEC) for Nova Scotia – NSDNR 2010).
2. The presence of mature/over mature red maple and ideally several other suitable host trees which could potentially support new thalli should the transplant be successful and proliferates. Trees with visibly coarse bark were targeted as this seems to be a habitat requirement for blue felt lichen (ECCC 2020).

3. The presence of mature trees with epiphytic bryophyte cover. There seems to be a relationship between the components of a lichen (i.e., mycobioint and photobiont) and the presence of moss and plays an important role in lichen development and growth.

4. Presence of lichens indicative of a rich arboreal lichen community, including species belonging to the Pannariacea, full suite of *Lobaria spp*., and *Sphaerophorus globusus*.

5. The habitat is minimum of 100 m away from any development or clearings to reduce potential edge effects.

6. The habitat is approximately 500 m or further away from any dust/particulate emitting Project infrastructure to reduce potential of air-born dust/particulates.

7. Presence of blue felt lichen.

8. No evidence of historical clearing within the wetland.

All suitable living host trees (which meet criteria 2 to 4) will be georeferenced and photographed and will be a candidate transplant host tree if that site is selected.

A limitation of this scoring system is that it assumes that each criterion has equal importance in determining blue felt lichen habitat suitability. For example, a site which has an existing blue felt lichen occurrence is likely more of an indicator of suitable habitat then the presence of *Lobaria* species, however, the presence of either species equates to the same score. Although this scoring system can be useful in the decision-making process, ultimately, the scores are to be scrutinized by a lichen expert and sites will be selected based on the surveyor's expertise and knowledge of blue felt lichen habitat suitability. The current scoring system is preliminary and will be further reviewed (e.g., NS Lichen Recovery Team) and refined based on the current state of knowledge prior to translocation.

Once all candidate recipient sites have been field verified and multiple candidate host trees have been selected, all data collected at each site and scores will be assessed. Sites which have the highest score and suitable site conditions, as verified by the expertise of MEL biologists, will be proposed as candidate recipient sites. Depending on the number of thalli available, the goal is to disperse thalli on multiple host trees within multiple wetlands in the boreal felt lichen critical habitat areas. All candidate recipient sites evaluated will be presented to NSL&F, ECCC and the Lichen Recovery Team (LRT) prior to translocation events.

5.1.2.3 Lichen Translocation Field Methods

This section describes methods which will be used to remove the thallus (transplant) from the donor host tree and deployment to the recipient host tree.

5.1.2.3.1 *Removal of Thallus*

Once a recipient site for the blue felt lichen transplant has been confirmed, a team of two biologists will visit the donor site. The thallus will be sprayed with distilled water until it is saturated to reduce the likelihood of damage during removal. The lichen will be handled with surgical tweezers and a clean scalpel or knife. Care will be taken to gently remove the lichen from the host tree to prevent creating lichen fragments. Thin pieces of bark may be left on the thallus to prevent the lichen from fragmenting. The removed lichen will be stored in a zip-loc bag and placed in a cooler until translocated to the recipient site. The transplant will be removed and translocated in the same day to prevent potential necrosis if long-termed storage were to occur.

5.1.2.3.2 *Deployment of the Lichen Transplant*

The blue felt lichen transplant will be attached to a living and suitable host tree within tree swamp habitat. Large thalli (>30 cm^2) may be cut into smaller fragments and dispersed on multiple host trees within suitable habitat to increase chances of survival. Thallus fragments will be no smaller than 15 cm^2 as thallus fragments of that size are prone to rapid water loss resulting in desiccation and inhibition of photosynthesis (Gauslaa and Solhaug 1998).

The thallus will be attached to the host tree either by using no. 19 gauge stainless steel wire 'staples' or a plastic mesh with approximate openings of 1 cm x 1 cm as described by Jones and Goudie (2018) and Gustafsson et al. (2012). If a plastic mesh is chosen to fasten the lichen to the host tree, a high-density polyethylene, polypropylene or another stable non-reactive plastic mesh will be used as these materials are more likely to withstand the elements. A translucent, black, white, blue or green mesh will be used. Pink, red or reddish tones meshes will not be used as these could attract birds (Schaefer et al. 2006).

Other methods of thallus attachment were explored during the development of this plan such as the use of glues. Glues were ruled out because of the likelihood of containing toxic materials which may harm the lichen, cause necrosis and even death. Furthermore, it is questionable if gluing the thallus to the host tree would withstand the elements (e.g., snow, wind, rain etc.) and remain on the tree in the long term. Methods such as attaching a fine plastic mesh to the tree, then fastening the lichen to it with a polyester thread as described by Gauslaa and Goward (2012) was also considered. This study attached lichens to twigs which were at a horizontal position vs a vertical position as will be the case for the blue felt lichen transplants. The issue with this method is that the thread may not be able to withstand the elements (e.g., snow, wind, rain etc.) and that the thallus will not be directly attached to the substrate. For these reasons, this method was also not selected.

The transplant will be deployed on the trunk of red maple trees approximately 2 to 6 feet up the tree. The cardinal direction the thallus will be placed will be dependent on canopy cover (%). From MEL's experience, blue felt lichen is often north facing in a more open canopy cover while in a closed canopy cover they can often be found south facing. Ultimately, having too much light or too little will be unfavorable. As such, the direction the thallus is placed on the host tree will be site-specific.

Another consideration when determining thallus orientation is placing it in a water receiving position as precipitation interception is one of the requirements for foliose lichens to thrive (Nash 2008). For example, if there is a host tree growing on an angle, the lichen may be placed oriented upwards facing towards the lean where it will receive stem-flow or direct throughfall precipitation.

Once the orientation and host tree has been selected in the suitable habitat, the plastic mesh or wire will be applied to the transplant. Prior to application, the plastic mesh will be cut to an appropriate size that covers the entire transplant. The thallus will carefully be removed from the plastic zip-loc bag with tweezers to where approximately the lichen will be fastened to the host tree. One biologist will press the lichen closely to the tree while the second biologist will carefully place the mesh or wire around the thallus. Once the mesh/wire has been applied appropriately and the lichen is tightly pressed to the host tree, the mesh will be fastened to the tree by the use of 1-inch stainless steel roofing nails or staples. If the no. 19 gauge stainless steel wire method is used, it will be placed under the bark to fasten the thallus to the tree.

5.1.2.3.3 *Time of Year*

Optimal time of year for lichen translocation is in the spring and fall months (Personal communication, Dr. Sean Haughian, November 3, 2020) because increased temperatures and dryer conditions in the summer may cause extra stress on lichen transplants and inhibit growth. In a study conducted by Larsson et al. (2012) that focused on seasonal growth patterns of

Lobaria scrobiculata and *L. pulmonaria*, determined that growth occurs in all seasons but at a slower rate in the winter and late summer. As described above, lichens grow year-round, therefore, translocation of blue felt lichen in the winter months is also a viable option. The translocation will occur in snow free conditions and when the tree bole is free of ice. The time of year when the translocation occurs is dependent on the final construction schedule of the Project. If possible, translocation will occur in the spring and fall months.

5.1.2.3.4 *Monitoring of the Transplant*

The proposed monitoring plan for translocated lichens (recipient sites) is described in Section 5.2. Data will be gathered from both the donor and recipient sites before translocation (baseline) and once translocation has occurred, data will only be collected at the recipient site for the duration of the monitoring period. If existing blue felt lichen locations are present within the recipient sites, they will act as a control to determine the effectiveness of the transplant. If present, at least one control site will be monitored as well, as per Section 5.2.

5.2 Lichen Monitoring Plan

The following lichen monitoring plan has been developed to track changes to lichen status and health, with respect to Project development and the proposed translocation of blue felt lichen. Specifically, this plan aims to achieve the following:

1. Monitor lichen health to detect change to the observed lichen due to edge effects and changes in air quality (i.e., dust from mining activities);
2. Monitor the effectiveness of the *At-Risk Lichens – Special Management Practices* (NSL&F 2018) 100 m setback;
3. Monitor the effectiveness of lichen SAR translocation, as described in Section 5.1;
4. Re-assess and monitor the three historical boreal felt lichen occurrences observed by MEL within the Study Area; and,
5. Provide data to inform provincial and federal SAR recovery strategies and action plans for these species and direct future mitigation and adaptive management approaches.

5.2.1 Proposed Monitoring Approach

Monitoring sites have been chosen based on the Project effects assessment (Section 3.0), specifically the impacts of edge effects and fugitive dust emissions. The proposed monitoring approach will include the following:

- All transplant recipient sites;
- All SAR lichen occurrences within a WSS;
- The three MEL observed boreal felt lichen occurrences;
- All SAR lichen occurrences where edge effects are anticipated due to Project impacts <100 m from the occurrence; and,
- SAR lichen occurrences within a spatial gradient from Project development (0-500 m) to capture potential impacts of dust/particulate deposition (which will include some of the previously listed occurrences) and additional control sites beyond the predicted area of impact.

The Project is expected to impact the provincial 100 m setback recommendation (NSL&F 2018) of three lichen SAR occurrences, beyond those proposed for translocation consideration, all of which are proposed for monitoring (Figure 3a and b). Any of the seven blue felt lichen occurrences that are not selected for translocation will also be monitored. AMNS will consider opportunities to set and monitor a benchmark lichen species or other species occurrences in proximity to the established lichen SAR monitoring sites. Greater consideration will be given to species more closely associated to the lichen SAR (i.e., same family).

Fugitive dust emissions, particularly from the Haul Road, may additionally impact nearby lichen SAR. Predicted Project atmospheric impacts are presented in the Air Emission Assessment Technical Report (AMNS 2021a, Appendix C.1). The Project is predicted to result in localized particulate and metal mobilization through dust generation during construction and operations (i.e., mining and hauling ore). The maximum modeled deposition levels are along the Haul Road, specifically three sections shown in Figure 3b. Along these sections the maximum predicted deposition rate is 0.4 $g/m^2/day$ (136 $g/m^2/year$) from Project related activities. This rate is below the dust deposition threshold of 1.0-2.5 $g/m^2/day$ where lichen species decline was observed in Farmer (1993). The Project deposition rate decreases to 0.05 $g/m^2/day$ at 125 m from the Haul Road. This rate is lower than the threshold of 0.07 $g/m^2/day$ where effects to lichen were still noted (Farmer 1993). As such, a selection of lichen SAR observations will be monitored using a graduated approach from Project development (Beaver Dam Mine Site and Haul Road), up to a maximum distance of 500 m, which allows capture of lichen locations within and beyond the predicted area of impact.

Additional baseline lichen SAR surveys will be conducted along the Haul Road, within the LAA (500 m). Previously, lichen surveys along the Haul Road were primarily focused within the PA boundary. The additional surveys will establish monitoring sites (observed lichen SAR occurrences) to allow for evaluation of potential impacts of dust. Three sections of road where Project modeled dust emissions are expected to be highest (Figure 3b; AMNS 2021a) will be targeted during these surveys. While these modeled air quality zones will be targeted, other areas along the Haul Road will also be surveyed and final monitoring stations will be chosen based on species presence, suitable habitat where lichens are most abundant and in consideration of predicted Project effects. Surveys will apply the proposed graduated monitoring approach along the Haul Road, where lichen SAR surveys will be targeted within defined impact zones from the Haul Road (0-100 m, 100-250 m and 250-500 m). When feasible, at minimum, a lichen SAR occurrence (for each observed species) will be monitored within each impact zone. Monitoring site selection will be dependant on the number of lichen SAR observed within these surveys.

This graduated survey and monitoring approach will capture lichen SAR occurrences beyond the expected dust/particulate impacts of the Project (>125 m), based on worst-case modeled values. This will allow data collection of control sites.

5.2.2 Monitoring Methodology

This plan has been developed to monitor observed occurrences of blue felt lichen, frosted glass-whiskers and boreal felt lichen within the defined study area (including additional Haul Road surveys) which meet the defined monitoring objectives in Section 5.2.

The monitoring plan will include a baseline monitoring survey at all proposed sites prior to Project construction to re-assess baseline conditions of each proposed monitoring and translocation site (donor and recipient sites). This will include the additional baseline surveys along the Haul Road. Subsequent monitoring events will occur within one year of construction and annually during the operations phase of the Project, until the end of Project operations (approximately 5 years). During the baseline surveys and subsequent annual monitoring event, opportunistic surveys for lichens will continue to be conducted. The monitoring plan will be reassessed if additional SAR lichen are observed. Post-operations monitoring has not been defined at this time. The outcomes of this monitoring plan will guide the determination of post-operation monitoring requirements.

While the three historic observations of boreal felt lichen within the LSA observed by MEL are thought to be lost, these sites are included in the monitoring plan as new thalli may emerge since suitable habitat is present and will be revisited annually during routine monitoring events to confirm their status. If no thalli are observed, then only data on vegetation community and photographs will be collected (Section 5.2.2.2). If thalli are observed, then all data collection described in Section 5.2.2.2 will be collected at these occurrences.

The identical monitoring techniques for the two foliose lichen SAR, blue felt lichen and boreal felt lichen, will be used since they are similar in habit (i.e., foliose lichens) and habitat (i.e., corticolous lichens). Frosted glass-whiskers, which is a minute calicioid lichen often which is 0.5 to 0.8 mm tall (McCune 2017) with an endosubstratic (immersed in the substrate) thallus presents a series of challenges when monitoring. To accommodate these differences, modification to the monitoring techniques have been developed for this species (Section 5.2.2.2.4). In this section the monitoring station design and monitoring data collected is discussed.

5.2.2.1 Monitoring Stations

The lichen monitoring stations will be clearly flagged on neighboring trees or the host tree branch and labelled with a metal forestry tag using a unique monitoring ID. If multiple thalli exist on a host tree, they will be labeled by placing a coloured pushpin/screw with an assigned unique ID next to the thallus. All pushpins/screws used will either be made out of stainless steel or will be coated with a rust-resistant enamel finish to prevent rusting and harm to the monitored lichens.

For frosted glass whiskers, the methods described above will also apply. Since the thallus of this species is endosubstratic, a faint white thallus occasionally can be seen if carefully observed. If a thallus is detectable, extent markers (non-reactive plastic markers) will be placed on either extent of the thallus as a reference point. If the thallus cannot be detected and only fruiting bodies can be seen, then the markers will be placed above and below the upper and lower extent of that population. These markers will be used as reference points to determine if growth is occurring during the monitoring years.

A total of 30 monitoring stations, including the seven possible transplants, have been proposed. The stations are presented in Figures 3a and b. At this time, this is an anticipated number of monitoring stations based on the current known occurrences of lichen SAR and does not include the sites from additional surveys proposed along the Haul Road, which will be selected following baseline surveys. Where observations permit, this plan will aim to monitor seven lichen SAR within each of the 3 sections of Haul Road, focusing monitoring closer to the road where effects are predicted to be highest (i.e., four stations at 0-100 m, two stations at 100-250 m, one station at 250-500 m).

While the plan will meet all described monitoring objectives, the specific number and locations of stations may be subject to change, depending on final Project design, baseline surveys, translocation recipient sites and consultations with NSE, NSL&F and ECCC. Final locations and monitoring details will be determined at the permitting stage. Specifics on the data collected at the monitoring stations and the location of these stations is described below.

5.2.2.2 Monitoring Data Collected

Lichen thallus, host tree and vegetation community data will be collected at all defined monitoring stations, as presented in the following sections, including those to be determine along the Haul Road. To standardize the monitoring observations the thalli will be sprayed with distilled water. Lichens often appear a different colour when dry vs. wet and by observing the thallus when wet will enable direct comparison from baseline and subsequent monitoring years (Gustaffson et al. 2012).

All data described below will be collected for blue felt lichen, boreal felt lichen and frosted glass-whiskers, however, slight variation of thallus descriptions will be collected for frosted glass-whiskers. Monitoring data will be collected at a vegetation community, host tree and thallus level on an annual basis. Additional temperature/relative humidity (RH) and dust deposition monitoring will be collected at a subset of locations, as described below, and at intervals as required by equipment, data storage, etc. All monitoring events and data collection will occur during the summer months, wherever feasible, to capture the period with the highest potential dust generation.

Dust/particulate deposition during the construction and operation of the Project has potential to have negative effects on lichen communities and lichen SAR. Measuring bark pH can give insight to the impacts of dust on the host tree and consequently, epiphytic lichens and communities (Kricke 2002). The collected pH data will be compared to baseline and control sites to determine if any correlation to alterations in bark pH, lichen health and mining activities exist. A small piece of bark will be removed from the tree and potassium chloride (KCl) will be applied and pH measurements will be collected as per methods described by Farmer et al. (1990).

Documenting the presence of necrosis (tissue death) and chlorosis (insufficient amount of chlorophyll, often resulting in a plant/lichen looking dull and/or lacking green pigments) is a key feature to monitor when determining lichen health. Measuring chlorophyll fluorescence and concentration via a chlorophyll fluorescence meter is a common practice but the techniques used are often invasive and destructive to the thallus.

As described in Section 5.2.2.2.3, chlorosis and necrosis ranks for each thallus will be determined. High resolution photos will be taken using a Nikon Coolpix p900 of each thallus, and imaging software (e.g., ImageJ) will be used to determine % chlorosis and necrosis. Using this software will reduce observational biases when determining necrosis/chlorosis percentages. When photographs are taken of each thallus during the monitoring program, a ruler (for scale) and a colour-standard will be placed next to the thallus. The colour-standard will be used when determining if chlorosis is occurring throughout the monitoring years. Lichen area and ultimately, lichen growth will also be calculated using this software.

Using imaging software will be attempted with monitoring frosted glass whiskers, however, due to the small size and the nearly invisible thallus, this technique may not be applicable. Furthermore, determining % necrosis/chlorosis in the field may not be possible either. See below for the data collected at the vegetation community, host tree and thallus level.

5.2.2.2.1 *Vegetation Community Level*

- Vegetation Type as per the Forest Ecosystem Classification (FEC) for Nova Scotia - NSDNR, 2010;
- Wetland Classification and type (softwood swamp, hardwood swamp, mixedwood swamp);
- Stand age (regenerative, immature, mature, over mature);
- Tree species present;
- Distance from edge of wetland from proposed/existing Project related infrastructure and non-Project related clearings;
- Canopy cover rank (1: <25%; 2: 25-50%; 3: 50-75%; 4:>75%);
- Invasive species present (yes or no, and list species); and
- Photograph of habitat.

5.2.2.2.2 *Host Tree Descriptions and Data Collection*

- Coordinates of the host tree in NAD83 UTM 20;
- Tree species;
- Age class (mature, over-mature, dead and note if tree is standing or leaning);
- Canopy cover relative to host tree (use ranks 1 to 4);
- Lichen species present;
- Bryophytes present (Yes or No? Identify species if possible);
- Photograph of host tree;
- Distance from proposed/existing Project related infrastructure and non-Project related clearings;
- Bark pH; and
- Comments.

5.2.2.2.3 *Thallus Descriptions*

- Unique thallus ID;
- Life stage (Juvenile [lacking apothecia], Adult, Necrotic, Dead);
- Necrosis rank (1: 0%; 2: 1-25% ;3: 26-50%; 4: 51% - 75%; 5: >76%);
- Chlorosis rank (1: 0%; 2: 1-25% ;3: 26-50%; 4: 51% - 75%; 5: >76%);
- Area of the lichen will be determined by analysis of photographic images using imaging processing data such as Image J. Additionally, measurements of horizontal and vertical axis of thallus (measurements will be taken from furthest point on each axis) will be taken in the field;
- Rank of apothecia[1] (1: 0%; 2: 1-25%; 3: 26-50%; 4: 51% - 75%; 5: >76%);
- Rank of herbivory (1: 0%; 2: 1-25%; 3: 26-50%; 4: 51% - 75%; 5: >76%), and identification of grazing species (e.g., slugs), if observed;
- Cardinal direction the thallus is facing;
- Height up the tree thallus is positioned (cm);
- Photograph of thallus with scale (ruler or quadrate will be used as a scale); and

[1] Apothecia rank is based on the absolute cover of the total thallus size

- Additional comments.

5.2.2.2.4 *Frosted Glass Whiskers*

As described above, frosted glass whiskers is a minute calicioid lichen with an endosubstratic thallus. The size of this species (often with stalks of 0.5 to 0.8 mm) and thallus which is a challenge to detect in the field, will limit the ability to monitor in detail without collecting specimens (Haughland pers. comm. 2020). To reduce any additional effects to this species, collecting of specimens will not occur, instead, presence-absence, thalli extent (if possible), approximate stalk number, presence of stalks and mazaedium state will be documented. The following data will be collected:

- Unique thallus ID;
- Life stage (Adult, Necrotic, Dead);
- Mazaedium state (% of stalks with 'empty' capitula);
- Measurements of horizontal and vertical axis of thallus (measurements will be taken from furthest point on each axis);
- Rank of stalks[2] (1: 0%; 2: 1-25%; 3: 26-50%; 4: 51% - 75%; 5: >76%);
- Rank of herbivory (1: 0%; 2: 1-25%; 3: 26-50%; 4: 51% - 75%; 5: >76%);
- Cardinal direction the thallus is facing;
- Height up the tree thallus is positioned (cm);
- Photograph of thallus with scale (ruler will be used as a scale); and
- Additional comments.

5.2.2.2.5 *Monitoring Microclimates*

Temperature/RH (dataloggers) will be deployed in a subset of representative monitoring stations, targeting each species, translocation recipient sites, WSS and considering the graduated monitoring approach. Data will be collected continuously to capture seasonal variations during baseline and operational monitoring periods. The data collected will be used in conjunction with information collected on thallus growth/health, to assess lichen health and track changes to microclimate.

Type and specifications of dataloggers will be determined at the implementation stage.

5.2.2.2.6 *Monitoring Dust Deposition*

Dust deposition will be monitored using dust collectors placed at a subset of representative monitoring stations. Dust collectors will be placed considering a graduated approach to capture changes in deposition with distance from Project

[2] Stalk rank is based on the absolute cover of the total thallus size

development and include control sites. Collector placement will target high dust producing areas (i.e., the Haul Road) to monitor areas where the greatest potential effects are expected to occur.

Type and specifications of dust collectors will be determined at the implementation stage.

5.2.3 Lichen Monitoring and Translocation Summary

The purpose of this plan is to monitor the direct and indirect effects of the Project on lichen SAR and to present translocation as a form of mitigation against potential Project impacts. A total of 30 monitoring stations, including the seven possible transplants, have been proposed at this time. The monitoring plan will also include additional sites proposed along the Haul Road, which will be selected following baseline surveys. Select monitoring stations will include data collection on microclimate and dust deposition. The data collected from this plan can be used to inform provincial and federal SAR recovery strategies and action plans for these species and direct future mitigation and adaptive management approaches. The translocation plan is proposed as a form of mitigation to preserve the lichen observations which could not be avoided by Project infrastructure or are expected to experience unmitigable impacts from Project development. This translocation plan will provide valuable information on the effectiveness of lichen translocation as a form of mitigation.

5.3 Reporting

An annual report will be submitted to NSL&F and ECCC which summarizes the methods and results of the monitoring and translocation plan. The report will include a summary on lichen health, verification of Project effects predictions, report on the status of the historic boreal felt lichen occurrences and the status and health of transplants. The report will also present an assessment of pH, dust deposition and temperature/RH results in comparison to observed lichen health. All data will be compared to pre-development baseline conditions to discern potential Project related impacts and adaptive management strategies.

Due to the novelty of this initiative, the findings of this plan aim to further the current state of knowledge of the effects to lichen SAR from industrial activities, specifically mining.

5.4 Mitigation and Adaptive Management

Efforts have been made to avoid lichen SAR occurrences, and maintain a 100 m setback where practicable, through detailed Project design and micro-siting infrastructure. The translocation plan is proposed as a form of mitigation where avoidance is not possible, due to construction or other biophysical constraints, and direct or unmitigable impacts to lichen SAR are predicted. However, it is recognized that translocation should not be considered a standard mitigation and only applied when other mitigation measures are not possible or sufficient. Currently translocation is proposed for two blue felt lichen occurrences expected to be directly impacted. The plan presents that an additional five occurrences within 60 m of Project infrastructure, may be considered for translocation, dependant on detailed Project design, site-specific conditions, and regulator consultation. The two designated boreal felt lichen critical habitat areas, which also supports frosted glass-whiskers and blue felt lichen, are proposed to be targeted when locating recipient sites.

The results of the monitoring plan, described in Section 5.2, will aid in supplementing, where necessary, the mitigation commitments outlined in Sections 6.13 of the Updated 2021 EIS (AMNS 2021a), which include air quality monitoring, hydrological monitoring, wetland monitoring and dust control plans. Findings from the lichen SAR monitoring program, peer-reviewed studies and species-specific SARA Recovery Strategies, Action Plans, and Management Plans will be evaluated to support of adaptive management approaches. Adaptive management strategies may include additional monitoring, increased dust suppression and consideration of alternative dust suppression methods.

Blue felt lichen occurrences within a 100 m setback are prone to negative edge effects and are at greater risk of impact from air-born dust/particulate. If determined to be necessary by NSL&F, additional occurrences between 60 m and 100 m from Project infrastructure may be translocated to suitable habitat within the LAA to support further research studies presented in Section 5.2.3.

It is important to acknowledge that greater understanding of the impacts of mining activities on lichen health is still required, specifically in Nova Scotia. While limited, studies have shown that lichen translocation efforts have had high success rates. Lichen SAR monitoring and translocation is a recent initiative in Nova Scotia. As a result, best-practices, adaptive management strategies and their effectiveness are not currently well defined. If desired, results of this program may be used to better inform and direct future mitigation and adaptive management approaches. AMNS will work to explore collaborative research opportunities who may further define research projects and objectives based on this plan. AMNS proposes the development of a working group, including lichen specialist (e.g., Lichen Recovery Team) and regulators, to further discussions on lichen SAR management with respect to the Project and broader industry best-management practices.

6.0 Limitations

This plan is proposed to monitor and mitigate Project related effects to lichen SAR. However, it is important to acknowledge the other activities in the Study Area that are not related to the Project and may impact lichen SAR (i.e., Highway 224, timber harvesting, ATV and other traffic along the bypass roads, etc.). AMNS cannot control impacts from activities unrelated to the Project, partially those beyond the PA. Timber harvesting or other non-Project related industrial activities (i.e., aerial lime dosing of nearby salmon-supporting watercourses and terrestrial environment) may be unavoidably captured in the monitoring plan and influence the overall health and microclimate of the monitored lichens and habitat. As a result, if effects are observed in the monitored lichen (e.g., evidence of necrosis), this will not necessarily be attributed to the Project and may be a result of exterior factors (e.g., adjacent timber harvesting, climate change, acid rain etc.). Efforts have been made to tailor this monitoring plan to limited external interference and focus on the validation of Project effects predictions. These non-Project sources of impacts will be considered when selecting final monitoring stations and during reporting

Limited, if any, published data exists relating to blue felt lichen translocation. The translocation plan has been developed based on several studies which used specimens similar in habit (foliose lichens) and in some cases species belonging to the same family. Based on the similarity on the specimens used in previous studies, it is inferred that the techniques proposed could result in a viable transplant. However, it should be noted that this is a novel experimental design which has not been performed for this species in Nova Scotia and based on available literature, does not appear to have ever been attempted.

Monitoring the calicioid frosted glass whiskers presents a series of challenges (i.e., endosubstratic thallus, small size) which limits in-situ data collection. As a result, the same level of detail that is proposed to be collected on foliose lichens cannot be collected for frosted glass whiskers without sampling and microscopy work.

Blue felt lichen is often tightly appressed to the substrate which presents a challenge when attempting to remove the thallus in one piece. Methods will be applied such as wetting the lichen and keeping thin pieces of bark attached to prevent breaking the thallus. However, creating unintentional lichen fragments while removal is a likely outcome of translocating efforts.

In-situ measurements of thallus area will be calculated using imaging process data on an annual basis which gives insight to lichen health, but biomass accumulation will not be calculated. If biomass accumulation were to be assessed, invasive techniques (taking thalli to the lab, drying and weighing them) would be required. In efforts to reduce harm to SAR, measuring biomass accumulation on an annual basis will not occur.

Methods to determine thallus vitality is limited to non-invasive in-situ approaches. Methods to measure lichen health such as chlorophyll concentrations and chlorophyll fluorescence, although useful when determining the effects of environmental stressors, are often invasive and destructive. Alternative methods, such as in-field chlorophyll fluorescence meters have been explored during the development of this monitoring plan, however, it is often challenging to interpret this data (Gauslaa pers. comm. 2020). Furthermore, cyanolichens require field meters with light with red wave lengths which most modern devices use blue light (Gauslaa pers. comm. 2020).

7.0 Closure

The methods for this translocation and monitoring plan have been selected from several studies referenced throughout. Adaptations have been made based on discussions with lichen experts within Nova Scotia, Europe and the expertise of the team of ecologists at MEL. The outcomes and lessons learned from this proposed plan could be used to help guide future translocation and monitoring efforts and further our understanding of industrial effects to Nova Scotian lichen SAR. This draft plan has been prepared with the intent to share with ECCC and NSL&F for input and feedback on proposed objectives and methodologies.

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Appendix A: Figures

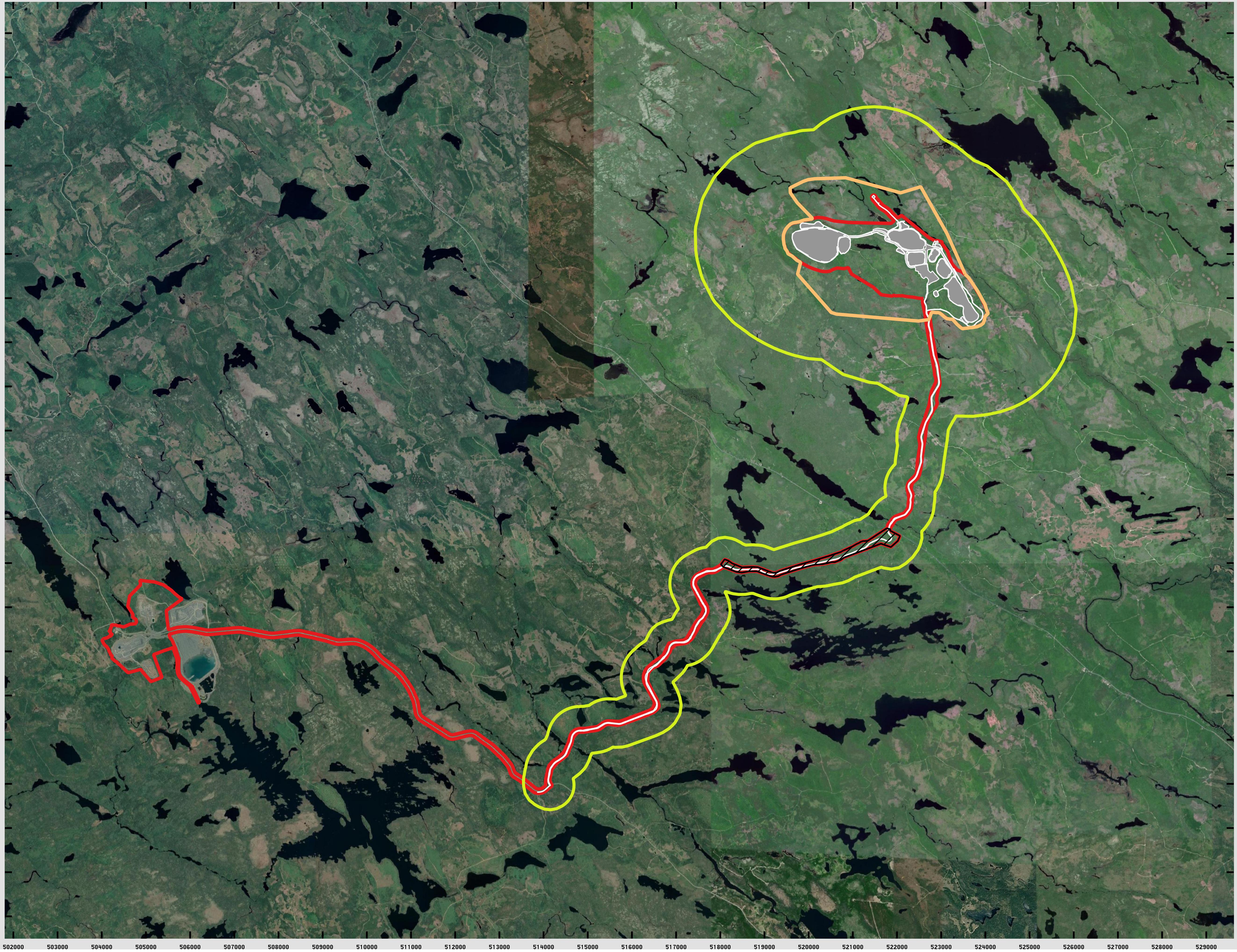

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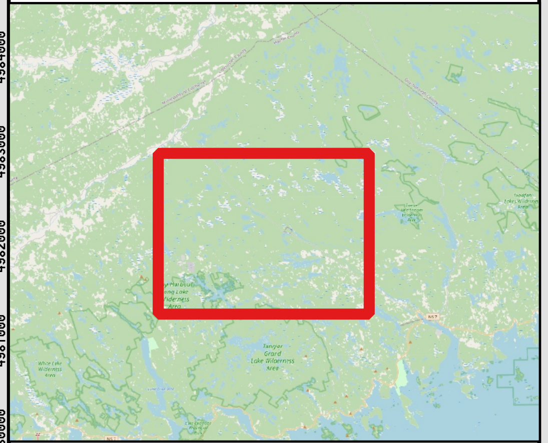
FIGURE 1

Beaver Dam Mine Project

Project Overview

Marinette, NS

- Proposed Infrastructure
- New Construction Haul Road Section
- Lichen Study Area (LSA)
- Local Assessment Area (LAA)
- Project Area



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Units: Meter

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Scale when printed @ 11" x 17"

Drawn By: JRG
Reviewed By: MM

2021-2-18

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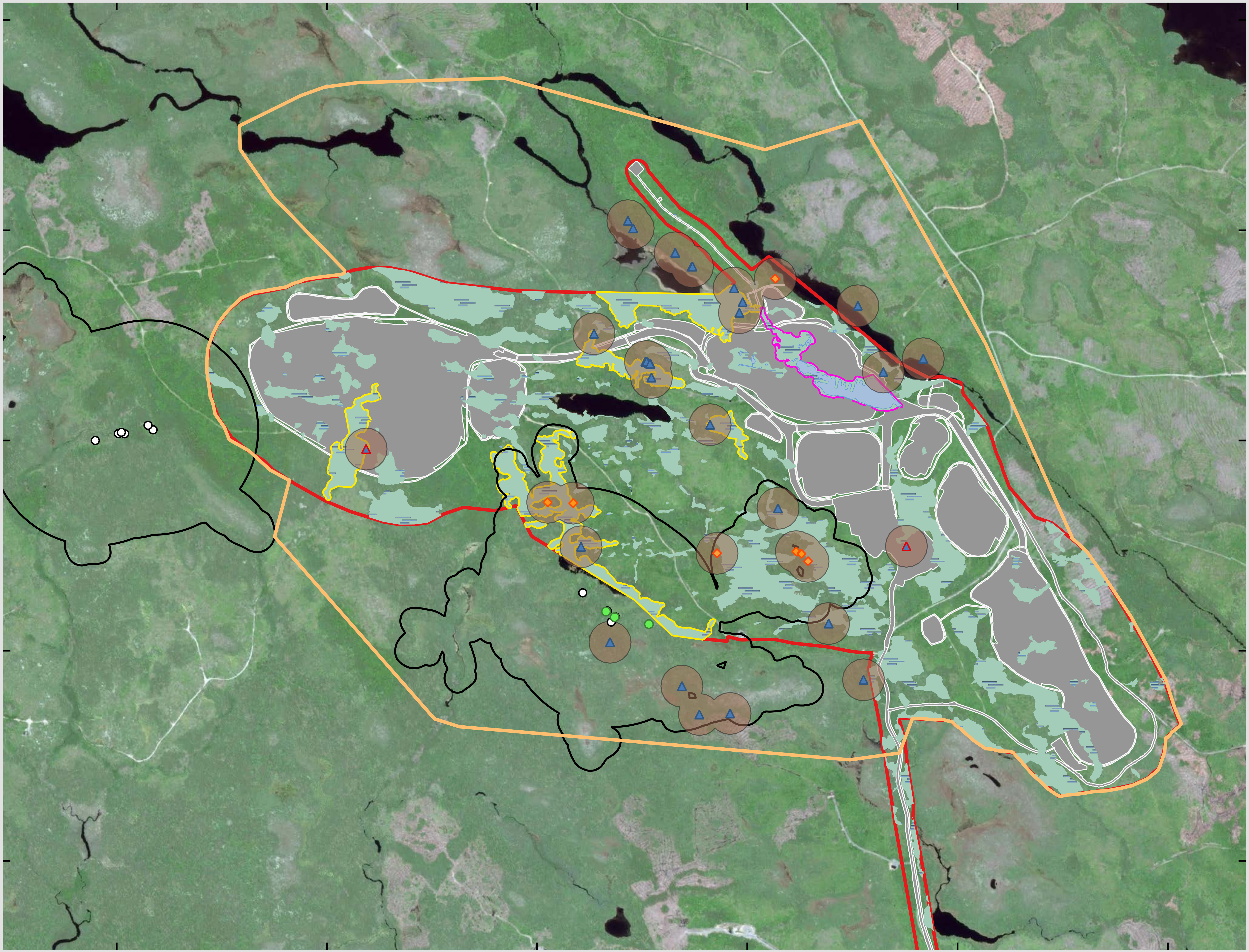

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FIGURE 2a

Beaver Dam Mine Project

Lichen SAR Occurances and Project Interactions

Wetlands (Field Delineated)
Setback (100 m)
Proposed Infrastructure
Frosted Glass-Whiskers Occurances

Blue Felt Lichen Occurances
Directly Impacted
Indirect or No Expected Impacts

Historical Boreal Felt Lichen Occurances
ACCDC
Observed (MEL)

WSS (Field Delineated)
Field Identified
Potential
Boreal Felt Lichen Critical HabitatArea
Lichen Study Area (LSA)
Project Area

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

0 300 600 900 m

Scale: 1:17,000 Scale when printed @ 11" x 17"

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Reviewed By: MM
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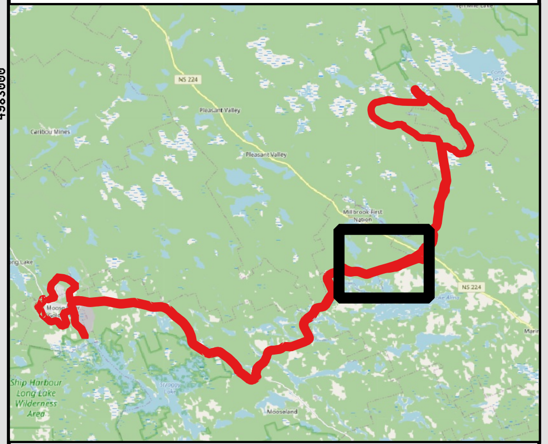
FIGURE 2b

Beaver Dam Mine Project

Lichen SAR Occurrences and Project Interactions

Wetlands (Field Delineated)
Setback (100 m)
Proposed Haul Road
Blue Felt Lichen Occurrences
Indirect or No Impacts
Project Area



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Scale when printed @ 11" x 17"

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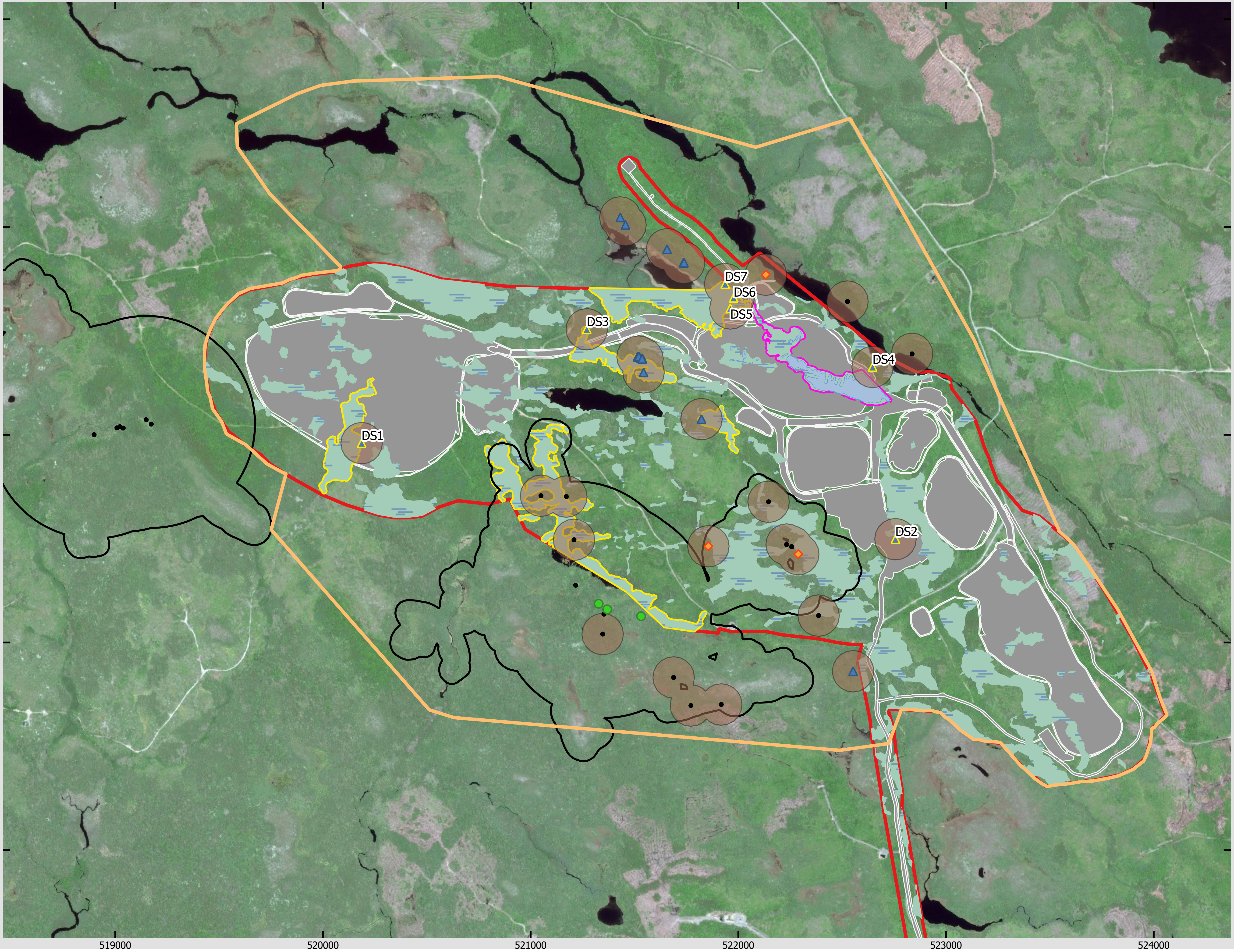

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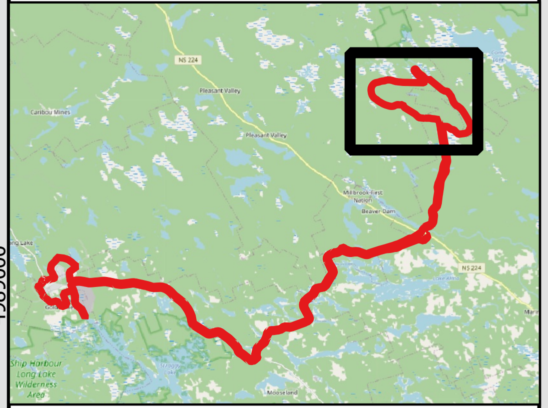
FIGURE 3a

Beaver Dam Mine Project

Lichen SAR Monitoring and Translocation Design

Wetlands (Field Delineated)
Setback (100 m)
Proposed Infrastructure
Proposed Boreal Felt Lichen Monitoring
Proposed Frosted Glass-Whiskers Monitoring
Proposed Blue Felt Lichen Monitoring
Potential Blue Felt Lichen Donor Site
Other Lichen Occurances

WSS (Field Delineated)
Field Identified
Potential
Boreal Felt Lichen Critical HabitatArea
Lichen Study Area (LSA)
Project Area



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0 300 600 900 m

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Scale when printed @ 11" x 17"

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Reviewed By: MM

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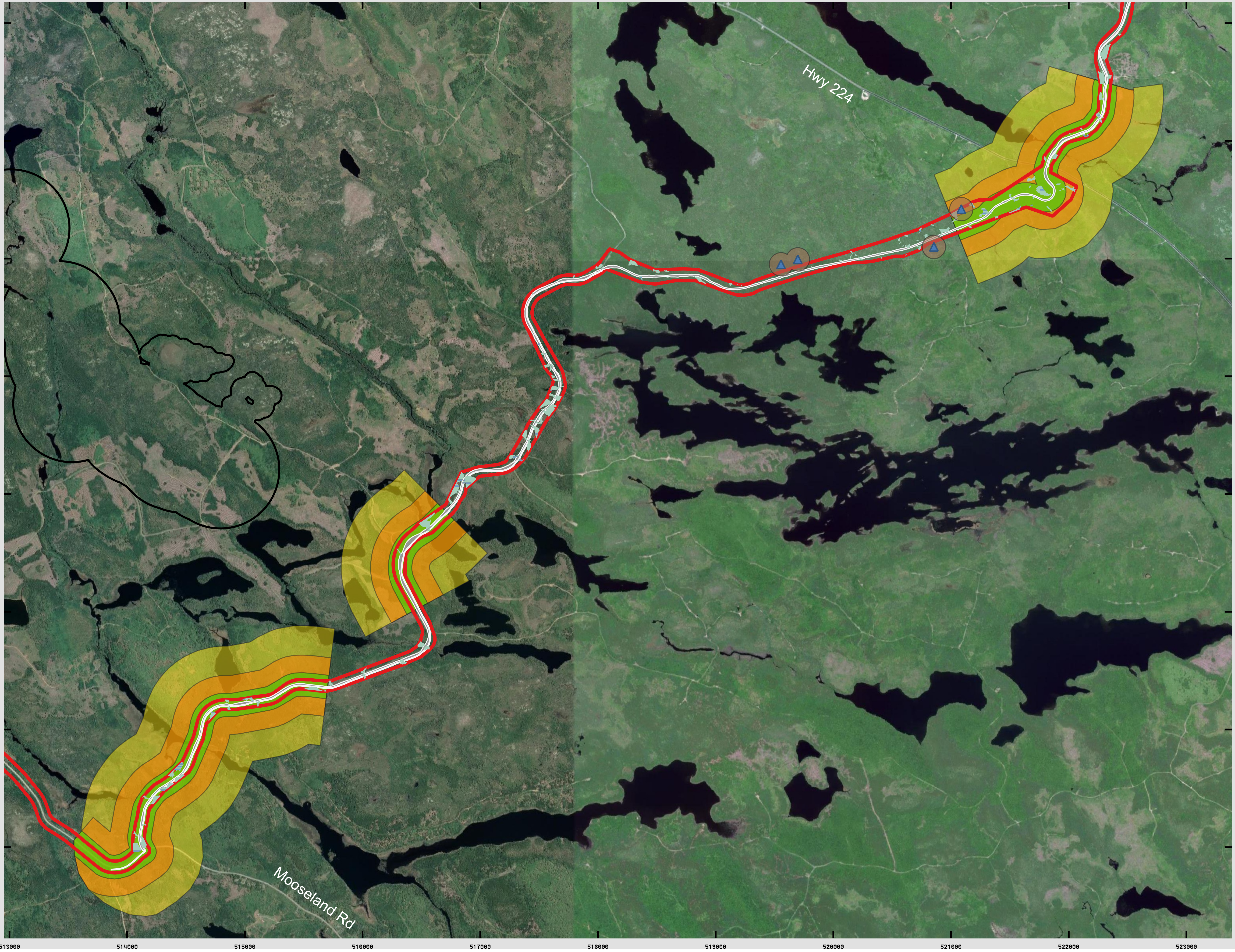

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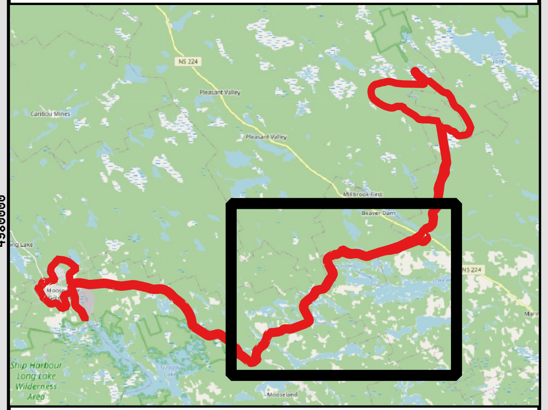
FIGURE 3b

Beaver Dam Mine Project

Lichen SAR Monitoring and Translocation Design

Wetlands (Field Delineated)
Setback (100 m)
Proposed Haul Road
Proposed Blue Felt Lichen Monitoring

Graduated Monitoring - Max Dust Zones
0-100 m
100-250 m
250-500 m
Boreal Felt Lichen Critical Habitat Area
Project Area



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