Sabina
GOLD & SILVER CORP.

BACK RIVER PROJECT
Conceptual Fish Offsetting Plan

November 2015

REVISION G.1

Volume 10: Revisions Log

Chapter	Section	Subject	Description (Major Revisions Only)
Chapter 21	All Sections	Replacement of DEIS Version	Complete document rewrite to reflect changes in facility design, water management, changes to losses/gains, TK, and to introduce the Bernard Harbour offset option.

BACK RIVER PROJECT
CONCEPTUAL FISH OFFSETTING PLAN

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

CRA	commercial, recreational, or Aboriginal
CPUE	Catch per unit effort
DFO	Fisheries and Oceans Canada
FEIS	Final Environmental Impact Statement
GIE	Goose Inflow East
Golder	Golder Associates Ltd.
ha	Hectare(s)
HTO	Hunters' and Trappers' Organization
KIA	Kitikmeot Inuit Association
km	Kilometre(s)
LSA	Local Study Area
MLA	Marine Laydown Area
NTKP	Naonaiyaotit Traditional Knowledge Project
PIT	Passive Integrated Transponder
Project, the	The Back River Project
RSE	Rascal Stream East
TF	Tailings Facility
TK	Traditional Knowledge
TSF	Tailings Storage Facility
VEC	Valued Ecosystem Component
WRSF	Waste Rock Storage Areas

1. Introduction

1.1 PURPOSE

The proposed Back River Project (the Project) lies in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. It is composed of two main areas: the Marine Laydown Area (MLA) and the Goose Property Area (MLA; Figure 1.1-1).

The MLA is located on the western shore of Southern Bathurst Inlet, approximately 130 kilometres (km) north of the Goose Property (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 vessels will report to the MLA for annual resupply and fuel as part of the Project. Key Project infrastructure for the Back River MLA includes the following:

- a temporary Lightering Barge Terminal;
- water intake pipe and desalination discharge pipe; and,
- the winter road where it crosses the Bathurst Inlet from the MLA to the Goose Property Area.

Mining will be completed using both open pit and underground methods. The Goose Property includes four open pits and four underground developments and the Project has an estimated mine life of ten years with a total production of 19.8 million tonnes (Mt) of ore (Figure 1.1-3). Key Project infrastructure at the Goose Property includes:

- four open pits, and four underground mines (Umwelt, Llama, Goose Main, and Echo);
- four waste rock storage areas;
- tailings storage facility (TSF);
- underground mining pads;
- a stockpile;
- camp;
- process plant; and,
- airstrip and roads, including a culvert for the haul road crossing.

The current mine plan includes the development of the Llama deposit, which is located under Llama Lake, and the construction of the Saline Water Pond at Umwelt Lake. Llama Lake and Umwelt Lake will be fished-out prior to the development of those Project components. Thus, the dewatering of Llama and Umwelt lakes for mining operations, and the construction of related infrastructure to support these activities is expected to result in unavoidable serious harm to fish (as defined in the *Fisheries Act*; see Section 1.1.1). The purpose of the Conceptual Fish Offsetting Plan (Chapter 21), a part of the Final Environmental Impact Statement (FEIS), is to summarize anticipated Project effects on fish and fish habitat, describe the option considered for offsetting (i.e., ‘Bernard Harbour’), and outline a proposed conceptual plan to offset the serious harm to fish according to Fisheries and Oceans Canada’s (DFO’s) Policy (DFO 2013a,b).

The development of the conceptual plan and the identification of the Bernard Harbour offsetting option within the plan is the result of continued community and regulatory engagement associated with the Project. The conceptual plan should demonstrate that it is reasonable to assume at this time that a feasible offsetting option exists, and that a Final Fish Offsetting Plan can be implemented for the Project. The Final Fish Offsetting Plan will be developed during the permitting phase of the Project.

PROJECT # 0194096-0040 GIS # BAC-01-068_S September 23 2015

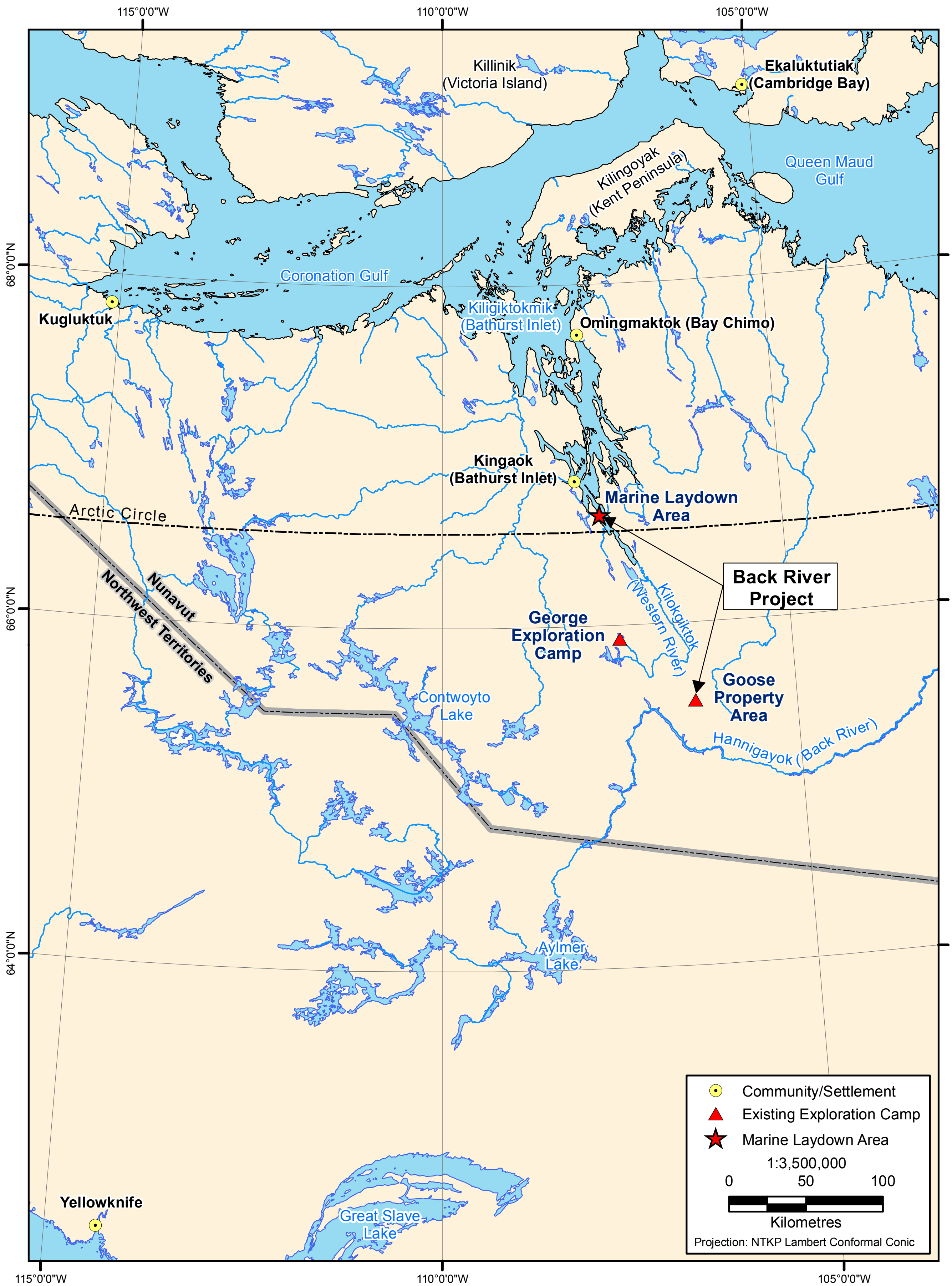

Figure 1.1-1

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Project Location

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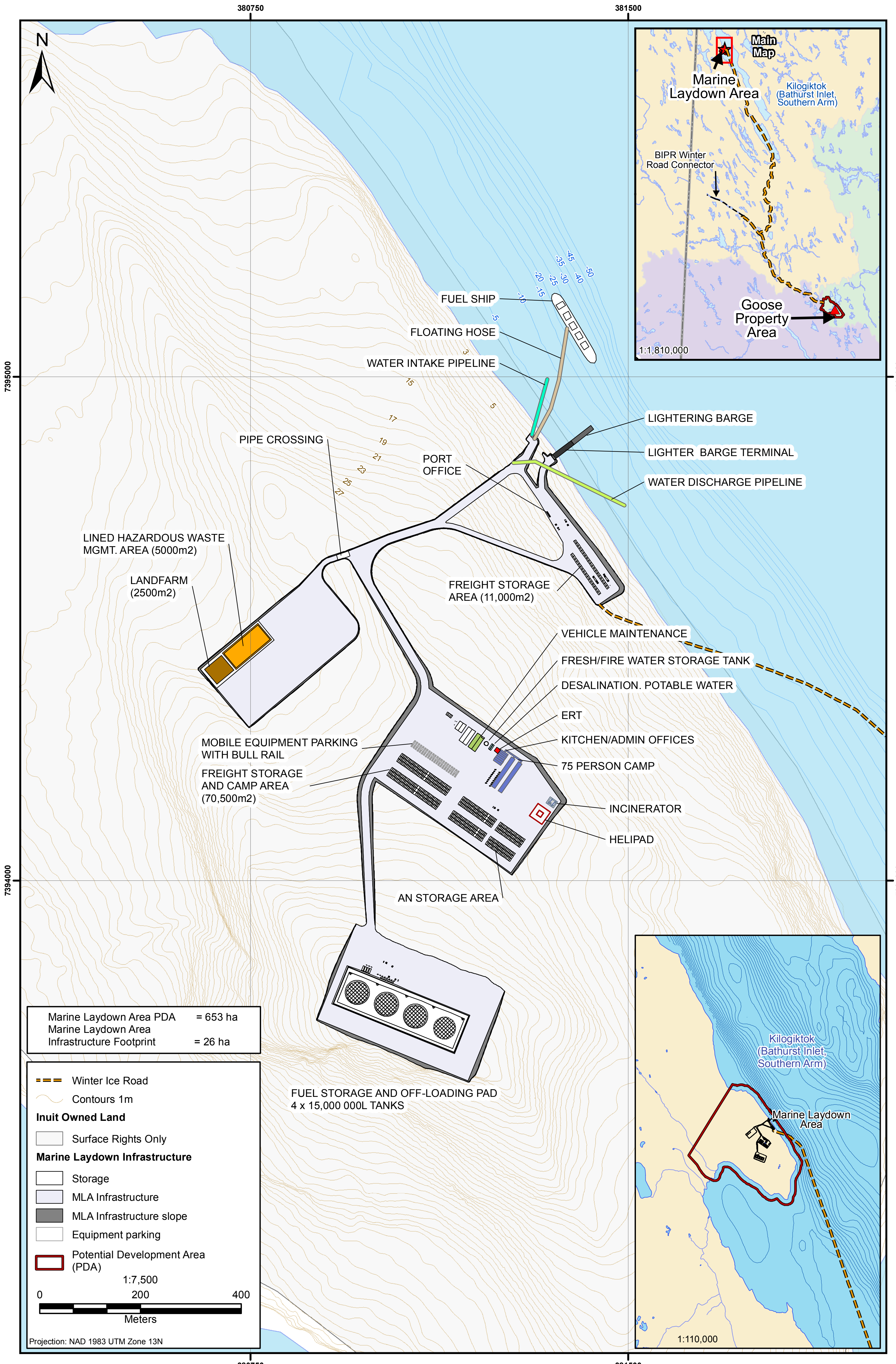

Figure 1.1-2

Potential Development Area and Layout
Marine Laydown Area

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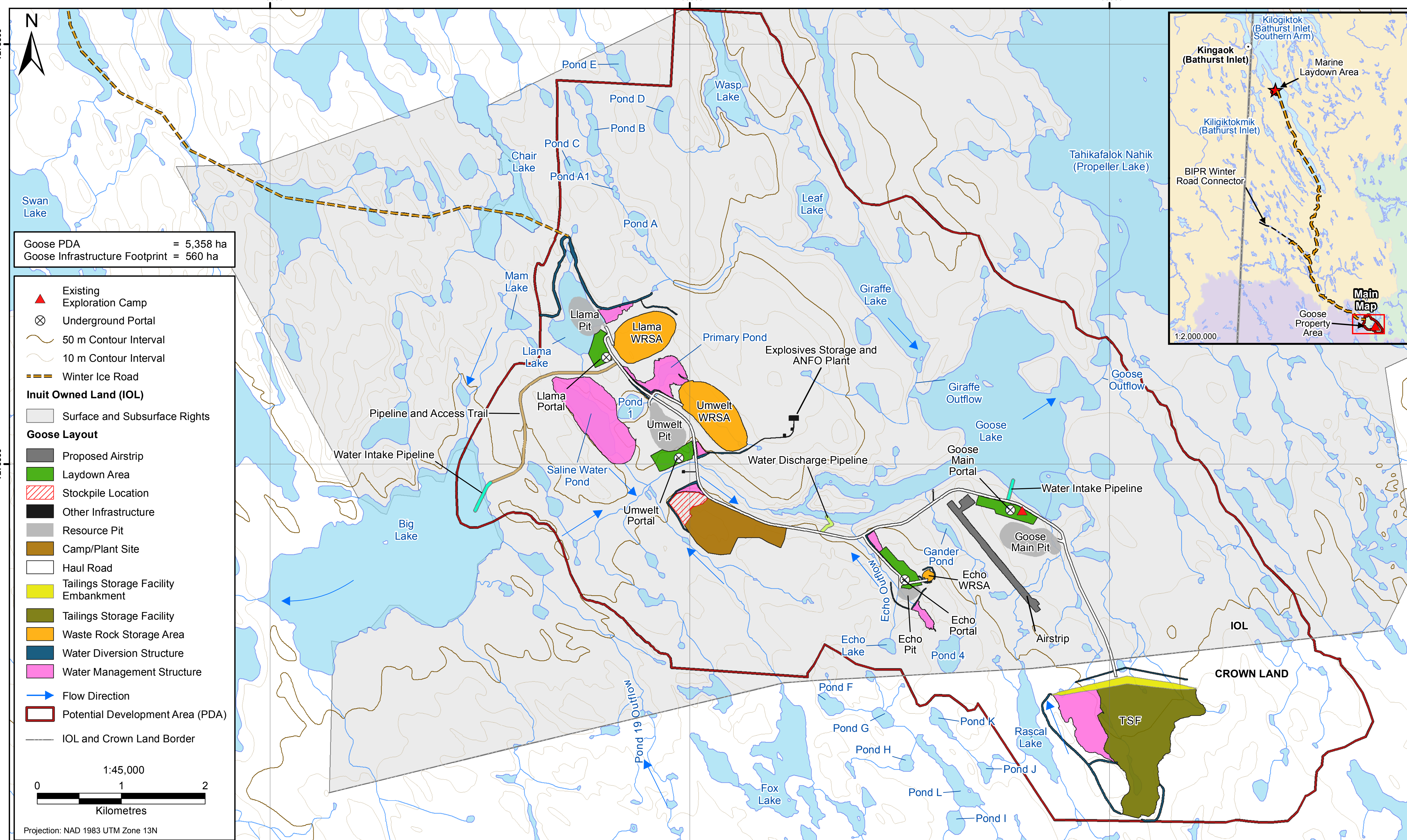

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Figure 1.1-3

Potential Development Area and Layout Goose Property Area

1.1.1 Requirements under the *Fisheries Act*

Subsection 35(1) of the *Fisheries Act* prohibits the carrying on of a work, undertaking, or activity that results in serious harm to fish[1] that are part of a commercial, recreational, or Aboriginal (CRA) fishery or to fish that support such a fishery. However, where it is not possible to completely avoid serious harm to fish such that some residual serious harm to fish remains, an authorization under paragraph 35(2)(b) of the *Fisheries Act* is required to carry on a work, undertaking, or activity. A *Fisheries Act* Authorization will be required for the Project.

The Application for Authorization must include the following information:

- description of proposed work, undertaking, or activity;
- project engineering specifications, scale drawings, and dimensional drawings (for physical works);
- timeline information;
- location information;
- description of fish and fish habitat (aquatic environment);
- description of potential effects on fish and fish habitat;
- description of measures and standards to avoid or mitigate serious harm to fish;
- description of the residual serious harm to fish;
- offsetting plan; and,
- letter of credit, as security for completion of the offsetting plan.

An offsetting plan is developed to undertake offsetting measures to counterbalance the unavoidable residual serious harm to fish from the Project, with the goal of maintaining or improving the productivity of the CRA fishery. DFO's approach to offsetting is described in the Fisheries Protection Policy Statement (DFO 2013a) and Fisheries Productivity Investment Policy (DFO 2013b). A Final Fisheries Offsetting Plan will be produced during the permitting phase of the Project with engagement of local communities and will need to be submitted as part of the Application for Authorization under the *Fisheries Act*. The plan would be approved by DFO as a condition of the Authorization.

As described in the Fisheries Productivity Investment Policy (DFO 2013b), an offsetting plan must include information about the objectives of the offsetting measures, the measures to offset residual serious harm to fish, an analysis of how the offsetting measure will meet their objectives (i.e., methodology used and estimate of the offset), schedule for implementation, and monitoring. Offsetting measures are focused on improving fisheries productivity. The preference of DFO is that offsets occur near a project or within the same watershed; however, offsetting measures can be undertaken in waterbodies or for fish species other than those affected by the project, provided the measures are supported by clear fisheries management objectives or regional restoration priorities. Offsetting plans are negotiated with DFO on a case-by-case basis and would require engagement with Aboriginal groups. Offsetting measures should meet the following principles:

[1] "Serious harm to fish" is defined in Subsection 2(2) of the *Fisheries Act* and means "the death of fish or any permanent alteration to, or destruction of, fish habitat".

1) offsetting measures must support fisheries management objectives or local restoration priorities;

2) benefits from offsetting measures must balance project effects;

3) offsetting measures must provide additional benefits to the fishery; and,

4) offsetting measures must generate self-sustaining benefits over the long term.

The three general categories of offsetting measures include: Habitat Restoration and Enhancement; Habitat Creation; and, Chemical or Biological Manipulations. Habitat restoration and enhancement includes physical manipulation of existing habitat to improve habitat function and productivity; examples include:

- placement of material to improve habitat structures (e.g., spawning beds or reefs);
- increasing shoreline complexity;
- river bank stabilization and re-vegetation of riparian areas;
- improving access to off-channel habitats;
- removal of anthropogenic barriers to fish migration; and,
- enhancement of vegetated areas in lakes.

Habitat creation involves the development or expansion of aquatic habitat into a terrestrial area, such as creation or expansion of natural stream channels, lakes, side channel habitats, wetlands, or bays. Chemical or biological manipulations may include chemical manipulation of waterbodies or stocking of fish; however, these measures should be used only when the other groups of offsetting measures are not available, and only under specific circumstances, such as where the site-specific issues are well understood, the limitations to fisheries productivity are known, and fisheries management plans contain clear objectives for the fishery (DFO 2013b).

In remote, pristine areas where there is a lack of information about fisheries productivity and where offsetting opportunities are limited, such as near the Project, complementary measures may be considered in addition to other offsetting measures. Complementary measures may include data collection and/or scientific research related to maintaining or enhancing the productivity of commercial, recreational, or Aboriginal fisheries. According to DFO Policy, complementary measures may comprise up to 10 percent (%) of the required amount of offsetting, with the remaining 90% consisting of one or more projects that fall under the habitat enhancement, restoration, creation, or manipulation categories of offsetting measures.

2. Community and Regulatory Engagement

2.1 COMMUNITY ENGAGEMENT

Sabina has regularly engaged local communities and representatives of the Kitikmeot Inuit Association (KIA) on the Project. This has included engagement on topics, such as fish offsetting requirements for the Project and, more specifically, the Bernard Harbour restoration project.

2.1.1 Back River Project

Sabina has been conducting community engagement and consultation activities for the Project since June 2012. During this time, dozens of meetings have been held with the public, Sabina's two community advisory groups in Cambridge Bay and Kugluktuk, local Hamlets, Hunters' and Trappers' Organization (HTOs), youth, and other stakeholder groups. The focus of these activities has generally been on the communities of Cambridge Bay, Kugluktuk, Bathurst Inlet, Bay Chimo, Gjoa Haven, Taloyoak, Kugaaruk, and Yellowknife. For example, public meetings were held in various communities in June 2012, November 2012, April 2013, August 2013, November 2013, and June 2015. One-on-one meetings with community stakeholder groups have also been held at various times. The Nunavut Impact Review Board has additionally held public meetings on the Project in February 2013, March/April 2014, and November 2014.

In addition to providing information to local communities on development plans for the Project, Sabina has discussed topics, such as fish offsetting, tailings and contaminant management strategies, lake dewatering, potential fisheries and water-related effects, and other environmental management and monitoring-related topics. Copies of all public meeting presentations made by Sabina can be found on www.backriverproject.com under the 'Additional Resources' tab. A complete list of the various stakeholder meetings Sabina has hosted or participated in since June 2012 is included in Appendix V3-1A of the Project FEIS.

Numerous questions, issues, and suggestions have been raised by local residents over the course of Sabina's public consultation and engagement program. Generally, communities have expressed support for the opportunities the Project will provide, but have also strongly expressed the need for the Project to be developed in a manner that is safe for both people and the environment. Particular concern has been expressed about potential long-term effects on fish, other wildlife resources, water quality, and from mine tailings and contaminants. Comments received during Sabina's public consultation and engagement program have been incorporated into a comprehensive public consultation database. This database contains over 165 topic directories and includes comments made by the public and information on when, where, and the forum in which the comments were made.

Topic directories (and the number of times a related comment was made) with potential relevance to fish offsetting requirements for the Project are presented in Table 2.1-1. Appendix V3-1G of the FEIS provides a full summary of the topics contained in Sabina's public consultation database, while Appendix V3-1C of the FEIS contains copies of all June 2012 – June 2015 meeting minutes and public comment forms from which the summary was developed.

Table 2.1-1. Example Topics Discussed and Related Number of Comments per Topic Made During Sabina's Public Consultation and Engagement Program

Back River Discussion Topic	Number of References by Community Members
Acid rock drainage	4
Environmental monitoring	35
Blocking watercourses	2
Dewatering of lakes	21
Mine contaminants and waste	77
Tailings	78
Waste rock	6
Water quality, quantity, and management	62
Wildlife – Fish	57

Sabina has gone through extensive effort to minimize or eliminate potential negative environmental and socio-economic effects in these areas. For example, a comprehensive environmental management and monitoring program has been developed, which addresses key areas of concern for local communities that were identified during public consultation. More details on Sabina's commitments to addressing community-identified issues are provided in Volume 3 (Public Consultation, Government Engagement, and Traditional Knowledge) of the FEIS.

All of the Project's existing camps and proposed infrastructure are located within the Kitikmeot Region. Accordingly, The KIA has been engaged on a regular basis by Sabina. Periodic site visits have been arranged for KIA board members and members of the KIA Lands, Environment and Resources Department, and the KIA has been kept informed of Sabina's various Project developments. The KIA is additionally responsible for issuing licences related to land and water use on Inuit Owned Land in the Kitikmeot Region, and Sabina is required to post reclamation security and negotiate wildlife compensation with them. Sabina is also required under the Nunavut Land Claims Agreement (NLCA) to negotiate an Inuit Impact and Benefit Agreement (IIBA) with the KIA. As such, regular communication pertaining to these matters has occurred between Sabina and the KIA throughout the Project's development. The KIA has likewise been an active reviewer and participant in the environmental assessment of Sabina's Back River Project.

2.1.2 Back River Offsetting Option

Sabina's commitment to the offsetting option proposed in the Conceptual Fish Offsetting Plan (i.e., Bernard Harbour) began in mid-2014. Since that time, Sabina has engaged local residents about the offsetting option in a number of ways (see Table 2.1-2). Foremost, Sabina has partnered with the Kugluktuk HTO in the planning and execution of the Bernard Harbour option. Stream remediation (or enhancement) activities in the Nulahugyuk Creek - Hingittok Lake system in the Kitikmeot Region of Nunavut (also known as Bernard Harbour) were initially proposed in the early 2000s by the Kugluktuk HTO. The Kugluktuk HTO has since worked closely with Golder Associates Ltd. (Golder) to advance early stages of the project (e.g. initial environmental baseline and habitat enhancement work) and, for some time, the two organizations were seeking an industry partner to help advance the project to completion.

Sabina was identified as an industry partner in early 2014 and has since advanced planning for the Bernard Harbour offsetting option in cooperation with the Kugluktuk HTO. Details on the relationship between the Kugluktuk HTO and Sabina in executing the Bernard Harbour offsetting option have been captured in the 'Bernard Harbour Restoration Project Agreement' between: The Kugluktuk Hunters and Trappers Organization and Sabina Gold & Silver Corp (see Appendix A), signed by both parties in June 2014. Importantly, the Bernard Harbour offsetting option is to remain a Kugluktuk HTO-led initiative with Sabina providing support to the Kugluktuk HTO such that the objectives of the offsetting plan are achieved.

The Kugluktuk HTO has remained involved in the Bernard Harbour offsetting option through semi-regular planning meetings and updates. The Kugluktuk HTO has also been instrumental in the planning and execution of baseline studies and initial remediation studies (in cooperation with Golder), and in the planning of future remediation of Bernard Harbour. While the activities, meetings, and correspondences associated with this baseline and initial work are not included in Table 2.1-2, they are reflected in the associated baseline reports that have been prepared by Golder (ANL and Golder 2005; Golder and ANL 2007; Golder 2013). The Kugluktuk HTO has also played a key role in the Traditional Knowledge (TK) study that was conducted for the Bernard Harbour Offsetting Option (for more details, see Appendix V3-3D of the FEIS, or a summary of the TK study provided further below).

The Kugluktuk general public have been engaged about the Bernard Harbour restoration project in different ways. For example, a public meeting was held in Kugluktuk on June 17, 2015 where results of the Bernard Harbour TK study, results of baseline fieldwork, and plans for the Bernard Harbour offsetting option were presented by Sabina representatives. The offsetting option was also briefly reviewed with representatives of Sabina's Community Advisory Group in Kugluktuk and the Hamlet of Kugluktuk during June 2015 community meetings held for the Project. Various members of the Kugluktuk public have also assisted in the baseline fieldwork and initial stream enhancement work that has been conducted at Bernard Harbour (ANL and Golder 2005; Golder and ANL 2007; Golder 2013).

Local residents generally appear very supportive of the remediation work planned for Bernard Harbour and wish to see the Bernard Harbour Arctic Char fishery returned to its previous status. The Kugluktuk HTO and those residents who have previously lived at Bernard Harbour (e.g., many of the TK study participants) have expressed a particular desire to see the offsetting option completed. A number of individuals have stated they appreciate the low impact approach that is being used (e.g., no use of heavy equipment) and the involvement of community members (including youth) in the project. Sabina intends to continue engaging the residents of Kugluktuk as necessary as the Bernard Harbour restoration project advances.

The KIA has been kept informed of plans for the Bernard Harbour offsetting option through semi-regular meetings and correspondence. A KIA representative additionally participated in a Bernard Harbour site visit hosted by Sabina in July 2014, where Golder's initial remediation work was examined and future offsetting plans were discussed. The KIA has also been provided with copies of the TK study data, so that it may be incorporated into their Naonaiyaotit Traditional Knowledge Project (NTKP) database. It is understood the KIA may utilize this information for their own purposes in the future. The data and results of the TK study are also intended to be freely shared with other Nunavut organizations that may benefit from its use.

Other members of the Nunavut and Northwest Territories public have been made aware of the Bernard Harbour offsetting option. For example, the project was briefly reviewed in the communities of Cambridge Bay, Taloyoak, Kugaaruk, and Yellowknife during June 2015 community meetings held for the Back River Project (with a visit to Gjoa Haven scheduled to occur later in the year). Two presentations on Bernard Harbour were additionally made by Sabina representatives at the 2015 Nunavut Mining Symposium held in Iqaluit, where various community, government, and industry stakeholders participated. A full list of community engagement activities undertaken by Sabina in regards to the Bernard Harbour offsetting option can be found in Table 2.1-2. Sabina will continue to engage northern residents as necessary on the Bernard Harbour restoration project as it advances.

Table 2.1-2. Community Engagement Activities Conducted by Sabina Regarding the Bernard Harbour Restoration Project

Location / Date	Individual(s) / Organization	Description
Kugluktuk		
March 19, 2014	David Nivingalok (Chairperson) and Kevin Klengenberg (Secretary-Treasurer), Kugluktuk HTO	Teleconference to discuss proposed fish offsetting work to be conducted at Bernard Harbour.
March 25, 2014	Kugluktuk HTO	Meeting to discuss proposed fish offsetting work to be conducted at Bernard Harbour and the associated TK study.
April 29, 2014	Kugluktuk HTO	Meeting to discuss 'Kugluktuk HTO-Sabina Bernard Harbour Restoration Project Agreement'.

(continued)

Table 2.1-2. Community Engagement Activities Conducted by Sabina Regarding the Bernard Harbour Restoration Project (continued)

Location / Date	Individual(s) / Organization	Description
June 1-6, 2014	Selected elders and knowledge holders	A series of traditional knowledge interviews were held with selected elders and local knowledge holders as a component of proposed fish offsetting activities in the Bernard Harbour, Nunavut area. A project overview meeting/presentation was also held with local study participants prior to the interviews commencing.
July 13, 2014	Bernard Harbour TK study participants, HTO chairperson, and acting HTO manager	A TK study results verification meeting was held with participants in the Bernard Harbour TK study and with the Kugluktuk HTO chairperson and acting manager. Various clarifications were made by the participants, which were later incorporated into the final TK study report.
July 17, 2014	Kugluktuk HTO chairperson	The chairperson of the Kugluktuk HTO accompanied Sabina representatives and various other attendees during a day-long site visit to Bernard Harbour.
February 12, 2015	Kugluktuk HTO representatives	Sabina met with the Kugluktuk HTO chairperson, treasurer, and manager to provide an update on the Bernard Harbour restoration project and Bernard Harbour TK study.
February 17, 2015	Kugluktuk HTO	Letter and copy of the draft 'Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek – Hingittok Lake Area (Bernard Harbour), Nunavut' provided to the HTO.
April 21, 2015	Kugluktuk HTO	Final copy of the 'Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek – Hingittok Lake Area (Bernard Harbour), Nunavut' provided to the HTO.
May 8, 2015	Barbara Adjun, Kugluktuk HTO Manager	Phone update on the Bernard Harbour offsetting option.
May 21, 2015	David Nivingalok, Kugluktuk HTO Chairperson	Phone update on the Bernard Harbour offsetting option.
June 17, 2015	General public	Public meeting – Project update and FEIS submission overview. The results of the Bernard Harbour TK study and plans for Bernard Harbour were reviewed.
June 18, 2015	Kugluktuk Community Advisory Group	Project update and FEIS submission overview. Plans for the Bernard Harbour were briefly reviewed.
June 18, 2015	Kugluktuk HTO	Project update and FEIS submission overview. The results of the Bernard Harbour TK study and plans for the Bernard Harbour were reviewed.
June 19, 2015	Hamlet of Kugluktuk	Project update and FEIS submission overview. Plans for Bernard Harbour were briefly reviewed.
July 8, 2015	David Nivingalok, Kugluktuk HTO Chairperson	Letter providing information on the 2015 Bernard Harbour work proposal.
Cambridge Bay		
June 7-10, 2014	Selected elders and knowledge holders	A series of traditional knowledge interviews were held with selected elders and local knowledge holders as a component of proposed fish offsetting activities in the Bernard Harbour, Nunavut area.
June 15, 2015	Cambridge Bay Community Advisory Group	Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting option were briefly reviewed.
June 16, 2015	Hamlet of Cambridge Bay Representatives	Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting option were briefly reviewed.
June 16, 2015	General public	Public meeting – Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting option were briefly reviewed.

(continued)

Table 2.1-2. Community Engagement Activities Conducted by Sabina Regarding the Bernard Harbour Restoration Project (completed)

Location / Date	Individual(s) / Organization	Description
Kingaok and Omingmaktok		
June 15, 2015	Residents of Kingaok and Omingmaktok	Dinner and meeting on the Back River Project (re: Project update and FEIS submission overview) in Cambridge Bay, specifically for residents of Kingaok and Omingmaktok. Plans for the Bernard Harbour were briefly reviewed.
Gjoa Haven		
October 6, 2015	General public	Project update and FEIS submission overview. Plans for Bernard Harbour were briefly reviewed.
Taloyoak		
June 17, 2015	General public	Public meeting – Project update and FEIS submission overview. Plans for the Bernard Harbour were briefly reviewed.
June 17, 2015	Hamlet of Taloyoak	Project update and FEIS submission overview. Plans for Bernard Harbour were briefly reviewed.
Kugaaruk		
June 16, 2015	General public	Public meeting – Project update and FEIS submission overview. Plans for Bernard Harbour were briefly reviewed.
Iqaluit		
April 14, 2015	Various community, government, and industry stakeholders participated	Sabina and Golder representatives participated in the Nunavut Mining Symposium in Iqaluit and made two presentations related to the Bernard Harbour offsetting option.
Yellowknife		
June 15, 2015	General public	Public meeting - Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting option were briefly reviewed.

2.1.3 Incorporation of Traditional Knowledge (TK)

The Conceptual Fish Offsetting Plan relies on the information collected from Inuit-led TK information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the offsetting plan, including existing environment and baseline summaries, mitigation and adaptive management plans, and the selection of the offsetting option to counterbalance any losses in fisheries productivity.

2.1.3.1 Environmental Assessment

The following reports were reviewed for TK specific information related to fisheries at the Project and are summarized in other sections of the FEIS:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) (KIA 2012) (Appendix V3-3A of FEIS);
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3B of FEIS); and,

Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014) (KIA 2014) (Appendix V3-3C of FEIS).

2.1.3.2 *Offsetting Option*

The Kugluktuk HTO and the TK provided by the HTO has been instrumental in the planning and execution of baseline studies and initial remediation studies (in cooperation with Golder), and in the planning of future remediation of Bernard Harbour (e.g., ANL and Golder 2005; Golder and ANL 2007; Golder 2013). The Kugluktuk HTO has also played a key role in the TK study that was conducted for the Bernard Harbour Offsetting Option.

In an effort to develop a better understanding of the Arctic Char fishery in the Bernard Harbour area (and related historic and contemporary environmental conditions), a TK study was conducted in 2014 to 2015. The TK study was carried out by Sabina in partnership with the Kugluktuk HTO and was intended to complement the scientific baseline studies that have also been conducted at Bernard Harbour. The TK study involved one-on-one interviews with 11 Bernard Harbour land users from Kugluktuk and Cambridge Bay, who were selected for inclusion in the study by the Kugluktuk HTO. The TK study also made use of various secondary sources (e.g., historic records, land use reports, academic publications) and a Bernard Harbour site visit to provide additional information on the Arctic Char fishery. Results of the study provided a baseline summary of a historically-significant Arctic Char fishery for local Inuit, and ultimately, confirmation that Bernard Harbour was the preferred offsetting option for the Project.

Further information on the TK study can be found in Appendix V3-3D of the FEIS, see:

Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek – Hingittok Lake Area (Bernard Harbour), Nunavut (Appendix V3-3D of FEIS).

2.2 REGULATORY ENGAGEMENT

Sabina has regularly engaged DFO on the Project (Table 2.1-3). This has included engagement on topics such as fish offsetting requirements for the Project and, more specifically, the Bernard Harbour restoration project.

Table 2.1-3. Regulatory Engagement Activities Conducted by Sabina Regarding the Bernard Harbour Restoration Project

Date	Organization	Location	Purpose
2014			
February	Fisheries and Oceans Canada – Central and Arctic Region	Yellowknife	Introduction to the contents and structure of the Draft Environmental Impact Statement. Introduction of the Proposed Fisheries Offset Concept at Bernard Harbour
April	Fisheries and Oceans Canada – Central and Arctic Region	Yellowknife	Introduction to the Back River Project
June	Fisheries and Oceans Canada – Central and Arctic Region	Yellowknife	Update meeting and discuss attendance at the location of the proposed fisheries offset (Bernard Harbour site)
July	Fisheries and Oceans Canada – Regional Director, Ecosystems Management	Ottawa	Project status, Bernard Harbour and next steps
	Fisheries and Oceans Canada – Central and Arctic Region	Kugluktuk	Attendance at the Bernard Harbour site: along with the Kugluktuk HTO and KIA

(continued)

Table 2.1-3. Regulatory Engagement Activities Conducted by Sabina Regarding the Bernard Harbour Restoration Project (completed)

Date	Organization	Location	Purpose
August	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Discussion of authorization requirements for Site Preparation Work
October	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Further discussion of authorization requirements for Site Preparation Work
2015			
January	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Exploring equivalency in Offsetting Policies
March	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Discussed PHC comment responses and direction on habitat banking process. Feedback on Site Preparation proposed methodology
April	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Discussed proposed approach to significance / residual effects assessment for FEIS
May	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Feedback on Rascal Lake Realignment and effects assessment approach. Update on Bernard Harbour status provided. Discussed baseline work prior to freshet.
September	Fisheries and Oceans Canada – Central and Arctic Region	Teleconference	Overall project update; discussion of potential Schedule 2 implications based on predicted habitat losses
	Fisheries and Oceans Canada – Executive Fisheries Protection	Ottawa	Project status update; discussion on Bernard Harbour direction

3. Regional Setting

3.1 MARINE LAYDOWN AREA

Bathurst Inlet is a fjord that is long (approximately 165 km), narrow (2 to 15 km), and deep (greater than 300 m). This waterbody is divided into two major basins separated by a shallow sill. The outer inlet is the deeper of the two basins and contains many islands and a complex bathymetry. The inner inlet runs landward from the vicinity of Kingaok, has a relatively simple structure with few islands, and is shallower than the outer inlet, with depths between 100 and 150 m. The Western River discharges into the head of the inlet at the south, and the Mara River and Burnside River discharge into the western shoreline of the inlet. Numerous small streams discharge into the inlet along eastern and western shorelines. Bathurst Inlet cuts through the Bathurst Hills Ecoregion, which is characterized by strong relief built from massive granite rocks. The deeply indented, rocky shorelines lead to steep bathymetry with narrow nearshore areas.

Bathurst Inlet is typical of oligotrophic Arctic marine ecosystems, i.e., oxygenated throughout the water column, low in nutrients and metals, and low in phytoplankton biomass levels. Benthic invertebrates are both diverse and abundant in Bathurst Inlet, characteristics shared with other Arctic marine ecosystems. Mud and fine sediments dominate the benthic environment.

The marine fish community of Bathurst Inlet is characteristic of Arctic marine ecosystems and includes marine, anadromous, and freshwater/estuarine species. Thirteen species captured have been observed in freshwater, brackish or estuarine habitats during at least one part of their life history. Many fish species serve roles in the ecological and cultural health of the area.

Nineteen fish species are presumed to occur in waters in the immediate vicinity of the MLA in Bathurst Inlet (i.e., Local Study Area [LSA]) based on TK (KIA 2012; KIA 2014) and baseline sampling (Table 3.1-1) (also see Section 5.1.6 in Volume 7). None of the captured species are currently considered endangered, threatened, or are listed under Canada's *Species at Risk Act* (Government of Canada 2002). Fourhorn Sculpin were the most abundant species in 2001 and 2010, but were the third most abundant species in 2012. Capelin was the most abundant species in 2012, followed by Pacific Herring. Capelin were not captured on any previous sampling occasions, and their dominance in the community sampling is attributed to the date of sampling coinciding with the Capelin spawning period in 2012. During non-spawning periods, adult Capelin are generally associated with offshore habitat and are not expected to be present year-round in the nearshore areas of the LSA. Pacific Herring, Starry Flounder, Arctic Cisco, and Saffron Cod were captured in all years and on average comprised 10% or greater of the total catch.

Table 3.1-1. Fish Species Captured or Presumed to Occur in Bathurst Inlet

Common Name	Scientific Name	Primary Habitat	Depth Range
Arctic Char	*Salvelinus alpinus*	Freshwater/Anadromous	Benthopelagic
Arctic Cisco	*Coregonus autumnalis*	Freshwater/Brackish	Benthopelagic
Arctic Cod	*Boreogadus saida*	Marine	Bathypelagic
Arctic Flounder	*Pleuronectes glacialis*	Marine	Demersal
Bering Wolffish	*Anarhichas orientalis*	Marine	Demersal
Broad Whitefish	*Coregonus nasus*	Freshwater/Brackish	Benthopelagic
Capelin	*Mallotus villosus*	Marine	Pelagic
Fourhorn Sculpin	*Myoxocephalus quadricornis*	Marine/Brackish	Demersal
Lake Trout	*Salvelinus namaycush*	Freshwater/Anadromous	Benthopelagic
Least Cisco	*Coregonus sardinella*	Marine/Anadromous	Pelagic
Ninespine Stickleback	*Pungitius pungitius*	Freshwater/Estuarine	Benthopelagic
Pacific Cod	*Gadus marcocephalus*	Marine	Demersal
Pacific Herring	*Clupea pallasii*	Marine	Pelagic
Rainbow Smelt	*Osmerus mordax*	Anadromous	Pelagic
Round Whitefish	*Prosopium cylindraceum*	Freshwater/Brackish	Demersal
Saffron Cod	*Eleginus gracilis*	Marine/Brackish	Demersal
Slender Eelblenny	*Lumpenus fabricii*	Marine	Demersal
Sockeye Salmon	*Oncorhynchus nerka*	Anadromous	Pelagic
Starry Flounder	*Platichthys stellatus*	Marine/Brackish	Demersal

Note: Species highlighted in grey were not captured during Baseline sampling in 2010 and 2012, but they have an historic precedence of capture in Bathurst Inlet and are presumed to occur in Bathurst Inlet (reviewed in Volume 7, Chapter 5).

The community composition of fish species and the fish harvested (e.g., Arctic Char) by traditional user in the Regional Study Area reflects the influence of freshwater in the system (Figure 3.1-1). Traditional Knowledge of Arctic Char (locally known as Ekalukipik), a Valued Ecosystem Component in the environmental assessment and one of the main fish species for Ocean Inuit and Kiligiktolmiut (see Section 5.3, Volume 7, of the FEIS), was primarily discussed with reference to freshwater fishing (KIA 2012; KIA 2014). However, some coastal areas of char habitat (fishing grounds) were identified. Arctic Char occurrence was identified in the majority of rivers that flow to the ocean with the mouth of the

Hiukkittak (River), the mouth of the Burnside River and the Mara River being important Arctic Char rivers for fishing.

Inuit uses of other marine fish species have also been described for tomcod (Arctic Cod or locally known as Hiughuktuk); both Arctic Char and Arctic Cod are the main fish species for Ocean Inuit and Kilikiktolmiut (KIA 2012; KIA 2014). TK information on the characteristics and uses of marine species also includes Saffron Cod, Capelin, smelt, flounder (i.e., turbot), herring, eels, wolfish, sculpin, crabs, oysters, and starfish. Arctic Cod and Saffron Cod are described as deep water, open ocean fish that are good for eating. Seasonal (summer) spawning migrations by Capelin in nearshore areas were observed and Capelin were used by drying them for eating or for dog food. Different eel species were identified in nearshore areas and considered potential food fish. Wolffish were described as strong tasting and as having thick skin. The occurrence of salmon and other unknown or new species (e.g., sharks) was also described.

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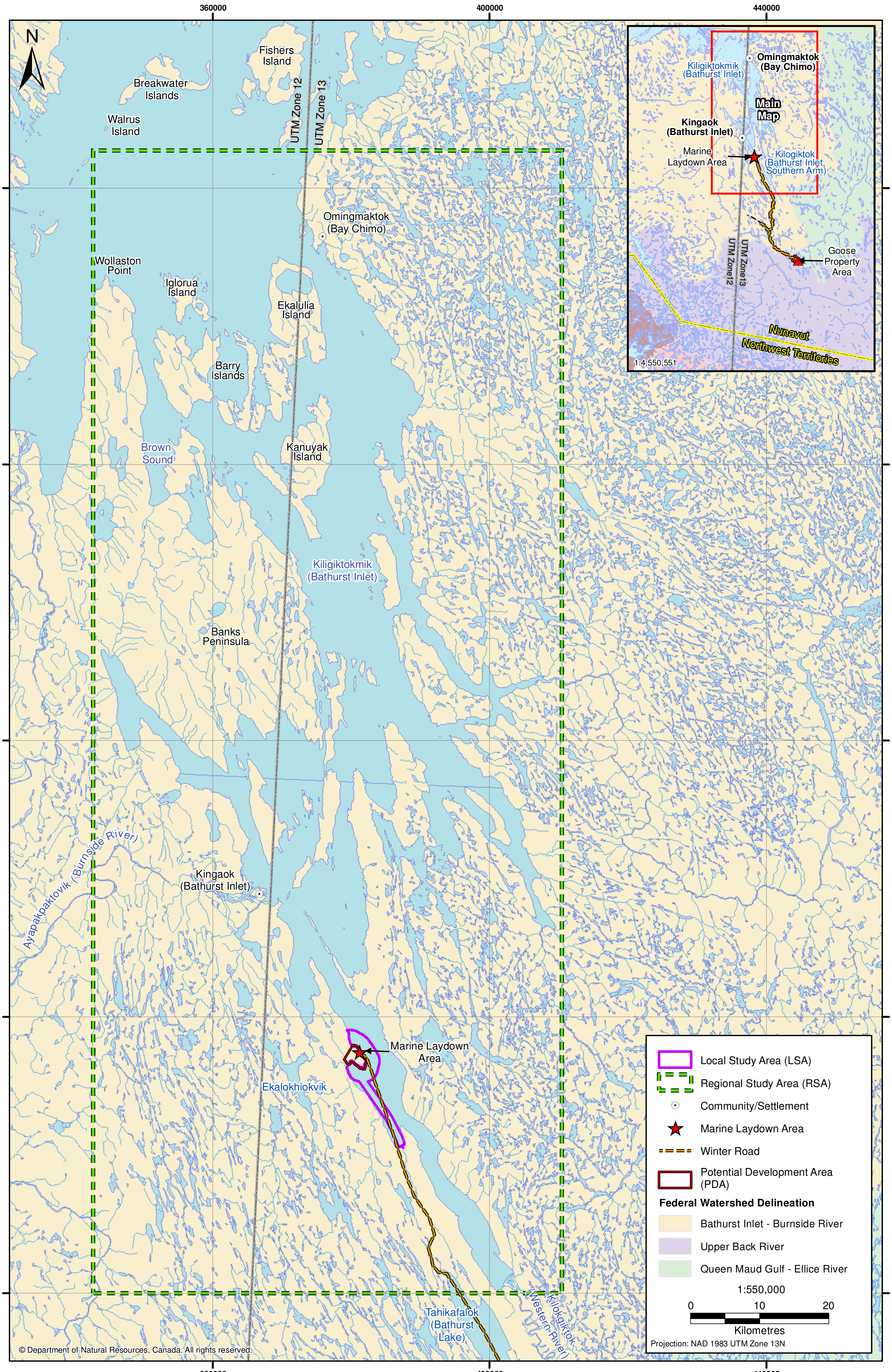

Figure 3.1-1

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Local Study Area and Regional Study Area for Arctic Char

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3.2 PROPERTY AREA

The Project is located in western Nunavut in the continuous permafrost zone of the continental Canadian Arctic. All proposed infrastructure at the Goose Property lies within the Ellis River Watershed. The Ellis River Watershed flows to the northwest, and enters the ocean on the west side of Bathurst Inlet. The Back River Watershed lies south of the proposed infrastructure in the Goose Property Area and flows to the east eventually entering the Arctic Ocean south of Gjoa Haven.

The region containing the Project is characterized by extensive networks of lakes and streams within a hummocky landscape with low elevation relief and exposed bedrock uplands. Winter is characterized by extreme cold (mean monthly temperatures -33°C), and ice cover is present on lakes between October and July. Air temperatures are highest in July, reaching a mean monthly temperature of 14°C. Regional meteorological stations report total annual precipitation between 125 mm (2009) to 344 mm (2007) for the interval 2006 to 2012 (see Volume 4, Chapter 3 for additional information). Ice depths on waterbodies are typically 1.5 to 2 metres (m) thick, and shallow waterbodies (< 1.5 m) freeze to the bottom. Hydrology in the Project area is snowmelt dominated, with peak flows occurring from early May to mid-June in most watersheds. Occasional rainfall-driven high flow events may occur between June and September.

The Goose Property is in the headwater region of its respective watersheds and has a relatively small upstream catchment. A few deep lakes provide the majority of year-round fish habitat (such as Propeller and Goose lakes), while shallow and ephemeral lakes and ponds provide seasonal habitat. Year-round habitat quality in lakes is primarily limited by depth, since overwintering by fish is only possible in lakes that do not freeze to the bottom or retain sufficient dissolved oxygen levels during ice cover. Streams in the Project area are generally small and shallow and do not provide overwintering fish habitat. Over the course of the summer, these streams tend to have low flow and low water levels. Many streams are ephemeral, flowing only during freshet, while others feature seasonal barriers such as boulder fields and seepages.

Fish distribution in the Goose Property Area is typical of inland, headwater regions of the Canadian Arctic. Lake Trout (*Salvelinus namaycush*) is the dominant freshwater fish species in the Local Study Area, followed by Round Whitefish (*Prosopium cylindraceum*), Arctic Grayling (*Thymallus arcticus*), Slimy Sculpin (*Cottus cognatus*), and Ninespine Stickleback (*Pungitius pungitius*). Other species reported in the study area include Burbot (*Lota lota*) and Lake Whitefish (*Coregonus clupeaformis*). No Arctic Char (*Salvelinus alpinus*) have been captured at the Goose Property; however, they have been captured nearer Bathurst Inlet approximately 76 km north of the Goose Property.

In the TK report (KIA 2012), the Inuit note that fish are present throughout the landscape surrounding and including the Project Area. While Goose Lake may be occasionally fished by traditional land users, they are not known to be destinations or key locations for fishing (Volume 8, Chapter 4).The TK reports also notes that freshwater fishing primarily takes place in the Back River Watershed, along the Western River, and nearby Bathurst Inlet. Lake Trout are found in lakes throughout the region; however, they are also found in rivers where large, deep pools do not freeze in winter. Whitefish and Cisco (*Coregonus artedi*) are also found in such lakes. Arctic Grayling are fished in several lakes, rivers, and streams in the Back River Watershed and along the Western River. The Inuit observe that Arctic Grayling spawn over shallow boulder fields, and that the juvenile fish are commonly found in shallow, sandy streams (KIA 2012).

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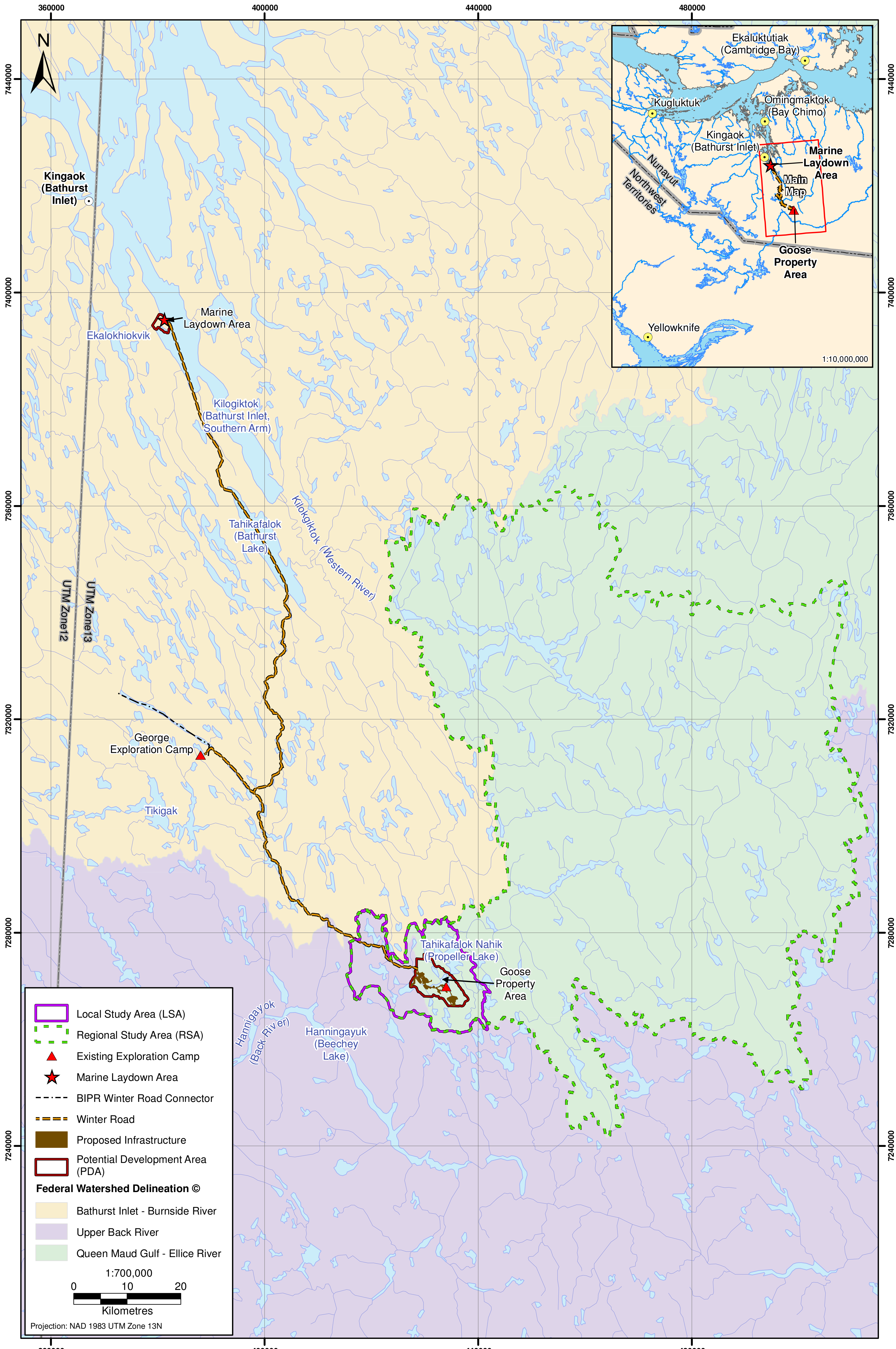

Figure 3.2-1

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 (FT), 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. 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. Procedures for the proposed fish-out are summarized in Section 11, whereas 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 (Chapter 4);
- Spill Contingency Plans (Chapter 5);
- Oil Pollution Emergency Plan (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 (Chapter 19);
- Tailings Management Plan (Chapter 22); and,
- Mine Closure and Reclamation Plan (Chapter 29).

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.
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 riparian vegetation 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 take 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 from May 1 to July 15 during spring spawning and incubation periods for Arctic Grayling. • 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 propellor 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.

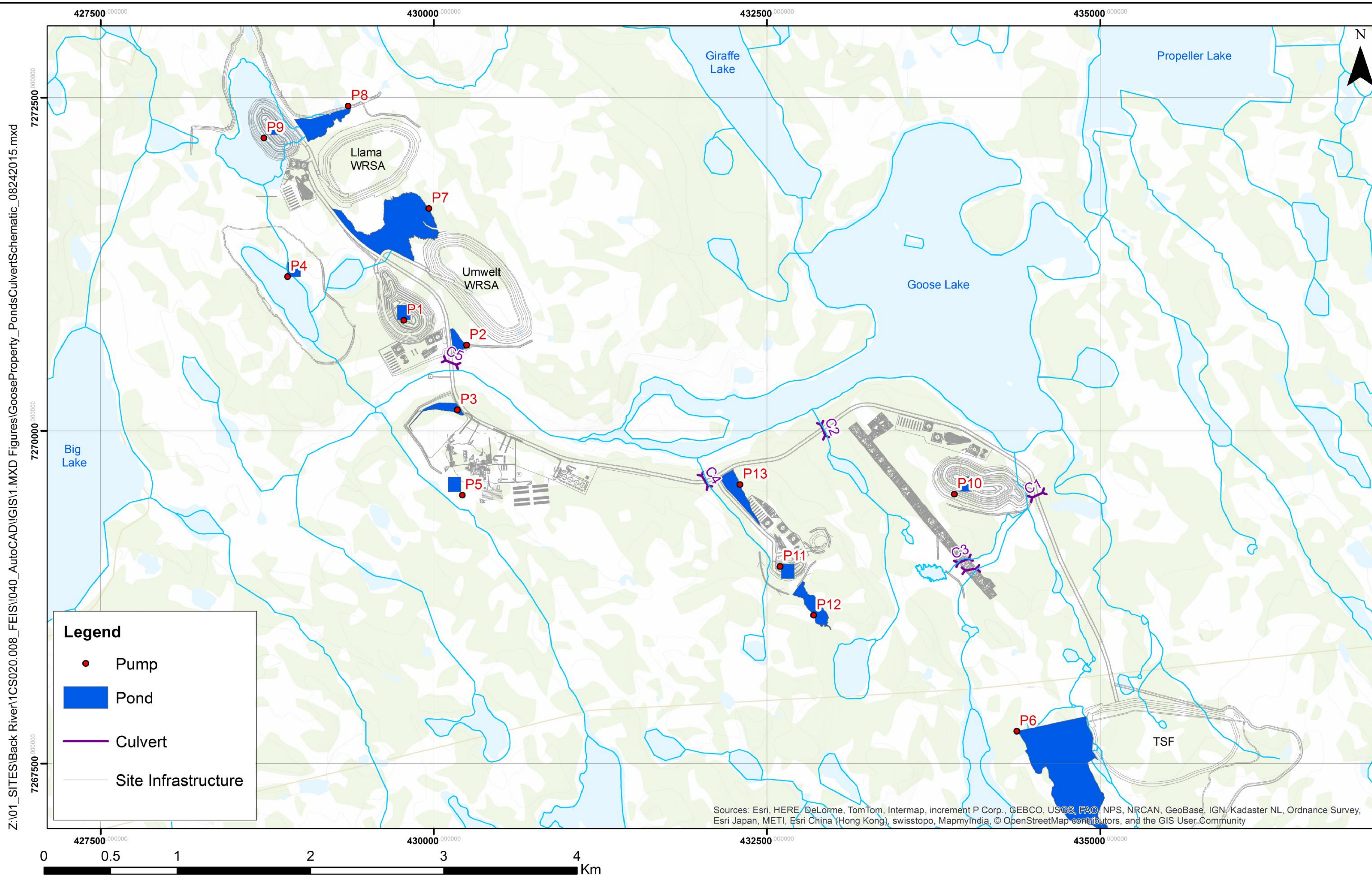
Water management plans were prepared for each phase of the mine life: construction, operations, closure and post-closure. The operational period consists of open pit and underground mining, and will take place over a ten-year period. Three tailings facilities are operated in sequence, which are presented 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	Figure: 5.2-1
Filename:	Fig3_Pumping_Culvert_Schematic.pptx				

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.

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). The potential introduction of deleterious substances to freshwater habitat at the Goose Property was 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 (i.e., serious harm) 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, it is considered to be local within 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.

6.2.1.1 Residual 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 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.

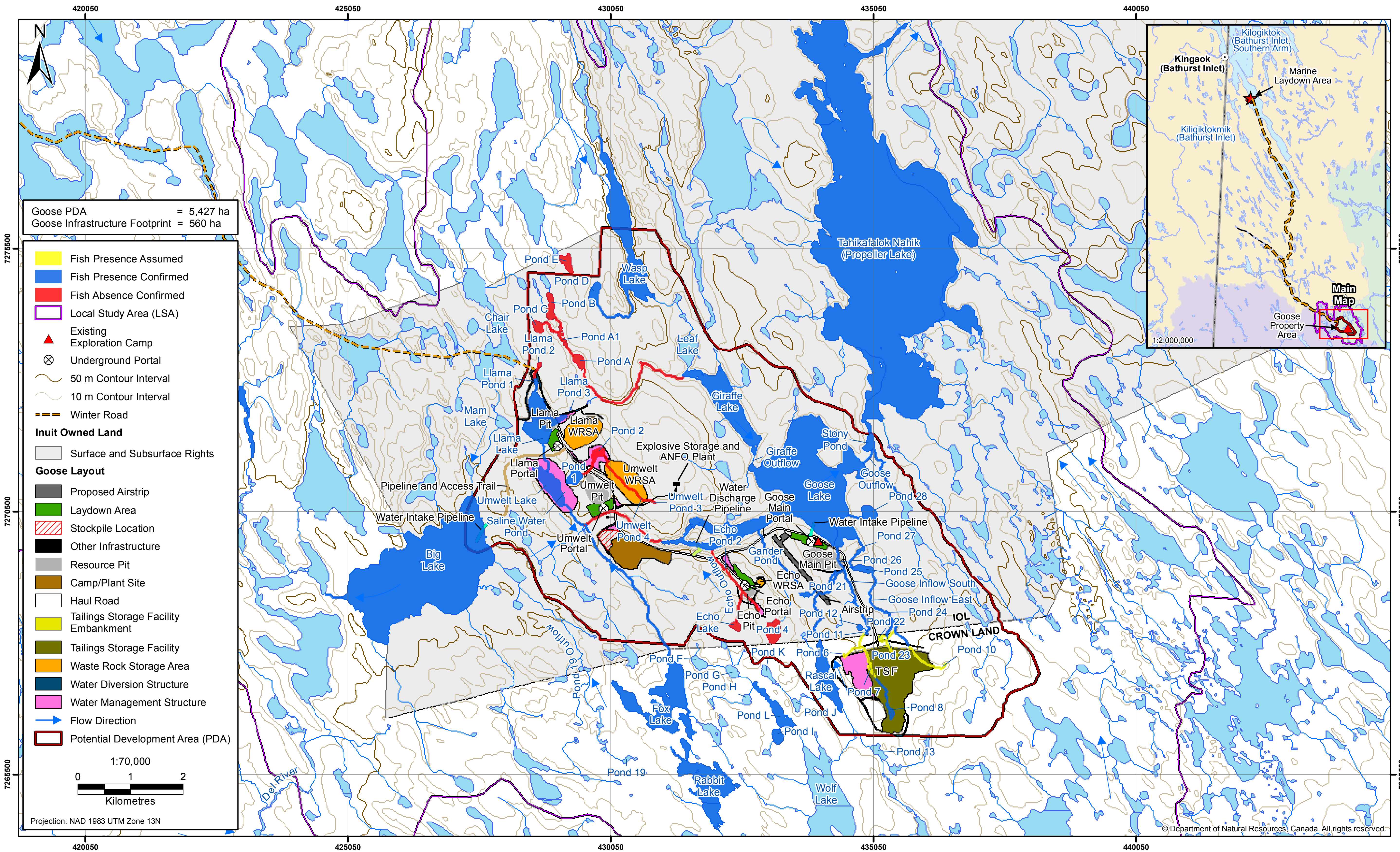


Figure 6.3-1

Fish Bearing Status within the LSA, Goose Property Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

6.3.1 Lakes

In fish bearing lakes, a direct loss of habitat will occur in Llama Lake as the result of construction of the Llama Pit and at Umwelt Lake as a result 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 (see Section 9).

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 rip rap, and daylighting the end of pipe at approximately 5 m water depth. The use of a rock apron is expected to mitigate any potential residual serious harm resulting from 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 serious harm resulting from 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 ponds located in the Llama Watershed (associated with the Llama and Umwelt Pits) and the Goose and Wolf watersheds (both associated with the TSF) will be lost to infrastructure (Figure 6.3-1), representing a total wetted area loss of 22.6 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) likely serve primarily as 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 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 habitat loss will be initiated during the Construction Phase and persist in perpetuity.

Fifteen 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), 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) and one by isolation from connected waterbodies (0.56 ha: pond 10) (Figure 6.3-1, Table 6.3-1). 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. Given their shallow nature, fish use of these ponds is limited to the summer. Within the potential TSF location overwintering habitat only exists in Pond 8. Pond 10, potentially isolated on the eastern side of the TSF, is also sufficiently deep to provide potential overwintering habitat to forage fish along with summer rearing habitat. 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 the spring freshet. 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 low in-stream flow conditions in the fall 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. However, for the establishment of a fisheries offsetting plan, all ponds are considered losses in perpetuity.

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	Loss Type	Area (ha)	Maximum Depth	Species Captured*	Data Source
Llama Lake**	Llama	Infrastructure (Llama Pit)	Total	36.59	13.6	LKTR, RDWF, NSSB	1,2,3
Llama Pond 1**	Llama	Infrastructure (Water Diversion Structure)	Total	0.71	>3		6
Llama Pond 3**	Llama	Infrastructure (Llama Pit)	Total	0.57	0.8		6
Umwelt Lake**	Llama	Infrastructure (Saline Water Pond)	Total	19.36	3.0	LKTR, ARGR, RDWF	1,2,3,4
Pond 1	Llama	Infrastructure (Isolation)	Total	6.25	3.0	SLSC, NSSB	2
Pond 6	Wolf	Infrastructure (Tailings Storage Facility; TSF)	Total	0.50	1.0		5,6
Pond 7	Wolf	Infrastructure (TSF)	Total	1.66	<1		5,6
Pond 8**	Wolf	Infrastructure (TSF)	Total	2.70	2.0	NSSB	5,6
Pond 9**	Goose	Infrastructure (TSF)	Total	0.22	0.4		5,6
Pond 10	Goose	Infrastructure (Isolation from connected waterbodies)	Total	0.56	>3		5,6
Pond 11	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	0.86	<1		5,6
Pond 12	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	0.24	<1	NSSB	5,6
Pond 20	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	0.19	NA		5,6
Pond 21**	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	0.73	0.7	NSSB	5,6
Pond 22	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	1.18	1.0		5,6
Pond 23	Goose	Infrastructure (Downstream of TSF loss of catchment)	Total	0.07	0.4	NSSB	5,6
Pond 24	Goose	Infrastructure (Downstream of TSF loss of catchment)	Total	0.22	0.7	NSSB	5,6
Pond 25**	Goose	Infrastructure (Downstream of TSF loss of catchment)	Total	4.20	0.4	NSSB	5,6
Pond 26**	Wolf	Infrastructure (Downstream of TSF loss of catchment)	Total	0.19	0.9		5,6
Pond 27*	Goose	Infrastructure (Downstream of TSF loss of catchment)	Total	1.56	>2	ARGR, SLSC, BURB, NSSB	5,6
Goose Lake	Goose	Infrastructure (Water Intake and Discharge Pipes)	Partial	0.51	16.5	LKTR, ARGR, RDWF, BURB, SLSC, NSSB	2,3
Big Lake	Big	Infrastructure (Water Intake Pipe)	Partial	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; ** losses potentially resulting in residual serious harm to fish.*

Data Sources: 1 – Rescan (2010); 2 – Rescan (2012a); 3 – Rescan (2012b); 4 – Rescan (2013); 5 – Rescan (2014); 6 – Rescan 2015 fisheries field data (in preparation)

6.3.3 Streams

Several small, 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 3.2 ha (Table 6.3-2).

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 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. 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. For the establishment of a fisheries offsetting plan, all ponds are considered losses in perpetuity.

Within the Goose and Wolf Watersheds, three streams will be lost, or partially lost totalling an approximate 2.6 ha of fish bearing habitat (Table 6.3-1). Two streams will be lost due to the construction of the TSF and the loss upstream catchment area (Goose Inflow East [GIE: 1.6 ha loss] and Goose Inflow South [GIS: 0.6 ha loss]), whereas Rascal Stream East (RSE: 0.5 ha loss) will be partially lost due to development of the airstrip and associated water management infrastructure (Figure 6.3-1).

The Goose Inflow East and South streams 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 GIE and GIS 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. 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. 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 are considered habitat losses in perpetuity.

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	Loss 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)	Total	1.55	3,887	4	ARGR, SLSC, BURB, NSSB	2,3
Goose Inflow South**	Wolf	Infrastructure (TSF and downstream loss of catchment)	Total	0.63	3,527	1.8	ARGR, SLSC, BURB, NSSB	1,2,3
Rascal Stream East**	Wolf	Infrastructure (airstrip and reaches downstream to Goose Inflow South)	Partial	0.45	1,228	3.7	ARGR, SLSC, BURB, NSSB	1
Llama Inflow from Llama Pond 1**	Llama	Infrastructure (water diversion structure)	Total	0.02	99	1.8		3
Umwelt Inflow from Pond 1	Llama	Infrastructure (isolation from connected waterbodies)	Total	0.01	129	1.0		3
Llama Outflow**	Llama	Infrastructure (Llama Pit dewatering; loss of catchment)	Total	0.08	436	1.8	ARGR, RDWF, SLSC, NSSB	3
Umwelt Outflow**	Llama	Infrastructure (Saline Water Pond dewatering; loss of catchment)	Total	0.44	551	8.0	ARGR, NSSB	3
Gander Outflow	Wolf	Infrastructure (culvert for Haul Road)	Partial	<0.01	30	0.7	ARGR, NSSB	1

** 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 (2013); 2 – Rescan (2014); 3 – Rescan fisheries field data (in preparation)

6.3.3.1 Residual Harm to Fish

It is expected that serious harm to fish will occur for 22 lakes and ponds, and 8 streams at the Goose Property. Total area of affected habitat is approximately 79.6 ha of lakes and ponds, and 3.2 ha of streams. Residual serious harm to fish is 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 rip rap. This use of a rock apron is expected to mitigate any potential residual serious harm resulting from the intake pipe. However, 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 10 lakes and ponds, and 7 streams, totalling 66.8 ha of lakes and ponds and 3.2 ha of streams. Most of the expected Residual Harm to fish will occur in Llama Lake (36.6 ha) and Umwelt Lake (19.4 ha).

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. 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 northern lakes (Samarasin et al. 2015) combined with catch data, including body size measurements, for Llama and Umwelt lakes. The equation applied for estimating losses for lakes was as follows:

$$\log_{10}(biomass) = 1.08 + 1.04\ (\log_{10}(lake\ area)) + 0.05\ (no.of\ species) + 0.03\ (mean\ annual\ air\ temp.);$$

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, 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, Goose Inflow East, 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 gill netting 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).

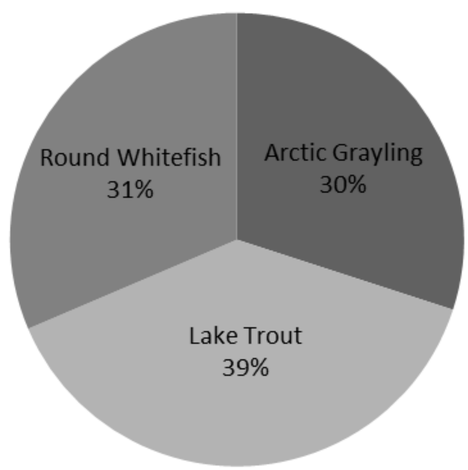


Figure 6.4-1. Species Composition of the Llama-Umwelt Lake System, Goose Property Area

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 northern lakes (Samarasin et al. 2015) 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 36.6 ha for area of Llama Lake, 19.4 ha for Umwelt Lake, 0.71 ha for Llama Pond 1, 0.57 ha for Llama Pond 3, five species (Arctic Grayling, Lake Trout, Ninespine Stickleback, Round Whitefish, and Slimy Sculpin), and a mean annual air temperature of -11.1°C. Thus, the total calculated biomass is 661.2 kg for the Llama-Umwelt lake system.

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%).

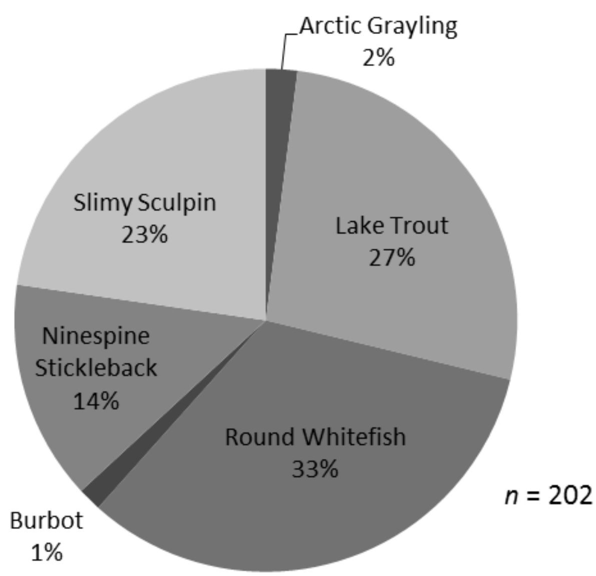


Figure 6.4-2. Species Composition of Goose Lake, Goose Property Area

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 the biomass equation derived for northern lakes (Samarasin et al. 2015). Equation inputs included 320.2 ha for area of Goose Lake, 2.7 ha for Pond 8, 0.22 ha for Pond 9, 0.73 ha for Pond 21, 4.2 ha for Pond 25, 0.19 ha for Pond 26, 1.56 ha for Pond 27, six species (Arctic Grayling, Burbot, Lake Trout, Ninespine Stickleback, Round Whitefish, and

Slimy Sculpin), and a mean annual air temperature of -11.1°C. With the application of these inputs to the biomass equation, 4,634 kg of fish biomass was calculated for Goose Lake, 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. 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. The calculation of losses produced 74 kg of Arctic Grayling, 9.0 kg of Slimy Sculpin, and 2.8 kg of Ninespine Stickleback in Goose Lake, for a total of 85.8 kg of fish biomass.

7. Offsetting Option - Bernard Harbour

7.1 INTRODUCTION

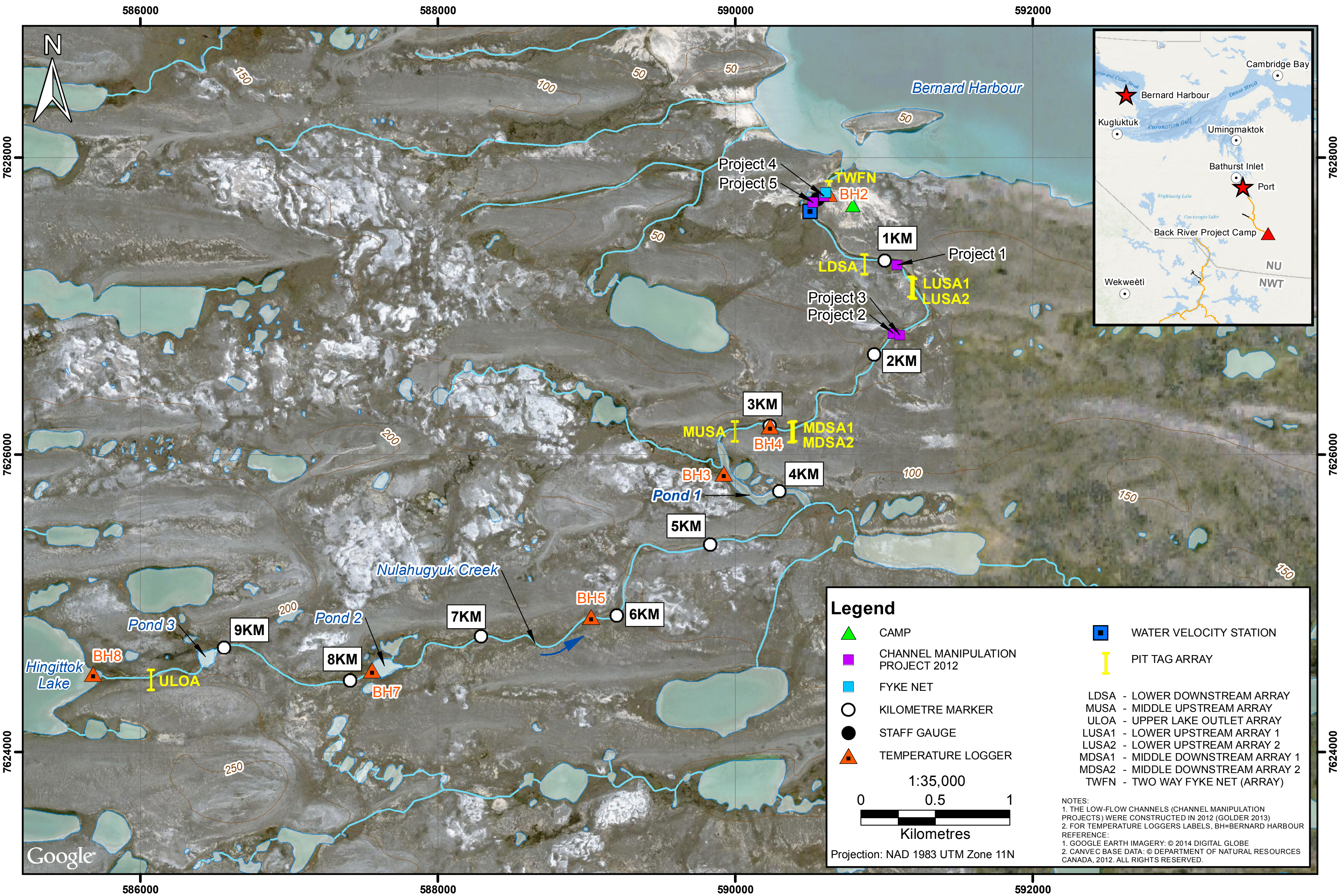
The Hingittok Lake-Nulahugyuk Creek (HLNC) system at Nulahugyuk (Bernard Harbour), Nunavut (Figure 1.1-1) was once the site of a traditional domestic fishery for Arctic Char (*Salvelinus alpinus*; char). Records from the Canadian Arctic Expedition indicate that the creek at Bernard Harbour supported 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 2013).

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 2013) 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 2013). 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.



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NULAHUGYUK CREEK BASELINE MONITORING, BERNARD HARBOUR, 2014

Figure 7.1-1

In 2014, Sabina initiated a comprehensive study of the migratory Arctic Char population at Bernard Harbour. The main goal was to provide rigorous baseline data in support of an offsetting plan for the Project. The baseline information would provide a reference for future quantification of the potential benefits of using "low-flow channel" methods. Specifically, the baseline study was designed to address four general objectives:

1) Monitor the timing and size of the annual migratory char run in Nulahugyuk Creek using two-way fyke net traps installed for the duration of the migration period; data was collected for the three migratory phases in 2014, including:
    a. the downstream (seaward) outmigration of adults (assumed to be spawners from the previous fall), which were predicted to be the first migratory fish captured in the trap during the spring freshet;
    b. the adult upstream (lakebound) migration (consisting of char that would spawn in the year following the sampling year); and,
    c. the downstream (seaward) outmigration of juveniles, which were assumed to be 4 or 5 years old and migrating later in the summer as occurred in 2012 (Golder 2013).
2) Monitor rates of movement and successful upstream passage to Hingittok Lake during the 2014 open water season using Passive Integrated Transponder (PIT) tag methods (e.g., Hering et al. 2010; Puffer et al. 2014); the movement data complement data on the size and timing of the run by providing a direct measurement of the effects of migrations conditions on Arctic Char in the creek for the study year under examination.
3) Assess fish habitat and the relative abundance of fish species in Hingittok Lake using standard inventory methods to gain some understanding of the carrying capacity of the lake for Arctic Char as it relates to enhancement efforts being made to improve fish access in the creek.
4) Collect habitat data to prepare a remediation plan for using low-flow channels to improve upstream passage for fish in Nulahugyuk Creek; this objective was performed in 2014 and 2015 and is a direct follow-up of work initiated by Golder in 2012 and includes:
    a. Assessments of the structural integrity and performance of low-flow channels previously constructed; and
    b. Scoping-level assessments of the number of problem locations and total length of the creek where low-flow channels could be constructed to effectively increase fish production.

In addition to the objectives outlined above, the 2014 and 2015 work was intended to complement and integrate objectives of the Kukgluktuk HTO. This was to be achieved by incorporating students, organizations, and community members and by designing a study that fosters education, stewardship and community involvement in conservation initiatives. Past studies (e.g., Stern et al. 2008) have demonstrated a lasting positive change in environmental attitude, action, and knowledge following environmental education programs, such as the one implemented at Bernard Harbour.

7.1.1 Study Area

The HLNC drainage at Bernard Harbour is located approximately 100 km directly north of the hamlet of Kugluktuk, Nunavut, along the south coast of Dolphin and Union Strait (Figure 7.1-1). The project site is about 4.5 hours (h) travel time by boat from the community. Nulahugyuk Creek, the outflow from Hingittok Lake (882 hectares [ha] in size), flows north for approximately 10 km before entering the sea at 68°44'52"N, 114°45'27"W. The contributing basin area at the mouth of creek is approximately 125 square kilometres (km^2) in area, and may be characterized by limited groundwater derived flows punctuated by precipitation-driven peak flows. It is expected that most of the precipitation falls as rain during the open water season. Based on 1981 to 2010 Canadian climate normal station data for Kugluktuk, mean total precipitation is approximately 247 millimetres (mm), of which 144 mm falls during June, July, August, and September (see http://climate.weather.gc.ca). Daily maximum temperatures, on average, are above zero for June through September, peaking in July at 15.6 °C, and below zero for the remaining months of the year.

7.2 METHODS

The field study in 2014 began on June 13 and was strategically planned to allow the field team to capture the first Arctic Char moving through Nulahugyuk Creek once the ice had melted enough to allow passage for fish. The commencement date was selected based on data collected during 2012 (Golder 2013), anecdotal information from the Canadian Arctic Expedition in 1916 (Jenness and Jenness 1991), as well as information from Kugluktuk residents. Field personnel remained on site until July 17, 2014 to capture the downstream outmigration of juvenile char. A short field program was also performed from July 21 to 25 in 2015 to collect supplemental information on habitat (fish were not monitored in 2015).

7.2.1 Fish Capture and Sampling

Fish were captured in Nulahugyuk Creek using a two-way fyke net trap installed on June 16, 2014, operating continuously until July 17, 2014 (Figure 7.2-1). The fyke net was installed 0.3 km upstream from the mouth of the creek (Figure 7.1-1) in a shallow run area with a mean width of about 18 m. The wings of the fyke net were installed across the creek such that all fish moving upstream or downstream would be directed into the opening. Once they had entered the trap they were directed through a series of funnels. Captured Arctic Char were directed for a total distance of about 6.4 m prior entering a holding basket at the base of the net. The trap was checked several times daily and fish were removed and processed accordingly. The frequency of checks increased with water temperature and capture success to reduce crowding and potential stress to fish.

In Hingittok Lake, multiple gill net sets (short-duration sets) and angling events were used to provide information on fish species composition and abundance. Gill net mesh size and configuration were based on Broad Scale Monitoring (BSM) techniques for North American (NA1) and Ontario small mesh (ON2) gill nets (Sandstrom et. al. 2013). A series of bottom-set gill nets were deployed over four days in July 2014 (July 8, 11, 13, and 14). Each set consisted of either two large (NA1) or two small (ON2) gangs joined for a double-gang configuration. The nets were checked frequently (maximum soak time was approximately four hours) to minimize mortalities. Angling at Hingittok Lake was also performed on July 11 and 13, 2014 using a variety of unbaited, spoon-type lures.

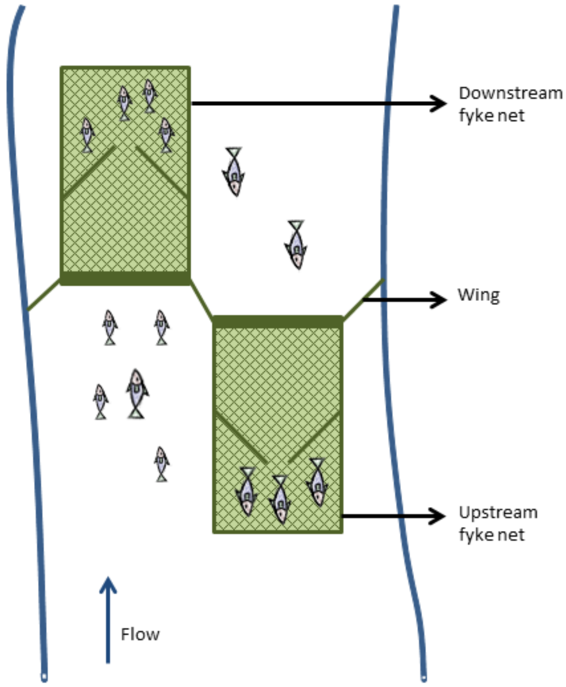

Figure 7.2-1. Conceptual Schematic Showing Two-Way Fyke Net Trap Configuration in Nulahugyuk Creek

Captured fish were enumerated, and identified to species, most of which were weighed (grams [g]) and measured (fork length [FL] [mm]), and a small number of representative individuals were photographed. To minimize stress during periods of warm water temperatures (>17°C), a small number of fish were enumerated but not processed at the fyke net trap (i.e., were immediately released on the side of the trap corresponding to their direction of travel). When possible, otoliths (the calcified structure from the inner ear) were removed from observed mortalities (e.g., from stranding at upstream locations), folded in parafilm, and stored in a labelled coin envelope for age analysis at a later date. For catch summaries, char smaller than 300 mm were classified as 'juveniles', fish between 300 and 550 mm were classified as 'immature' (or sub-adults), and fish larger than 550 mm were classified as adults (Golder 2013).

7.2.1.1 Mortality Surveys

Mortality data was collected opportunistically as incidental observations, for example, during habitat assessments. When there was an opportunity, field crew members visually surveyed the creek for dead char and when located, carcass information was documented using a hand-held GPS, photographs, and field notes. Carcasses were scanned with a hand-held tag reader (see further below for a description of tags and readers).

7.2.2 Movement Monitoring

Upstream movements for a subset of captured Arctic Char were monitored using implanted PIT tags and Radio Frequency Identification (RFID) antenna-reader arrays installed at strategic locations on the creek (Figure 7.1-1) (similar to methods discussed in Hering et al. 2010; Puffer et al. 2014). PIT tag methods are ideal for monitoring movements of fish in shallow streams such as Nulahugyuk Creek (i.e., constricted environments) because of the low cost of the tags and a high number of individuals can be tracked to reliably describe movements. PIT tags are also ideal for long-term studies since they contain no battery and will be operational for the lifespan of the tagged fish.

Seven PIT tag antennae-reader arrays were installed strategically in relation to the location of the 2012 low-flow channel project areas and reference sections. An array was also installed near the outlet of Hingittok Lake (Figure 7.1-1). The arrays were configured using either a single antennae (Lower Downstream Array [LDSA], Middle Upstream Array [MUSA], Upper Lake Outlet Array [ULOA]) or paired antennas (i.e., Lower Upstream Array 1 [LUSA1], Lower Upstream Array 2 [LUSA2] and Middle Downstream Array 1 [MDSA1], Middle Downstream Array 2 [MDSA2]), each of which was constructed from bound T90 cable.

Boulder spurs or weirs were constructed to prevent fish from moving around the arrays and to direct fish through the arrays. Antennas were oriented vertically to increase PIT tag reception range. The bottom of the antenna loop was embedded in the creek substrate and the top of the loop was suspended approximately 5 centimetres (cm) above the water surface. This configuration ensured that Arctic Char passed through the loop perpendicular to the antenna field. Antennas were connected to individual tuner boxes located creek-side, with twinax cable extending from the tuner boxes to a multi antenna HDX-PIT tag reader box. The arrays were powered by deep-cycle 130 ampere marine batteries which were kept continually charged using solar panels.

7.2.2.1 Statistical Analyses

Detection probabilities (p) were generated for individual antennae by assigning binary detection values for individual char based on whether they were detected (1) or not (0) at a given array. Detection probabilities were calculated for each array based on the mean detection value. Zero values above the furthest upstream detection were excluded from the detectability calculations because these fish were assumed to have been removed from the system. Therefore, detection values for each array were based only on data where detection occurred, or was known to occur further upstream. Detectability for the ULOA array was based on the mean detectability of the downstream arrays, with the exception of MUSA where a technical malfunction reduced detectability at that site.

Binary logistic regressions were used to explore relationships between upstream migration success (fish detected [1], or not detected [0] at the lake outlet) and environmental and biological parameters including migration date, stream discharge (daily and 4-day mean), water temperature (daily and 4-day mean), length, weight and condition factor. Various models were compared based on their Akaike Information Criterion (AIC) score, with lower values identifying models better representing the data analyzed, and Receiver Operating Characteristic (ROC), with higher values indicating greater sensitivity and specificity of the model (Hosmer and Lemeshow 2000).

Arctic Char movement speed (metres per hour [m/h]) was compared between arrays using analysis of variance (ANOVA). Movement speed was square root transformed to meet assumptions of normality. The significance level, alpha (α), was defined a priori as $\alpha = 0.05$. Normality was assessed graphically by examining the distribution of residuals using normal probability plots (Zar 1999). All analyses were conducted using Systat 13 (Systat Software, San Jose, CA).

7.2.3 Habitat Surveys

7.2.3.1 Water Temperature and Discharge Measurements

A stream discharge station with staff gauge was established approximately 0.5 km upstream from the mouth of Nulahugyuk Creek (Table 7.2-1). Water velocities and water depths were measured at 0.75 m intervals along a transect set perpendicular to flow of water at the station. Each point velocity was measured at 0.6 times the depth from the creek bed, which is representative of the mean velocity at that vertical profile. Velocity was measured using a direct read-out Swoffer™ Model 2100 velocity meter and top-setting wading rod. Discharge was calculated across the wetted width of the channel based on the point measurements of velocity, depth, and interval width represented by each point measurement. Stream discharge measurements were collected 22 times between June 13 and July 15, 2015; the staff gauge was read an additional 28 times between June 13 and July 16. Daily flows were also measured during the 2015 program (July 22 to 24).

Water temperatures were measured at 0.25 h intervals at six locations along Nulahugyuk Creek using Onset® HOBO Water Temperature Pro V2 Data Loggers in 2015 (Figure 7.1-1). The loggers collected data every 15 minutes and ran continuously for the duration of the field study.

7.2.3.2 Nulahugyuk Creek Habitat

Habitat was assessed along the entire length of Nulahugyuk Creek (approximately 10 km) between July 10 and July 14, 2014. Major habitat types within the sections were described in accordance with the classification system outlined in O'Neil and Hildebrand (1986). Supplemental information on problem locations (i.e., barriers) were then collected on July 16, 2014, and again on July 23 and 24, 2015, but with a focus on the lower 3.5 km of Nuluhugyuk Creek where most of the barriers are located on the creek (Golder and ANL 2007). The surveys for barriers were timed to coincide with both low flows and the upstream migration period of char. To prepare for future remedial works, global positioning system (GPS) coordinates were obtained for each problem location, and each problem location was rated according to level of adult char upstream impassibility. Field technicians assigned ratings (1 to 3) to all problem locations based on their knowledge of observations of mortalities and fish passage made in 2012 (Golder 2013) and 2014 (Table 7.2-2), where higher rankings represent higher risks for fish strandings and barriers.

The highest risk locations (rank 3) were those where fish stranding and partial barriers to movement may be common during average-to below average conditions through most of the upstream migration period. These locations were characterized by dispersed flows and boulder fields at the reach-level, impeding upstream movements and may directly expose fish to terrestrial predators, such as gulls. Higher-risk locations were also characterized by significant barriers to movement during average to below-average flow conditions during the later stages of migration. Rank 2 locations were those that may be difficult for fish to pass during peak periods of migration under below average flow conditions and may also present a high potential for stranding and partial blockage of movements during the later stages of migration when water levels decline (even during average years). Rank 1 locations were those that are likely passable through most of the upstream migration period during average flow conditions, but present the potential for stranding and stressful conditions during below-average flow conditions and towards the later stages of migration when water levels decline in summer.

Table 7.2-2. Characterization of Barriers and Problem Locations for Fish Passage

Types of Barriers	Ranking of Expected Risk of Mortality and Failed Migration (Higher Rank = Higher Risk)	
	Average Flows	Below Average Flows
Small-scale partial barrier	Rank 1	Rank 2
Large-scale partial barrier	Rank 2	Rank 3
Small-scale full barrier	Rank 3	Rank 3
Large-scale partial blockage with complete barriers present	Rank 3	Rank 3

The integrity of previously completed low-flow channels was also visually assessed and photographed during low discharge conditions (July 18, 2014, and again on July 22, 2015). Supporting information on channel width, velocity and depth within the assumed thalweg (deepest area of channel) was collected every 2 m for the length of each project. Mean values and standard deviations of channel characteristics are reported.

7.2.3.3 Hingittok Lake Bathymetry

Bathymetry at Hingittok Lake was determined while gill nets were in place as part of the lake fish inventory. Bathymetry transects were completed from July 8 to July 11, 2014 using a Garmin GPSMAP 298 sounder (Garmin, Olathe, KS) coupled with a GPS. Transect layout consisted of longitudinal transects in a north/south orientation along the lake, bisected by lateral transects across the width of the lake. Longitudinal and lateral transects were approximately equally spaced to provide as much coverage of the lake as possible. Data were stored in the boat-mounted sonar with a GPS enabled and downloaded onto a computer as 'gpx' file. Bathymetry data (i.e., depth and GPS position) were then transcribed onto a 1-m bathymetric contour map using the ArcGIS 'topo to raster' tool (ArcMapTM v9.3.1, 2009). Erroneous points were screened out by eliminating any unrealistic depths with the visual aid of georeferenced aerial imagery provided by Google Earth.

7.3 RESULTS

7.3.1 Fish Capture and Sampling

7.3.1.1 Nulahugyuk Creek

The fyke net was in place for a total of 35 days, 16 hours and 17 minutes beginning the evening of June 12, 2014 (18:15) and ending July 17, 2014 (10:32). In total, 1,332 Arctic Char were captured from Nulahugyuk Creek with the first char captured moving downstream on June 16 (Figure 7.3-1). Three distinct groups of migratory char were described including adults moving downstream after overwintering in Hingittok Lake (*n* = 478), adults moving upstream (*n* = 332) to overwinter and potentially spawning first, and juveniles moving downstream from Hingittok Lake (*n* = 522). Downstream movement by adults was documented from the first day of the program and was largely completed by July 4 (Figure 7.3-1). Upstream movement attempts by adults began on June 25 and continued through to the completion of the field study. Downstream movement by juveniles began on June 25 and also continued to the completion of the field study. Migration successes were quantified for adult Arctic Char migrating upstream from the ocean to Hingittok Lake (see below – Upstream Passage).

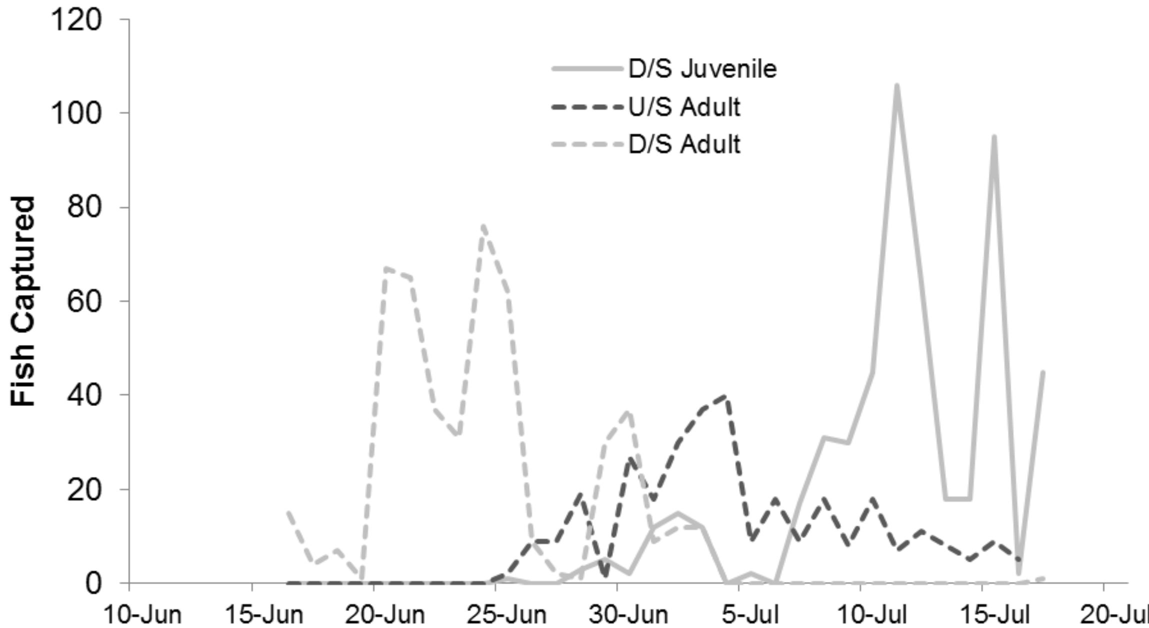

Figure 7.3-1. Daily Captures of Migratory Arctic Char in Nulahugyuk Creek, 2014

Note: D/S = downstream travelling fish and U/S = upstream travelling fish

Arctic Char catch-per-unit-effort (CPUE) for the upstream fyke net was 0.39 fish/hour, while CPUE for the downstream fyke net was 1.17 fish/hour. The combined CPUE for upstream and downstream fyke nets was 1.56 fish per hour. Three Ninespine Stickleback were also captured but not included in CPUE calculations. Maximum daily upstream CPUE for adults was 1.17 fish/hour on July 4, 2014; whereas maximum downstream CPUE for adults was 3.17 fish/hour on June 24, 2014; and maximum daily juvenile CPUE (migrating downstream) was 4.42 fish/hour on July 11, 2014.

Arctic Char length and weight measurements and condition factor for the three migratory groups and one immature individual are summarized and described in Table 7.3-1 and Figure 7.3-2 (not every individual was measured). The largest captured Arctic Char was 887 mm in length with a weight of 6,645 g. Adult char moving upstream had the highest average condition factor (± standard deviation [SD]) of the three migratory groups (K_{us} = 1.09 [± 0.1]); whereas, downstream-moving juveniles had lowest average condition factor (K_{juv} = 0.81 [± 0.1]). Adult char moving downstream had an average condition factor of 0.84 (± 0.1). Adult char moving downstream from Hingittok Lake were approximately 27% lighter in weight than char moving upstream from the ocean. It was noted by the field crew that although none appeared obviously ripe for spawning, many char moving upstream were developing spawning colours had better condition (visual judgment of weight to length ratio) than adults moving downstream.

Table 7.3-1. Summary of Arctic Char by Size Class Captured in Fyke Nets in Nulahugyuk Creek, June 12 to July 17, 2014

Migratory Group	Number of Char	Length Range (mm)	Mean Length (mm) ± SD	Weight Range (g)	Mean Weight (g) ± SD	Mean Condition Factor ± SD
Adults moving upstream	329	602 to 887	728.8 ± 53.9 *(n = 328)*	2,250 to 7,545	4,271.2 ± 991.3 *(n = 329)*	1.09 ± 0.1
Adults moving downstream	476	509 to 859	717.0 ± 54.3 (*n* = 475)	1,545 to 5,080	3,134.6 ± 747.6 (*n* = 473)	0.84 ± 0.1
Immature fish moving downstream	1	305	-	243	-	0.86
Juveniles moving downstream	521	145 to 261	192.5 ± 19.1 *(n = 347)*	25 to 140	60.3 ± 18.2 *(n = 313)*	0.81 ± 0.1

Note: mm = millimetres; ± = plus or minus; SD = standard deviation; g = grams; n = number of fish; - = no data

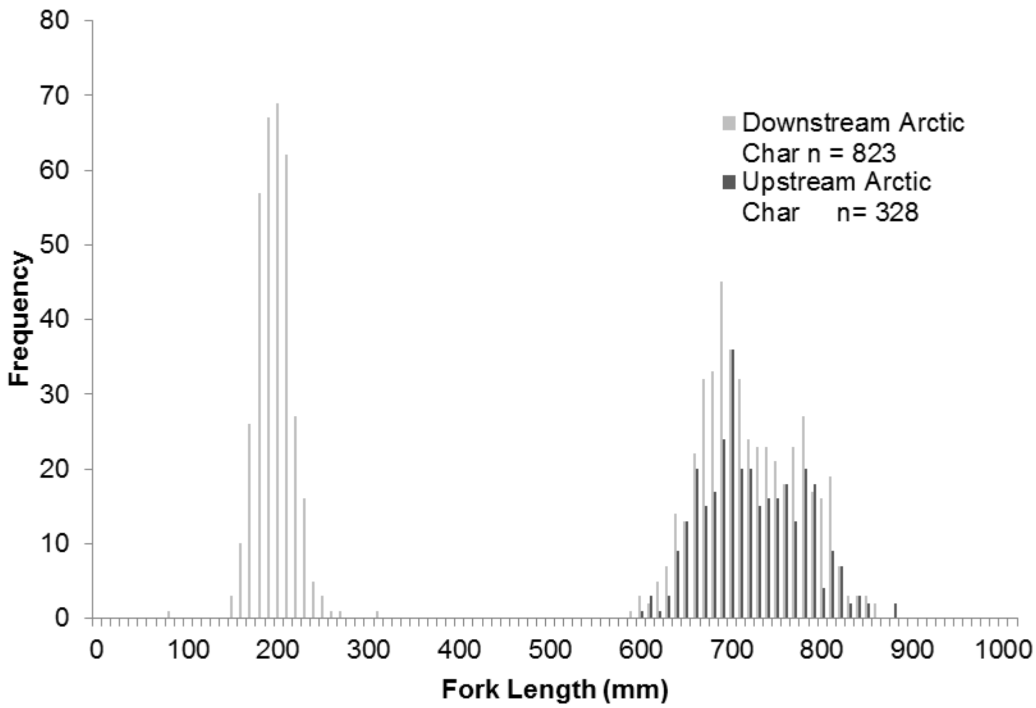

Figure 7.3-2. Length-Frequency Distribution of Arctic Char Captured in the Fyke Net Trap

7.3.1.2 Hingittok Lake

Twenty-nine short-duration gill net sets were deployed for a total of approximately 65 hours in Hingittok Lake in 2014 (Figure 7.3-3). Gill netting efforts in Hingittok Lake captured a total of 54 fish including 36 Lake Trout (*Salvelinus namaycush*), 10 Arctic Char, 7 Cisco (*Coregonus artedi*), and 1 Ninespine Stickleback (*Pungitius pungitius*). Of the 10 char captured, 7 were adults and 3 were juveniles. Mean CPUE for large mesh nets was 2.16 fish/h/100 m; approximately twice that of small mesh nets which was 1.07 fish/h/100 m. It is noteworthy that two of the captured char were PIT tagged earlier in the season in 2014.

PROJECT # 1419666 GIS # Hingittok Lake Baseline Study October 01 2015

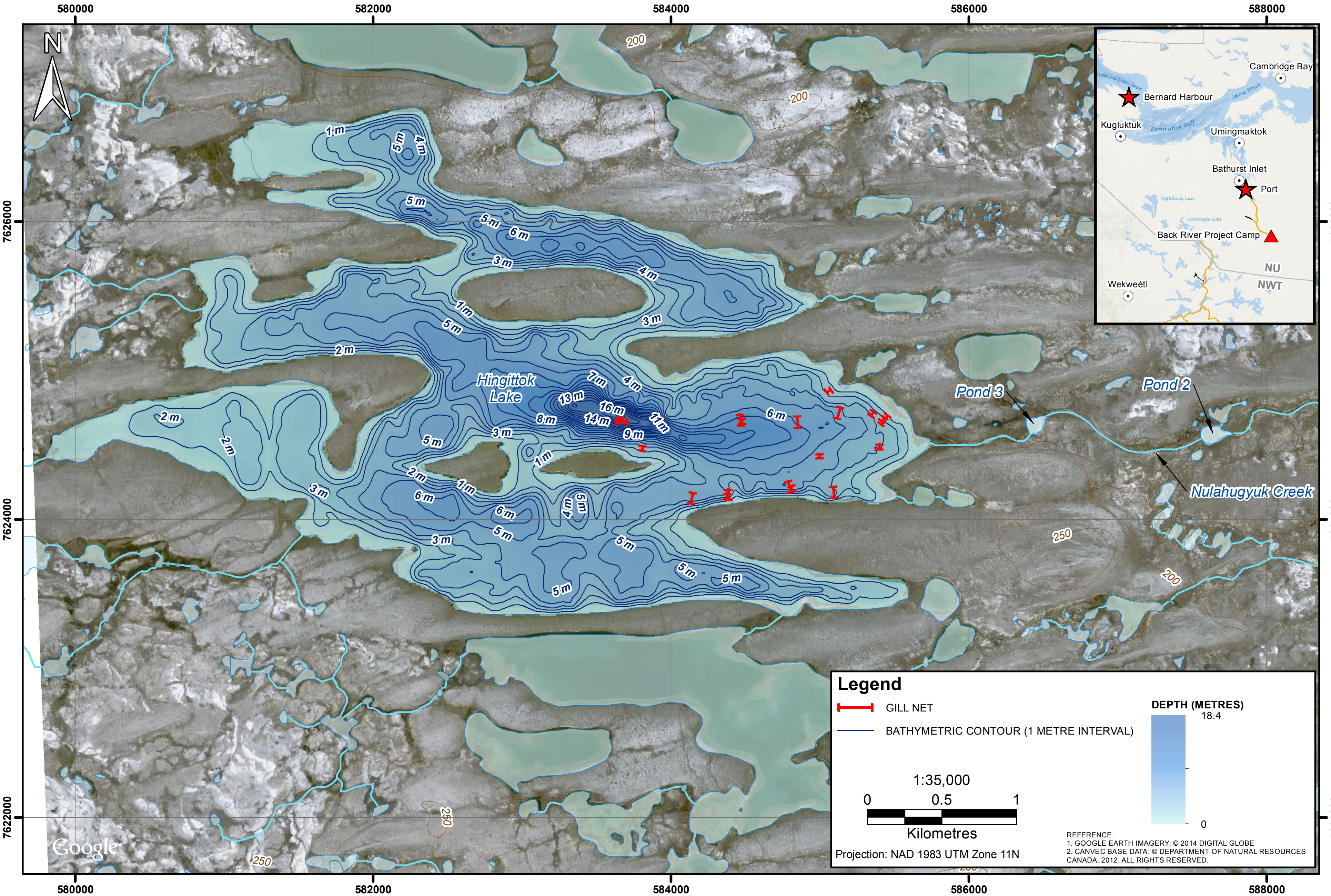

Figure 7.3-3

HINGITTOK LAKE FISH BASELINE MONITORING, BERNARD HARBOUR, 2014

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Gold & Silver Corp.

A total of 2.5 hours, mid to late afternoon, was spent angling by two crew members in the lake, resulting in the capture of eight Lake Trout (CPUE of 1.5 fish/angler hour). Overall, Lake Trout was the dominant species captured from Hingittok Lake (based on gill netting and angling combined), contributing 71% to the total catch (Figure 7.3-4).

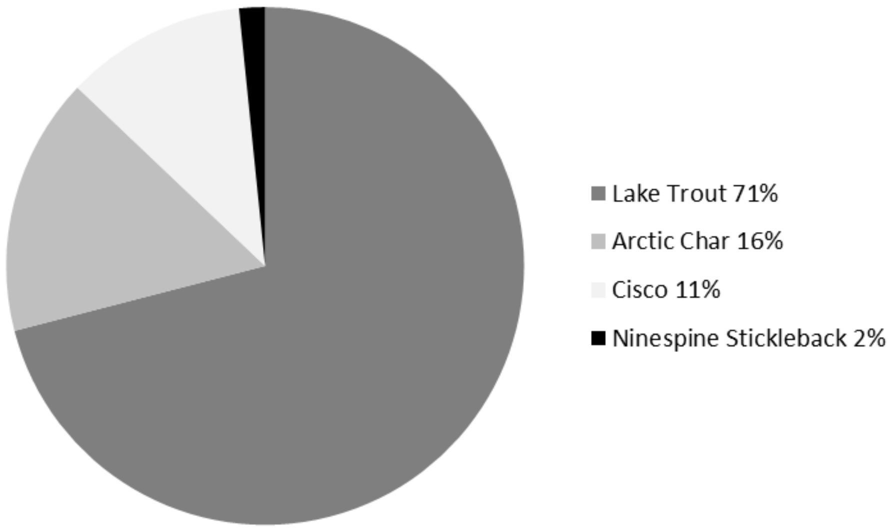

Figure 7.3-4. Fish Species Composition in Hingittok Lake, 2014

7.3.2 Upstream Passage

In total, 315 upstream migrating adult char were implanted with PIT tags with unique identification numbers. Selected Arctic Char for PIT tag monitoring were a representative sample of the population moving upstream, and characterized by an average length (± SD) of 726.8 (± 52.4) mm, weight of 4229.8 (± 949.8) g and condition factor or 1.09 (± 0.1).

A high degree of detectability was obtained at most antennae-reader arrays (Table 7.3-2). The only exception was MUSA which suffered from a series of technical issues including a malfunctioning battery from July 8 to July 9, and suboptimal tuning prior to July 11, resulting in reduced detectability.

Of the 315 tagged Arctic Char, 103 were detected at the ULOA indicating the completion of a successful upstream movement from the sea. Adjusted for array detectability, this equated to 110 tagged fish, or a success rate of 34.9% between June 25 and July 17, 2014 (Table 7.3-2). Although migratory success was relatively high early on in the study (93%), it declined rapidly over time with none of the fish tagged after July 6 detected at the ULOA (Figure 7.3-5). This indicates that a threshold was reached and stream conditions became impassable for char after this date. Any remaining fish either perished, likely from exhaustion, predation, or stranding, or remained in the ponds located in the middle and upper reaches of the creek. Twelve tagged char were incidentally confirmed as mortalities while field crews were working along the creek in July 2014; half of the mortalities were observed after July 6.

Table 7.3-2. Location of Radio Frequency Identification (RFID) Arrays and Detection Information

Array	Approximate Distance Upstream from Bernard Harbour (km)	Detection Probability	Detected Total	Corrected Total
Two-way fyke net (TWFN)	0.30	1.00	315	315
Lower Downstream Array (LDSA)	0.75	0.90	263	293
Lower Upstream Array 1 (LUSA1)	1.14	0.93	261	280
Lower Upstream Array 2 (LUSA2)	1.16	0.91	255	279
Middle Downstream Array 1 (MDSA1)	2.73	0.97	205	212
Middle Downstream Array 2 (MDSA2)	2.75	0.96	202	211
Middle Upstream Array (MUSA)	3.15	0.59	94	158
Upper Lake Outlet Array (ULOA)	9.43	0.93	103	110

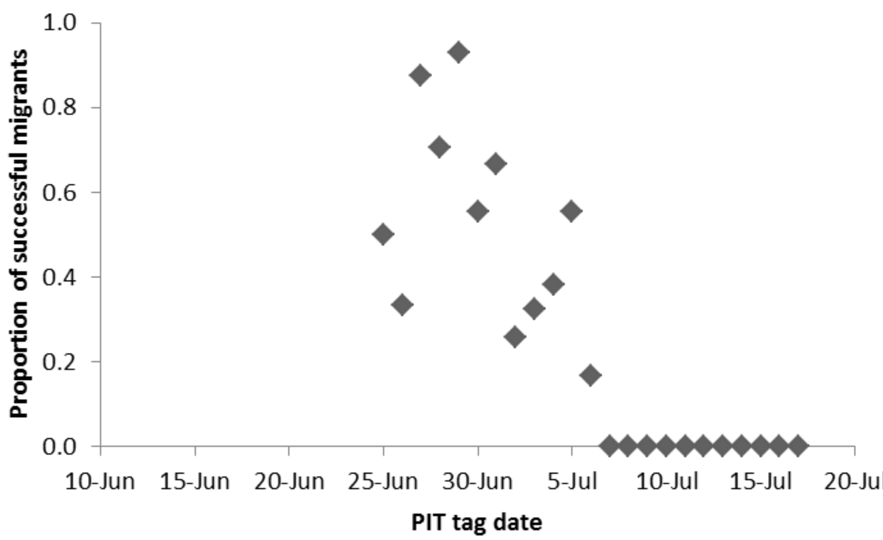

Figure 7.3-5. Proportion of Successful Migrants Detected at ULOA Plotted Against Passive Integrated Transponder (PIT) Tag Implantation Date

For those fish recorded as being successful migrants to Hingittok Lake, migration time between the farthest downstream array and the farthest upstream array (distance of 8.68 km) varied among individuals and throughout the study period with a mean migration time (± standard error) of 108.3 h (± 4.7). The fastest fish completed the migration in 34.2 h, and the slowest in 239.0 h. The migration time was generally faster from June 25 to June 30 (79.3 h [± 5.4]) than from June 30 to July 6 (123 h [± 5.8]).

7.3.2.1 Migration Success Model

The number of Arctic Char observed among the RFID arrays declined sequentially as the fish moved upstream. Prior to July 6, a considerable reduction in detected char occurred over a 0.35 km reach between MDSA2 (2.75 km) and MUSA (3.15 km) with a 24% reduction in individuals occurring in this area. After July 6, a 50% reduction in the number of char detected occurred over a 1.57 km reach between LUDS2 (1.16 km) and MDSA1 (2.73 km), with no fish detected after MUSA (>3.15 km).

Using a binary logistic regression, the primary factors influencing migratory success were determined to be four day mean discharge and char weight (Table 7.3-3). Model fit was significant ($p < 0.001$) with an ROC value of 0.84. The output of the formula (when fish weight is held constant at 4.2 kg) is presented graphically in Figure 7.3-6. With respect to the four-day mean discharge, the probability of migration success ranged from a high of 85% at greater than 1.5 m^3/s, declining to a low of 0% at 0.5 m^3/s and lower discharge values. Regarding fish weight, the probability of migratory success ranged from a high of 95% for fish that weigh 2.5 kg to a low of 31% in fish that weigh 7.5 kg when discharge was held constant at 1.76 m^3/s.

Table 7.3-3. Parameter Estimates for Binary Logistic Model Predicting Migration Success

Parameter	Estimate	Standard Error	Z	p-Value	95% Confidence Interval Lower	Upper
Constant	-8.398	2.417	-3.48	0.001	-13.134	-3.661
Four day mean discharge	15.714	4.134	3.8	<0.001	7.612	23.815
Four day mean discharge (squared)	-4.612	1.643	-2.81	0.005	-7.831	-1.392
Weight	-0.77	0.192	-4.02	<0.001	-1.146	-0.395

Note: Z = statistical score; p-Value = probability value; % = percent; < = less than; kg = kilograms.

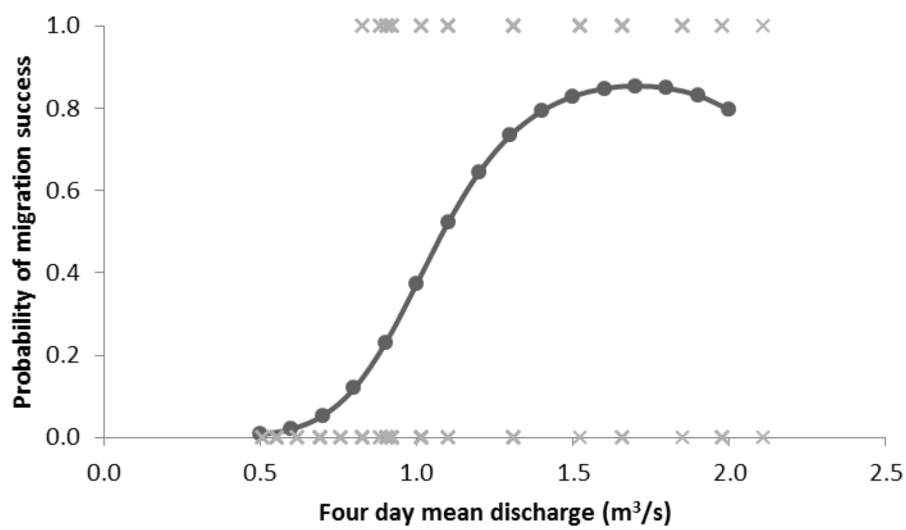

Figure 7.3-6. Results of Binary Logistic Regression Plotting the Probability of Migration Success Against Stream Discharge, Holding Arctic Char Body Weight Constant at 4.2 kg

Note: X symbols represent whether individual fish succeeded in migrating to ULOA (1) or not (0).

7.3.3 Fish Habitat

7.3.3.1 Nulahugyuk Creek

From the confluence with the sea, Nulahugyuk Creek transitions from faster moving riffles to run and pool habitats near Hingittok Lake. Approximately 82% of the lower section of the creek to the first pond was quantified as riffle habitat in July 2014 (Plate 7.3-1). The creek then transitions from riffle (44%) to run (53%) habitats in the middle section of the creek between the first and second ponds. It is largely shallow run habitat (90% or more) from the second pond to the outlet of Hingittok Lake.

Substrate was predominantly cobble (60% or more) and boulder (approximately 5 to 19%) and gravel (approximately 5 to 13%) with small amounts of sand and silt typically occurring in pool habitats. The maximum depth in the creek (excluding the three ponds on the creek) was less than 0.75 m.

In general the habitat characteristics of flowing sections of the creek indicate little cover for large fish with only small patches of intermittent (or discontinuous) cover provided by large boulders and undercut banks, and associated small pools. Where this habitat was provided (e.g., Plate 7.3-1), Arctic Char were often incidentally observed holding.

Plate 7.3-1. Riffle habitat with small pool provided near bank (left), looking upstream, approximately 1.3 from mouth of Nulahugyuk Creek, July 16, 2014.

Potential barriers to fish passage were identified at 13 sites in total (Table 7.3-4). These locations were characterized as difficult for adult Arctic Char to migrate upstream because of boulder barriers, 'broken' thalwegs and lack of water depth, resulting in possible strandings and mortalities (for example, see Plates 7.3-2a, 7.3-2b, 7.3-3a, and 7.3-3b). The problem sites are where low-flow-channel (enhancement) projects may benefit production of Arctic Char (Table 7.3-4). Three sites were identified as the highest the priority for site remediation, as a rank 3, followed by five rank 2 locations, and five rank 1 locations where remediation efforts are needed. Five of the problem sites were identified within a sharp bend in the lower section of the creek, starting 1.3 km from the mouth of Nulahugyuk Creek and for an upstream distance of approximately 800 m. Many strandings and mortalities were incidentally observed along this section during 2012 and 2014. Furthermore, most of the problem sites where remediation work is proposed (approximately 77%) are within the lower 3 km of the creek, which is consistent with previous habitat assessments of the creek (Golder and ANL 2007).

Table 7.3-4. Summary of Potential Locations for Fish Passage Enhancement Projects

Site Identification	Approximate Distance Upstream of Bernard Harbour (km)	Ranking Based on Expected Risk of Mortality and Blockage (Higher Ranking = Higher Risk)	Minimum Required Low-Flow Channel Length to Improve Passage (m)
Site 1*	1.3	Rank 3	41
Site 2	1.5	Rank 2	42**
Site 3	1.6	Rank 2	34***
Site 4	2.0	Rank 2	30
Site 5	2.1	Rank 3	22
Site 6	2.4	Rank 3	45
Site 7	2.9	Rank 2	14
Site 8	4.8	Rank 1	20
Site 9	5.7	Rank 1	40
Site 10	7.8	Rank 1	15
Site 11****	2.6	Rank 1	38
Site 12****	2.8	Rank 1	19
Site 13****	3.0	Rank 1	15

Note: km = kilometres; m = metre; extended rock weirs are recommended for most sites, for example, to direct migrating fish upstream through the low-flow channel.
** the site was initially described as two separate problem locations in 2014 but was later characterized in 2015 as one problem site requiring an extended low-flow channel (versus two separate consecutive channels); ** two parallel low-flow channels recommended (length represents combined length of parallel channels);*** requires further evaluation; a directional weir may be a viable alternative for this location; and **** problem sites identified in 2015.*

Plate 7.3-2a. Looking upstream towards barriers at Site 5, July 16, 2014.

Plate 7.3-2b. Looking downstream towards barriers at Site 5, July 16, 2014.

Plate 7.3-3a. Looking upstream towards barriers at Site 6, July 16, 2014.

Plate 7.3-3b: Looking downstream towards barriers at Site 6, July 16, 2014.

Water Temperature and Flows

The water temperatures in 2014 in Nulahugyuk Creek increased steadily as the season progressed with mean daily temperatures rising from 2.7°C on June 14 to 12.3°C on July 17 (Figure 7.3-7). The warmest temperatures occurred during the latter half of the study period exceeding 17°C at the downstream site (BH2) for 24.3 hours. Diurnal variation in water temperature was evident with a mean difference of 8.8°C between daily minimum and maximum values. A temperature gradient was also observed between the upstream and downstream sites (BH2 and BH7; Figure 7.1-1) with a consistent mean difference of 2.4°C across the sampling period, indicating a rate of change of 0.3°C/km in downstream direction.

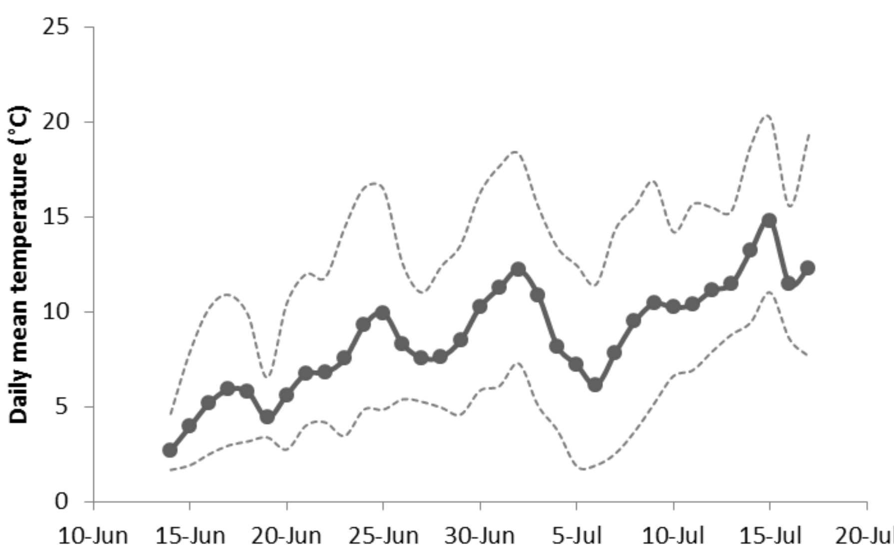

Figure 7.3-7. Daily Mean Temperature (°C) Recorded at Nulahugyuk Creek from June 10, 2014 to July 17, 2014

Note: Maximum and Minimum Daily Values Indicated by Upper and Lower Dotted Lines Respectively.

In 2014, creek discharge declined over the study period ranging from a high of 6.0 cubic metres per second (m^3/s) on June 15 to a low of 0.5 m^3/s on July 15 (Figure 7.3-8). Discharge was also low on July 22, 2015 (0.4 m^3/s). A 5.5 m^3/s decline in discharge corresponded to a 29 cm decrease in water depth over the 2014 study period, based on the following relationship between the gauge water level and creek discharge:

$$water\ level\ (cm) = 56.012 + (5.2795 \times creek\ dischage\ (m^3/s)), \qquad R^2 = 0.97.$$

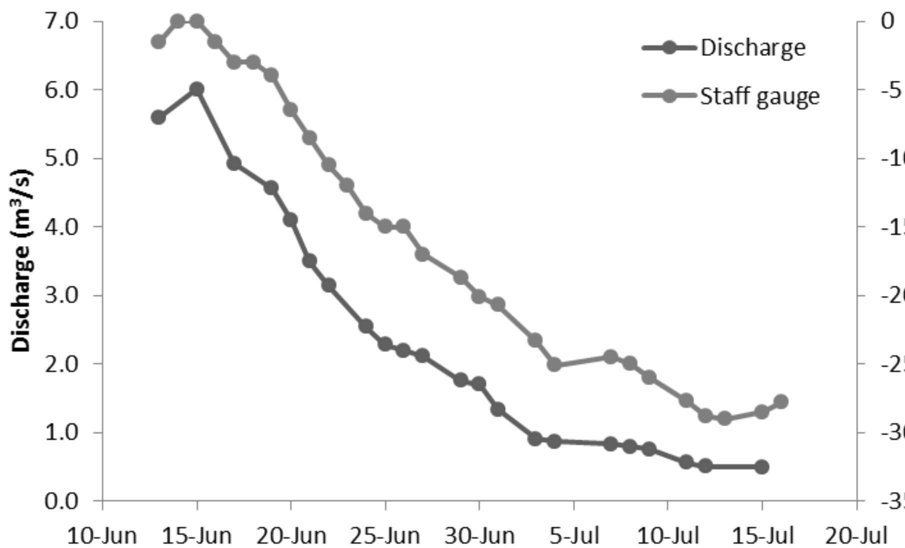

Figure 7.3-8. Stream Discharge (m^3/s) and Staff Gauge Depth (cm) Recorded at Nulahugyuk Creek Between June 13, 2014 and July 15, 2014

7.3.3.2 Hingittok Lake

Based on 1:50,000 CanVec data, Hingittok Lake is 982.3 ha in area and features numerous peninsulas and bays around three large islands in the centre of the lake (Figure 7.3-3). Shoreline length (38,085 m including island shorelines) was extensive relative to the size of the lake and the shoreline development factor (the ratio of a lake's perimeter to surface area that provides a measure of irregularity of shoreline) was approximately 12.3. The higher the ratio, the more irregular the shoreline is, and thus, more shoreline habitat is potentially available (a perfect circle would have a shoreline development factor of 1). The bathymetry data derived a lake volume of approximately 30,553,000 m^3 (Table 7.3-5). The maximum depth was approximately 18 m and mean depth was 3.7 m.

Table 7.3-5: Approximate Lake Area and Volume for Various Depth Intervals in Hingittok Lake, July 10 to 14, 2014

Depth (m)	Volume (m^3)	Area (ha)	Depth (m)	Volume (m^3)	Area (ha)
>0	30,553,274	982.3	>10	553,638	14.7
>2	15,767,454	607.7	>12	308,168	10.2
>4	6,214,620	352.4	>14	138,401	6.9
>6	2,002,020	95.6	>16	32,068	3.7
>8	964,592	28.9	>18	335	0.2

Note: m = metres; m^3 = cubic metres, ha = hectares; > = greater than.

7.4 REMEDIATION PLAN

7.4.1 Low-Flow Channels

Existing habitat and fish passage conditions in Nuluhugyuk Creek are poor, a combination of boulder fields and dispersed flows are preventing many char from accessing spawning locations in Hingittok Lake, as confirmed by local knowledge (Golder and ANL 2007; Appendix V3-3D of the FEIS) and by the previously collected fisheries data at Bernard Harbour (Golder 2013; including 2014 baseline data reported in this plan). Thus, the goal of remediation is to improve passage for fish migration in Nulahugyuk Creek by removing boulder barriers in the creek and by increasing water levels within specified paths or movement corridors within the channel. 'Soft' engineering methods (without the use of heavy machinery) will be deployed. Upon remediation of fish passage conditions, benefits to the local fishery are predicted through increased adult survival and increased fecundity (See Section 7.5).

The methods will follow those successfully developed by the Kugluktuk HTO and Golder in 2012 (Golder 2013; see Plate 7.4-1), which are based on local knowledge of traditional fishing activities at Bernard Harbour (Golder and ANL 2007; Golder 2013; Appendix V3-3D of the FEIS). Specifically, the methods will include the construction of low-flow channels and the use of directional rock weirs at problem locations in Nulahugyuk Creek; where a low-flow channel is characterized by a manipulation of flows and substrates such that there is an unobstructed flow path with sufficient depths (greater than approximately 20 cm) within the larger channel for fish passage. All small boulders will be relocated to form the low-flow channel within the area of the assumed thalweg of the problem sections of the creek. Where needed, weirs above the low-flow channel will be constructed to direct and augment flows through the channel and weirs below the low-flow channel may also be created to direct Arctic Char migrating upstream, such that fish avoid adjacent shallow boulder gardens where stranding may occur (Plate 7.4-2). It is expected that each problem location will be remediated by a field crew of approximately five people and one supervisor (Golder 2013). This cost-effective method can increase water levels by up to 102% (or up to 10 cm) during the latter part of the upstream migration period when water levels are in decline (Golder 2013).

Field personnel are expected to be provided by the Kugluktuk HTO, who will be a partner in completing the remediation work, as well as future monitoring and maintenance of the low-flow channels. The accessibility of Bernard Harbour, which can be reached by a four hour boat ride from Kugluktuk during open water conditions, provides a logistical advantage over less accessible options in the Canadian Arctic. Furthermore, local enthusiasm for the Project is well documented, and the many residents in Kugluktuk who still maintain a camp at Bernard for hunting and fish will be engaged while there are opportunities through the life of the offsetting option. The integration of local and traditional knowledge will continue during subsequent field programs, workshops, and meetings.

Plate 7.4-1. A Low-Flow Channel Previously Created in 2012 ('Project 2'), Looking Upstream, July 18, 2014

Plate 7.4-2. Directional Weir (Kugluktuk HTO Students in Background) for Migrating Arctic Char in Nulahugyuk Creek, June 24, 2015

7.4.2 Benefits to Fisheries Productivity

To estimate the potential increases in fisheries production (as a surrogate of fisheries productivity) following the remediation of Nulahugyuk Creek, the effects of the low-flow channels on migration success was estimated and then related to changes in the number and biomass of adult Arctic Char in in Nulahugyuk Creek and Hingittok Lake. The effects of remediation on migration success was estimated using hydrologic data collected in 2012 and 2014, combined with the migration success results from 2014. Using the same dataset, a water level target in the low-flow channels that maximizes the migration success was also identified.

7.4.2.1 Predicted Changes in Migration Success

An understanding of flow conditions that determine water levels at the low-flow channel locations is needed as part of predicting changes in migration success. Using the pre-manipulation depths of the pilot projects in 2012, which was, on average, 12.5 cm when discharge was approximately 0.4 m^3/s (Golder 2013), and the relationship between stream discharge and stream depth at the staff gauge presented in Section 6.3.3.1, a 12.5 cm depth equates to a level of 58.1 cm at the staff gauge. Furthermore, creating an increase in depth from 12.5 cm to 22.5 cm with the construction of a low-flow channel would be equivalent to an increase in water levels from 58.1 to 68.1 cm at the staff gauge, assuming the wetted width of the creek at the staff gauge location was equal to or less than the wetted width at the location of the low-flow channel projects. This increase in depth to 68.1 cm at the staff gauge would be equivalent to a stream discharge of 2.3 m^3/s, based on the relationship between gauge water level and creek discharge presented above (Section 7.3.3.1).

With an understanding of how changes in water levels at the low-flow channel locations (prior to remediation) relate to flows in the creek, changes in the probability of migration success were estimated using the logistic equation provided in Section 7.3.2.1. For example, when discharge is 0.4 m^3/s, the probability of migration success prior to remediation is predicted to be very low (0.002), whereas when discharges is 2.3 m^3/s, the probability of migration success is maximized (0.85), assuming fish weight is held constant at 4.2 kg. As a consequence, a 10 cm increase in depth at the selected problem locations would equate to an increase in the probability of migration success from 0.002 to 0.850 during low-flow periods of the upstream migration, once remediation activities are completed.

Based on the logistic equation, Arctic Char reached the greatest probability of migration success when discharge reached 1.6 m^3/s or greater (See Figure 7.3-6). This equates to a staff gauge level of 64.5 cm, 6.4 cm greater than the depth initially observed at the enhancement location. This would suggest an 'optimal' channel depth of greater than 19 cm to maximize the migration success for an Arctic Char of average size, and confirms that the methods deployed in 2012 can improve fish passage. Indeed, a behavioral response of Arctic Char to increased flows was noted in Golder (2013). Field crews observed successful upstream movements of adult char shortly after the completion of the low-flow channels in 2012 (within 1 h of completion), suggesting lack of depth was a limiting factor to upstream movements.

7.4.2.2 Predicted Changes in Fish Biomass

Changes in fish abundance and biomass for the Arctic Char run in Nulahugyuk Creek and Arctic Char arriving in Hingittok Lake were predicted using baseline data on the 2014 upstream migration applied to a simplified 'population' model. Assuming that 2014 represents an 'average' or 'below-average' year for the Arctic Char run, the increase in the number of fish in Hingittok Lake following site remediation was based on the difference between the product of the probability of migration success offsetting year 0 (0.349) multiplied by the size of the 2014 run (332), which equals 116 fish, and the product of the probability of migration success post-remediation (0.85) multiplied by the expected size of the run (332), which equals 282 fish. Thus, the predicted increases are approximately 166 char or 697 kg of char (using a mean weight of 4.2 kg) arriving at Hingittok Lake to spawn for year 1 post-remediation (Figure 7.4-1).

By year 3 post-remediation it is expected that the size of the run at Bernard Harbour would be larger than years 1 and 2 post-remediation, potentially comprising an additional 72 Arctic Char that would have otherwise perished during offsetting year 1 without remediation (so 415 char in total). This prediction assumes that sexually mature Arctic Char spawn every second year (e.g., Babaluk et al. 1998), and that the average return rate is 50% (Klemetsen et al. 2003).

By year 8 post-remediation, the run size may more than double in size when offspring of the adults arriving to Hingittok Lake during year 1 post-remediation return to Bernard Harbour; where the predicted increase assumes consistent fecundity and juvenile survival rates over time (e.g., by year 9 two offspring return from each ‘added’ adult) and that mature char in Nulahugyuk Creek are age 8 or older (Golder, unpublished data). Thus, by approximately offsetting year 9, there may be over 747 Arctic Char (or 3,137 kg) in the run at Nulahugyuk Creek, and 635 Arctic Char (or 2,667 kg) successfully arriving in Hingittok Lake each year (Figure 7.4-1).

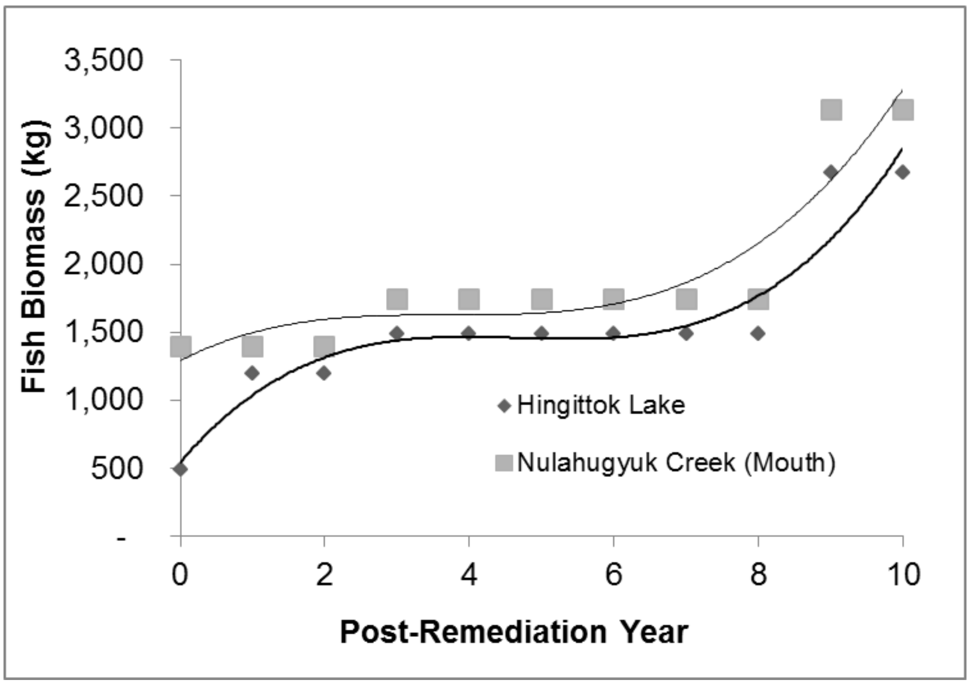

Figure 7.4-1. Post-Remediation Predictions for Fish Biomass in Nulahugyuk Creek and Hingittok Lake (Bernard Harbour)

It is important to note that the actual increases in fish abundance and biomass post-remediation will be greater if the 2014 baseline values for the average size of the Arctic Char run are greater than the selected model inputs. For the purposes of the offsetting plan, the modelled changes conservatively used the upstream migration abundance data, versus the downstream migration abundance data, as an approach to reduce uncertainty in predictions. The abundance data for the downstream migration of adult Arctic Char, which would reflect the upstream migration in 2013, was approximately 1.4-times higher than the upstream migration in 2014 (478 adults captured downstream versus 332 adults capturing upstream in 2014).

7.4.2.3 Offsetting Accounting

The potential losses and gains in fisheries productivity were projected across time using fish production as a surrogate measure of fisheries productivity (Randall et al. 2013). Fish production provided a transferable unit for the calculation of both losses at the Goose Property Area and gains at Bernard Harbour.

Serious harm to fish (i.e., losses) will be incurred with the temporary drawdown of Llama and Umwelt Lakes, and the construction of related infrastructure, affecting Goose Lake tributary streams and ponds in the Goose and Wolf watersheds. The fish-out and subsequent drawdown of Llama and Umwelt lakes will result in a biomass loss of 661.2 kg in total for the Llama-Umwelt lake system (Section 6.4.1). With construction of the airstrip extension and Tailings Storage Facility, and subsequent reduction in downstream flows, the calculated biomass loss for Rascal Stream East, Goose Inflow South and other waterbodies in the Goose and Wolf watersheds will be 85.8 kg of fish biomass (Section 6.4.2). Thus, the total loss of biomass at the Goose Property Area during construction is predicted to be 747 kg. Annual losses associated with a hypothetical optimal harvest strategy were also considered (e.g., Hillborn and Stokes 2010), estimated to be 10% of total biomass for affected habitat. This was projected as additional losses across time as a conservative approach to the offsetting accounting as means to address any uncertainty in the predictions. In other words, it was assumed that when all residual serious harm to fish are realized during construction within the Goose Property Area, there is a loss of an additional 74.7 kg of biomass that would have otherwise been harvested without the Project development. For example, over a ten-year period, total cumulative losses include the initial 747 kg of biomass due to construction of infrastructure plus the hypothetical annual loss of 74.7 kg of surplus biomass that could be harvested in the nine years that follow, which all together is equivalent to 1,419 kg of biomass (Figure 7.4-2).

Substantial gains in fish productions are predicted at Bernard Harbour, which will counterbalance losses incurred at the Goose Property Area (Figure 7.4-2). Gains in biomass of Arctic Char are predicted to range from almost 700 kg during year 1 and 2 post-remediation to over 1,880 kg by year 9 post-remediation. Over a ten-year period, the offsetting option may generate a total cumulative gain of 11,134 kg of Arctic Char, almost 8-times the predicted losses over the same period. Furthermore, predicted gains are expected to magnify over time until char abundance (e.g., juvenile densities) approach the carrying capacity of Hingittok Lake.

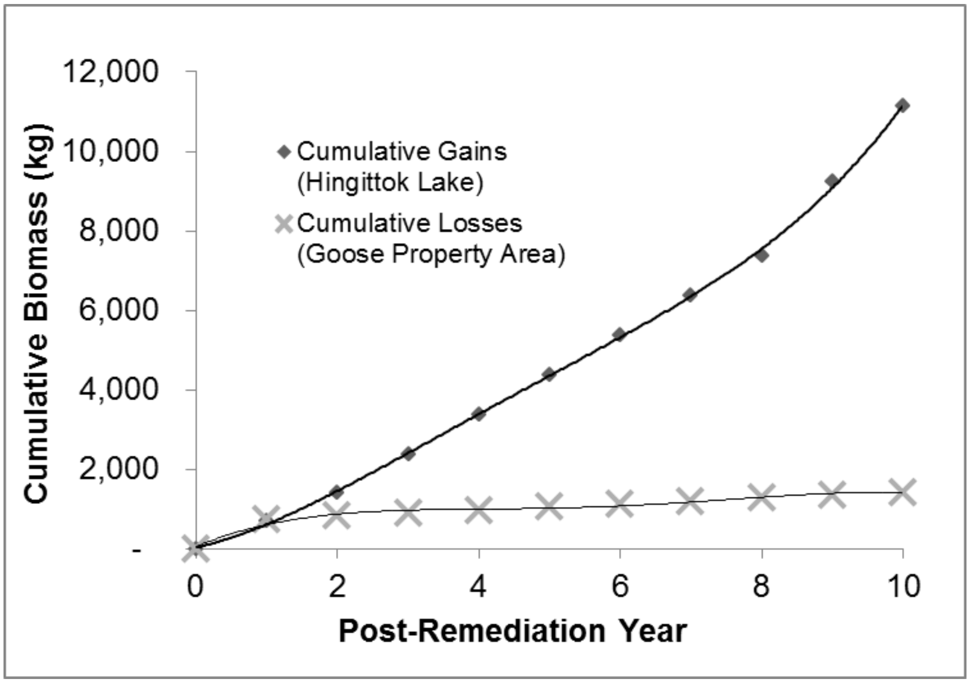

Figure 7.4-2. A Comparison of Predicted Cumulative Gains in Fish Production Versus Cumulative Losses Over Time

7.4.3 Schedule

The temporal scope of the proposed offsetting program at Bernard Harbour is 2014 to 2025 (Table 7.4-1). The proposed monitoring program is planned for a period of no more than 10 years post-enhancement and will include up to four sampling years of the Arctic Char run. This length of time and level of effort are expected to be adequate to demonstrate that the offsetting objectives have been achieved, where the goal of monitoring will be to demonstrate that fish production follows a projected trajectory of cumulative gains that will eventually exceed cumulative losses (Section 7.4.2.3). Sabina would conduct annual field monitoring and maintenance, working with community members. Biological monitoring and reporting to DFO would occur in offsetting year 1, 4, 9, and 10 (as needed) of the monitoring period. However, it is important to note that this schedule assumes that complete remediation of the creek occurs within one open-water season, and that the schedule may shift if additional remedial works are required the following season.

Table 7.4-1. Overview of Activities in Support of the Conceptual Fish Offsetting Plan for the Back River Project (2014 to 2025)

Phase	Offsetting Year	Annual Activities / Deliverables
Baseline	2014	Monitor adult and juvenile migrations, and passage conditions
		DFO/community engagement
	2015	DFO/community engagement
		Follow-up field investigation of habitat conditions
		Conceptual Fish Offsetting Plan
Remedial Works	Summer 2016 (Year 0)	DFO/community engagement
		Construct habitat offsetting enhancements (pending authorization and practical arrangements)
	Fall 2016	Remediation report
		Final Fish Offsetting Plan
Evaluation	2017 (Year 1 or 2)*	Monitor adult and juvenile migrations, and passage conditions Annual Report
	2018 – 2019 (Year 2 – 3)	Sabina/Kugluktuk HTO inspection years; inspect each year and repair channels (as needed) Annual field summary memo
	2020 (Year 4)	Monitor adult and juvenile migrations, and assess passage conditions Annual Report
	2021 – 2024 (Year 5 – 8)	Sabina/Kugluktuk HTO inspection years; inspect each year and repair channels (as needed) Annual field summary memo
	2024 (Year 9)	Monitor adult and juvenile migrations, and assess passage conditions Annual Report
		Offsetting Project Synthesis Report
		DFO/community engagement
	2025 (Year 10)	Final monitoring program (as needed) Technical memo update to synthesis report

** schedule may shift if, for example, remediation efforts require additional efforts and extend beyond one open water season.*
DFO = Fisheries and Oceans Canada; HTO = Hunters and Trappers Organization

7.5 EVALUATION MONITORING

Monitoring will include at least one year of baseline monitoring and up to four years of evaluation monitoring (years 1, 4, 9 and 10) over a period of 10 years. This length of time of the monitoring program and level of monitoring effort are expected to be adequate to demonstrate that the offsetting objectives have been achieved, where the goal of monitoring will be to demonstrate that fish production follows a projected trajectory of cumulative gains that will eventually exceed cumulative losses. Monitoring will also inform any required improvements to remediated habitats, or supplementary habitat enhancements.

Objectives of the fish and fish habitat monitoring will be similar to those outlined for the 2014 baseline monitoring study. Sampling methods will be consistent across years and phases of the offsetting plan to allow for a reliable assessment of gains. Monitoring will include biological and environmental components to provide a suite of measurement indicators under two primary objectives:

1) quantify the size and timing of the Arctic Char migrations (for the three migratory phases); and,

2) assess improvements in environmental conditions for fish passage.

The primary objectives of fish habitat monitoring will be to evaluate the physical integrity and function of the remediated sections of the creek for fish passage under spring and summer conditions. Detailed habitat measurements will be collected concurrently with fish monitoring. Measurements will include depths, channels widths, composition of streambed substrate, and channel stability. Measurements will be collected at both remediated and non-remediated (reference) sections of the creek. Monitoring reports will be submitted to DFO by December 31 of any given year that monitoring is carried out.

Any signs of measurable accumulations of substrates within the low-flow channels will be measured in detail, and recommendations for actions taken to remediate areas affecting fish passage will be provided. It is not expected that Nulahugyuk Creek will be maintenance-free after the remediation, but annual inspections and light maintenance are expected to provide acceptable performance. For example, only minor shifts of two to three small boulders are expected in 20 to 40% of the low-flow channels each year based on the 2014 and 2015 habitat assessments at Bernard Harbour.

Sabina will conduct observational monitoring (e.g., inspections of signs of erosion, sedimentation) and address any minor maintenance problems, if needed, working with community members during Years 2, 3, 5, 6, 7, and 8. Activities will include qualitative visual assessments and photographs of the remediated sections of the creek. Inspection reports will be submitted to DFO by December 31 of any given year that observation monitoring is carried out.

7.6 CONTINGENCIES

Sabina will evaluate the success of the offsetting project after each year of monitoring to determine if the proposed offsetting project is performing to expectations within the specific timeframe of the project. At any point within the monitoring period, should it be determined that the performance of the project is not meeting expectations, either through channel design modifications not providing passage, insufficient flow conditions or lack of fish utilization, alternate channel design options or additional habitat enhancements will be investigated and applied, if appropriate, in order to improve the performance of the offsetting option to meet the expectations under DFO’s Policy (DFO 2013a,b). If it is determined by Sabina, in consultation with DFO, that the proposed offsetting project will not meet the offsetting objectives for the Back River Project, an alternate project will be identified and implemented, with an associated monitoring plan, to achieve the offsetting commitments for fisheries losses at the Project.

8. Complementary Measures

In remote areas where there are low levels of human developments, such as the Canadian Arctic, there are not only limited opportunities for offsetting fisheries productivity losses, but there is also a general lack of knowledge on fisheries populations beyond that generated from baseline monitoring programs. Thus, an investment in data collection and scientific research may also be considered as a Complementary Measure for an offsetting plan when it takes into account the guiding principles outlined in the Fisheries Productivity Investment Policy. Research must relate to improving the state of knowledge around maintaining or enhancing the productivity of commercial, recreational, or Aboriginal fisheries to be considered as a Complementary Measure. A suite of Complementary Measures for the Back River Project will be considered. As Complementary Measures, the research investments may contribute up to 10% of gains to offset losses and reduce uncertainty associated with predicted gains from the offset option (e.g., described in Figure 7.4-1).

8.1 FISH-OUT LIFE HISTORY DATABASE

As described for the Conceptual Fish-Out Plan (Section 9), the fish out of Llama and Umwelt lakes will follow the sampling framework and protocols described in DFO's General Fish-Out Protocol (Tyson et al. 2011). Under DFO's protocol, life history information (i.e., lengths and weights) on all fish and species in Llama and Umwelt lakes will be collected. Laboratory analyses will be performed on a subset of captured fish. Aging structures will be collected and analyzed from a subset of captured species (e.g., Lake Trout) to characterize the age structure and growth characteristics of populations. Tissue samples (e.g., muscle) from a subset of captured species will also be collected and prepared for analyses of metal concentrations at an accredited laboratory. The combined dataset on life history, population, and environmental variables will then be provided to DFO, contributing to a regional fisheries database on lakes in Nunavut.

The proposed level and type of data collection follows DFO's General Fish-Out Protocol and is in support of the development of a regional database for managing fisheries in Arctic lakes. This level of effort is in excess of what would otherwise be required in support of a fish-out program; therefore, this work qualifies for consideration as a Complementary Measure for the Back River offsetting plan. This Complementary Measure will represent an important contribution to fisheries science and the management of stocks of fish species in the region. The details on data collection and reporting will be confirmed in the Final Fish-Out Plan.

8.2 BERNARD HARBOUR TK STUDY

As noted previously, a TK study was conducted in 2014-2015 in an effort to develop a better understanding of the Arctic Char fishery in the Bernard Harbour area (and related historic and contemporary environmental conditions). The TK study was carried out by Sabina in partnership with the Kugluktuk HTO and was intended to complement the scientific baseline studies that have also been conducted for the Bernard Harbour remediation project. The TK study involved one-on-one interviews with 11 Bernard Harbour land users from Kugluktuk and Cambridge Bay, who were selected by the Kugluktuk HTO for inclusion in the study. The TK study also made use of various secondary sources (e.g., historic records, land use reports, academic publications) and a Bernard Harbour site visit to provide additional information on the Arctic Char fishery. The TK study was led by a qualified social scientist using proven qualitative TK research methods. Further information on the TK study can be found in Section 2.1.3., while a copy of the TK study report can be found in Appendix V3-3D of Sabina's FEIS.

Considering the remote, pristine area that Bernard Harbour is located in and the lack of existing scientific information and documented TK on the local Arctic Char fishery, Sabina considers the Bernard Harbour TK study a Complementary Measure. For one, the TK study provides a significant amount of new environmental baseline information related to the Arctic Char fishery at Bernard Harbour. This includes information on Arctic Char harvesting, migration, spawning, health, response to changing environmental conditions, and other topics. This information will be useful for assessing the relative success of any future remediation activities that are undertaken at Bernard Harbour, while helping to address existing knowledge gaps related to the management and conservation of the Arctic Char fishery in the Coronation Gulf. Second, the TK study describes recent environmental changes observed by Inuit in the area and the negative implications these changes have had on the Arctic Char fishery in the region. This highlights the potential benefit stream remediation activities may have on the Arctic Char population at Bernard Harbour, while also contributing to the growing literature on environmental change in the Canadian Arctic.

The TK study also presents detailed information on an area of historic and contemporary importance to Inuit, and on a species readily harvested by Inuit (i.e., Arctic Char). The contributions the TK study makes to the local historic and cultural record are thus notable. Finally, the TK study demonstrates how the proposed approach to stream remediation (i.e., using low-impact stream channel manipulation methods) is grounded in historic Aboriginal fisheries management strategies that have been used at Bernard Harbour (i.e., seasonal stream channel manipulation and rock weir construction). This 'made in the north' approach represents a unique opportunity for fisheries offsetting and community benefits to be realized simultaneously, while also serving as a potential model for future project proponents.

While the results of the TK study are to remain the property of the Kugluktuk HTO, the data and results of the study are intended to be freely shared with other Nunavut organizations that may benefit from its use (as per the terms of the Bernard Harbour Restoration Project Agreement Between: The Kugluktuk Hunters and Trappers Organization and Sabina Gold & Silver Corp. signed by both parties in June 2014). For example, the KIA has been provided with copies of the data obtained from the TK study, so that it may be incorporated into their NTKP database. As noted by the KIA (2012), the NTKP is the foundation for recorded and geo-referenced Inuit TK in the western Kitikmeot Region. The NTKP covers Inuit land use, and fish and wildlife ecological data within a 750,000 km² study area, the Slave Geological Province. As well as being a repository of Kitikmeot Inuit TK, the NTKP was designed as a land use planning tool, designed to inform and improve the quality of environmental assessments for proposed developments in the Kitikmeot Region.

8.3 ARCTIC CHAR MOVEMENT STUDY

Research on the migratory movements of Arctic Char was conducted in 2014 in an effort to develop a better understanding of the ecology of Arctic Char at Bernard Harbour (i.e., the Nulahugyuk Creek-Hingittok Lake system). The research was carried out by Sabina in partnership with the Kugluktuk HTO and was intended to supplement previously completed scientific baseline studies at Bernard Harbour. It is expected that the Arctic Char movement studies will continue as part of a complementary measure when monitoring the Bernard Harbour Offsetting Option into the future.

The research will address questions on how Arctic Char move within Nulahugyuk Creek, and also on where Arctic Char from Bernard Harbour move within the broader region of the Coronation Gulf. The first question is being addressed by quantifying upstream movements for the duration of the migration period for a subset of capture Arctic Char using implanted PIT tags and Radio Frequency Identification (RFID) antenna-reader arrays installed at strategic locations on the creek. In 2014, a total of 315 upstream migrating adult char were implanted with PIT tags, each of which has a unique identification number that can be tracked by a handheld reader or remotely deployed antennae-reader array. Seven PIT-tag antennae-reader arrays were installed strategically in relation to the location of the 2012 low-flow channel project areas and reference sections to monitor the speeds and rates of successful passage across a range of conditions in the creek. An antennae-reader array was also installed near the outlet of Hingittok Lake to quantify the rate of successful upstream passage from the mouth of Nulahugyuk Creek to the spawning lake. Further information on the results of the PIT-tagging study completed in 2014 can be found in Section 7.3.2.

A Floy-tag program was also initiated in 2014 and included the use of external (Floy) tags for a subset of adult char moving downstream from Hingittok Lake such that char captured by local community members (e.g., later in the season in the Coppermine River) could be identified as individuals originating from Bernard Harbour. The external tags were implanted through the dorsal surface of the char lateral to the dorsal fin. The tags were orange, and each tag had a visible identification number for tracking the fish. A total of 475 adult char captured moving downstream were implanted with Floy tags. Resulting data from recaptures by domestic and recreational anglers, as well as future research teams, will be collected over time through tag return programs initiated by Sabina and the Kugluktuk HTO. This program will contribute valuable information on 'large-scale' movements of Arctic Char in the Coronation Gulf, and possibly the location of overwintering sites. Data collection is ongoing and the analysis of the return information will supplement the information collected on 'small-scale movements' of Arctic Char in Nulahugyuk Creek.

Considering the remote, pristine area that Bernard Harbour is located in and the lack of existing scientific information on the local Arctic Char fishery, Sabina considers information generated from the Arctic Char movement study a Complementary Measure. The study will provide a significant amount of new environmental baseline information related to the migratory ecology of Arctic Char, an area of fisheries science where there is currently a paucity of data to support any new management or conservation initiatives. This includes information on Arctic Char migration speeds, migration survival, environmental factors that influence the migration of Arctic Char, and the distribution or home ranges of Arctic Char from Bernard Harbour. This information will be useful for assessing the relative success of any future remediation activities that are undertaken at Bernard Harbour, while helping to address existing knowledge gaps related to the management and conservation of the Arctic Char fishery in the Coronation Gulf.

9. Conceptual Fish-Out Plan

9.1.1 Overview

A fish-out program will be carried out for any lakes that are lost as a result of the Project (i.e., Llama and Umwelt lakes). The fish-out program will follow DFO's General Fish-Out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut (Tyson et al. 2011). A fish-out or the removal of fish from a waterbody offers a unique opportunity to gather information on lake productivity and the fish community, as well as avoid any "wastage" by making the fish available for traditional use by local communities (Tyson et al. 2011). It is important to note that the detailed Final Fish-Out Plan will be developed during the water licencing phase of the Project.

9.1.2 Data Collection

9.1.2.1 Fish Community

In accordance with the General Fish Out Protocol, the fish out at Llama and Umwelt lakes will proceed in two major phases: a CPUE phase, and a final removal phase. The first (CPUE) phase is expected to begin mid-June immediately after "ice-out" and before dewatering later that summer. The final removal phase will occur immediately following the CPUE phase and during dewatering. The final removal phase is expected to be completed by late summer. Field sampling efforts will include community input to support the fish-out program.

The goal of the CPUE phase is to enumerate fish community CPUE data for each fish population in the lake and is intended to remove a substantial proportion of the fish biomass prior to changes in Llama and Umwelt lakes occurring. The CPUE phase also represents the period where most of the large-bodied fish are removed before the dewatering phase begins. Based on the General Fish-Out Protocol, the CPUE phase will exclusively use multi-panel (index) gill nets (small and large mesh sizes) configured as double-gangs for fish capture. The sampling will follow a stratified random design to allow for later calculation of population sizes. The transition from the CPUE phase to the final removal phase will be based on DFO's General Fish-Out Protocol.

Phase 2 will begin immediately following Phase 1 and will consist of a targeted gill netting program (i.e., not required to follow the sampling design in Phase 1) that will target habitats likely supporting fish as determined during the Phase 1 effort. Additional fish capture methods (e.g., electrofishing, angling, set lines, minnow traps, seine nets, fyke net traps) will be deployed where necessary to also target small-bodied fish and species (e.g., Burbot) not effectively captured using gill nets. Phase 2 may include fishing efforts concurrent with initial phases of dewatering and is expected to be completed by mid to late summer.

Diving Bird Mitigation

The fish-out program will aim to be completed outside of periods where there is high migratory bird use of the lake (i.e., nesting, brood rearing and migration periods) to avoid the incidental take of migratory birds through entanglement in any gill nets. Mitigation measures for minimizing mortalities of diving birds will include increasing the visibility of gill nets, use of visual or auditory deterrents to prevent birds from landing on the lake during active gill-netting, monitoring migratory bird usage of the lake and determining high use feeding areas prior to setting gill nets and avoiding these areas, and reporting of by-catch to adjust mitigation measures.

9.1.2.2 Aquatic Biology and Limnology

The Aquatic Biology and Limnology component of the fish-out program includes physical limnology measurements, water quality, chlorophyll a, and zooplankton samples. All samples will be collected multiple times during the fish-out program (including sampling before the fish-out in late spring/early summer, during the fish-out and just prior to dewatering in late summer). Benthic invertebrate sampling will be collected once from four different depth intervals mid-summer and sampling methods will be the same as those outlined in the Aquatic Effects Monitoring Program (Volume, Chapter 19 of the FEIS). Information on habitat (e.g., substrate, depth) will be collected at all sampling locations.

10. Summary

The purpose of the Conceptual Fish Offsetting Plan (Chapter 21) was to summarize anticipated serious harm to fish based on the assessment provided in the Final Impact Statement (FEIS), and to describe the offsetting option to counterbalance the unavoidable serious harm to fish, as defined in the *Fisheries Act*. The plan was constructed as per the guiding policies of Fisheries and Oceans Canada (DFO), with the goal of maintaining or improving the productivity of the commercial, recreational, or Aboriginal (CRA) fishery. In addition to the offsetting plan, a number of mitigation measures will be in place for the Back River Project (Project) to avoid or minimize the potential effects on the productivity of the CRA fishery. These mitigation measures will be supplemented by the use of adaptive management, as required. For any lakes that are lost as a result of the Project (i.e., Umwelt and Llama lakes), a fish-out will be conducted and will offer a unique opportunity to gather information on lake productivity and the fish community, as well as avoid any "wastage" by making the fish available for traditional use by local communities.

The Conceptual Fish Offsetting Plan for the Project is the result of continued community and regulatory engagement associated with the Project. The outcome of engagement activities identified an offsetting measure or option focused on improving the productivity of an Arctic Char fishery at Bernard Harbour (i.e., the Hingittok Lake-Nulahugyuk Creek system), which is located approximately 100 kilometres (km) directly north of the hamlet of Kugluktuk, Nunavut, along the south coast of the Dolphin and Union Strait. Bernard Harbour was once the site of a traditional domestic fishery for Arctic Char.

The Bernard Harbour offsetting option for the Back River Project was identified in response to reports by local harvesters in the 1990s that the traditional fishery was in decline. Follow-up investigations concluded that conditions of the creek may be deteriorating because of natural causes (e.g., changes in climate, resulting in low water levels, and boulder barriers), affecting the upstream migration success of adult Arctic Char to spawning areas in Hingittok Lake. Investigations also provided evidence that migration conditions could be remediated at problem locations by creating low-flow channels using low-impact construction methods. During 2014 to 2015, a Traditional Knowledge (TK) study combined with environmental monitoring provided a better understanding of the Arctic char fishery at Bernard Harbour (and related historic and contemporary environmental conditions). The baseline studies, all of which included Kugluktuk Hunters and Trappers Organization (HTO) as full partners, demonstrated how the proposed approach to stream remediation is grounded in historic Aboriginal fisheries management strategies that have been used at Bernard Harbour (i.e. seasonal stream channel manipulation and rock weir construction). This ‘made in the north’ approach represents a unique opportunity for fisheries offsetting and community benefits to be realized simultaneously. To estimate the potential benefits of the offsetting option to fisheries production (as a surrogate of fisheries productivity), changes in migration success were estimated and then related to changes in the biomass of adult Arctic Char in Nulahugyuk Creek. The predicted gains in biomass following remediation may be substantial, magnifying over time when offspring return as adults (by offsetting year 8 or 9). It is also predicted that gains in biomass at Bernard Harbour will exceed losses in fisheries production resulting from temporary drawdowns of small lakes (Llama and Umwelt lakes), and related infrastructure (e.g., Tailings Storage Facility) at the Goose Property Area.

The Conceptual Fish Offsetting Plan will be finalized and presented as a Final Fish Offsetting Plan during the permitting phase of the Project and submitted as part of the Application for Authorization under the Fisheries Act. The plan would be approved by DFO as a condition of the Authorization required for the development of the Project.

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Appendix A

Bernard Harbour Restoration Project Agreement between the Kugluktuk Hunters and Trappers Organization and Sabina Gold & Silver Corp.

BERNARD HARBOUR RESTORATION PROJECT

AGREEMENT BETWEEN:
THE KUGLUKTUK HUNTERS AND TRAPPERS ORGANIZATION AND
SABINA GOLD & SILVER CORP.

Purpose of the Agreement:

The purpose of this Agreement is to outline the relationship between the Kugluktuk Hunters and Trappers Organization (HTO) and Sabina Gold & Silver Corp. (Sabina) in executing the Bernard Harbour Restoration Project.

Background:

Stream restoration activities in the Nulahugyuk Creek - Hingittok Lake area (also known as Bernard Harbour) were initially proposed in the early 2000s by the Kugluktuk HTO. These activities were proposed with the goal of restoring a traditional Inuit Arctic char fishery, which has suffered from significant harvesting declines in recent years. The Kugluktuk HTO has worked closely with Golder Associates (Golder) to advance early stages of the project (e.g. initial environmental baseline and stream restoration work), and the two have recently applied to the Canadian Northern Economic Development Agency (CanNor) for additional project funding. The two organizations have also been seeking an industry partner to help advance the project to completion. Sabina has now been identified as this industry partner, who will support stream restoration work in the Nulahugyuk Creek - Hingittok Lake area in order to satisfy Fisheries Act offsetting requirements for its Back River Project while supporting the desires of the Kugluktuk HTO and the community members of Kugluktuk.

Objectives of the Agreement:

There are two primary objectives of this agreement:

1. ***Short term objective (2-3 years)***: To enable Sabina to satisfy a Department of Fisheries and Oceans (DFO) requirement to offset fisheries habitat effects at the Back River Project. This objective would be achieved by improving the viability of the Nulahugyuk Creek - Hingittok Lake traditional Arctic char fishery. To the greatest extent practicable, local community members will be involved throughout the process to help support this objective. Selected local high school students will also be involved in the project where possible, so that skills and knowledge may be transferred to them.

2. ***Long term objective (3+ years)***: To enable the Kugluktuk HTO and Sabina to restore a historic, locally-utilized Arctic char fishery, for the benefit of Kugluktuk residents. This will be accomplished, in part, by the provision of resources and training by Sabina.

Structure of the Relationship between the Kugluktuk HTO and Sabina:

The Bernard Harbour Restoration Project is envisioned as a partnership between the Kugluktuk HTO and Sabina. This partnership will be structured in the following ways:

- The Bernard Harbour Restoration Project is to remain a Kugluktuk HTO-led initiative. Sabina will support the Kugluktuk HTO in achieving their objectives for the Bernard Harbour Restoration Project, but control and ownership of the project will ultimately reside with the Kugluktuk HTO.
- A Traditional Knowledge (TK) study on the Arctic char fishery in the Nulahugyuk Creek - Hingittok Lake area (see following section) will be conducted to support the objectives of this agreement. This study will be coordinated and executed by Sabina, although the Kugluktuk HTO will remain the owners of all TK data that is collected and reports that are issued. The Kugluktuk HTO and Sabina are currently exploring options for the funding of this TK study. In the event third party funding cannot be obtained, Sabina will provide all necessary resources for the TK study to be completed.
- Environmental baseline work, stream restoration work, and DFO-required follow-up monitoring and reporting will all be funded by Sabina. However, these particular work areas will be coordinated and executed by Golder (or other similar consultant), who will act as the Kugluktuk HTO / Sabina representative onsite at Bernard Harbour.
- The Bernard Harbour Restoration Project will, to the greatest extent practicable, provide opportunities for the involvement of summer students hired by the Kugluktuk HTO.
- Once the Bernard Harbour Restoration Project's short term objective has been met (see above), Sabina intends to phase-out its involvement in the project. In the long-term, full management of this project will be turned over to the Kugluktuk HTO. The timing of this phase-out will be determined in consultation with DFO, Sabina, the Kugluktuk HTO, and possibly other organizations like the KIA. As a rough estimate, this phase-out would likely occur 3 years after all stream restoration work has been completed (e.g. 4-6 years after the signing of this agreement).
- Sabina acknowledges the Kugluktuk HTO's strong desire to learn the skills and knowledge necessary in order to manage all future stream restoration and monitoring work themselves. Sabina will work with the Kugluktuk HTO to provide this training and will help develop a management plan/document and workshop that addresses these objectives.

Traditional Knowledge Study

In an effort to develop a better appreciation of historic and contemporary environmental conditions in the Nulahugyuk Creek - Hingittok Lake area, a TK study will be conducted. While additional details on the TK study are included in the TK study proposal document that was shared with the Kugluktuk HTO in early April 2014 (see Appendix A), the following points are of particular relevance to this Agreement:

- All TK data and reports that result from the TK study will be owned by the Kugluktuk HTO. However, all TK data collection, analysis, and reporting activities will be conducted by Sabina on behalf of the HTO.
- Opportunities for youth involvement in the TK study (e.g. as research assistants) will be investigated on an ongoing basis.
- All TK data and reports that result from the TK study will be made available to the Kitikmeot Inuit Association (KIA) for inclusion in their Naonaiyaotit Traditional Knowledge Project (NTKP) database, with the

understanding the KIA may utilize and distribute this data and information for their own purposes. The data and results of the TK study are also intended to be freely shared with other Nunavut organizations that may benefit from its use.

- Sabina reserves the right to publish the final TK study report in the Back River Project Final Environmental Impact Statement (FEIS) and / or in other regulatory submissions. TK study results may also be presented by Sabina and / or its representatives in other public forums (e.g. conferences, company publications and presentations).

Implementation Schedule

This Agreement will be implemented over three periods:

1. ***2014 - 2015***
   - TK study (to be conducted by Sabina in Kugluktuk)
     - Potential Bernard Harbour site visit with selected TK study participants
   - Baseline fieldwork (to be conducted by Golder at Bernard Harbour)
     - Potential Bernard Harbour site visit with partners and DFO
2. ***2015 - 2016***
   - Fisheries offsetting plan to be drafted by Golder for Sabina's FEIS (submission of this plan will initiate the DFO approval process)
3. ***Future considerations***
   - Conduct stream restoration work, pending DFO approval of offsetting plan. This work will include:
     - Identifying main stream channels
     - Removal of fish passage barriers
     - Relocation of in-stream boulders to create low-flow channels
   - Project monitoring requirements to be determined in consultation with DFO; Sabina will follow all monitoring requirements as set out by DFO
   - At this time, it is expected that monitoring programs will be conducted by Sabina (or a consultant) at *Year 1* and *Year 7* following initial stream restoration activities. Sabina will also negotiate appropriate funding with the Kugluktuk HTO, so that interim monitoring activities (i.e. monitoring during the years when Sabina / a consultant are not present) can be conducted directly by the Kugluktuk HTO. Longer-term funding arrangements may also need to be arranged in the future.
   - Sabina to eventually phase out corporate involvement in Bernard Harbour Restoration Project; role of HTO in long-term management of stream restoration activities to be determined in consultation with DFO and Sabina.

Duration of the Agreement

This Agreement will be effective as of the signing date in the Endorsement section below. The initial term of this Agreement will be for two years, but the Agreement will be subject to renewal after this time. During the two years of this initial Agreement a number of tasks will be completed by Sabina to better define long-term project requirements. These will include:

- Collection of baseline data.
- Analysis of baseline data and development of plans in Sabina's Final Environmental Impact Statement (FEIS) to determine specifically what will be required for Sabina to meet its fisheries offsetting obligations.
- Finalization of fisheries offsetting terms and conditions with DFO (Note: project plans may change somewhat as a result of this process).

Upon completion of this initial two-year Agreement, it is anticipated that Sabina and the Kugluktuk HTO will negotiate a new, longer-term project agreement.

Endorsement

The following parties endorse this agreement:

For the Kugluktuk Hunters and Trappers Organization:

David Nivingalok
Chairperson
Kugluktuk Hunters and Trappers Organization
P.O. Box 309
Kugluktuk, Nunavut, X0B 0E0
kugluktukhto@qiniq.com

Signature ______________________ Date June 5/2014

For Sabina Gold & Silver Corp.:

Matthew Pickard
Vice President, Environment & Sustainability
Sabina Gold & Silver Corp.
202 - 930 West First Street
North Vancouver, British Columbia, V7P 3N4
mpickard@sabinagoldsilver.com

Signature ______________________ Date June 3, 2014