GIS # BAC-06-264

September 30 2015

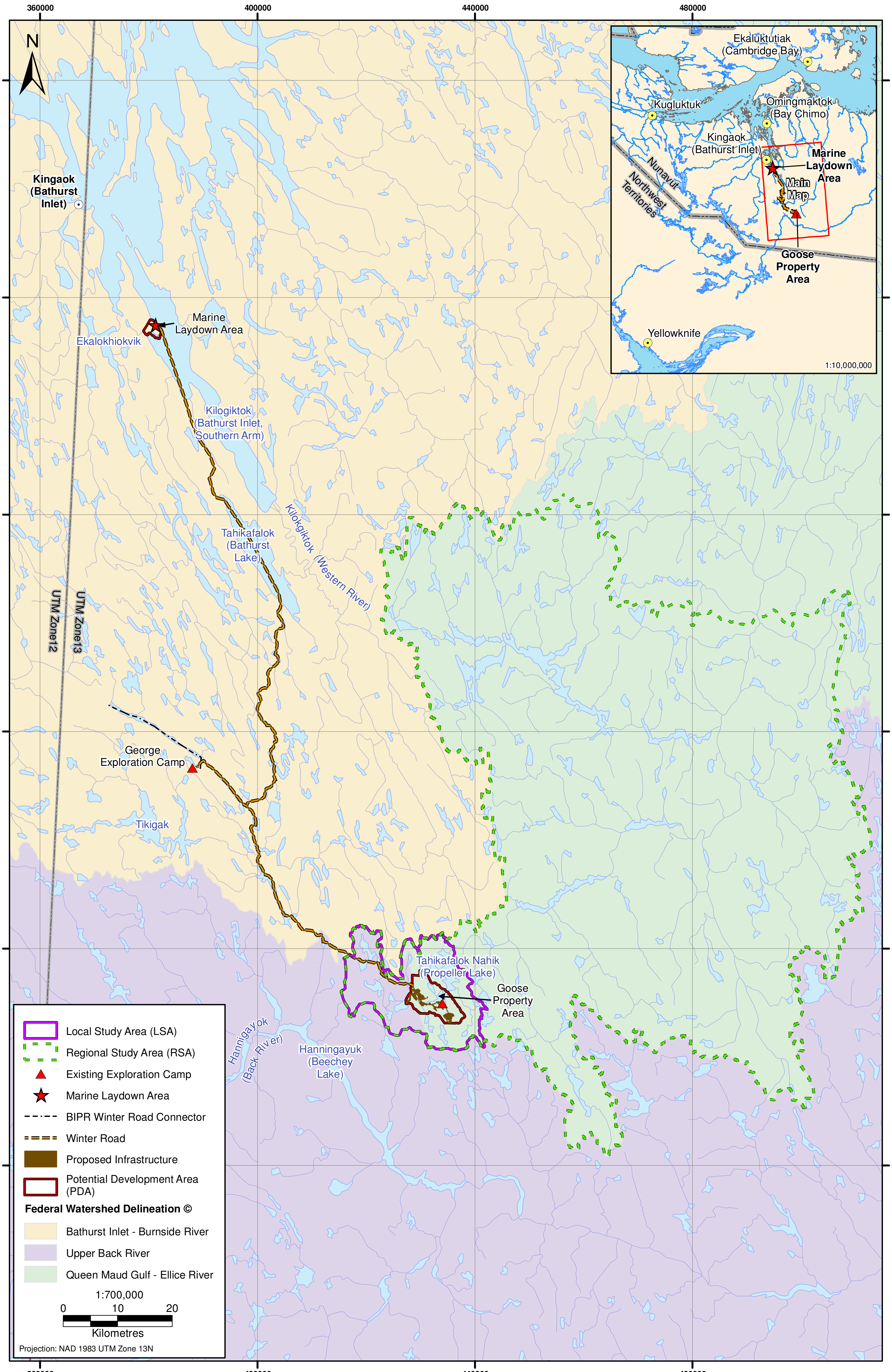

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Figure 3.2-1

Local Study Area and Regional Study Area for Freshwater Fish/Aquatic Habitat

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4. Project Activities Affecting Surface Waters

4.1 MINE PLAN OVERVIEW

The Project involves the construction, operation, and closure of open pit and underground mines at the Goose Property. A MLA will be established on the western shore of Bathurst Inlet to deliver supplies, via a 160 km winter ice road connecting the MLA to the Goose Property. (Figure 1.1-1)

The MLA infrastructure includes a temporary Lightering Barge Terminal, water intake and desalination discharge pipes, and the winter road where it crosses the Bathurst Inlet from the MLA to the Goose Property Area (Figure 1.1-2). Here, the Project will sealift materials and supplies through Bathurst Inlet to the MLA annually during the open-water season only. Ships could travel via either the eastern or western portion of the Northwest Passage and then south in to Bathurst Inlet. It is estimated that between three and five ships will report to the MLA for annual resupply and fuel as part of the Project.

The Goose Property is composed of four open pits and underground mines (Umwelt, Llama, Goose Main, and Echo), four waste rock storage areas (WRSA) established close to each pit, a Tailings Storage Facility (TSF), the Umwelt Tailings Facility (TF), the Goose Main Tailings Facility (TF), underground mining pads, a stockpile, camp, process plant, airstrip, and roads (Figure 1.1-3). The life of mine ore production will be approximately ten years. The total mine life of the Project from construction to the end of closure is estimated to be approximately 21 years. The mine life was divided into four phases and three stages to describe key periods. Table 4.1-1 provides a summary of the four phases of the Project, with Phase 2 broken down into stages by the tailings deposition plan.

Table 4.1-1. Mine Phase and Stage

Phase	Stage	Description	Start	End	Comment
1	-	Construction	Year -3	Year -1	Building TSF and start Umwelt open pit mining and underground mining
2	1	TSF Operation	Year -1	Year 2	Begin milling and tailings deposition in TSF
	2	Umwelt TF Operation	Year 2	Year 6	Tailings deposition in Umwelt TF
	3	Goose Main TF Operation	Year 6	Year 10	Tailings deposition in Goose Main TF
3	-	Closure	Year 10	Year 18	Active site closure, continue water treatment and remove site infrastructure
4	-	Post-Closure	Year 18	Year 23	Site closed. Performance monitoring

The following sections provide a brief description of key pieces of infrastructure that directly or indirectly affect surface waters at the Goose Property (for more details see the Water and Load Balance Report, Appendix V2-7H in the FEIS).

4.1.1 Tailings Storage Facility (TSF)

Tailings deposition in the TSF, located approximately 300 m east of Rascal Lake, will last for two years of the Project life, resulting in 3.15 Mm^3 of deposited tailings. In addition to the tailings volume, the TSF was designed to contain site-wide contact water, mill process water, as well as saline groundwater from

Llama open pit dewatering. The capacity of the TSF up to the full supply level (FSL) is 4.4 Mm^3. After tailings deposition in the TSF ceases, the available water storage up to the FSL level is 1.3 Mm^3. Once tailings deposition in the TSF is complete, the remaining supernatant water in the TSF will be reclaimed to the Goose Process Plant.

The closure plan for the TSF is to cover the exposed tailings and the containment dam with waste rock originating from the Goose Main open pit and convert the TSF into a waste rock storage area (TSF WRSA). This WRSA will in turn be covered with a 5 m cap of non-potentially acid generating (NPAG) waste rock. The Goose Main open pit is located 2 km north, and downstream of the TSF. Development of the Goose Main open pit is scheduled to overlap for three months with active tailings deposition in the TSF. It is assumed that waste rock will be deposited on the tailings beaches and the upstream and downstream face of the TSF dam.

Following the dewatering of supernatant water in the TSF, a portion of the TSF containment dam will be used to store contact water until the start of Closure. The available capacity of the pond at this point is 1.2 Mm^3. At Closure, runoff from the Goose WRSA will naturally flow downstream into Goose Main open pit; now named Goose tailings facility (TF).

4.1.2 Umwelt Open Pit and Tailings Facility (TF)

The Umwelt open pit is the first pit to be mined at the Goose Property and is scheduled to start one year before milling begins. Pit dewatering flows will be pumped to the former Llama Lake (then called Llama Reservoir), followed by the TSF once milling operations begin. After completion of Umwelt open pit mining, the open pit will be used for storage of mine water, tailings deposition, and the Goose Process Plant reclaim water as the Umwelt tailings facility (Umwelt TF). Based on available pit shell information, the estimated total storage capacity of the Umwelt open pit is 7.8 Mm^3, measured below a discharge elevation of 299.7 metres above sea level (masl).

Tailings will be deposited in the Umwelt TF until the solids are at an elevation 5 m below the discharge elevation. A total of 7.1 Mm^3 of tailings will be deposited in the Umwelt TF over a period of about four years. Once the Goose open pit mining is complete, excess water from the Umwelt TF during Operations will be pumped to the Goose Main TF.

At Closure, 5.0 m of water will cover the tailings deposited in the Umwelt TF (total water volume of 0.7 Mm^3). After Closure and once site specific water quality discharge criteria are met, excess water from the Umwelt TF will be directed to Goose Lake.

4.1.3 Llama Open Pit and Reservoir Facility

The Llama open pit is expected to be developed and mined in just under three years. The Llama open pit is the only pit on the Property that will be developed in an open talik and where groundwater inflows are expected to be encountered during mining. Pit dewatering flows will be routed to the TSF, followed by the Umwelt TF once it becomes active.

Following the completion of Llama open pit mining, the pit will be used to store excess site-wide contact water during Operations (as the Llama Reservoir) and hypersaline water (creating a meromictic lake). At Closure, once site specific water quality discharge criteria are met, excess water will be routed to Goose Lake. The available storage capacity of the Llama open pit below a discharge elevation of 294.4 masl is 5.6 Mm^3.

4.1.4 Goose Main Open Pit and Tailings Facility (Goose Main TF)

The Goose Main open pit will be mined and developed within four years, and will be used in Year 7 as a tailings facility. Pit dewatering flows will be pumped to the TSF, followed by the Umwelt TF once it becomes active.

The available storage capacity of the Goose Main open pit after development is 10.8 Mm^3 below a discharge elevation of 279.2 masl. Based on the mine schedule and milling rate, approximately 6.2 Mm^3 of tailings will be deposited to an elevation of 247.9 masl, providing 4.6 Mm^3 of storage for process water and site-wide contact water, and 31 m of water cover above the tailings surface. Process water inventory from the Goose Main TF will be treated during Operations and Closure and pumped back to the Goose Main TF until water quality discharge criteria are met.

4.1.5 Llama Lake

As described in the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), the intent is to initially dewater Llama Lake to 450,000 m^3 to provide adequate storage for site-wide contact water from the Umwelt open pit dewatering and waste rock runoff during the construction of the TSF. Based on available bathymetry, Llama Lake has a total storage capacity of 1.1 Mm^3.

4.1.6 Umwelt Lake and Saline Water Pond

During the underground development of Umwelt, Llama, and Goose Main, it is expected that a significant volume of groundwater will need to be dewatered as underground development will occur in open taliks. As chloride concentrations in the groundwater are expected to be high, it was determined that the saline groundwater from the underground workings would need to be separated from the site-wide contact and process water managed on site.

The Umwelt Lake will be dewatered and the Saline Water Pond will be constructed in its footprint. Intercepted groundwater from underground development will be stored in the Saline Water Pond until water can be pumped to the Llama Reservoir and into the Llama, Umwelt, and Goose Main underground workings once mining is complete. Based on available bathymetry, the Umwelt Lake and Saline Water Pond have total capacities of 362,480 m^3 and 1.1 Mm^3, respectively.

At Closure, once the Saline Water Pond is dewatered to the Llama Reservoir, the first 2 m of sediments (773,817 m^3) may be excavated and transferred to the Goose Main TF.

5. Mitigation and Adaptive Management Measures

5.1 OVERVIEW

Mitigation measures will be in place to avoid or minimize the potential effects of the Project on fish and fish habitat (summarized in Table 5.1-1; also see Section 6.5.3 in Volume 6). Mitigation measures are supplemented by the use of additional management measures, when needed. The primary mitigation measure to avoid potential effects on freshwater fish/aquatic habitat is the Project design of siting infrastructure to avoid freshwater fish habitat wherever feasible. The camp/plant site, stockpile location, and waste rock storage areas have been located to avoid fish-bearing waters. Another key mitigation measure is the establishment of maximum water volume uses which have been based on protecting critical life stages of fish in Goose, Propeller, and Big lakes. The proposed mitigation and management measures are considered to be technically, environmentally, and economically feasible. Unavoidable losses of fish habitat (e.g., loss of Llama Lake due to Llama Open Pit and loss of Umwelt Lake due to Saline Storage Pond) will be counterbalanced through the implementation of a Fish Offsetting Plan. Details on other mitigation and management measures are presented within the following plans in Volume 10 of the FEIS:

- Environmental Management Plan (Chapter 1);
- Environmental Protection Plan (Chapter 2);
- Fuel Management Plan (FEIS Addendum Chapter 4);
- Spill Contingency Plans (FEIS Addendum Chapter 5);
- Oil Pollution Emergency Plan (FEIS Addendum Chapter 6);
- Site Water Monitoring and Management Plan (Chapter 7);
- Mine Waste Management Plan (Chapter 9);
- Waste Management Plan (Chapter 10);
- Incineration Management Plan (Chapter 11);
- Road Management Plan (Chapter 14);
- Shipping Management Plan (Chapter 15);
- Borrow Pits and Quarry Management Plan (Chapter 16);
- Air Quality Monitoring and Management Plan (Chapter 17);
- Aquatic Effects Management Plan (FEIS Addendum Chapter 19);
- Tailings Management Plan (Chapter 22);
- Mine Closure and Reclamation Plan (Chapter 29); and,
- Conceptual Fish-out Plan (FEIS Addendum Chapter 31).

Table 5.1-1. Summary of Select Mitigation and Management Measures for Fish and Aquatic Habitat

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	• The Project has been designed to employ winter road only access corridors, thereby limiting dust emissions and hence the potential influence on fish and aquatic habitat. There are no all-weather roads connecting the MLA to the Goose Property. • Infrastructure, waste rock storage areas, and the TSF have been confined to the local watersheds where the deposits are located, and have stayed out of the regional Upper Back River Watershed, thereby confining potential influence on fish habitat and community to the local drainage areas. • The area of landscape disturbance will be minimized, and restoration will occur as soon as possible in order to minimize erosion potential. • Sabina proposed mitigation by design (Rascal Fishway) to ensure adequate fish passage between Goose Lake and upper RSE following DFO's preference to mitigate rather than offset (DFO 2013a). More information can be found in FEIS Addendum Appendix V6-6F.

2. Best Management Practices	• Construction, including winter road construction, will follow all applicable DFO's 'Measures to Avoid Causing Harm to Fish and Fish Habitat'.
	• Efforts will be made during the final design stage to have the right-of-way cross each stream as close to perpendicular as possible to minimize the amount of stream bank disturbance that may need to be disturbed during construction.
	• Where water will be withdrawn from fish-bearing lakes, reduction in water level and discharge will be below a threshold determined to have no significant residual effects on fish and fish habitat, as directed by DFO.
	• In-water work at the MLA will not take place from mid-July through mid-August during the Capelin spawning migration; in-stream work at the Goose Property will not take place within the spring spawning and incubation periods for Arctic Grayling in central Nunavut.
	• Where possible, buffers along existing natural surface flow features will be used to maintain native vegetation and aquatic conditions.
	• Silt fences will be used in areas of cuts and excavations, downslope from exposed or erodible areas to prevent sedimentation of waterbodies.
	• All water intakes will be screened to avoid entrainment of fish in accordance with the DFO Fresh Water Intake End of Pipe Screening Guideline.
	• All Project activities requiring the use of explosives in or near waterbodies will consider the Guidelines for Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopkey 1998) and other applicable and available best management practices.
	• Speed limits will be followed for vessel operations to minimize propeller wash and wake effects.
	• The dewatering of waterbodies, will follow an approved dewatering plan, whereby water will not be discharged to the receiving environment if it does not meet approved criteria. Any poor quality water will be retained, discharged to the TSF or other appropriate holding facility.
	• Fishing will be banned within all Project areas and, thus, will not result in fish mortality.
	• Fish removal from waterbodies prior to dewatering will follow the DFO's General Fish-Out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut (Tyson et al. 2011).
	• Guidelines for vessel discharges and anti-fouling surface treatments will be adhered to at the MLA. These guidelines include the following requirements:
	  o organotin compounds are prohibited for vessels in Canadian waters;
	  o vessels must treat sewage prior to discharge, or discharge offshore; and
	  o vessels travelling in international water must exchange ballast water offshore.

3. Adaptive Management	• The need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:
	  o if results from the Surveillance Network monitoring program (which will be outlined in the future Type A Water Licence) show non-compliance;
	  o if results from the Aquatic Effects Monitoring Program, which will monitor the receiving environment around the mine infrastructure and activities, show adverse effects to the freshwater environment; or
	  o if results from the Fish Offsetting Monitoring Program show that the offsetting program is not successful.

4. Monitoring	• The Aquatic Effects Monitoring Program will consist of the following components:
	  o water quality and sediment quality monitoring;
	  o monitoring primary producers and benthic invertebrates; and
	  o monitoring fish and shellfish populations, as well as fish and shellfish tissues.

5.2 SITE WATER MANAGEMENT

The Site Water Monitoring and Management Plan (Chapter 7, Volume 10 of the FEIS) was designed to mitigate potential negative effects from Project activities on the aquatic environment. In the Goose Property Area, site contact water (including runoff from WRSA and mine water) and treated sewage effluent will be directed to the tailings facilities and discharged to an approved site meeting applicable water licence criteria. At the MLA, greywater will be discharged on-land at an approved site and sewage will be collected by Pactos and incinerated.

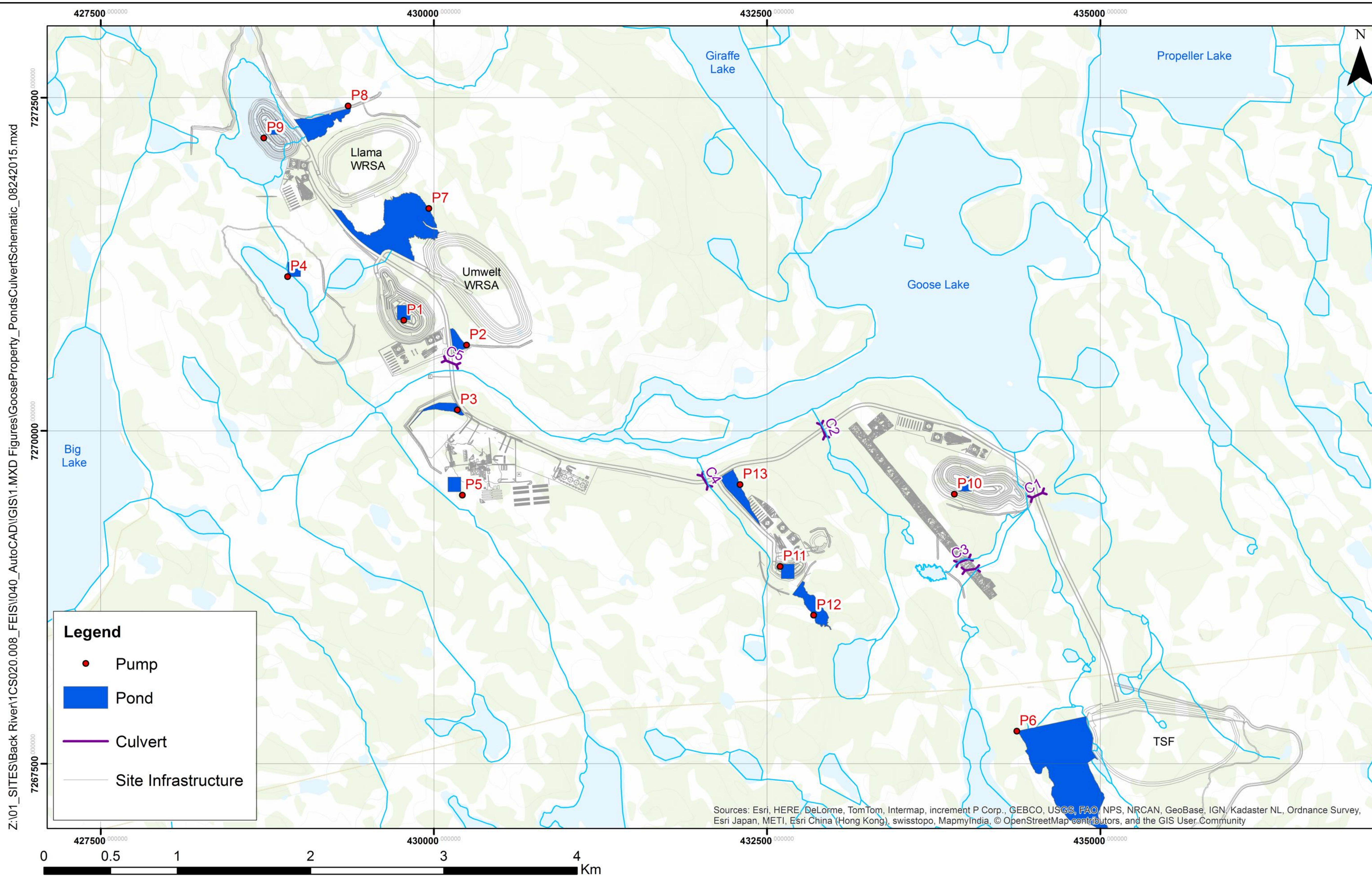
Water management plans were prepared for each phase of the mine life: construction, operations, closure and post-closure. The operational period consists of open pit and underground mining, and will take place over a ten-year period. Three tailings facilities are operated in sequence, which are presented as three stages within the operations. The closure period will take place over an additional eight years, at which point the site enters post-closure and all remaining facilities are decommissioned.

Water on site is categorized into three types, including contact water, which is affected by mine workings (waste rock, ore stockpile, pits, tailings, etc.), non-contact water, which is runoff from undisturbed areas, and saline water, which is the groundwater inflows to mining areas. Each type of water is managed separately throughout each Project phase.

Contact water is contained in event ponds and tailings facilities, and is transferred via diversions and pumped pipelines (Figure 5.2-1). Non-contact water is diverted off-site through event ponds, pumped pipelines, berms and culverts. Saline water is pumped from the underground facilities and stored in the Saline Water Pond, which is subsequently pumped back underground or into the bottom of the Llama Reservoir.

A water treatment plant will be operational in the open water season at the Goose Property in the construction phase to initially dewater Llama and Umwelt Lakes in order to create storage for contact water and saline water, respectively. Treatment is inactive between Years 1 and 5, but begins again year-round from the Goose Main TF in Year 6 to reduce metal and suspended solids loading in the facility. Once mining is complete in Year 10, water treatment continues during the open water season from the Goose Main TF, until Year 18, at which point the site is finally closed.

Five culvert crossings are required to maintain drainage patterns across the haul road and Goose airstrip at the Goose Property as illustrated on Figure 5.2-1. All crossings occur over small, ephemeral streams. One of these crossings will occur over a fish-bearing stream, the Gander Pond outflow stream located north of the airstrip, and therefore will be designed for passage of fish (i.e., Arctic Grayling). The remaining four crossings will occur over non-fish bearing streams. The culvert which requires fish passage will contain a 150 mm layer of cobble substrate material. Culvert sizing was done using the commercial code HY-8 (Federal Highway Administration 2015). Detailed design drawings of culverts will be provided to DFO during the regulatory phase of the Project.



Coordinate System: NAD 1983 UTM Zone 13N

srk consulting

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Site Wide Water Management Report

Goose Property Pumping & Culvert Schematic

Job No: 1CS020.008	BACK RIVER PROJECT	Date: August 2015	Approved: SAB
Filename: Fig3_Pumping_Culvert_Schematic.pptx		Figure: 5.2-1	

5.3 SEDIMENT AND EROSION CONTROL

Sediment and erosion control measures will be applied throughout construction and maintained for the life of the Project. Efforts will be made to minimize the disturbance of the landscape and natural vegetation cover, and to schedule ground preparation to maintain adequate cover and avoid activities during periods of expected rainfall. The Project has been designed to use winter road only access corridors thereby limiting stream crossing and instream works and hence the potential effects on water and sediment quality. Efforts will be made during the final design stage to have the right-of-way cross each stream as close to perpendicular as possible to minimize the amount of riparian vegetation that may need to be disturbed during construction. Depending on the site-specific requirements, civil design structures may be used to prevent erosion and the deposition of sediment in the aquatic environment (a list of potential structures and approaches shown in Table 6.1-1, Chapter 19, Volume 10 of the FEIS).

Runoff in the Project area occurs during a short period of June through September/October, due to the Arctic climate and permafrost ground conditions. Streams and rivers begin to flow in May, after freezing solid during the winter, and peak during freshet in June and July. The freshet period is typically short, and instantaneous flows can be quite large (see the Hydrology baseline information, Volume 6, Chapter 1 of the FEIS). Water control and erosion control structures will be designed to freshet peak flows, and areas and structures vulnerable to freshet flows will be identified. Water control structures will be monitored for ice and snow blockages, which will be cleared as necessary.

5.4 BLASTING PLAN

All Project activities requiring the use of explosives in or near waterbodies will consider the Guidelines for Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopkey 1998) and other applicable and available best management practices, as directed by DFO. The blasting management plan will be discussed with DFO prior to any blasting activities, and will be subject to adaptive management.

During the FEIS Final Hearing, Sabina and DFO jointly submitted the following Term and Condition (DFO-T-1):

> The Proponent shall engage with Fisheries and Oceans Canada in exploring possible Project specific thresholds, mitigation, and monitoring for blasting that would exceed the requirements of Fisheries and Oceans Canada's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998).

5.5 ROUTINE INSPECTION AND MONITORING

In addition to specific monitoring programs, including those required under regulatory approvals, routine inspections will be done on Project activities and components that could interact with the aquatic environment (Table 6.1-2 in Chapter 19, Volume 10 of the FEIS). These routine inspections will ensure mitigation and management goals are met, help identify if additional mitigation measures are required, and provide important information on the performance of the Aquatic Effects Management Plan.

6. Project-Related Serious Harm to Fish

6.1 INTRODUCTION

Serious harm to fish (as defined in the *Fisheries Act*) refers to the ways that the aquatic environment is changed as a result of unavoidable adverse impacts with the Project. This would include the unavoidable death of fish or permanent alteration to, or destruction of, fish habitat. Serious harm can result in residual serious harm, impacting the productivity of a CRA fishery. Thus, there are two key steps required for the assessment in the offsetting plan:

1) A screening assessment to determine whether serious harm to fish is likely to occur; and,
2) An assessment of residual serious harm to the productivity of the fishery if it has been determined that effects are likely to occur.

The Pathway of Effects models (or diagrams) developed by the DFO can be used to identify any serious harm, which can ultimately lead to reductions in fisheries productivity (DFO 2014b). The Pathway of Effects models are similar to the general method of the environmental assessment for the Project. Project activities, the expected cause-effect relationship, and the mechanisms by which stressors ultimately lead to effects in the aquatic environment are described within Chapter 6 and 7 of the FEIS. For additional detail on the assessment approach for fish and fish habitat, see the General Methodology for Project Effects Assessment (Volume 9, Chapter 1).

Although mitigation measures will be in place to avoid or minimize the potential effects of the Project on fish and fish habitat (see Section 5), adverse effects may remain and lead to residual serious harm to fish. The offsetting plan summarizes predicted adverse effects to occur for the MLA and Goose Property area, as concluded in the environmental assessment of Project effects on fish habitat (Volume 6, Chapter 6, and Volume 7, Chapter 4) and on the fish community valued ecosystem components (VECs) (Volume 6, Chapter 7, and Volume 7, Chapter 5). The offsetting plan focuses on Project infrastructure that may interact with the fish and fish habitat wherever the locations overlap with fish habitat (e.g., that may result in permanent alteration of habitat, or require a fish-out prior to the alteration of habitat). Any releases of potentially deleterious substances to freshwater habitat at the Goose Property will meet scheduled criteria and were determined to not measurably affect fish health (as stated in Volume 6, Chapter 7 of the FEIS), and water and sediment quality (as stated in two chapters in the FEIS: Volume 6, Chapters 4 and 5 for water and sediment quality, respectively).

6.2 MARINE LAYDOWN AREA

With consideration of the application of proposed mitigation and management measures, serious harm is predicted for Arctic Char and aquatic habitat VECs in the environmental assessment. Effects are summarized in Volume 7, Sections 4.5.4, and 5.5.4, all of which were classified as being Not Significant.

6.2.1 Aquatic Habitat Footprint

An adverse effect arising from the Project on the marine VEC fish/aquatic habitat is predicted due to habitat loss under the footprint of the Lightering Barge Terminal (Figure 1.1-2). At the MLA, the magnitude of effects on fish/aquatic habitat due to the footprint of the Lightering Barge Terminal is anticipated to be negligible. This conclusion is drawn from two lines of reasoning. First, the footprint affected by the Lightering Barge consists of the most common and abundant shoreline substrate and habitat along western Bathurst Inlet (sand and cobble). Second, the footprint area (equal to 0.038 ha and 14.6 m and of shoreline) is negligible when compared to the area within the LSA (2,100 ha) and the amount of shoreline within the LSA (2,800 m). The geographical extent of the effect is confined to the

Project footprint, entirely within the Potential Development Area and LSA (Figure 1.1-2, and Figure 3.1-2), and accounts for only 0.00001% of the LSA area and 0.005% of the LSA shoreline; therefore it is considered to be local within the Project footprint. The frequency of the effect will be sporadic (in place intermittently during the open-water season) during the construction and operation phases of the Project. The effect is anticipated to be immediately reversible following closure. The re-colonization of benthic invertebrates would likely be immediate following the permanent removal of the structure and the community will re-establish naturally with no intervention.

An adverse effect arising from the Project on the marine VEC fish/aquatic habitat is predicted due to habitat loss under the footprint of the in-water construction zone for the intake and discharge pipes (Figure 1.1-2). At the MLA, the magnitude of effects on fish/aquatic habitat due to the footprint of the pipe construction is anticipated to be negligible. This conclusion is drawn from two lines of reasoning. First, the footprint affected by pipe construction consists of the most common and abundant shoreline substrate and habitat along western Bathurst Inlet (sand and cobble). Second, the footprint area (equal to 0.55 ha) is negligible in magnitude when compared to the area within the LSA (2,100 ha). The geographical extent of the effect is confined to the Project footprint, entirely within the Potential Development Area and LSA, and accounts for only 0.0003% of the LSA area; therefore, the effect is considered local, within the Project footprint. The frequency of the effect will be once in the construction phase of the Project. The effect is anticipated to be immediately reversible following closure. The re-colonization of benthic invertebrates is likely to occur immediately following construction when the pipes and trench are covered with natural substrate or clean non-acid generating rock. The benthic invertebrate community will re-establish naturally with no intervention. Furthermore, the in-water work will take not take place from mid-July through mid-August during the spawning period of Capelin, an important forage fish for Arctic Char.

6.2.2 Residual Serious Harm to Fish

Although any permanent alteration or destruction of habitat may affect the distribution of Arctic Char and other species that are part of a CRA fishery, the relationship between habitat area and fisheries productivity is typically curvilinear where declines in productivity manifest beyond a certain threshold (DFO 2014a). The expectation is that this threshold is considerable higher than the aquatic footprint because the predicted absolute losses in habitat are small and because the affected habitat types are abundant in the region. Furthermore, any serious harm to fish will be immediately reversible following closure. Therefore, with the implementation of proposed mitigation measures and best available and applicable management practices, it is unlikely that the MLA will result in residual serious harm to fish. The on-going productivity of fisheries will be maintained within the Bathurst Inlet marine ecosystem.

6.3 GOOSE PROPERTY AREA

Although the majority of Project infrastructure has been sited to avoid fish bearing water, some of the Project infrastructure has the potential to interact with the VEC freshwater fish (Lake Trout and Arctic Grayling) and aquatic habitat wherever the locations overlap with freshwater (Figures 1.1-3 and 6.3-1). Any such interactions may result in permanent alteration to, or destruction of fish habitat (i.e., serious harm to fish). Direct mortality with subsequent decreases in population abundance is also predicted to occur as part of fish-outs prior to lake dewatering. Effects to fish and fish habitat are summarized in Volume 6, sections 6.5, and 7.5 of the environmental assessment, all of which were classified as being Not Significant.

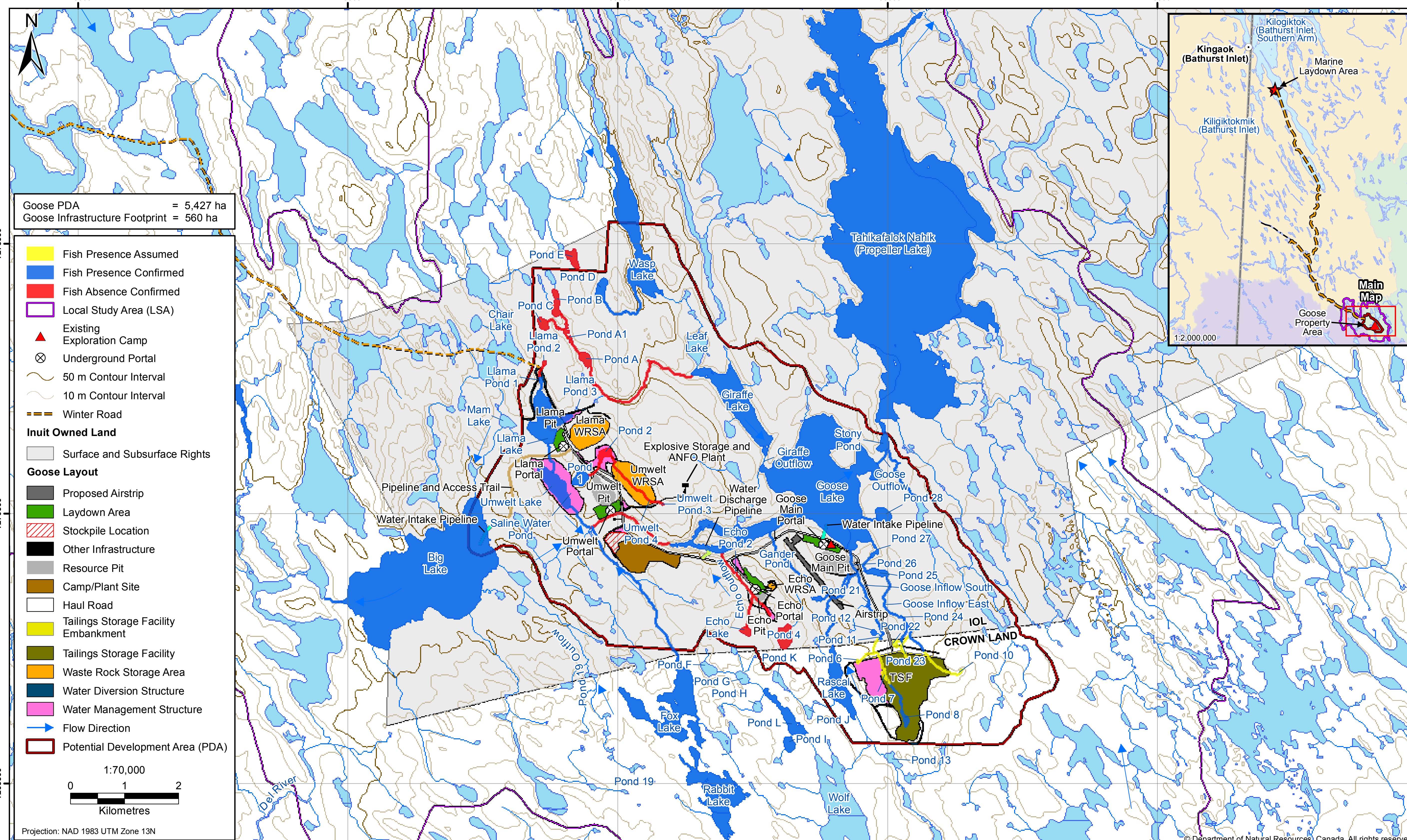

Figure 6.3-1

Fish Bearing Status within the LSA, Goose Property Area

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6.3.1 Lakes

In fish bearing lakes, a direct loss of habitat will occur in Llama Lake because of the construction of the Llama Pit and in Umwelt Lake because of Saline Water Pond construction (Figures 6.3-1). These habitat losses will result from draining each of the lakes during the Construction Phase and will persist in perpetuity. Prior to the draining of each of these lakes, a fish-out will be performed as directed by DFO (FEIS Addendum Chapter 31).

At Llama Lake, the entire basin will be drained in preparation for the construction of the Llama Pit, which represents a complete loss of 36.6 ha of habitat used by Lake Trout, Arctic Grayling, Round Whitefish, and Slimy Sculpin (Figure 6.3-1; Table 6.3-1). The majority of the area of the lake is composed of shallow water (less than 4 m), with large, boulder-cobble substrate, followed by deep water areas (greater than 4 m) with fine substrates, and nearshore areas (less than 2.5 m deep) with fine substrates. Llama Lake was categorized as high quality habitat overall as it provides the majority of deepwater overwintering habitat in the northern section of the Llama Watershed and spawning habitat for Lake Trout and Round Whitefish.

Llama Pit will be decommissioned during Operations, when it will be used as a contact water storage facility (Llama Reservoir). From this point onwards, all saline groundwater from the Saline Water Pond will be pumped to the bottom of the partially flooded Llama Reservoir to create a meromictic lake. Llama Reservoir is predicted to overtop during the Reclamation and Closure phase, with water from the reservoir discharging towards the south and into the reclaimed Saline Water Pond catchment (formerly Umwelt Lake).

Umwelt Lake will be drained to construct a Saline Water Storage Pond, which represents a complete loss of 19.4 ha of habitat used by Lake Trout, Arctic Grayling, and Round Whitefish and likely Slimy Sculpin (Figure 6.3-1; Table 6.3-1). The majority of the area of the lake is composed of shallow water (less than 2 m) with mixed cobble and boulder and fine substrates, followed by a small area of slightly deeper water habitat (maximum depth 3 m). Umwelt Lake was categorized as medium quality habitat overall as it provides mainly summer rearing habitat with limited deep-water areas for overwintering Arctic Grayling. The Saline Water Pond will begin to be drained into Llama Reservoir during Operations. After draining is complete, the berms of the Saline Water Pond will be breached during the Reclamation and Closure Phase. After the Saline Water Pond closure and reclamation is complete, the diversion berms around the Llama Reservoir will be breached, and the reservoir will be allowed to fill with non-contact water. Details regarding the closure and reclamation of the area around the Saline Water Pond are presented in the Mine Closure and Reclamation Plan (Volume 10, Chapter 29).

The installation of water intake and discharge pipes during the Construction Phase in Goose Lake will affect 0.51 ha of fish bearing habitat (Figure 6.3-1; Table 6.3-1). In southeast Goose Lake, the dimensions of the in-water construction zone for the intake pipe are anticipated to be a maximum of 15 m wide by 129 m long for an approximate footprint of 3,563 m^2 (or 0.36 ha). In western Goose Lake, the dimensions of the in-water construction zone for the discharge pipe are anticipated to be a maximum of 15 m wide by 64 m long for an approximate footprint of 1,502 m^2 (or 0.15 ha). The natural substrate types found under both construction zones are common within Goose Lake and consist of predominantly cobble and boulder at the intake pipe location and predominantly boulder and bedrock at the discharge location. Construction of the intake and discharge pipelines will consist of placing the 4 inch pipe on the substrate surface, covering the pipe and construction zone with clean non-acid generating boulder/cobble riprap, and daylighting the end of pipe at approximately 5 m water depth. The use of a rock apron is expected to mitigate any potential changes in habitat resulting from the installation of the intake and discharge pipes. The pipes will be decommissioned by cutting to the substrate level and capping; rip rap will be permanently left in place.

The installation of a water intake pipe at the eastern shore of Big Lake during the Construction Phase will result in a loss of approximately 0.52 ha of fish bearing habitat (Figure 6.3-1). The dimensions of the in-water construction zone are anticipated to be a maximum of 20 m wide by 304 m long. The natural substrate type found under the intake pipe construction zone is common within Big Lake and consists of predominantly cobble and boulder. To construct the intake pipeline, a 4-inch pipe will be placed on the substrate surface then the pipe will be covered to the extent of the construction zone with clean non-acid generating boulder/cobble rip rap. The end of the pipe will be daylighted at approximately 5 m water depth. The use of a rock apron is expected to mitigate any potential changes in habitat resulting from the installation of the intake pipe. The pipes will be decommissioned by cutting at the substrate level and capping; rip rap will be permanently left in place.

6.3.2 Ponds

Several small, fish-bearing and non-fish-bearing ponds (n = 21) located in the Llama Watershed (associated with the Llama and Umwelt Pits) and the Goose and Wolf watersheds (associated with the Echo Pit and TSF) will be lost to infrastructure (Figure 6.3-1), representing a total wetted area loss of 25.7 ha (Figure 6.3-1; Table 6.3-1).

Within the Llama Watershed, Llama ponds 1 (0.71 ha north of Llama Lake) and 3 (0.57 ha east of Llama Lake) have the potential to provide summer rearing habitat for juvenile fish from Llama Lake and will be indirectly lost through isolation by the placement of water management structures. Both ponds are ephemerally connected to Llama Lake by short streams, which dry up in summer and are dominated by boulders nearshore and fine substrates in deeper regions. Llama Pond 1 may provide some overwintering habitat as it is estimated to be approximately 4 m deep, whereas Llama Pond 3 is less than 1 m deep and provides no overwintering capacity. These habitat and connectivity losses will be initiated during the Construction Phase and persist in perpetuity.

Pond 1 (located east of Umwelt Lake; Figure 6.3-1) will also be indirectly lost from the Llama Watershed due to disconnection and isolation from Umwelt Lake for the construction of the Saline Water Pond. Pond 1 provides approximately 6.3 ha of low quality rearing habitat for forage fish (Slimy Sculpin and Ninespine Stickleback) which may overwinter within its 3 m depth. This connectivity loss will be initiated during the Construction Phase and persist in perpetuity.

Three small ponds within the Echo Pit watershed will be modified because of the development of the Echo Pit. However, this system has been classified as non-fish bearing based on previous baseline studies (Rescan 2012a, 2014a, and 2015).

Fourteen ponds within the Goose and Wolf watersheds will be lost due to the placement of infrastructure: four within the boundary of the TSF (5.1 ha: ponds 6, 7, 8, and 9), and ten due to the loss of catchment discharge downstream of the TSF (9.4 ha: ponds 11, 12, 20, 21, 22, 23, 24, 25, 26, 27). One pond with overwintering potential (i.e., depths exceed expected maximum ice thickness of 2.0 to 2.5 m) may be affected through isolation from downstream waterbodies (0.56 ha: pond 10) (Figure 6.3-1, Table 6.3-1); however, this pond is naturally isolated from downstream populations because of the ephemeral outflow stream and distance from Goose Lake. Within the planned TSF boundary, ponds 6, 7, and 9 are shallow (less than 1 m maximum depth) and consist predominantly of boulder and fine substrate. Fish use of these ponds is expected to limited to spring and early summer. Within the potential TSF location overwintering habitat only exists in Pond 8. The remainder of the ponds downstream of the TSF are split into two groups based on seasonal connectivity; those ponds lower in the watershed that have good connectivity to Goose Lake throughout the summer, and those ponds higher in the watershed that have only ephemeral connectivity to Goose Lake during spring. Those ponds lower in the watershed (ponds 21, 25, 26, 27) provide medium quality summer rearing habitat for Arctic Grayling and forage fish. Ponds located higher in the watershed (ponds 11, 12, 20, 22, 23, and 24) provide low quality summer rearing habitat for forage fish. In dry years, fish may become trapped and perish in ponds higher in the watershed if flow conditions prevent fish from accessing viable overwintering habitat. Pond habitat losses will be initiated during the Construction Phase and the loss of ponds directly underneath the TSF (ponds 6, 7, 8, and 9) will persist in perpetuity. All remaining ponds may receive an increase in discharge and potentially a return to fish bearing condition once the TSF is breached and decommissioned in post-closure.

Table 6.3-1. Fish-Bearing Lakes and Ponds with Total or Partial Habitat Losses, Resulting in Serious Harm to Fish

Name	Watershed	Project Effect	Effect Type	Area (ha)	Maximum Depth	Species Captured*	Data Source
Llama Lake**	Llama	Infrastructure (Llama Pit)	Loss	36.59	13.6	LKTR, RDWF, NSSB	1,2,3
Llama Pond 1**	Llama	Infrastructure (Water Diversion Structure)	Loss	0.71	>3		6
Llama Pond 3**	Llama	Infrastructure (Llama Pit)	Loss	0.57	0.8		6
Umwelt Lake**	Llama	Infrastructure (Saline Water Pond)	Loss	19.36	3.0	LKTR, ARGR, RDWF	1,2,3
Echo Lake	Goose	Infrastructure (Isolation)	Alteration	2.6	<2		2,4,6
Echo Pond 1	Goose	Infrastructure (Echo Pit Water Management)	Alteration	0.13	2.5		4,6
Echo Pond 2	Goose	Infrastructure (Downstream of Echo Pit)	Loss	0.33	<1		6
Pond 1**[a]	Llama	Infrastructure (Isolation)	Alteration	6.25	3.0	SLSC, NSSB	2,4,6
Pond 6	Wolf	Infrastructure (Tailings Storage Facility; TSF)	Loss	0.50	1.0		5,6
Pond 7**[a]	Wolf	Infrastructure (TSF)	Loss	1.66	<1		5,6
Pond 8**	Wolf	Infrastructure (TSF)	Loss	2.70	2.0	NSSB	5,6
Pond 9	Goose	Infrastructure (TSF)	Loss	0.22	0.4		5,6
Pond 10	Goose	Infrastructure (Isolation)	Alteration	0.56	>3		5,6
Pond 11	Wolf	Infrastructure (Downstream of TSF)	Loss	0.86	<1		5,6
Pond 12**[a]	Wolf	Infrastructure (Downstream of TSF)	Loss	0.24	<1	NSSB	5,6
Pond 20	Wolf	Infrastructure (Downstream of TSF)	Loss	0.19	NA		6
Pond 21**	Wolf	Infrastructure (Downstream of TSF)	Loss	0.73	0.7	NSSB	6
Pond 22	Wolf	Infrastructure (Downstream of TSF)	Loss	1.18	1.0		6
Pond 23**[a]	Goose	Infrastructure (Downstream of TSF)	Loss	0.07	0.4	NSSB	6
Pond 24**[a]	Goose	Infrastructure (Downstream of TSF)	Loss	0.22	0.7	NSSB	6
Pond 25**	Goose	Infrastructure (Downstream of TSF)	Loss	4.20	0.4	NSSB	6
Pond 26**	Wolf	Infrastructure (Downstream of TSF)	Loss	0.19	0.9		6
Pond 27**	Goose	Infrastructure (Downstream of TSF)	Loss	1.56	>2	ARGR, SLSC, BURB, NSSB	6
Goose Lake	Goose	Infrastructure (Water Intake /Discharge Pipes)	Partial Alteration	0.51	16.5	LKTR, ARGR, RDWF, BURB, SLSC, NSSB	2,3,4
Big Lake	Big	Infrastructure (Water Intake Pipe)	Partial Alteration	0.52	5.6	LKTR, ARGR, RDWF, LKWF, BURB, SLSC	3

** LKTR - Lake Trout, ARGR - Arctic Grayling, RDWF - Round Whitefish, LKWF - Lake Whitefish, SLSC - Slimy Sculpin, BURB - Burbot, NSSB - Ninespine Stickleback, where no species has been captured, fish presence assumed due to direct connectivity (no barriers) with fish bearing habitat; ** residual serious harm to fish may result from effects to these waterbodies; [a] waterbodies previously excluded from list of affected waterbodies resulting in residual serious harm to fish in FEIS.*
Data Sources: 1 – Rescan (2010); 2 – Rescan (2012a); 3 – Rescan (2012b); 4 – Rescan (2014a); 5 – Rescan (2014b); 6 – Rescan (2015)

6.3.3 Streams

Several small, fish-bearing or potentially fish-bearing streams will be lost to infrastructure (Figures 6.3-1; Table 6.3-2) and are located in three watersheds, the Llama watershed (associated with the Llama and Umwelt Pits), the Goose watershed (associated with the TSF), and the Wolf watershed (associated with airstrip construction, the Goose Pit, and the TSF), representing a total wetted area loss of 3.4 ha (Table 6.3-2). Stream sections downstream of Echo Lake and Echo Pond 1 will also be modified because of the development of the Echo Pit; however, this system has been classified as non-fish bearing (Rescan 2012a, 2014a, and 2015).

Within the Llama Watershed, four stream reaches will be lost totalling 0.6 ha of fish bearing habitat. Two streams are associated with the construction of the Llama Pit and the associated water management structures (Llama Inflow from Llama Pond 1 and Llama Outflow) and two streams are associated with the construction of the Saline Water Pond (Umwelt Inflow from Pond 1 and Umwelt Outflow). Llama Inflow from Llama Pond 1 contains overall medium quality habitat but offers good connectivity between Llama Lake and Llama Pond 1 for rearing Lake Trout and forage fish. Llama Outflow habitat is high quality habitat overall, consisting of fair to good quality spawning habitat for Arctic Grayling, good spawning habitat for forage fish and good quality juvenile rearing habitat. Umwelt Inflow from Pond 1 is of fair quality overall with good connectivity between Umwelt Lake and Pond 1 and fair to good rearing and spawning habitat for forage fish only. Umwelt Outflow habitat is high quality overall, consisting of fair quality spawning habitat for Arctic Grayling, good spawning habitat for forage fish and good quality habitat for juvenile rearing fish. All streams will experience a complete, or very nearly complete reduction of discharge from upstream waterbodies and will provide little to no habitat for fish. In addition, there is a potential for small amounts of runoff along the Umwelt Outflow providing the opportunity for fish to become stranded in its lower reaches; however, the potential for reduced flow in these channels to allow fish to enter and become stranded, perish or to spawn and strand eggs will be mitigated, details of which will be provided in Final Offsetting Plan. These habitat losses will be initiated during the Construction Phase when Llama and Umwelt lakes are drained. The loss of the upstream catchment will persist through operations and closure, after which the discharge will resume along the natural stream route.

Within the Goose and Wolf Watersheds, four streams will be lost, or partially lost totalling an approximate 2.9 ha of fish-bearing habitat (Table 6.3-1). Two streams will be lost due to the construction of the TSF and the lost upstream catchment area (Goose Inflow East [GIE: 1.55 ha loss] and Goose Inflow South [GIS: 0.63 ha loss]). Rascal Stream East (RSE: 0.45 ha loss) will be partially lost due to development of the airstrip and associated water management infrastructure (Figure 6.3-1), and Rascal Stream West (RSW: 0.27 ha) will be partially lost due to the diversion of flows below Rascal Lake into Rascal Stream East (F-DFO-TC-8).

The Goose Inflow East and Goose Inflow South can be generally classified into two habitat types based on seasonal connectivity: sections lower in the watershed maintain good connectivity to Goose Lake throughout the summer and provide habitat for Arctic Grayling and forage fish (sections downstream of Pond 24 in GIE, and of Pond 21 In GIS; Figure 6.3-1), whereas sections higher in the watershed have only ephemeral connectivity to Goose Lake during the spring freshet and provide habitat only for forage fish. In sections of GIS and GIE lower in the watershed, the habitat is rated as high quality, providing good spawning and rearing habitat for Arctic Grayling and forage fish from Goose Lake and direct connection to overwintering habitat in Goose Lake. The lower section of GIS also provides part of the corridor that Arctic Grayling use to migrate between Goose and Rascal lakes (Figure 6.3-1). In sections of GIS and GIE higher in the watershed, the habitat is generally rated as low, with fair spawning and rearing habitat for forage fish, but often a discontinuous connection between ponds, of which only two provide overwintering capability (Pond 8 and 10). Stream habitat losses in Goose Inflow East and Goose Inflow

South will be initiated during the Construction Phase and the loss of higher watershed sections directly underneath the TSF will persist in perpetuity. All remaining downstream sections of GIE and GIS will receive reduced flows because of lost upstream catchment area resulting in channel discontinuity, increased periods of dry channel and fewer flow days. GIE and GIS may return to baseline discharge and potentially a return to fish bearing condition once the TSF is breached and decommissioned in post-closure. However, for the establishment of a fisheries offsetting plan, the entire length of GIE and GIS are considered losses in perpetuity.

The Rascal Stream East (RSE) was surveyed in 2012 and 2013, and is characterized by a heavily braided channel that is dominated by glide and riffle habitat. Boulders dominate the substrate, punctuated by patches of gravel and cobble substrate. The stream is heavily utilized by Arctic Grayling, and contains good quality spawning, rearing, and foraging habitat. The 1.1 km section of RSE upstream of the airstrip culverts, nearest Rascal Lake, will remain undisturbed and provide approximately 0.7 ha of habitat available for spawning, rearing and foraging Arctic Grayling and forage fish from Rascal Lake. Stream habitat losses in RSE will be initiated during the Construction Phase when the culverts for the airstrip are installed and a culvert diverting flow to GIE is established to realign discharge in RSE around the Goose Pit and under a haul road. The habitat losses will continue through post-closure, when the entire volume of RSE is diverted into the Goose TF to reduce filling time for the Goose Pit Lake. Once the Goose TF is full, the pit lake will be breached to allow flow to Goose Lake along the natural RSE alignment. Thus, the RSE will have habitat losses under two culverted areas and reduced flows during the filling of the Goose Pit. Reduced flow in the RSE may be sufficient to allow fish to enter and become stranded, perish or to spawn and strand eggs. RSE may return to baseline discharge and potentially a return to fish bearing condition once the culverts are removed and the Goose Pit Lake is breached in post-closure. However, for the establishment of a fisheries offsetting plan, the length of RSE downstream of the airstrip culverts is considered a habitat loss in perpetuity.

An approximately 740 m section of upper Rascal Stream West may be lost through the operation of the proposed 'fishway' (see FEIS Addendum Chapter 31). Operation may entail the diversion of flow away from this stream section to flow through upper Rascal Stream East. Rascal Stream West was previously characterized as a boulder garden during baseline studies (Rescan 2014a), deemed as poor to fair spawning habitat. This reach may become seasonally impassable to fish during low flow periods due to the abundance of large, closely packed boulders, dispersed flows, and may restrict upstream movements under natural flow conditions (Rescan 2012b).

Fish habitat loss related to Project infrastructure will also be incurred in Gander Outflow, which will be culverted during site road construction and result in the loss of 21 m^2 (or less than 0.01 ha) of fish bearing habitat underneath the culvert footprint. This section of Gander Outflow includes fair spawning and good rearing habitat for Arctic Grayling and was rated as important overall. Habitat loss will be mitigated with crossing structures that are properly sized and installed using best available and applicable management practices. At stream crossing sites, these impacts could reduce or eliminate spawning, rearing and feeding habitat for Arctic Grayling. However, the Gander Outflow crossing will be culverted with a closed bottom corrugated metal pipe designed to maintain Arctic Grayling passage by keeping water velocities under 1.5 m/s (Site Water Monitoring and Management Plan (Volume 10, Chapter 7). Furthermore, the culvert will be embedded to a depth of 0.4 m and filled with streambed material to promote fish passage and habitat suitability. Any habitat alteration will be initiated during the Construction Phase and persist until decommissioned in post-closure.

Table 6.3-2. Fish-Bearing Streams with Total or Partial Habitat Losses, Resulting in Serious Harm to Fish

Name	Watershed	Project Effect	Effect Type	Area (ha)	Length (m)	Width (m)	Species Captured*	Data Source
Goose Inflow East**	Goose	Infrastructure (Tailings Storage Facility [TSF] and downstream loss of catchment)	Loss	1.55	3,887	4	ARGR, SLSC, BURB, NSSB	4,5,6
Goose Inflow South**	Wolf	Infrastructure (TSF and downstream loss of catchment)	Loss	0.63	3,527	1.8	ARGR, SLSC, BURB, NSSB	4,5,6
Rascal Stream East**	Wolf	Infrastructure (airstrip and reaches downstream to Goose Inflow South)	Partial Loss	0.45	1,228	3.7	ARGR, SLSC, BURB, NSSB	1,2,4
Rascal Stream West**	Wolf	Infrastructure (flows between Rascal Lake and Gosling Pond 1 to be diverted to Rascal Stream East)	Partial Loss	0.27	740	3.7	ARGR, SLSC, BURB, NSSB	1,2,4
Llama Inflow from Llama Pond 1**	Llama	Infrastructure (water diversion structure)	Loss	0.02	99	1.8		6
Umwelt Inflow from Pond 1**	Llama	Infrastructure (isolation from connected waterbodies)	Loss	0.01	129	1.0		6
Llama Outflow**	Llama	Infrastructure (Llama Pit dewatering; loss of catchment)	Loss	0.08	436	1.8	ARGR, RDWF, SLSC, NSSB	3
Umwelt Outflow**	Llama	Infrastructure (Saline Water Pond dewatering; loss of catchment)	Loss	0.44	551	8.0	ARGR, NSSB	4
Gander Outflow-Rascal Stream West	Wolf	Infrastructure (culvert for Haul Road)	Alteration	<0.01	30	0.7	ARGR, NSSB	1,2,4

** LKTR - Lake Trout, ARGR - Arctic Grayling, RDWF - Round Whitefish, LKWF - Lake Whitefish, SLSC - Slimy Sculpin, BURB - Burbot, NSSB - Ninespine Stickleback, where no species has been captured, fish presence assumed due to direct connectivity (no barriers) with fish bearing habitat; ** losses potentially resulting in residual serious harm to fish.*

Data Sources: 1 – Rescan (2010); 2 – Rescan (2012a); 3 – Rescan (2012b); 4 - Rescan (2014a); 5 – Rescan (2014b); 5 – Rescan (2015)

6.3.4 Residual Serious Harm to Fish

The screening criteria for the assessment of losses followed the Fisheries Protection Policy Statement (DFO 2013a), where the potential for residual serious harm to fish was any potential Project-related effect on the productivity of a CRA fishery. An effect to productivity may include a direct impact to a potential CRA species (e.g., Lake Trout, Arctic Grayling, Round Whitefish) or an indirect impact to forage species that support a CRA fishery. A direct impact may include the death of a CRA species, or any permanent alteration to, or destruction of habitat supporting a potential CRA species; whereas an indirect impact may include the death of forage species that support a CRA fishery, or any permanent alteration to, or destruction of habitat supporting a potential CRA species.

Consistent with the Fisheries Protection Policy Statement, any Project-related effects to aquatic habitat that may support a CRA species or forage fish that may support the CRA fishery were screened. For example, any direct or indirect effects to shallow ponds that do not support small-bodied fish species and are characterized by limited hydrologic connectivity to waterbodies supporting large-bodied CRA species were determined to not result in serious harm to fish. This included Echo Lake, Echo Pond 1, Echo Pond 2, Pond 6, Pond 9, Pond 10, Pond 11, Pond 20, and Pond 22.

Residual serious harm to fish is also not expected at the Gander Outflow crossing where best management practices will be deployed to maintain fish passage to upstream locations. For example, the culvert will be embedded to a depth of 0.4 m and filled with streambed material to promote fish passage and habitat suitability.

Residual serious harm to fish is also not expected to result from the construction of the water intake and discharge pipe. The natural substrate types found under the pipe construction zones are common within the affected lakes and consists of predominantly cobble and boulder. Furthermore, pipes will be covered to the extent of the construction zone with clean non-acid generating boulder/cobble riprap. This use of a rock apron is expected to mitigate any potential habitat changes resulting from the intake pipe (i.e., similar lake-bottom substrates will be present after construction).

Some of the Project infrastructure is expected to result in residual serious harm to fish, specifically where infrastructure overlaps with habitat supporting CRA species, such as Arctic Grayling and Lake Trout, and with potential spawning/rearing and foraging habitat with discernible connections to habitat supporting CRA species. It is expected that residual serious harm to fish will occur within up to 14 lakes and ponds, and 8 streams (including Rascal Stream West), totalling up to 75.0 ha of lake and pond habitat and 3.4 ha of stream habitat. Most of the expected Residual Harm to fish will occur in Llama Lake (36.6 ha) and Umwelt Lake (19.4 ha).

The list of affected waterbodies resulting in serious harm to fish has expanded from that submitted with the earlier submissions of the environmental assessment. For greater clarity and conservatism the updated list now includes Pond 1, Pond 7, Pond 12, Pond 23, Pond 24, and Rascal Stream West. For the purposes of a Conceptual Fisheries Offsetting Plan, all fish-bearing ponds or ponds with fish-bearing potential that will be affected by the TSF were conservatively classified as losses resulting in residual serious harm to fish (Table 6.3-1); these include Ponds 23 and 24 and all downstream ponds (as part of Goose Inflow east), and Pond 8 and all downstream ponds (as part of Goose Inflow south). All streams, lakes and ponds listed in Tables 6.3-1 and 6.3-2 and their role in supporting the local fishery will receive further review in consultation with DFO and KIA during the permitting stage of the Back River Project.

6.4 LOSSES IN FISHERIES PRODUCTIVITY

Fisheries production (e.g., biomass), as a surrogate of fisheries productivity (Randall et al. 2013), was estimated for lakes and streams where residual serious harm to fish is expected. Where possible, conservative inputs were considered such that losses were overestimated, reducing the uncertainty in the assessment that offsets would fully counterbalance the losses. For losses incurred within the Llama-Umwelt lake system, two approaches were considered. The first approach considered population sizes estimated for fish from hydroacoustic data (surveys completed in 2010) combined with catch data collected during baseline surveys, including body size measurements, for Llama and Umwelt lakes (see Appendices V6-6A to V6-6C). The second approach considered a biomass equation derived for lakes in the NWT (Samarasin et al. 2015; also see F-KIA-TC-17) combined with catch data, including body size measurements, for Llama and Umwelt lakes. The equation applied for estimating losses for lakes was as follows:

$$\log_{10}(biomass) = 0.402 + 1.332\ (\log_{10}(lake\ area)),$$

where biomass is measured in kg, and lake area in ha.

The above biomass equation was also applied to derive the calculation of losses associated with the Goose Lake tributary streams and ponds in the Goose and Wolf watershed, including Goose Inflow South/East, and Rascal Stream East streams. Losses within the tributaries to Goose Lake were based on the predicted total biomass of fish in Goose Lake derived from the biomass equation, combined with catch data for Goose Lake to determine species composition (Appendices V6-6A to V6-6C of FEIS; also see Golder 2007), and the estimated proportion of biomass of fish in Goose Lake that use the affected tributary streams and ponds as part of a species life history. The assumed life history functions of the affected tributary streams include foraging, rearing and spawning habitat; however, as a conservative assumption, the calculated proportion of fish in Goose Lake that use the affected tributary streams and ponds was assumed to be all individuals of the following species: Arctic Grayling, Ninespine Stickleback, and Slimy Sculpin, all of which have been recorded as frequent users of both Goose Lake and the affected streams. This assumption is conservative because it is expected that other tributary systems of Goose Lake (e.g., Giraffe Outflow, Gander Outflow) will continue to provide suitable habitat for species with the development of the Project and some proportion of the population of Goose Lake will be sustained.

6.4.1 Llama Lake-Umwelt Lake System

6.4.1.1 Species Composition

Hydroacoustic gear was used to estimate abundance of fish (age 1 or older) in Llama and Umwelt lakes in 2010. The total number of fish in each lake was estimated at 226 (95% CI 4 to 1,794) and 155 (95% CI 5 to 864), respectively. Based on concurrent sampling conducted with gillnets, roughly 78% of the fish in Llama Lake were estimated to be Lake Trout, while 22% were Round Whitefish. Based on the same kind of concurrent sampling, approximately 77% of the fish in Umwelt Lake were estimated to be Arctic Grayling, while the remainder of the fish in that waterbody were Round Whitefish. However, variation in species relative abundance was observed when taking into account all sampling years (2010, 2011, and 2012). For example, based on all gillnetting years, Lake Trout is the dominant species in Llama Lake, accounting for approximately 65% of the total number of fish, whereas Round Whitefish make up most of the remaining 35% of individuals. For Umwelt Lake, the dominant species is Arctic Grayling if considering data across all gill netting years (70%), followed by Round Whitefish (27%), and Lake Trout (3%). Thus, for the two lakes combined, the population size was predicted to be 381 fish, based on hydroacoustic surveys and to include a catch composition of 39% Lake Trout, 31% Round Whitefish, and 30% Arctic Grayling based on sampling efforts (Figure 6.4-1). Thus, species-specific population estimates include 147 Lake Trout, 120 Round Whitefish, and 114 Arctic Grayling (Figure 6.4-1).

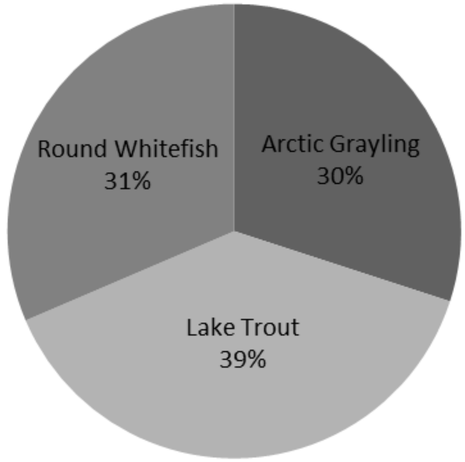

Figure 6.4-1. Species Composition of the Llama-Umwelt Lake System, Goose Property Area

6.4.1.2 Fish Biomass

The first approach for calculating biomass considered population sizes estimated from hydroacoustic data combined with catch data for Lake Trout, Round Whitefish, and Arctic Grayling, including body size measurements (e.g., weight), for Llama and Umwelt lakes. Given reported populations sizes in Section 6.4.1.1, and recorded mean weight of fish captured in Llama and Umwelt lakes, which were 0.236 kg for Arctic Grayling, 0.802 kg for Lake Trout, and 0.367 kg for Round Whitefish, the estimated biomass per species is 27 kg of Arctic Grayling in Umwelt Lake, 118 kg of Lake Trout in Llama Lake, and 44 kg of Round Whitefish in the two lakes combined. Total estimated biomass for the two lakes combined is approximately 189 kg.

The second approach for calculating biomass was based on an equation derived for lakes in NWT (Samarasin et al. 2015; F-KIA-TC-17) combined with baseline catch data, including body size measurements, for Llama and Umwelt lakes. This second approach also considers contributions of small-bodied species, such as Ninespine Stickleback and Slimy Sculpin. Equation inputs included 36.59 ha for area of Llama Lake, 19.36 ha for Umwelt Lake, 0.71 ha for Llama Pond 1, 0.57 ha for Llama Pond 3, and 6.25 ha for Pond 1. The total calculated biomass for the Llama-Umwelt lake system is 467.5 kg; however, the final biomass estimate to be used in the offsetting accounting will be verified using data collected from the fish-outs of Llama and Umwelt lakes.

6.4.2 Goose Lake and Tributaries

6.4.2.1 Species Composition

In general, Arctic Grayling and Slimy Sculpin were the most abundant species captured in streams, followed by Ninespine Stickleback, Burbot, Round Whitefish, and Lake Trout. The highest abundance of fish (CPUE) caught by electrofishing streams was recorded in the Rascal Stream East (connecting Rascal Lake to Goose Lake) where numerous young-of-year Arctic Grayling and Slimy Sculpin were captured. Arctic Grayling fry (over 1,000 individuals) were also observed in each of the Goose Inflow South and Rascal Stream East during fry surveys.

Goose Lake contains six fish species: Lake Trout, Round Whitefish, Arctic Grayling, Slimy Sculpin, Burbot, and Ninespine Stickleback. Based on four sampling years (2006, 2011, 2012, and 2013) and multiple gear types (gill nets, electrofisher, and beach seines), the total catch included 202 fish, most of which were Round Whitefish (34% of total catch) and Lake Trout (26%), followed by Slimy Sculpin (22%), Ninespine Stickleback (14%), Arctic Grayling (2%), and Burbot (2%).

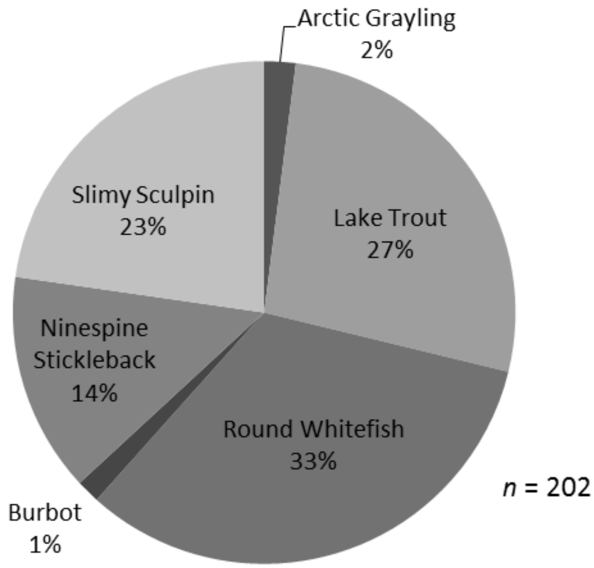

Figure 6.4-2. Species Composition of Goose Lake, Goose Property Area

6.4.2.2 Fish Biomass

To calculate biomass of fish that rely on affected tributary habitats (see Table 6.3-1 and 6.3-2), available biomass in Goose Lake was first estimated using a biomass equation derived for northern lakes (adapted from Samarasin et al. 2015; F-KIA-TC-17). The reported relative abundances of fish species in Section 6.4.2.1, combined with mean weights of fish captured in Goose Lake (0.183 kg for Arctic Grayling, 0.002 kg for Slimy Sculpin, and 0.001 kg for Ninespine Stickleback) were then applied to calculate biomass loss.

Equation inputs included 320.2 ha for area of Goose Lake, and the areas for Pond 7, 8, 12, 21, 23, 24, 25, 26, and 29 (11.57 ha in total). With the application of these inputs to the biomass equation, 5,424.3 kg of fish biomass was calculated for the Goose Lake fishery, and of this value, it was assumed that all biomass of Arctic Grayling, Ninespine Stickleback, and Slimy Sculpin was linked to the affected tributary streams and ponds. Thus, the calculation of proportional losses from the Goose Lake fishery include 88.2 kg of Arctic Grayling, 10.7 kg of Slimy Sculpin, and 3.3 kg of Ninespine Stickleback in Goose Lake, for a total of 102.3 kg of fish biomass.

7. Offsetting Option - Bernard Harbour

7.1 INTRODUCTION

The Hingittok Lake-Nulahugyuk Creek (HLNC) system at Nulahugyuk (Bernard Harbour), Nunavut (Figure 1.1-1) was once the site of a traditional domestic fishery for Arctic Char (*Salvelinus alpinus*; char). Records from the Canadian Arctic Expedition indicate that the creek at Bernard Harbour supported a large migration of anadromous char in the early 1900s (Jenness and Jenness 1991). By the early 1990s, however, harvesters were reporting that the run was in decline and that the numbers of migrating char were much lower than those observed 30 or 40 years ago based on local knowledge (ANL and Golder 2005; Golder and ANL 2007). In response to these concerns, members of the Kugluktuk HTO, and Golder biologists, performed a preliminary assessment of the size and timing of the Arctic Char run, and habitat conditions for fish passage during 2004 and 2005 (ANL and Golder 2005; Golder and ANL 2007), and again in 2012 (Golder 2013a).

Although the previous work reflected only a short window (i.e., less than 2 weeks) within an assumed longer migratory window per study year, the results suggested a decline in the size of the char run. In addition, the timing of the upstream char migration appeared to have shifted to earlier in the summer. It was hypothesized that the char run was affected by lower flows and poor channel conditions in mid to late summer when char generally undertake a return migration from the sea.

During earlier investigations (ANL and Golder 2005; Golder and ANL 2007; Golder 2013a) site-specific blockages (e.g., channel crossover locations) at several sites, which appeared problematic for migrating adult Arctic Char, were identified. Upstream movements by char were particularly restricted during low flow periods (Plate 7.1-1) and primarily within the lower (approximately 3.5 km) section of the creek. As a possible corrective measure, it was proposed that 'low-flow channels' be constructed to facilitate fish passage during low discharge periods to extend the migration window; where a low-flow channel is characterized by an unobstructed flow path with sufficient depths within the larger channel. The low-flow channels would be particularly beneficial during drier than normal years.

Plate 7.1-1. Arctic Char struggling to migrate upstream through a shallow section of Nulahugyuk Creek, July 5, 2014.

In 2012, a stream enhancement and community stewardship project aimed at understanding and enhancing the use of the Bernard Harbour system by Arctic Char was successfully undertaken (Golder 2013a). Five low-flow channels, combined with directional weirs to aid fish navigation, were constructed with the guidance from local Traditional Knowledge to assess the feasibility of applying this approach on a wider scale to increase fish production in the HLNC system (Figure 7.1-1). The project was designed and executed by Golder in collaboration with local partners, including students and residents of Kugluktuk, Nunavut, the Kugluktuk HTO, and the Nunavut Department of Environment.