BACK RIVER PROJECT

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.

%	percent
±	plus or equal to
<	less than
>	greater than
cm	centimetre
CRA	commercial, recreational, or Aboriginal
DFO	Fisheries and Oceans Canada
FEIS	Final Environmental Impact Statement
g	gram
Golder	Golder Associates Ltd.
GPS	Global Positioning System
ha	hectare
HTO	Hunters and Trappers Organization
kg	kilogram
KIA	Kitikmeot Inuit Association
km	kilometre
km^2	square kilometre
LDSA	Lower Downstream Array
m	metre
m^2	square metre
m^3	cubic metre
m^3/km/yr	cubic metres per kilometre per year
m^3/s	cubic metres per second
MLA	Marine Laydown Area
mm	millimetre
mm/s	millimetres per second
Mm^3	million cubic metres
MDMER	Metal Mining Effluent Regulations
Mt	million tonnes

MUSA	Middle Upstream Array
NA1	North American small mesh gillnets
NIRB	Nunavut Impact Review Board
NTKP	Naonaiyaotit Traditional Knowledge Project
NWB	Nunavut Water Board
NWT	Northwest Territories
ºC	degrees Celsius
ON2	Ontario small mesh gillnets
P	probability
P:B	production to biomass ratio
PIT	Passive Integrated Transponder
Project, the	Back River Project
Sabina	Sabina Gold & Silver Corp.
SD	standard deviation
t/d	tonnes per day
t/m^3	tonnes per cubic metre
TF	Tailings Facility
TK	Traditional Knowledge
TSF	Tailings Storage Facility
ULOA	Upper Lake Outlet Array
WIR	winter ice road
WRSA	Waste Rock Storage Area

1. Introduction

1.1 PURPOSE

The Back River Project (Project) is a proposed 27-year gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut (Figure 1.1-1). It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 525 km northeast of Yellowknife, Northwest Territories (NWT). The Project is located predominantly within the Queen Maud Gulf watershed. The closest community areas to the Project are Kingaok, located approximately 160 km north of the Goose Property, and Omingmaktok, located approximately 250 km northeast of the Goose Property.

The Project is comprised of two main areas with an interconnecting winter ice road (WIR): the Goose Property, and the Marine Laydown Area (MLA) (Figure 1.1-1) situated along the western shore of southern Bathurst Inlet. The Goose Property Potential Development Area is predominantly on Inuit Owned Land. A WIR spur will also connect to Sabina's George Exploration Camp. The Project will be supported by year-round resupply by aircraft and seasonal marine resupply by open water shipping (approximately 3 to 5 vessels per year).

The mine plan at the Goose Property (also discussed in Section 3.2) consists of open pits and underground mining operations supporting a 6,000 tonnes per day (t/d) milling operation using a standard gravity separation and cyanide leaching circuit to extract the gold. The current plan for combined mine production focuses on achieving average production of 350,000 ounces of gold annually. Four deposits at Goose Property (Umwelt, Llama, Goose Main, and Echo) are planned to be mined using both open pit and underground mining methods.

Mining will begin with open pits at the Goose Property with pre-stripping and ore stockpiling beginning in Year -2. Throughout the mine life, production from open pit mining will be supplemented by the underground mines starting with production from Llama underground in Year -1. Project development will require establishing a Tailings Storage Facility (TSF), and multiple waste rock storage areas (WRSAs). The TSF will be located on Crown Land with all other infrastructure on Inuit Owned Land. Tailings (and potentially waste rock) will be deposited in the TSF, and two mined-out open pits: Umwelt Tailings Facility (TF), and Goose Main TF. After tailings deposition transitions from the TSF to the Umwelt TF or Goose Main TF, the TSF will be converted to a WRSA (namely, the TSF WRSA).

The life of the Project, from mobilization/construction to Post-Closure, is 27 years including: Construction Phase of 4 years (Year -4 to Year -1), Operations Phase of 10 years (Year 1 to Year 10), Closure Phase of 8 years (Year 10 to Year 18), and Post-Closure monitoring for 5 years (Year 18 to Year 23). The Operations Phase may be extended beyond 10 years should additional mineral deposits become economical to be developed.

The purpose of the Fish Offsetting Plan is to summarize anticipated Project effects on fish and fish habitat, describe the selected offsetting measure (i.e., Bernard Harbour project), and outline a plan to offset the residual serious harm to fish according to the Fisheries and Oceans Canada (DFO) Policy (DFO 2013a,b). In brief, the selected offsetting measure is an Inuit-directed habitat enhancement (or remediation) project with the goal of improving fish production for anadromous Arctic Char at Bernard Harbour, Nunavut. The final Fish Offsetting Plan will be part of the application for a *Fisheries Act* Authorization under Section 35, and the request for an Amendment to Schedule 2 of the Metal and Diamond Mining Effluent Regulations (MDMER), under Section 36 of the *Fisheries Act*.

The following subsections in Section 1 of this document include an introduction to the regional baseline setting for fish (Section 1.2), the history of the environmental review and permitting process for the Project (Section 1.3), and the expected permitting requirements under the *Fisheries Act* (Section 1.4). The content of the document also includes:

Section 2—outlines the integration of Traditional Knowledge and the engagement process completed by Sabina for the environmental assessment and the selection of the Bernard Harbour project as the offsetting option for the Back River Project

Section 3—outlines Project infrastructure and activities that have the potential to result in effects to fish and fish habitat

Section 4—describes the mitigation and avoidance measures to be implemented for the Project to minimize or avoid effects on fish and fish habitat

Section 5—provides a summary of the fish and fish habitat resources that interact with Project activities at the Goose Property that may result in serious harm to fish, and are expected to be listed under Schedule 2 of MDMER

Section 6—calculates Project-related losses, measured in fish production units (e.g., biomass), for residual serious harm to fish and MDMER Schedule 2 habitat to be offset by the Bernard Harbour project

Section 7—outlines the proposed Bernard Harbour offsetting measure for the Project, including the baseline data collected during 2014, 2015 and 2016, and the analysis of gains to demonstrate that equivalency has been met for losses related to Section 35(2) of the *Fisheries Act* and Section 27.1 of the MDMER

Section 8—outlines the monitoring plan specific to the offsetting activities and the overall monitoring schedule proposed by Sabina

Section 9—summarizes complementary measures that are proposed to be included as components of the Fish Offsetting Plan

Section 10—summarizes offsetting contingencies proposed in the draft Conceptual Offsetting Plan

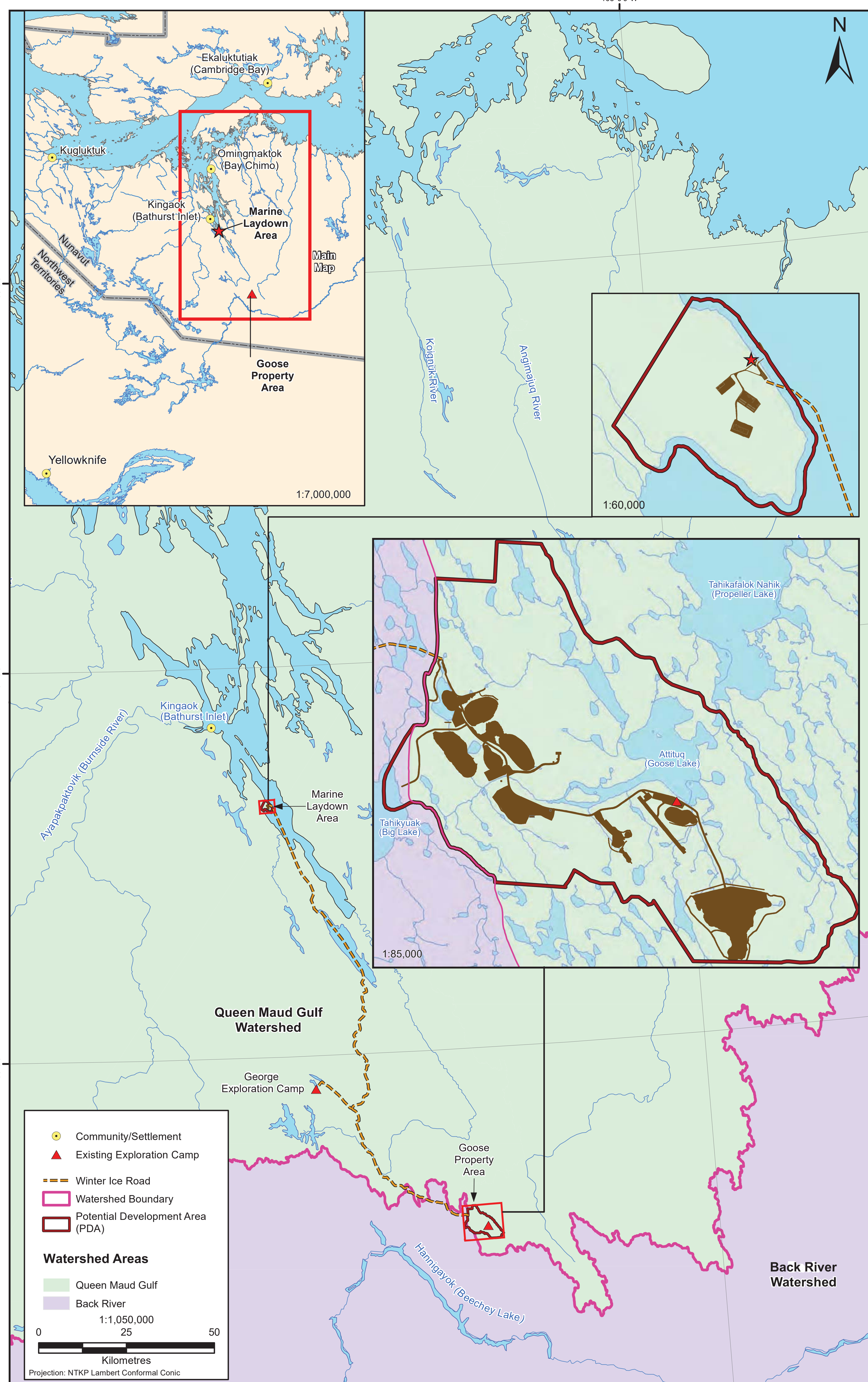

Figure 1.1-1

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Nunavut Watershed Areas of the Back River Project

1.2 REGIONAL SETTING

The Project is in southwestern Nunavut in the continuous permafrost zone of the continental Canadian Arctic. The majority of 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 degrees Celsius [°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 millimetres (mm) (2009) to 344 mm (2007) for the interval 2006 to 2012 (see Final Environmental Impact Statement [FEIS] Volume 4, Chapter 3 for additional information; Sabina 2015). Ice depths on waterbodies are typically 2 metres (m) thick, and shallow waterbodies (less than 2.0 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 watershed (Ellis River) and has a relatively small upstream catchment. A few deep lakes provide most of the 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 depths. 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 Local Study Area include Burbot (*Lota lota*) and Lake Whitefish (*Coregonus clupeaformis*). No Arctic Char (*Salvelinus alpinus*) have been captured in the Goose Property Area; however, they have been captured nearer Bathurst Inlet approximately 76 km north of the Goose Property.

In the Traditional Knowledge (TK) report (KIA 2012), the Inuit note that fish are present throughout waterbodies on the landscape surrounding and including the Project area. While Goose Lake may be occasionally fished by traditional land users, the lakes in the Goose Property Area are not known to be destinations or key locations for fishing (FEIS Volume 8, Chapter 4; Sabina 2015). The TK report 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).

1.3 REGULATORY HISTORY

Sabina commenced the Environmental Assessment of the Project on June 14, 2012 with the submission of a Project Proposal to the Nunavut Impact Review Board (NIRB; File No. 12MN036). The NIRB issued a screening decision report in September 2012 to the Minister recommending the project proceed. The Minister issued a decision in support of the NIRB screening report in December 2012. In January 2014, Sabina submitted a conformant Draft Environmental Impact Statement which included a Draft Type A Water Licence Application for Mine Development for consideration by the NIRB and Nunavut Water Board (NWB), respectively (Sabina 2014). Initially and early in the review process, Sabina requested that the Project be considered by the NIRB and NWB concurrently, consistent with the Detailed Coordinated Process Framework for NIRB Reviews and NWB Licensing (April 2012).

On December 19, 2014, the NIRB issued a Technical Meeting/Pre-hearing Conference Report Decision that included the NWB Technical Review requirements for a Type A Water Licence. Following the receipt of the NIRB's Pre-hearing Conference Report, Sabina submitted the FEIS on November 23, 2015, which was deemed conformant to the Project Guidelines (Sabina 2015). A Conceptual Fish Offsetting Plan was submitted with the FEIS (Volume 10, Chapter 21). Of note, Sabina advised NIRB that moving forward through the environmental review that the Project scope was reduced, now focused on the Goose Property and MLA, with activities associated with the development of George Property removed from the Project Description. Sabina also requested that applications for NIRB and NWB processes not be reviewed concurrently.

The Final Hearing concluded on April 30, 2016, with the Kitikmeot Inuit Association (KIA), Government of Nunavut, and all selected representatives of the Kitikmeot communities recommending that the Project should be allowed to proceed. On June 15, 2016, the NIRB released their Final Hearing Report to the Minister which recommended that the Project should not be approved to proceed at this time. On January 12, 2017, the Minister directed the NIRB to reconsider the Project under Section 12.5.7(e) of the Nunavut Agreement due to deficiencies in the NIRB Final Hearing Report.

On February 15, 2017, Sabina submitted an FEIS Addendum to the NIRB in response to the NIRB direction letter to address issues and concerns identified by the NIRB and address highlighted issues within the Minister's (January 12, 2017) referral letter (Sabina 2017a). The Conceptual Fish Offsetting Plan was updated and submitted with the FEIS Addendum (Volume 10, Chapter 21). A subsequent Technical Meeting was held by NIRB on May 24, 2017 (via telecom) with a Final Hearing held from May 31 to June 2, 2017 in person in Cambridge Bay, Nunavut. On July 18, 2017, the NIRB concluded in their Revised Final Hearing Report that the Project should now be allowed to proceed to the regulatory stage. The NIRB issued a Project Certificate on December 19, 2017.

Once the Project was approved, it entered the permitting phase, which involved applications for the licences, permits, and authorizations that fall under federal and territorial jurisdictions. In September 2017, Sabina applied to the NWB for an Early Works Type B Water Licence. An application for a Type A Water Licence for the Project was submitted to the NWB in October 2017 (Sabina 2017b). Through the Type A water licensing process, Sabina responded to information requests (February 2018) and technical comments (April 2018), and participated in a technical meeting and pre-hearing conference (May 2018). The Final Public Hearing was held August 2018. Sabina will obtain an Authorization under the *Fisheries Act* from DFO to undertake any activities that will cause residual serious harm to fish after implementation of mitigation measures.

To align with the timing of Sabina's early development works at the Goose Property, including the watercourse crossing construction, a Request for Review was submitted to DFO in February 2018. A subsequent Request for Review was submitted to DFO on June 6, 2018, for early development works at the MLA, including a lightering barge terminal and the installation of water intake/discharge pipes in Bathurst Inlet. DFO's review of those applications determined that the potential for serious harm to fish under the *Fisheries Act* could be avoided with the application of the identified mitigation measures (DFO 2018a,b). These measures will be implemented during the open water season in 2018, and therefore, consideration of early works activities for the Goose Property or MLA are not required for the Authorization application, and therefore, not considered in the Fish Offsetting Plan.

1.4 *FISHERIES ACT* AND OFFSETTING REQUIREMENTS

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. The dewatering of Llama and Umwelt lakes for mining operations will require a *Fisheries Act* Authorization under Section 35.

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
- letter of credit, as security for completion of the offsetting plan

Using a natural water body frequented by fish for mine waste disposal also requires a federal legislative action, specifically an Amendment to the MDMER. The MDMER, enacted in 2002 and revised in 2018, was developed under subsections 34(2), 36(5), and 38(9) of the *Fisheries Act* to regulate the deposit of mine effluent, waste rock, tailings, low-grade ore, and overburden into natural waters frequented by fish. These regulations, administered by Environment and Climate Change Canada, apply to both new and existing metal mines. Schedule 2 of the MDMER lists water bodies designated as tailings impoundment areas, where a water body is added to that Schedule through a regulatory amendment. Section 27.1 of the MDMER requires the project proponent to develop and implement a fish habitat compensation (i.e., offsetting) plan to counterbalance the loss of fish habitat with the addition of a water body to Schedule 2. This is required for the proposed Project.

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[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".

Both the application for a Schedule 2 Amendment to the MDMER and the application for a Section 35 *Fisheries Act* Authorization will require an offsetting plan. Because the same offsetting measure (i.e., Bernard Harbour project) is proposed for both applications, one offsetting plan will be submitted for the Project. The selected offsetting measure, which is an Inuit-directed habitat enhancement (or remediation) project with the goal of improving fish production for anadromous Arctic Char at Bernard Harbour, Nunavut, is expected to fully counterbalance the unavoidable residual serious harm to fish from the Project. The offsetting measure is expected to meet all of the principles of DFO's Fisheries Productivity Investment Policy described below. The plan follows DFO's approach to offsetting, described in the Fisheries Protection Policy Statement (DFO 2013a) and Fisheries Productivity Investment Policy (DFO 2013b). The plan, including the offsetting measure, would be approved by DFO and Environment and Climate Change Canada (ECCC) as a condition of the requested Amendment and Authorization for the Project.

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 require engagement with Indigenous groups. Offsetting measures should meet the following principles:

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

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
- 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 CRA 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. Engagement and Traditional Knowledge

2.1 COMMUNITY ENGAGEMENT

Sabina has regularly engaged local communities and representatives of the KIA on the Project. This has included engagement on various topics, such as fish offsetting requirements for the Project and, more specifically, the Bernard Harbour 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, a significant number of meetings have been held with the public, Sabina's two community advisory groups in Cambridge Bay and Kugluktuk, local Hamlets, Hunters and Trappers Organizations (HTOs), youth, and other stakeholder groups. Approximately 185 community and stakeholder meetings on the Project were held prior to the November 2015 FEIS submission, during which time a substantial amount of feedback was received by Sabina. Since the November 2015 FEIS submission, over 66 additional meetings with community and stakeholder representatives have been held on the Project (for a total of over 251 Project-related meetings to-date).

The focus of the engagement 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, June 2015, June 2016, July 2016, and November-December 2016. One-on-one meetings with community stakeholder groups have also been held at various times. The NIRB has additionally held public meetings on the Project in February 2013, March/April 2014, November 2014, and April 2016.

In addition to providing information to local communities on development plans for the Project, Sabina has discussed various 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. A complete list of the various stakeholder meetings Sabina has hosted or participated in since June 2012 is included in Main Application Document submitted in support of the Type A Water Licence refer to Table 3.7-1 (Sabina 2017b).

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 with Indigenous communities 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 FEIS Addendum Appendix V3-1C contains copies of all June 2012 to June 2015 meeting minutes and public comment forms from which the summary was developed (Sabina 2015). FEIS Addendum Appendix V3-1C also includes meeting minutes and public comment forms for meetings held since the FEIS submission (up to February 2017) (Sabina 2017a).

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

Note: this only covers the period up to the submission of the FEIS.

Sabina has worked hard to ensure communities are given regular updates on the Project and are provided with opportunities to share feedback. For example, Sabina conducted a tour of all the Kitikmeot communities in July 2016 to explain the Final Hearing Report and describe the next steps that would be taken by Sabina. Sabina has also continued to advance the Bernard Harbour Restoration Project with the Kugluktuk HTO, hosted a Project site visit with community members in April 2016, and has participated in various other meetings and events (e.g., the annual Kitikmeot Socio-economic Monitoring Committee meeting, Kitikmeot Career Fair, Kitikmeot Mayors Conference, Kitikmeot Trade Show). As before, a significant amount of support for the Project continues be received from community stakeholders.

Sabina also visited the communities of Cambridge Bay and Kugluktuk in November and December 2016 (meeting with the public, HTOs, Community Advisory Groups, and residents of Bathurst Inlet and Bay Chimo) to describe recent improvements made by Sabina. Feedback obtained from community members was generally very positive and recommendation were fed into the appropriate mitigation plan.

While there have been a number of new engagement activities conducted since the FEIS submission, the overall approach, methods, and findings of Sabina's public consultation and engagement program have not changed. Sabina continues to build upon the positive relationships it has developed through this meaningful engagement. Sabina will also maintain a public consultation and engagement program throughout the life of the Project, as described in its Community Involvement Plan.

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 has agreed to wildlife compensation (including fish) with them. Sabina is also required under the Nunavut Agreement to negotiate an Inuit Impact and Benefit Agreement 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 and water licensing process for the Project.

2.1.2 Bernard Harbour Offsetting Measure

Sabina's commitment to the offsetting measure proposed in the Conceptual Fish Offsetting Plan (i.e., Bernard Harbour project) 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 project. Stream remediation (or enhancement) activities in the Hingittok Lake-Nulahugyuk Creek 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 the planning and implemented the Bernard Harbour offsetting measure in cooperation with the Kugluktuk HTO. Details on the relationship between the Kugluktuk HTO and Sabina in executing the Bernard Harbour offsetting measure 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, and later renewed in January 2017. Importantly, the Bernard Harbour offsetting measure is to remain a Kugluktuk HTO-led initiative with Sabina providing support to the Kugluktuk HTO and ensuring that the objectives of the Fish Offsetting Plan are achieved.

The Kugluktuk HTO has remained involved in the Bernard Harbour offsetting measure 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 work, 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 2013a). The Kugluktuk HTO has also played a key role in the TK study that was conducted for the Bernard Harbour offsetting measure (for more details, see Appendix B, or a summary of the TK study provided further below).

The Indigenous community members of Kugluktuk have been engaged in the Bernard Harbour 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 measure were presented by Sabina representatives. Another public meeting was held on June 7, 2016, to discuss the Project and the offsetting measure with DFO staff. The Bernard Harbour offsetting measure 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 2013a).

Local residents are 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 measure 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 the Bernard Harbour project advances.

The KIA has been kept informed of plans for the Bernard Harbour offsetting measure 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 NWT public have been made aware of the Bernard Harbour offsetting measure. 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 Project (a visit to Gjoa Haven had to be re-scheduled). 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 regarding the Bernard Harbour offsetting measure can be found in Table 2.1-2. Sabina will continue to engage northern residents and Indigenous community members on the Bernard Harbour project as it advances.

Table 2.1-2. Community Engagement Conducted by Sabina for the Bernard Harbour 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'.
June 1-6, 2014	Selected elders and knowledge holders	A series of TK 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 project and 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.

(continued)

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

Location / Date	Individual(s) / Organization	Description
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 Bernard Harbour were briefly reviewed.
June 18, 2015	Kugluktuk HTO	Project update and FEIS submission overview. The results of the Bernard arbour 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 reviewed.
July 8, 2015	David Nivingalok, Kugluktuk HTO Chairperson	Letter providing information on the 2015 Bernard Harbour work proposal.
June 7, 2016	General public	Public meeting – Project Update and Back River Offsetting Plan presented to community by Sabina and DFO.
June 8-9, 2016	Kugluktuk HTO and Invited Participants	Bernard Harbour Restoration Project Workshop
November 9, 2016	Kugluktuk HTO	Conference call – results from 2016 field program were presented and discussed.
December 2, 2016	Kugluktuk HTO	Project update, Bernard Harbour project update, and update on revised Wildlife Mitigation and Monitoring Program
Cambridge Bay		
June 7-10, 2014	Selected elders and knowledge holders	A series of TK 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 measure were briefly reviewed.
June 16, 2015	Hamlet of Cambridge Bay Representatives	Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting measure were briefly reviewed.
June 16, 2015	General public	Public meeting – Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting measure were briefly reviewed.
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.
Taloyoak		
June 17, 2015	General public	Public meeting – Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting measure were briefly reviewed.
June 17, 2015	Hamlet of Taloyoak	Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting measure were briefly reviewed.

(continued)

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

Location / Date	Individual(s) / Organization	Description
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 measure.
Yellowknife		
June 15, 2015	General public	Public meeting - Project update and FEIS submission overview. Plans for the Bernard Harbour offsetting measure were briefly reviewed.

2.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

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

2.2.1 Back River Project Environmental Assessment

The following reports were reviewed for TK specific information related to fisheries at the Project and are summarized in the FEIS (Sabina 2015):

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

2.2.2 Bernard Harbour Offsetting Measure

The Kugluktuk 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 the remediation of the creek at Bernard Harbour (e.g., ANL and Golder 2005; Golder and ANL 2007; Golder 2013a). The Kugluktuk HTO has also played a key role in the TK study that was conducted for the Bernard Harbour offsetting measure.

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.

The TK study findings are summarized in the Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek - Hingittok Lake Area (Bernard Harbour), Nunavut (Appendix V3-3D of FEIS or see Appendix B).

2.3 DFO ENGAGEMENT

Sabina has regularly engaged DFO on the Back River Project (Table 2.3-1). This has included engagement on topics such as offsetting requirements for the Project and, more specifically, the Bernard Harbour project.

Table 2.3-1. DFO Engagement Conducted by Sabina for the Bernard Harbour Project

Date	Organization	Location	Purpose
2014			
February	DFO – Central and Arctic Region	Yellowknife	Introduction to the contents and structure of the Draft Environmental Impact Statement. Introduction of the proposed fisheries offsetting concept at Bernard Harbour
April	DFO – Central and Arctic Region	Yellowknife	Introduction to the Project, including offsetting accounting memo prepared by Golder
June	DFO – Central and Arctic Region	Yellowknife	Update meeting and discuss attendance at the location of the proposed fisheries offset (Bernard Harbour site)
July	DFO – Regional Director, Ecosystems Management	Ottawa	Discussed Project status, Bernard Harbour, and next steps with Dale Nicholson
	DFO – Central and Arctic Region	Kugluktuk	Meeting at the Bernard Harbour site along with the Kugluktuk HTO and KIA
August	DFO – Central and Arctic Region	Teleconference	Discussion of Authorization requirements for Site Preparation Work
October	DFO – Central and Arctic Region	Teleconference	Further discussion of Authorization requirements for Site Preparation Work
2015			
January	DFO – Central and Arctic Region	Teleconference	Discussion related to equivalency in DFO's Offsetting Policies
March	DFO – Central and Arctic Region	Teleconference	Discussed habitat banking process. Feedback on Site Preparation proposed methodology
April	DFO – Central and Arctic Region	Teleconference	Discussed proposed approach to significance / residual effects assessment for FEIS
May	DFO – 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	DFO – Central and Arctic Region	Teleconference	Overall Project update; discussion of potential Schedule 2 implications based on predicted habitat losses

(continued)

Table 2.3-1. DFO Engagement Conducted by Sabina for the Bernard Harbour Project (completed)

Date	Organization	Location	Purpose
September	DFO – Executive Fisheries Protection	Ottawa	Project status update; discussion on Bernard Harbour direction with Christine Loth-Brown and Nicholas Winfield
September	FEIS submitted to NIRB		
December	Federal Departments and Agencies	Teleconference	Review of FEIS structure
2016			
March	DFO – Central and Arctic Region	Teleconference	Discussed submission of final offsetting plan to ensure understanding on technical issues related to fisheries. Feedback on Rascal Lake Realignment
May	DFO – Executive Fisheries Protection Headquarters	Ottawa	Discussed proposed approach to fisheries offset and banking with Nick Winfield and Tania Gordanier
August	DFO – Executive Fisheries Protection Headquarters	Ottawa	Update on Bernard Harbour offsetting measure with Nick Winfield and Tania Gordanier
2017			
February	DFO – Executive Fisheries Protection	Ottawa	Project status update; discussion on direction of Bernard Harbour offsetting measure with Nick Winfield, Tania Gordanier, and Helene Marquis
July	DFO – Central and Arctic Region	Bernard Harbour	DFO staff site visit at Bernard Harbour
June	DFO – Executive Fisheries Protection Headquarters	Ottawa	Discussion status of overall project and Bernard Harbour with Nick Winfield, Tana Gordanier, and Helene Marquis
2018			
May	DFO – Central and Arctic Region and Environment and Climate Change Canada	Teleconference	Confirmed one final Fish Offsetting Plan for the application for the *Fisheries Act* Authorization and Schedule 2 Amendment
September	DFO – Executive Fisheries Protection Headquarters	Ottawa	Discussion of status of final Fish Offsetting Plan with Tana Gordanier
November	DFO – Central and Arctic Region	Yellowknife	Discussion of DFO comments on the draft final Offsetting Plan submitted in September 2018

2.4 ENVIRONMENT AND CLIMATE CHANGE CANADA ENGAGEMENT

Sabina has regularly engaged ECCC (formerly Environment Canada or EC) on the Back River Project (Table 2.4-1). This has included engagement on topics such as the TSF, MDMER Schedule 2 Amendments, and related offsetting requirements for the Project.

Table 2.4-1. ECCC Engagement Conducted by Sabina for the Back River Project (2012 to 2018)

Date	Organization	Location	Comments
July 2012	National Headquarters	Ottawa	Project introduction and importance of staying in touch through process due to possible Schedule 2 Amendment
September 2012	Regional office	Back River Project site	Participated in 2 day site tour of the Back River Project site
September 2012	Regional Office	Yellowknife	Follow-up discussion to site tour. Included discussion of possible Schedule 2 Amendment requirements
December 2012	Regional Office	Yellowknife Teleconference	Discuss the launch of the NIRB EA process and ways ECCC and Sabina can work effectively together through the process
January 2013	National Headquarters	Ottawa	Discussion of potential MDMER review process. Confirm that Headquarters is the lead for any discussion on MDMER Schedule 2 Amendment
January 2013	Regional office - Canadian Wildlife Service (CWS)	Yellowknife	Discussion of engagement with CWS on wildlife/bird issues that arise in the EA process
January 2013	Regional Office	Yellowknife Teleconference	Confirmed ECCC leads for the review process for the Back River Project
January 2013	Prairie and Northern Regional Headquarters	Vancouver	Project introduction for Regional Director
February 2013	Regional Office – Canadian Wildlife Service	Yellowknife Teleconference	Outline of requirements for analysis of bird populations along the shipping route
April 2013	Regional Office and National Headquarters	Iqaluit	Overview of the status of the EA process and responses to various questions
May 2013	Edmonton Regional Headquarters including representatives from National Headquarters		Discussion of various issues within ECCC mandate that are important in the EA process in particular water quality issues, climate change and tailings impoundment area (TIAs)
July 2013	National Headquarters	Back River Project site	Site visit for senior staff
September 2013	Regional Headquarters	Back River Project site	ECCC technical officials participated
November 2013	Regional Office	Yellowknife	Project status review
January 2014	Regional Office	Yellowknife	Project status review
April 2014	Regional Office	Iqaluit	Discussion issues in the EA within the ECCC mandate
July 2014	Regional Headquarters including representatives from National Headquarters	Edmonton	Project status and next steps. Noted to ECCC that the location for the TSF is being re-considered and may involve a Schedule 2 amendment
October 2014	Regional Office	Iqaluit	Discussions prior to technical meetings in the EA process
April 2015	Regional Office	Iqaluit	Project status review

(continued)

Table 2.4-1. ECCC Engagement Conducted by Sabina for the Back River Project (2012 to 2018) (completed)

Date	Organization	Location	Comments
September 2015	National Headquarters	Ottawa	Explored how plans for the Back River Project may relate to MDMER, in particular, potential amendments to the regulations that would add water bodies to Schedule 2. Outlined Bernard Harbour project as potential fisheries offset
September 2015	Regional Office, Regional Headquarters	Yellowknife, Edmonton Teleconference	Update on Project plans
March 2016	Regional Office, National Headquarters	Yellowknife, Edmonton, Ottawa Teleconference	Preparations for Final Hearing
May 2016	National Headquarters	Ottawa	Overview and review of Final Hearing issues: Climate Change and closure issue; Schedule 2 – potential areas Umwelt Lake and under the Tailings Storage Area
August 2016	National Headquarters	Ottawa	Project Status
February 2017	National Headquarters	Ottawa	Discussion next steps and timelines for potential Schedule 2 amendments
April 2017	Regional Office	Yellowknife Teleconference	Discussion FEIS Addendum technical comments
October 2017	National Headquarters	Teleconference	Discussion requirements for Schedule 2 Amendment
October 2017	Regional Office	Yellowknife	Project update
January 2018	National Headquarters	Ottawa	Discussion of next steps and requirements for the Schedule 2 Amendment including consultation needs.
March 2018	National Headquarters	Ottawa Teleconference	Discussion of alternatives assessment for Tailings Storage Facility
September 2018	National Headquarters	Ottawa	Discussion of status of final Offsetting Plan and requirements for Schedule 2 Amendment

3. Project Infrastructure and Activities

The Project is comprised of two main areas, the Goose Property Area and the MLA, with an interconnecting WIR corridor with spur roads (Figure 1.1-1); the Goose Property will be the hub of the Project with the Process Plant, all-weather airstrip, four open pits, four underground operations, and a camp capable of housing a maximum of 465 employees (or 611 including the existing exploration camp) during Construction and Operations. Additional details are summarized in Sabina (2017b).

3.1 EXISTING INFRASTRUCTURE AND EARLY WORKS

Existing infrastructure at the Goose Property Area includes a 146-person all-season camp consisting of sleeping units, dry/kitchen/dining facilities, offices, core processing facility, heavy equipment storage, a maintenance shop, a fuel tank farm (13 × 75,000 litre dual walled enviro tanks) and additional drummed fuel storage. The camp is powered by a 433 kilowatt diesel-powered generator with backup. The camp is currently operated on a seasonal basis to support exploration and environmental baseline data collection and is generally closed annually from early October to late January. The Goose Property also has a 914 m all-weather gravel airstrip that can be used year-round, and during the winter months, January to May, a 2,000 m ice airstrip can be established on Goose Lake. During the ice-free months, float-equipped aircraft may land on lakes in the area.

Proposed infrastructure or activities excluded from the final Fish Offsetting Plan are the early development work activities at the Goose Property Area and MLA that were recently reviewed and approved by DFO through the Request for Review process. The following applications for early development activities were submitted to DFO in 2018:

- The Request for Review application submitted to DFO in February 2018 for early development work activities at the Goose Property Area including the construction of a culvert crossing on Rascal Stream West, and increased water use from Goose Lake; DFO's review of that application (under DFO file no. 18-HCAA-00185), dated May 4, 2018, identified the mitigation measures to avoid the potential for serious harm to fish under the *Fisheries Act* (DFO 2018a);
- The Request for Review application submitted in June 2018 for surface waters potentially affected by the MLA infrastructure, excluding the WIR; DFO's review of that application (under DFO file no. 18-HCAA-00871), dated September 11, 2018, identified the mitigation measures to avoid the potential for serious harm to fish under the *Fisheries Act* (DFO 2018b); and
- The Request for Review application submitted in November 2018 for surface waters potentially affected by the construction of the WIR for the Back River Project; DFO's review of that application (under DFO file no. 18-HCAA-01626), dated December 20, 2018, identified the mitigation measures to avoid the potential for serious harm to fish under the *Fisheries Act* (DFO 2018c).

3.2 MINE PLAN OVERVIEW

The mine plan consists of open pits and underground mining operations supporting 6,000 t/d milling operation using a standard gravity separation and cyanide leaching circuit to extract the gold. (Figure 3.2-1 and Figure 3.2-2) The current plan for combined mine production focuses on achieving average production of 350,000 ounces of gold annually. Four deposits at Goose Property (Umwelt, Llama, Goose Main, and Echo) are planned to be mined using both open pit and underground mining methods. The proposed underground mining methods include post pillar cut-and-fill, drift and fill, and longitudinal open stoping; the proposed open pit mining method is truck and shovel.

Mining will begin with open pits at the Goose Property Area with pre-stripping and ore stockpiling beginning in Year -2. Throughout the mine life, production from open pit mining will be supplemented by the underground mines starting with production from Llama underground in Year -1. Ore will be stockpiled to optimize mill feed grades and add flexibility to the mine plan. Project development will require establishing a Tailings Storage Facility (TSF), and multiple waste rock storage areas (WRSAs), including the Llama, Umwelt, and Echo WRSA. The TSF and service roads for the TSF will be located on Crown Land with all other infrastructure on Inuit Owned Land. Tailings (and potentially waste rock) will be deposited in the TSF, and two mined-out open pits: Umwelt Tailings Facility (TF), and Goose Main TF. After tailings deposition transitions from the TSF to the Umwelt TF or Goose Main TF, the TSF will be converted to a WRSA (namely, the TSF WRSA) and used to dispose of potential acid generating (PAG) and non-potential acid generating (NPAG) waste rock. Water will be reclaimed from the active TF (Umwelt or Goose Main) for use as process water.

The life of the Project, from mobilization/construction to Post-Closure, is 27 years: Construction Phase of 4 years (Year -4 to Year -1), Operations Phase of 10 years (Year 1 to Year 10), Closure Phase of 8 years (Year 10 to Year 18), and Post-Closure monitoring for 5 years (Year 18 to Year 23). The Operations Phase may be extended beyond 10 years should additional mineral deposits become economical to be developed.

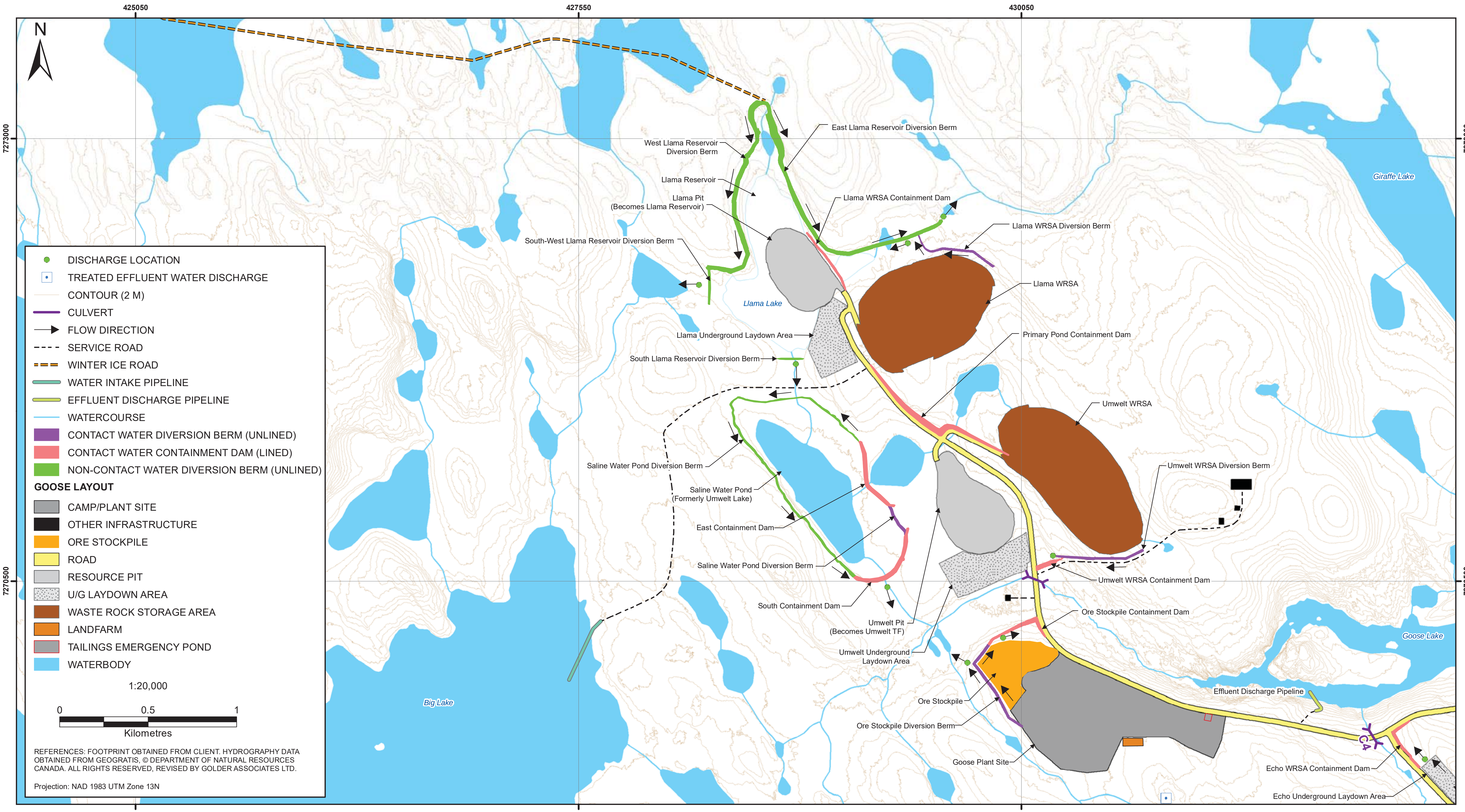

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Figure 3.2-1

General Mine Layout Sheet 1 of 2
Back River Project, Fish Offsetting Plan

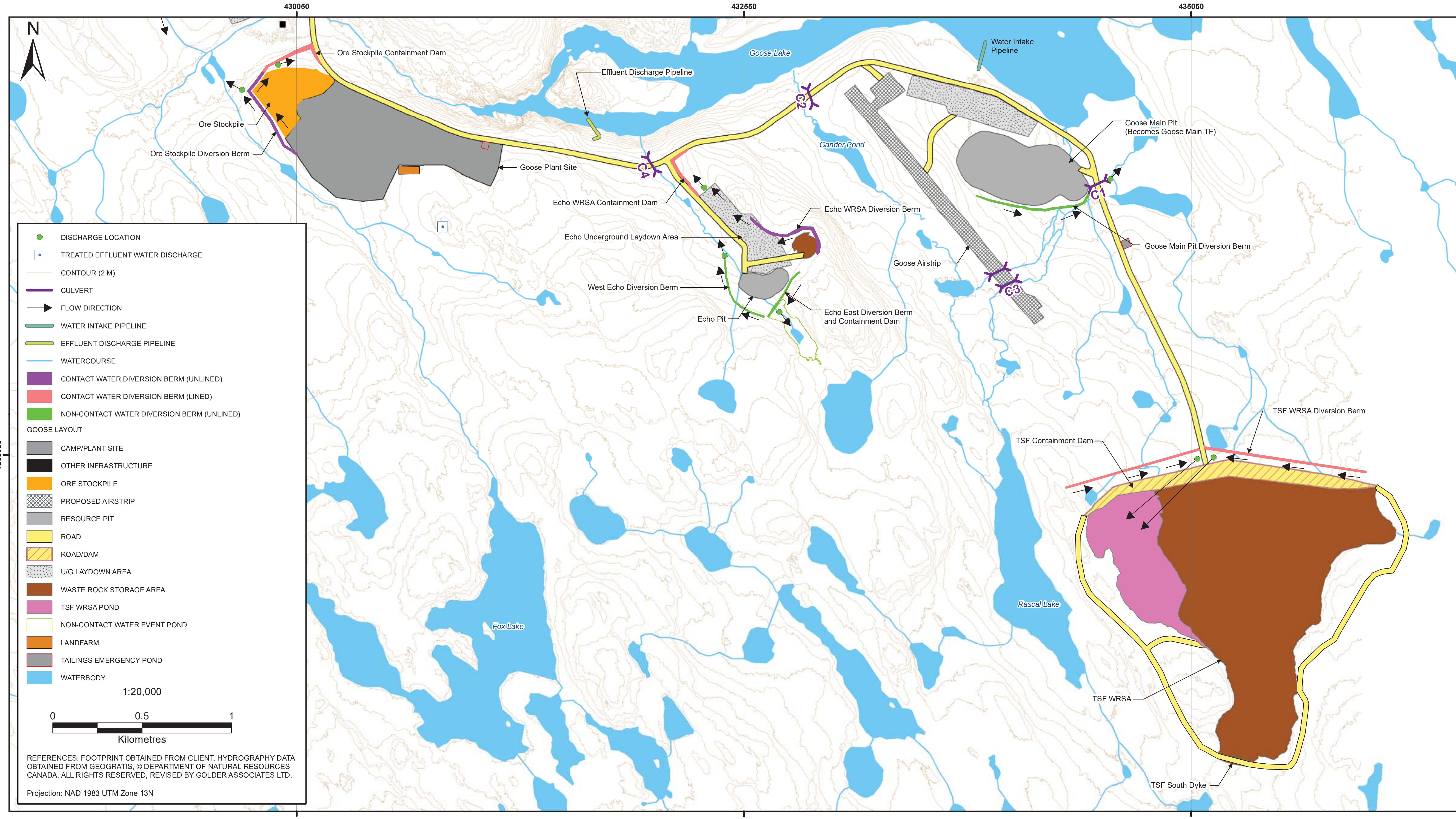

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Figure 3.2-2

General Mine Layout Sheet 2 of 2
Back River Project, Fish Offsetting Plan

3.2.1 Tailings Storage

The mine plan includes 10 years of mining operations with about 19.8 million tonnes (Mt) of ore processed at a rate of 6,000 t/d. Based on an assumed density of 1.2 tonnes per cubic metre (t/m^3), the required tailings storage capacity is in the order of 16.5 million cubic metres (Mm^3).

The tailings management system at the Goose Property Area will entail deposition of tailings at three separate locations. The initial two years of production will be deposited in a purpose-built TSF located about 2 km south of the Goose Main Pit. Tailings deposition will then transition to in-pit deposition into the mined-out Umwelt Pit (referred to as Umwelt TF) for a period of about four years. Finally, tailings deposition moves to the mined-out Goose Main Pit (referred to as Goose Main TF), for deposition during the remaining four years of the mine life. This schedule is summarized in Table 3.2-1.

Table 3.2-1. Tailings Deposition Location Summary

	Period (Year and Quarter)	Tailings (million tonnes)	Tailings (million cubic metres)
TSF	Y-1 Q4 to Y2 Q3	3.8	3.1
Umwelt TF	Y2 Q4 to Y6 Q3	8.6	7.2
Goose Main TF	Y6 Q3 to Y10 Q2	7.4	6.2
Total Project	Y-1 Q4 to Y10 Q2	19.8	16.5

Note: Some facilities have additional capacity than is currently planned for use; as Operations develops, the timelines and use of the facilities may shift.

The TSF will be covered with waste rock and overburden material once tailings deposition is complete. Water covers with a minimum water depth of 5 m will be used for closure of the Umwelt and Goose Main TFs.

3.2.2 Lake Dewatering

3.2.2.1 Llama Lake

Beginning in Year -3, there will be a need to partially dewater Llama Lake to allow Umwelt Pit development to start in Year -2. Early Construction contact water is pumped to, and stored in, the partially dewatered Llama Lake, which becomes Llama Reservoir. Contact water collected in Llama Reservoir is treated at the water treatment plant during the open water season of Year -1; this water is then discharged into Goose Lake. It is assumed that 50% of the lake volume can be discharged directly to Goose Lake, while the remaining 50% will require treatment for total suspended solids, and potentially arsenic, prior to discharge. Llama Lake will be fully dewatered by the end of Year -1 in advance of Llama Pit mining in Year 1.

During the dewatering process, sediment basins will be established as required. Once complete, bottom sediments within the pit boundaries will be disposed of in the TSF. Diversion ditches and berms will be established around the perimeter of the future open pit to divert water. A dewatering plan will be prepared and approved by the NWB prior to dewatering activities. This plan will include provisions for diversion of incoming flows to the Llama Lake. In advance of the dewatering, a fish-out program will be completed following DFO's protocols and in collaboration with local communities (Appendix C).

3.2.2.2 Umwelt Lake

Beginning in Year -3, there will be a need to dewater Umwelt Lake to provide storage capacity for saline water from groundwater inflows encountered during mining. It is assumed that 50% of the lake volume can be discharged directly to Goose Lake, while the remaining 50% will require treatment at the water treatment plant for total suspended solids prior to discharge. A dewatering plan will be prepared and approved by the NWB prior to dewatering activities. This plan will include provisions for diversion of incoming flows to Umwelt Lake. In advance of the dewatering, a "fish-out program" will be completed following DFO's protocols and in collaboration with local communities (Appendix C).

3.2.3 Open Pit Mining

A conventional load-haul (also known as truck and shovel) mining method was selected for all open pits included in the mining schedule. Bench height in the final pit design is 20 m for all pits. During the working stages, the waste areas will be drilled, blasted, and loaded using 10 m benches. To achieve the planned selectivity, 5 m benches will be used when the operation is at or near the ore zones. It is also expected that, as the knowledge of the ore body increases, certain ore zones will be recovered on 10 m benches without compromising the selectivity. The high-level pit shapes are described in Table 3.2-2.

Table 3.2-2. Open Pit Dimensions

Open Pit	Length (m)	Width (m)	Depth (m)
Umwelt	550	330	135
Llama	500	300	135
Goose Main	700	300	150
Echo	260	120	45

Conventional blasting will be performed with ammonium nitrate/fuel oil and pre-splitting explosives. Based on the results of geomechanical and hydrogeological work, water-resistant explosives are not anticipated to be required. The estimated powder factors and column charges are 0.26 kilograms per tonne (kg/t) and 372 kg, respectively for both ore and waste (Sabina 2017b).

4. Mitigation Measures

4.1 OVERVIEW

Mitigation measures will be in place to avoid or minimize the potential effects of the Project on fish and fish habitat. The primary mitigation measure to avoid potential effects on fish and fish habitat is the Project design of siting infrastructure to avoid fish-bearing waters wherever feasible. The camp/plant site, stockpile location, and WRSAs 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 Lake and downstream waterbodies.

A list of select mitigation and management measures for fish and fish habitat to be applied at the Project include the following (also see Sabina 2017b):

- 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 Area.
- Infrastructure, WRSAs, and the TSF have been confined to the local watersheds where the deposits are located, and have avoided the 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 to minimize erosion potential.
- 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 Hopky 1998) and other applicable and available best management practices.
- Blasting will occur in isolated and dewatered areas outside of fish-bearing waters and blasting in the Goose Main Pit will be outside of the recommended setback distances for the protection of fish and fish habitat; best management practices for blasting will be included with the blasting plan submitted to DFO prior to development of the open pits.
- Construction, including winter ice road construction, will follow all applicable DFO's 'Measures to Avoid Causing Harm to Fish and Fish Habitat Including Aquatic Species at Risk'.
- 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.
- 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 (e.g., in Big Lake, Goose lake) will be screened to avoid entrainment of fish in accordance with the DFO Fresh Water Intake End of Pipe Screening Guideline (DFO 1995).
- All water intakes (e.g., in Big Lake, Goose Lake) will be installed with a rock apron to mitigate any potential changes in habitat resulting from the installation of the intake pipe.

- o Discharge pipe (diffuser) will be designed to maximize dispersion and attenuation of the discharge to reduce the potential for re-suspension of sediments and any potential effects to water and sediment quality and aquatic habitat.
- o Speed limits will be followed for vessel operations to minimize propeller wash and wake effects.
- o 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 for total suspended solids. Any water that does not meet the discharge criteria will be retained, discharged to the TSF or other appropriate holding facility.
- o Fishing will be banned within all Project areas and, thus, will not result in fish mortality.
- o 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).

The mitigation measures applied to the Project are based on best management practices and are expected to prevent or minimize adverse effects on the receiving environment, and ongoing monitoring will inform Sabina of their effectiveness. If any unforeseen adverse effects are identified during the life of the Project, measures will be taken to correct them where appropriate and prevent them from occurring in the future. Adaptive management, an iterative approach based on a learning process gained from monitoring, will improve long-run management outcomes. Sabina is committed to implementing effective mitigation measures and to use an adaptive management approach to ensure mitigation measures are optimized.

The list of Management Plans and their applicability through the life of the Project are presented in Table 4.1-1, submitted as Supporting Documents of the Type A Water Licence Application for the Back River Project (Sabina 2017b).

Table 4.1-1. List of Management Programs and Associated Management Plans for the Project

Document[(a)]	Construction	Operations and Ongoing Maintenance	Temporary Closure / Care and Maintenance	Final Closure	Post-Closure
Infrastructure and Access Management Program					
Road Management Plan (SD-02)	x	x	X	x	
Borrow Pits and Quarry Management Plan (SD-03)	x	x	X	x	
Water Management Program					
Water Management Plan (SD-05)	x	x	X	x	
Waste Management Program					
Ore Storage Management Plan (SD-07)		x	X		
Mine Waste Rock Management Plan (SD-08)	x	x	X	x	
Tailings Management Plan (SD-09)	x	x	X	x	x
Landfill and Waste Management Plan (SD-10)	x	x	X	x	
Incineration Management Plan (SD-11)	x	x	X	x	
Landfarm Management Plan (SD-12)					
Hazardous Materials Management Plan (SD-13)	x	x	X	x	

(continued)

Table 4.1-1. List of Management Programs and Associated Management Plans for the Project (completed)

Document[a]	Construction	Operations and Ongoing Maintenance	Temporary Closure / Care and Maintenance	Final Closure	Post-Closure
Emergency Response Program					
Risk Management and Emergency Response Plan (SD-15)	x	x	X	x	
Fuel Management Plan (SD-16)	x	x	X	x	
Spill Contingency Plan (SD-17)	x	x	X	x	
Oil Pollution Emergency Plan (SD-18)	x	x	X	x	
General and Aquatic Effects Monitoring Program					
Environmental Management and Protection Plan (SD-20)	x	x	X	x	x
Aquatic Effects Management Plan (SD-21)	x	x	X	x	
Conceptual Fish Offsetting Plan (SD-22)	x	x		x	
Marine Monitoring Plan (SD-23)	x	x	X	x	
Quality Assurance / Quality Control Plan (SD-24)	x	x	X	x	x
Interim Closure and Reclamation Program					
Interim Closure and Reclamation Plan (including Interim Closure Cost Estimate) (SD-26)		x	X	x	x
Vegetation Monitoring Plan	x	x			

a) SD = Supporting document for Sabina's Type A Water Licence Application for the Back River Project.

4.2 SITE WATER MANAGEMENT

The Water Management Plan (see Supporting Document 05 for the Type A Water Licence Application; Sabina 2017b) was designed to mitigate potential negative effects from Project activities on the aquatic environment.

The main objectives of Sabina's water management strategies are to:

- minimize the amount of water that contacts mine ore and wastes, which ultimately reduces the volume of water requiring management
- appropriately manage all contact water and discharges to protect local aquatic resources
- implement water conservation and recycling to maximize water reuse and minimize the use of natural waters

Sabina is committed to maintain a Water Management Plan designed to the above main objectives. 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 TFs 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 (i.e., waste rock, ore stockpile, pits, tailings); 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 3.2-1 and 3.2-2). 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 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.

4.3 LLAMA AND UMWELT FISH-OUT

To minimize effects of dewatering activities on the local fishery, a fish-out of the Llama and Umwelt lakes will be completed. The Conceptual Fish-Out Plan was included with the FEIS Addendum (FEIS Volume 10, Chapter 31, or see Appendix C). The plan provided an overview of the preliminary plan, based on initial engagement with local communities and DFO, as well as previous fish-outs and site-specific protocols. The main goals of the Back River fish-out will be to:

- remove and utilize as many of the fish from Llama and Umwelt lakes as practical
- collect and incorporate community input into the plan, and use local community members as part of the fish-out crew, where feasible
- conduct the fish out in a manner consistent with DFO's General Fish-out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut (General Fish-out Protocol; Tyson et al. 2011)

The fish-out of Llama and Umwelt lakes is scheduled to begin during the open water season in 2019. The fish-out is expected to occur over one open-water season and will be deemed complete when sufficient biomass of fish has been removed, as determined by criteria to be discussed with DFO. In accordance with DFO's General Fish-out Protocol, the fish-out will proceed in two phases: a catch-per-unit-effort phase; and a final removal phase.

The Conceptual Fish-Out Plan was developed through engagement efforts between Sabina and affected communities to help identify mitigations that can be implemented (Appendix C). Sabina has committed to additional engagement with communities related to the fate and beneficial uses of fish collected during the fish-out. The details of the final Fish-Out Plan will incorporate additional feedback received through ongoing engagement. The final plan will be submitted to DFO within six months prior to the start of fish-out activities.

4.4 RASCAL STREAM DIVERSION

The Rascal Stream Diversion is being proposed as a mitigation measure for Rascal Stream Arctic Grayling in response to feedback from DFO (e.g., DFO 2017) during the environmental assessment review of the Project. The mitigation design includes the diversion of water from Rascal Stream East / Main Goose Pit Stream to Rascal Stream West using a berm installed to direct all or most of the water into Gosling Pond 1 through to Gander Pond, then Goose Lake (Figure 4.4-1). The berm would be combined with a constructed channel less than 100 m in length for Rascal Stream East (upper section of Reach 4 and lower section of Reach 5), creating what was previously termed the 'Rascal Stream Fishway'.

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February 01 2019

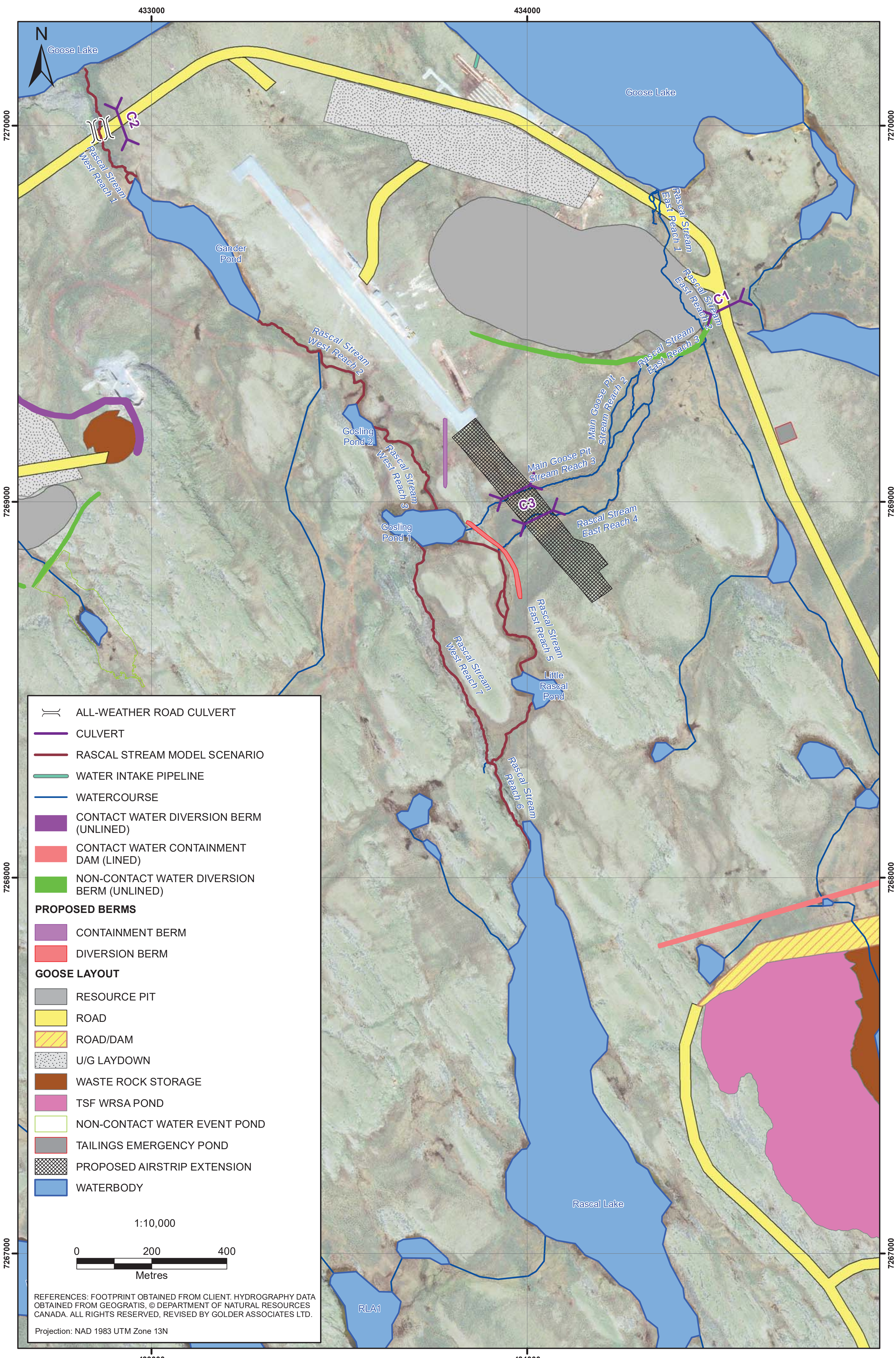

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Figure 4.4-1

Proposed Rascal Stream Diversion Mitigation
Back River Project, Fish Offsetting Plan

The rationale for the Rascal Stream Diversion is to redirect flows from low-quality habitats to higher-quality habitats where they can be utilized by spawning Arctic Grayling. This modification is expected to mitigate effects of altered habitats that lie east of the runway where the mining infrastructure footprint and related water management of that infrastructure (e.g., TSF, Goose Main Pit) will modify the hydrology of the watershed. The diverted flows (either partial or full diversion) will supplement those in Rascal Stream West, increasing depths for fish passage and increasing available habitat for spawning fish. It is important to note that a berm placement to redirect flows from Rascal Stream West Reach 7 was also considered to further improve habitat in upper Rascal Stream East (Reach 5). However, this design is not being evaluated further, as a preliminary assessment of that design deemed it unlikely to result in measurable benefits to fish production.

Hydraulic modelling for a range of diversion scenarios is ongoing, the results of which will be used to estimate the number of suitable flow days for Arctic Grayling passage (adult and juvenile upstream migrations, and young of year downstream migration) to better evaluate and inform the mitigation design (e.g., full diversion versus partial diversion of flows) for Rascal Stream Arctic Grayling. Suitable flow days will be calculated using hydraulic predictions combined with criteria for minimum depth and maximum water velocity criteria (e.g., Katopodis and Gervais 2016). The final design for the Rascal Stream Diversion will be submitted prior to the construction of the TSF and Goose Main Pit.

Sabina is committed to ongoing maintenance and monitoring of the Rascal Stream berm and diversion channel. This will include regular inspections of the berm and diversion channel to promptly identify requirements for maintenance activities including the removal of accumulated sediment, or the repair of damaged channel or berm linings immediately to limit the potential for erosion.

4.5 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 Hopky 1998) and other applicable and available best management practices, as directed by DFO. The blasting plan will be discussed with DFO prior to any blasting activities and will be subject to adaptive management. The setback distances will be developed to protect fish and their incubating eggs from maximum allowable limits for blasting-induced overpressure (50 kilopascals) in fish-bearing water and peak particle velocity (13 millimetres per second [mm/s]) in spawning beds. It is expected that all blasting will occur in isolated and dewatered areas outside of fish-bearing waters and that blasting in the Goose Main Pit will be outside of the recommended DFO setback distances.

If the recommended setback distances are approached, then site-specific operating mitigation could be implemented to protect fish if required. If necessary, it may be possible to adjust blasting practices to use controlled blasting techniques during the time of highest biological sensitivity (i.e., the window of early development for eggs of Lake Trout and Lake Whitefish). As shown in Figure 3.4-8 in Appendix V6-6D of the FEIS (Sabina 2015), there are no spawning beds in Goose Lake that are in close proximity to Goose Main Pit. Of note, several studies have demonstrated that the effects of exposure to a blast that generates up to 28.5 mm/s (expected at Goose Main Pit) would be minimal as eggs are resilient to effects from vibrations within this range (Faulkner et al. 2006, 2008). In addition, overpressure and vibrations in nearby surface waters generated from blasting will be reduced as the pit depth increases.

4.6 SEDIMENT AND EROSION CONTROL

As part of the Water Management Plan (see Supporting Document 05 for the Type A Water Licence Application; Sabina 2017b), surface water will be managed within the Project footprint such that sediment-laden runoff is minimized, intercepted, and/or treated prior to entering downstream receiving waters or mine process facilities. Effective sediment control depends on the isolation of easily-eroded, disturbed ground surfaces.

Measures will be implemented to reduce the quantity of runoff where the mobilization of sediments cannot be eliminated. Sediment-laden water will be captured and routed to sediment basins.

Sediment and erosion management and control during initial and ongoing construction may involve establishing contact water collection ditches/berms, constructing sediment ponds, limiting land disturbance to a practical minimum, reducing water velocities across the ground through surface texturing and re-contouring, and progressively rehabilitating and stabilizing disturbed land surfaces to minimize erosion.

Exposed landscape surfaces will be protected by the installation of covering material such as riprap, aggregate, or rolled erosion control products. Runoff flow may be controlled by a combination of measures, including:

- texturing/grading of slopes to slow runoff and reduce effective slope length
- synthetic permeable barriers and/or fibre rolls to reduce runoff velocities and retain sediments
- check dams, gabions, and energy dissipation structures to reduce flow velocities in channels

Sediment levels in runoff will be minimized by intercepting sediment before it reaches the freshwater environment. In addition to measures aimed at controlling runoff flow, the quantity of transported material in runoff may be controlled by measures including:

- preserving riparian zones which trap sediment and reduce flow velocities
- installing synthetic permeable barriers, fibre rolls, and/or silt fences as required
- installing check dams, gabions, and sediment basins to reduce flow velocities and encourage sediment deposition

5. Effects to Fish and Fish Habitat

5.1 INTRODUCTION

The Fish Offsetting Plan summarizes predicted adverse effects for fish and fish habitat in the Goose Property area, as concluded in the environmental assessment (FEIS Volume 6, Chapter 6 and Chapter 7; Sabina 2015). The plan focuses on Project infrastructure that may interact with fish and fish habitat wherever the locations overlap with fish habitat (i.e., that may result in permanent alteration of habitat, or require a fish-out prior to the alteration of habitat). Any introductions of potentially deleterious substances (e.g., from the TSF) to freshwater habitat at the Goose Property are also described (see Section 5.4).

For the Fish Offsetting Plan, the assessment of impacts to the productivity of CRA fishery was evaluated in two steps:

1) A summary of serious harm to fish to occur from Project activities, which includes activities that have the potential to result in the death of fish or the permanent alteration to, or destruction of, fish habitat; and
2) An assessment of residual serious harm to fish, which examined whether any of the serious harm to fish, summarized in the first step, has the potential to contribute to a measurable change in the productivity of the CRA fishery.

The Pathway of Effects models (or diagrams) developed by DFO were considered in the identification of any serious harm (DFO 2014a). The application of the DFO models is inline with 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 FEIS Volume 6, Chapters 6 and 7 (Sabina 2015). For additional detail on the assessment approach for fish and fish habitat, see the General Methodology for Project Effects Assessment (FEIS 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 4), adverse effects may remain and lead to residual serious harm. Conceptual responses of fisheries productivity to disturbance (i.e., productivity-state response curves) were applied to predicted adverse effects to fish and fish habitat to assist with the determination of any residual effects on the ongoing productivity of the fishery (DFO 2014b), ultimately directing the quantification of ‘losses’ and the amount of offsetting required to counterbalance the effects from the Project (see Section 6).

5.2 SERIOUS HARM TO FISH

5.2.1 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 affect aquatic habitat for species such as Lake Trout and Arctic Grayling where the footprint interacts with waterbodies (Figure 5.2-1). For the purposes of the offsetting plan, serious harm to fish is assumed for any direct effects of the Project on fish-bearing waters, as well as waterbodies and watercourses that only have low potential to support fish. Any such interactions may result in permanent alteration to, or destruction of fish habitat (i.e., serious harm to fish). Direct mortality with subsequent decreases in population abundance is also predicted to occur as part of fish-outs prior to lake dewatering.

5.2.1.1 Lakes

In fish-bearing lakes, a direct loss of habitat will occur in Llama Lake because of the construction of the Llama Pit and in Umwelt Lake because of Saline Water Pond construction (Figure 5.2-1). These construction activities will result in serious harm to fish. 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 per the fish-out plan developed through engagement with DFO (Appendix C).

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 5.2-1; Table 5.2-1). The majority of the area of the lake is composed of shallow water (less than 4 m), with large, boulder-cobble substrate, followed by deepwater 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.

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October 18, 2018

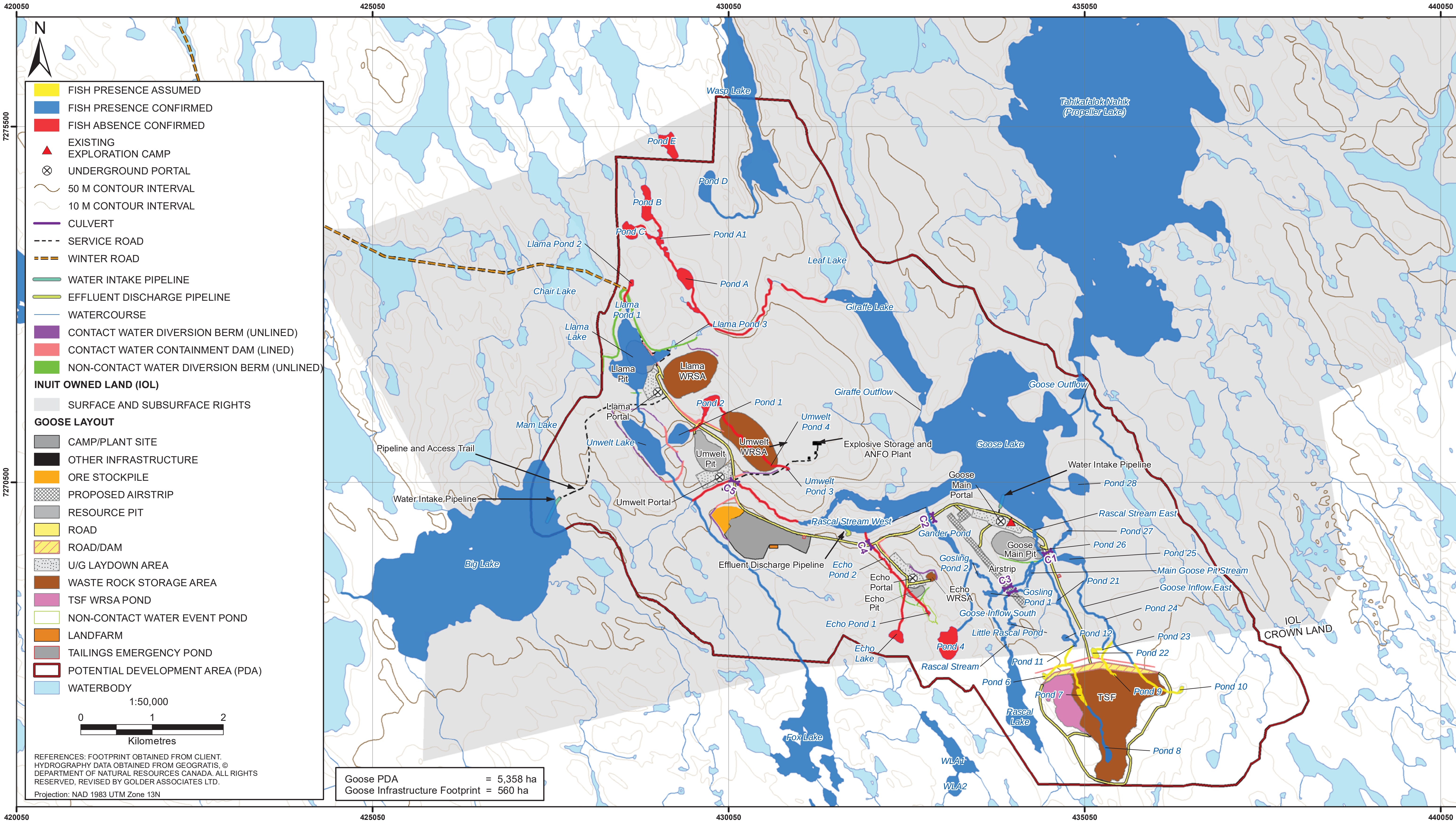

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Figure 5.2-1

Fish-Bearing Habitat within the Potential Development Area, Goose Property
Back River Project, Fish Offsetting Plan

Table 5.2-1. Fish-Bearing Lakes and Ponds with Total or Partial Habitat Losses, Resulting in Serious Harm to Fish

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

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

Llama Pit will be decommissioned during the Operations Phase, 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 Pond, which represents a complete loss of 19.4 ha of habitat used by Lake Trout, Arctic Grayling, Round Whitefish, and likely Slimy Sculpin (Figure 5.2-1; Table 5.2-1). 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 for fish species captured, with limited deepwater areas for overwintering by 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 (FEIS Volume 10, Chapter 29; Sabina 2015) or the Interim Closure and Reclamation Plan (Type A Water Licence Application SD-26; Sabina 2017b).

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 5.2-1; Table 5.2-1). 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 5.2-1). 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 riprap. The end of the pipe will be daylighted at approximately 5 m water depth. The use of a rock apron is expected to mitigate any potential changes in habitat resulting from the installation of the intake pipe. The pipes will be decommissioned by cutting at the substrate level and capping; riprap will be permanently left in place.

5.2.1.2 Ponds

Several small, fish-bearing and non-fish bearing ponds (n = 18) located in the Llama watershed (associated with the Llama and Umwelt pits) and the Goose and Wolf watersheds (associated with the Echo Pit, TSF containment dam and service road, and related downstream changes) will be lost to infrastructure (Figure 5.2-1), representing a total wetted area loss of 21.09 ha (Figure 5.2-1; Table 5.2-1).

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

Pond 1 (located east of Umwelt Lake; Figure 5.2-1) will also be indirectly lost from the Llama watershed due to disconnection and isolation from Umwelt Lake by 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) that may overwinter in Pond 1. This connectivity loss will be initiated during the Construction Phase and persist in perpetuity.

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

Twelve ponds within the Goose and Wolf watersheds will be lost due to the placement of infrastructure and the loss of catchment discharge downstream of the TSF and containment dam, which also functions as a service road (10.5 ha: Ponds 6, 10, 11, 12, 20, 21, 22, 23, 24, 25, 26, and 27). Deleterious substances associated with the TSF will be introduced in Ponds 7, 8, and 9.

The ponds downstream of the TSF are split into two groups based on seasonal connectivity: ponds lower in the watershed that have good connectivity to Goose Lake throughout the summer, versus ponds higher in the watershed that have only ephemeral connectivity to Goose Lake during spring. The ponds lower in the watershed (Ponds 21, 25, 26, 27) provide medium quality summer rearing habitat for Arctic Grayling and forage fish. Ponds located higher in the watershed (Ponds 11, 12, 20, 22, 23, and 24) provide low quality summer rearing habitat for forage fish. In dry years, fish may become trapped and perish in ponds higher in the watershed if flow conditions prevent fish from accessing viable overwintering habitat. Pond habitat losses will be initiated during the Construction Phase. The loss of Pond 6 directly underneath the service road for the TSF and containment dam will persist in perpetuity. All remaining ponds may receive an increase in discharge and potentially a return to suitable conditions for fish once the TSF is breached and decommissioned in the Post-Closure Phase.

5.2.1.3 Streams

Several small, fish-bearing or potentially fish-bearing streams will be lost to infrastructure (Figure 5.2-1; Table 5.2-2) 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 2.13 ha (Table 5.2-2). Stream sections downstream of Echo Lake and Echo Pond 1 will also be modified because of the development of the Echo Pit; however, this system has been classified as non-fish bearing.

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 from Project development, and therefore, will provide little to no habitat for fish. Although runoff into upper sections of Umwelt Outflow may provide some flows for fish, flows will be affected because of upstream water management and fish access to that stream will be blocked using a semipermeable barrier installed above the confluence with the Fox Lake Outflow. 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 phases, after which the discharge will resume along the natural stream route.

Within the Goose and Wolf watersheds, four streams will be lost, or partially lost, totalling an approximate 1.58 ha of fish-bearing habitat (Table 5.2-2). Two streams will be lost due to the construction of the TSF service road and containment dam and the lost upstream catchment area (Goose Inflow East and Goose Inflow South). Rascal Stream East will be partially lost due to development of water management infrastructure (Figure 5.2-1). Flows in Rascal Stream East (Reach 4 and downstream) and Main Goose Pit Stream will also be diverted through the construction of a diversion mitigation berm, which divert all or partial flows to Gosling Pond 1 and Gander Pond, then Goose Lake. Total stream loss downstream of the mitigation berm was estimated to be 0.45 ha.

The Goose Inflow East and Goose Inflow South can be generally classified into two habitat types based on seasonal connectivity: sections lower in the watershed that maintain good connectivity to Goose Lake throughout the summer and provide habitat for Arctic Grayling and forage fish (sections downstream of Pond 24 in Goose Inflow East, and of Pond 21 in Goose Inflow South; Figure 5.2-1), and sections higher in the watershed with only ephemeral connectivity to Goose Lake during the spring freshet and provide habitat only for forage fish. In sections of Goose Inflow South and Goose Inflow East 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 Goose Inflow South also provides part of the corridor that Arctic Grayling use to migrate between Goose and Rascal lakes (Figure 5.2-1). In sections of Goose Inflow East and South 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 one may provide reliable overwintering capability (Pond 10). Stream habitat losses in Goose Inflow East and Goose Inflow South will be initiated during the Construction Phase and the loss of higher watershed sections directly underneath the TSF will persist in perpetuity (see Section 6). All remaining downstream sections below the TSF will receive reduced flows because of lost upstream catchment area resulting in channel discontinuity, increased periods of dry channel and fewer flow days. Goose Inflow East and South 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 Fish Offsetting Plan, the entire lengths of Goose Inflow East and South are considered losses in perpetuity.

The Rascal Stream East and Main Goose Pit Stream 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 streams are heavily utilized by Arctic Grayling and contain good quality spawning, rearing, and foraging habitat. The 1.1 km section of Rascal Stream East upstream of the proposed diversion berm will remain undisturbed and provide approximately 0.7 ha of habitat available for spawning, rearing, and foraging Arctic Grayling and forage fish either from Rascal Lake or Goose Lake.

Stream habitat losses in Rascal Stream East and Main Goose Pit Stream will be initiated during the Construction Phase when stream flows are diverted (partially or fully) to Gosling Pond 1 through to Gander Pond, then Goose Lake. The diversion berm mitigation will be installed prior to, or concurrently with the installation of the culvert crossing for the airstrip extension (as required), the culvert crossing for the haul road, and the diversion channel for directing flows from Rascal Stream East to Goose Inflow East (around the Goose Pit). Although runoff into lower sections of Rascal Stream East and Goose Inflow East may provide some flows for fish, flows may continue to be affected through closure because of upstream modifications to the watershed. Fish access to Goose Inflow East from Goose Lake will be blocked using a semipermeable barrier installed at the mouth of the creek. The habitat losses will continue through closure, when the Rascal Stream East flows are redirected 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 Rascal Stream East alignment. For the purposes of the Fish Offsetting Plan, the stream sections of Rascal Stream East and Main Goose Pit Stream downstream of the diversion berm mitigation are considered a loss in perpetuity.

Table 5.2-2. Fish-Bearing Streams with Total or Partial Habitat Losses, Resulting in Serious Harm to Fish

Name	Watershed	Project Effect	Affected Area (ha)	Affected Length (m)	Approx. Width (m)	Species Captured*	Data Source
Goose Inflow East**	Goose	Infrastructure (TSF service road and dam footprint and downstream losses)	0.72	967	7.4	ARGR, SLSC, BURB, NSSB	4,5,6
Goose Inflow South**	Wolf	Infrastructure (TSF service road and dam footprint and downstream losses)	0.41	849	4.8	ARGR, SLSC, BURB, NSSB	4,5,6
Rascal Stream East / Goose Main Pit Stream**	Wolf	Infrastructure / diversion to Rascal Stream West	0.45	1,228	3.7	ARGR, SLSC, BURB, NSSB	1,2,4
Llama Inflow from Llama Pond 1**	Llama	Infrastructure (water diversion structure)	0.02	99	1.8		6
Umwelt Inflow from Pond 1**	Llama	Infrastructure (isolation from connected waterbodies)	0.01	129	1.0		6
Llama Outflow**	Llama	Infrastructure (Llama Pit dewatering; loss of catchment)	0.08	436	1.8	ARGR, RDWF, SLSC, NSSB	3
Umwelt Outflow**	Llama	Infrastructure (Saline Water Pond dewatering; loss of catchment)	0.44	551	8.0	ARGR, NSSB	4

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

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

5.3 RESIDUAL SERIOUS HARM TO FISH

The screening criteria for the assessment of losses that were carried through the offsetting plan followed the Fisheries Protection Policy Statement (DFO 2013a), specifically, losses that require offsetting were those with the potential for residual serious harm to fish, resulting in measurable effects to the productivity of a CRA fishery. An effect to the productivity of a CRA fishery can occur through effects to CRA species such as Lake Trout, Arctic Grayling, and Round Whitefish or through effects to forage species, such as Ninespine Stickleback and Slimy Sculpin that support CRA species. An effect to productivity may include the death of a CRA species, or permanent alteration to, or destruction of habitat used by a CRA species. An effect to productivity may also include the death of forage species that support a CRA fishery, or any permanent alteration to, or destruction of habitat used by a forage species that supports a CRA species.

All Project interactions that may result in serious harm to fish (summarized in Section 5.2) were reviewed and screened to identify the potential for residual harm to fish and loss to the productivity of a CRA fishery. Based on the application of productivity-state response curves to predicted adverse effects to fish and fish habitat (DFO 2014b), many of the Project interactions will not contribute to a measurable change in the productivity of a fishery, in part, because of selected mitigation and avoidance of fish-bearing habitats. Residual serious harm to fish is not expected to result from the construction of the water intake and discharge pipes. The pipes will be covered to the extent of the construction zone with clean non-acid generating boulder/cobble riprap as a ‘rock apron’, which is expected to mitigate any potential habitat changes resulting from the installation of the pipes (i.e., similar lake-bottom substrates will be present after construction).

Residual serious harm to fish is also not expected when Project infrastructure overlap with waterbodies or watercourses that do not support fish or have low potential to support fish. Waterbodies with low potential to support fish include shallow ponds with limited, to no hydrologic connectivity to lakes supporting large-bodied CRA species. Based on the previously completed baseline studies at the Goose Property area, waterbodies that do no support fish or have low potential to support fish include Echo Lake, Echo Pond 1, Echo Pond 2, Pond 6, Pond 20, and Pond 22.

Some of the Project infrastructure is expected to result in residual serious harm to fish, for example, where infrastructure removes suitable habitats of CRA species, such as Arctic Grayling and Lake Trout, and habitats with potential to support CRA species, including habitat with discernible connections to where CRA species have been recorded or are expected to occur. It is expected that residual serious harm to fish will occur for 14 lakes and ponds, and 8 streams (including Rascal Stream East and Goose Pit Main Stream), totalling up to 72.11 ha of lake and pond habitat and 2.13 ha of stream habitat. Most of the expected residual serious harm to fish will occur in Llama Lake (36.6 ha) and Umwelt Lake (19.4 ha).

For the purposes of the final Fish Offsetting Plan, habitats downstream of the TSF where fish have been observed or where there is the potential to support fish were classified as losses resulting in residual serious harm to fish (Table 5.2-1), for example, Ponds 11, 12, 21, 23 and 24.

5.4 MDMER SCHEDULE 2 HABITAT

The operation of the TSF will result in the loss or alteration of fish-bearing or potentially fish-bearing habitat (i.e., deleterious substances will be deposited in water that may be considered to be frequented by fish). The loss of any fish habitat directly underneath the TSF will persist in perpetuity. The use of a natural water body frequented by fish for mine waste disposal will require an Amendment to the MDMER.

Losses include small ponds in the headwaters of Goose Inflow South and Goose Inflow East (Figure 5.4-1), including Ponds 7, 8, and 9 (Figure 5.2-1, Table 5.4-1). Pond 10 (0.56 ha), which has overwintering potential for fish, was conservatively included as residual serious harm to fish under Section 35 losses because the TSF footprint will isolate Pond 10 (see Table 5.2-1).

Combined total loss of pond habitat is 4.58 ha (Table 5.4-1). Affected ponds may support Ninespine Stickleback during the open-water season depending on the connectivity to downstream habitats, which is restricted to only periods of high flow. Fish use of these ponds is expected to be limited to spring and early summer. Although there were no fish captured in habitat sampled within the TSF footprint during the 2014 baseline program (Rescan 2014b), 20 Ninespine Stickleback were captured in Pond 8 in 2015 (Rescan 2015). Within the TSF location, overwintering habitat for Ninespine Stickleback may exist in Pond 8. However, Pond 8 has a maximum depth of 2 m, and during most years, the pond is unlikely to provide overwintering habitat as maximum ice thickness in the region can exceed depths of 2 m. Any fish in affected habitats will be removed (e.g., salvaged) prior to the construction of the TSF.

Fish-bearing or potentially fish-bearing streams in the headwaters of Goose Inflow South and Goose Inflow East will also be lost to the TSF footprint (Figure 5.4-1) and therefore also considered under Schedule 2; this represents a total loss of 0.13 ha or 1,177 m of habitat (Table 5.4-2). Affected stream habitats includes upper reaches of Goose Inflow South and Goose Inflow East, and their tributaries, all of which may support Ninespine Stickleback during periods of high flow (e.g., spring freshet conditions). Although there were no fish captured in habitat sampled within the TSF footprint during the 2014 baseline program (Rescan 2014b), eight Ninespine Stickleback were captured in upper Goose Inflow South (above Pond 7) in 2015 (Rescan 2015). Fish habitats in the upper reaches of Goose Inflow South and Goose Inflow East are rated as marginal quality, with ephemeral connectivity and numerous obstacles for fish passage between ponds.

Table 5.4-1. Fish-Bearing or Potentially Fish-Bearing Ponds to be Listed under Schedule 2

Name	Watershed	Effect Type	Affected Area (ha)	Maximum Depth	Species Captured*	Data Source
Pond 7	Wolf	Loss	1.66	<1		1,2
Pond 8	Wolf	Loss	2.70	2.0	NSSB	1,2
Pond 9	Goose	Loss	0.22	0.4		1,2

** NSSB - Ninespine Stickleback; Data Sources: 1 – Rescan (2014b); 2 – Rescan (2015)*

Table 5.4-2. Fish-Bearing or Potentially Fish-Bearing Streams to be Listed under Schedule 2

Name	Watershed	Effect Type	Affected Area (ha)	Affected Length (m)	Approx. Width (m)	Species Captured*	Data Source
Goose Inflow East[(a)]	Goose	Loss	0.07	566	1.3		1,2,3
Goose Inflow South	Wolf	Loss	0.05	611	0.9	NSSB	1,2,3

*[(a)] Includes Pond 9 outflow and Pond 10 outflow segments; * NSSB - Ninespine Stickleback; Data Sources: 1 - Rescan (2014a); 2 – Rescan (2014b); 3 – Rescan (2015)*

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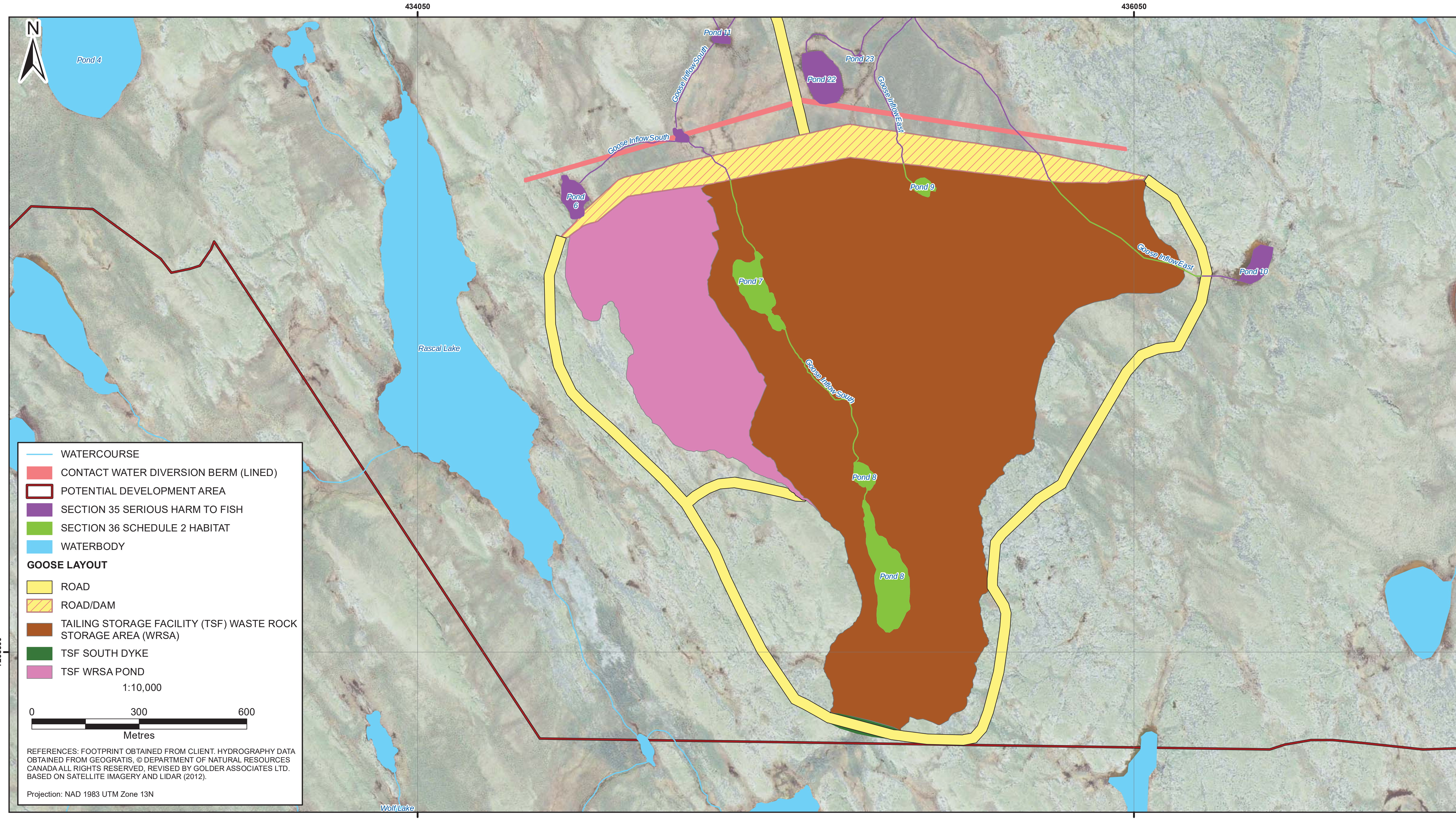
March 13, 2019



Sabina
GOLD & SILVER CORP.

Waterbodies and Watercourses Affected by the Tailings Storage Facility
Back River Project, Fish Offsetting Plan

Figure 5.4-1

6. Fish Production Losses

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. Fish production provided a transferable unit for the calculation of both losses at the Goose Property Area and gains at Bernard Harbour, and this approach to offsetting accounting was developed through engagement with DFO. Where possible, conservative inputs were considered such that losses were overestimated, reducing the uncertainty in the assessment that offsets would fully counterbalance the losses. For losses incurred within the Llama-Umwelt lake system, two approaches were considered in the calculation of losses. The first approach was based on hydroacoustic data, and the other based on a biomass equation presented in the peer-reviewed literature. The approach that generated the higher biomass value was selected for the calculation of losses for the offsetting plan.

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; Sabina 2015). The second approach considered a biomass equation derived for lakes in Nunavut and NWT (Samarasin et al. 2015) combined with catch data, including body size measurements, for Llama and Umwelt lakes. The equation (Samarasin et al. 2015) applied for estimating losses for lakes is as follows:

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

where biomass is measured in kilograms, and lake area in hectares.

The above biomass equation was also applied to derive the calculation of losses associated with the Goose Lake tributary streams and ponds in the Goose and Wolf watershed, including Goose Inflow South/East, and Rascal Stream East/Main Goose Pit 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; Sabina 2015), 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. 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., Gander Outflow) will continue to provide suitable habitat for adfluvial species and some proportion of the population of Goose Lake will be sustained with the development of the Project.

6.1 LLAMA LAKE-UMWELT LAKE SYSTEM

6.1.1 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 in Umwelt Lake, approximately 77% of the fish in Umwelt Lake were estimated to be Arctic Grayling, while the remainder of the fish in that water body were Round Whitefish. Based on gillnetting catch results from 2010, 2011, and 2012, there is some variation in species relative abundance across the sampling years; however, 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 based on all gillnetting years. For Umwelt Lake, the dominant species is Arctic Grayling if considering data across all gillnetting 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 with a catch composition of 39% Lake Trout, 31% Round Whitefish, and 30% Arctic Grayling based on sampling efforts (Figure 6.1-1). Thus, species-specific population estimates for Llama and Umwelt lakes include 147 Lake Trout, 120 Round Whitefish, and 114 Arctic Grayling.

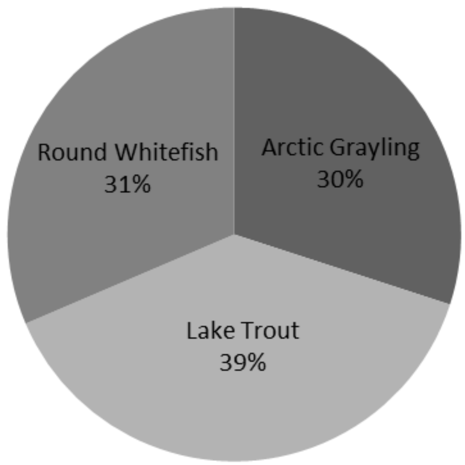


Figure 6.1-1. Species Composition of the Llama-Umwelt Lake System, Goose Property Area

6.1.2 Fish Biomass

As indicated above, two approaches were used to calculate 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 calculated population sizes and recorded mean weight of fish captured in Llama and Umwelt lakes (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 considered an equation derived for lakes in NWT (Samarasin et al. 2015) combined with baseline catch data, including body size measurements, for Llama and Umwelt lakes. This second approach also considered contributions of small-bodied species, such as Ninespine Stickleback and Slimy Sculpin. Equation inputs included 36.59 ha for the surface area of Llama Lake, 19.36 ha for Umwelt Lake, 0.71 ha for Llama Pond 1, 0.57 ha for Llama Pond 3, and 6.25 ha for Pond 1. The total calculated biomass for the Llama-Umwelt lake system is 467.5 kg (Table 6.1-1). This value was selected for the calculation of losses because it is greater than the estimate derived by hydroacoustics, as part of a conservative approach to the offsetting calculations. Estimated biomass losses will also be verified using data collected from the fish-outs of Llama and Umwelt lakes, and estimated losses will be adjusted, as required.

Table 6.1-1. Summary of Fish Production Losses that Require Offsetting

	Loss Type	Total Area (ha)	Biomass (kg)	Biomass Density (kg/ha)
Umwelt-Llama System	Section 35	64.03[(a)]	467.5	7.30
Goose Lake Tributaries	Section 35	10.21[(b)]	133.0	13.03
	MDMER	4.58[(c)]	10.6	2.32

a) Umwelt Lake, Llama Lake, Llama Pond 3, Llama Pond 1, Pond 1 and outflows; b) Lower reach of Goose Inflow East, Goose Inflow South, and Rascal Stream East, and Ponds 10, 11, 12, 21, 23, 24, 25, 26, and 27; c) Upper reach of Goose Inflow East, Goose Inflow South, and Ponds 7, 8, and 9.

6.2 GOOSE LAKE AND TRIBUTARIES

6.2.1 Species Composition

Goose Lake contains six fish species (Figure 6.2-1): 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 (gillnets, electrofisher, and beach seines), the total catch in Goose Lake included 202 fish, most of which were Round Whitefish (33% of total catch) and Lake Trout (27%), followed by Slimy Sculpin (23%), Ninespine Stickleback (14%), Arctic Grayling (2%), and Burbot (1%).

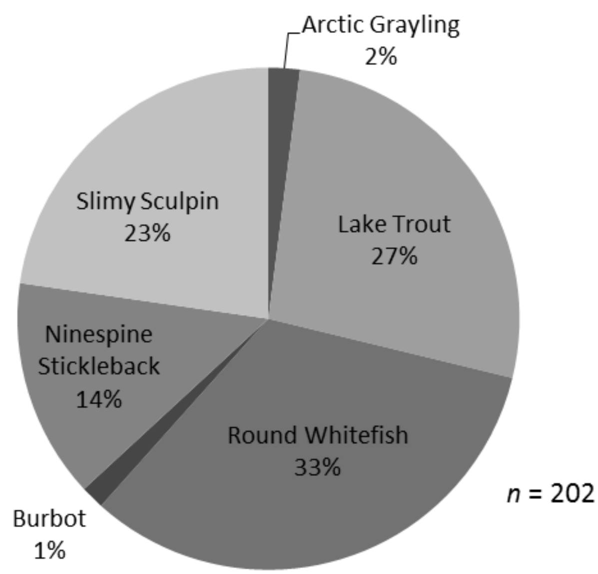


Figure 6.2-1. Species Composition of Goose Lake, Goose Property Area

Arctic Grayling and Slimy Sculpin were the most abundant species captured or observed in streams, followed by Ninespine Stickleback, Burbot, Round Whitefish, and Lake Trout. The highest abundance of fish caught by electrofishing in streams was recorded in Rascal Stream East / Goose Main Pit Stream where numerous young-of-year Arctic Grayling and Slimy Sculpin were captured. Arctic Grayling fry (over 1,000 individuals) were also visually observed in Rascal Stream East and Goose Inflow South during fry surveys. Based on five sampling years (2006, 2011, 2012, 2013, and 2014) and multiple gear types (gillnets, electrofisher, and beach seines), the total catch (excluding visual observations of fish) in Goose Lake and tributary habitats was 277 fish, most of which were Slimy Sculpin (26% of total catch), Round Whitefish (25%), Lake Trout (19%), Ninespine Stickleback (19%), Arctic Grayling (10%), and Burbot (1%).

6.2.2 Fish Biomass

To calculate biomass of fish that rely on affected tributary habitats of Goose Lake, available biomass in the Goose Lake fishery was estimated using a biomass equation derived for northern lakes (Samarasin et al. 2015). The calculation was broken into two components. The first component was an indirect estimation of the biomass of fish in the affected tributary streams and ponds that rely on Goose Lake for overwintering and foraging. The quantification of available biomass of fish in Goose Lake was as a step for this first component. The second component was a direct estimation of the biomass in Pond 27, a tributary pond to Goose Lake that is deep enough to function as overwintering habitat for fish.

The calculated biomass of the fishery that rely on affected tributary habitats was based, in part, on the biomass output from the application of the surface area value for Goose Lake in the biomass equation. The reported relative abundance of fish species in the Goose Lake fishery, combined with mean weights of fish captured in Goose Lake (0.033 kg for Arctic Grayling, 0.008 kg for Burbot, 0.002 kg for Slimy Sculpin, and 0.001 kg for Ninespine Stickleback) were then applied to calculate biomass per fish species that may rely on affected tributary streams and ponds. The combined biomass value of tributary dependent species, such as Arctic Grayling, Burbot, Slimy Sculpin, and Ninespine Stickleback, was assigned as the biomass loss of tributary habitats (excluding Pond 27).

Based on the above approach for Goose Lake and affected tributary streams and ponds, the biomass equation input included 320.2 ha as the surface area of Goose Lake. With the application of this input to the biomass equation, 5,486 kg of fish biomass was calculated for the Goose Lake fishery, and of this value, it was assumed that all biomass of Arctic Grayling, Burbot, Ninespine Stickleback, and Slimy Sculpin was linked to the affected tributary streams and ponds. The calculation of proportional losses from the Goose Lake fishery yielded 103.6 kg of Arctic Grayling, 2.5 kg of Burbot, 16.3 kg of Slimy Sculpin, and 6.0 kg of Ninespine Stickleback, all of which total 128.4 kg of fish biomass.

For Pond 27, the equation input was 1.56 ha, and the resulting biomass was 4.6 kg of Arctic Grayling, Burbot, Slimy Sculpin, and Ninespine Stickleback. Therefore, the total biomass of fish that rely on affected tributary habitats of Goose Lake, including Pond 27, was determined to be 133.0 kg (Table 6.1-1).

6.3 MDMER SCHEDULE 2 HABITAT

As done for habitat where there will be residual serious harm to fish, losses in fisheries production (e.g., biomass; see Section 6.1 and 6.2) were estimated for each pond and stream that requires a listing under Schedule 2 of the MDMER. To calculate biomass of fish that rely on affected fish habitats under the TSF, available biomass was estimated using a biomass equation derived for northern lakes (Samarasin et al. 2015). Equation inputs include the surface water areas for Pond 10 (0.56 ha) and Pond 8 (2.7 ha) as these two ponds are the assumed primary sources of any Ninespine Stickleback in the vicinity of the TSF. With the application of these inputs to the biomass equation, 10.6 kg of fish biomass was calculated (Table 6.1-1), and of this value, it was assumed that all biomass was of Ninespine Stickleback and linked to the affected tributary streams and ponds under the TSF footprint.

7. Bernard Harbour Offsetting Measure

7.1 INTRODUCTION

The Hingittok Lake - Nulahugyuk Creek system at Nulahugyuk (Bernard Harbour), Nunavut 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). This population of Arctic Char was harvested at the mouth of Nulahugyuk Creek during the migration between the ocean where fish forage during the summer and Hingittok Lake where fish spawn and overwinter, located 10 km upstream from the ocean. By the early 1990s, however, local harvesters were reporting that the run was in decline and that the numbers of migrating char were much lower than those observed 30 or 40 years ago based on local knowledge (ANL and Golder 2005; Golder and ANL 2007). In response to these concerns, members of the Kugluktuk HTO and Golder biologists performed a preliminary assessment of the size and timing of the Arctic Char run, and habitat conditions for fish passage during 2004 and 2005 (ANL and Golder 2005; Golder and ANL 2007), and again in 2012 (Golder 2013a).

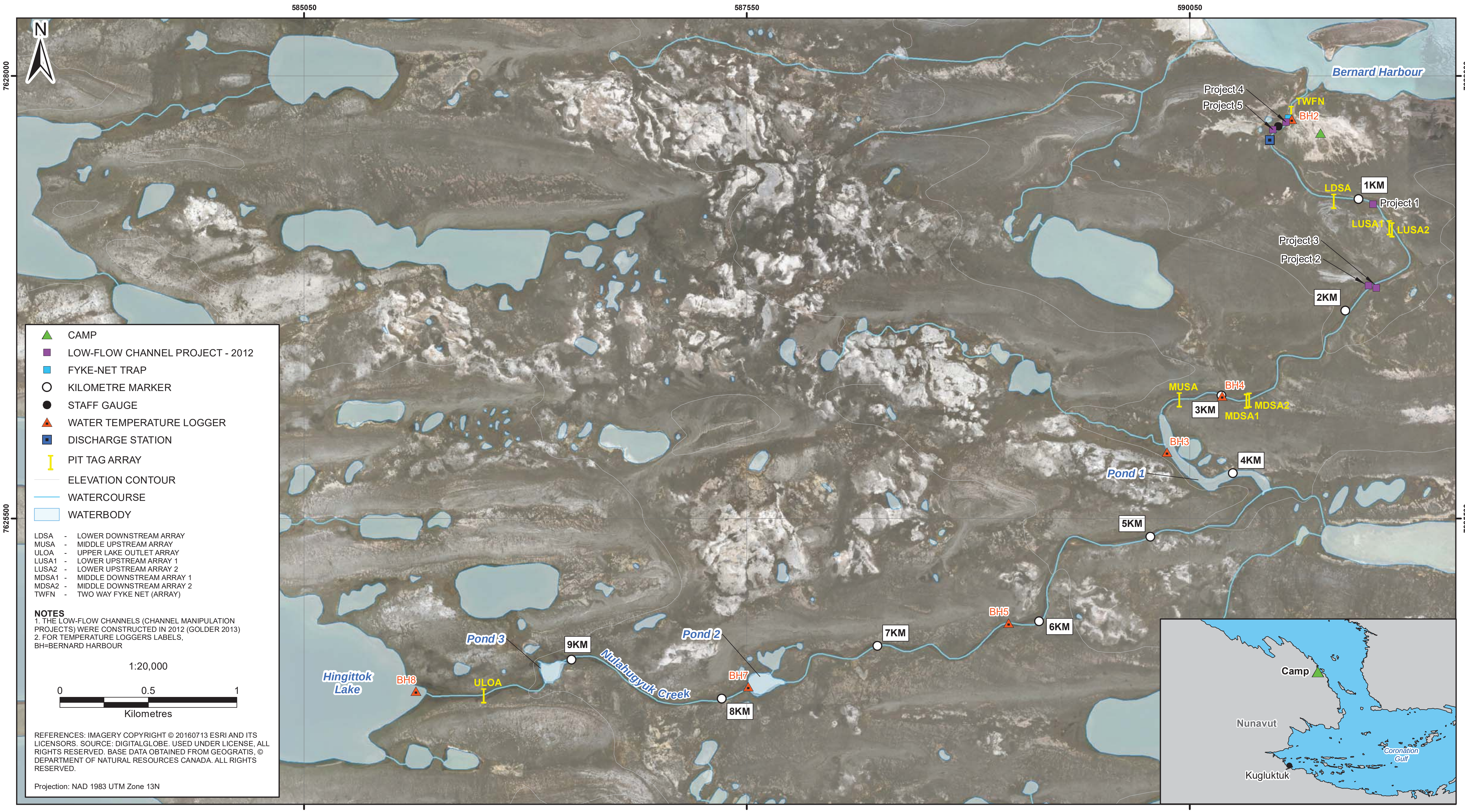
Although the previous work reflected only a short window (i.e., less than 2 weeks) within an assumed longer migratory window per study year, the results suggested a decline in the size of the char run. In addition, the timing of the upstream char migration appeared to have shifted to earlier in the summer.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

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

In 2012, a stream enhancement and community stewardship project aimed at understanding and enhancing the use of the Bernard Harbour system by Arctic Char was successfully undertaken (Golder 2013a). Five low-flow channels, combined with directional weirs to aid fish navigation, were constructed with the guidance from local Inuit to assess the feasibility of applying this approach on a wider scale to increase fish production in the Bernard Harbour system. 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.

In 2014, Sabina initiated a comprehensive study of the migratory Arctic Char population at Bernard Harbour (Figure 7.1-1, Figure 7.1-2). The main goal was to collect rigorous baseline data in support of a Fish 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.

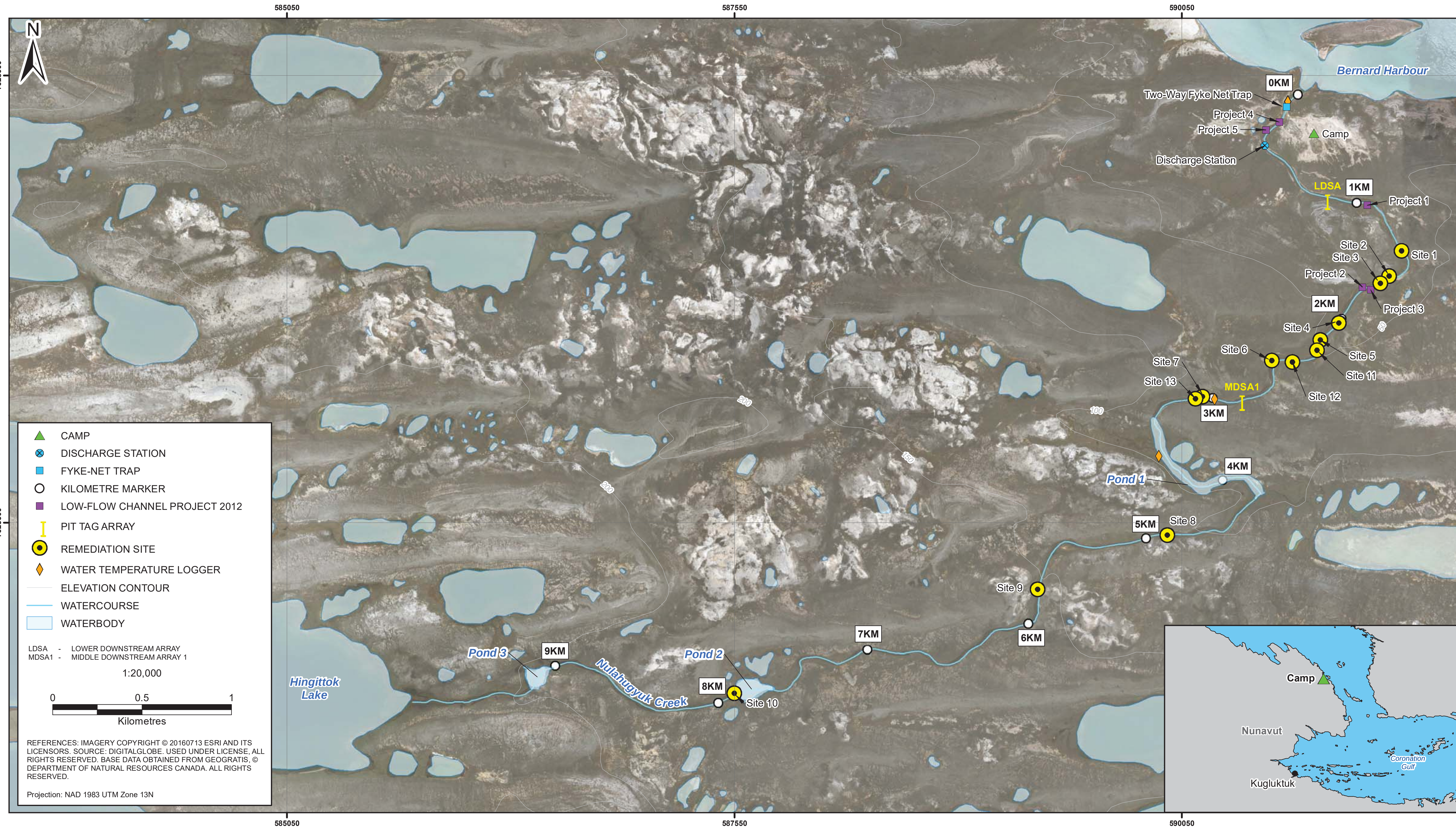
Plate 7.1-1. Arctic Char struggling to migrate upstream through a shallow section of Nulahugyuk Creek, July 5, 2014.



Sabina GOLD & SILVER CORP.

Figure 7.1-1

Nulahugyuk Creek Baseline Study Area, Bernard Harbour, 2014
Back River Project, Fish Offsetting Plan



Sabina GOLD & SILVER CORP.

Figure 7.1-2

Nulahugyuk Creek Baseline Study Area, Bernard Harbour, 2016
Back River Project, Fish Offsetting Plan

Baseline studies, which continued from 2014 to 2016, were designed to address four objectives:

1) Monitor the timing and size of the annual migratory char run in Nulahugyuk Creek using two-way fyke-net traps during the migration period (in 2014 and 2016); data were collected for the three migratory phases, 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 2013a).
2) Monitor rates of movement and successful upstream passage to Hingittok Lake during the open water season (in 2014 and 2016) 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 (during 2014) 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 baseline habitat data to prepare a remediation plan for using low-flow channels to improve upstream passage for fish in Nulahugyuk Creek (during 2014 to 2016); this objective was performed as a direct follow-up of work initiated by Golder in 2012.

In addition to the objectives outlined above, the completed baseline work (2014 to 2016) was intended to complement and integrate conservation objectives of the Kugluktuk 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. Golder field technicians and HTO staff, including local students and other community members, worked together in the field sharing traditional and scientific knowledge towards a common goal of improving migration conditions for Arctic Char. As a local partner, the HTO provided community involvement in nearly all aspects of the project, including both the design of the remediation plan and the implementation of the approach in 2016.

The following sections summarize methods and results from any monitoring and offsetting activities completed to date. For additional details, baseline and remediation reports related to the Bernard Harbour offsetting measure are provided in Appendix D and Appendix E (Golder 2015a,b, 2017a,b, 2018). The baseline TK related to the Bernard Harbour offsetting measure is summarized in the Traditional Knowledge Study Report on the Arctic Char Fishery in the Hingittok Lake - Nulahugyuk Creek system (Bernard Harbour), Nunavut (see Appendix B).

7.1.1 Study Area

The Hingittok Lake - Nulahugyuk Creek system 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 (Figures 7.1-1 and 7.1-2). The project site is about 4.5 hours travel time by boat from the community of Kugluktuk. Nulahugyuk Creek, the outflow from Hingittok Lake (882 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 mm, of which 144 mm falls during June, July, August, and September (see http://climate.weather.gc.ca; Government of Canada 2018). 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 BASELINE

Baseline field studies began in June 2014 and were timed to capture Arctic Char moving through Nulahugyuk Creek once the ice had melted enough to allow passage for fish (Golder 2015a; Appendix D). The spring timing of field studies was selected based on data collected during 2012 (Golder 2013a), 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 through early summer to capture the downstream outmigration of juvenile char.

A short field visit to Bernard Harbour was also made in July 2015 to collect supplemental information on habitat (fish were not monitored in 2015; Golder 2015b; Appendix D), and a field program was performed the following summer in July 2016 focusing on the later stages of the upstream migration of adult Arctic Char (Golder 2017a; Appendix D). The following sections focus on data collected during 2014 and 2016 for the three migration types (i.e., the downstream outmigration of adults, upstream migration of adults, and downstream outmigration of juveniles), with focus on the upstream migration of adults.

7.2.1 Methods

7.2.1.1 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, and again on July 6, 2016, operating continuously until July 25, 2016 (Plate 7.2-1). The fyke net was installed in a shallow run area approximately 150 m upstream from the mouth of the creek in 2014 (Figure 7.1-1), and approximately 100 m upstream from the mouth of the creek, closer to the interface of fresh and brackish water, in 2016 (Figure 7.1-2). The mean wetted width of the channel at the trap location was approximately 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, the fish 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.

Plate 7.2-1. Two-Way Fyke-Net Trap at Mouth of Nulahugyuk Creek, July 2016

In Hingittok Lake, multiple gillnet sets (short-duration sets) and angling events were used in 2014 to provide information on fish species composition and abundance. Gill net mesh size and configuration were based on Broad Scale Monitoring techniques for North American (NA1) and Ontario small mesh (ON2) gillnets (Sandstrom et al. 2013). A series of bottom-set gillnets 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.

Captured fish were enumerated, and identified to species, most of which were weighed (grams [g]) and measured (fork length [mm]), and a small number of representative individuals were photographed. To minimize stress during periods of warm water temperatures (greater than 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 2013a).

7.2.1.2 Movement Monitoring

Upstream movements for a subset of captured Arctic Char were monitored using implanted PIT tags and Radio Frequency Identification antenna-reader arrays installed at strategic locations on the creek (Figures 7.1-1 and 7.1-2) (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 (Figures 7.1-1 and Figure 7.1-2). An array was also installed near the outlet of Hingittok Lake (Figure 7.1-1; Table 7.2-1). The arrays were configured using either a single antenna (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. PIT tag monitoring in 2016 focused on LDSA and MDSA1 locations (Figure 7.1-2), to provide supplemental information on the migration success rates in the lower sections of the creek and to determine whether success rates under similar flow conditions differ between years.

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.

Table 7.2-1. Locations of the Fyke-Net Trap and Antennae Arrays, Nulahugyuk Creek

Array	Location (UTM, Zone 11 W)		Distance from Nulahugyuk Creek Mouth (km)[a]	Year Installed	
	Easting	Northing		2014	2016
Two-Way Fyke-Net Trap (TWFN)[b]	590644	7627855	0.10	X	X
Lower Downstream Array (LDSA)	590865	7627313	0.84	X	X
Lower Upstream Array 1 (LUSA1)	591178	7627164	1.23	X	
Lower Upstream Array 2 (LUSA2)	591192	7627151	1.25	X	
Middle Downstream Array 1 (MDSA1)	590387	7626190	2.83	X	X
Middle Downstream Array 2 (MDSA2)	590372	7626185	2.84	X	
Middle Upstream Array (MUSA)	589992	7626191	3.22	X	
Upper Lake Outlet Array (ULOA)	586065	7624520	9.56	X	

a) Distances upstream were measured from the mouth of Nulahugyuk Creek using collected GPS data and a creek shapefile updated in GIS in 2016; b) Fyke-net trap positioned approximately 50 m downstream from the location used in 2014; UTM=Universal Transverse Mercator; km=kilometre.

Statistical Analyses

Binary logistic regressions (Hosmer and Lemeshow 2000) were used to explore relationships between upstream migration success (fish detected [1], or not detected [0] at the upstream array) and environmental and biological factors such as migration date, stream discharge (either discharge at day tagged, or a mean discharge over four consecutive days starting on day tagged), mean daily water temperature for day tagged, length, weight, and condition factor. Various models were compared based on their Akaike Information Criterion score, with lower values identifying models better representing the data analyzed, and on their Receiver Operating Characteristic, with higher values indicating greater sensitivity and specificity of the model.

One logistic model was developed for the 2014 movement data, covering the entire length of the creek from the fyke-net trap to Hingittok Lake. The migratory success of char traveling upstream from the fyke-net trap to the upstream array labelled MDSA1 in 2014 was also modelled using data collected in 2014 (Golder 2015a) and 2016 (Golder 2017a) under similar discharge conditions (less than 0.5 m^3/s). Because no significant differences were observed in migratory success between 2014 and 2016 for the migration period of similar discharge conditions ($P = 0.452$), migratory data were pooled to develop a single baseline model describing biological and environmental factors affecting migratory success of char through the lowest 2.8 km of the creek.

7.2.1.3 Habitat Surveys

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 (Figure 7.1-1, Figure 7.1-2). 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 then calculated across the wetted width of the channel based on the point measurements of velocity, depth, and interval width represented by each point measurement. Velocity and water levels were measured 22 times between June 13 and July 15, 2014, 3 times between July 22 and July 24, 2015, and 8 times between July 7 and July 14, 2016.

Water temperatures were measured at 0.25 hour intervals at multiple locations along Nulahugyuk Creek using Onset® HOBO Water Temperature Pro V2 Data Loggers. The loggers collected data every 15 minutes and ran continuously for the duration of the field study in 2014 and 2016.

Nulahugyuk Creek Habitat

Habitat was assessed along the entire length of Nulahugyuk Creek (approximately 10 km) between July 10 and July 14, 2014, and again between July 8 and July 13, 2016. Major habitat types within the sections were described in accordance with the classification system outlined in Hawkins et al. (1993).

Potential char migration barriers (problem locations) along the entire length of the creek were identified, photographed, and described during low flow conditions (i.e., less than 0.8 m^3/s). Aerial photos of selected problem locations in the lower section of Nulahugyuk Creek were taken using a drone.

To prepare for future remedial works, GPS coordinates were obtained for each problem location, and each problem location was qualitatively rated according to the perceived level impassibility for adult char moving upstream during the later stages of migration. The most impassible locations (rank ‘3’ locations) were those where fish stranding has been previously observed or where flows are dispersed flows and boulder fields often occur at the reach-level, impeding upstream movements and exposing fish to terrestrial predators. Highest risk locations were obvious barriers to fish passage during the later stages of the upstream migration (e.g., early July), and may also present a risk to fish earlier in the migration period. Rank 2 locations were those characterized by a moderate to high potential for stranding and a partial migration barrier during the later stages of migration when water levels decline. Rank 1 locations were those that may be passable during average flow conditions for most of the upstream migration period, but present the potential for stranding and stressful conditions during the later stages of migration. All problem locations were identified in a detailed remediation plan, which was finalized in the field in 2016, capturing the spatial extent and location of pinch-points on the creek.

The integrity of previously completed (2012) low-flow channels was also visually assessed and photographed in 2014, 2015, and 2016. Width, velocity, and depth measurements within the thalweg were collected every 2 m for the length of each 2012 low-flow project and any displaced substrates were identified and photographed. Mean values and standard deviations of channel characteristics were calculated.

Hingittok Lake Bathymetry

Bathymetry at Hingittok Lake was determined while gillnets 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.

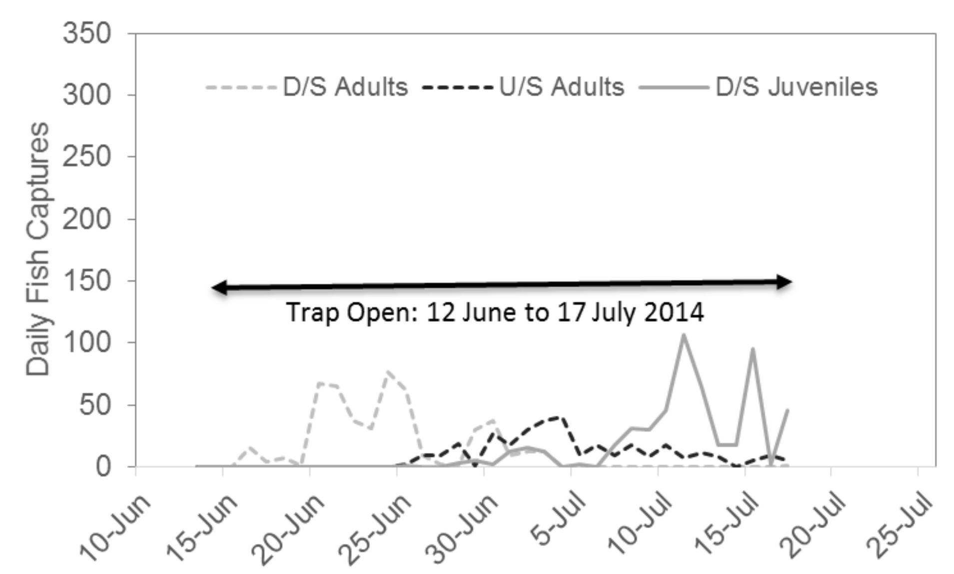
7.2.2 Results and Discussion

7.2.2.1 Fish Catch

Nulahugyuk Creek

In 2014, the fyke-net trap 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 7.2-1). 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 7.2-1). Upstream movement attempts by adults began on June 25 and continued through to the completion of the field study. Downstream movement by juvenile Arctic Char began on June 25 and continued to the completion of the field study. Other species captured in the fyke-net trap included Ninespine Stickleback.

A)



B)

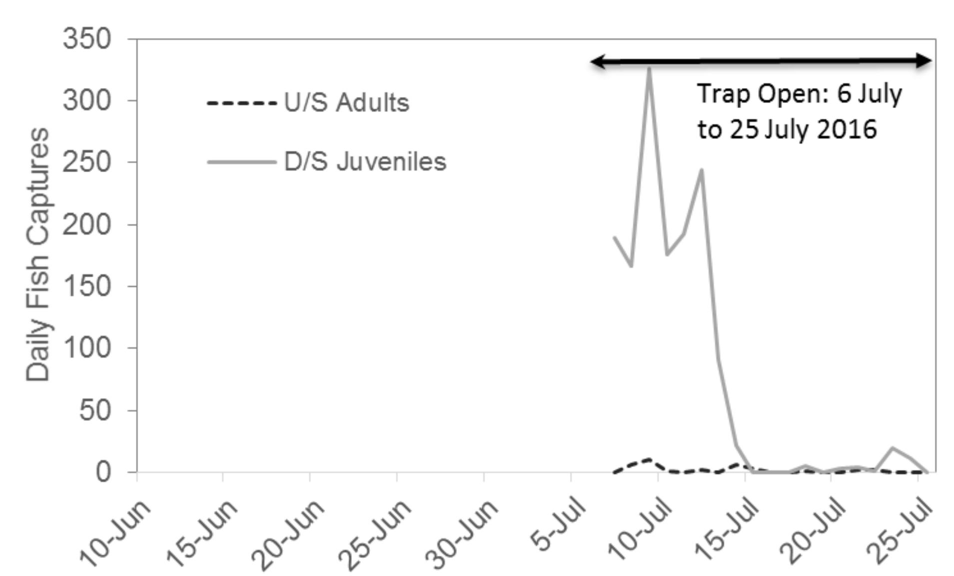


Figure 7.2-1. Daily Captures of Migratory Arctic Char in Nulahugyuk Creek, 2014 (A) and 2016 (B). D/S = downstream travelling fish and U/S = upstream travelling fish

In 2016, the fyke-net trap was in place for a total of 19 days, 21 hours, and 40 minutes beginning the afternoon of July 6, 2016 (14:10) and ending July 25, 2016 (11:50). The trap captured 1,467 juvenile Arctic Char and 55 adult Arctic Char (Figure 7.2-1). A portion of the catch was recaptured fish that were moving within the lower section of the creek where the fyke-net trap was installed. For example, the 55 captures of adult char represented 33 individual fish (60% of the catch) based on PIT tag identification. These Arctic Char were lake-bound fish, first recorded in the downstream opening portion of the fyke-net trap as they started their upstream migration to Hingittok Lake from the ocean. The downstream migration of adult char, which was monitored in 2014, was not monitored in 2016 as the migration was complete by the start of monitoring. The 1,467 juvenile char captured in 2016 were all seaward bound, captured in the upstream opening portion of the fyke-net trap during their downstream migration to the ocean. Other species captured in the fyke-net trap included Ninespine Stickleback, Arctic Cisco (*Coregonus autumnalis*), Arctic Cod (*Arctogadus glacialis*), and Spoonhead Sculpin (*Cottus ricei*).

Based on the timing of migrations observed in 2014, it is expected that the downstream migration by adult char was completed 1 to 2 weeks prior to the installation of the fyke-net trap in 2016. The trapping period in 2016 is assumed to have captured the majority of the downstream migrating juvenile char, and any movements associated with the later stages of the upstream migration of adult char.

Arctic Char length and weight measurements and condition factor for the three migratory groups are summarized and described in Table 7.2-2. Length and weight measurements for adult Arctic Char in 2014 and 2016 were combined (*n* = 680) to provide the following length-weight relationship:

$$\log_{10} Weight\ (g) = -4.6039 + 2.8733 \times \log_{10} Length\ (mm) (R^2 = 0.87)$$

Table 7.2-2. Summary of Arctic Char by Migratory Group Captured in Fyke-Net Trap in Nulahugyuk Creek

Migratory Group	Year	Mean Length (mm) ± SD	Mean Weight (g) ± SD	Mean Condition Factor ± SD
Adults moving upstream	2014	729 ± 54 (n = 328)	4,271 ± 991 (n = 329)	1.09 ± 0.09
	2016	709 ± 84.6 (n = 30)	3,990 ± 1,357 (n = 27)	1.09 ± 0.17
Adults moving downstream	2014	717 ± 54 (n = 475)	3,135 ± 748 (n = 473)	0.84 ± 0.10
	2016	-	-	-
Juveniles moving downstream	2014	193 ± 19 (n = 347)	60.3 ± 18.2 (n = 313)	0.81 ± 0.07
	2016	157 ± 16 (n = 249)	-	-

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

Hingittok Lake

Twenty-nine short-duration gillnet sets were deployed for a total of approximately 65 hours in Hingittok Lake in 2014. Gillnetting efforts in Hingittok Lake captured a total of 54 fish including 36 Lake Trout, 10 Arctic Char, 7 Cisco, and 1 Ninespine Stickleback. Of the 10 char captured, 7 were adults and 3 were juveniles. Mean catch-per-unit-effort for large mesh nets was 2.16 fish/hour/100 m; approximately twice that of small mesh nets which was 1.07 fish/hour/100 m. Two of the captured char were PIT tagged earlier in the season in 2014.

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 (catch-per-unit-effort of 1.5 fish/angler hour). Overall, Lake Trout was the dominant species captured from Hingittok Lake (based on gillnetting and angling combined), contributing 71% to the total catch (Figure 7.2-2).

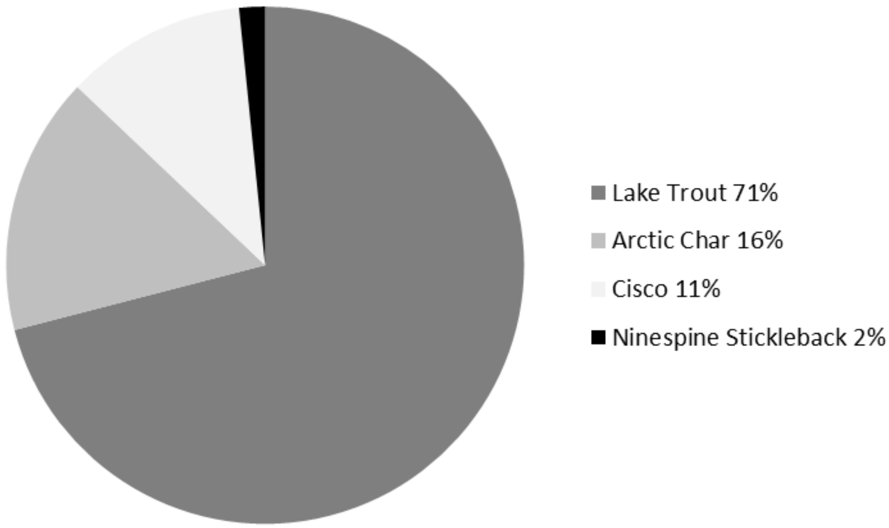


Figure 7.2-2. Fish Species Composition in Hingittok Lake, 2014

7.2.2.2 Spawning Migration

Spawning Migration 2014

In 2014, 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 of 1.09 (± 0.1).

A high degree of detectability was obtained at most antennae-reader arrays (Table 7.2-3). 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 (Hingittok Lake) 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 7.2-3). 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. 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; less than 2% of char that entered the creek (but did not arrive in Hingittok Lake) were observed to successfully exited the system by July 17, 2014. 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 7.2-3. Radio Frequency Identification Arrays and 2014 Detection Information

Array	Approximate Distance Upstream from Bernard Harbour (km)	Detection Probability	Detected Total	Corrected Total
Two-Way Fyke Net (TWFN)	0.20	1.00	315	315
Lower Downstream Array (LDSA)	0.84	0.90	263	293
Lower Upstream Array 1 (LUSA1)	1.23	0.93	261	280
Lower Upstream Array 2 (LUSA2)	1.25	0.91	255	279
Middle Downstream Array 1 (MDSA1)	2.83	0.97	205	212
Middle Downstream Array 2 (MDSA2)	2.84	0.96	202	211
Middle Upstream Array (MUSA)	3.22	0.59	94	158
Upper Lake Outlet Array (ULOA)	9.56	0.93	103	110

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 8.7 km) varied among individuals and throughout the study period with a mean migration time (± standard error) of 108.3 hours (± 4.7). The fastest fish completed the migration in 34.2 hours, and the slowest in 239.0 hours. The migration time was generally faster from June 25 to June 30 (79.3 hours [± 5.4]) than from June 30 to July 6 (123 hours [± 5.8]).

The number of Arctic Char observed among the Radio Frequency Identification arrays declined sequentially as the fish moved upstream (Table 7.2.3). Using a binary logistic regression, the primary factors influencing migratory success were determined to be four-day mean discharge and char weight (Table 7.2-4). Model fit was significant (P <0.001) with an Receiver Operating Characteristic value of 0.84. The output of the formula (when fish weight is held constant at 4.2 kg) is presented graphically in Figure 7.2-3. This weight is the mean weight of adults moving upstream. 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. The P_{50} was 1.09 m^3/s. 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. The P_{50} was 6.48 kg.

Table 7.2-4. Parameter Estimates for Binary Logistic Model Predicting Migration Success to ULOA in 2014

Parameter	Estimate	Standard Error	Z	P-Value	95% Confidence Interval Lower	95% Confidence Interval Upper
Constant	-8.398	2.417	-3.48	0.001	-13.134	-3.661
Four day mean discharge (m^3/s)	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 (kg)	-0.77	0.192	-4.02	<0.001	-1.146	-0.395

Z = statistical score; P-Value = probability value; percentage = percent; <= less than; kg = kilograms.

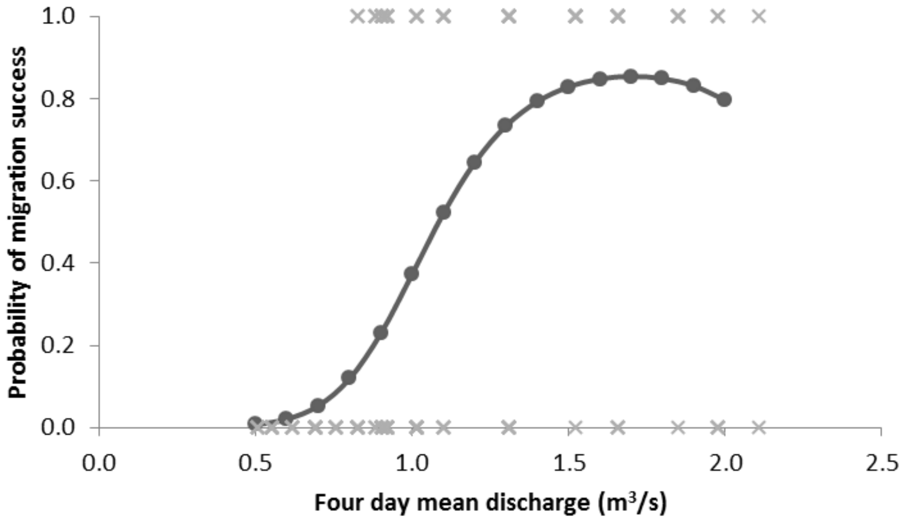


Figure 7.2-3. Results of Binary Logistic Regression Plotting the Probability of Migration Success to ULOA Against Stream Discharge in 2014

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

<u>Spawning Migration 2016</u>

In 2016, field data collection occurred from July 8 to 24 with discharge declining from 0.5 to 0.2 m^3/s over that period. In 2014, field data collection occurred from June 12 to July 17 with discharge declining from 6.0 to 0.4 m^3/s over that period. Differences in the timing of the data collection resulted in lower catch numbers in 2016 compared with 2014; however, migration success results were similar when comparing sampling periods with similar discharge (less than 0.5 m^3/s).

Of the 33 adult char captured while migrating upstream in 2016, 24 were new captures and implanted with PIT tags, five were recaptures previously tagged in 2014, and four were new captures but not tagged due to their poor health condition. The average length of upstream migrating adult char was 706 ± 16 mm, ranging from 560 to 879 mm in length and had an average weight of 3,897 ± 254 g ranging from 1,700 to 7,350 g. Of the tagged adults, 14 fish were detected at the LDSA and three were detected at the upstream antenna array (MDSA1). On average, it took char 7.7 hours travelling 96 m/h (mean rate of travel) to reach LDSA, and another 24.9 hours travelling 80 m/h to reach MDSA. Generally, char either moved relatively quickly to LDSA arriving at the array in less than 6.5 hours, or progressed slowly taking over 11 hours to complete the same distance.

Using a binary logistic regression, the primary factors influencing migratory success to MDSA1 in 2014 and 2016 were determined to be discharge and char weight (Table 7.2-5; Figure 7.2-4). Model fit was significant (P <0.001) with an Receiver Operating Characteristic value of 0.87. There was no significant difference in the number of char reaching the upstream array between 2014 and 2016 under similar discharge conditions (less than 0.5 m^3/s; P = 0.452).

With respect to discharge, the probability of successfully reaching the upstream array ranged from a high of 95% at 1.6 m^3/s or greater, declining to a low of 0% at 0.2 m^3/s, when char weight was held constant using the mean char weight of 4.20 kg. The P_{50} was 0.79 m^3/s. With respect to char weight, the probability of successfully reaching the upstream antenna array ranged from a high of 96% for char that had a maximum weight of 2.0 kg to a low of 38% for 7.55 kg (the maximum char weight measured), when discharge was held constant using the weighted mean discharge of 1.06 m^3/s. The P_{50} was calculated as 6.75 kg.

Table 7.2-5. Parameter Metrics for Binary Logistic Regression of Migratory Success to MDSA1 Using 2014 and 2016 Data

Parameter	Estimate	Standard Error	*Z*	*P*-Value	95% Confidence Interval	
					Lower	Upper
Constant	-5.475	1.11	-4.933	<0.001	-7.651	-3.300
Discharge (m^3/s)	13.709	1.834	7.477	<0.001	10.115	17.302
Discharge (squared)	-4.282	0.67	-6.391	<0.001	-5.595	-2.969
Weight (kg)	-0.628	0.156	-4.029	<0.001	-0.9341\	-0.323

Z = z score; P-Value = probability value; % = percent; < = less than; kg = kilograms.

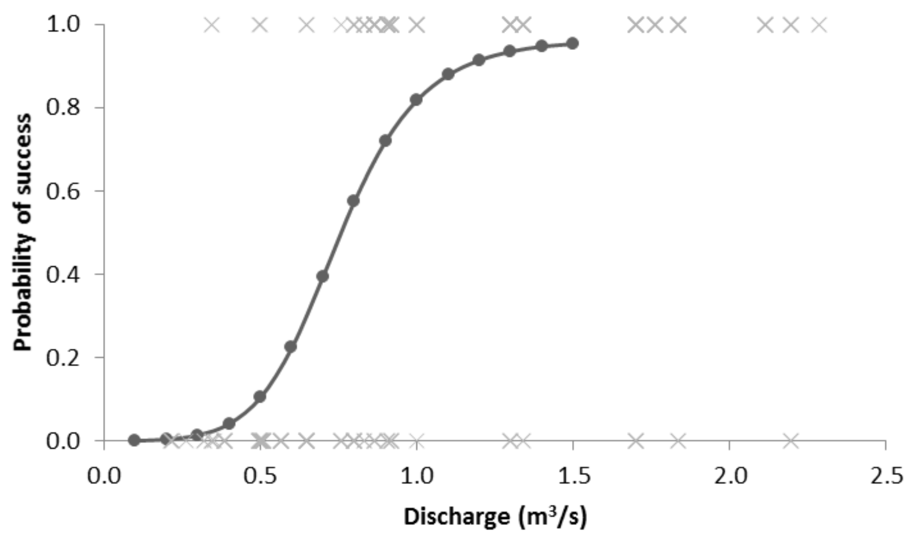


Figure 7.2-4. Results of Binary Logistic Regression Plotting the Probability of Migration Success to MDSA1 against Stream Discharge in 2014 and 2016

7.2.2.3 Fish Habitat

Water Temperature

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. 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 increase of 0.3°C/km in downstream direction.

Daily mean water temperatures in 2016 ranged from a high of 19.8°C on July 12 to a low of 7.0°C on July 22. The warmest recorded temperatures occurred during the first half of the study period and exceeded 21°C (thermal stress barrier for salmonids [McCullough 1999]) for a combined total of 40 hours as measured at the fyke-net trap. As observed in 2014, diurnal variation in water temperature was evident during the sampling period in 2016. The mean difference between daily minimum and maximum values during the 2016 monitoring period was 7.4°C.

Water temperatures during the 2016 sampling period were warmer than those measured in 2014 when the highest daily mean water temperature was 7.5°C lower (i.e., only 12.3°C), and the maximum recorded water temperature remained below 21°C for the duration of the 2014 monitoring period. Mean maximum daily air temperatures for the 2016 study year were also above the 30-year normal for the months of June (by 1.8°C), July (by 1.2°C), and August (by 1.5°C) (climate data obtained for station at Kugluktuk, Nunavut, at http://climate.weather.gc.ca; Government of Canada 2018). For comparison, monthly mean maximum daily temperatures for the 2014 study year were below normal for the months of June (by 1.2°C) and August (by 1.2°C) and were only marginally above normal for July (by 0.2°C).

Creek Discharge

In 2014, creek discharge declined over the study period ranging from a high of 6.0 m^3/s on June 15 to a low of 0.5 m^3/s on July 15 (Figure 7.2-5). Monthly precipitation totals for the 2014 study year were above normal for the months of May (0.6 mm above normal), June (9 mm above normal), and July (1.7 mm above normal) (climate data obtained for station at Kugluktuk, Nunavut, at http://climate.weather.gc.ca; Government of Canada 2018).

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:

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

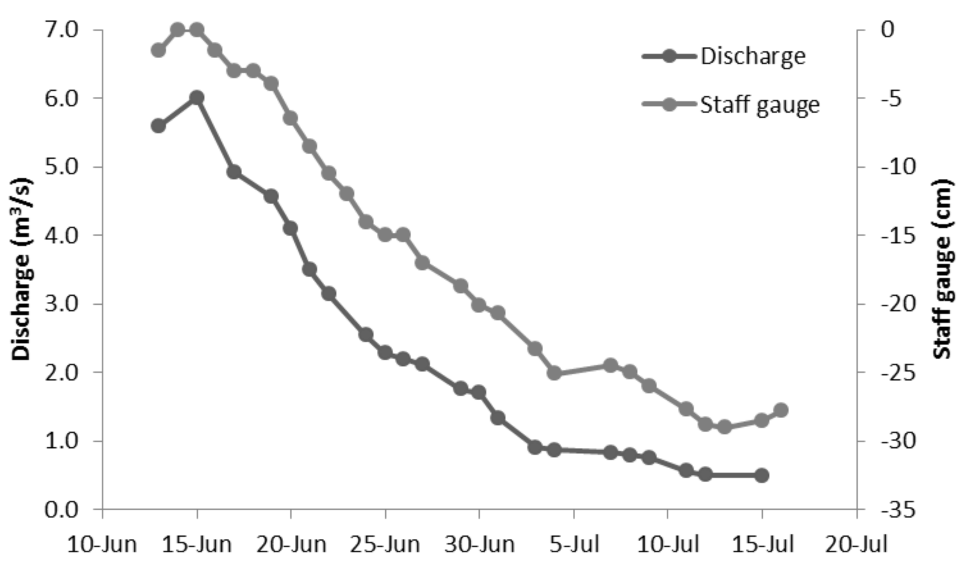


Figure 7.2-5. Stream Discharge (m^3/s) and Staff Gauge Depth (cm) Recorded at Nulahugyuk Creek for June 13 to July 15, 2014

In 2016, discharge declined over the study period ranging from a high of 0.5 m^3/s on July 8 to a low of 0.2 m^3/s on July 25. For comparison, discharge during the 2014 study period started at a high of 6.0 m^3/s on June 15, 2014 to a low of 0.4 m^3/s on July 17, 2014. Additional data on flow conditions are provided in Section 7.2.3. Monthly precipitation totals for the 2016 study year were above the 30-year normal for the months of May (10.2 mm above normal), and June (21.1 mm above normal), but were below the 30-year normal for the month of July (6.5 mm below normal) (climate data obtained for station at Kugluktuk, Nunavut, at http://climate.weather.gc.ca).

Habitat Types

Moving upstream 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 7.2-2). 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 provide 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 7.2-2), Arctic Char were often incidentally observed holding.

Plate 7.2-2. Riffle habitat with small pool provided near bank (left), looking upstream, approximately 1.3 from mouth of Nulahugyuk Creek, July 16, 2014.

During the habitat assessment in July 2014, a number of problem locations were identified in the creek where fish passage may be impaired by low water depths and boulder gardens (e.g., see Plate 7.2-3a to 3d). The problem locations were confirmed in 2016 (Figure 7.1-2), see Appendix D for more details. Most of the problem locations are in the lower section of the creek, within the lower 3.1 km below Pond 1.

Plate 7.2-3a. Looking upstream towards barriers at Site 5, July 16, 2014.

Plate 7.2-3b. Looking downstream towards barriers at Site 5, July 16, 2014.

Plate 7.2-3c. Looking upstream towards barriers at Site 6, July 16, 2014.

Plate 7.2-3d. Looking downstream towards barriers at Site 6, July 16, 2014.

<u>Hingittok Lake</u>

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 7.2-6). Shoreline length (38,085 m including island shorelines) was extensive relative to the area of the lake and the shoreline development factor (i.e., the ratio of lake perimeter to surface area) was approximately 12.3. The higher the ratio, the more irregular the shoreline, resulting in potentially more shoreline habitat for spawning and rearing (a perfect circle would have a shoreline development factor of 1).

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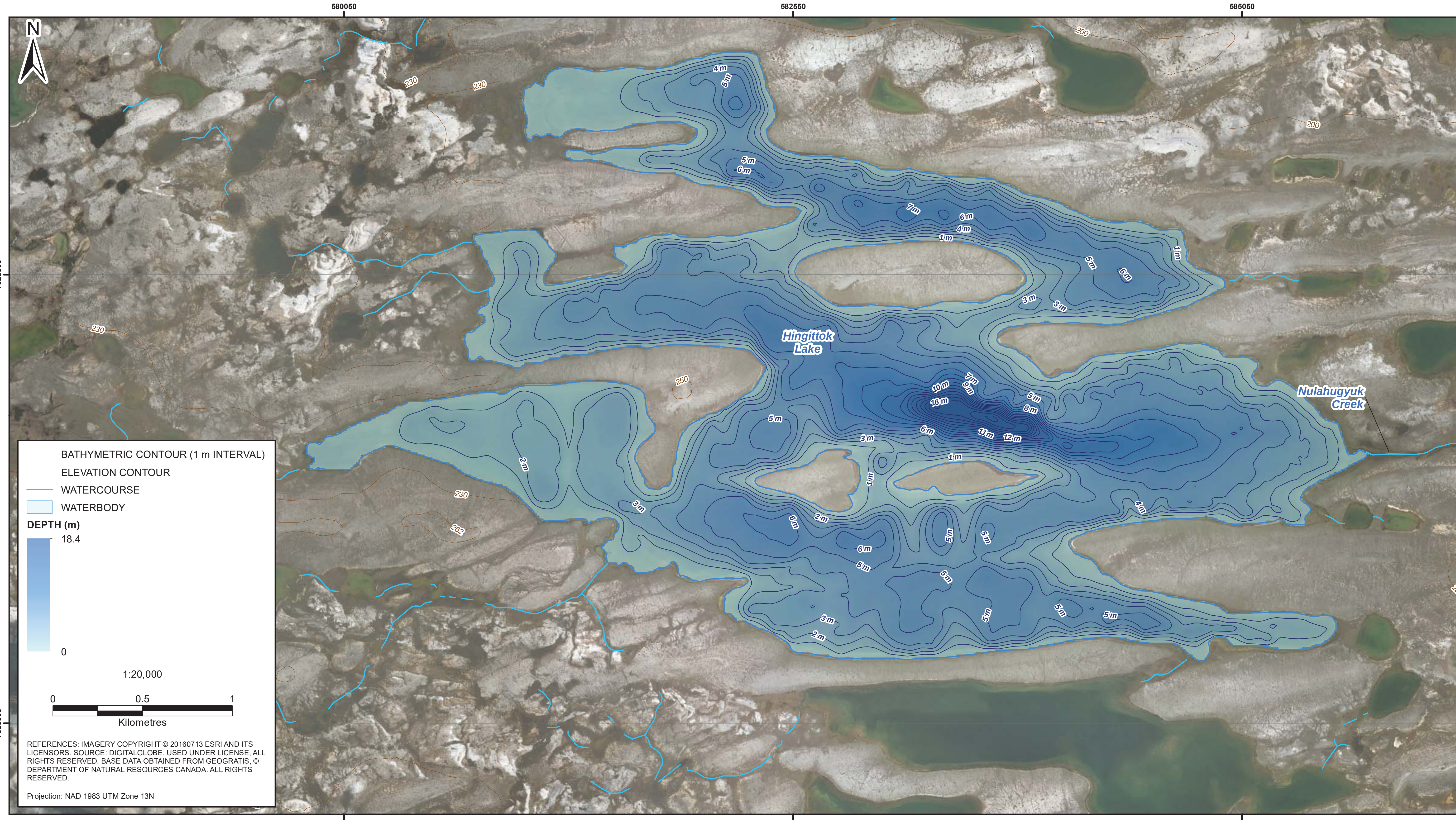

Sabina GOLD & SILVER CORP.

Hingittok Lake Bathymetry, Bernard Harbour, July 2014
Back River Project, Fish Offsetting Plan

Figure 7.2-6

The bathymetry data collected in July 2014 derived a lake volume of approximately 30,553,000 m^3 (Table 7.2-6). The maximum depth was approximately 18 m and mean depth was 3.7 m.

Table 7.2-6. Approximate Lake Area and Volume for Various Depth Intervals in Hingittok Lake, July 10 to 14, 2014

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

m = metre; m^3 = cubic metre, ha = hectare; >= greater than.

7.2.3 Synthesis of Baseline Information

The Bernard Harbour population of Arctic Char displays a unique life history as part of a diversity of Arctic Char life histories described across other localities (e.g., Vollestad and L'Abee-Lund 1994; Power et al. 2008). Three distinct Arctic Char migration types were recorded at Bernard Harbour. The first adult char captured during the spring migration were those migrating downstream (mid-June to early July). The migration of the second adult group, adults moving upstream towards Hingittok Lake, began late June and peaked in early July. The third migration type was defined by the downstream migration of juveniles peaking in early to mid-July.

Consistent with life history theory, anadromous species such as Arctic Char that live in a dynamic Arctic environment are adaptable to changes in site-specific conditions (i.e., behaviours must be phenotypically plastic, otherwise populations would not exist). At Bernard Harbour, an early-season migration period for spawning adults is advantageous for the overall fitness of the population because stream conditions later in the open water season (e.g., low water depths) preclude access to spawning habitats in Hingittok Lake (Golder 2013a). It is expected that the adult char that successfully reach Hingittok Lake either overwinter, then spawn during the fall of the next year, or spawn then overwinter, migrating downstream to Bernard Harbour the following spring. Non-spawning fish from Hingittok Lake that are foraging in the ocean are expected to overwinter in more accessible systems such as the Coppermine River rather than risk injury or death in Nulahugyuk Creek in late summer. This life history strategy of using two separate watersheds has been described for anadromous species, including Arctic Char (Jensen et al. 2015).

Although adults were still captured while attempting to migrate upstream near the end of the monitoring periods in July of each study year, PIT tag data indicated that adults attempting migration through most of July would be unsuccessful. The primary factors affecting upstream migration success at Nulahugyuk Creek during 2014 and 2016 were discharge and fish weight. Discharge was strongly correlated with water depth, and as depth declined over time, new impediments to fish passage were created until fish passage was no longer possible. In addition, larger fish were less likely to overcome impediments to fish passage, presumably due to an increased probability of stranding and predation in shallower water. Unfortunately, larger fish are generally the most productive in a spawning population (Jeuthe et al. 2013), producing greater numbers of viable offspring, and loss of these individuals could have significant effects on recruitment potential.

In 2014, the estimated discharge at which there is a 50% probability of an adult Arctic Char successfully navigating to Hingittok Lake in 2014 was 1.1 m^3/s, and a potential barrier threshold was noted on July 7, 2014 as stream discharge declined to approximately 0.8 m^3/s and water depths declined by 25 cm at the staff gauge over the monitoring period. At lower flows, fish passage was no longer possible; indicating a brief and discrete window of opportunity exists for the upstream migration at Nulahugyuk Creek. Between the time fish were initially detected moving upstream (June 25) and passage was no longer possible (July 7), the migration window in 2014 was 13 days. While some of the unsuccessful migrants may have taken temporary shelter in upstream pools eventually retreating to the sea, the majority of the remaining char likely perished through stranding, exhaustion, or predation.

The results of the 2016 monitoring study, which focused on the later stages of the upstream migration, were consistent with those from 2014 during similar, low-flow conditions. The 2016 monitoring period coincided with flows below the previously identified discharge threshold at which adult char can successfully migrate to Hingittok Lake. Even under the low-flow conditions, 33 adult char were captured in the fyke-net trap in 2016. Of these, only three char (10.3% of tagged char) were detected 2.83 km upstream, and using 2014 and 2016 data combined, the estimated discharge at which there is a 50% probability of an adult Arctic Char successfully navigating the lower reach of the creek was 0.8 m^3/s. The probability of any char successful migrating past the lower reach to Hingittok Lake is expected to be very low, in part, because of the stress incurred while navigating shallow water in the lower sections of Nulahugyuk Creek.

The baseline characterization of Nulahugyuk Creek at Bernard Harbour is also supported by the data collected in summer 2004 and 2005 when members of the Kugluktuk HTO and Golder carried out a fish and fish habitat assessment on the Hingittok Lake-Nulahugyuk Creek system (e.g., Golder and ANL 2007). These field studies also observed deteriorating migration conditions later in the summer, conditions that are very difficult to navigate or impassable for char based on all recent visits to Bernard Harbour in mid-July through September (Table 7.2-7). Most of the measured discharge values for mid to late summer flows are below the discharge threshold of 0.8 m^3/s required for upstream migration, with the exception of a 1.07 m^3/s record on July 12, 2012.

Table 7.2-7. Summary of mid-July to September Flow Conditions at Nulahugyuk Creek, Nunavut (2004-2016)

Summer Dates	Discharge	Habitat Conditions	Reference
August 19-23, 2004[(a)]	0.106 to 0.122 m^3/s	Impassable	Golder and ANL 2005
July 15-September 13, 2005[(b)]	0.098 to 0.756 m^3/s	Difficult to impassable	Golder and ANL 2007
July 8-16, 2012	0.34 to 1.07 m^3/s	Difficult to impassable	Golder 2013a
August 8-12, 2013	0.04 to 0.06 m^3/s	Impassable	Golder 2013b
July 8-16, 2014[(c)]	0.5 to 0.79 m^3/s	Difficult to impassable	Golder 2015a
July 22-24, 2015	0.29 to 0.42 m^3/s	Impassable	Golder 2015b
July 8-25, 2016	0.17 to 0.51 m^3/s	Impassable	Golder 2017a

a) 7 adult char captured moving upstream over 3 days of continuous trap net operation at the mouth of the creek; b) high flow event recorded on August 28, 2005; this was of short duration (1 - 2 days) with flows quickly returning to low levels (below 0.2 m^3/s) such that there was no opportunity for fish to move upstream to the lake; c) discharge available from June 13 to July 16.

The baseline characterization of the Arctic Char migration at Bernard Harbour is expected to reliably inform future monitoring methods and the evaluation of the implementation of the Bernard Harbour offsetting measure. The baseline characterization of Arctic Char in the Hingittok Lake-Nulahugyuk Creek system is also supported by previously completed field programs (e.g., Golder 2013a), and a TK study (see Appendix B or FEIS Volume 3, Appendix V3-3D). There are multiple years of data on the migration success rate of adult Arctic Char (2012, 2014, and 2016), which will be used as a measurement indicator for the post-remediation evaluation of the success of the Bernard Harbour offsetting measure. Furthermore, the 2014 dataset provides a suitable benchmark for the Arctic Char run during the upstream migration period because of average spring flow conditions during that year.

7.3 HABITAT ENHANCEMENTS

7.3.1 Low-Flow Channel Method

Existing habitat and fish passage conditions in Nulahugyuk Creek are poor; a combination of boulder fields and dispersed flows are preventing many char from accessing spawning locations in Hingittok Lake, which is consistent with local knowledge (Golder and ANL 2007; Appendix B) and previously collected fisheries data at Bernard Harbour (e.g., Golder 2013a). The goal of the habitat enhancements (i.e., habitat remediation) is to improve passage for upstream migrations in Nulahugyuk Creek by removing boulder barriers in the creek and by increasing water depths within specified paths or movement corridors within the channel. The approach is based on 'soft' engineering methods (without the use of heavy machinery). Upon remediation of fish passage conditions, benefits to the local fishery are predicted through increased migration success, increased adult survival, and ultimately, through increased recruitment in Hingittok Lake.

The remediation methods follow those successfully developed by the Kugluktuk HTO and Golder in July 2012 (Golder 2013a; see Plate 7.3-1). The methods 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 constructed by the manipulation of substrates to direct the flow through an unobstructed flow path within the larger channel. Small to large boulders within the larger channel are relocated to form the low-flow channel within the area of the assumed thalweg (i.e., deepest path within the creek) of the problem section of the creek. Where needed, weirs above the low-flow channel are constructed to direct and concentrate flows through the low-flow channel. Weirs below the low-flow channel are also created to direct Arctic Char migrating upstream, such that fish avoid adjacent shallow boulder gardens where stranding may occur (Plate 7.3-2). The method can increase water depths by up to 100% (or up to 10 cm) relative to the natural dispersed flow conditions during the latter part of the upstream migration period when water levels are in decline (Golder 2013a).

As demonstrated in 2012, a problem location on the creek can be remediated by a field crew of approximately five people and one supervisor. Most of the field personnel for the remediation of Nulahugyuk Creek were resourced through the Kugluktuk HTO, who will be a partner in future monitoring and maintenance of the low-flow channels. 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 monitoring opportunities through the life of the offsetting measure. The integration of local and traditional knowledge will continue during subsequent field programs, workshops, and meetings.

Plate 7.3-1. A Low-Flow Channel Previously Created in 2012 ('Project 2'), Looking Upstream, July 18, 2014

Plate 7.3-2. Directional Weir (Kugluktuk HTO Students in Background) for Migrating Arctic Char in Nulahugyuk Creek, June 24, 2015

Ongoing monitoring of the five low-flow channels (i.e., pilot projects) created in 2012 has been performed in 2014 (Golder 2015a), 2015 (Golder 2015b), 2016 (Golder 2017a), and 2018 (Golder 2019) (see Appendix D and E). Results from all monitoring years indicate that the low-flow channels constructed in 2012 have remained structurally intact since their construction, providing char with suitable depths and unobstructed paths for upstream migration. The required maintenance typically has included minor repairs to the directional weirs installed below a low-flow channel, requiring one field technician with less than one hour of effort to repair a weir.

In early July 2016 prior to creek remediation, the entirety of Nulahugyuk Creek was evaluated for problem locations where Arctic Char movement may be impeded by lack of depth and boulder barriers (Golder 2017a; Appendix D). Problem locations identified in 2014 (Golder 2015a) and 2015 (Golder 2015b) were also re-evaluated for current conditions. Thirteen problem locations were confirmed (Table 7.3-1) and are described in detail in Golder (2017a) in Appendix D. These locations are where low-flow channel projects may benefit Arctic Char production. Three problem locations were identified as Rank 3, the highest priority for site remediation, followed by five Rank 2 locations, and five Rank 1 locations. Based on information collected during these surveys, a detailed plan for constructing the low-flow channels and directional weirs at each site was developed (Golder 2017a in Appendix D).

The remediation sites are located 1.4 to 7.9 km upstream of the mouth of Nulahugyuk Creek (identified in Figure 7.1-2; also see Table 7.3-1). Ten sites are located within the lower 3.1 km of the creek, with only three sites occurring further upstream. Approximately 17 low-flow channels and 11 directional weirs were proposed for all 13 remediation sites, resulting in a total of 597 m of manipulated creek bed. For all low-flow channels, remediation efforts are expected to increase flows at the assumed thalweg location. For additional details, please see Appendix E (Golder 2016, Golder 2017b).

Table 7.3-1. Summary of Potential Locations Selected for Fish Passage Remediation

Site Identification	Approximate Distance Upstream from Creek Outlet (km)	Expected Risk of Mortality and/or Blockage Rank (Higher Ranking = Higher Risk)	Minimum Required Low-Flow Channel Length to Improve Passage (m)
Site 1	1.40	Rank 3	41
Site 2	1.63	Rank 2	42
Site 3	1.69	Rank 2	34
Site 4	2.03	Rank 2	30
Site 5	2.15	Rank 3	22
Site 6	2.50	Rank 3	45
Site 7	3.05	Rank 2	14
Site 8	4.87	Rank 1	20
Site 9	5.76	Rank 1	40
Site 10	7.89	Rank 1	15
Site 11	2.22	Rank 1	38
Site 12	2.40	Rank 1	19
Site 13	3.10	Rank 1	15

Note: Extended rock weirs are recommended for most sites, for example, to direct char migrating upstream through the low-flow channels.

7.3.2 Productivity Predictions

To estimate the potential increases in fisheries productivity following the remediation of Nulahugyuk Creek, fish production was used as a surrogate of fisheries productivity. Fish production is one the best indicators of the quantitative performance of a fish population in any type of habitat, and it is a measure of productive capacity (Randall and Minns 2000). To model increases in production, key components of that model considered predictions for migration success and related changes to the number of adult Arctic Char in Nulahugyuk Creek and Hingittok Lake, and considered the assumption that low-flow channels will be passable during the upstream migration period (see Golder 2013a).

7.3.2.1 Migration Success

Predicting changes in migration success with the implementation of the remediation plan considered the relationship between discharge and water levels as measured at the staff gauge in 2014, and the relationship between migration success and discharge described in Section 7.2.2. 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 2013a), and the relationship between stream discharge and stream depth at the staff gauge, 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 pre-manipulation water levels at the staff gauge of at least 10 cm (from 58.1 cm to a minimum of 68.1 cm), where the water level of 68.1 cm at the staff gauge is equivalent to a stream discharge of 2.3 m^3/s, based on the relationship between the water level gauge and creek discharge.

With an understanding of how changes in water depths at the low-flow channel locations relate to flows in the creek, changes in the probability of migration success were estimated using the logistic equation provided in Section 7.2.2.2. 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 discharge is 2.3 m^3/s, the probability of migration success prior to remediation is maximized (0.85), assuming fish weight is held constant at 4.2 kg.

The logistic equation also shows that Arctic Char reach the greatest probability of migration success when discharge is 1.6 m^3/s or greater. The 1.6 m^3/s threshold equates to a staff gauge level of 64.5 cm, 6.4 cm greater than the depth at the problem locations pre-enhancement. This would also suggest an 'optimal' channel depth of greater than 19 cm to maximize the migration success for an Arctic Char of average size. Given that the 2012 channels increased depths by 7.7 cm, the equation also 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 (2013a). Field crews observed successful upstream movements of adult char shortly after the completion of the low-flow channels in 2012 (within 1 hour of completion), suggesting lack of depth and unobstructed movement paths were a limiting factor to upstream movements.

7.3.2.2 Fish Abundance

The size of the Arctic Char run in Nulahugyuk Creek and the spawning Arctic Char population in Hingittok Lake in response to remediation was predicted using inputs from the migration success models, baseline inputs derived from catch data (primarily 2014 data), and the methods described below. These calculations were intended to not only support estimates of fish production but also to provide an understanding of how the abundance of the Arctic Char stock may change over time.

As described in the preceding section, a migration success model and hydrometric model were developed and applied to predict changes in success rates for the upstream migration following remediation. A key assumption was that an increase in water depths of at least 6.4 cm post-remediation results in migration success rates improving from 34.9 to 85.0%. The next step, prior to predicting changes in spawning populations, included the selection of a baseline run size. A relatively small baseline run size compared to sizes recorded across monitoring years was selected as a conservative input to the biomass model. The selected parameter input was 332 adults, which was based on captures for the upstream migration in 2014. This run size is smaller than the number of adults captured during the downstream migration in 2014 (478 adults), and number of adults captured during the upstream migration in 2012 (424 adults; Golder 2013a).

To calculate the number of Arctic Char that successfully migrate to Hingittok Lake during a typical baseline (pre-remediation) year, the overall upstream migration success rate calculated for the baseline year (i.e., 34.9% during the 2014 baseline study) was multiplied by the baseline run size (332 adults), which equates to 116 adult fish. The number of adult Arctic Char that successfully migrate to Hingittok Lake post-remediation was also calculated, by multiplying the overall upstream migration success rate predicted for the post-remediation year (i.e., 85%) by the baseline run size (332 adult fish), which equates to 282 adult fish, which is an increase of 166 adults from baseline. For post-remediation Year 1 and 2, it was assumed that 282 adult Arctic Char arrive at Hingittok Lake each year to spawn.

To predict beyond post-remediation Years 1 and 2, the expected run size and spawning population size during post-remediation years 3 to 8 were also estimated (Figure 7.3-1). Assuming that the return rate of spawners is 50% (which includes a ‘marine’ survival rate component; Klemetsen et al. 2003), and that fish spawn every second year (Babaluk et al. 1998), run size was calculated to increase from 332 to 415 adults for post-remediation Year 3. Similar incremental increases in run size were projected through post-remediation Years 4 to 8, where the predicted run size by Year 8 equals 466 adult char. This also means that the annual spawning population of Arctic Char in Hingittok Lake is predicted to increase over the same period from 282 adults for Year 1 to 396 adults by Year 8 (i.e., an increase of 280 adults relative to baseline).

Beyond offsetting Year 8, the expectation is that the Arctic Char run will respond with a marked increase in the number of char entering Nulahugyuk Creek. This increase will reflect the returning offspring from adults added to Hingittok Lake following remediation of the creek, for example, arrivals in offsetting years 9 and 10 will include the sexually mature adults that are the recruits of the 166 adult fish that successfully migrated to Hingittok Lake to spawn during offsetting Years 1 and 2. A hypothetical scenario beyond post-remediation Year 8 is presented in Figure 7.3-1, where two offspring recruits per added spawner return to Bernard Harbour at offsetting Years 9 and 10 (i.e., the run size increases to 804 adult char). This outcome assumes that the population is near, or at maximum production because of lake conditions and low initial cohort size favourable for high juvenile survival. Larger ratios of maximum recruits per spawner are possible, as reported for Pacific salmon populations (Naish et al. 2008). The models also assume that Arctic Char reach sexual maturity 8 years post-hatch.

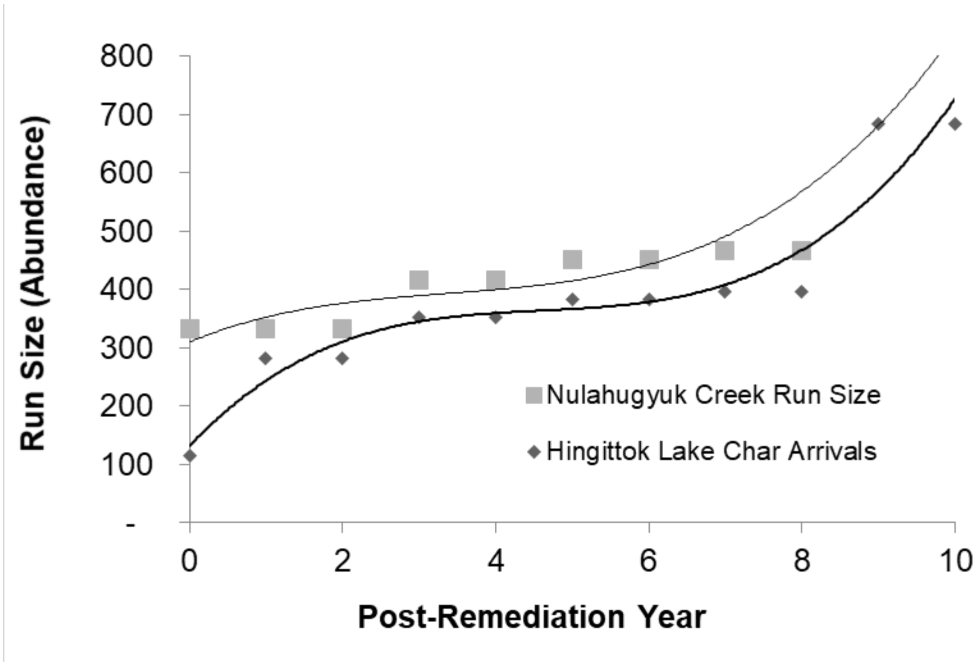

Figure 7.3-1. Post-Remediation (Offsetting) Predictions for Fish Abundance in Nulahugyuk Creek and Hingittok Lake, Bernard Harbour, Nunavut

Modest increases in the population over the duration of the offsetting option are ecologically realistic and within the capacity of Hingittok Lake to support an increase in fish density. There is evidence to conclude that Hingittok Lake is currently well below carrying capacity: Bernard Harbour Arctic Char are presently captured as part of an active fishery in the lower Coppermine River based on an on-going tagging study by the HTO, the local Arctic Char fishery at Bernard Harbour has been in decline for the past 40 years based on TK, and stream migration conditions in Nulahugyuk Creek have also deteriorated over approximately the same period, which have been identified as the underlying cause of the decline by both TK (see Appendix B), and baseline studies performed by Sabina, Golder, and the Kugluktuk HTO (e.g., Golder 2013a). Any uncertainty related to the carrying capacity of Hingittok Lake is related to whether the spawning population in Hingittok Lake can increase 7-fold or higher (beyond offsetting Year 8 post-remediation) and is not related to whether the Bernard Harbour offsetting measure will achieve equivalency (see Offsetting Accounting in Section 7.4.3).

7.3.2.3 Fish Production

For Bernard Harbour, the calculation of annual increases in production was based, in part, on the post-remediation increase in (standing stock) biomass of Arctic Char in Hingittok Lake. This was calculated as a minimum of 697.2 kg/yr as determined by the predicted increase in the size of the spawning population arriving to Hingittok Lake (166 adults) during Year 1 and 2 multiplied by the mean weight of adults migrating in Nulahugyuk Creek (4.2 kg). The actual increases in fish abundance and biomass post-remediation will be greater if the average size of the Arctic Char run at Bernard Harbour is greater than 332 adults, which it should be following Year 3 in Figure 7.3-1.

The Bernard Harbour production predictions were also conservative by relying on the 2014 upstream migration abundance data, versus the downstream migration abundance data, as an approach to reduce uncertainty in predictions. The 2014 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). Similarly, the baseline input for the starting run size was based on the primary migration period during late spring/early summer. If including small numbers of adult fish that attempt to migrate upstream later in the summer (i.e., consideration of higher use of Nulahugyuk Creek as a migration corridor), the result would be higher fish production estimates than those predicted in the Bernard Harbour production model.

7.4 OFFSETTING ACCOUNTING

Calculated losses and gains across time were compared to demonstrate that the gains from the offsetting measure counterbalance or compensate for the losses of the Back River Project, in other words, meet the condition of equivalency as per DFO's policy. To address any uncertainty in the Back River Project offsetting plan, equivalency was defined by a gain to loss ratio of 2:1. To provide a transferable unit for the comparison of losses at the Goose Property Area versus gains at Bernard Harbour, fish production was used as a surrogate measure of fisheries productivity (Randall et al. 2013). Production (P) at the level of a fish population was defined as the population (standing stock) biomass (B) multiplied by the rate that the population grows over a year; where the ratio of mean annual production to mean annual biomass (P:B) was considered a measure of the turnover rate of a population and linked to production and productivity for fish (Dolbeth et al. 2012). This approach to offsetting accounting was developed through engagement with DFO.

7.4.1 Residual Serious Harm to Fish

Residual serious harm to fish (i.e., losses) will be incurred with the dewatering 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 dewatering of Llama and Umwelt lakes will result in an estimated biomass loss of 467.5 kg in total for the Llama-Umwelt lake system (Section 6.1). With construction of the airstrip extension and TSF service roads and dam, and subsequent reduction in downstream flows, the calculated biomass loss for Rascal Stream East, Goose Inflow South/East and other waterbodies in the Goose and Wolf watersheds will be 133.0 kg of fish biomass (Section 6.2). Thus, the total loss of biomass (standing stock) at the Goose Property Area during construction is predicted to be 600.5 kg. These losses in biomass will be verified using data from the fish-outs.

Annual production losses associated with the removal of habitats from contributing to the ongoing productivity of the fishery were also considered (e.g., Randall and Minns 2000). Annual production was estimated to be 21% of total biomass for affected habitats (based on the P:B ratio calculated in De Beers [2015]), which will be verified using data from the fish-out of Llama and Umwelt lakes. This was projected as additional losses that accumulate across time as a conservative approach to the offsetting accounting. 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 annual loss of 126.1 kg of biomass that would have otherwise been available for harvest without the Project development. Over a ten-year period, total cumulative losses include the initial 600.5 kg of biomass due to construction of infrastructure and removal of fish during the fish-outs plus the hypothetical annual loss of production of 126.1 kg in the nine years that follow (which is a total production loss of 1,135 kg), which all together is equivalent to 1,735 kg of biomass loss (Figure 7.4-1). Therefore, the target production level to offset the residual serious harm to fish is approximately 3,470 kg of biomass gain.

Substantial gains in fish biomass are predicted at Bernard Harbour upon remediation of the creek, which will counterbalance losses incurred at the Goose Property Area (Figure 7.4-1). Total annual gains in fish production were conservatively calculated as the sum of the post-remediation increase in (standing stock) biomass at Hingittok Lake (697.2 kg) and related production of biomass (108.9 kg); where biomass production was based on a P:B ratio of 0.156, derived from the allometric relationship described in

Randall and Minns (2000) and the weight of maturity for the Bernard Harbour Arctic Char (3.2 kg). Therefore, total annual gains in biomass are calculated to be 607.2 kg for Year 1, and 806.0 kg/yr for Years 2 to 10, and over a ten-year period equates to 7,951 kg (Figure 7.4-1). This biomass gain is 4.6-times greater than the predicted loss over the same period, and 2.3-times greater the equivalency target.

If only considering the direct biomass gain from predicted increases in migration success to Hingittok Lake from 35% to 85% (i.e., not accounting for any gains of juvenile production or returning offspring from the adults 'added' to Hingittok Lake), the trajectory of cumulative gains in biomass by Year 1 post-remediation (697.2 kg) will exceed that of losses related to the fish-outs (600.5 kg), by Year 3 will exceed losses calculated for a ten-year period of operation for the Project, and by Year 5 will exceed the equivalency target. Of note, calculated biomass gains in the Bernard Harbour model assume a consistent run size of 332 adults, and that the low-flow channels will add a minimum of 166 adults to the spawning lake each year, where each fish weighs, on average, 4.2 kg.

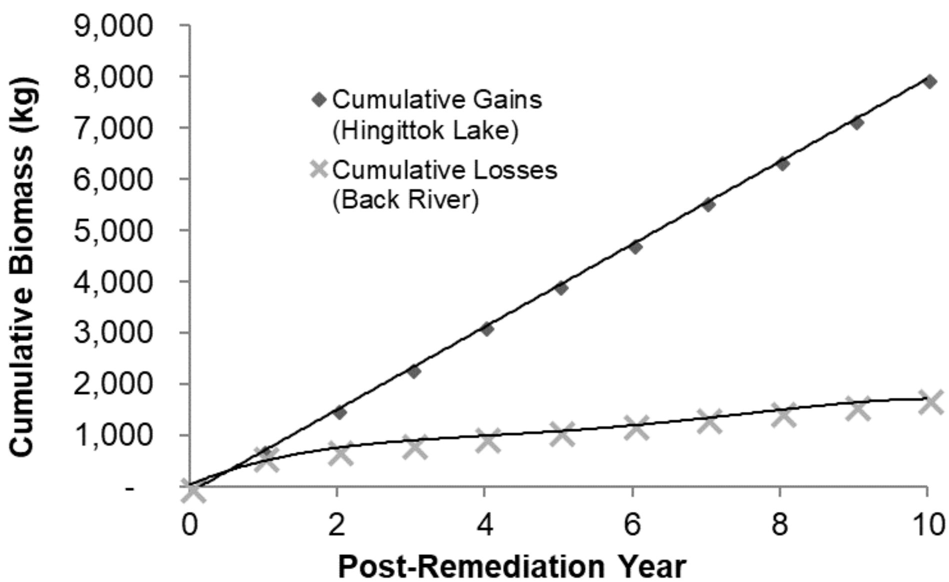

Figure 7.4-1. A Comparison of Calculations of Cumulative Gains in Fish Production Versus Cumulative Losses Over Time

7.4.2 MDMER Schedule 2 Habitat

The operation of the TSF will result in the loss or alteration of fish-bearing or potentially fish-bearing habitat to allow for the deposit of deleterious substances into waterbodies, thus requiring listing on Schedule 2 of the MDMER. The total loss of fish biomass (standing stock) related to the TSF footprint was predicted to be 10.6 kg.

Annual production losses associated with the removal of habitats were also considered in offsetting accounting (e.g., Randall and Minns 2000). Annual production was estimated to be 21% of total biomass for affected habitats (based on the P:B ratio calculated in De Beers [2015]). This was projected as additional losses that accumulate across time as a conservative approach to the offsetting accounting, specifically, annual production losses were estimated as 2.2 kg of biomass per year.

Over a ten-year period, total cumulative losses include the initial 10.6 kg of biomass due to construction of infrastructure plus the hypothetical annual loss of production of 2.2 kg in the nine years that follow (which is a production loss of 19.8 kg for all nine years), which all together is equivalent to 30.4 kg of lost biomass. Therefore, the target production level to offset the Schedule 2 habitat is 60.8 kg. This biomass loss from the operation of the TSF represents a small proportion (only 1.7%) of total losses at the Back River Project (i.e., most of the combined losses of residual serious harm and Schedule 2 habitat are from Project components other than the TSF).

The estimated biomass loss from the operation of the TSF is also small relative to estimated gains from the Bernard Harbour offsetting measure. Over a ten-year period, the offsetting measure may generate a cumulative gain of 7,951 kg of Arctic Char. The offsetting measure will meet the equivalency objective for both residual serious harm to fish and MDMER Schedule 2 habitat.

7.4.3 Summary

Substantial gains in fish biomass are predicted with the implementation of the Bernard Harbour offsetting measure, which will counterbalance losses incurred at the Goose Property Area (Figure 7.4-1). Over a ten-year period, the offsetting option may generate a total cumulative gain of 7,951 kg of Arctic Char biomass, almost 5-times the predicted biomass loss incurred under both Section 35 of the *Fisheries Act* and Section 27.1 of the MDMER over the same period (Table 7.4-1). Predicted annual gains may magnify by post-remediation years 9 and 10, and continue until char abundance (e.g., juvenile densities) approach the carrying capacity of Hingittok Lake.

Note that if only considering the direct biomass gains from predicted increases in migration success to Hingittok Lake from 35% to 85% (i.e., not accounting for any gains of juvenile production or returning offspring from the adults ‘added’ to Hingittok Lake), the trajectory of cumulative gains in biomass by Year 1 post-remediation (697.2 kg) will exceed that of losses related to the fish-outs (600.5 kg), by Year 3 will exceed that of losses calculated for a ten-year period of operation for the Project, and by Year 5 will exceed the equivalency target.

The projected increases in biomass of ‘added’ Arctic Char through the implementation of low-flow channels in Nulahugyuk Creek will offset losses to be incurred at the Back River Project. The trajectory of annual biomass gains achieved through the offsetting is much greater than the annual production losses and the cumulative gains over time is sufficient to fully counterbalance the losses from the Project, including losses from the construction and operation of the TSF. The magnitude of the difference in predicted gains versus losses is substantial providing confidence that equivalency can be achieved and any remaining uncertainty in the predictions will be addressed through monitoring into the future.

Table 7.4-1. Estimated Offsetting Currency Balance by Year 10

Accounting Components	Fish Production (Biomass)
Bernard Harbour Gain	7,950.9 kg
Residual Serious Harm	- 1,735.4 kg
MDMER Schedule 2 Habitat	- 30.4 kg
Balance	6,185.4 kg
Uncertainty[1]	-1,765.8 kg
Revised Balance	**4,419.6 kg**

Based on the equivalency target of two-times the projected losses; note that the 10% discount from complementary measures was not applied to losses in the table.

8. Monitoring

8.1 OVERVIEW

The purpose of the proposed monitoring plan is to provide DFO a framework for a comprehensive monitoring program for the Bernard Harbour offsetting measure. Planned monitoring described further below is in addition to the commitments in the draft Aquatic Effects Monitoring Program Design Plan for the Back River Project – Construction Phase. The draft Aquatic Effects Monitoring Program Design Plan was submitted with the Type A Water Licence application to NWB and describes monitoring in the aquatic receiving environment planned during the construction period of the Project (Sabina 2017b).

The scope of the proposed offsetting program at Bernard Harbour will occur over a ten-year period following the implementation of the habitat remediation plan on Nulahugyuk Creek (Table 8.1-1). 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 support model assumptions and demonstrate that fish production follows a projected trajectory of cumulative gains that will eventually exceed cumulative losses (Section 7.4).

Annual monitoring and reports over a ten-year period will allow for the following (DFO 2013a):

- Biological or physical changes to be reflected in the data collected
- Possible adjustments to the monitoring to better estimate changes in fishery productivity
- The restored habitat to reach full ecological functionality

The plan includes annual field monitoring and maintenance, working with community members. Biological monitoring and reporting to DFO is scheduled for offsetting Years 0, 3, 6, and 10 of the monitoring period. The monitoring plan and schedule will also consider on-going feedback from DFO, and other interested parties (e.g., KIA) to meet the requirements of the Fisheries Protection Policy Statement (DFO 2013b).

Table 8.1-1. Overview of Activities in Support of the Fish Offsetting Plan for the Project (2014 to 2026)

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
Remedial Works and Early Inspections	Summer 2016 (Year 0)	DFO/community engagement
		Monitor adult and juvenile migrations, and assess passage conditions
		Construct habitat offsetting enhancements in Bernard Harbour
		Baseline Monitoring and Construction Reports
	Summer 2017 (Year 1)	Sabina/Kugluktuk HTO inspection years; inspect each year and repair channels (as needed) Annual Inspection Report
	Summer 2018 (Year 2)	Sabina/Kugluktuk HTO inspection years; inspect each year and repair channels (as needed)
		Annual Inspection Report

(continued)

Table 8.1-1. Overview of Activities in Support of the Fish Offsetting Plan for the Project (2014 to 2025) (completed)

Phase	Offsetting Year	Annual Activities / Deliverables
Application Submission	2019	Submit *Fisheries Act* Authorization Application and Final Offsetting Plan
Post-Remediation Monitoring	2019 (Year 3)	Monitor adult and juvenile migrations, and assess passage conditions Annual Monitoring Report
	2022 (Year 6)	Monitor adult and juvenile migrations, and assess passage conditions Annual Monitoring Report
	2026 (Year 10)	Monitor adult and juvenile migrations, and assess passage conditions Annual Monitoring Report

DFO = Fisheries and Oceans Canada; HTO = Hunters and Trappers Organization

The proposed methodology and criteria for monitoring the Bernard Harbour offsetting measure will consider TK and will be selected to best evaluate the success of the offsetting measure, specifically to confirm that the offsetting measure has been effective in counterbalancing the residual serious harm to fish (DFO 2013a,b). Monitoring of the Bernard Harbour offsetting measure will also include two types of monitoring: functional monitoring (e.g., physical conditions of low-flow channels), and effectiveness monitoring (e.g., migration success rate) (Smokorowski et al. 2015). A multi-year monitoring effort will be implemented (see Table 8.1-1) with considerations of lessons learned during previous monitoring years. During any given year, monitoring will be adapted to reflect the seasonal timing of migration (e.g., related to trends in seasonal flows), and inter-year variability in the Arctic Char migration. For example, an unusually wet (i.e., high flow) or late spring may warrant a monitoring period that extends into late July or August.

Monitoring metrics or indicators will be selected to demonstrate that the offsetting objectives have been achieved, where a goal of monitoring will be to demonstrate that fish production follows a projected trajectory of cumulative gains that will eventually exceed cumulative losses. Data collection will be similar to methods outlined for the 2014 and 2016 baseline monitoring studies and will be consistent across years and phases of the offsetting plan, where possible, to allow for a reliable assessment of gains. Data collected from scheduled monitoring and inspection programs will be reviewed on an annual basis with DFO to confirm that the proposed length of time and level effort of monitoring adequately meets the objectives of the offsetting plan.

8.2 FUNCTIONAL MONITORING

Functional monitoring may include detailed habitat data, including data on the physical integrity of the remediated sections of the creek under spring and summer conditions (Table 8.2-1). Measurements will include depths, channels widths, composition of streambed substrate, and channel stability, and will be made at both remediated and non-remediated (reference) sections of the creek. With the assistance of the Kugluktuk HTO, inspections of the remediation sites (e.g., for signs of erosion or damage) will also be conducted and will address any minor maintenance problems, as needed. Maintenance may be expected for some of the directional weirs where boulders can be displaced during the spring freshet. Inspection 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 observational monitoring is carried out.

Table 8.2-1. Monitoring Design for Evaluation of Low-Flow Channel Functions

Objective: Confirm water depth and unobstructed flow path predictions for low-flow channels		
Study Design	Physical measurements of all remediation sites (13), and related low-flow channels and directional weirs	
Monitoring Frequency/Timing	Inspections to be completed during a site visit in Year 1 and 2, and will be timed to overlap with the later stages of the upstream migration (mid-July); inspections will also occur through the migration period when coinciding with fish monitoring during post-remediation Years 3, 6, and 10	
Field Measurements	Channel depth, velocity, and substrate composition to be collected at all remediation sites, including depths and velocities every 2 m along the assumed thalweg of the low-flow channel Substrate composition of the low-flow channel Photographs of each remediation site, including photographs from the downstream, centre, and upstream extent of a site, with upstream and downstream photograph orientations Creek discharge and water temperature (daily during the site visit)	
Supporting Data	Climate data summary from Environment and Climate Change Canada's Kugluktuk station	
Analyses	Quantitative summaries of depths, velocities, and substrate for all remediation sites (e.g., means and standard deviations)	
Action Threshold(s)	Low-flow channel depths within 25% of target channel depths, and channels provide an unobstructed flow path during migration	Low-flow channel depths more than 25% less target depths, or channels do not provide an unobstructed path for the migration
Management Actions(s)	Continue with regular scheduled monitoring and maintenance activities	Identify under-performing low-flow channels and plan further modifications to increase depths for fish passage in discussion with DFO
Reporting Frequency	Per inspection year	

8.3 EFFECTIVENESS MONITORING

In offsetting Years 3, 6, and 10, detailed habitat measurements will be collected concurrently with monitoring of the Arctic Char run (effectiveness monitoring), which would include a tagging program to monitor movements of char in Nulahugyuk Creek, and a two-way trap-net installed at the mouth of the creek to monitor the upstream and downstream migrations (Table 8.3-1). The primary focus of the effectiveness monitoring will be on upstream migration success of migrating adults to confirm the assumptions of the biomass model. Collection of data on run size for the migration types will also be incorporated into the monitoring plan; results will contribute to an understanding of self-sustaining properties of the offsetting measure, but not necessarily be linked to a quantitative target for determining effectiveness.

Following each year of monitoring, the success of both monitoring efforts and the offsetting measure will be evaluated and discussed in the monitoring report submitted to DFO. Collected data will be analyzed and applied to biomass models to confirm predictions. It may be determined that additional effort is required to describe fish use of Nulahugyuk Creek through the summer season in subsequent years (e.g., monitoring movements that may occur in August), which would only demonstrate additional gains for the offsetting measure. Also, at any point within the monitoring period should it be determined that the performance of the project is not meeting expectations (i.e., 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, to meet the expectations under DFO's Policy (DFO 2013a,b). If it is determined by Sabina, in consultation with the KIA and DFO, that the offsetting measure may not meet the offsetting objectives for the Back River

Project (i.e., equivalency can not be achieved), an alternate project will be explored and implemented, if necessary, to achieve the offsetting commitments for fisheries losses at the Project (see Section 10).

Table 8.3-1. Monitoring Design for Evaluation of Offsetting Effectiveness

<table>
<tr><td colspan="3">Objective: Confirm predictions of migration success and biomass modelling</td></tr>
<tr><td colspan="3">Stage 1</td></tr>
<tr><td>Study Design</td><td colspan="2">Monitor the run size and success rate of the upstream migration of Arctic Char using a two-way fyke-net trap and PIT tag antennae arrays on the creek</td></tr>
<tr><td>Monitoring Frequency/Timing</td><td colspan="2">In Years 3, 6, and 10, operate two-way fyke-net trap and PIT antennae arrays on Nulahugyuk Creek for the duration of the upstream migration period (approximately mid-June to late July)</td></tr>
<tr><td>Field Measurements</td><td colspan="2">Daily discharge
Geo-referenced locations of installed fyke-net trap and antennae arrays
Length and weight of captured fish, including tagged fish
Enumeration of migrating fish (e.g., upstream and downstream migrations)
PIT-tag location data at antennae array loggers</td></tr>
<tr><td>Supporting Data</td><td colspan="2">Water temperature data logged at multiple locations on the creek
Climate data from Environment and Climate Change Canada's Kugluktuk station
Incidental observations of fish mortalities on creek</td></tr>
<tr><td>Analyses</td><td colspan="2">Estimation of migration success per stream segment and overall (estimate mean ± variance)
Modelling of migration success related to flow conditions
Estimation of fish speeds per stream segment and overall (estimate mean ± variance)
Updates of projected biomass gains using monitoring results</td></tr>
<tr><td>Action Threshold(s)</td><td>Calculated migration success rate has increased to 85%</td><td>Migration success rate is less than 85%</td></tr>
<tr><td>Management Actions(s)</td><td>Continue with regular, scheduled monitoring</td><td>Identify under-performing low-flow channels and plan further modifications to increase depths for fish passage, as needed
Engage with DFO
Move to Stage 2 Monitoring</td></tr>
<tr><td>Reporting Frequency</td><td colspan="2">Annually</td></tr>
<tr><td>Reporting</td><td colspan="2">Annual reports will follow a template designed through engagement with DFO. Reports may include the following:
Quantitative target (i.e., migration rate) for establishing effectiveness (this may be the same for all annual monitoring reports)
Detailed field methods, sampling intensity, and duration
Maps depicting the locations of each PIT tag antennae arrays
Table(s) summarizing recorded depths, velocities, and substrate of low-flow channels
Geo-referenced photos
Table(s) summarizing statistical tests
Table(s) comparing overall monitoring results to modelled predictions
Figure and equation showing the relationship between migration success and discharge
Figures showing discharge and temperature for the monitoring period
Calculation of (realized) offset gains
Comments on statistical power
Comments on the effectiveness of the habitat offset
Recommendations and notes for the next field season</td></tr>
</table>

(continued)

Table 8.3-1. Monitoring Design for Evaluation of Offsetting Effectiveness (completed)

Objective: Confirm predictions of migration success and biomass modelling		
Stage 2		
Study Design	Expected to be the same as Stage 1 with the exception that the study design may be expanded to include monitoring into late summer and the use of an alternative tagging method to monitor movements and survival	
Monitoring Frequency / Timing	Although timing expected to be the same as Stage 1, the duration of monitoring within a given year and the frequency of monitoring would be reconsidered following discussions with DFO	
Field Measurements / Observations	Same as Stage 1	
Supporting Data	Refer to the Supporting Data requirements for Stage 1; the collection of supplementary movement data will be discussed with DFO and considered for the next field season, as needed	
Analyses	Refer to the Analyses requirements for Stage 1; confounding influences of water temperature will be explored, and additional analyses for any new supporting data will be performed, as needed	
Action Threshold(s)	Migration success rate is lower than expectations (e.g., less than 85%), but biomass gains to offset losses can still be achieved	Migration success rate lower than expectations, resulting in reduced biomass gains that may not offset losses
Management Actions(s)	Continue with regular scheduled monitoring and reporting, and review and update biomass calculations as needed	Engage with DFO to determine requirements for implementing contingency measures and additional updates to the biomass calculations
Reporting Frequency	Annually	
Reporting	Refer to the Reporting Requirements for Stage 1	
	Review and update modelling, as required	Updates to the calculations of gains Recalculate predictions of biomass gains and discuss with DFO if additional contingency measures are required

8.4 COSTS

As the Bernard Harbour offsetting measure was implemented in 2016 and monitoring of the offsetting measure is currently underway for offsetting Year 3, reported cost in the offsetting plan cover remaining years in the plan, specifically the completion of post-remediation monitoring and maintenance of the remediation works by Sabina and the Kugluktuk HTO at Bernard Harbour. Costs include two years of low-channel inspections and migration monitoring during Year 6 (2022) and Year 10 (2026), where annual costs are $193,729 for Year 6 and $209,698 for Year 10 (Table 8.4-1).

Additional details have been provided in a separate Letter of Credit for DFO as per the template provided in Annex B of *An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act* (DFO 2013). The Letter of Credit includes costs to monitor the Bernard Harbour offsetting measure. This Letter of Credit is assumed to be subject to approval by DFO alone, and to be satisfactory in meeting the requirements of both a Section 35 *Fisheries Act* Authorization application and a Schedule 2 Amendment application under MDMER of the *Fisheries Act*.

Table 8.4-1. Cost Estimate for Future Monitoring at Bernard Harbour

Offsetting Year	Planning / Mobilization Costs ($)	Equipment Costs ($) [a]	Transportation ($)	Technical Labour ($)	Local Labour ($) [b]	Reporting ($)	Total ($)	Total with 2% inflation [c]
Year 6 (Migration monitoring, summary report)	8,500	18,500	49,000	63,880	19,500	23,175	182,555	193,729
Year 10 (Migration monitoring, summary report)	8,500	18,500	49,000	63,880	19,500	23,175	182,555	209,698

Note: costs are based on actual costs for previous monitoring efforts; (a) estimate includes costs for ATV rentals, generator rentals, food, miscellaneous supplied, and fish tracking equipment; (b) includes costs for repairs and maintenance of low-flow channels; (c) calculated using the Consumer Price Index (CPI) from December 2018 for Yellowknife, NWT.

9. Complementary Measures

In remote areas where there are low levels of human development, 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 considers 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 CRA fisheries to be considered as a Complementary Measure. A suite of Complementary Measures for the Project will be considered as part of the offsetting accounting. As Complementary Measures, the research investments may contribute up to 10% of gains required to offset losses and reduce uncertainty associated with predicted gains from the offset option.

9.1 FISH-OUT LIFE HISTORY DATABASE

As described for the Conceptual Fish-Out Plan (Appendix C), 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 as a Complementary Measure for the Fish 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.

9.2 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 2.2, while a copy of the TK study report can be found in Appendix B.

Considering the remote, pristine area of Bernard Harbour 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.

9.3 ARCTIC CHAR MOVEMENT STUDY

Research on the migratory movements of Arctic Char was conducted in 2014 and 2016 in an effort to develop a better understanding of the ecology of Arctic Char at Bernard Harbour (i.e., the Hingittok Lake-Nulahugyuk Creek 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 previously completed Arctic Char movement studies and future studies through ongoing monitoring at Bernard Harbour will provide a complementary measure.

The research is addressing questions on how Arctic Char move within Nulahugyuk Creek, and on where Arctic Char from Bernard Harbour move within the broader region of the Coronation Gulf. The first question is addressed by quantifying upstream movements for the duration of the migration period for a subset of captured Arctic Char using implanted PIT tags and antennae-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 and 2016 can be found in Appendix D.

A Floy-tag program was also initiated in 2014 and included the use of external (Floy t-bar) 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 has collected and will continue to collect valuable information on 'large-scale' movements of Arctic Char in the Coronation Gulf, and possibly the location of overwintering sites. Data collection is ongoing.

Considering the remote, pristine area where Bernard Harbour is located 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 studies have provided 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 not only be useful for assessing the relative success of remediation activities undertaken at Bernard Harbour, but will also help address existing knowledge gaps related to the management and conservation of the Arctic Char fishery in the Coronation Gulf.

10. Contingencies

Sabina will evaluate the success of the offsetting measure after each year of monitoring to determine if the offsetting project is performing to expectations within the specific timeframe of the project. If it is determined by Sabina, in consultation with DFO, that the proposed offsetting project will not meet the offsetting objectives for the Project, an alternate offsetting option will be identified and implemented, with an associated monitoring plan, to achieve equivalency. Contingencies include those listed in the draft Conceptual Fish Offsetting Plan submitted with the Draft Environmental Impact Statement, for example, the Canyon Lake Berm Option and Bathurst Lake Arctic Char Passage Option. A brief description is provided below with additional details provided in Appendix F.

10.1 CANYON LAKE BERM OPTION

This proposed offsetting project involves the enhancement of deep-water overwintering habitat for Lake Trout and Arctic Grayling in a canyon lake system approximately 18 km northeast of the Goose Property area. Currently, a chain of four lakes (Canyon Lake 2, 3, 4 and 5) are proposed to be deepened by 3 m through the creation of a berm at the outlet of the lowermost lake (Canyon Lake 2). The channels within the canyon are confined within bedrock, requiring a berm dimension of approximately 3 m high, 50 m wide, with a 1:3 side slope. Additional spawning, rearing, and foraging habitat for Lake Trout and Arctic Grayling will be created along the up and downstream ends of the berm. This will be accomplished through the creation of a rocky shoal (50 m wide and 3 m deep) at the upstream and downstream ends of the berm. The total estimated habitat area gained will be approximately 9 ha, with an increase in deep-water overwintering habitat of 2.9 ha for Lake Trout and Arctic Grayling. In addition, this offsetting option will result in a 0.03 ha increase of Lake Trout spawning and rearing habitat through berm construction. The habitat improvements are expected to increase fish production through an increase in the carrying capacity of the lake to support overwintering fish and through an increase in the availability of spawning habitat for Lake Trout and Arctic Grayling.

10.2 BATHURST LAKE ARCTIC CHAR PASSAGE OPTION

This proposed offsetting project involves the creation of access to an 8,000 ha lake (Bathurst Lake) with spawning and overwintering habitat for anadromous Arctic Char from Bathurst Inlet, enhancing the productivity of the overall fishery in the Bathurst Inlet region. Bathurst Lake currently contains a freshwater resident population of Arctic Char, along with Lake Trout and Arctic Grayling.

Anadromous Arctic Char are an important fish species, both culturally and economically, for Inuit resource users in Nunavut. However, current conditions on the Bathurst Lake Outlet include a 4-m high water fall (UTM 13 W 0405475 m E 7349337 m N); where the outlet channel from Bathurst Lake to the Western River is approximately 8.5 km in length total, 2 km of which occurs above the falls and 6.5 km of which occurs below the falls. The water fall is an obvious barrier for upstream migration into the lake for all species, including anadromous Arctic Char.

Although modifications to the main falls on the Bathurst Lake Outlet could pose potential risks to freshwater resident Arctic Char populations in Bathurst Lake, freshwater resident and anadromous Arctic Char subpopulations may coexist with each other, as observed in some coastal Arctic lakes (Jonsson and Jonsson 1993; Swanson et al. 2010). Furthermore, opening up Bathurst Lake to migrating Arctic Char will initiate a stable, long-term yearly influx of marine nutrients from the Bathurst Inlet to Bathurst Lake, thereby increasing the productive capacity of the whole lake ecosystem and of the Arctic Char populations in particular.

11. References

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Appendix A: Bernard Harbour Restoration Project Agreement Between: The Kugluktuk Hunters and Trappers Organization and Sabina Gold & Silver Corp.

Appendix B. Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek – Hingittok Lake Area (Bernard Harbour), Nunavut

Appendix C. Conceptual Fish-Out Plan for the Back River Project

Appendix D. Bernard Harbour Baseline Studies for the Back River Project Offsetting Plan, 2014-2016

Appendix E. Bernard Harbour Remediation Activities for the Back River Project Offsetting Plan, 2016-2018

Appendix F. Draft Conceptual Fish Offsetting Plan (No Net Loss Plan)