Environment

Auriga Gold Corp.

Puffy Lake Mine
Notice of Alteration

draft for discussion

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Revision Log

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Executive Summary

This Notice of Alteration Request to Environment Act Licence No. 1207E has been prepared to obtain approval for the development of five open pits at the existing Puffy Lake Mine. This will supplement the pending operation of the underground mine, mill, and Ragged Tailings Impoundment Area (Ragged TIA) which would operate as licensed under *Environment Act* Licence No. 1207E. The report has been developed following the information described in *Environment Act Proposal Report Guidelines* (Manitoba Conservation 2011a).

The mine is located at 55º01'56" north latitude and 100º58'54" west longitude in north-central Manitoba, approximately 60 km northeast of Flin Flon and approximately 12 km southeast of the community of Sherridon. It lies wholly within Mineral Lease 065 and Crown Land Miscellaneous Lease 96093, the corresponding surface lease. Access to the Puffy Lake Mine controlled by a security gate located on a 9 km long gravel main access road that extends east from kilometre 66 on the all-season gravel road that connects Sherridon to Provincial Trunk Highway (PTH) #10 (the Access Road).

The Puffy Lake Mine, approved under Environment Act Licence No. 1207E was developed and operated from December 1987 to March 1989 by Pioneer Metals Corporation (Pioneer), when it was placed in care and maintenance. Auriga Gold Corp. (Auriga) has advised that its intention is to re-open the mine in the fourth quarter of 2014, commencing with a program of underground test mining, and followed in 2015 by resumption of mill operations, production of gold for the market, and the deposition of tailings into the existing Ragged TIA, all in accordance with *Environment Act* Licence No. 1207E and the letter of the Director of Environmental Approvals dated May 17, 2012.

Auriga Gold Corporation (Auriga) is the current licence holder for the Puffy Lake Mine and proposes to develop five open pits at the existing Puffy Lake Mine site that will be supported by the existing licensed infrastructure (*e.g.,* mill, access road, Ragged TIA). The proposed Project involves the sequential operation of five open pits that will be progressively rehabilitated as mining progresses over three years.

The proposed Project covered in this Notice of Alteration includes:

- Five open pits;
- One new temporary potential acid generating waste rock stockpile;
- Four new overburden stockpiles;
- Four new combination overburden and non-acid generating waste rock stockpiles;
- Haulage roads from the open pits to the on-site access roads that lead to the existing mill and new waste rock stockpiles; and
- Upgrades to the existing main access road or on-site roads.

The original Closure Plan developed by Pioneer Metals Inc. for the Puffy Lake Mine was approved by the Director of Mines. An amendment to the Puffy Lake Mine Closure Plan is included as part of this Notice of Alteration to account for operation of the proposed open pits. It is anticipated that site conditions will return to pre-development conditions following the completion of closure activities. Post-closure monitoring will occur for six years to assess the success of the closure activities.

The Environmental and Social Components were selected for assessment in accordance with the *Environment Act Proposal Report Guidelines*. Environmental Components (ECs) include topography, soil, air, noise and vibration, climate, groundwater, surface water, aquatic resources, protected species, flora and fauna. Social Components (SCs) include resource use, heritage resources, and aesthetics. The conclusions of the environmental effects assessment are as follows:

Topography

The partially backfilled pits represent the most substantial long term alteration to topography as it is today, but their final configuration will represent only a minor change in topography in context with the area of the mine and the region in which it is found. Overall, given the mitigation measures in place, the natural terrain of the area and region and the residual areal extent of disturbance, the residual effect on topography following closure is considered minor in the area and region.

Soil

Given the implementation of mitigation measures, the nature of the waste rock and the short length of time the waste rock and pit walls will be exposed to weathering, it is anticipated that effects to soil quality because of ARD/ML will be negligible. Soil disturbance will be limited in extent and duration to the practical extent possible and is anticipated to result in a minor to negligible residual effect during the mining phase and a negligible residual effect following closure. Waste management strategies and policies employed and disposal of any wastes at licensed facilities will result in a negligible effect on soil. Progressive rehabilitation of the site will include remediating potentially contaminated soils, contouring, applying overburden and topsoil, and re-vegetating the developed areas and as a result, the residual effect on soil quality and quantity will be negligible following closure.

Air

The residual effect of dust generation on air quality is anticipated to be minor to negligible in the area during mining activities. The residual effect of ARD/ML dust on air quality is anticipated to be minor to negligible at the site. Although the increase in traffic associated with the Proposed Alteration is considered major, the increase in emissions due to the increase in vehicles is anticipated to have a minor to negligible effect on air quality in the area.

Noise and Vibration

All activities performed on the Puffy Lake Mine site will be carried out in accordance with the *Provincial Workplace Safety and Health Act* and pit contractor's health and safety plans, which will minimize potential effects on humans due to noise. Noise levels are anticipated to return to existing ambient levels within the region. Based on the implementation of the proposed mitigation measures, and the distance to human receptors, it is anticipated that noise and vibration effects on humans will be minor to negligible during the mining phase of the Proposed Alteration.

Climate

The greenhouse gas emissions generated during the mining and closure of the Proposed Alteration is considered to have a negligible effect on climate change. It is anticipated that the reduction in CO_2 uptake by plants due to clearing will be minor during the mining of the open pits in the site. Following closure, the residual effect of vegetation loss on GHG emissions is anticipated to be negligible.

Groundwater

No registered groundwater users have been identified within 9.6 km of the site. Any effects on shallow groundwater quality and quantity are anticipated to be limited in spatial extent to the site and immediate area. The residual effect of pit dewatering on shallow groundwater quantity is anticipated to be minor during mining. Water discharged from the open pits is anticipated to be of sufficient quality such that residual effects on deep and shallow groundwater quality will be negligible. The deep groundwater has low hydraulic conductivity and as a result, the residual effect of pit dewatering on deep groundwater quantity is anticipated to be negligible during mining.

The shallow and deep groundwater water tables are anticipated to recover from mining within a moderate period and given the implementation of appropriate mitigation measures and the progressive pit rehabilitation, it is anticipated that the residual effect on groundwater quantity and quality following closure will be negligible.

Surface Water

Contamination of pit discharge water, including blast residues or sediment, is anticipated to be minimal with the implementation of proposed mitigation measures with negligible residual effects on surface water quality. Natural process within the surrounding bogs will further minimize the levels of potential contamination from pit dewatering discharge before entering the Ragged TIA. Discharge effluent from the Ragged TIA will be monitored as per the conditions in Environment Act Licence No. 1207E.

Residual effects on surface water quantity because of pit dewatering or changes to surface hydrological patterns are anticipated to be minor to negligible. Soil disturbance during mining is anticipated to result in minor to negligible residual effects on surface water quality and quantity.

Protected and Other Aquatic Resources

The mitigation measures recommended for the protection of surface water are anticipated to sufficiently mitigate potential surface water effects and will prevent adverse effects on aquatic resources. Shortjaw Cisco will not be affected by the Proposed Alteration. The aquatic habitat value of Fire Pond is categorized as Marginal as it provides habitat only for small-bodied fish (i.e., Brook Stickleback) and there is no connectivity to other waterbodies that prevents it from forming part of or supporting commercial, recreational, or Aboriginal fisheries. Given that the type of habitat potentially lost (i.e., slow moving, unconnected boggy areas including Fire Pond) is readily available throughout the area and that the species using this type of habitat (Brook Stickleback) are widespread and abundant, the residual effect to aquatic resources within the area is minor to negligible.

Protected and Other Flora Species

Although the Proposed Alteration will result in a loss of vegetation in the site, no unique vegetation communities will be lost as confirmed through a terrestrial survey. In addition, the actual extent of disturbance is expected to be a fraction of the site and the roads, stockpiles and open pits will be progressively rehabilitated which will further minimize the duration and extent of the potential effect. Overall, the residual effect of vegetation loss during mining and closure phase is considered minor to negligible in the site. No protected flora species are known to occur within the region and as a result, no effects on protected species are anticipated during the mining or closure of the Proposed Alteration.

Protected and Other Fauna Species

No habitat of specific or critical value to wildlife was observed at the site (such as calving or over-wintering areas) and, based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the area. A large portion of the area was affected by historical development at the Puffy Lake Mine site or severe forest fires in 1989, and as a result, the quality of habitat available in the area is reduced. Although the Proposed Alteration will result in a loss of wildlife habitat (through vegetation loss) at the site, the type of growing conditions that has been lost is not uncommon in the area and region. As a result, the residual effect of habitat loss on flora during mining is considered minor. Wildlife abundance in the region is anticipated to be low, based on past and recent surveys as well as the reduced habitat value as a result of forest fires.

Given the mitigation measure implemented and the reasons above, the potential noise effects on wildlife during mining of the open pits is anticipated to be moderate within the site and minor within the area. During mining and

closure, light pollution is anticipated to result in a negligible residual effect on fauna. Although the increase in traffic on the main access road and the Sherridon Road are anticipated to be major, it is anticipated that road speed limits on the site, given the low abundance of wildlife species, will result in a minor residual effect of collisions on wildlife. It is anticipated that potential effects of noise and light pollution on fauna following closure are anticipated to be negligible to minor.

The Kississing-Naaosap Boreal Woodland Caribou herd, whose snow-free season range overlaps with the site, is composed of an estimated 150 individuals and is currently considered stable (COSEWIC 2002). According to Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou (Government of Manitoba 2005), the conservation risk of the Kississing and Naaosap herds are considered to be high risk and medium risk, respectively. Boreal Woodland Caribou have typically avoided young forest or disturbed areas, including those areas impacted by the 1989 forest fires. As a result of the lack of suitable habitat and historical and recent presence of activity, the residual effects of noise, light pollution, collisions and habitat loss on Boreal Woodland Caribou is anticipated to be minor to negligible during mining and following closure, the residual effects are anticipated to be negligible.

Resource Use

Auriga has indicated that they are committed to working with local trappers and interested stakeholders to ensure access to trap lines and other resource harvesting is not impacted by the Proposed Alteration.

Heritage Resources

There are no known or potential historic or heritage resources at the Puffy Lake Mine site. Therefore, the residual effect on heritage resources is anticipated to be negligible during mining and closure of the Proposed Alteration.

Aesthetics

Based on the mine's remote location, surrounding vegetation, and historical disturbances associated with the 1989 forest fires or previous development at the Puffy Lake Mine site, effects on aesthetics during the mining and closure phase are anticipated to be negligible.

Glossary

Item	Explanation
ABA	Acid base accounting; is the balance between acid-production and acid-consumption properties of a mine waste rock.
ARD	Acid Rock Drainage; is when there is a net acid-production capacity in mine waste rock and there is a low pH drainage.
Ambient	Surrounding, encircling - pertaining to any local non-point source conditions such as temperature, air quality or noise levels.
Aquatic habitat value	The value of aquatic habitat is based on its sensitivity, use (for spawning), and distribution or availability. Habitats that are rare or highly sensitive would be considered to have a High value.
Auriga	Auriga Gold Corp..
Bedrock	Solid rock that underlies soil, sand, clay, gravel, and loose materials on the Earth's surface.
Benthic Invertebrate	Invertebrates living on or in the sediment of a water body.
Berm	A sloped wall or embankment used to prevent the inflow or outflow of material into/from an area.
Bog	An area having a wet, spongy, acidic substrate composed chiefly of sphagnum moss and peat in which characteristic shrubs and herbs and sometimes trees usually grow.
CSQG	*Canadian Sediment Quality Guidelines for the protection of aquatic life.*
CWQG	*Canadian Water Quality Guidelines for the protection of aquatic life.*
EC	Environmental Components (ECs) include topography, soil, air, climate, groundwater, surface water, terrestrial resources, aquatic resources, and protected species.
EEM	Environmental Effects Monitoring.
EIS	Environmental Impact Statement
Ecodistrict	Unit of land that is characterized by relatively homogenous physical landscape and climatic conditions. As a sub-division of Ecoregions, they have a more uniform biological production potential.
Ecoregion	Large unit of land characterized by various items including distinctive climate, ecological features and terrestrial communities.
Ecozone	The largest scale biogeographic division of the earth's surface based on the historic and evolutionary distribution patterns of plants and animals.
FMU	Forestry Management Unit.
Fauna	All animal life in a particular region.
Fen	A low and frequently flooded area of land.
Flora	All plant life and vegetation in a particular region.
Groundwater	Water that exists beneath the earth's surface in underground streams and aquifers.
Ha	Area in hectares, equivalent to 10,000 square metres.
HRIA	Heritage Resources Impact Assessment.
Humidity Cell Test	Humidity cell tests are designed to mimic rock weathering at the laboratory scale in a controlled fashion. This standard kinetic test determines the rate of acid generation, the variation over time in leachate water quality and thus provides information to develop mitigating strategies.
Hydrology	The study of the distribution and movement of water.
masl	Metres Above Sea Level.

Item	Explanation
MCDC	Manitoba Conservation Data Centre.
MESA	*Manitoba Endangered Species Act.*
MMER	Federal *Metal Mining Effluent Regulations*.
ML	Metal Leaching; is the process by which acid drainage or weathering results in the dissolution of metals into solution.
Marginal fish habitat	Fish habitats that require minimal protection have a low productive capacity and contribute marginally to fish production, but do have reasonable potential for enhancement or restoration.
Mitigation	Actions taken to reduce effects by limiting, reducing or controlling hazards and contamination sources.
NAG	Non-acid generating.
NOA	Notice of Alteration
NP/AP	Neutralizing potential to acidification potential ratio. A rock sample with a NP/AP ratio less than two suggests that rock is potentially acid generating (PAG).
OB	Overburden; materials overlying the pit or deposit, usually includes vegetation and soils.
PAG	Potentially acid generating.
PTH	Provincial Trunk Highway.
Phytoplankton	Small, often microscopic organisms that are capable of photosynthesis that live in the water.
Proponent	A person or organization seeking approval to conduct a business or activity that impacts on the environment.
RCMP	Royal Canadian Mounted Police.
ROI	Radius of influence
RQD	Rock quality designation.
RTLs	Registered trap lines.
Residual Effects	Effects that remain after mitigation has been applied.
SARA	*Species at Risk Act.*
SC	Social Components (SCs) include protected areas, resource uses, heritage resources and aesthetics.
Sediment	Any particulate matter that can be transported by fluid flow and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid.
Sewage	Wastewater produced in showers, toilets, sinks, laundry facilities stored in holding tanks until removal and treatment at a licensed off-site facility.
Surface Water	Water that sits or flows above the earth, including lakes, oceans, rivers, and streams.
Terrestrial	Existing on land.
TIA	Tailings Disposal Area.
Tpd	Tonnes per day.
Tonne	Unit of mass equal to 1,000 kg or 2,204.6 pounds. Also referred to as “metric tons”.
Topography	The physical features of the land.
USgpm	US gallons per minute.
WMA	Wildlife Management Area.

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1. Introduction and Background

1.1 Location of the Existing Development

The existing Puffy Lake Mine is located at 55º01'56" north latitude and 100º58'54" west longitude in north-central Manitoba, approximately 60 km northeast of Flin Flon and approximately 12 km southeast of the community of Sherridon (**Figure 01**) and lies wholly within Mineral Lease 065 and Crown Land Miscellaneous Lease 96093, the corresponding surface lease. Access to the Puffy Lake Mine controlled by a security gate located on a 9 km long gravel main access road that extends east from kilometre 66 on the all-season gravel road that connects Sherridon to Provincial Trunk Highway (PTH) #10 (the Access Road) as shown on **Figure 02**.

1.2 Description of the Existing Development

The Puffy Lake Mine, approved under *Environment Act* Licence No. 1207E (**Appendix A**), was developed by Pioneer Metals Corporation (Pioneer). Approval of the Puffy Lake Mine was supported by baseline terrestrial and aquatic investigations carried out in May 1987, which formed the basis for the 1987 Environmental Impact Statement (EIS) prepared by Ilam Associates Ltd. and filed at that time with Manitoba Environment (as it then was known).

The Puffy Lake Mine was operated from December 1987 to March 1989, when it was placed in care and maintenance.

The Puffy Lake Mine consists of:

- Decline and underground mine;
- Mill for concentrating ore on site designed for a 1,000 Tpd capacity;
- Ragged Lake Tailings Impoundment Area (Ragged TIA);
- Supporting infrastructure including: mine office, dry (change house), lab assay office, emergency diesel generator, parking lot, paste backfill facility, concrete transformer pad, explosives storage area, fuel tank storage area, and telecommunications system; and
- Access road and security gate.

1.3 Proponent

Auriga Gold Corp. (Auriga) is an emerging Canadian gold producer focused on re-starting the Puffy Mine and expanding gold resources on its Puffy and Nokomis gold deposits (collectively the "Maverick Gold Project"). The Maverick Gold Project is located in the Flin Flon Greenstone Belt, approximately 65 km northeast of Flin Flon, Manitoba. Auriga acquired the Puffy Lake Mine in October of 2010, with the intention of re-commencing operation of the mine.

Auriga acquired a 54% interest in the adjacent Nokomis property from Pioneer in October 2010, at the same time as it acquired the Puffy Lake Mine, and the remaining 46% interest in the Nokomis property was acquired from Claude Resources Inc. in November 2011. The Nokomis property is located less than 8 km northeast of the Puffy Lake Mine (**Figure 03**). Additional staked claims in this area were acquired by Auriga in April 2011. The Puffy Lake Mine, Nokomis property and the staked claims are collectively named the Maverick Gold Project, which cover an area of approximately 6,640 hectares (ha) (**Figure 03**).

With the assistance of various consultants, Auriga has undertaken further environmental work to update information with respect to the site. Further to this effort, AECOM carried out aquatic and terrestrial investigations in September

2012, the results of which are contained in the AECOM 2012 updated Environmental Baseline Assessment (EBA) (AECOM, 2014).

Auriga has advised that it intends to re-open the mine in the third quarter of 2014, commencing with a program of underground test mining, and followed in 2015 by resumption of mill operations, production of gold for the market, and the deposit of tailings into the Ragged Tailings Impoundment Area (TIA). All in accordance with *Environment Act* Licence No. 1207E and the letter of the Director of Environmental Approvals dated May 17, 2012.

1.4 Proposed Alteration

Auriga has determined that the near surface ore included in the Puffy Lake Mine mineral resource would be accessed more economically and efficiently from the surface than from the existing underground workings. Auriga therefore proposes the development of five open pits and related infrastructure (the Proposed Alteration).

The five open pits are located adjacent to the existing underground workings and will be developed sequentially and progressively rehabilitated as mining progresses. Mining and concurrent rehabilitation of the open pits would occur over a 3 year period, with peak ore production from the open pits anticipated in 2016/17. By the end of 2018, the open pits will be exhausted, with closure activities ceasing in early 2019 (for a total period of approximately 3 years).

The conversion from underground to open pit method for a portion of the resource does not reflect an increase in the available mineral resource. Nor does it change the quantity or quality of ore to be processed on the site. The production life of the Puffy Lake Mine, including the open pits and underground workings, continues to be anticipated to be approximately 8 to 9 years.

The proposed alteration mainly consists of:

- Five open pits, developed sequentially;
- One new potentially acid generating (PAG) waste rock stockpile;
- Four new overburden (OB) stockpiles;
- Four new combination OB and non-acid generating (NAG) waste rock stockpiles;
- Additional internal haulage roads from each of the open pits to the on-site access roads leading to the existing mill and new waste rock stockpiles; and
- Minor widening of the existing access road.

The proposed alteration will be located entirely within the area occupied by the existing development. The approximate locations of the open pits are shown in **Figure 04.** The only element of the Proposed Alteration whose footprint overlaps with surface water is where a berm will be constructed in Fire Pond to prevent drainage into the pit. Fire Pond is an isolated, shallow pond which contains no fishery resource.

Upon closure, three of the five open pits will be completely backfilled and re-vegetated while the remaining two open pits will be partially backfilled with pit slopes flattened, fenced off, and allowed to flood naturally. PAG waste rock will be used to backfill the open pits and no PAG waste rock will remain at surface following closure. The remaining surface stockpiles will be contoured, covered with overburden, and re-vegetated.

The Puffy Lake Mine Closure Plan approved by the Director of Mines will be amended as required to include the addition of the open pits and associated infrastructure, but as noted above, the open pits will be subject to progressive rehabilitation during the life of the mine.

The average daily ore extraction rate during peak production from the open pit(s) is estimated to be 739 tpd (266,200 tonnes of ore) (ACA Howe, 2012). The existing mill is licensed to operate at a rate of 1,000 tpd. It is expected that the open pits and the underground mine will provide mill feed at different rates over the life of the operation of Puffy Lake Mine. However, the combined rate of production from the underground workings and open pit(s) will not, at any time, exceed the licensed processing rate of the mill.

1.5 Purpose of this Report

AECOM Canada Ltd. (AECOM) was retained by Auriga to review the description of this intended alteration to the development and conduct an environmental assessment of same. This report contains the results of that assessment.

1.6 Regulatory Framework

1.6.1 Mineral and Surface Leases

In total, the contiguous land position comprising the Maverick Properties covers 6,640 ha (**Figure 03**).

The Puffy Lake Mine, including the proposed alteration, lies wholly within Mineral Lease 065 and Crown Land Miscellaneous Lease 96093, the corresponding surface lease (**Figure 03, Appendix A)**.

1.6.2 Crown Land General Permits

The following Crown Land general permits also support the Puffy Lake Mine:

- Crown Land Permit GP4134: Site for mine tailings containment on east end of Ragged Lake, renewed annually, subject to mineral disposition;
- Crown Land Permit GP4058: All-weather access road from Jay Lake to the mill, renewed annually and subject to annual rental fees;
- Crown Land Permit GP2799: All-weather access road from the public road to the mill, renewed annually and subject to annual rental fees; and
- Crown Land Permit GP3758: Water pipeline right-of-way and all-weather road, renewed annually and subject to annual rental fees.

1.6.3 Environmental License

Copies of *Environment Act* Licence No. 1207E, Auriga's letter to the Director dated May 2, 2012, and the reply of the Director of Environmental Approvals dated May 17, 2012 are included in **Appendix A**.

1.6.4 Closure Plan

The Closure Plan for the Puffy Lake Mine was developed by Pioneer in 2010 and approved by the Director of Mines. The Puffy Lake Mine Closure Plan will have to be amended in accordance with the *Mine Closure Regulation, Manitoba Regulation 67/99*, to account for operation and rehabilitation of the proposed open pits and a copy of the proposed draft amendment is included in **Appendix B**.

2. Description of the Proposed Alteration

2.1 Components

As noted in **Section 1.1** the proposed alteration consists of:

- Five open pits, developed sequentially, shown in **Figure 04**;
- One new potential acid generating (PAG) waste rock stockpile;
- Four new overburden (OB) stockpiles;
- Four new combination OB and non-acid generating (NAG) waste rock stockpiles;
- Additional internal haulage roads from each of the open pits to the on-site access roads leading to the existing mill and new waste rock stockpiles; and
- Minor widening of the existing access road.

A process flow diagram showing how the proposed alteration will integrate with the existing development is shown in **Figure 05.**

2.2 Open Pits and Stockpiles

The five proposed open pits are shallow with depths ranging from 30 m to 75 m and surface areas ranging from 0.6 ha to 4.3 ha (**Table 2.1**). It is estimated that 530,000 diluted ore tonnes (indicated and inferred) will be mined from the five proposed open pits, with a diluted average grade of 4.8 g/tonne and 70,000 ounces of gold expected to be recovered (ACA Howe, 2012). The proposed open pits will supply an initial two-month ore stockpile with the average daily ore extraction rate estimated to be 739 tpd (266,200 tonnes of ore) (ACA Howe, 2012).

Table 2.1: Physical Attributes of the Five Proposed Open Pits

Parameter	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Total
Depth (m)	40	35	45	75	30	**-**
Size (ha)	4.0	0.6	1.4	4.3	0.6	**10.9**
Diluted Mill Feed (tonnes)	162,000	14,000	59,000	273,000	19,300	**530,000**
Gold Recovered (ounces)	20,760	4,950	6,060	35,700	2,040	**70,000**
Waste Rock (tonnes)	2,020,000	211,000	583,000	4,400,000	180,000	**7,400,000**

Note: Totals may not sum exactly due to rounding.

In addition to making the extraction of the near surface ore economical, development of the proposed open pits will provide for continuity of mill feed in the event that the production of the underground mine is temporarily reduced or interrupted.

The five proposed open pits will be mined using conventional open pit mining methods and equipment. Mining of the proposed open pits includes clearing vegetation to prepare areas for road upgrades, new road development, stockpile areas, and open pits. Overburden will be stripped from open pit areas and stockpiled or provide a base for the stockpile areas during the mining phase. Road upgrades and new road development includes the installation or replacement of culverts under roads, and infilling the road right-of-way with NAG waste rock. Road upgrades will be completed prior to any work on the open pits.

All pits will have western (footwall) pit slopes of 35 degrees and eastern (hanging wall) pit slopes of 70 degrees with benches. Hanging wall pit slopes are supported by Rock Quality Designation (RQD) analyses that show competent

rock characteristics capable of supporting relatively high angle pit walls (Piteau Associates Engineering Ltd. 1987 in Auriga 2012).

A qualified mining pit contractor will be hired by Auriga to supply supervisors, equipment operators, maintenance personnel, mobile equipment, and consumables such as equipment parts, diesel fuel, and explosives (**Table 2.2**). Equipment and personnel will be moved from one pit to another following the mine sequencing steps outlined in the following section.

Table 2.2: Equipment Used During the Mining and Closure of the Proposed Open Pits

Equipment	Units	Duration of Use
Front End Loader	2	Life of Project (LoP)
Bobcat	1	LoP
Excavator	2	LoP
Brush Grubbing – Caterpillar	1	6 months
Dozer	2	LoP
Grader	1	LoP
Water Pump	4	LoP
Diesel Generator	2	LoP
Drill	2	LoP
Construction Trailer	1	LoP

2.2.1 Pit Sequencing

The proposed open pit mining plan involves the sequential operation of five open pits that will be progressively rehabilitated as mining progresses, as described below (**Figure 05**). A detailed schedule for the Proposed Alteration is described in **Section 2.8**.

It is expected that a 5 m buffer around the excavated extents of the proposed open pits, stockpiles, and haulage roads will be cleared of vegetation for safety considerations. Including the 5 m buffer around the proposed open pits and the stockpiles, the area of disturbance is estimated to be 29 ha (excluding roads).

2.2.1.1 Phase I

Phase I is shown in **Figure 06**. Pit 3 will be stripped of a total of 23,805 m³ of overburden, which will be placed temporarily in Stockpile 1. The PAG waste rock (approximately 75,563 m³) will be placed temporarily in Stockpile 3, located immediately west of the TIA in order for water drainage from the stockpile to be captured within the Ragged TIA. The NAG waste rock (approximately 160,395 m³) will be placed in Stockpile 2 and used for possible site levelling or road construction.

2.2.1.2 Phase II

Phase II is shown in **Figure 07**. Overburden (21,390 m³) will be stripped from Pit 2 and placed temporarily in Stockpile 4. With the mining of Pit 2, approximately 32,213 m³ of PAG waste rock will be moved to the exhausted Pit 3 for pit rehabilitation. The NAG waste rock (approximately 39,195 m³) will be placed in Stockpile 9, located in close proximity to the mill facility where it can be crushed and used for possible site levelling or road construction.

Pit 4 is the only feature whose footprint overlies or affects a surface water feature. It infringes upon an isolated shallow pond, known locally as Fire Pond, centrally located on the Puffy Lake Mine (**Figure 07**). Fire Pond is not a water body that provides fish habitat that is part of or supports commercial, recreational, or Aboriginal fisheries (**Section 3.2.1**). To limit the inflow of water into the proposed open pit, as well as minimize the impact on Fire Pond, a berm will be constructed in Fire Pond using overburden from Pit 2 and Pit 3 (Stockpile 4 and Stockpile 1, respectively) during Phase II. Small quantities of NAG waste may be used as riprap to protect the berm as well as minimize deposition of sediments (*e.g.*, run-off from the berm) into Fire Pond.

2.2.1.3 Phase III

Phase III is shown in **Figure 08**. Pit 1 will be stripped of a total of 276,000 m³ of overburden, which will be placed temporarily in Stockpile 5 located adjacent to the mill facility where it can be used in preparation of a laydown area for the NAG stockpile. The PAG waste rock from Pit 1 (approximately 207,761 m³) will be moved to the exhausted Pit 3 for pit rehabilitation. The PAG waste rock from Stockpile 3 (approximately 75,563 m³) will be moved to Pit 2 for pit rehabilitation. The NAG waste rock (approximately 383,548 m³) will be placed in Stockpile 6, located in close proximity to the mill facility where it can be crushed and used for possible site levelling or road construction.

2.2.1.4 Phase IV

Phase IV is shown in **Figure 09**. Pit 4, the largest of the five proposed open pits, will be stripped of a total of 287,500 m³ of overburden. The majority of overburden removed from Pit 4 will be placed temporarily in Stockpile 7 (180,600 m³) and the remainder will be used in the rehabilitation of Pit 1, Pit 2 and Pit 3. Excess overburden from Stockpile 4 (Pit 2) and Stockpile 1 (Pit 3) will be placed in Pit 3 before contouring and re-vegetation efforts. Pit 1 and Pit 2 will be contoured and re-vegetated. The portion of Fire Pond that will be bermed in Phase II will be dewatered by directing water overland towards the Ragged TIA prior to overburden stripping. A portion of the NAG waste rock from Pit 4 (approximately 928,821 m³) will be placed in Stockpile 8, located in close proximity to the mill where it can be crushed and used for site levelling and road construction, if required. The remaining NAG waste rock (approximately 409,605 m³) and the PAG waste rock extracted from Pit 4 (approximately 348,706 m³) will be used in the rehabilitation of Pit 1.

2.2.1.5 Phase V

Phase V is shown in **Figure 10**. The final pit to be mined is Pit 5, the smallest of the five proposed open pits. The PAG waste rock (approximately 18,726 m³), the NAG waste rock (approximately 26,679 m³), and the overburden (28,750 m³) will be moved to Pit 4 for the rehabilitation of that pit. Pit 5, as well as any remaining NAG stockpiles, will be capped with the overburden from Stockpile 1 (Pit 3) and Stockpile 7 (Pit 4). Fencing and signage will be installed around the partially backfilled Pit 4 and Pit 5.

2.3 Road Upgrades and Development

Minor upgrades will be required to the existing main access road and on-site roads, including widening (and associated vegetation clearing) and/or culvert installation or replacement as required accommodating the additional traffic volumes anticipated for the Proposed Alteration. Upgrades to the main access road and on-site roads will occur prior to development of the open pits and haulage roads. It is anticipated that traffic volumes will vary throughout the lifetime of the project. Traffic estimates are discussed in detail in **Section 2.6.5**.

Short internal haulage roads will be constructed to transport mill feed and waste rock/overburden from the proposed open pits to the ore stockpile adjacent to the mill and stockpiles, respectively (**Figures 06 to 10**). A 5 m buffer from

the road centreline will be cleared of trees to achieve appropriate sight lines. The short haulage roads will be constructed from NAG waste rock generated during former operation of the Puffy Lake Mine and/or a portion of the NAG waste rock extracted from the proposed open pits.

Haulage roads will be located and designed to keep the footprint to a minimum. The development of haulage roads will follow the mine sequencing, with each new road developed only when required and decommissioned immediately following rehabilitation of the open pit or stockpile it supports, as described in **Section 2.3**. Equipment used for the mining and closure of the proposed open pits (**Table 2.2**) will be used to install the haulage roads and upgrade the existing roads.

2.4 Pit Dewatering System

During active surface mining, groundwater seepage, rainfall, and surface runoff will be continuously removed from the open pits and discharged as overland flow towards the Ragged TIA. Groundwater inflow was estimated using a mean hydraulic conductivity of 5×10^{-7} m/s and resulted in relatively modest inflow rates of 1.3 Litres per second (L/s) or 20 US gallons per minute (USgpm) to 4.4 L/s (70 USgpm) in Pit 4, the largest pit (WESA 2012a). Based on AECOM estimates, average surface runoff and precipitation into the proposed open pits is estimated to be 5.8 L/s (92 USgpm) with a maximum rate of 8.3 L/s (132 USgpm) (AECOM, 2014). This would result in a maximum total discharge volume, from Pit 1, of 12.7 L/s (202 USgpm).

The dewatering system will consist of small diameter flexible pipes (*i.e.*, less than 4”), a mobile diesel generator, and a portable pump. The dewatering equipment will be mobile and the location of the system will change throughout the lifetime of the Proposed Alteration. The water collected in the dewatering system will be discharged as overland flow towards the Ragged TIA. Pit dewatering will likely be required during the winter months and be accomplished by intermittent pumping and allowing the discharge line to drain thereafter.

2.5 Inputs

2.5.1 Power

Power will be required for pit dewatering management, lighting, and the construction trailer. Power for these purposes will be supplied by either portable diesel generators or grid power supplied by MB Hydro.

2.5.2 Employees

A pit contractor will be hired by Auriga to supply operational staff such as supervisors, equipment operators, and maintenance personnel. It is estimated that on average up to 60 pit contractor employees will be working on the proposed open pits during any one time over a 24 hour period. An additional 40 employees could be expected to access the site per day, including suppliers, ore truck haulers, site visitors, etc. Pit contractor employees likely will housed in the community of Sherridon with no camp located on site.

2.5.3 Raw Materials

Raw materials used at the proposed open pits will include: gasoline, diesel fuel, propane, rebar, pipe, screen, rock bolts, explosives, and other operating supplies. All raw materials will be supplied by the pit contractor. Raw materials will be delivered on a regular basis to the Puffy Lake Mine site via truck. The majority of raw materials will be stored off-site and will be provided by the pit contractor as “just-in-time” deliveries. On-site storage, where

required, will be within the Puffy Lake Mine site, in areas previously developed for this purpose during the operations at Puffy Lake Mine.

Auriga estimates that mining and closure of the open pits would require, on an annual basis, 360 m³ of propane, 360,000 L of diesel, 18,000 L of gasoline, and 1,360 tonnes of bulk emulsion explosives.

2.6 Outputs

2.6.1 Ore Management

It is anticipated that an approximately two-month ore stockpile (45,000 tonnes) will be required, pre-production, to maintain the initial target operating rate at the existing mill of 750 tpd. The ore stockpile will be located adjacent to the existing mill at the location used by the underground operations. This same location will continue to be used during the approximately **three** years in which the open pits are operated.

2.6.2 Waste Rock and Overburden Management

The waste rock, including the NAG and PAG waste rock, will be drilled, blasted, excavated and hauled to waste rock stockpiles within the TIA drainage area or will be used to backfill mined out pits. A portion of the NAG waste rock extracted from the open pits will be crushed and used for possible site levelling or road construction (if required). It is not anticipated that crushing of waste rock will occur at the proposed open pits; however, some crushing of this material may occur at the mill.

Overburden will be stripped and cleared from the area of the proposed open pits. To the maximum extent practical, clearing will be kept to a minimum. The cleared areas will include an additional 5 m buffer around the excavated extents of the open pit to allow equipment access and provide safe clearance. **Table 2.3** shows the estimated overburden material and waste rock volumes to be removed from each proposed open pit.

Table 2.3: Open Pit Materials Summary

Open Pit	Overburden (m³)	Potentially Acid Generating Waste Rock (m³)	Non-Acid Generating Waste Rock (m³)
Pit 1	276,000	207,761	383,548
Pit 2	21,390	32,213	39,195
Pit 3	23,805	75,563	160,395
Pit 4	287,500	348,706	1,338,426
Pit 5	28,750	18,726	26,679
Total	**637,445**	**682,969**	**1,948,243**

Note: A bulking factor of 1.15 and 1.3 was applied to overburden and waste rock, respectively.

Waste rock and overburden removed from the proposed open pits will be placed in stockpiles within the drainage area of the existing Ragged TIA and/or used for progressive rehabilitation of the exhausted open pits (**Figures 06 to 10**). The stockpile area will be cleared of scrub, brush and trees and overburden will be placed as a base for the stockpiles. There are three designated types of stockpile areas, based on materials stored:

- **Area A**: Restricted for stockpiling overburden only. These stockpile areas are shown as green on **Figures 06 to 10**.

- **Area B**: Restricted for stockpiling overburden and NAG waste rock only. These stockpile areas are shown as orange on **Figures 06 to 10**.
- **Area C**: Restricted for stockpiling PAG waste rock only. There is only one temporary PAG stockpile placed over a layer of overburden, shown in red on **Figure 06.**

Stockpile parameters for the Proposed Alteration are detailed in **Table 2.4**. The total area of disturbance resulting from the stockpiles, including the 5m buffer, is approximately 17 ha).

Table 2.4: Stockpile Parameters

Stockpile Number	Open Pit	Volume (m^3)	Diameter (m)	Height (m)	Size (ha)
Area A (Overburden)					
1	3	23,805	60	13	0.28
4	2	21,390	60	11	0.28
5	1	276,000	152	20	1.81
7	4	180,550	150	12	1.77
Area B (NAG waste rock)					
2	3	160,395	120	20	1.13
6	1	383,548	180	19	2.54
8	4	928,821	263	20	5.43
9	2	39,195	90	8	0.64
Area C (temporary PAG waste rock)					
3	3	75,563	120	8	1.13

Note: A bulking factor of 1.15 and 1.3 was applied to overburden and waste rock volumes, respectively.

Based on information provided by Auriga, Acid Base Accounting (ABA) tests on rock samples representative of open pit waste show that the majority of samples are unlikely to generate acid rock drainage (ARD). Approximately 25% of waste rock samples are classified as PAG rock with neutralization potential to acid potential (NP/AP) ratios less than two (NP/AP ratios greater than two indicate NAG rock). Auriga determined, based on the results of the humidity cell tests, arsenic was the most mobile contaminant of concern for waste rock leachate, with a peak concentration of 0.28 mg/L in one sample following seven weeks of exposure. The arsenic concentration in this sample, after 33 weeks of humidity cell testing was stable around 0.1 mg/L. At all times, the arsenic concentrations were below the maximum monthly mean concentration of 0.5 mg/L in the Federal *Metal Mining Effluent Regulation* (*MMER*) (Government of Canada 2002).

It is anticipated that the temporary PAG stockpile will remain on the surface for, at most, nine months before being used in pit rehabilitation. It is anticipated that NAG waste rock Stockpile 2, 6, 8 and 9 may remain on surface following the cessation of mining activities. However, their final size at closure will depend on the amount of NAG waste rock used during the life of the Proposed Alteration for site levelling, road construction and pit rehabilitation.

2.6.3 Discharge Water

Maximum groundwater seepage inflow has been estimated at 4.4 L/s (70 USgpm) in Pit 4, the largest pit, with a maximum surface runoff rate of 8.3 L/s (132 USgpm), for a maximum total discharge volume of 12.7 L/s (202 USgpm) (AECOM, 2014). The water pumped from the open pits will be discharged as overland flow towards the Ragged TIA. Water pumped out of the bermed-off portion of Fire Pond will also be directed towards the Ragged TIA.

Waste rock stockpiles are all located within the drainage basin of the Ragged TIA. As a result, surface run-off from the waste rock stockpiles will flow towards the Ragged TIA (AECOM, 2014).

It is anticipated that the pit contractor staff will use existing facilities on site (*e.g.*, bathrooms). Sewage generated by pit contractor staff during open pit mining will be collected in the existing 4,000 L sewage holding tank that will be pumped out and trucked to a licensed sewage treatment facility, in accordance with *Onsite Wastewater Management System Regulation, Manitoba Regulation 83/2003*.

2.6.4 Solid Wastes

Garbage collection bins will be located throughout the site and will be managed by the pit contractor. Bins will be emptied on a regular basis, with materials removed for disposal at the existing licensed waste disposal facility in Flin Flon, Manitoba.

Hazardous materials including waste oil, lubricants, and other petroleum products will be removed by a licensed hazardous material handler for recycling or approved disposal as required by the pit contractor. Hazardous materials for use at the site (*e.g.,* diesel fuel, explosives) will be stored by suppliers in Sherridon and transported to site as required.

2.6.5 Traffic

Traffic volumes will vary throughout the two to three year life of the Proposed Alteration. Pit contractor vehicles, supply vehicles, waste and ore haul trucks will all travel throughout the site on a daily basis throughout mining of the open pits. No traffic is expected at the site following the completion of closure activities (**Table 2.5**).

Table 2.5: Estimated Open Pit Daily Traffic Volumes

Traffic Source	2014	2014-2017
Trucks – haul waste rock and overburden to stockpiles	3 to 6	3 to 6
Trucks – ore transport to ore stockpile	up to 2	2 to 4
Trucks – site deliveries	10	5
Cars, pick-up trucks, employee bus shuttle	20	25
TOTAL one-way trips per day	**38**	**40**

The estimate of traffic volumes does not include equipment required on-site as listed in **Table 2.2** to accomplish mining within the proposed open pits and associated infrastructure upgrades. It is expected that 18 construction vehicles and equipment may be required on-site on any given day during the mining and closure of the open pits.

2.7 Decommissioning and Closure Plan

Following the decommissioning of the open pits, the site will be returned to a natural state to the practical extent possible. This will be accomplished through the implementation of the Closure Plan developed for the site in accordance with the *Manitoba Mine Closure Regulation 67/99,* provided in **Appendix B**. It is anticipated that the end-use of the Puffy Lake Mine site will be a natural space with no planned residential, commercial, or industrial development.

Upon cessation of mining activities at each location, three of the five pits (Pit 1, Pit 2, and Pit 3) will be backfilled and re-vegetated. The remaining two of five pits (Pit 4 and Pit 5) will be partially backfilled, with pit slopes flattened (3:1 slope) to below the flooded pit level, fenced off and allowed to flood naturally. The remaining surface stockpiles will be flattened (3:1 slope), contoured, covered with overburden, and re-vegetated. PAG waste rock will be placed in the exhausted open pits first, followed by NAG waste rock, then overburden and topsoil. There will be no PAG waste rock stockpile on surface following closure. It is anticipated that NAG waste rock Stockpile 2, 6, 8 and 9 may remain following the cessation of mining activities as shown in **Figure 04**; however, their final size at closure will depend on the amount of NAG waste rock used during the life of the Proposed Alteration for site levelling and road construction. Topsoil, stockpiled on-site or provided by a supplier will be placed on disturbed areas, contoured, and re-vegetated. Materials will be removed from the roads (*e.g.,* culverts and NAG waste rock), and roads will be graded, covered with topsoil and re-vegetated. Remediation activities may occur if an assessment identifies impacted soil (for example). Post-closure monitoring will occur to observe the success of the re-vegetation efforts.

2.8 Schedule

Table 2.6 displays the schedule for development and closure of the open pits.

Table 2.6: Proposed Alteration Schedule

Project Component	2015				2016				2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Roads																
Pit 3																
Pit 2																
Pit 1																
Pit 4																
Pit 5																

Notes: Yellow denotes road upgrades and development, which will follow the mine sequencing. Green denotes removal of overburden; blue denotes mining of the open pit. Orange denotes rehabilitation and/or closure activities.

3. Environmental Setting of Proposed Alteration

As described in **Section 1.2**, the approval of the Puffy Lake Mine was supported by baseline terrestrial and aquatic investigations carried out in May 1987, which formed the basis for the Environmental Impact Statement (EIS) filed in 1987 by Ilam Associates Ltd. Auriga, with the assistance of various consultants undertook further environmental work to update information with respect to the site. Further to this effort, AECOM was retained to carry out supplemental aquatic and terrestrial investigations which were conducted in September 2012. The environmental baseline information relied upon in this report is contained in the report of the AECOM 2012 updated Environmental Baseline Assessment (AECOM, 2014). A copy of this report is provided for review.

3.1 Terrestrial Assessment

3.1.1 Topography

The Puffy Lake Mine is situated on terrain typical of the Canadian Shield characterized by extensive areas of rock outcrop on higher ridges interspersed with lakes and low lying swampy areas. The area to be occupied by the Proposed Alteration is characterized by variable terrain with occasional bedrock outcrops, low peat-filled depressions, regenerative forest which developed following the 1989 forest fires, bedrock outcrops, and previously developed areas. Soils within the Granville Lake Ecodistrict are described as compact clayey subsoil with large amounts of cobbles and stones and coarse surface textures. These characteristics suggest that the soils in region may resist erosion.

Drainage from any of the proposed stockpiles and dewatering activities in the proposed open pits will be directed or placed within the Ragged Lake TIA watershed. Any water resulting from these activities will form part of the inflows to the Ragged Lake TIA, outflow from which will be monitored in accordance with the Metal Mining Effluent Regulations, as per the conditions in *Environment Act* Licence No. 1207E and further letter of the Director, dated May 17, 2012.

3.1.2 Vegetation and Wildlife

The area of the Proposed Alteration shows evidence of the 1989 forest fire (AECOM, 2014). Natural regeneration is progressing at a normal rate and the area is returning to a typical post-burn forest stand. The majority of forest on the rocky uplands shows evidence of being affected by the 1989 forest fire. There are isolated stands of older forest that may have escaped burning, particularly in the area of Pit 2. Fire events, and subsequent regeneration, are a natural and common feature of the boreal zones of Canada. The bog areas that are targeted for pit development show little evidence of fire due to their wet nature. Some tree growth in the bogs was burned and ground cover in the wet meadows adjacent to the bogs shows evidence of past burning.

Burned areas do not provide high quality nesting habitat for birds, with the exception of the boundary between the burned areas and unburned remnant areas (edge habitats). A burned area is highly disturbed and does not contain habitat critical to wildlife species. Due to the impact of the 1989 forest fire and historical development at the Puffy Lake Mine site, the terrestrial habitat is in this area is not, at present, ideal to support diverse wildlife and would not represent an area that would be attractive for most animals that are commonly considered for trapping or hunting.

3.2 Aquatic Habitat Assessment

Development of the proposed open pits at the Puffy Lake Mine will require installation of a berm in Fire Pond and installation of haulage roads to support the proposed open pits. AECOM fisheries biologists conducted aquatic

habitat assessments in three areas in the vicinity of the site (AECOM, 2014) in September 2012 to describe fish habitat potentially affected by Alteration activities:

- Within the vicinity of the proposed open pits, with particular emphasis within and downstream of Fire Pond;
- Along the main access road, from the Sherridon road to the existing mill facility; and
- Along the on-site road leading from the existing underground mine portal to the mill facility.

At the time of the assessment, water levels were very low and as a result, potential fish habitats present during high water conditions could not be determined.

3.2.1 Fire Pond

The area around the Proposed Alteration is defined by small to large headwater lakes and numerous ponded areas. General observations of the site indicate that there are no waterbodies that could support fish habitat in the areas of the proposed open pits or stockpiles, with the exception of Fire Pond, which was studied in detail.

Fire Pond is characterised as a depression because there is no clearly defined inflow or outflow and the contributing area and receptors are intermittent flow from wetlands surrounding part or all of this ponded area. Fire Pond is relatively shallow, with a mean depth of 1.6 m and a maximum depth of 2.2 m (AECOM, 2014). The total surface area of Fire Pond was 19,126 m^2 and the total calculated volume was 30,764 m^3. The average grade is typical of headwater lakes, with little topographical relief within the pond and no evidence of a creek or potential for fish or fish habitat downstream of Fire Pond.

The invertebrate communities (i.e., phytoplankton, zooplankton, and benthic invertebrates) in Fire Pond are generally comparable to the communities identified by AECOM as ubiquitous in the area.

The only fish species captured in Fire Pond was Brook Stickleback (*Culaea inconstans*). This species is typical of small, headwater lakes and is widespread throughout the province. The aquatic habitat value of Fire Pond is categorized as Marginal as it provides habitat only for small-bodied fish (*i.e.,* Brook Stickleback) and there is no connectivity to other waterbodies. These characteristics prevent Fire Pond from forming part of or supporting commercial, recreational, or Aboriginal fisheries.

3.2.2 Access Roads

No unique or critical fish habitat was observed during the aquatic habitat assessments. Fish habitat at watercourse crossings along the main access road provided, at most, Marginal aquatic habitat value (**Table 5.3**). Marginal habitats have low productive capacity and contribute marginally to fish production (Fisheries and Oceans Canada 1998). Several ponded areas and culverts were observed along the main access road. The ponded areas are generally low-lying areas in which water accumulates between bedrock outcrops and culverts at these locations permit drainage across the roadway. These ponded areas do not support fish and provide no fish habitat. Significant Beaver (*Castor canadensis*) activity in the area creates impediments to fish passage. No fish were captured.

Table 5.3: Summary of Aquatic Habitat Assessment Along the Main Access Road, September 2012

Crossing ID	Photograph #	KM from Sherridon Road	Fish Use				Connectivity	Aquatic Habitat Sensitivity	Aquatic Habitat Value
			Spawning	Migration	Rearing	Over-Wintering			
PLM-01	14, 16	8.4	Poor	Poor	Poor	Poor	Poor	Low	None
PLM-02	15, 17	7.9	Poor	Poor	Poor	Poor	None	Low	None
PLM-03	18,19, 20	5.5	Good	Poor	Good	Poor	Good	Low	Marginal
PLM-04	21, 22	1.7	Good	Poor	Good	Poor	Poor	Low	Marginal

There were no potential fish bearing waterbodies or fish habitat identified along the on-site roads and only two small ponded areas were observed. Limited connectivity and shallow water that would freeze to the bottom in winter limits the habitat value of these ponded areas.

3.3 Groundwater

Shallow groundwater is water encountered below the ground surface within the overburden materials and is most likely to be influenced by mine surface activities. Deep groundwater is considered to be the water encountered below the ground surface within the bedrock. Both deep and shallow groundwater may be influenced by open pit mining.

The site is characterized by bedrock outcrops and several bogs. Due to the bedrock outcrop and peat bog nature of the region, shallow groundwater is typically at, or near, the ground surface. Local runoff from bedrock and upland areas collects in peat filled lows (bogs), which slowly release excess water to surrounding lakes and creeks as described in the EBA (AECOM, 2014). Groundwater tables are high in most bogs and in low areas bordering the bogs. Bogs are widespread in the area of the proposed open pits, indicating that shallow groundwater movement is likely somewhat limited.

4. Scope of the Assessment

This section outlines the scope of the assessment, including the temporal and spatial boundaries as well as environmental components that could potentially interact with the Proposed Alteration. The activities to be assessed (the Activities) are as described in **Section** 2.

4.1 Temporal Boundaries

Temporal boundaries of the assessment reflect the sequential mining of the proposed open pits over 3 years (2015-2018) with closure of each occurring as the next is mined, and some final closure activities occurring following the exhaustion of the final pit, for a total span of approximately three years.

4.2 Spatial Boundaries

For this assessment, the footprint of the Proposed Alteration is defined as the area that encompasses the five proposed open pits, portions of the main access road to the mine site that require upgrades, waste rock and overburden stockpiles and the internal haulage roads.

The footprint covers approximately 29 ha which, with the exception of the access road, lies behind the gates of the existing operations, as shown on **Figure 04**.

4.3 Environmental and Social Components

The Environmental and Social Components were selected for assessment in accordance with the *Environment Act Proposal Report Guidelines* (Manitoba Conservation 2011a). Environmental Components (ECs) include topography, soil, air, noise and vibration, climate, groundwater, surface water, aquatic resources, protected species, flora and fauna. Social Components (SCs) include resource use, heritage resources, and aesthetics.

Potential interactions between the Activities and ECs and SCs are summarized in **Table 4.1**. These potential interactions are based on judgement of the assessor in the expectation that standard environmentally responsible construction techniques and operating procedures will be applied in the course of mining and closure phases of the Alteration. The potential interactions are assessed and mitigation measures proposed with residual effects as described in **Section** 5**.**

Table 4.1: Identification of EC/SC Interactions with Alteration [1]

Alteration Components	Environmental Components										Social Components		
	Topography	Soil	Air	Noise & Vibration	Climate	Groundwater	Surface Water	Protected and Other Aquatic Resources	Protected and Other Fauna	Protected and Other Flora	Resource Use	Heritage Resources	Aesthetics
Mining of Open Pits													
Transporting, Storing, and Handling of Materials (including Waste Disposal)		X	X	X	X	X	X	X	X	X	X		
Construct New Haulage Roads	X	X	X	X	X		X	X	X	X	X	X	X
Upgrade Existing Roads	X	X	X	X	X		X	X	X	X	X	X	X
Maintenance and Inspections													
Phase I (Mining Pit 3)													
Clear Area of Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X	X	X
Haul and Stockpile Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X		X
Blasting and Excavation	X		X	X	X	X	X	X	X	X	X	X	X
Haul and Stockpile Waste Rock (PAG and NAG) and Ore	X	X	X	X	X	X	X	X	X	X	X		X
Dewater Pit 3		X	X	X	X	X	X	X	X	X	X	X	
Phase II (Mining Pit 2 + Rehabilitation of Pit 3)													
Clear Area of Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X	X	X
Haul and Stockpile Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X		X
Blasting and Excavation	X		X	X	X	X	X	X	X	X	X	X	X
Haul and Stockpile Waste Rock (NAG) and Ore	X	X	X	X	X	X	X	X	X	X	X		X
Dewater Pit 2		X	X	X	X	X	X	X	X	X	X	X	
Backfill Pit 3 with PAG Waste Rock	X		X	X	X	X			X	X	X		X
Berm Construction in Fire Pond	X	X	X	X	X		X	X	X	X	X	X	X
Phase III (Mining Pit 1 + Rehabilitation of Pit 2 & Pit 3)													
Clear Area of Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X	X	X
Haul and Stockpile Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X		X
Blasting and Excavation	X		X	X	X	X	X	X	X	X	X	X	X
Haul and Stockpile Waste Rock (NAG) and Ore	X	X	X	X	X	X	X	X	X	X	X		X
Dewater Pit 1		X	X	X	X	X	X	X	X	X	X	X	
Backfill Pit 2 with PAG Waste Rock	X		X	X	X	X			X	X	X		X
Backfill Pit 3 with NAG Waste Rock	X		X	X	X	X			X	X	X		X

[1] *Notes: X = Potential interaction between a Project Component and an Environment Component; a = Only indirect interactions with Social Components as a result of a direct potential Project/Environmental Component interaction were considered.*

Table 4.1: Identification of EC/SC Interactions with Alteration (continued) 2

Alteration Components	Environmental Components										Social Components		
	Topography	Soil	Air	Noise & Vibration	Climate	Groundwater	Surface Water	Protected and Other Aquatic Resources	Protected and Other Fauna	Protected and Other Flora	Resource Use	Heritage Resources	Aesthetics
Mining of Open Pits (continued)													
Phase IV (Mining Pit 4 + Rehabilitation of Pit 1, Pit 2 & Pit 3)													
Clear Area of Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X	X	X
Haul and Stockpile Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X		X
Blasting and Excavation	X		X	X	X	X	X	X	X	X	X	X	X
Haul and Stockpile Waste Rock (NAG) and Ore	X	X	X	X	X	X	X	X	X	X	X		X
Dewater Pit 4		X	X	X	X	X	X	X	X	X	X	X	
Dewater Fire Pond		X	X	X	X	X	X	X	X	X	X	X	
Backfill Pit 1 with PAG and NAG Waste Rock	X		X	X	X	X			X	X	X		X
Backfill Pit 1, Pit 2, & Pit 3 with Overburden, Contour and Re-Vegetate	X		X	X	X	X			X	X	X		X
Phase V (Mining Pit 5 + Rehabilitation of Pit 4 & Pit 5)													
Clear Area of Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X	X	X
Haul and Stockpile Vegetation and Overburden	X	X	X	X	X		X	X	X	X	X		X
Blasting and Excavation	X		X	X	X	X	X	X	X	X	X	X	X
Haul and Stockpile Ore	X	X	X	X	X	X	X	X	X	X	X		X
Dewater Pit 5		X	X	X	X	X	X	X	X	X	X	X	
Backfill Pit 4 with PAG and NAG Waste Rock and Overburden, Contour and Re-Vegetate	X		X	X	X	X			X	X	X		X
Backfill Pit 5 with Overburden, Contour and Re-Vegetate	X		X	X	X	X			X	X	X		X
Install Fencing and Signage at Pit 4 & Pit 5			X	X					X		X		
Closure Phase													
Flatten, Contour, Re-Vegetate Remaining Surface Stockpiles	X	X	X	X	X		X	X	X	X	X		X
Remove Culverts, Regrade and Re-Vegetate Roads	X	X	X	X	X		X	X	X	X	X		X
Dispose of Wastes, Remediate, Regrade and Re-Vegetate Laydown and Storage Areas	X	X	X	X	X	X	X	X	X	X	X		X

[2] *Notes: X = Potential interaction between a Project Component and an Environment Component; a = Only indirect interactions with Social Components as a result of a direct potential Project/Environmental Component interaction were considered.*

5. Effects Assessment and Mitigation Measures

5.1 Effects Assessment Methodology

Applying professional judgment and a thorough understanding of the components of the Proposed Alteration (described in **Section** 2), AECOM determined the potential for each component of the Proposed Alteration to interact with each Environmental Component (EC) and Social Component (SC). **Table 3.1** (in **Section** 0 of this report) displays these potential interactions, which are the subject of the analyses set out in the sections below. Mitigation measures that have been incorporated into the proponent's proposed plan are taken into account. Where required, recommendations for additional mitigation measures have been provided in addition to those proposed by the proponent.

The following sections assess the potential interactions between ECs and the activities for the proposed development, considering mitigation measures and identifying residual adverse effects. The analysis also includes any effects on SCs that may result from residual adverse effects on relevant ECs (*e.g.,* fauna or flora). Environmental effects that may be caused by malfunctions or accidents are discussed separately in **Section 5.13**. Definitions of the terms used to guide the effects assessment are provided in **Table 5.1**.

Table 5.1: Explanation of Terms Used in Effects Assessment

Alteration Phase:	**Refers to the phase of the Alteration as mining of the open pits or closure. See Section 3 for a list of Proposed Alteration activities in each phase.**
Potential Effect:	Classification of the type of effects possible during a specific Alteration phase.
Magnitude of Effect:	Refers to the estimated percentage of population or resource that may be affected by activities associated with the mining and closure of the Proposed Alteration. Where possible and practical, the population or resource base has been defined in quantitative or ordinal terms (*e.g.*, hectares of soil types, units of habitat). Magnitude of effect has been classified as either immeasurable (negligible), less than (<) 1% (minor), 1% to 10% (moderate), or greater than (>) 10% (major) of the population or resource base. Where the magnitude of an effect has been defined as an immeasurable change from background in the population or resource, the effect is considered negligible. An exception to this is in terms of potential human health effects where, for example health issues due to water-borne diseases amounting to 1% of the population being affected would still be considered major.
Direction of Effect:	Refers to whether an effect on a population or a resource is considered to have a positive, adverse, or neutral effect.
Duration of Effect:	Refers to the time it takes a population or resource to recover from the effect. If quantitative information was lacking, duration was identified as short-term (<1 year), moderate term (1 to 10 years) and long term (>10 years).
Frequency of Effect:	Refers to the number of times an activity occurs over the Alteration phase, and is identified as once, rare, intermittent, or continuous.
Scope of Effect:	Refers to the geographical area potentially affected by the effect. Where possible, quantitative estimates of the resource affected by the effect were provided.
Degree of Reversibility:	Refers to the extent an adverse effect is reversible or irreversible over a 10-year period.
Residual Effect:	A qualitative assessment of the residual effect remaining after employing mitigation measures in reducing the magnitude and/or the duration of the identified effect on the environment.

A summary table of the potential effects, mitigation measures and residual effects is included in **Appendix C, Table 10**.

5.2 Topography

5.2.1 Rock and Soil Movement

During mining of the open pits, topography of the footprint will be altered due to clearing, blasting, excavating, infilling, and stockpiling of rock and overburden. Clearing, excavation, and infilling may be required for the upgrades to existing roads or construction of new haulage roads. The exact location of the new internal haulage roads will be determined once the plan is in implementation, but the extent of clearing, infilling, and excavation required for their development will be kept to a minimum to the extent practical. It is not anticipated that blasting will be required for road development.

The five proposed open pits, with depths ranging from 30 m to 75 m and a total area of approximately 11 ha, will be blasted and materials removed will either be milled, placed as backfill in exhausted open pits or in stockpiles. In total, there will be nine waste rock and overburden stockpiles covering an area of approximately 15 ha. The stockpiled material will be used as backfill for progressive pit rehabilitation, to reduce the amount of stockpiles remaining at surface. During mining, the progressive rehabilitation of the pits will occur and will include the complete backfill of three of five open pits (Pit 1, Pit 2 and Pit 3) and partial backfill of the two remaining open pits (Pit 4 and Pit 5). Pit 1, Pit 2 and Pit 3 will be backfilled with an additional 10% of waste rock prior to covering and contouring in order to create a mounded surface that will prevent water ponding. Overburden or NAG waste rock will be used to flatten the pit slopes before allowing the remainder of Pit 4 and Pit 5 to flood naturally.

The closure phase will include restoration of the topography of the site to match the surrounding area to the extent that is practical. As part of closure, the stockpiles that remain at surface will be contoured as much as possible to match surrounding topography. The size of the stockpiles remaining at surface will depend on the amount of material used for road construction and site levelling. Further, it is possible that some of this material may eventually be used as backfill for the underground mine and will reduce the residual effect on topography.

The total area of disturbance is anticipated to be approximately 20.6 ha following closure of the five open pits and remaining four stockpiles (Stockpiles 2, 6, 8, and 9) which represents 11% of the footprint of the area occupied by the existing Puffy Lake Mine (192 ha). The partially backfilled pits, Pit 4 and Pit 5 (area of 4.9 ha), represent the most substantial long-term alteration to topography as it is today, but their final configuration will represent only a minor change in topography in context with the area of the mine and the region in which it is found, which is variable in nature and which includes the presence of numerous shallow lakes and water bodies.

Overall, given the mitigation measures in place, the natural terrain of the area and region and the residual areal extent of disturbance, the residual effect on topography following closure is considered minor in the area and region.

5.3 Soil

5.3.1 Acid Rock Drainage and Metal Leaching

PAG waste rock and ore (and their dust) have the potential, when exposed to air and water, to create acid rock drainage (ARD). ARD can adversely affect soil quality (pH change) as well as local vegetation, groundwater and surface water. ARD also has the effect of liberating metals from the ore, waste rock or dust which can increase soil, groundwater and surface water metal concentrations (*i.e.,* metal leaching (ML)).

Soil quality effects can result from deposition of PAG waste rock and ore dust resulting from wind erosion or blasting and surface runoff from stockpiles containing PAG waste rock or ore. Another source of ARD/ML is through pit dewatering where the water removed from the pit may have contacted sulphide containing rock walls resulting in

ARD/ML and may affect soil, surface water, or groundwater quality in the environment where the pit water is discharged. ARD/ML can be a concern following closure if PAG waste rock or ore is present at surface and is exposed to weathering.

Acid based accounting (ABA) tests conducted by Auriga on rock samples representative of the open pit waste rock show that the majority of samples are unlikely to generate ARD. Approximately 25% of waste rock samples are classified as PAG rock, with NP/AP ratios less than two (NP/AP ratios greater than two indicate NAG rock). Auriga determined, based on the results of the humidity cell tests, that arsenic was the most mobile contaminant of concern for waste rock leachate, with a peak concentration of 0.28 mg/L in one sample following seven weeks of exposure. The arsenic concentration in this sample, after 33 weeks of humidity cell testing was stable around 0.1 mg/L. At all times, however, the arsenic concentrations were below the maximum monthly mean concentration in the Federal *Metal Mining Effluent Regulation* (*MMER*) of 0.5 mg/L (Government of Canada 2002).

Based on this information, Auriga concluded that:

- Most of the waste rocks sampled to date are unlikely to produce ARD/ML, although some samples with low sulphide levels also have low neutralization potential and may in time develop ARD/ML.
- Sulphide-containing rock walls left exposed after extraction of the ore are likely to generate ARD/ML after exposure to the air and water where any ore remains in the rock walls.
- Stockpiles of ore containing sulphide are likely to generate ARD/ML prior to milling.

The following mitigation measures are proposed to mitigate ARD/ML generation during open pit mining:

- The temporary surface storage of PAG waste rock (Stockpile 3) will be located within the catchment of the existing TIA.
- PAG waste rock will be used as backfill for pit rehabilitation as soon as practical to minimize the amount of time this material is at surface.
- If required, soil surrounding the location of Stockpile 3 will be remediated following PAG waste rock removal.
- Other than in Stockpile 3, there will be no need for surface storage of PAG waste rock because progressive rehabilitation of the pits will include using PAG waste rock generated in the current pit being mined to backfill the pit being rehabilitated.
- A temporary drainage and water diversion measure (*e.g.,* ditch or berm) may be constructed to minimize the amount of water passing through Stockpile 3.
- PAG waste rock and ore will be stockpiled in a manner that minimizes the potential for wind and water erosion.
- The ore stockpile will be located adjacent to the existing mill at the same location used by underground operations.
- Pit discharge water will be diverted to the existing TIA by overland flow.
- The short time the pits are open (maximum of 18 months for Pit 1) is anticipated to minimize the potential generation of ARD/ML, as limited weathering will occur.
- Discharge from the existing TIA will continue to be monitored under the *MMER* and *Environment Act* Licence No.1207E.
- Best management practices for blasting and other dust suppression activities (including load covers for haul trucks) will be employed to minimize the potential for ARD/ML dust generation during the mining of the open pits. (Additional mitigation measures to limit dust generation are listed in **Section 5.4.1** and will be applied, where required).
- As part of pit rehabilitation, PAG waste rock used as backfill will be covered with NAG and/or overburden for the pits being completely filled.

- The walls of the partially filled pits (including any sulphide-containing wall rocks) will be covered with NAG and/or overburden. Partially filled pits will be allowed to flood to further minimize sulphide containing wall rock weathering.

Following pit rehabilitation and closure activities, no PAG waste rock will remain at surface. Further, no sulphide-containing rock walls will be left exposed in the partially filled pits. Post-closure environmental monitoring will occur to confirm recovery of affected areas. Given these mitigation measures, the nature of the waste rock and the short length of time the waste rock and pit walls will be exposed to weathering, it is anticipated that residual effects to soil quality as a result of ARD/ML will be negligible during both the mining and closure phases of the Proposed Alteration.

5.3.2 Soil Disturbance

Soil Erosion

Wind and precipitation can cause erosion of soil which, in turn, has the potential to cause subsequent effects on air (through dust generation), flora (decreased soil availability and dust deposition) and surface water (turbidity).

Mining of the proposed open pits will involve clearing, excavating, and stockpiling of vegetation and overburden. To mitigate the potential effects on soil due to erosion from clearing, excavating and stockpiling, the following mitigation measures will be implemented:

- Areas will be cleared of vegetation only when absolutely necessary.
- A buffer of undisturbed forest will be maintained around the development to mitigate soil erosion due to wind.
- Erosion control devices, including the use of silt fences, silt curtains, riprap, etc. will be used as appropriate.
- NAG waste rock will be placed on new roads as soon as possible to minimize extent and duration of soil exposure.

A berm will be constructed in Fire Pond to isolate it from Pit 4, using primarily overburden from the open pits. Materials used for berm construction or for temporary measures to drain or divert water around the berm will be appropriately compacted when necessary to minimize effects of wind and water erosion. During berm construction, erosion and sediment control measures, such as a turbidity curtain, will be installed to avoid sediment deposition within Fire Pond. If necessary, riprap or a suitable equivalent will be placed on the berm surfaces to reduce water and wind erosion once the berm is in place. The berm will remain in Fire Pond after closure.

Pit dewatering discharge rates, if sufficiently high, have the potential to result in soil erosion. The maximum pit inflow rate was estimated to be 12.7 L/s (202 USgpm) (**Section 2.4**). To mitigate the potential effects on soil due to erosion from pit dewatering during pit mining, the following mitigation measures will be implemented:

- To minimize the potential erosion of soils, discharge from pit dewatering will be to a splash pad consisting of NAG waste rock.
- To minimize the amount of pit water discharged and the potential for erosion along the drainage path, dewatering will be limited to areas in which active construction activities cannot be completed appropriately if underwater (such as blasting).

With these mitigation measures in place, soil and sediment disturbance during the mining phase will likely result in minor to negligible residual effects on soil.

In addition, closure activities will include contouring, applying overburden and topsoil, and re-vegetating the developed areas. The following mitigation measures will be implemented as part of closure to minimize the potential for soil erosion:

- Disturbed areas will be contoured and re-vegetated as soon as possible.
- The success of re-vegetation efforts will be monitored until vegetation has re-established, with additional re-vegetation activities to occur on an as needed basis.

With the implementation of the above mitigation measures, the residual effect on soil following closure due to erosion following closure activities is anticipated to be negligible.

Soil Compaction

Vehicle traffic, heavy equipment operation, and stockpiling have the potential to cause soil compaction. Heavily compacted soils have reduced void space and have a reduced rate of water infiltration. Compacted soils are not able to absorb rainfall and, thus, increase surface run-off. In addition, the reduced pore size can also affect the diffusion of gases and nutrients and root penetration (flora effects). Burrowing animals may also be affected by reduced availability of suitable soil conditions (fauna effects). Soils that undergo deep freeze-thaw cycles have an intrinsic resistance to soil compaction, but the effects of compaction may not be completely reversed through this natural process (Raper & MacKirby 2006).

The mitigation measures that will be implemented during open pit mining to reduce the effects of soil compaction include:

- Existing roads and laydown areas will be used to the greatest extent possible to minimize the area of disturbance.
- Areas will be cleared of vegetation only when absolutely necessary.

The stockpile and new road areas will be cleared of scrub, brush, and trees, with overburden placed to act as a base for these developments. The majority of potential effects of soil compaction will be limited to vehicle traffic, heavy equipment operation, and stockpiling outside of these areas. Although traffic, equipment use, and stockpiling during the operational phase of pit development will likely result in soil compaction, the mitigation measures to be implemented will reduce the impact of compaction to a minor residual effect within the footprint of the Proposed Alteration, which is considered to be of negligible impact in the context of the area surrounding the footprint.

Closure activities will include contouring and re-vegetation of disturbed areas as well as road scarification and decommissioning. To mitigate potential soil compaction effects during closure, in addition to those measures implemented during the mining phase (where appropriate), the following mitigation measures will be undertaken:

- Roads will be stripped of materials and scarified as soon as possible.
- Disturbed areas will be contoured and re-vegetated as soon as possible to encourage natural tillage through root development.

The residual effects of compaction on soils are anticipated to be negligible following closure, given the mitigation measures in place.

Horizon Mixing

Mining activities such as excavating and backfilling have the potential to mix soil horizons, leading to a potential decline in the quality of soil within the footprint of the Proposed Alteration. Disruption of the soil horizons can affect flora growth by affecting the habitat quality and nutrient distribution as well as groundwater (by reducing groundwater infiltration rates). Soils within the footprint and more generally in the area of the Puffy Lake Mine are generally of poor structure and horizon development is not anticipated (Smith *et al.,* 1989).

Where practical during mining, care will be taken to keep the topsoil and subsoil layers separate during stockpiling and placement. In addition, the area of disturbance will be minimized to limit the potential for soil horizon mixing. As soils in the ecoregion do not develop well defined horizons (Smith *et al.,* 1989) and in light of the adequacy of the proposed mitigation measures, the residual effect of soil horizon mixing on soil quality during mining is considered to be negligible.

Closure activities, including backfilling, contouring, and re-vegetation will be conducted to ensure that soil horizons resemble natural conditions, to the maximum extent possible. Topsoil will be placed on top of subsoil and waste rock before re-vegetation activities occur. Topsoil will preferably originate from the site, separated from subsoil during overburden removal, or will be provided by a supplier. Re-vegetation will occur as soon as practical to encourage re-establishment of organic topsoil layer. The success of re-vegetation efforts will be monitored until vegetation has re-established, with additional re-vegetation activities to occur on an as-needed basis pursuant to the conditions detailed in the amended Puffy Lake Mine Closure Plan. With implementation of the proposed mitigation measures, the residual effect on soils due to horizon mixing would be negligible after completion of the proposed closure activities.

5.3.3 Waste Management

Solid wastes such as used oils, rags, drums, and miscellaneous garbage have the potential to cause adverse effects on soil and surface water quality, with potential consequent exposure to flora, fauna, aquatic resources, and groundwater. Solid wastes will be present during the three years in which the Alteration is carried out. To prevent any potential adverse effects on soil quality that could be caused by wastes, the following waste management practices will be undertaken:

- The majority of trees are of small diameter or are deadfall, and as a result, will not be able to be salvaged for sale or use. Trees and brush cleared from areas of development will be placed in piles adjacent to the area cleared.
- Wastes generated on-site will be disposed of in garbage collection bins maintained at specific locations throughout the Puffy Lake Mine site. These bins will be emptied on a regular basis for disposal at a licensed waste disposal facility in Flin Flon, Manitoba or other permitted disposal site.
- Waste oils, fuels, and hazardous wastes (if any) will be handled in a manner that prevents potential spills. Staff will be required to transport, store, handle, and dispose of all such substances as recommended by the suppliers and/or manufacturers and in compliance with all applicable Federal, Provincial and Municipal regulations. Manitoba Conservation and Water Stewardship shall be notified immediately if a reportable spill occurs. Spills will be mitigated as described in **Section 5.13.3**.

The magnitude of the potential effects on soil quality due to waste management can range from negligible to moderate without mitigation measures and would depend on the volume and characteristics of the waste materials. With the implementation of the proposed mitigation measures, it is anticipated that the residual effect of waste management on soil quality will be negligible.

5.3.4 Remediation

The Proposed Alteration, like any operation that uses fuel or other potential contaminants, has the potential to deposit contaminants in soil, which may be transported into groundwater, surface water, or air (dust) with subsequent effects on fauna, flora, and human health. It is anticipated that all fuelling activities will occur within designated areas with the proper mitigation measures, (spill containment, etc.) in place. Closure activities will include assessment of any potential contamination caused by the development, followed by any remediation that may be required to eliminate risk to human health, safety or the environment. It is anticipated that remediation activities will result in a neutral effect on soil quality, with a negligible residual effect.

5.4 Air

5.4.1 Dust Generation

Dust and particulate matter have the potential to adversely affect air quality with consequent effects on human health (respiratory concerns and potential transportation safety concerns due to impaired visibility on roads), vegetation (decreased growth due to dust deposition), and surface water and soil quality (deposition of contaminants). Release and deposition of contaminated windblown dust can lead to soil contamination, and associated human, animal and plant health issues. It is expected that dust generation will primarily occur during the summer and fall, due to higher winds and warmer temperatures.

Vehicle and Equipment Operation

During the mining and closure phases of the Alteration, dust will be generated by vegetation clearing, excavation, rock and soil movement and placement into stockpiles, and vehicle traffic on unpaved roads. Employee vehicles, ore trucks, waste rock trucks, material delivery trucks/vehicles, and other equipment vehicles will travel to and from the site on a regular basis. As indicated in **Section 2.6.5**, a daily maximum of 40 trucks and vehicles may access the site via the Sherridon Road, main access road, and haulage roads. Dust generation is anticipated on these roads, as they are unpaved. However, the forests and topography surrounding the mine site are expected to limit wind effects and overall potential dust migration is anticipated to be limited to the site of the Puffy Lake Mine within which the Proposed Alteration is contained.

The mitigation measures that will be implemented to reduce the potential for air quality effects due to dust generation from vehicle and equipment operation include:

- Disturbed/exposed areas will be kept to a minimum. Existing roads and laydown areas will be utilized to the greatest extent possible.
- A buffer of undisturbed forest will be maintained around the Proposed Alteration to mitigate wind erosion.
- New haulage roads will be cleared and developed only when necessary.
- Haulage roads will be rehabilitated as soon as possible following pit closure and travel will be limited to designated areas.
- The number of trips required for ore or waste rock movement from the proposed open pits to the stockpiles will be minimized to the maximum extent possible.
- Speed limits will be implemented as appropriate to minimize potential for dust generation caused by traffic.
- If required, dust suppression activities, such as the use of an approved dust control agent, will be undertaken for the main access road, on-site roads, and haulage roads.
- Pit dewatering discharge may be used to wet the waste rock within the pit to reduce the potential for dust generation during excavation, hauling and stockpiling.

- Waste rock and ore truck loads will be covered to minimize dust coming off loads.

During normal weather conditions, with implementation of the abovementioned mitigation measures, the residual effect of dust on air quality is anticipated to be minor to negligible and limited to the footprint of the particular Alteration activity and its immediate surroundings. During extreme dry, high wind conditions, the residual effect of dust on air quality is anticipated to be minor on the site of the Proposed Alteration during mining activities.

During closure and rehabilitation activities, waste rock placement within the exhausted open pits, contouring the site and soil placement for re-vegetation will contribute to the potential generation of dust. As there will be less rock and soil movement during the closure phase and fewer available roads on which to travel, the potential for dust generation will be less than during the mining phase. Disturbed areas will be re-vegetated as soon as practical and throughout the progressive pit rehabilitation. As in the mining phase, the implementation of mitigation measures during closure activities is expected to be successful in reducing the residual effects of dust on air quality to a negligible to minor level.

Following closure, it is anticipated that air quality will return to pre-development levels and the residual effect is anticipated to be negligible.

Use of Explosives

Dust generation from blasting can be a source of fugitive dust in surface mining (PEDCo-Environmental Specialists, Inc. 1976). Blasting in the open pits will occur throughout the active mining phase of the Proposed Alteration (*i.e.,* 2.5 years). However, blasting in the open pits may not occur as frequently as other potentially dust generating activities, such as hauling or stockpiling. As such, its time-average contribution to overall dust emissions is likely to be minor. Although the frequency of blasting in the open pits will vary depending upon the type of rock to be removed (waste versus ore)and the size and elevation of the open pit itself, as an average, Auriga anticipates blasting to occur on a weekly basis.

In order to minimize the amount of dust generated during blasting, blasting will not occur during high winds. The pit contractor will design, use, and continually improve site-specific blasting plans. Good blasting practices will keep airborne particles to a minimum by optimizing the detonation. Blasting mats will also be used to minimize the potential for fly rock and coarse particulate matter from becoming airborne. Dust generation during the mining of the open pits will be highest during the initial surface blasting and will reduce with increasing pit depth. As the depth of the pit increases, the generation of dust will be below grade and will mitigate particulate emissions and transport. Dust emission from within the pit will have a lesser impact on ambient dust concentration than the same activity at ground surface (PEDCo-Environmental Specialists, Inc. 1976). Under normal wind conditions, a few meters of pit depth will provide protection from wind effects. Vegetated buffers around the open pits will also help minimize the propagation and transport of dust. In addition, because of the sequencing of pit development, surface blasting will occur in only one pit at a time.

With the mitigation measures implemented and the intermittent frequency of blasting, the residual effect on air quality as a result of the use of explosives is anticipated to be minor to negligible.

Acid Rock Drainage

In addition to the potential adverse effects of exposure to particulate matter, contaminants can also have an effect when mobilized as part of fugitive dust. ARD/ML dust can have effects on soil and surface water quality, human health, aesthetics, flora and fauna. ARD/ML dust can originate during blasting within the pits, excavation and hauling to stockpiles as well as from the stockpiles themselves.

Dust generated by blasting in the open pits may contain materials capable of generating ARD/ML but only a portion of the dust generated during blasting will contain materials capable of generating ARD/ML. The percentage of PAG and ore anticipated to be extracted from the open pits range from approximately 34% (Pit 4) to 62% (Pit 5). As a result, the residual effect of ARD/ML dust on air quality caused by blasting during the mining phase is anticipated to be negligible in and near the footprint of the Proposed Alteration. There will be no blasting during the closure phase.

The greatest potential for the generation of ARD/ML dust will occur during the handling, transport and stockpiling of PAG waste rock and ore during the mining and closure phases of the Proposed Alteration. Pit dewatering discharge may be used to wet the waste rock within the pit to reduce the potential for dust generation prior to excavation. This will reduce the potential dust generation during the hauling and stockpiling of ARD/ML materials. The overall risk of ARD/ML dust generation will be minimized by reducing the length of time PAG material is stockpiled on the surface, minimizing the height of the PAG stockpile to reduce wind erodibility, and placing PAG waste rock in exhausted open pits. With respect to potential dust generation from PAG waste rock and ore, the mitigation measures described in **Section 5.4.1** will limit the amount of PAG and ore present at surface and exposed to weathering.

With the implementation of mitigation measures to limit dust generation during vehicle and equipment operation, such as load covers on haul trucks and use of dust suppression agents, as well as management of potential ARD/ML generation, the residual effect of ARD/ML dust on air quality caused by material handling, transport and stockpiling is anticipated to be minor to negligible..

5.4.2 Emissions

Exhaust emissions from vehicles and equipment have the potential to adversely affect air quality. Emissions will be generated during the delivery of materials to the site, employee traffic, heavy equipment, and generator use required during the mining and closure phases.

As indicated in **Section 2.6.5**, up to 40 vehicles may access the site on a daily basis, including waste rock and ore trucks, material deliveries, and employee shuttle bus service to support the development of the open pits. It is anticipated that the majority of traffic would originate in or travel to Sherridon or Flin Flon.

Ore and waste rock haul trucks will remain on site and travel to Sherridon or Flin Flon would be infrequent.

According to Manitoba Infrastructure and Transportation, the 1995 AADT flow for the Sherridon Road was 160 vehicles per day. The additional traffic from the Alteration, compared to 1995 AADT levels, is therefore considered to be a major increase in traffic on the Sherridon Road (25% increase). The AADT level in 2011 on PTH#10 at Baker's Narrows was 840 vehicles per day. The additional traffic on PTH#10 as a result of the Proposed Alteration is expected to present a moderate increase in the traffic on PTH#10 (5% increase).

Vehicles and equipment will generate emissions through combustion of diesel or gasoline. The number of vehicles (40) and pieces of equipment (18) used will remain fairly constant throughout the brief 3-year operational life of the Proposed Alteration, as open pit mining and closure activities will occur concurrently. As for the licensed underground operations, trucks and vehicles used for the Proposed Alteration will comply with the Federal *On-Road Vehicle and Engine Emission Regulations (SOR/2003-2)*, as required.

The combustion of propane in the construction trailer heater will generate pollutants including nitrogen oxides (NO_x), carbon monoxide, sulphur dioxide, and particulate matter. Diesel-fueled generators, either used as power source for tools and site lighting or for pit dewatering management, will also generate emissions 24 hours per day, 7 days per week, for 360 days per year.

Greenhouse gas emissions will also be generated by the combustion of propane, diesel, and gasoline and are discussed below in **Section 5.6.1**

To mitigate potential air quality effects due to emissions, the following mitigation measures are proposed:

- Vehicles and equipment will be well maintained and regularly inspected.
- Vehicle idling will be kept to a minimum.
- Vehicular travel will be limited to/from/around the site to designated areas.
- Propane heaters will be equipped with low NOx burners, if possible.

Due to the nature of the surrounding vegetation and topography (**Section 3.1.1**), emissions will be constricted to the footprint of the Proposed Alteration and its immediate surroundings. Remediation activities at the former Sherritt-Gordon tailings area in Sherridon, and traffic within Sherridon and along the Sherridon Road are currently the primary sources of emissions in the region surrounding the Puffy Lake Mine.

Based on implementation of the above-noted mitigation measures during the mining and closure activities, the potential effect on air quality is anticipated to be minor to negligible. As the air quality is expected to return to pre-existing conditions following the closure, potential residual effects are considered reversible.

5.4.3 Waste Management

Implementation of the mitigation measures outlined in **Section 5.3.3** will prevent odour emissions that may be caused by inappropriate solid waste management.

The sewage holding tanks used to contain liquid wastes from the onsite bathrooms have the potential to generate limited and local odour emissions during pump-out. To minimize potential odour generation during the pumping out of the sewage holding tanks, the tanks will be properly sized and will be emptied and serviced on a regular basis by trained personnel with sewage disposed of at an off-site licensed facility.

The nearest human receptors to the Puffy Lake Mine site are the residents of the Sherridon, located 12 km northwest of the Puffy Lake Mine. Based on the distance between the Puffy Lake Mine site and Sherridon and the mitigation measures provided, it is anticipated that potential off-site air quality effects as a result of odours will be negligible.

5.5 Noise and Vibration

All activities will be carried out in accordance with the Provincial *Workplace Safety and Health Act* and pit contractor's health and safety plans, which will minimize potential effects on humans due to noise. The pit contractor will provide hearing protection as required to ensure site workers are protected from noise during mining and closure activities.

The Puffy Lake Mine is located approximately 12 km southeast of Sherridon, the closest community. Noise generated at the Puffy Lake Mine will be buffered by the surrounding terrain and forest cover. There is currently limited activity on-site related to the care and maintenance of the former Puffy Lake Mine, and therefore little noise is currently generated at the Puffy Lake Mine, though as noted above, underground mining and mill activity is also scheduled to resume. Remediation activities at the former Sherritt-Gordon tailings area in Sherridon, and traffic within Sherridon and along the Sherridon Road are currently the primary sources of noise near the region. Shortly after mining of the open pits begins, refurbishment of the mill and underground mine will commence and generate

noise. Traffic noise from the Sherridon Road was not heard at the Puffy Lake Mine site during the AECOM field visit. The majority of the region currently has noise levels typical of undeveloped forest.

Use of Explosives

The most prominent source of noise and vibration associated with the Proposed Alteration will be blasting in the open pits. An increase in noise has the potential to influence people and wildlife in the surrounding area. Potential effects on fauna as a result of noise are discussed in **Section 5.11**. Vibrations are associated with many types of equipment used in mining operations but blasting is considered the major source of vibration. Vibration can affect the stability of infrastructure and buildings near open-pit mining operations.

Blasting in the open pits will occur throughout the active mining phase of the Proposed Alteration (*i.e.,* approximately 3 years). However, blasting in the open pits will not occur as frequently as other potential noise generation activities, such as equipment use and material handling and stockpiling. No blasting will occur during the closure phase of the Proposed Alteration. The pit contractor will use several best management practices for blasting, including, but not limited to, design and use of (and continuous improvement to) specific blasting plans, blasting mats, correct charging procedures and blasting ratios, and micro-delayed detonations. These methods are designed to maximize rock breakage without compromising worker safety, while minimizing the generation of dust, fly rock, and vibration. Multiple small blasts, delayed properly, result in less vibration and noise than the same amount of explosives detonated individually. To minimize the exposure to noise, blasting will be performed when the fewest receptors (*i.e.,* site workers) are on-site. Prior to blasting, a siren will sound to signal evacuation of the site and to deter wildlife from the area of active blasting. The nearest human receptors (outside of site workers) to the Puffy Lake Mine are the residents of the Sherridon, located 12 km northwest. Based on the implementation of the proposed mitigation measures, and the distance to human receptors, it is anticipated that off-site noise and vibration effects on humans will be minor in the area during the mining phase of the Proposed Alteration.

The mill and underground mine will also begin production and will contribute to ambient noise and vibration levels during the mining and closure phases of the Proposed Alteration. The noise and vibration levels at the site will be reduced as a result of cessation of open pit mining and the residual effect of blasting on noise and vibration is anticipated to be negligible in the area following closure.

Vehicle and Equipment Operation

In addition to blasting, activities associated with mining that generate noise include vehicle and equipment operation, excavating, loading, and unloading of rock into haul trucks and stockpiles. An increase in noise in the area during mining and closure activities has the potential to influence people and wildlife in the surrounding area. Potential effects on fauna are discussed in **Section 5.11**.

Throughout the mining and closure phases, vehicle and equipment use (including generators) will occur on a regular basis and as such, noise from their use is anticipated to be relatively continuous. The number of vehicles (40) and pieces of equipment (18) used will remain fairly constant throughout the operational life of the Alteration, as mining and closure activities will occur concurrently.

A buffer of undisturbed forest will be maintained around the development to temper the noise generated during mining and closure activities. Vehicle and equipment use will be limited to the maximum extent possible. Vehicle idling will be kept to a minimum and all vehicles and equipment will be well maintained and regularly inspected. The operation of various auditory safety signals, alarms, or sirens (*e.g.,* vehicle or equipment back-up alarms and blast sirens) will also generate noise on a regular basis. These safety signals are required to maintain worker safety therefore mitigation is not appropriate. Noise generated by waste rock and ore excavation and stockpiling will occur

during the mining and closure phases of the Proposed Alteration and will be minimized to the extent practical by minimizing the ore/waste rock drop height.

As noted above, the nearest human receptors (outside of site workers) to the Puffy Lake Mine site are the residents of Sherridon, located 12 km northwest of the Puffy Lake Mine site. Given the mitigation measures in place and the distance to the nearest human receptors (outside of site workers), it is anticipated that the residual effect of noise on humans as a result of equipment and vehicle operation during mining and closure will be negligible in the area. Following closure, noise levels will be reduced as a result of cessation of open pit mining and the off-site residual effect of noise generation by equipment and vehicle operation humans is anticipated to be negligible.

5.6 Climate

5.6.1 Greenhouse Gas Emissions

During mining and closure of the proposed open pits, combustion of propane (in construction trailer heater), diesel (in heavy-duty vehicles and equipment, including generators) and gasoline (in vehicles), greenhouse gas (GHG) emissions will be generated, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) which can contribute to climate change effects. Detonation of the bulk emulsion explosives will release CO_2 as a result of the combustion of the fuel source (*e.g.,* diesel) used in the mixture. Auriga estimates that mining and closure of the open pits would require, on an annual basis, 360 m³ of propane, 360,000 L of diesel, 18,000 L of gasoline, and 1,360 tonnes of bulk emulsion explosives (**Table 5.2**). Although a portion of the 1,000 L (ACA Howe, 2012) of propane used per day may also be used to support the licensed underground mine, the total propane amount was included in this assessment as a conservative estimate of emissions generated by the Proposed Alteration.

Table 5.2: Annual Greenhouse Gas Emissions as a Result of the Proposed Alteration

Fuel Type	Quantity Combusted Per Year (unit)	Carbon Dioxide (CO_2)		Methane (CH_4)		Nitrous Oxide (N_2O)	
		EF (g/unit)	Emissions (g/yr)	EF (g/unit)	Emissions (g/yr)	EF (g/unit)	Emissions (g/yr)
Propane	360 (m³)	1500	540,000	0.024	9	0.108	39
Bulk emulsion explosives	1,360 (tonnes)	0.189	257	-	-	-	-
Diesel (mobile)	360,000 (L)	2730	982,800,000	0.14	50,400	1.1	396,000
Gasoline (mobile)	18,000 (L)	2360	42,480,000	2.7	48,600	0.05	900
Total (g/yr)		-	**1,025,820,257**	-	**99,009**	-	**396,939**
Total Annual Alteration Emissions (tonnes/yr)		-	**1,026**	-	**0.099**	-	**0.397**
100-year Global Warming Potential		-	**1**	-	**21**	-	**310**
Total CO_2e (tonnes/yr)		**1,151**					

Notes: EF = emission factor from Environment Canada 2004. The 100-year Global Warming Potential was multiplied by the total annual CH_4 and N_20 emissions to obtain a CO_2 equivalent (Environment Canada 2012b).

Manitoba Conservation's *Environment Act Proposal Report Guidelines* provide for climate change implications, including a greenhouse gas inventory, to be included in an assessment of the anticipated environmental effects of a development. The Guidelines indicate that the inventory should be calculated according to guidelines developed by Environment Canada and the United Nations Framework Convention on Climate Change. According to Environment Canada's technical guidance document, reported emissions are to include direct emissions associated with the operation of a contiguous facility (Environment Canada 2012b).

The approach for estimating GHG emissions used in this assessment followed the detailed fuels-based approach outlined in *A Guidance Manual for Estimating Greenhouse Gas Emissions from Fuel Combustion and Process-Related Sources for Metal Mining* (Environment Canada 2004). For the most part, information regarding the quantity of fuel combusted by each combustion source was not available. Where multiple combustion sources were likely to be used (*e.g.,* diesel fuel in stationary generators as well as heavy construction equipment), the most conservative emission factor (EF) was selected. In general, it was assumed that no emission control devices would be employed (with the exception of those required by legislation). Direct emissions were calculated for the Proposed Alteration and included the combustion of propane, diesel, gasoline, and bulk emulsion explosives (**Table 5.2**; Environment Canada 2004). Global Warming Potentials (GWP) was applied to emissions of CH_4 and N_2O to express these GHG emissions as CO_2 equivalent (CO_2e) following the *Technical Guidance on Reporting Greenhouse Gas Emissions* (Environment Canada 2012b). It is estimated that the Proposed Alteration will emit 1,151 tonnes of CO_2e on an annual basis (**Table 5.2**).

To determine the magnitude of this increase in GHG emissions at the Provincial level, the annual CO_2 emissions reported for the Province of Manitoba in 2009 in Canada's National Inventory Report 1990-2009 were compared to the annual CO_2e emissions predicted to result from the Proposed Alteration. According to the report, the Province of Manitoba emitted a total of 20,300,000 tonnes of CO_2e in 2009 (Environment Canada 2011). The increase of 1,151 tonnes annually of CO_2e emissions from the mining of the proposed open pits at the Puffy Lake Mine is considered to be a negligible increase (approximately 0.006%) in GHG emissions at the Provincial level.

Environment Canada's mandatory reporting threshold for GHG emissions is 50,000 tonnes of CO_2e on an annual basis. The mining of the proposed open pits is anticipated to generate 2% of the reporting threshold; therefore, it is not considered a major contributor of GHG emissions in the Province.

During mining phase, clearing and excavation of vegetation and overburden will occur. Removal of vegetation will result in a reduction of CO_2 uptake at the site. The total area of disturbance is approximately 29 ha for the five open pits and nine stockpiles (including a 5 m buffer around these components) which represents 15% of the Existing Development (192 ha). As the areas of development will be progressively rehabilitated and the area of active construction will be minimized at any given time during the life of the Alteration, it is anticipated that the reduction in CO_2 uptake by plants will be result in a minor residual effect during the mining of the open pits. Following closure, the site will be contoured with overburden, covered in topsoil and re-vegetated to restore the original rates of CO_2 uptake.

To mitigate potential climate effects due to GHG emissions, the following mitigation measures are proposed:

- The number of vehicles and equipment in operation at the site will be minimized to the maximum extent practical.
- Vehicles and equipment will be well maintained and inspected on a regular basis. Vehicle idling will be kept to a minimum.
- The use of best management practices for blasting will optimize the blasting operation to maximize the localized rock breakage using the minimum amount of explosives.
- The extent of clearing will be minimized as much as practical.
- Disturbed areas will be re-graded and re-vegetated as soon as practical to minimize the duration of un-vegetated soils.

Overall, with the implementation of the proposed mitigation measures, the residual effect of direct Alteration-related GHG emissions on climate change during mining, although irreversible, is considered to be negligible. Following the closure phase, re-vegetation and removal of combustion sources will result in a negligible residual effect on GHG emissions.

5.7 Groundwater

5.7.1 Acid Rock Drainage and Metal Leaching

As described in **Section 5.3.1**, ARD/ML can adversely affect groundwater quality. With the implementation of the mitigation measures described in **Section 5.3.1** to prevent the generation of ARD/ML at the site, effects on groundwater quality that could be caused by ARD/ML are anticipated to be negligible during the mining phase.

Upon closure, three of the five pits (Pit 1, Pit 2, and Pit 3) will be completely backfilled and re-vegetated. PAG waste rock used in the rehabilitation of the open pits will be placed at the bottom of the open pit, covered with NAG waste rock then overburden and topsoil. The remaining two of five pits (Pit 4 and Pit 5) will be partially backfilled, with pit slopes flattened (3:1 slope) to below the flooded pit level, fenced off and allowed to flood naturally. NAG and overburden will be used to cover the walls of the pit to ensure sulphide-containing materials on the wall rocks are not available for ARD/ML generation. Following closure, there will be no PAG material remaining at surface. The flooding of the partially backfilled pits will further prevent the potential generation of ARD/ML within the pit as oxygen will be limited and waste rock will be submerged.

With the implementation of these mitigation measures, the residual effect on groundwater quality is anticipated to be negligible following closure.

5.7.2 Soil Disturbance

As described in **Section 5.3.2**, soil disturbance has the potential to affect groundwater quantity through a reduction in infiltration rates. Vehicle traffic, heavy equipment operation, stockpiling, and excavation have the potential to adversely affect infiltration rates through soil disturbance. Following closure of the site, the residual effects on groundwater due to soil disturbance are anticipated to be negligible, given the mitigation measures listed in **Section 5.3.2**.

5.7.3 Use of Explosives

Explosives used during the mining of the pits have the potential to introduce contaminants that could result in adverse effects on groundwater and surface water quality. Ammonium nitrate/fuel oil (ANFO) will be used in blasting and will be transported to site when required and stored on surface in designated areas, if required. Ammonium nitrate is water-soluble and as such, blast residuals or spills and leaks from storage areas have the potential to affect groundwater and surface water quality. Spills and leaks are considered an accident or malfunction and are discussed in **Section 5.13.3**.

Open pit dewatering, required in order to mine within the open pits, will minimize the potential for blast residuals to come into contact with the deep groundwater surrounding the open pit. As the open pits will act as a groundwater sink during mining, there is limited potential for blast residues to infiltrate into the groundwater surrounding the pit. Groundwater seepage, surface runoff, and precipitation have the potential to come into contact with blast residues within the pits before being pumped to the surface for discharge towards the Ragged TIA. Infiltration into the shallow groundwater by this potentially contaminated water could result in minor degradation of groundwater quality.

The following mitigation measures will be applied to minimize the amount of blast residuals generated:

- The use of best management practices for blasting, including, but not limited to, design and use of (and continuous improvement to) specific blasting plans, blasting mats, correct charging procedures, blasting ratios, and micro-delayed detonations. Best management practices maximize the efficiency of the detonation with the minimum amount of explosives practical, thus reducing the potential for blast residuals to be generated by limiting the amount of blasting compounds.
- Emulsion type explosives will be used in wet areas to minimize the potential for ammonium nitrate to dissolve in pit water.

The implementation of the above measures will limit the potential for blast residuals in the pit discharge water and as a result, contamination of water discharged from the open pits is anticipated to be minor to negligible. Shallow groundwater is susceptible to contamination through infiltration of surface water into the overburden.

Open pit dewatering will be discharged as overland flow towards the Ragged TIA and will pass through some of the sphagnum bogs abundant in the area. The concentration of blast residuals in the pit discharge water is anticipated to be minimal. In addition, the natural processes within bogs (*e.g.,* uptake from plants, chemical reactions, and reduced flows) will remediate the water prior to infiltration into the shallow groundwater (Smith 1997; California State University Sacramento 2009). It is anticipated therefore that residual effects on shallow groundwater quality due to the use of explosives will be negligible during the mining phase.

If groundwater is exposed to blast residuals during the flooding of the partially or completely backfilled open pits in closure, the low hydraulic conductivity of the rock formation would restrict the migration of blast residuals in deep groundwater to the immediate area of development. In addition, there are no registered groundwater wells in use within at least 9.6 km (6 miles).

For these reasons, and considering the measures proposed to mitigate the generation of blast residuals in the first place, effects on groundwater quality following closure are anticipated to be negligible.

5.7.4 Pit Dewatering

Development of the open pits and subsequent dewatering may change the level and flow direction of the shallow groundwater table. These dewatering activities can artificially create drainage patterns for the groundwater and can affect shallow and deep groundwater movement within the area of the pits.

Shallow groundwater is water encountered below the ground surface within the overburden materials and is most likely to be influenced by mine surface activities. The open pit developments will be of relatively short duration, *i.e.,* maximum of twelve months for each of Pit 1, Pit 4, and Pit 5 with the remaining two pits open for a shorter period. The open pits will be mined sequentially so that, at most, two open pits may be in operation at one time. This represents the period for the greatest potential to affect shallow groundwater level and flow direction, based on areal extent of disturbance (4.9 ha), depth (75 m and 30 m for Pit 4 and Pit 5, respectively) and the proximity of these pits to open water (*i.e.,* Fire Pond). The majority of water entering the pits in the winter will originate as snowfall which can be removed mechanically (*i.e.,* during excavation) and as such, it is anticipated that pit dewatering will be reduced during winter months. The pit dewatering discharge rate will match the inflow rates to minimize the gradient as much as practical to limit the effect on shallow groundwater level and flow direction. A temporary drainage and water diversion measure (*e.g.,* ditch or berm) may be constructed around the open pit to discourage excessive volumes of shallow groundwater from entering the pit. No additional mitigation measures are proposed, as mine dewatering is required to safely operate the open pit. During mining of the open pits, the residual effect on shallow groundwater as a result of pit dewatering would be considered minor within the area, given the limited extent and duration.

Deep groundwater is considered to be the water encountered below the ground surface within the bedrock. Based on the hydraulic conductivity of the bedrock, the deep groundwater is not available for use as a water supply as the time of recharge precludes the continuous use of this water source. The open pit developments will be of relatively short duration (*i.e.,* maximum of twelve months for each Pit 1, Pit 4, and Pit 5) such that there will be limited change in the water table of the deep groundwater, given the low hydraulic conductivity of the bedrock. Dewatering is not anticipated to be substantial during winter months as water entering through the pit walls will freeze, blocking additional groundwater seepage. No additional mitigation measures are proposed, as there are no other groundwater users affected and mine dewatering is required to safely operate the mine. During mining of the open pits, the residual effect on deep groundwater quantity as a result of pit dewatering would be considered negligible, given the implementation of the mitigation measures.

During the progressive pit rehabilitation, the open pits will be backfilled with waste rock and will continue to act as a groundwater sink until reaching equilibrium. Backfilling decreases the amount of water required for recovery of the groundwater table by reducing the available space within the pit. The average inflow rate, including groundwater seepage, average annual precipitation, and surface runoff, ranges from 7.1 L/s in Pit 5 to 10.2 L/s in Pit 4 (AECOM, 2014). The maximum recharge time (*i.e.,* length of time required to fill the available space within the pit), estimated using average inflow rate and the volume of available space within each pit, ranges from two months (Pit 2) to 45 months (Pit 4). If equilibrium of the shallow groundwater table requires a length of time equal to the time of active mining, the duration of effect (active mining plus pit recharge time plus equilibrium time) ranges from one year (Pit 2) to nearly seven years (Pit 4). Therefore, recovery of the shallow groundwater table will occur over the moderate term and, as such, is considered a reversible effect. In order to minimize the length of time required for shallow groundwater table recovery, discharge from open pit dewatering could be directed into open pits undergoing rehabilitation if their proximity allows this to practically occur. Following closure, the residual effect on groundwater quantity and quality is anticipated to be negligible.

5.7.5 Waste Management

As described in **Section 5.3.3**, inappropriate waste disposal has the potential to affect groundwater quality. Following the waste management practices outlined in **Section 5.3.3**, the residual effect on groundwater quality is anticipated to be negligible during mining and closure.

5.7.6 Remediation

Closure activities may include the remediation of potentially contaminated soils as described in **Section 5.3**. The removal of contaminated soils will eliminate the potential exposure pathway for contaminants to affect groundwater, soil, air and surface water quality and potential indirect effects on flora, fauna, and human health. In the event that groundwater has been directly impacted by activities at the site, remediation or monitoring of groundwater will be undertaken as appropriate under the direction of regulatory authorities. As there are no direct groundwater users in the immediate area, the residual effect on groundwater is anticipated to be negligible with the implementation of these mitigation measures.

5.8 Surface Water

5.8.1 Acid Rock Drainage and Metal Leaching

As described in **Section 5.3.1**, ARD/ML can adversely affect surface water quality. The proposed open pits, Fire Pond and the underground mine portal are located immediately adjacent to the Ragged TIA catchment area.

Potential effects of pit dewatering discharge containing contaminants, including ARD/ML runoff, are discussed in **Section 5.8.2**.

Pit 4 is the only feature whose footprint overlies or directly affects a surface water feature. It infringes upon Fire Pond, which is an isolated pond and which is not a water body that provides fish habitat that is part of or supports commercial, recreational, or Aboriginal fisheries (**Section 3.2.1**).

As described in **Section 5.3.1**, the mitigation measures to be implemented will minimize the generation of ARD/ML at the site. However, additional mitigation measures will be implemented to minimize the potential effects of ARD/ML generated by the PAG waste rock and ore on surface water. Although there are no streams or lakes between the proposed open pits or stockpiles and the Ragged TIA, there are bog and fen areas throughout the area. These areas are abundant and widespread throughout the region, however, they provide limited habitat for aquatic life and amphibians. Sphagnum bogs facilitate natural oxidation and precipitation of metals resulting from ARD/ML; where rich organic content and anoxic conditions neutralize the pH and precipitate metals from solutions (Smith 1997). There are no anticipated adverse effects on the bogs as a result of exposure to runoff or pit discharge from ARD/ML materials as these materials will be limited through the mitigation measures described in **Section 5.3.1** and **Section 5.4.1**.

Discharge out of the Ragged Lake TIA will comply with the MMER and it will be monitored in accordance with the MMER and *Environment Act* Licence No. 1207E. With the implementation of mitigation measures to prevent the generation of ARD/ML at the site, in addition to those listed above, the residual effect on surface water quality as a result of ARD/ML is anticipated to be negligible during mining of the open pits.

As part of pit rehabilitation, PAG waste rock used as backfill will be covered with NAG and/or overburden for the pits being completely filled. Following pit rehabilitation and closure activities, no PAG waste rock will remain at surface. Following closure, the residual effect on surface water quality as a result of ARD/ML is anticipated to be negligible as a result of no available PAG material remaining on surface or exposed to weathering.

5.8.2 Pit Dewatering

Potential Contaminants

The discharge from the open pit dewatering, if contaminated through contact with the sulphide-containing material in the rock walls in the open pits, spills and leaks (discussed in **Section 5.13.1**), blast residuals, and sediment, would have the potential to adversely affect surface water quality, which in turn could impact aquatic resources, flora and fauna, and aesthetics.

As discussed in **Section 5.3.1**, open pit rock walls left exposed after extraction of the ore would be likely to generate ARD/ML after exposure to the air and water where any ore remained in the rock walls; however, the mitigation measures implemented will minimize the potential for generation of ARD/ML at the site. The maximum duration an open pit will be exposed is 18 months (Pit 1), for a total of up to 48 months for all open pits (**Section 2.8**). Arsenic concentration in one sample peaked to 0.28 mg/L following seven weeks of exposure during humidity cell testing. At all times, the arsenic concentrations were below the *MMER* maximum monthly mean concentration of 0.5 mg/L (**Section 5.3.1**). The extent and duration of exposed rock walls will be limited, where practical, and is anticipated to minimize ARD/ML in pit discharge water.

Blasting residue from explosives is a potential source of ammonia to potential surface water receiving pit discharge during mining operations. The implementation of the mitigation measures described in **Section 5.7.3** will minimize the concentration of any blast residuals in the pit discharge water.

Surface runoff over exposed soils or dust within or towards the open pits can result in suspended solids in the discharge from the open pit dewatering. Sediment-laden discharge from the open pit dewatering will be discharged, either from the open pits or from the bermed portion of Fire Pond, towards the Ragged TIA, as overland flow. Suspended sediments will settle out as this water slowly passes through the natural vegetation and/or bogs as it moves towards the Ragged TIA. Given the mitigation measures implemented to minimize the potential effects on soil erosion due to pit dewatering, as described in **Section 5.3.2**, the amount of sediments entering or discharging from the pits will be kept to a minimum.

The discharge from the open pit dewatering will flow overland towards the Ragged TIA and will pass through the sphagnum bogs abundant in the site. There are no receiving surface waterbodies between the open pits and the Ragged TIA. Natural processes (*e.g.,* uptake from plants, chemical reactions), and reduced flows, within bogs have demonstrably remediated contaminants, including metals, ammonia, and suspended sediments (Smith 1997; California State University Sacramento 2009).

Even without such natural remediation, the pit discharge water is expected to be of sufficient quality and based on the implementation of the mitigation measures described above, there are no residual effects on the bog anticipated (**Section 5.8.1**). Discharge effluent from the Ragged TIA will be monitored for ammonia concentration as per the requirements of the MMER and *Environment Act* Licence No. 1207E.

With the implementation of the mitigation measures described in **Section 5.7.3**, and there are no receiving surface waterbodies between the open pits and the Ragged TIA, it is anticipated that residual effects on surface water quality due to pit dewatering will be negligible in the site during mining of the open pits. Following closure, pit dewatering management will no longer be required and the residual effect on surface water quality will be negligible.

Surface Hydrology

A berm will be constructed in Fire Pond to isolate it from Pit 4. During mining of the open pits, water may seep through the berm in Fire Pond, potentially resulting in eventual drawdown of Fire Pond. The residual effect on aquatic resources as a result of drawdown of Fire Pond is discussed in **Section 5.9**. There are abundant and widespread waterbodies of a similar size within the area and as such, the drawdown of Fire Pond is anticipated to result in a minor residual effect on the quantity of surface water within the area. It is anticipated that recovery of Fire Pond will mirror the recovery of the shallow groundwater table in Pit 4 and will occur over the moderate term (nearly seven years as described in **Section 5.7.4**).

Water discharged from the open pits may represent a change from natural surface water movement towards the TIA. The pit dewatering volumes have the potential to impact the quantity of surface water at the site during mining of the open pits. This type of effect is potentially compounded by any change in soil compaction and removal of vegetation, which can adversely affect natural water absorption. Temporary drainage and water diversion measures may be constructed around the open pits to minimize the surface runoff entering the open pits.

If excessive volumes of water were to be discharged to the Ragged TIA, this could result in an uncontrolled release of effluent from the discharge point of the TIA towards Puffy Lake. Klohn Leonoff Ltd. (1988) determined the water balance of the Ragged TIA and, at the time of the assessment, the total inflows were 29,135 L/s, which included tailings discharge from the mill, mean annual precipitation, and displaced lake water. Pit dewatering is required during mining of the open pits and at most, two pits will be mined concurrently. The maximum inflow volume, based on the maximum discharge volume from Pit 1, is 12.7 L/s (202 USgpm) (**Section 2.2.1**). To conservatively estimate the total contribution to the Ragged TIA when two pits are mined concurrently, AECOM considered a doubling this discharge volume and found that this represents 0.09% of the total inflow into Ragged TIA.

This is considered a very minor increase in the inflow to the Ragged TIA and it is anticipated that this volume will not exceed the capacity of the Ragged TIA.

In winter, it is anticipated that limited dewatering of the open pits will occur by intermittent pumping followed immediately by draining the discharge lines. The pit walls will freeze, limiting the seepage of groundwater into the pits during the winter months. Most of the water entering the pits will originate as snowfall, which will be excavated with the waste rock or ore removed from the open pit.

Potential effects related to malfunctions of the pit dewatering equipment are discussed in **Section 5.13.1**.

At closure, re-vegetation and contouring will restore natural absorption by soil and vegetation. Following closure, the berm in Fire Pond will remain in place. Pit 4 and Pit 5 will be contoured with pit slopes flattened, fenced off, and allowed to naturally flood. This will ultimately reduce the size of the existing Fire Pond and result in the creation of two waterbodies (partially backfilled Pit 4 and Pit 5). Is it anticipated that Fire Pond will recharge once Pit 4 is flooded and the shallow groundwater table has recovered (**Section 5.7.4**).

Following the mitigation measures described in **Section 5.7.4**, pit dewatering is anticipated to result in a minor residual effect on surface water quantity following closure activities.

5.8.3 Rock and Soil Movement

During mining of the open pits, local drainage patterns will be disturbed during stockpiling, clearing, excavating, and blasting. The mitigation measures to minimize the effect of soil and rock movement on topography (**Section 5.2**) will be implemented. The total area of disturbance is approximately 29 ha for the five open pits and nine stockpiles which represents 15% of the Existing Development (192 ha). As the area of disturbance is limited by the mine sequencing of the open pits and the progressive rehabilitation of the open pits, stockpiles and roads, it is anticipated that the effect of rock and soil movement during the mining of the open pits on surface water quantity will be minor in the area.

The closure phase will include restoration of the topography of the site to match the surrounding area to the extent that is practical. The residual minor disturbance to topography (*e.g.,* remaining surface stockpiles, partially backfilled open pits, etc.) will result in alteration of local surface water drainage patterns. The open pits are largely situated in bog areas, where water flows slowly as overland flow towards Puffy Lake to the south of the site. Following closure, the berm in Fire Pond will remain in place. Pit 4 and Pit 5 will be contoured with pit slopes flattened, fenced off, and allowed to naturally flood. This will ultimately reduce the size of the existing Fire Pond and result in the creation of two waterbodies (from partially backfilled Pit 4 and Pit 5). The completely backfilled pits (Pit 1, Pit 2 and Pit 3) and the remaining surface stockpiles, once contoured, will form small hills. Water will move around these high points. However, the area of disturbance is anticipated to be approximately 15.7 ha following closure of the three completely backfilled open pits and remaining four stockpiles (Stockpiles 2, 6, 8, and 9) which represents 8% of the Existing Development (192 ha). Given that the bog areas affected by pit development are widespread in the area, that the drainage of the catchment towards the Ragged TIA will, for the most part, remain unchanged, and following the mitigation measures described in **Section 5.2**, it is anticipated that a negligible effect on surface water quantity at the site will occur following closure.

5.8.4 Soil Disturbance

Wind and precipitation can cause erosion of exposed soil that, in turn, has the potential to cause effects on surface water (*i.e.,* turbidity). Soils will be disturbed during clearing, excavation, culvert replacement, and installation, or

stockpiling. Mitigation measures to minimize the risk of impacts to surface water quality as a result of soil disturbance will be implemented, in addition those described in **Section 5.3.2**. Although the effect of sediment transport on surface water quality in Fire Pond during installation of the berm is anticipated to be moderate in the short term within Fire Pond, the potential effect of soil erosion on surface water quality is anticipated to be minor in the area during mining. Work conducted near waterbodies, such as replacing culverts or installing and maintaining roads and installation of the berm in Fire Pond, will be conducted in accordance with standard erosion protection measures and/or applicable Fisheries and Oceans Operational Statements. Disturbance to riparian vegetation will be limited where practical. During installation of the berm in Fire Pond, turbidity curtains may be installed to minimize the likelihood of sediment transport within Fire Pond. The berm will also be armoured with NAG waste rock to protect the berm from wind and water erosion once in place.

There were no observed outflows from Fire Pond and as such, sediment transport downstream is considered unlikely (**Section 5.8.2**). In the event that an outflow does exist (but was not observed due to the low water levels at the time of the aquatic habitat assessment), additional erosion and sediment control methods will be implemented, where necessary.

Precipitation falling on the stockpiles, thawing of snow in/on stockpiles, and surface water runoff around the base of the stockpiles can result in the mobilization of particulate matter that can have adverse effects on surface water quality. The waste rock stockpiles (Stockpiles 2, 3, 6, 8, and 9) and one overburden stockpile (Stockpile 4) are located within the catchment of the Ragged TIA. The remaining overburden stockpiles (Stockpiles 1, 5, and 7) are located immediately adjacent to the Ragged TIA catchment area, where surface water flows towards Puffy Lake as diffuse overland flow (not through the Ragged TIA). Suspended sediments from the stockpiles will settle out as the water slowly passes through the natural vegetation and/or bogs as it moves towards the Ragged TIA or Puffy Lake. Pit discharge water, including surface runoff, precipitation, and groundwater seepage, may be used to wet the waste rock within the pit to reduce the potential for the waste rock stockpiles to release particulate matter into surface or precipitation runoff. The nine stockpiles cover an area of approximately 15 ha or 7.5% of the Existing Development and material from the stockpiles will be used during the progressive rehabilitation of the open pits.

It is anticipated that the effects of sediment-laden water from the stockpiles on surface water quality will be effectively mitigated with the proposed measures with residual effects considered minor to negligible within the area during the mining phase of the Alteration.

Closure activities will include contouring, applying overburden and top-soil, and re-vegetating the developed areas as well as road scarification and decommissioning, including culvert removal. Following the implementation of the mitigation measures described in **Section 5.3.2**, the residual effect of erosion on surface water quality is anticipated to be negligible after closure.

5.8.5 Waste Management

As described in **Section 5.3.2**, inappropriate waste disposal has the potential to affect surface water quality. Following standard waste management practices, as outlined in **Section 5.3.2**, will prevent potential impacts to surface water quality. As a result, the residual effect of waste management, as proposed, on surface water quality is anticipated to be negligible.

5.8.6 Remediation

Closure activities may include the remediation of potentially contaminated soils as described in **Section 5.3.1**. The remediation or removal of contaminated soils will eliminate the potential exposure pathway for contaminants to affect groundwater, soil, air and surface water quality and potential indirect impacts to flora, fauna, and human health. In

the event that soil contamination has resulted in surface water contamination, remediation or monitoring of surface water will be undertaken as appropriate as approved by regulatory authorities. The residual effect on surface water is anticipated to be negligible with the implementation of these mitigation measures.

5.9 Protected and Other Aquatic Resources

For the purpose of this environmental assessment, aquatic resources refers to any living species present in a surface water body, including benthic invertebrates, macrophytes, fish, and fish habitat. Any potential effects on surface water quality and quantity can potentially affect aquatic resources. Mitigation measures implemented to protect surface water quality and quantity will also protect aquatic resources (**Section 5.8**).

Shortjaw Cisco is the only protected aquatic species that has potential to occur within the Churchill River Upland Ecoregion. The distribution of the Shortjaw Cisco is restricted to waterbodies outside the Nelson River watershed, within which the site exists. The closest record of Shortjaw Cisco is in Athapapushkow Lake, over 70 km southeast from the site. As such, Shortjaw Cisco will not be affected by the Proposed Alteration. No other protected aquatic species are anticipated to occur in the region.

Construction of a berm in Fire Pond or installation and maintenance of culverts has the potential to affect the aquatic resources through sedimentation in the water body (water quality) and loss of habitat through a reduction in size of the water body (water quantity). Fire Pond is not a water body that provides fish habitat that is part of or supports commercial, recreational, or Aboriginal fisheries (**Section 3.2.1**).

Work conducted near waterbodies, such as replacing culverts or installing and maintaining roads and installation of the berm in Fire Pond, will be conducted in accordance with standard fish habitat protection measures and/or applicable Fisheries and Oceans Operational Statements. The mitigation measures implemented to minimize the effects of erosion on surface water quality are described in **Section 5.8.3**. With the implementation of these mitigation measures, it is anticipated that there will be minor to negligible residual effects due to erosion on aquatic resources at the site.

The shoreline of Fire Pond will be reduced by one-third with the installation of the berm. The potential drawdown of Fire Pond during mining of Pit 4 will prevent this water body from supporting any fish habitat during the mining phase. The only fish species present in Fire Pond was Brook Stickleback, which is not a part of a commercial, recreational, or Aboriginal fishery. The invertebrate communities in waterbodies, such as Fire Pond that occur near historically disturbed sites, are generally characterized as having a low abundance and diversity. These invertebrate communities form the foundation of the food web and hence, the fish habitat quality within a water body. As a result, the Marginal fish habitat (**Section 3.2.1)** (AECOM, 2014)**,** that will be lost during the mining phase of the Alteration is considered to be a minor effect on aquatic resources within the site. No Federal approvals are anticipated to be required for any of the Alteration activities. Given that the type of habitat potentially lost (*i.e.,* slow moving, unconnected boggy waterbodies) is readily available throughout the area and that the species using this habitat (Brook Stickleback) are widespread and abundant, the residual effect to aquatic resources within the area is considered negligible.

Following closure, the berm in Fire Pond will remain in place. This will ultimately reduce the size of the existing Fire Pond. The partial backfilling of Pit4 and Pit 5 will also result in the creation of two waterbodies. It is anticipated that Fire Pond will recharge once Pit 4 is flooded and the shallow groundwater has recovered. The population of Brook Stickleback in Fire Pond is currently limited by ice depth in the winter. As Brook Stickleback are very prolific, it is anticipated that re-establishment of Brook Stickleback in Fire Pond would occur within the moderate term. It is anticipated that the residual effect to aquatic resources in the area following closure will be negligible.

5.10 Protected and Other Flora Species

As described in the EBA (AECOM, 2014), the federally protected Flooded Jellyskin has the potential to occur within the Churchill River Upland Ecoregion. This lichen species was not observed in the terrestrial surveys conducted for the Alteration. The nearest record of occurrence of the Flooded Jellyskin to the site is near Flin Flon, approximately 54 km southeast. As such, no effects on Flooded Jellyskin are anticipated during the mining or closure of the Proposed Alteration.

5.10.1 Acid Rock Drainage and Metal Leaching

As described in **Section 5.3.1**, ARD/ML can adversely affect soil and surface water quality with subsequent effects on flora. Pit water will be discharged from active open pits only, and may be directed to pits undergoing rehabilitation. As such, the extent and duration of potential for the effects on flora as a result of pit dewatering is anticipated to be minimal. With the implementation of the mitigation measures described in **Section 5.3.1** to prevent the generation of ARD/ML at the site, residual effects on flora species as a result of ARD/ML are anticipated to be negligible.

5.10.2 Dust Deposition

Dust will be generated during construction and closure activities as described in **Section 5.4.1**. Dust deposition has the potential to affect vegetation growth and species diversity. To mitigate potential dust deposition effects, the mitigation measures described in **Section 5.4.1** will be implemented during mining and closure. With these mitigation measures employed as necessary, potential residual effects on flora due to dust deposition during mining and closure are anticipated to be negligible.

5.10.3 Vegetation Clearing

During mining of the open pits, clearing of vegetation and overburden will result in a direct loss of flora. The mitigation measures listed in **Section 5.3** will be applied to minimize the footprint of flora loss. No rare or endangered plant species were encountered during the terrestrial survey conducted by AECOM (AECOM, 2014). Much of the area observed in 2012 had been damaged by the 1989 forest fires and there were infrequent, isolated patches of forest that escaped burning. There were no indications that the site contained unique opportunities for plant growth outside of that present in the region.

During mining, the progressive rehabilitation of the pits will occur and will include the complete backfilling of three of five open pits (Pit 1, Pit 2 and Pit 3) and partial backfill of the two remaining open pits (Pit 4 and Pit 5). Pit 1, Pit 2 and Pit 3 will be backfilled with an additional 10% of waste rock prior to covering and contouring in order to create a surface that will allow surface runoff. As part of closure, the stockpiles that remain at surface will be contoured as much as possible to match surrounding topography. Closure activities will include contouring and re-vegetation of disturbed areas as well as road scarification and decommissioning. Topsoil, will be placed on top of waste rock and subsoil before re-vegetation activities occur. Topsoil will preferably originate from the site, separated from subsoil during overburden removal or provided by a supplier. Re-vegetation will occur as soon as practical to encourage re-establishment of organic topsoil layer using native seeds. The success of re-vegetation efforts will be monitored until vegetation has re-established with additional re-vegetation activities to occur on an as needed basis as detailed in the Puffy Lake Mine Closure Plan. Natural plant succession is anticipated to encourage recovery of developed areas, where active re-vegetation efforts have been performed. The residual effect on flora thus is anticipated to be minor following closure.

5.10.3.1 Regional Vegetation Analysis

The vegetation that may be lost as a result of the development within the site (including the open pits, haulage roads, and waste stockpiles) was characterized using a regional analysis of vegetation as defined by the Forestry Branch of Manitoba Conservation. An analysis was undertaken to compare the vegetation communities potentially lost at the proposed site as a result of the Proposed Alteration to the abundance of those vegetation communities in the area and region. The calculation of the potential vegetation communities that may be lost at the proposed site was performed using Forest Management Units (FMU) to determine if the vegetation was unique in the area or region and to determine the availability of similar vegetation within the area and region.

The forestry inventory maps created for this region predate the 1989 forest fire that impacted the majority of the site. Therefore, although these maps do not accurately reflect the current baseline conditions, the vegetative communities present on the forestry inventory maps are those that will likely develop over time as the forest regenerates following the 1989 forest fire. Further, it is anticipated that the vegetation regeneration will be determined by soils, topography and water availability that, for the most part, were all similarly affected by the fire. Therefore, although the FMU mapping does not capture the vegetation changes by the 1989 forest fire, it does reflect the similar conditions for vegetation growth within the broader area and region and can provide context to determine if the growth conditions for vegetation are unique to the site or if similar conditions are available in the broader area and region. A description of the vegetation observed at the site is provided in the EBA (AECOM, 2014).

To determine the potential vegetative cover disturbed as a result of the Proposed Alteration, the area disturbed by the footprint was calculated. The cover classes present at the site were determined by clipping the footprint of the Existing Development (192 ha) from the FMU that covers the region. The site includes nine different vegetated cover classes, one class of disturbed area, and one class of water area as shown in **Table 5.4**.

Of the nine different vegetated cover classes, the largest area within the footprint of the site was *Black Spruce 40-70%, with Jack Pine* (104 ha); the smallest cover class disturbed was *Trembling Aspen with Black Spruce, Balsam Fir and Tamarack Larch* (0.6 ha).

To determine the availability of the classes of vegetation at the site within a 2 km (area) and region (10 km), the remaining undisturbed areas of these nine vegetated cover classes were calculated as above and the percentage within the area and region were determined. Other cover classes exist within the area and region that were not found within the site, these other combined cover classes have an area of 238 ha and 4,684 ha within the area and region, respectively.

To determine if the vegetation lost to the site was considered unique or rare within the area or region, the vegetation cover of the site footprint was compared with area and region vegetation cover to determine what percentage of the vegetation fell within the site footprint. The resulting percentages are the amount of area within the site footprint of that cover class compared to the total area of that cover class within the area and region. This is an estimate of the uniqueness of that cover class lost to the site footprint, where higher percentages are interpreted as representative of vegetation cover classes that are less common in the area or region compared to the site.

Table 5.4: Cover Classes and Areas

Cover Class	Species Composition or Subtype	Area (ha) of Cover Class			site as a % of	
		Site	Area	Region	Area	Region
Black Spruce	40-70%, with Jack Pine	103.7	2192.3	14658.7	4.7	0.7
Black Spruce	71-100%	2.2	195.5	1721.7	1.1	0.1
Treed Muskeg	with Black Spruce	36.4	1044.3	8763.7	3.5	0.4
Jack Pine	40-70%, with Spruce	8.2	917.8	10147.8	0.9	0.1
Jack Pine	Treed Rock	22.3	233.2	562.6	9.6	4.0
Trembling Aspen	Spruce, Balsam Fir, Tamarack Larch	0.6	24.2	549.9	2.3	0.1
Trembling Aspen	71-100%	2.2	17.5	272.5	12.5	0.8
Muskeg		11.0	95.1	867.0	11.6	1.3
Small Islands		0.2	3.8	53.0	5.5	0.4
Disturbed		0.4	29.8	158.5	1.2	0.2
Water		4.8	732.4	9051.9	0.6	0.1
Cover Classes not Found Within the site		-	238.4	4684.4	-	-
Total		**192.0**	**5,724.3**	**51,491.7**	3.4	0.4

The impacted cover class in the site that was the least common throughout the area was *Trembling Aspen 71-100%* (2 ha). This area represented approximately 12.5% of total of that vegetation class in the area. The impacted cover class in the site that was the least common throughout the region was *Jack Pine Treed Rock* (22 ha). This area represented approximately 4.0% of total of that vegetation class in the region.

It should be noted that the loss of these cover classes to the site leaves a large amount of this cover class remaining within the area and Region (17.5 – 2.2 = 15.3 ha in the area for *Trembling Aspen 71-100%* and 562.6 - 22.3 = 540.3 ha in the region for *Jack Pine Treed Rock*).

The site covered nine vegetated cover classes of 23 total classes found within the region for a total disturbed vegetated area of 186.8 ha. None of the cover classes disturbed was unique to the area or region, and the largest disturbances calculated by percentage of area disturbed of total area available did not substantially affect the availability of this cover class to the area or region. **Figure 11** provides a spatial overview of the vegetation cover classes lost to the site and their distribution throughout the area and region.

It should be noted that the vegetation analysis for the site encompasses the Puffy Lake Mine footprint and wholly contains the anticipated footprint resulting from development of the proposed open pits, waste stockpiles, and haulage roads. Additionally, the vegetation cover types currently present at the site are not necessarily reflected in the forestry inventory maps because of the 1989 forest fires that devastated large areas. However, this analysis provides a conservative estimate of the potential impact of the proposed development on uncommon vegetative communities.

5.11 Protected and Other Fauna Species

5.11.1 Protected Fauna Species

As described in the EBA (AECOM, 2014), the federally protected Monarch, Boreal Woodland Caribou, Northern Leopard Frog, and Yellow Rail have the potential to occur within the Churchill River Upland Ecoregion. The

distribution range of the Yellow Rail and Monarch are outside of the region. The range of Northern Leopard Frog is within the region, however none were observed during the terrestrial surveys conducted by AECOM in September 2012. Northern Leopard Frogs prefer flowing streams, therefore, they are not likely to be found in the area of the proposed open pits and stockpiles. As a result, no effects on Monarch, Shortjaw Cisco, Northern Leopard Frog, and Yellow Rail are anticipated during the mining or closure of the Proposed Alteration.

The Kississing-Naaosap Boreal Woodland Caribou herd, whose snow-free season range overlaps with the site, is composed of an estimated 150 individuals and is currently considered stable (COSEWIC 2002). According to *Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou* (Government of Manitoba 2005), the conservation risk of the Kississing and Naaosap herds are considered to be high risk and medium risk, respectively. In many parts of their range, including the site, anthropogenic activities have resulted in the loss, alteration or have created discontinuity of important caribou habitat.

The proposed open pits and stockpiles are located on the site of an existing mine within 500 m of previously disturbed forest, through either the former operations at Puffy Lake Mine or the 1989 forest fire. The 1989 forest fire burned approximately 12% of their 10,060 km² range (COSEWIC 2002). In a radio telemetry study conducted on the Kississing-Naaosap herd in 2002-2005, the collared Boreal Woodland Caribou (eleven individuals) typically avoided young or deciduous forest and disturbed areas, including those impacted by the 1989 forest fires. There are some areas within the site that escaped the 1989 forest fires, however, these are isolated and small and, as such, will not likely be used by Boreal Woodland Caribou.

It is anticipated that Boreal Woodland Caribou are likely already avoiding the site and immediate area, given the lack of suitable habitat and historical and recent presence of activity. However, they may exist within the region and residual effects on Boreal Woodland Caribou from habitat loss, noise disturbance, and collisions are discussed below. It is anticipated that the residual effect on Boreal Woodland Caribou within the region will be minor during mining or closure of the Proposed Alteration, given that they are likely presently avoiding the site as a result of lack of suitable habitat and historical and recent presence of activity and following implementation of the mitigation measures minimizing the potential effects on fauna (**Section 5.11.2 to 5.11.5**) and flora (**Section 5.10**), where appropriate.

5.11.2 Habitat Loss

Changes in soil, surface water, and air quality can result in habitat loss or degradation during mining of the open pits. Clearing and excavation can result in loss of fauna habitat through removal of vegetation. In **Section 5.10.3**, the vegetation loss analysis concluded that no unique flora species will be lost as a result of the Proposed Alteration.

As described in the EBA (AECOM, 2014), the abundance and diversity of fauna species within the site was limited. In addition, although burned areas provide habitat for some species, the terrestrial habitat in the area is not, at present, ideal to support diverse wildlife and would not represent an area that would be attractive for most animals. Boreal Woodland Caribou typically avoid disturbed areas, including those impacted by the 1989 forest fires such as the area. Disturbance to the edge habitats, including the unburned remnant areas, will be avoided to the maximum extent possible. It is expected that a 5 m buffer around the excavated extents of the proposed open pits, stockpiles, and haulage roads will be cleared of vegetation for safety considerations. Including the 5 m buffer around the proposed open pits and the stockpiles, the area of disturbance is estimated to be 29 ha (excluding roads) which represents 0.5% of the area. Based on the implementation of the mitigation measures as discussed in **Section 5.3**, **Section 5.4**, and **Section 5.6**, that the vegetative communities present within the area are not unique, and that the habitat available in the area has been previously disturbed by forest fires and other human activity, the residual effects of habitat loss on fauna species during mining of the open pits are considered minor in the area.

As part of the closure phase, the disturbed areas will be progressively rehabilitated and returned to its natural state to the maximum extent practical with the implementation of the re-vegetation and monitoring measures as described in **Section 5.3**. Following closure, the re-vegetation will be a positive effect for local fauna and will return the local habitat previously available prior to the mining phase. It is anticipated that the re-vegetation will result in negligible neutral residual effect following closure.

5.11.3 Noise Disturbance

As described in **Section 5.5**, noise generation associated with mining may include noise from vehicle and equipment operation, excavating, loading and unloading of rock into haul trucks and stockpiles, generator use, and blasting. An increase in noise in the area during mining and closure activities has the potential to influence people and wildlife in the surrounding area.

As described in the EBA (AECOM, 2014), the abundance of wildlife in the area is considered low. The activities currently occurring at the Puffy Lake Mine site have been limited to general site maintenance and have generated nominal amounts of noise on an infrequent basis to date. At the Puffy Lake Mine site, noise will be generated on an increasingly regular basis as refurbishment of the existing buildings progresses. During the mining and closure of the open pits, wildlife will be deterred from the site as a result of the noise that will be generated 24 hours a day and 7 days a week for 360 days per year. Overall impact to wildlife will be limited, as the impacted area is not considered a critical or unique habitat area and is located within an area of existing mining and road development. Therefore, if local wildlife is deterred from the site or portions of the area, it is not anticipated that this will critically affect wildlife, as similar habitats are available in the area and Region as described in **Section 5.10.3**. Potential noise effects on wildlife during mining of the open pits are anticipated to be moderate within the site and minor within the area.

The closure activities will generate noise as described in **Section 5.5**. Noise during the closure phase will be generated only from vehicle and equipment operation as no blasting will occur. Given the mitigation measures implemented to minimize the generation of noise, it is anticipated that the residual effects of noise on fauna during closure activities will be moderate to minor within the site. Following closure of the open pits, the underground mine will be in full production; however, the noise levels will be reduced as a result of cessation of open pit mining and the residual effect of noise on fauna is anticipated to be negligible in the area.

It is anticipated that Boreal Woodland Caribou are likely already avoiding the site and immediate area, given the lack of suitable habitat and historical and recent presence of activity (**Section 5.11.1**). The residual effects of noise on Boreal Woodland Caribou are anticipated to be minor within the area, given the implementation of the mitigation measures to minimize the generation of noise and that they are likely avoiding the disturbed areas throughout the site and area.

5.11.4 Light Pollution

The mining of the open pits will operate 24 hours per day and seven days per week resulting in the need for lighting for work safety. Lighting will be provided by site lights connected to mobile generators. Light pollution can adversely affect animal behaviour including navigation and biological cycles as well as degrade the site aesthetics (discussed separately in **Section 5.12.3**).

The number and placement of lights will be limited and directed only to the site(s) of active mining, hauling, and stockpiling, to prevent potential light pollution effects. With the selection of appropriate lighting, residual light pollution effects would be limited to the immediate area of active work within the site. It is anticipated however, that the noise associated with the active mining of the open pits would deter wildlife and as such, fauna are not

anticipated to be present within the potential zone of influence of the site lighting. The resulting effect on fauna, including Boreal Woodland Caribou, as a result light pollution is considered negligible within the area during the mining phase of the Alteration. Following closure of the open pits, the underground mine will be in full production; however, the light levels may be reduced as a result of cessation of open pit mining and the residual effect of light pollution on fauna, including Boreal Woodland Caribou, is anticipated to be negligible in the area.

5.11.5 Collisions

With the anticipated major increase in vehicular traffic on access and haulage roads as well as the Sherridon Road during the mining and closure phases of the Proposed Alteration (**Section 5.4.2**), there is a potential for increased vehicular and wildlife collisions. Large mammals, such as Moose, Coyotes, Boreal Woodland Caribou, and Black Bear may pass through the area, including Sherridon Road, the main access road, and on-site roads. The roads and cleared areas provide corridors for migration, making the area attractive to some wildlife. Boreal Woodland Caribou are likely avoiding the site and immediate area given the lack of suitable habitat and historical and recent presence of activity. Overall, the abundance and diversity of wildlife populations in the area is considered low (AECOM, 2014), therefore, the potential for increased risk of collisions is also considered low. To prevent vehicle/wildlife collisions, road speed limits will be implemented. Overall, the residual effect of collisions on wildlife populations is anticipated to be minor to negligible in the site.

5.12 Socio-Economic Environment

5.12.1 Resource Use

As indicated in the EBA (AECOM, 2014), Grass River Provincial Park, located approximately 15 km southeast of the site, is the nearest protected area. Given that there are no adverse residual effects on any environmental component that extend beyond the region, no potential adverse effects on this protected area are anticipated.

Potential noise or light pollution effects on wildlife have the potential for subsequent effects on resource use, where local abundance may be limited because of deterrence. The generation of noise and light will be limited as described in **Section 5.5** and **Section 5.11.4**, respectively. As the effect of noise and light on local wildlife is anticipated to be minor to negligible in the area, it is not anticipated that the mining and closure of the open pits will have residual effects on the resource use (*e.g.,* trapping). The development of the open pits and stockpiles are located wholly within Auriga's Mineral Lease and Surface Lease, which together permit use and (exclusive) occupation of the land surface for the purpose of prospecting, exploring for, developing, mining or production of minerals on, in, or under the land. Access to the Puffy Lake Mine site is controlled by a gate on the main access road from the Sherridon Road and restricted to personnel connected with the mine. Auriga has indicated that they are committed to working with local trappers and interested stakeholders to ensure access to trap lines and other resource harvesting is not affected by the Proposed Alteration.

5.12.2 Heritage Resources

Ground disturbance and excavation in soils as well as drilling and blasting of surface bedrock have the potential to damage heritage resources if any were present. Potential effects on heritage resources can be either reversible (in the case of additional burial or flooding) or irreversible (in the case of physical damage to site integrity).

A Heritage Resource Impact Assessment (HRIA) was originally conducted by Quaternary Consultants Ltd. and was included in the EIS report prepared by Ilam Associates Ltd 1987. As a result of the HRIA in 1987, conducted under the terms of Heritage Permit A1-87 issued by Historic Resources Branch, Quaternary Consultants Ltd. concluded

that the impoverished biotic diversity and abundance in the area explained the lack of archaeological evidence in the region and that, as a result, there were no impediments to the proposed development of Puffy Lake Mine (Ilam Associates Ltd 1987). More recently, information from the Historic Resources Branch (**Appendix D**) confirmed that there were still no known heritage resources located at the site and that the potential to impact heritage resources was considered low.

The Proposed Alteration is contained entirely within the Puffy Lake Mine site that was assessed during the original HRIA. No evidence of pre-mining human presence in the area was found in the original HRIA and there is a low likelihood for impact to heritage resources according to the heritage screening conducted in 2012 by the Historic Resources Branch of Manitoba Culture, Heritage, and Tourism. As such, the Proposed Alteration is not anticipated to affect heritage resources.

If artefacts, historical features, or skeletal remains are encountered during mining activities, work activities will stop immediately around the affected area with the find reported to the site supervisor. A qualified archaeologist may investigate and assess the find prior to the continuation of work. If skeletal remains are encountered during construction activities, the find will be immediately reported to the site supervisor and the RCMP.

Auriga is committed to working with local stakeholders to ensure heritage resources are not affected by the Proposed Alteration. With the implementation of these mitigation measures, the residual effect on heritage resources is considered negligible.

5.12.3 Aesthetics

During mining and closure of the open pits, the site will contain stockpiles, open pits, heavy equipment, materials and equipment laydown areas, pit dewatering equipment, and a construction trailer and has the potential to affect site aesthetics. In addition, emissions from vehicles and equipment, dust, lighting, waste, and noise may also affect the site aesthetics.

The Puffy Lake Mine is accessed by a 9 km main access road from the Sherridon Road and the nearest human receptors (outside of site workers) to the Puffy Lake Mine are the residents of the Sherridon. Much of the site was cleared of vegetation with infrastructure constructed on crushed rock as part of the construction of the Puffy Lake Mine and has never been converted for other uses.

Effects on topography during the mining of the open pits will be mitigated as described in **Section 5.2.1**. Waste management techniques, as described in **Section 5.3.3** will be implemented to maintain a site free of domestic waste. Noise and light pollution will be mitigated as described in **Section 5.5** and **Section 5.11.4**, respectively. Considering the distance between the Puffy Lake Mine and Sherridon, and the fact that the site has been a mining site for over 25 years, and the applicable mitigation measures, it is anticipated that potential aesthetic effects as a result of mining of the open pits will be negligible.

Closure activities will include contouring, applying overburden and top-soil, and re-vegetating the developed areas as well as road scarification and decommissioning, including culvert removal. Fences will be installed around the perimeters of Pit 4 and Pit 5 for safety considerations. To ensure the success of re-vegetation efforts, vegetation growth will be monitored and if necessary, areas may have to undergo repeated efforts of re-vegetation until vegetation has been re-established as described in **Section 5.3.2**. It is anticipated that following closure, the residual effect on aesthetics will be neutral and negligible.

5.13 Accidents and Malfunctions

All practices performed at the Puffy Lake Mine will be carried out in accordance with the Provincial *Workplace Safety and Health Act* and pit contractor's health and safety plans, which will minimize potential effects on human health and safety.

5.13.1 Pit Dewatering

Pipe leaks can result in the uncontrolled release of discharge from open pit dewatering to the environment. In the event of a pipe failure, erosive effects may also occur, as the pipe will be operated under pressure. Releases of water have potential to adversely affect local soil, surface water, and groundwater (and potential for subsequent effects on flora, fauna, and aquatic resources). In addition, water accumulation within the open pits may result in work delays and unsafe conditions for workers.

To prevent leaks or failure of the pit dewatering equipment, all equipment will be tested prior to operation to identify any potential leaks. Leaks or failure of pit dewatering equipment will be apparent during mining as the pipes will be on surface. In the event of a leak or failure, repair of the equipment will occur as soon as possible. The volume of water discharged from the open pits is not anticipated to be substantial during winter months, when there may be an increased likelihood of equipment failure. Following intermittent pumping in the winter, the discharge lines will be immediately drained to minimize the risk of pipe freezing and subsequent leakage. These mitigation measures are anticipated to appropriately mitigate the potential risk of leaks or failures of the pit dewatering equipment. In the event of a pipe leak or failure, open pit dewatering discharge is not anticipated to result in adverse effects on surface water or groundwater quality as the risk of contamination will be mitigated as described in **Section 5.8.2**.

5.13.2 Power Failure

During mining and closure of the open pits, there is potential for power failure with subsequent effects on the worker health and safety. Site power may be lost due to equipment malfunction, fire/explosion, and/or severe weather. Effects on workers' health and safety are also possible if there is an interruption in lighting or pit dewatering during active work. As there will be no storage of equipment or hazardous materials within the open pits, accumulation of water in the pits is not anticipated to adversely affect pit discharge water quality, with subsequent effects on soil, surface water and groundwater quality.

Site lighting, dewatering pumps and the construction trailer will require power provided by mobile diesel generators. All equipment will be inspected prior to use and will be regularly maintained to minimize the risk of equipment malfunction resulting in power failure. Additional backup diesel generators will be available to provide power for these components, in the event of a generator breakdown or malfunction. The supply of backup generators is anticipated to appropriately mitigate the potential risks of a power failure during mining and closure.

5.13.3 Spills or Leaks

There is the potential for contamination through spills or leaks in refuelling areas or material storage areas (developed during the former operation of Puffy Lake Mine) and the possibility of mechanical breakdown of construction equipment that may result in release of hazardous materials. These contaminants can potentially affect surface water quality, soil quality, and air quality with consequent effects on flora, fauna, groundwater quality, and aquatic resources. It is proposed that if a spill were to occur, containment would occur as soon as possible followed by timely remediation. To prevent spills from occurring during Alteration activities, the following procedures will be employed:

- Follow proper waste management practices (**Section 5.3.3**);
- All potentially hazardous products will be stored in a pre-designated, safe, and secure product storage area in accordance with applicable legislation. Storage sites will be inspected periodically for compliance with the requirements;
- Ensure that the appropriate emergency response measures, materials and equipment will be in place and readily available;
- Should refuelling be required on-site, refuelling areas will be equipped with secondary containment facilities and spill kits;
- Vehicles are to be well maintained to minimize leaks. Regular inspections of hydraulic and fuel systems on machinery shall be completed on a routine basis by trained personnel;
- Service, fuelling, and minor repairs of equipment performed on-site will only be performed by trained personnel;
- Best management practices for handling, storage and use of explosives will be implemented to minimize the risk of spills or undetonated explosives; and
- If necessary, remedial activities will be completed to remove impacted materials.

Although potential spills could result in moderate to minor adverse effects to soil, surface water, groundwater, air, flora, fauna, aquatic resources and aesthetics in the site, they would likely only occur on a rare basis. Depending on the material released to the environment during a spill, effects could occur over the short to moderate term although effects to soil, surface water, groundwater, air, flora, fauna, aquatic resources, and aesthetics are considered reversible. Given the implementation of the mitigation measures to minimize the potential for spills or leaks, the residual effects of potential spills or leaks on the environment in the site are considered minor to negligible.

5.13.4 Fire or Explosions

During mining and closure activities, the presence of mechanical equipment, fuels, and explosives creates the potential for fires and explosions. Effects related to fires and explosions include, but are not limited to, harm to on-site personnel, damage to equipment, and the potential release of contaminants and hazardous materials with subsequent effects on soil, surface water, groundwater, air, flora, fauna, aquatic resources and aesthetics. Potential socio-economic effects may occur if mine shut-downs are required or if evacuation from the site is necessary.

The region also has the potential to be affected by off-site forest fires during the summer months. Effects could include loss of infrastructure or inability to access the site resulting in an adverse economic effect on the Puffy Lake Mine. The site of the Puffy Lake Mine has been previously damaged by an extensive forest fire in 1989. Much of the site was cleared of vegetation with infrastructure constructed on crushed rock as part of the construction of the Puffy Lake Mine. The existing crushed rock will act as a fire barrier for the site.

Fire suppression activities for the Puffy Lake Mine site will be provided by the community of Sherridon, Manitoba. The fresh water supplies at the mill building may also be used for firefighting purposes, if required.

The following on-site safety precautions and procedures will be employed to minimize the risk of fires or explosions:

- Explosives and detonators will be stored in designated areas;
- Surface explosive storage areas will comply with the requirements of the Explosives Act.;
- Explosives will be provided in “just-in-time” deliveries;
- All flammable waste will be removed on a regular basis and disposed of at an approved disposal site;
- Fire extinguishers will be available on the work site during mining and closure activities. Such equipment will comply and be maintained in accordance with the manufacturers’ standards;

- Greasy or oily rags or materials subject to spontaneous combustion will be deposited and stored in appropriate receptacles. This material will be removed from the site on a regular basis and will be disposed of at an appropriate waste disposal facility;
- Chemical and hazardous material storage and use will be in compliance with regulatory requirements; and
- Smoking will be restricted to designated areas.

With these mitigation measures employed and assuming the implementation of typical safe work practices, the risk of fires and explosions is considered to be appropriately mitigated.

5.13.5 Transportation Accidents

An increase in traffic has the potential to increase the potential for transportation accidents including vehicular collisions and wildlife collisions. Transportation accidents can also result in the release of vehicle fluids (such as diesel, oils etc.) and the material the vehicles were transporting (such as waste rock and fuel) to the environment. Effects related to spills can include air, soil, surface water, and groundwater quality effects with potential for subsequent effects on flora, fauna, aquatic resources, and human health. In the event of a large transportation accident, potential socio-economic effects may occur if lost time occurs.

As indicated in **Section 5.4.2**, up to 40 vehicles may access the site on a daily basis including waste rock and ore trucks, material deliveries, and employee shuttle bus service during all Alteration phases. The additional traffic is considered a moderate increase in traffic on the Sherridon Road and a minor increase in traffic on PTH #10. The increase in area traffic is anticipated to be moderate and has the potential to result in a measureable increase in factors leading to transportation accidents. To prevent transportation accidents the following mitigation measures will be implemented and enforced by Auriga or the pit contractor:

- Vehicle speed limits will be imposed on the Puffy Lake Mine site and access roads to minimize the possibility of vehicle and animal collisions;
- Vehicular travel will be limited to/from/around the site to designated areas;
- Appropriate road signage will be provided on the access roads within the Puffy Lake Mine. Signage and speed limits on the Sherridon Road and PTH #10 is provided and maintained by the Province of Manitoba; and
- Personnel retained to drive vehicles will have a valid Driver's License.

The implementation of these mitigation measures is anticipated to appropriately mitigate the potential for transportation accidents during the mining and closure phase.

6. Monitoring and Follow-Up

6.1 Environment Act License Monitoring

Pursuant to the conditions of the *Environment Act* License No. 1207E and Manitoba *Mine Closure Regulations*, post-closure monitoring will occur for six years and will include:

- Surface water quality monitoring of the discharge from Ragged TIA control structure at a frequency specified in the *Environment Act* License No. 1207E;
- Environmental monitoring to confirm recovery of affected areas, either affected through spills or the temporary PAG waste rock stockpile;
- Post-closure environmental monitoring will occur to confirm recovery of affected areas; and
- The success of re-vegetation efforts will be monitored until vegetation has re-established with additional re-vegetation activities to occur on an as needed basis.

Auriga will undertake appropriate measures as required to mitigate environmental effects identified during post-closure monitoring.

6.2 Environmental Effects Monitoring

During the operation of the Puffy Lake Mine, Environmental Effects Monitoring (EEM) conducted under the *Metal Mining Effluent Regulations* (*MMER*) will be initiated. Monitoring will include examining the potential effects of effluent on fish population, fish tissue and on benthic invertebrate communities in local waterbodies potentially influenced by the Puffy Lake Mine support facilities. As per the requirements of the *MMER*, a study design for the initial monitoring phase will be submitted for review within 12 months of the mine being subject to Section 7 of the *MMER* (Environment Canada 2002). If sufficient information is deemed available, a report summarizing the historical biological data will be submitted for review within 12 months of the mine being subject to Section 7 of the *MMER*. A study design for the appropriate investigative report (*i.e.,* Periodic Monitoring, Focussed Monitoring, or Investigation of Cause) will be submitted for review within 12 months of the mine being subject to Section 7 of the *MMER.*

7. Public Involvement

The open pits and stockpiles are located wholly within the Puffy Lake Mine site on Auriga's Mineral Lease and Surface Lease. Access to the area that will be occupied by these features therefore is restricted to personnel and contractors of the Puffy Lake Mine. Access to the site is restricted by a gate on the main access road from the Sherridon Road.

When Auriga acquired the Puffy Lake Mine, it began meeting with the local communities of Sherridon and Cold Lake and Mathias Colomb Cree Nation, to keep neighbouring communities informed both of potential employment and business opportunities and Auriga's commitment to responsible environmental performance. Auriga has advised that it intends to continue operations with an active community information process which will keep the local public informed during the life of the mine. This will include providing information about plans for the open pits. To that end, Auriga has written to Chief Arlen Dumas and Council of Mathias Colomb Cree Nation on April 28, 2014 to initiate public information meetings. Previous communications with the local community and First Nations included one-on-one meetings with several Sherridon residents in December 2013, again in January 2014 & May 2014 and prior to that a meeting with Chief Dumas in Pukatawagan in May 2012. Auriga continues to be committed to directly and indirectly employing local residents to the extent practical and to provide local economic benefits.

Auriga also has indicated that they are committed to working with local trappers and interested stakeholders to ensure access to trap lines and other resource harvesting is not affected by the Proposed Alteration, although no such impacts are anticipated.

8. Conclusions and Recommendations

Overall, the residual effects of the proposed open pits at the Puffy Lake Mine were considered minor to negligible in magnitude with the implementation of the mitigation measures recommended in **Section** 5 with one exception. The residual effect of noise on wildlife is anticipated to be moderate (in the site) or minor (in the region) during mining operations; however, following closure, the residual effect is anticipated to be negligible. The results of the effects assessment can be summarized as follows:

Topography

The partially backfilled pits, Pit 4 and Pit 5 (area of 4.9 ha), represent the most substantial long term alteration to topography as it is today, but their final configuration will represent only a minor change in topography in context with the area of the mine and the region in which it is found. Overall, given the mitigation measures in place, the natural terrain of the area and region and the residual areal extent of disturbance, the residual effect on topography following closure is considered minor in the area and region.

Soil

Given the implementation of mitigation measures, the nature of the waste rock and the short length of time the waste rock and pit walls will be exposed to weathering, it is anticipated that effects to soil quality because of ARD/ML will be negligible during the mining and closure phases of the Proposed Alteration. Soil disturbance will be limited in extent and duration to the practical extent possible and is anticipated to result in a minor to negligible residual effect during the mining phase and a negligible residual effect following closure. Waste management strategies and policies employed and disposal of any wastes at licensed facilities will result in a negligible effect on soil. Progressive rehabilitation of the site will include remediating potentially contaminated soils, contouring, applying overburden and topsoil, and re-vegetating the developed areas and as a result, the residual effect on soil quality and quantity will be negligible following closure.

Air

During the mining and closure phases of the Alteration, dust will be generated by vegetation clearing, blasting, excavation, rock and soil movement and placement into stockpiles, and vehicle traffic on unpaved roads. The residual effect of dust generation on air quality is anticipated to be minor to negligible in the area during mining activities. The residual effect of ARD/ML dust on air quality is anticipated to be minor to negligible at the site.

Although the increase in traffic associated with the Proposed Alteration is considered major, the increase in emissions due to the increase in vehicles is anticipated to have a minor to negligible effect on air quality in the area.

Noise and Vibration

All activities performed on the Puffy Lake Mine site will be carried out in accordance with the Provincial *Workplace Safety and Health Act* and pit contractor's health and safety plans, which will minimize potential effects on humans due to noise. Noise and vibration sources include blasting of the open pits and vehicle and equipment operation (including material handling). Noise levels are anticipated to return to existing ambient levels within the region. Based on the implementation of the proposed mitigation measures, and the distance to human receptors, it is anticipated that noise and vibration effects on humans will be minor to negligible during the mining phase of the Proposed Alteration.

Climate

Although climate change effects due to greenhouse gas emissions are considered irreversible, the greenhouse gas emissions generated during the mining and closure of the Proposed Alteration is considered to have a negligible effect on climate change. It is anticipated that the reduction in CO_2 uptake by plants due to clearing will be minor during the mining of the open pits in the site, as the areas of development will be progressively rehabilitated and the area of active construction will be minimized at any given time during the life of the Alteration. Following closure, the residual effect of vegetation loss on GHG emissions is anticipated to be negligible.

Groundwater

For the purposes of this environmental assessment, a distinction has been made between shallow and deep groundwater resources. Any effects on shallow groundwater quality and quantity are anticipated to be limited in spatial extent to the site and immediate area. The residual effect of pit dewatering on shallow groundwater quantity is anticipated to be minor during mining. No registered groundwater users have been identified within 9.6 km of the site. Water discharged from the open pits is anticipated to be of sufficient quality such that residual effects on deep and shallow groundwater quality will be negligible. The deep groundwater has low hydraulic conductivity and as a result, the residual effect of pit dewatering on deep groundwater quantity is anticipated to be negligible during mining.

The shallow and deep groundwater water tables are anticipated to recover from mining within a moderate period and given the implementation of appropriate mitigation measures and the progressive pit rehabilitation, it is anticipated that the residual effect on groundwater quantity and quality following closure will be negligible.

Surface Water

Effects on surface water quality are possible during mining and are mitigated through management of ARD/ML generation, pit dewatering, rock and soil movement, soil disturbance, waste management and remediation. Contamination of pit discharge water, including blast residues or sediment, is anticipated to be minimal with the implementation of proposed mitigation measures with negligible residual effects on surface water quality. Natural process within the surrounding bogs will further minimize the levels of potential contamination from pit dewatering discharge before entering the Ragged TIA. Discharge effluent from the Ragged Lake TIA will be monitored as per the conditions in Environment Act Licence No. 1207E.

Residual effects on surface water quantity because of pit dewatering or changes to surface hydrological patterns are anticipated to be minor to negligible. Soil disturbance during mining is anticipated to result in minor to negligible residual effects on surface water quality and quantity.

Protected and Other Aquatic Resources

The mitigation measures recommended for the protection of surface water are anticipated to sufficiently mitigate potential surface water effects and will prevent adverse effects on aquatic resources. Shortjaw Cisco is not known to occur within the region and as a result, will not be affected by the Proposed Alteration. The only surface water in proximity to be affected by the proposed Alteration is Fire Pond. The aquatic habitat value of Fire Pond is categorized as Marginal as it provides habitat only for small-bodied fish (i.e., Brook Stickleback) and there is no connectivity to other waterbodies that prevents it from forming part of or supporting commercial, recreational, or Aboriginal fisheries. Given that the type of habitat potentially lost (i.e., slow moving, unconnected boggy areas including Fire Pond) is readily available throughout the area and that the species using this type of habitat (Brook Stickleback) are widespread and abundant, the residual effect to aquatic resources within the area is minor to negligible.

Protected and Other Flora Species

Although the Proposed Alteration will result in a loss of vegetation in the site, no unique vegetation communities will be lost as confirmed through a terrestrial survey. In addition, the actual extent of disturbance is expected to be a fraction of the site and the roads, stockpiles and open pits will be progressively rehabilitated which will further minimize the duration and extent of the potential effect. Overall, the residual effect of vegetation loss during mining and closure phase is considered minor to negligible in the site. No protected flora species are known to occur within the region and as a result, no effects on protected species are anticipated during the mining or closure of the Proposed Alteration.

Protected and Other Fauna Species

No habitat of specific or critical value to wildlife was observed at the site (such as calving or over-wintering areas) and, based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the area. A large portion of the area was affected by historical development at the Puffy Lake Mine site or severe forest fires in 1989, and as a result, the quality of habitat available in the area is reduced. Although the Proposed Alteration will result in a loss of wildlife habitat (through vegetation loss) at the site, the type of growing conditions that has been lost is not uncommon in the area and region. As a result, the residual effect of habitat loss on flora during mining is considered minor. Wildlife abundance in the region is anticipated to be low, based on past and recent surveys as well as the reduced habitat value as a result of forest fires.

Given the mitigation measure implemented and the reasons above, the potential noise effects on wildlife during mining of the open pits is anticipated to be moderate within the site and minor within the area. During mining and closure, light pollution is anticipated to result in a negligible residual effect on fauna. Although the increase in traffic on the main access road and the Sherridon Road are anticipated to be major, it is anticipated that road speed limits on the site, given the low abundance of wildlife species, will result in a minor residual effect of collisions on wildlife. It is anticipated that potential effects of noise and light pollution on fauna following closure are anticipated to be negligible to minor.

The Kississing-Naaosap Boreal Woodland Caribou herd, whose snow-free season range overlaps with the site, is composed of an estimated 150 individuals and is currently considered stable (COSEWIC 2002). According to Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou (Government of Manitoba 2005), the conservation risk of the Kississing and Naaosap herds are considered to be high risk and medium risk, respectively. Boreal Woodland Caribou have typically avoided young forest or disturbed areas, including those areas impacted by the 1989 forest fires. As a result of the lack of suitable habitat and historical and recent presence of activity, the residual effects of noise, light pollution, collisions and habitat loss on Boreal Woodland Caribou is anticipated to be minor to negligible during mining and following closure, the residual effects are anticipated to be negligible.

Resource Use

Auriga has indicated that they are committed to working with local trappers and interested stakeholders to ensure access to trap lines and other resource harvesting is not impacted by the Proposed Alteration. There is no anticipated impact on any harvestable resource outside the mine site. Access to the mine site is restricted to those connected with the operation.

Heritage Resources

There are no known or potential historic or heritage resources at the Puffy Lake Mine site. Therefore, the residual effect on heritage resources is anticipated to be negligible during mining and closure of the Proposed Alteration.

Aesthetics

Based on the mine's remote location, surrounding vegetation, and historical disturbances associated with the 1989 forest fires or previous development at the Puffy Lake Mine site, effects on aesthetics during the mining and closure phase are anticipated to be negligible.

Recommendations

It is recommended that the mitigation measures and monitoring programs described in this report be implemented to ensure potential environmental effects are minimized and/or are identified early so that appropriate action can be undertaken. Monitoring and follow-up activities include environmental effects studies and monitoring requirements under Environment Act License No. 1207E as well as monitoring the success of re-vegetation efforts.

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Figures

Photographs

Appendix A

Existing Crown Land Permits and Mineral Lease

Appendix B

Closure Plan Amendment

Appendix C
Tables

Appendix D

Memorandum from Historic Resources Branch