21. Draft Conceptual Fish Offsetting Plan (No Net Loss Plan)

an ERM company

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
Draft Conceptual Fish Offsetting Plan (No Net Loss Plan)

Sabina
GOLD & SILVER CORP.

Rescan an ERM company

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BACK RIVER PROJECT
DRAFT CONCEPTUAL FISH OFFSETTING PLAN (NO NET LOSS PLAN)

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BACK RIVER PROJECT
DRAFT CONCEPTUAL FISH OFFSETTING PLAN (NO NET LOSS PLAN)

Table of Contents

List of Figures

List of Tables

TABLE **PAGE**

List of Plates

PLATE **PAGE**

List of Appendices

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.

CCME	Canadian Council of Ministers of the Environment
Chl *a*	Chlorophyll *a*
CPUE	Catch per unit effort
DFO	Fisheries and Oceans Canada
ha	Hectare(s)
HU	Habitat Unit(s)
KIA	Kitikmeot Inuit Association
LSA	Local Study Area
MLA	Marine Laydown Area
MMER	Metal Mining Effluent Regulations
NNL	No Net Loss
PAD	Permanent alteration to, or destruction of, fish habitat
Project, the	The Back River Project
RSA	Regional Study Area
TIA	Tailings Impoundment Area
TK	Traditional Knowledge

1. Introduction

1.1 OVERVIEW

The Back River Project (the Project) is a proposed gold mining and milling operation located in the West Kitikmeot region of Nunavut (Figure 1.1-1). The Project includes three areas connected by winter road access: Goose Property, George Property, and Marine Laydown Area (Figure 1.1-2). The operational mine plan for the Project includes a 10 year mine life with a total ore feed from both Properties of 20 - 28 million tonnes (Rescan 2012a). All ore will be processed at a single mill at the Goose Property. Currently open pit and underground mining methods are under consideration for mineral extraction at all deposits. The optimal mining methods will be determined as part of the ongoing pre-feasibility and future feasibility studies.

The Project infrastructure will include camps, a mineral processing plant, storage areas, maintenance and mechanical repair warehouses, fuel storage tanks, a Tailings Impoundment Area (TIA), waste rock storage areas, airstrips, winter and all-weather roads within each Property, winter roads connecting the Properties, and a marine landing at the Marine Laydown Area. Most of these facilities would be removed at the end of mine life. Roads, airstrips, tailings storage and waste rock storage areas cannot be removed and would be returned to an agreed-upon land use with regulators and the communities.

1.2 REGIONAL SETTING

The Project Area lies at approximately 65˚ to 66˚ north latitude, 106˚ to 107˚ west longitude near the northern reaches of the North American continent in the West Kitikmeot region. The region is subject to cold, dry Arctic air masses and continental air masses to the south. The area can be subject to high wind speeds due to the relative absence of obstructions that normally impede and slow wind. Total annual precipitation, which consists of snow and rain, can range from approximately 125 to 344 mm (Rescan 2012a).

The West Kitikmeot region is characterized by long dark cold winters and short bright summers. In most years, the ground is covered in snow from October to June. Lakes are typically ice-covered from approximately October to June, with ice thickness reaching depths of 2 m.

The Project is subdivided into three general areas: the Marine Laydown Area on southern Bathurst Inlet, George Property, and Goose Property (Figure 1.1-1). The northern portion of the proposed Project falls within the 'Bathurst Hills' ecoregion, which extends through Bathurst Inlet and along the coastline of Coronation Gulf (WKRLUP 2005). This ecoregion is characterized by higher elevations that are moderated by open water during the late summer and early fall.

Marine shoreline habitat is dominated by a shallow water shelf which extends at a slope of approximately 8% to a depth of approximately 10 m and a distance of 120 m offshore (Rescan 2012a). Beyond this distance, the shoreline drops off steeply at a gradient of 30% to depths greater than 40 m. The nearshore bottom substrate is often a mix of sand, soft marine silts, and clays, with the occasional presence of gravel and cobble rock along the shore and narrow intertidal band.

The Goose and George Properties lie within the 'Takijuq Lake Uplands' ecoregion, which covers the south central portion of the West Kitikmeot region (WKRLUP 2005). This ecoregion is made up of broad, sloping uplands, plateaus, and lowlands, along with the rugged ridges of the Bathurst Hills, and is dotted with thousands of lakes.

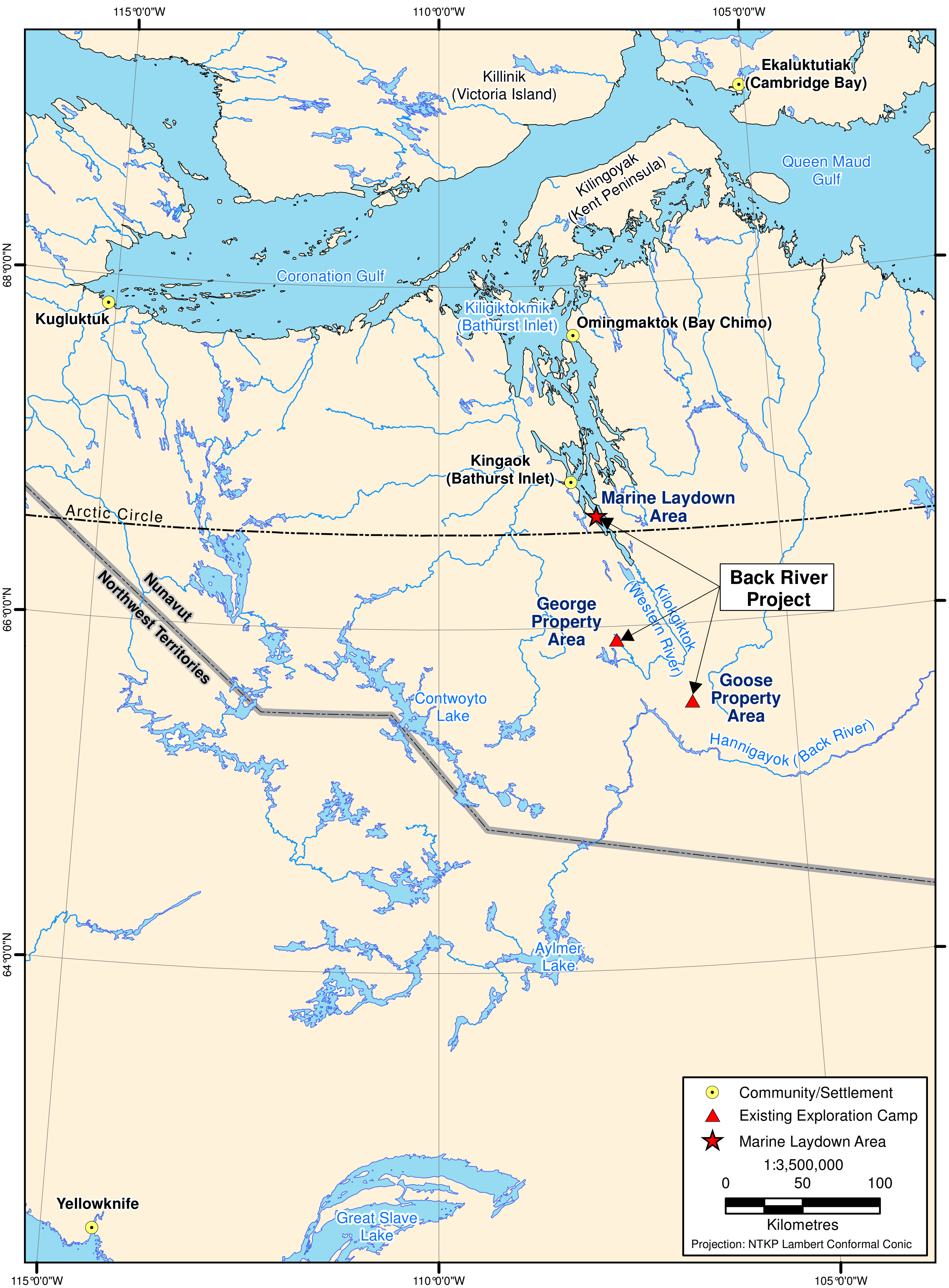

Figure 1.1-1

Project Location

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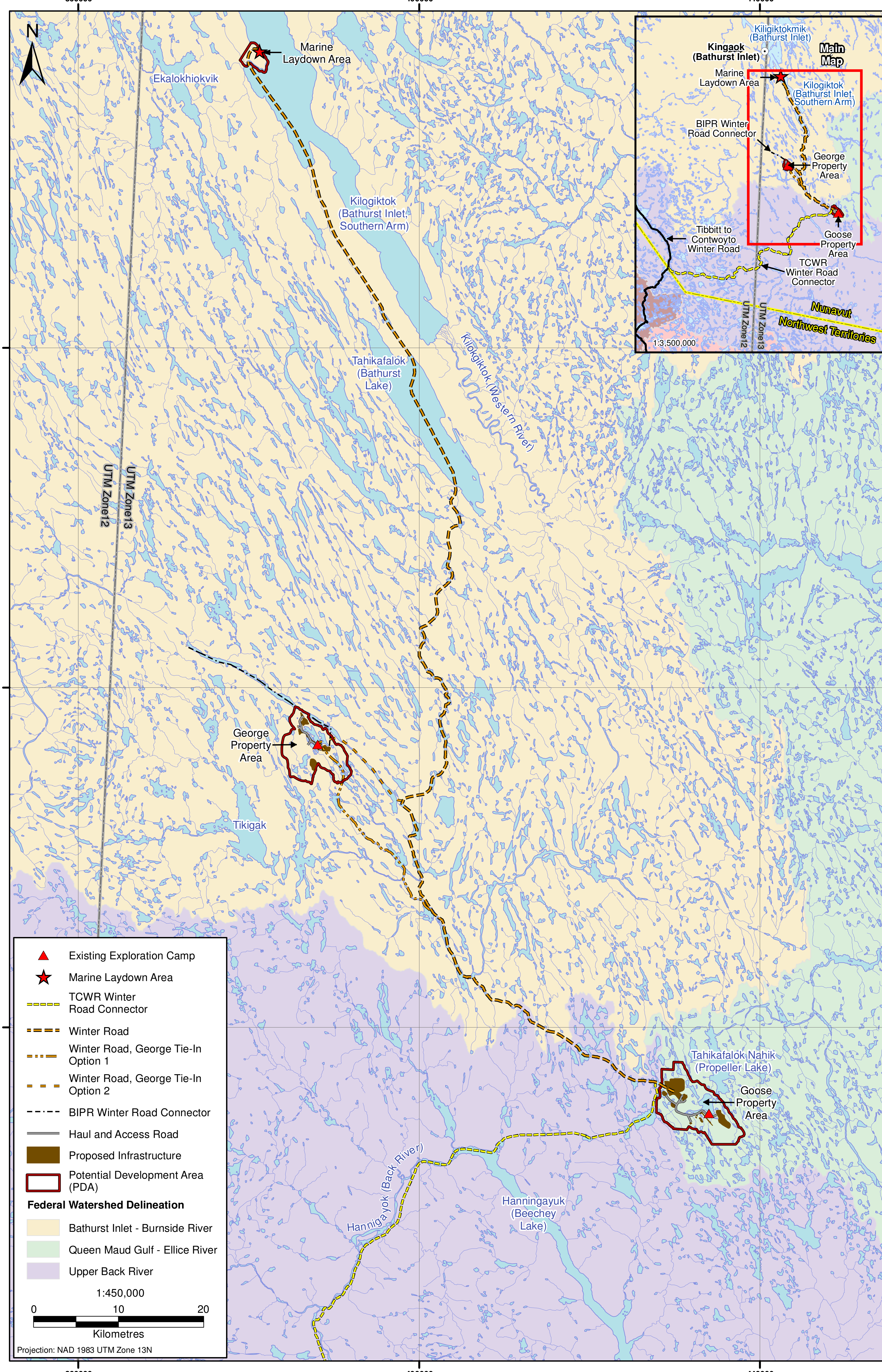

Figure 1.1-2

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Back River Project Layout

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Most of the lakes in the George and Goose Property areas feature shorelines dominated by mixed rock, with occasional outcrops of bedrock, or sometimes overlain with organic fine sediments (fines; Rescan 2010a, 2012b, 2012c). Larger waterbodies may contain deeper sections that remain unfrozen throughout the year, however, smaller lakes and ponds are generally shallow (less than 3 m deep) and likely freeze to the bottom in winter months.

Stream habitat in the George and Goose Property areas features some well-developed beaded tundra streams, which contain deep pools interspersed with runs and occasional riffles (Rescan 2010a, 2012b, 2012c). In addition, reaches featuring substantial cobble and boulder fields, shallow wetted depths, low flow, and riffle morphology are often present. Smaller streams may be ephemeral, running only during spring freshet periods (Rescan 2010a, 2012b, 2012c).

1.3 REGULATORY FRAMEWORK

1.3.1 Legislation

1.3.1.1 The Fisheries Act

Fish and fish habitat are protected under the *Fisheries Act* (1985), as well as other federal regulatory acts and principles. In 2012, the *Fisheries Act* was amended to establish into legislation the federal government's direction to focus efforts on protecting the productivity of commercial, recreational, and Aboriginal fisheries; to institute enhanced compliance and protection tools that are more easily enforceable; to provide clarity, certainty, and consistency of regulatory requirements; and to enable enhanced partnerships with stakeholders.

The changes to the *Fisheries Act* include a prohibition against causing serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery (Section 35), provisions for flow and passage (Sections 20 and 21), and a framework for regulatory decision-making (Sections 6 and 6.1).

The new Purpose section states that the fisheries protection provisions of the *Fisheries Act* aim to provide for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries.

The four factors in Section 6 and 6.1 to be taken into account by the Minister in decision-making (e.g. issuing authorizations) or making regulations are:

- The contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries.
- Fisheries management objectives.
- Whether there are measures and standards to avoid, mitigate, or offset serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery.
- The public interest.

For the purposes of the *Fisheries Act*, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat (PAD). The *Fisheries Act* defines fish habitat as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." The term "fish" includes parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.

On November 1, 2013, The Fisheries Protection Policy Statement (DFO 2013a) was issued and replaced the earlier Policy for the Management of Fish Habitat (DFO 1986). Although the new policy statement does not include the “no net loss” principle, as outlined in the earlier policy, application of this NNL principle provides some useful guidance when considering “serious harm to fish”. In addition, the direction found within the 2013 scientific guidance document (Koops et al. 2013; Randall et al. 2013) has been consulted and followed.

Any project or activity that causes a serious harm to fish that are part of, or support, a commercial, recreational, or Aboriginal fishery requires an authorization from DFO. Regulations have been developed to guide the application for this authorization: Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations. DFO has issued additional guidance in “The Fisheries Protection Program Operational Approach”.

1.3.1.2 Metal Mining Effluent Regulations

In 1996, Environment Canada undertook an assessment of the aquatic effects of mining in Canada. This assessment provided recommendations regarding the review and amendments of the Metal Mining Liquid Effluent Regulations, currently titled the Metal Mining Effluent Regulations (MMER; SOR/2002-222), and the design of a national Environmental Effects Monitoring (EEM) program for metal mining. The MMER, under the *Fisheries Act*, instruct metal mines to conduct EEM as a condition governing the authority to deposit effluent (MMER, Part 2, section 7).

The MMER (SOR/2002-222) permit the deposition of mine effluent into water containing fish if the effluent pH is within a defined range, if the concentrations of the MMER deleterious substances in the effluent do not exceed authorized limits, and if the effluent is demonstrated to be non-acutely lethal to Rainbow Trout (*Oncorhynchus mykiss*). These discharge limits were established to be minimum national standards based on best available technology economically achievable at the time that the MMER were promulgated. To assess the adequacy of the effluent regulations for protecting the aquatic environment, the MMER include EEM requirements to evaluate the potential effects of effluents on fish, fish habitat, and the use of fisheries resources.

Regulations Amending the MMER were published in the Canada Gazette, Part II, in October 2006 (Canada Gazette 2006). The purpose of these amendments was to clarify the regulatory requirements by addressing matters related to the interpretation and clarity of the regulatory text that had emerged from the implementation of the Regulations.

Additional amendments to the MMER were published in the Canada Gazette, Part II, in March 2012 (Canada Gazette 2012). The following changes were made to improve the EEM provisions of the MMER:

- Modifications to the definition of an “effect on fish tissue” in order to be consistent with the Health Canada fish consumption guidelines and to clarify that the concentration of total mercury in tissue of fish from the exposure area must be statistically different from and higher than its concentration in fish tissue from the reference area.
- Addition of selenium and electrical conductivity to the list of parameters required for effluent characterization and water quality monitoring.
- Exemption for mines, other than uranium mines, from monitoring radium 226 as part of the water quality monitoring, if 10 consecutive test results showed that radium 226 levels are less than 10% of the authorized monthly mean concentration (subsection 13(2) of the Regulations; SOR/2002-222).

- Change to the time frame for the submission of interpretative reports for mines with effects on the fish population, fish tissue, and benthic invertebrate community from 24 to 36 months.
- Change to the time frame for the submission of interpretative reports for magnitude and geographic extent of effects, and for investigation of cause of effects, from 24 to 36 months.
- Minor changes to the wording for consistency within Schedule 5.

1.3.2 The *No Net Loss* Principle

Currently, DFO is in a transition phase with respect to implementing *Fisheries Act* legislative changes. In developing the Conceptual Fish Offsetting Plan described herein, the guiding principles found in the Policy for Management of Fish Habitat (DFO 1986) were followed along with new scientific guidance documents for managing fisheries (Koops et al. 2013, Randall et al. 2013). DFO's past policy was to maintain *No Net Loss* (NNL) of fish habitat in order to "balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented" (DFO 1986). To achieve this goal, the recommended strategy is to compensate for lost fish habitat in a 2:1 compensation ratio (Minns and Moore 2003), though increasing the amount of offset habitat alone is not entirely sufficient to ensure NNL (Quigley and Harper 2005). As the amended *Fisheries Act* and new policies are implemented in the coming year other available Fish Offsetting Plan options that could provide more value may be pursued.

The objective of DFO's '*No Net Loss*' principle, outlined in the *Policy for Management of Fish Habitat* (DFO 1986), is to balance unavoidable habitat losses with habitat replacement or with other mitigation measures, such as improved access to spawning or rearing areas. This principle aims to prevent overall reductions in the productive capacity of fisheries resources by maintaining overall fish population sizes and the areas of suitable fish habitat through time. Proceeding from DFO's most preferred option to the Department's least preferred option, *No Net Loss* is achieved through a "hierarchy of preferences" as follows:

- Avoidance of a serious harm to fisheries through the redesign of the project.
- Compensation (offsetting) by replacing lost habitat with similar habitat in the same ecological unit (i.e., like-for-like compensation).
- Compensation (offsetting) by increasing the productive capacity of existing habitat with unlike habitat in the same ecological unit.
- Compensation (offsetting) by replacing lost habitat with natural habitat in another ecological unit.
- Compensation (offsetting) by using artificial production (i.e., building hatcheries or fertilizing lakes).

1.4 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Available traditional knowledge (TK) on important fish species and Aboriginal fishery locations was obtained through the Kitikmeot Inuit Association's (KIA's) Naonaiyaotit Traditional Knowledge Project (NTKP) database. This is summarized in the report entitled *Inuit Traditional Knowledge of Sabina Gold & Silver Corporation's Back River (Hannigoyok) Project NTKP Report* (KIA 2012).

Maps presented in Figures 30–32 in Chapter 7 of the *NTKP* report (hereafter, TK Report) specifically indicate the presence of important freshwater fishing locations for Arctic Char (*Salvelinus alpinus)* and Arctic Grayling (*Thymallus arcticus*) in the Western River (*Kilokgiktok*). The Western River lies within the freshwater Regional Study Area (RSA) of the George Property Area (see Volume 6, Chapters 6 and 7). In addition, the maps in the TK Report indicate that, outside the Goose and George Property freshwater RSAs, important marine fishing sites occur in Bathurst Inlet (i.e., within the Project's marine RSA). The maps in the TK Report also show that other freshwater fishing sites of value to the Inuit occur in and around Beechey Lake, which is located just south of the Goose and George Property freshwater RSAs.

Pertinent information on Aboriginal fisheries resources was also obtained from Land Use Focus Group Sessions, which were held in November of 2012; these sessions included Inuit hunters and trappers from Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet (see Chapter 4, Land Use, in Volume 8: Human Environment). The Focus Group participants from Bathurst Inlet and Omingmaktok described and mapped a contemporary travel route that leads from Bathurst Inlet (community) south past Bathurst Lake and George Lake, down to the Beechey Lake and Goose Lake areas (Figure 4.1-2 in Chapter 4, Volume 8). These participants also indicated that Bathurst Lake, located in the George Property RSA, is fished, specifically for Lake Trout (*Salvelinus namaycush*). The participants also indicated that hunting and fishing take place along the length of this route. The people may stop at George Lake, located in the freshwater Local Study Area (LSA) of the George Property Area, to take a break and hunt and/or fish. Focus group participants reported that they stay near Beechey Lake while hunting, trapping, and fishing in the area. Goose Lake, located in the Goose Property LSA, was also identified as an area where fishing may occur while staying near Beechey Lake. While Goose Lake and George Lake may be fished by traditional land users, they are not known to be destinations or key locations for fishing (Volume 8, Chapter 4).

In the TK Report (KIA 2012), the Inuit note that fish are present throughout the landscape surrounding and including the Project Area. This is exemplified by the following quotations contained in the TK Report:

> *... This river (Hiukkittak) has a really strong current and they used to have a weir back then on it right by this bend (near the mouth). There is also another weir around here. I remember we restored the stones and used that ancient weir for spearing fish...*
>
> *... The fish go further up into the lakes using the rivers. All kinds of fish do this. They also use the same river to go down to the ocean.*
>
> *Sometimes the fish will winter in the lakes because the rivers get too shallow for the fish to go down river. In the spring they start to migrate down river...*
>
> *When the fish went up the river (Arctic Charr fall migration) at Hiukkittak... Inuit speared them or used baskets to scoop them up.*
>
> *... There would be lots of fish at Hiukkittak, Kugyoak and around Kangihoakyok (waters feeding into Kangihoakyok) during the spring. Even in the summer when the fish were ready to go up river, there was lots of fish...*
>
> *Inuit jigged for fish where the fishing was good. They fished in the lakes.... They fished these places using hooks during the spring or winter and sometimes they used nets.*
>
> *... The people from Kingaok and Omingmaktok must know about that river (Hiukkittak). It is really sandy from all the way up here (at the mouth) downstream... People fish the ocean at the mouth of the river. I have nets at Ehokhikhiovik (initial river section of Hiukkittak)... I usually have nets at this place...*

Inuit fished anywhere in the rivers. They fished the river when the fish were going downriver and upriver, when they needed food. (We fished at Hakvaktok (south coast of Melville Sound), Naoyak and Etibliakyok, Kolgayok (Tingmeak River), Kunayok (Ellice River). Hiukkittak, Aniakhiokvik (Fishing Creek), Kingaok, Daniel Moore Bay (Kangihoakyok) and all along the coast of Victoria Island up to Wellington Bay (including Paatlik or Byron Bay)...

These areas (coastal Parry Bay, Etibliakyok (Kent Peninsula isthmus), Kolgayok (Tingmeak River, and an area east of Fishing Creek) are fishing places. They have charr and trout... and cisco whitefish...

Lake trout, charr, whitefish and grayling are found in lakes.

When we were young, the fishing areas were identified by our parents. You should mark that place (mouth of Burnside River (Ayapakpaktokvik)) because people still go there to fish. Our parents taught us these things, even about tomcod fishing.

I remember those fishing places because my parents stayed there when I was growing up. Niptanatiak(s) and Tigitkok(s) used to stay there (south portion of Gordon Bay and the inlet to the west)...

The lake is where we would have nets in the winter. lnukholik (near Hiukkittak) is where they would set nets in the winter...

... At the rivers (mouth of Hannigayok (Back River) at Beechey Lake and stream on north-central shore of Beechey Lake) they liked to net for fish, for... lake trout and whitefish.

They net fish near Kingaok every fall Ayapakpaktokvik (Burnside River). This lake (Ekalokhiokvik (Tahikafalok Lake)) has a small river to the ocean (Aniakhiokvik (Fishing Creek)). That is another area that they mainly fish, I know this because my grandfather liked fishing there...

... Inuit fished along the shore... at Kingaok (northwest of Fishing Creek). Over here at Kingaok (stream leading into and south of Ayapakpaktokvik (Burnside River) near its mouth) Inuit have fished for a long time. That river has charr and whitefish...

... They would jig for fish in the lakes around here (north of Beechey Lake) when they were traveling to see the white people (to the trading post at Kingaok). They jigged for fish in the lakes as they were traveling, when they camped... They fished when they stopped so they could have fresh food, I remember. I was following them that time.

... These parts of the Jakes (narrows)... are called 'kongunik' (pl.) and that is why this is called 'konngok' (sf.). This narrow spot (at the narrows of Hanningayuk (Beechey Lake)) never freezes all winter. That is why they tell Inuit who are traveling to be careful because this narrow spot doesn't freeze. We call those narrow parts of the Jakes 'kongunik'. We know about that konngok where Inuit set fish nets because it doesn't freeze all winter. You have to be careful when you travel through there...

Those rivers where Inuit mostly fish (Ayapakpaktokvik and Hivogahik) and where they hunted the caribou near the mouth of the lakes are important. Some of these areas *where they mostly fished during the winter don't freeze that well. These areas sometimes are scary (dangerous places for traveling).*

In the fall we used gill nets to catch a lot of fish for the dogs, and for dry fish too. All these places where we had our nets have inokhok or rock pile markers. On our trap Jines too we fished. We did a lot of fishing especially on the days that were stormy. We did a lot of fishing to pass the time...

In the Bathurst Inlet area C51 mapped Tagionoak (Goulburn Lake), Swan Lake (Tagionuak), and a lake west of Amagok as good for fishing.

This is a good spot for fishing too (at the mouth of Ayappappaktokvik). This long arm in here, it's a good spot for fishing. When I was there in February, it was good, a good fishing spot there...

There is a river there as well Kokiviayok. It's small but there are a lot of fish.

Based on the above information in the TK Report (KIA 2012), as well as the information gathered from the Focus Group Sessions (Volume 8, Chapter 4 of the DEIS), the Conceptual Fish Offsetting Plan described herein focuses the freshwater offsetting options on three freshwater (either resident or anadromous) fish species: Arctic Grayling, Lake Trout, and Arctic Char. In contrast, the single marine offsetting option (described below) focusses more on general habitat offsetting for the marine fish community as a whole (Volume 7, Chapter 5), though Arctic Char and Arctic Cod (*Arctogadus glacialis*) were identified in the TK Report as being important marine fisheries species in various parts of Bathurst Inlet.

The Project design has been planned such that placement of infrastructure on locations identified as important freshwater *or* marine fish habitat will be avoided to the extent feasible. Ongoing consultation with DFO, and future engagement with the KIA and other stakeholders, regarding the further development of the Conceptual Fish Offsetting Plan, including the development of additional or alternative options that could provide value to the local communities, is intended through 2014.

1.5 OBJECTIVES

The objectives of this Draft Conceptual Fish Offsetting Plan are as follows:

- Describe the fish habitat and species in areas with predicted project effects.
- Describe the concepts proposed to offset lost fish production and fish habitats.
- Describe the proposed monitoring program for each potential offsetting project.

2. Summary of Predicted Project Effects

Several Project activities have the potential to result in serious harm to fish habitats and species inhabiting the Project footprint. In Bathurst Inlet, such activities include a very small area of in-water work: the construction of a rock ramp and seasonal dock for land-sea access. At Goose Property potentially harmful activities include the development of open pit mines at Llama Lake and the southwestern inflow to Goose Lake, and the withdrawal of water from Goose and Propeller lakes for camp and mill activities. At George Property activities include the development of open pits impinging on Lytle and Occurrence lakes and occupying a small section of the stream connecting George and Lytle lakes.

Road works and other onsite construction activities also have the potential to cause serious harm to fish habitat and species. For the purposes of this draft plan, any permanent alteration or destruction of fish habitat resulting from such activities will be avoided through Project design and by following DFO operational statements for Nunavut.

Construction of the Tailings Impoundment Area (TIA) will cover sections of an ephemeral freshwater stream discharging to Giraffe Lake at the Goose Property. However, no fish were captured during the baseline sampling of this stream in 2013 (Rescan 2013a). Moreover, the presence of barriers to fish entering the stream also indicates that this ephemeral stream is fishless (Rescan 2013a). Therefore, no fish offsetting is planned for the waterbodies covered by the TIA (see Section 2.2.2 for further detail).

2.1 MARINE LAYDOWN AREA IN BATHURST INLET

A marine ramp and seasonal dock at the proposed Marine Laydown Area in southern Bathurst Inlet will be constructed for annual resupply and seasonal transport during the open-water season to bring in equipment, supplies, and fuel. The beach ramp and dock will be rock-filled structures built perpendicular to shore with above water dimensions measuring approximately 30 x 30 m and 20 x 20 m, respectively. The side-slope of constructed infrastructure is assumed to be approximately 2:1, with a maximum depth below high water of 5 m, resulting in a total area of in-water infrastructure of 0.15 ha and 0.08 ha, respectively.

2.1.1 Marine Habitat

Marine fish habitat has been documented in southern Bathurst Inlet in 2001 and 2007 (Rescan 2007b), in 2010 (Rescan unpublished data), 2012 (Rescan 2012d) and 2013 (Rescan 2013b). Shoreline habitat along the western shore in southern Bathurst Inlet is dominated by a shallow water shelf which extends at a slope of 8% to a depth of approximately 10 m and a distance of 120 m offshore. Beyond this distance, the shoreline drops off steeply at a gradient of 30% to depths greater than 40 m. During the spring freshet, sediment enters Bathurst Inlet and settles to the bottom, resulting in a fine, marine clay substrate that supports flatfish, marine bivalves, and crustaceans. Sediment is likely deposited along the shoreline as well; however, yearly ice scour prevents significant amounts of fine sediment from accumulating in the intertidal zone.

In 2012, substrate composition was mapped along the shoreline region of the inlet adjacent to the MLA (Figure 2.1-1; Rescan 2012b), and in 2013 substrate composition was mapped along the shoreline of the MLA (Rescan 2013b). It was found that gravel and cobble dominated the beach along the shoreline throughout the MLA (Plate 2.1-1). Nearshore intertidal and subtidal substrate was generally composed of distinct patches of gravel/cobble rock or fine sand/clay.

Plate 2.1-1. Typical beach zone substrate at MLA looking north. Bathurst Inlet, July 2012.

In deeper waters, fine clay and silt dominated the substrate composition. Marine algae and invertebrates were only found in deeper water below the depth of ice scour (Plate 2.1-2). Moreover, larger diameter rocky substrates (gravel, cobble, and boulder) were only found very close to shore and not found deeper than 2 m. Soft, fine substrates (soft mud, firm mud, and/or fine sand) predominated in deeper water (Rescan 2012d).

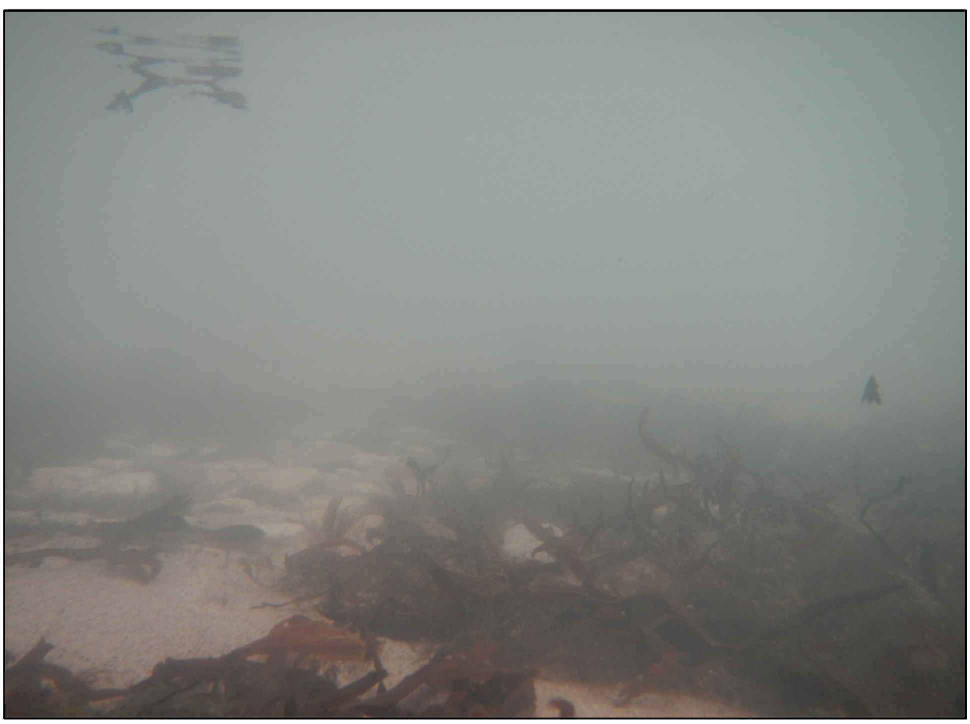

Plate 2.1-2. Sparse subtidal algae on fine sand at MLA. Bathurst Inlet, July 2012.

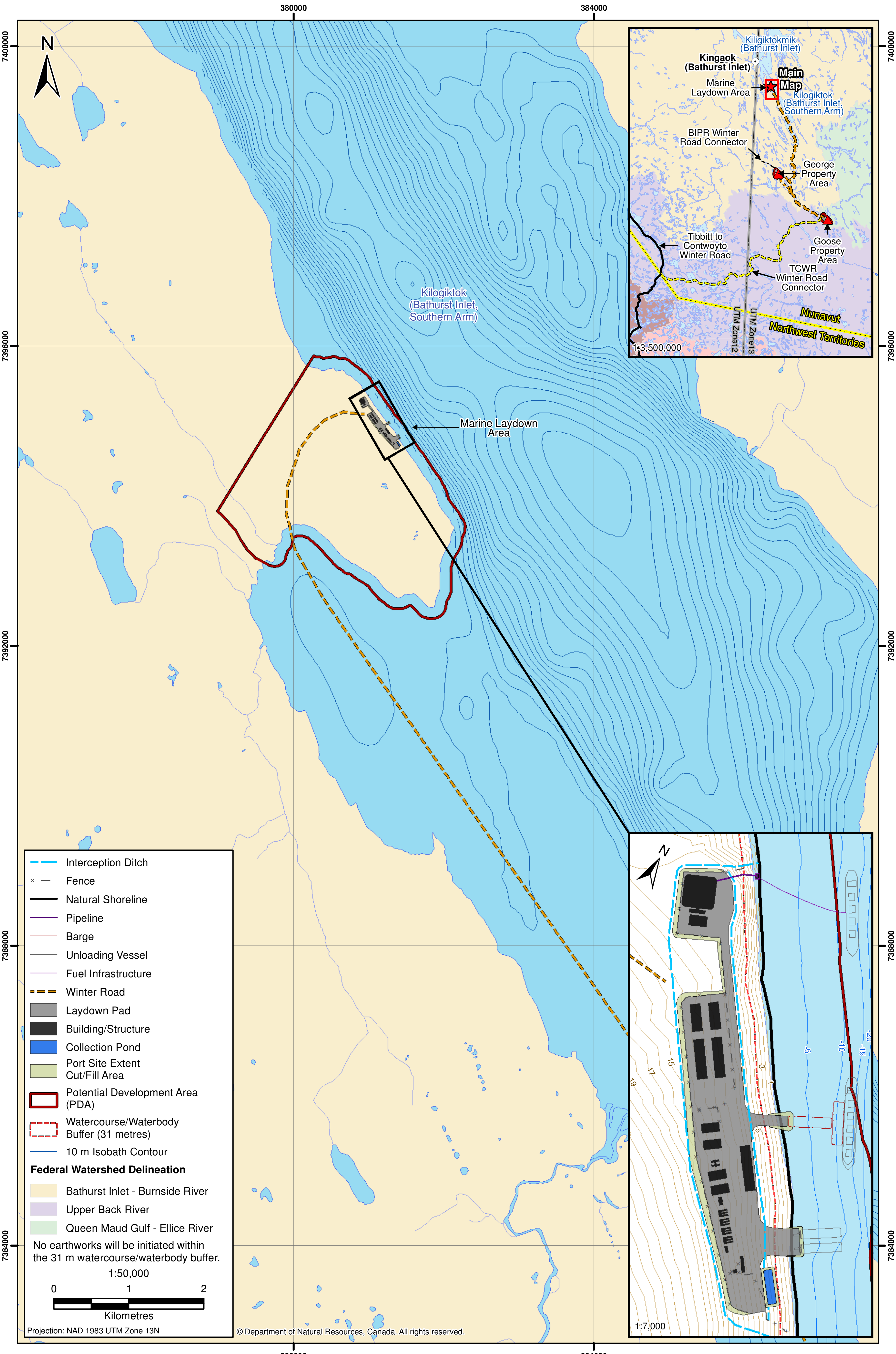

Figure 2.1-1

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Marine Laydown Area

Figure 2.1-1

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2.1.2 Marine Fish

Approximately 0.23 ha of fish habitat will be adversely affected by the construction of the proposed in-water infrastructure. This is equivalent to the surface area of the beach ramp, seasonal dock and associated side slopes on the surface of the sea floor. The in-water infrastructure will be placed on primarily medium-quality fish habitat — marine sands, silts, and clays — that likely freezes 2 m depth throughout the winter.

Marine baseline studies (Rescan 2012d) showed that 12 fish species have been captured near the proposed Marine Laydown Area (Table 2.1-1; Appendix 2.1-1), though only a few are specialized for inhabiting the fine sediment located in the nearshore area of the MLA (namely the flounders). None of the fish species found thus far in Bathurst Inlet are currently considered threatened or endangered (COSEWIC 2010), though the Bering Wolfish is currently listed as data deficient. The construction of the ramp and seasonal dock could potentially shift feeding opportunities for flounder species away from the immediate area, as well as remove spawning sites for Capelin. However, Bathurst Inlet contains an abundance of other areas that are dominated by marine sand, silt, and/or clay.

Table 2.1-1. Fish Species Captured near the Marine Laydown Area in Bathurst Inlet, 2001, 2010 and 2012

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

Note: Species highlighted in grey were not captured during Baseline sampling in 2010 and 2012, but they have an historic precedence of capture in Bathurst Inlet (Richardson 1833; Senate of Canada 1888; Walters 1955; Ellis 1962, Stewart et al. 1993).

2.2 FRESHWATER AREAS WITH PREDICTED PROJECT EFFECTS

The predicted project effects to freshwater fish and fish habitat at the Goose Property are anticipated to include the loss of Llama Lake and the loss of one of the Goose Lake inflows to open mine pits (the Llama and Main deposits, respectively; see Figure 2.2-1). Predicted effects at the George Property are the loss of approximately half of the stream (i.e., the lower section) discharging from George Lake into Lytle Lake, and the loss of small sections of Lytle and Occurrence lakes, to open mine pits (Figure 2.2-2).

2.2.1 Freshwater Habitat

Goose Property

Fish habitat was assessed in the Goose Property area in 2007, 2010, 2011, 2012 and 2013 (Rescan 2010a, 2012b, 2012c, 2013a). Good quality littoral (i.e., nearshore) fish habitat is present in the lakes located within the potential impact areas, including Llama Lake and Goose Lake (Golder 2007; Rescan 2010a, 2012b, 2012c, 2013a). Most lakes in the region feature littoral habitat well suited for northern fish species, i.e., shorelines dominated by mixed rock, with occasional outcrops of bedrock (Rescan 2010a, 2012c, 2013a; Figure 2.2-3; Plate 2.2-1). However, deeper lake areas (> 2.5 m), which serve as fish overwintering habitat, are found less commonly in the Goose Property area and may be limiting fish population sizes in many lakes and ponds in this area (Rescan 2012c).

Plate 2.2-1. Typical shoreline substrate of lakes in the Goose Property area. Llama Lake, August 2012.

Pond habitat in the Goose Property area is generally shallow and many of the ponds featured ephemeral inflows or outflow that would limit fish migration into and out of these waterbodies (Rescan 2012c; Plate 2.2-2). Owing to their shallow depths, these ponds freeze all the way to the bottom in winter, making them unsuitable for overwintering habitat.

George Property

Fish habitat in the George Property area was assessed in 1990, 2007, 2012 and 2013 (Sekerak 1990; Golder 2007; Rescan 2012c, 2013a). Good to fair quality fish habitat is present in larger waterbodies that contain deeper water within potential impact areas (Figure 2.2-4). Most of the lakes and streams in the George Property contain cobble or boulder substrates, which are overlaid with fine organic sediments in some areas. Both Lytle and Occurrence lakes are small, shallow (<2 m deep) lakes that contain poor quality habitat for rearing, because they provide little cover, or for overwintering, because they freeze to the bottom during winter (Rescan 2012c).

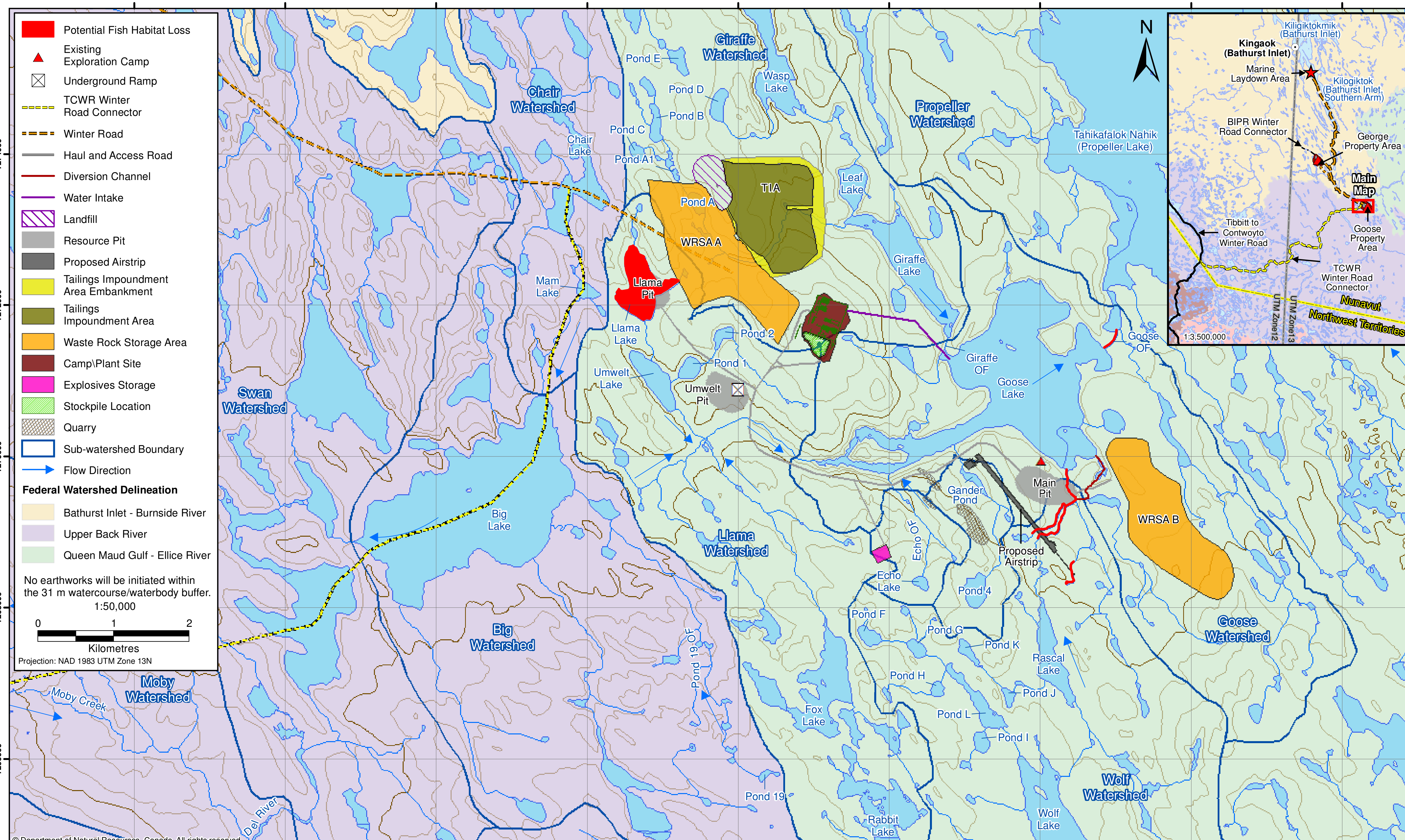

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Figure 2.2-1

Infrastructure Layout and Locations of Potential Habitat Loss, Goose Property Area, Back River Project, 2013

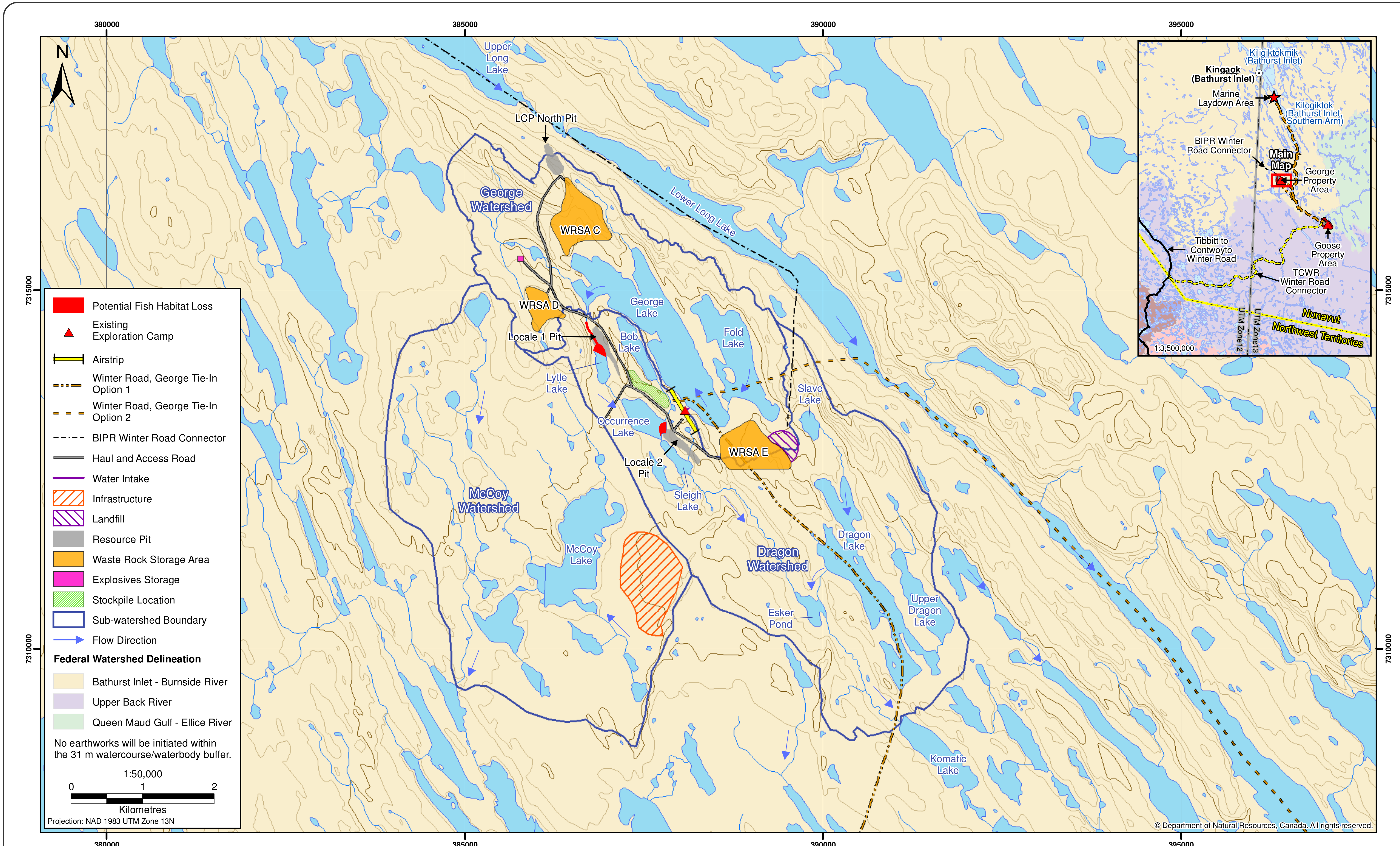

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Figure 2.2-2

Infrastructure Layout and Locations of Potential Habitat Loss, George Property Area, Back River Project, 2013

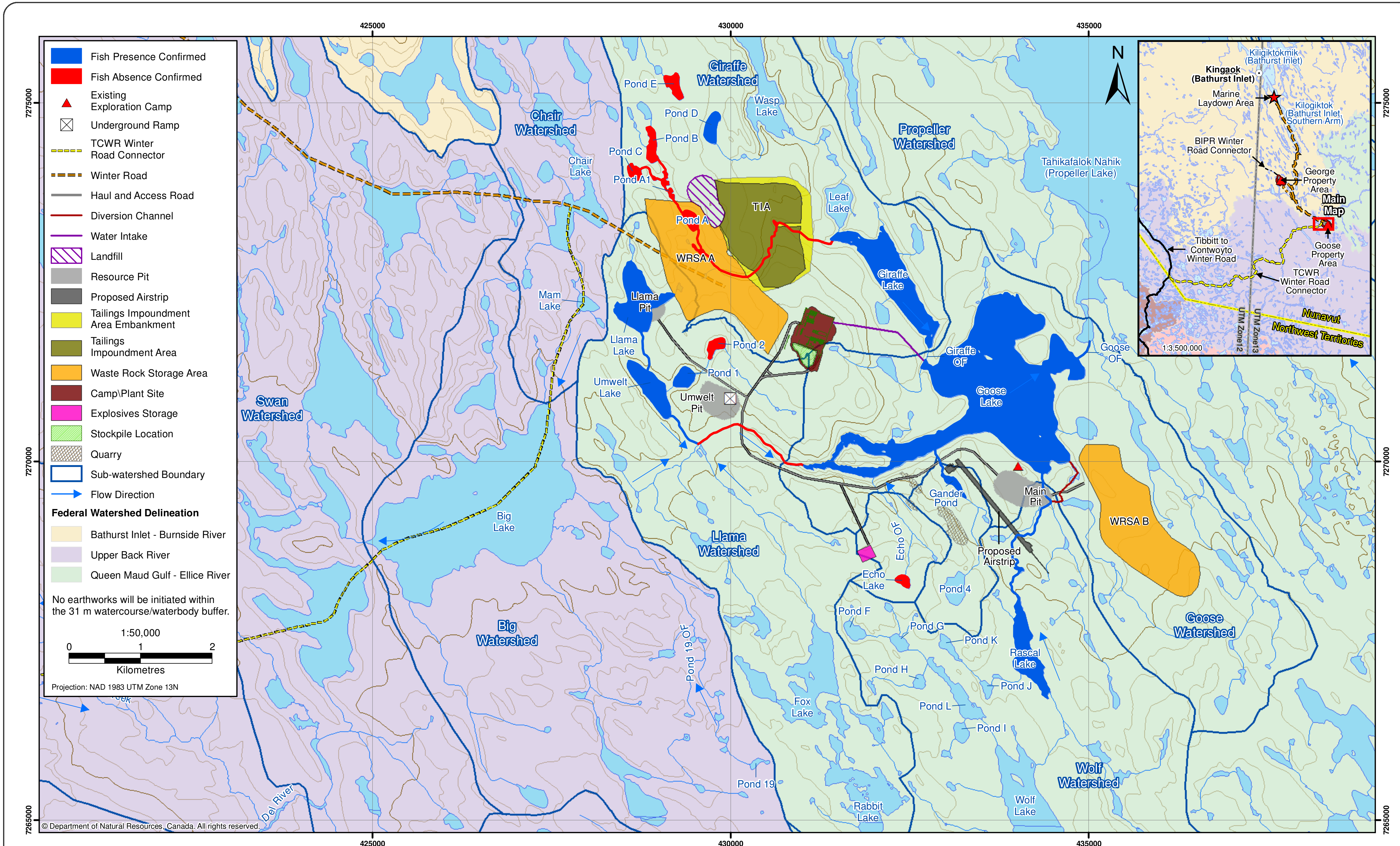

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Figure 2.2-3

Fish Presence / Absence at Goose Property Area, Back River Project, 2013

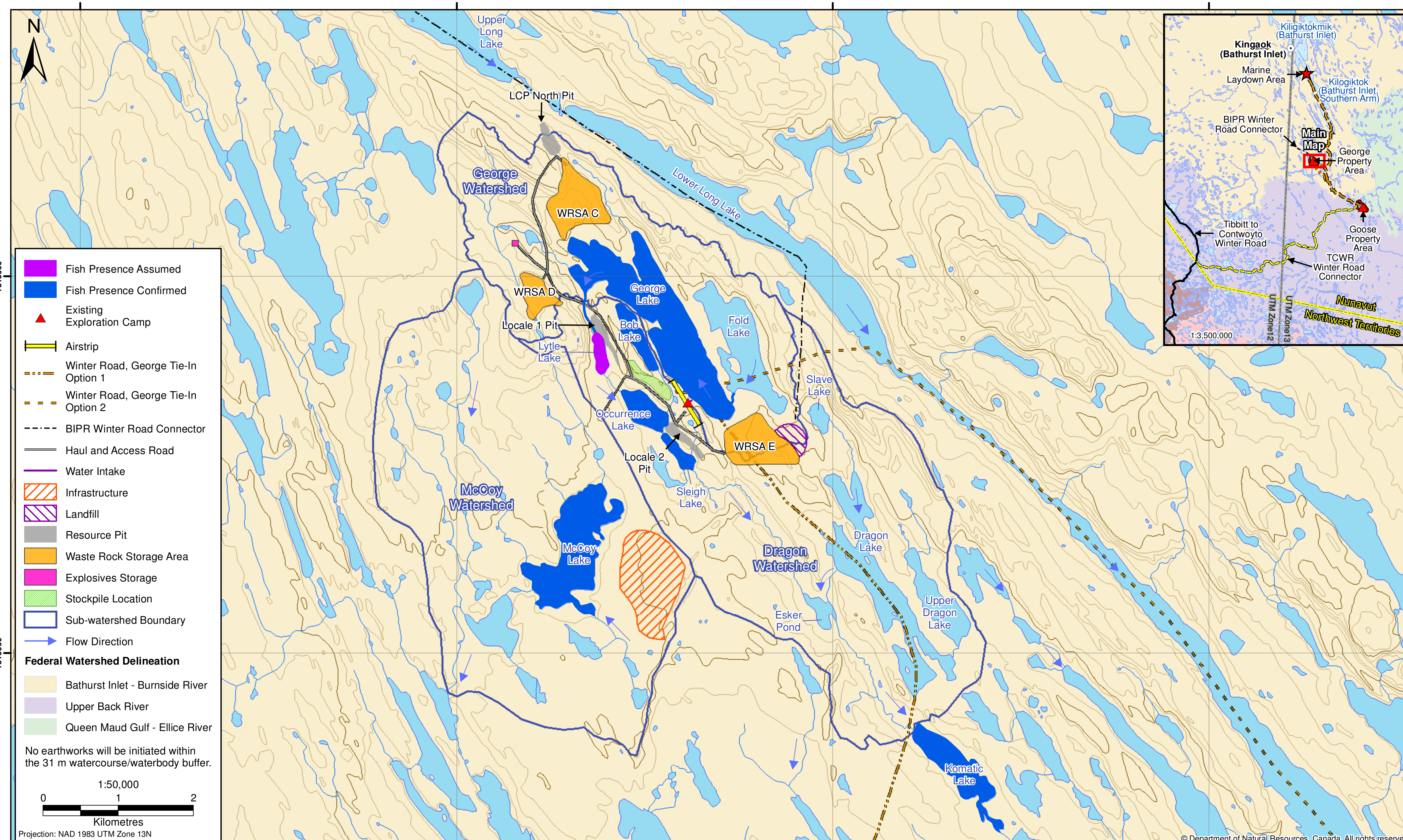

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Figure 2.2-4

Fish Presence / Absence at George Property Area, Back River Project, 2013

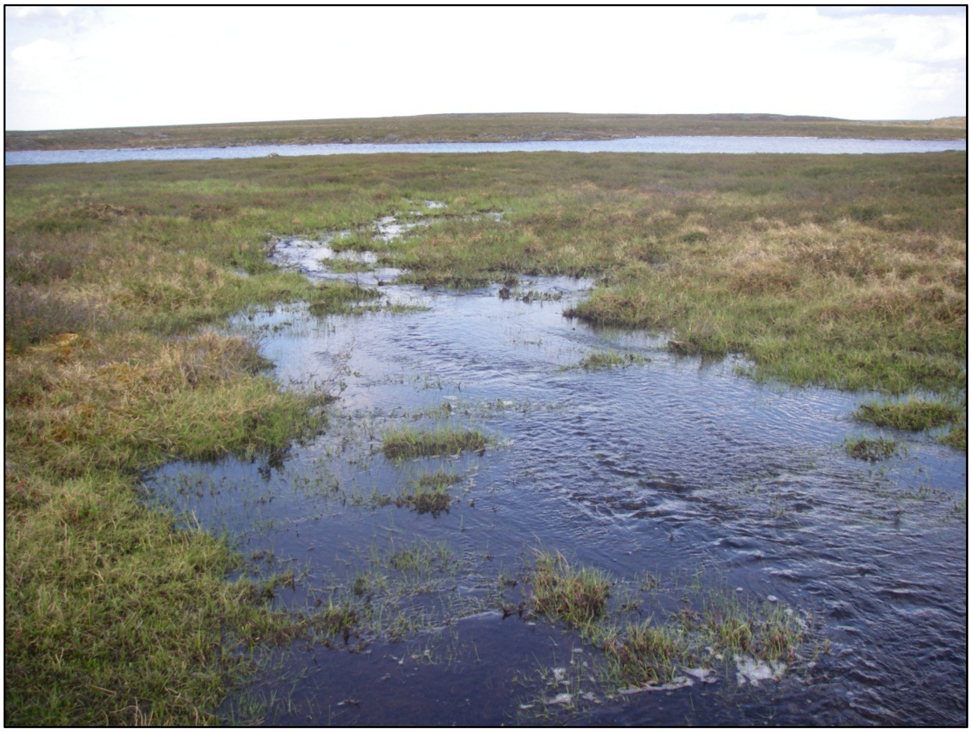

Plate 2.2-2. Ephemeral outflow from a Goose Property pond, featuring overland flow and seepage properties. Pond H, July 2011.

Stream habitat in the George Property is characterized by well-developed beaded tundra streams with deep pools, interspersed with runs and occasional riffles (Rescan 2012c). Fish habitat in the beaded channels was generally considered good quality for rearing and feeding, while cobble and gravel habitat may provide good spawning habitat for spring spawning species such as Arctic Grayling. However, periodic reaches featuring cobble and boulder fields, shallow flow, and riffle morphology are also present and may limit fish migration during low flow periods.

2.2.2 Freshwater Fish

<u>Goose Property</u>

Information on freshwater fish and fish habitat in the Goose Property area is available for 1997, 2007, 2010, 2011, 2012 and 2013 (Rescan 2010a, 2012a, 2012b, 2012c, 2013a). The data collected in 1997 was not directly available from the consultant; however, it was referenced by Hubert and Associates Ltd. (2004) in a review of the existing baseline studies. Fish sampling in 2007 focused on Goose Lake and its outflow (Golder 2007).

The Goose Property area is located north of Back River, straddling the watershed divide between the regional Back River and Ellice River watersheds. The area of predicted Project-related effects contains a total of seven freshwater fish species (Table 2.2-1; Appendix 2.2-1 and 2.2-2), four of which are Lake Trout, Round Whitefish, Lake Whitefish, and Arctic Grayling. None of these species are fished locally for commercial or sporting purposes.

Table 2.2-1. Fish Species Captured near Potential Areas of Impact in the Goose Property Area, 1997 to 2012

Waterbodies Sampled	Species						
	Lake Trout (*Salvelinus namaycush*)	Round Whitefish (*Prosopium cylindraceum*)	Lake Whitefish (*Coregonus clupeaformis*)	Arctic Grayling (*Thymallus arcticus*)	Burbot (*Lota lota*)	Slimy Sculpin (*Cottus cognatus*)	Ninespine Stickleback (*Pungitius pungitius*)
Goose Lake	X	X	X	X	X	X	X
Goose-Rascal Inflow	-	-	-	X	-	-	-
Umwelt Lake	X	X	-	X	-	-	X
Llama Lake	X	X	-	-	-	X	-
Rascal Lake	X	X	-	X	-	-	-
Canyon Lake	X	X	-	X	X	X	X
Propeller Lake	X	X	-	X	X	X	X
Gander Pond and Outflow	-	-	-	X	X	X	X

Llama Lake

The proposed future development of the Llama deposit will result in the complete loss of Llama Lake, equalling 33.6 ha of fish habitat (Figure 2.2-5; Appendix 2.2-3). Although the loss of Llama Lake will result in serious harm to three fish species (Lake Trout, Round Whitefish, and Slimy Sculpin), the total number of fish in Llama Lake is estimated to be rather low. The entire lake contains an estimated 226 individuals of Lake Trout and Round Whitefish, combined (Rescan 2010a). Although this is the best estimate of the total fish population size of these two species combined, there are wide confidence limits around this estimate, reflecting a substantial degree of uncertainty surrounding the population sizes of either species. Approximately 60% of this estimate is through to consist of Round Whitefish individuals, whereas the remaining 40% is thought to consist of Lake Trout individuals. The only species of forage fish collected in Llama Lake was Slimy Sculpin (Table 2.2-1). Only a small number of Slimy Sculpin individuals were captured during the baseline fish surveys in Llama Lake (Rescan 2010a), possibly because the baseline sampling methods did not target Slimy Sculpin and were focused on assessing the two larger species, Lake Trout and Round Whitefish. As noted in Chapter 6 of Volume 6 (see Table 6.1-7 of that Chapter), Llama Lake was assigned a forage-fish quality rating of fair based on all data collected during the baseline surveys.

Goose Lake

Withdrawal of water from Goose Lake will be required for mill and camp use throughout the year. Based on the maximum allowable winter withdrawal of 10% under ice volume (DFO 2010), a total of 2,208 m^3/day would be permitted for withdrawal (Figure 2.2-6). The project will require water withdrawal during construction (2-4 years), operation (10 years) and possibly closure.

To avoid serious harm to fish production in Goose Lake, maximum water withdrawal volumes will be implemented such that resulting changes to lake outflow volume and water level do not impact Lake Trout, Round Whitefish or Arctic Grayling life histories. The maximum water volumes are 1,000 m^3/day throughout the year with an increase to 2,000 m^3/day during freshet. However, the operational water needs of the Project may vary below these estimates.

For Goose Outflow, maximum water withdrawal volumes would reduce the average daily discharge by 20.6% and have a negligible effect on habitat use for Arctic Grayling and Round Whitefish. Baseline flow and water level in Goose Outflow are marginal to insufficient for fish production during critical periods (flow less than 20% Mean Annual Discharge; DFO 2013b; Figure 2.2-7) and the 20.6% reduction in discharge does not alter the date or duration of the critical period when Goose Outflow is marginal for fish use.

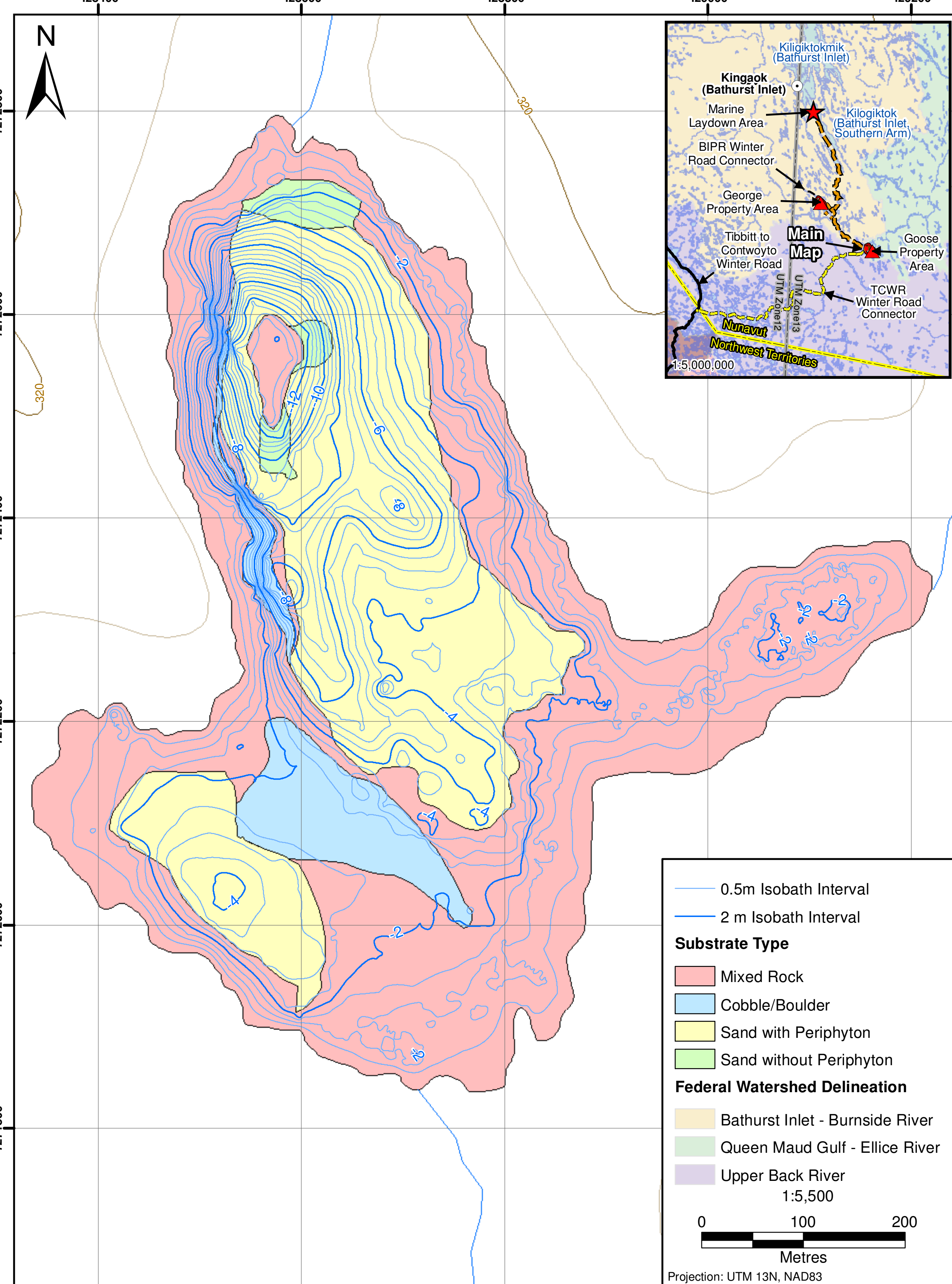

Figure 2.2-5

Substrate Composition of Llama Lake, Back River Project, 2013

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For Goose Lake, maximum summer water withdrawal volumes would result in an average daily reduction in water level of 2 cm (maximum 6 cm), which is within the range of seasonal variation for Goose Lake (approximately 30 cm; Figure 2.2-7). During winter months, maximum water withdrawal is estimated to result in a cumulative reduction in water level of 10 cm under ice potentially exposing overwintering Lake Trout eggs to air. The effect of opening up 10 cm of airspace on Lake Trout eggs is considered negligible as ice thickness in Goose Lake varies up to 20 cm among years and locations (Rescan 2012e, Rescan 2012f). Moreover, bathymetry and substrate type indicate that Lake Trout spawning sites are found at depths greater than 2.5 m (Rescan 2013a).

Propeller Lake

Withdrawal of water from Propeller Lake may be required during operations and closure. A maximum water withdrawal volume for Propeller Lake has been set at 1,510 m^3/day (2,510 m^3/day during freshet). This maximum is based on removing no more than 10% of the available outflow volume of Propeller Lake. The assumption of "no serious harm to fish" as a result of the maximum water withdrawal volume will be verified by analyzing bathymetric and substrate composition to be collected in September 2013.

Stream Connecting Rascal and Goose Lakes

Fish habitat that will be adversely affected by the construction of the airstrip and the Main deposit is a 1.82 km length section of high-quality stream connecting Rascal and Goose lakes (Plate 2.2-3; Appendix 2.2-4). This stream is the lower reach of the stream connecting several medium-sized lakes (upstream) to Goose Lake (downstream). Artic Grayling have been observed in large numbers within this section of stream, and this species use this reach for spawning, nursery, and foraging habitat (Hubert et al. 1985; Rescan 2012c). Upstream lakes within the Wolf Watershed, as well as the downstream Goose Lake, likely serve as overwintering habitat (Rescan 2012c). Maintaining connectivity between Goose Lake and the upper reaches of the Wolf Watershed is likely critical for conserving the Arctic Grayling population in this system.

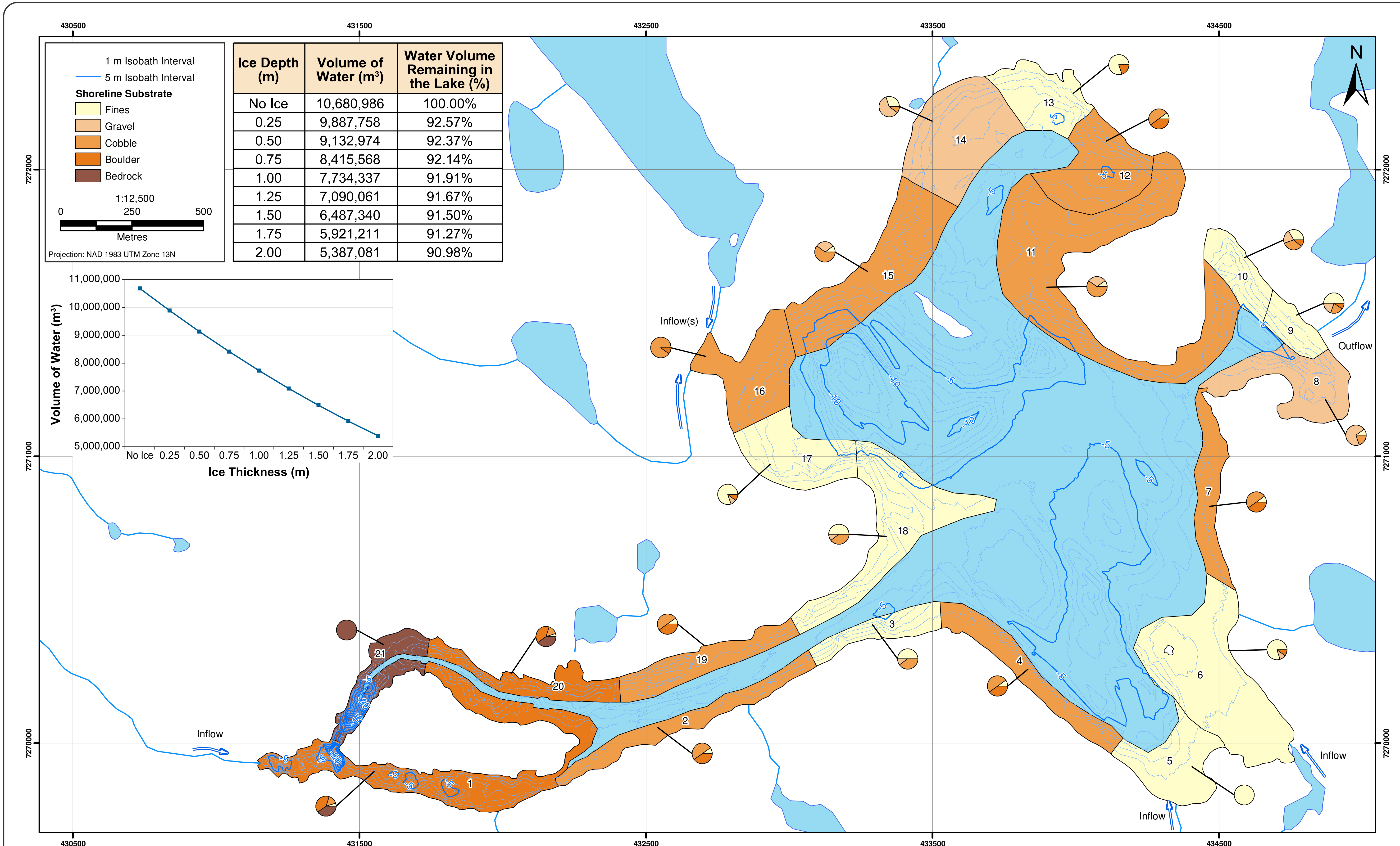
Tailings Impoundment Area: Giraffe Inflow Stream

Approximately 3.1 km of ephemeral stream and shallow ponds will be affected by the construction of the TIA (Figure 2.2-1). Electrofishing sampling and habitat assessment completed in 2013 demonstrated that this stream is devoid of fish due to the presence of several natural fish barriers located adjacent to the inflow of Giraffe Lake, and due to seasonal interruptions in flow (Plate 2.2-4). No fish have been caught in the small ponds connected by Giraffe Inflow Stream (Ponds A-C; Table 2.2-1).

In addition to Giraffe Inflow Stream, a larger, approximately 2 m deep Pond (Pond A) is located within the potential TIA boundary. This pond features one ephemeral outflow and one ephemeral inflow, and its shoreline is dominated by fines (Plate 2.2-5). No fish have been captured at Pond A, and, because migration into Pond A from the nearest lake (Giraffe Lake) is inhibited by impassible barriers, it is not considered fish bearing.

<u>George Property</u>

Information on freshwater fish in the George Property Area has been collected in 1990, 2007, 2012, and 2013 (Sekarak 1990; Golder 2007; Rescan 2012c, Rescan 2013a). The George Property is located in the headwaters of the Western River watershed, which flows north into Bathurst Inlet. The area of predicted project effects contains a total of four species (Table 2.2-2), two of which are Lake Trout and Arctic Grayling. Neither of these species is fished locally for commercial or sporting purposes.



Ice Depth (m)	Volume of Water (m³)	Water Volume Remaining in the Lake (%)
No Ice	10,680,986	100.00%
0.25	9,887,758	92.57%
0.50	9,132,974	92.37%
0.75	8,415,568	92.14%
1.00	7,734,337	91.91%
1.25	7,090,061	91.67%
1.50	6,487,340	91.50%
1.75	5,921,211	91.27%
2.00	5,387,081	90.98%

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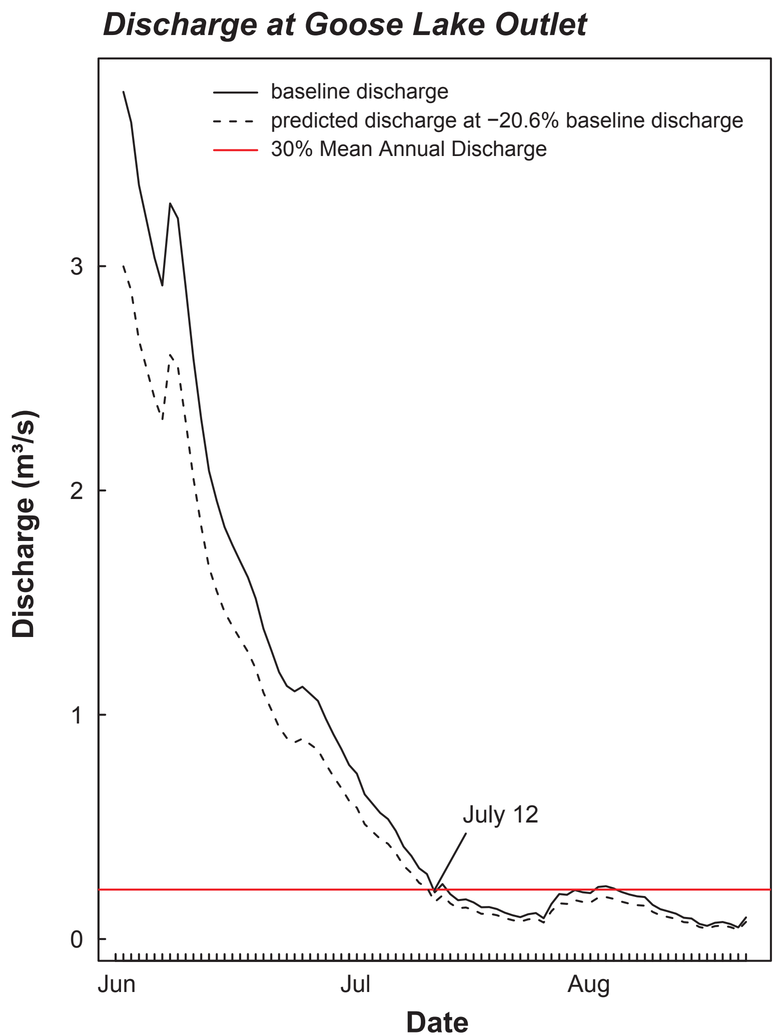
Figure 2.2-6

Under Ice Water Volume and Substrate in Goose Lake, Back River Project, 2013



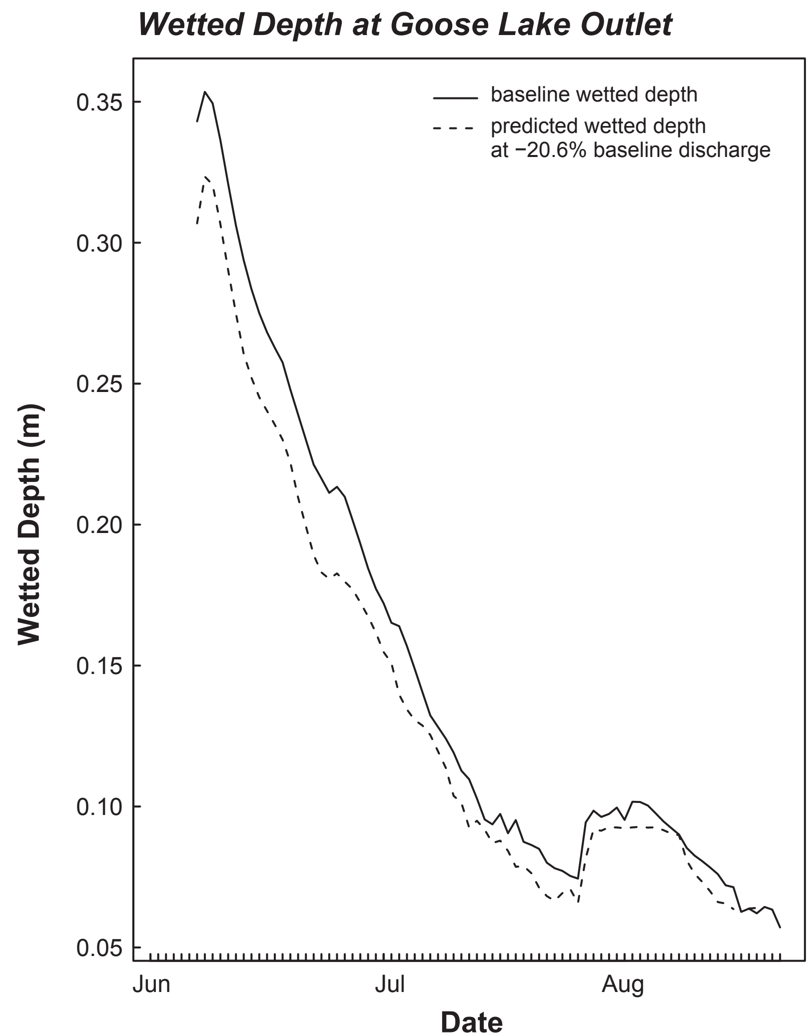


Figure 2.2-7

Daily Discharge and Wetted Depth at Goose Lake Outlfow, Back River Project, 2013

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Figure 2.2-7

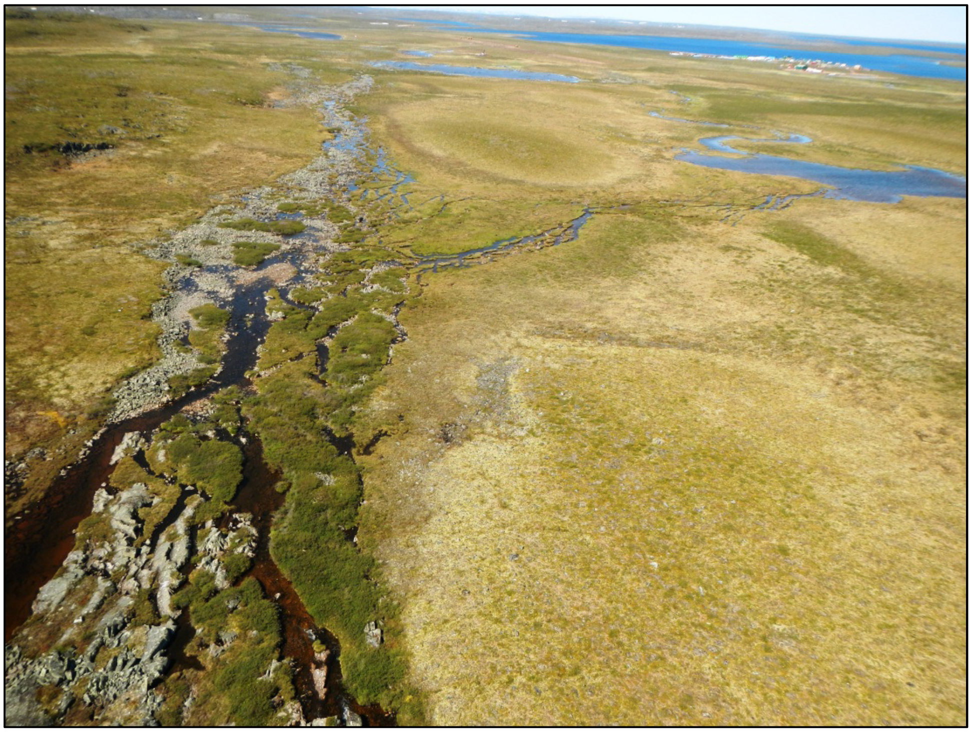

Plate 2.2-3. Goose-Rascal Outflow, looking north from Rascal Lake towards Goose Lake and existing Goose exploration camp (upper right). July 2012.

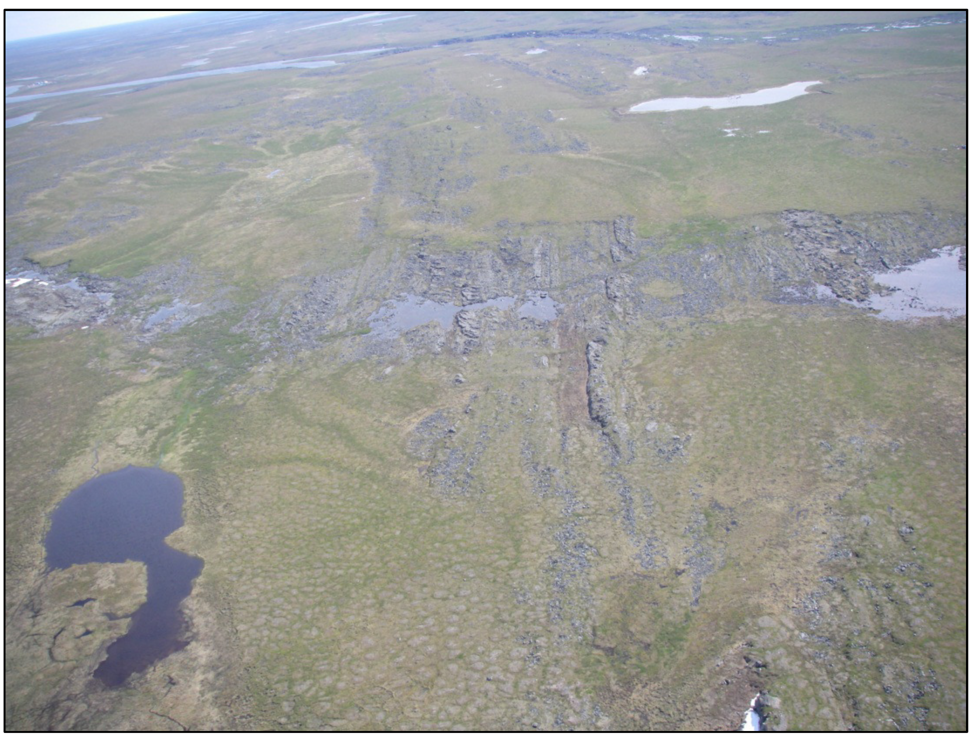

Plate 2.2-4. Aerial view of Giraffe Inflow Stream, looking south towards Goose Lake. July 2011.

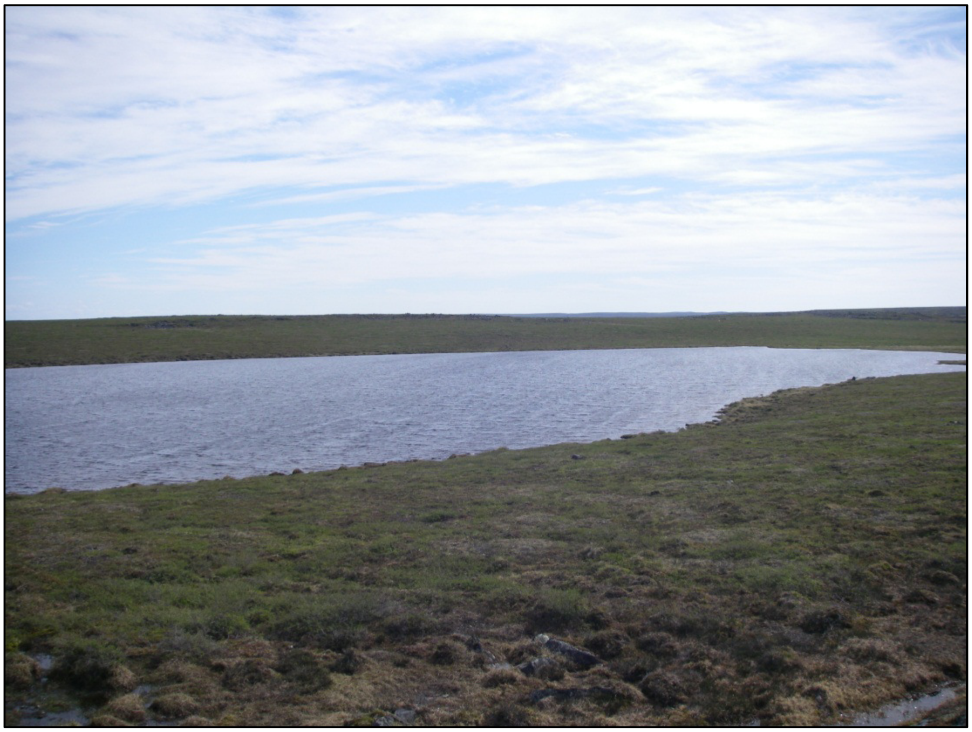

Plate 2.2-5. Pond A, looking south. July 2011.

Table 2.2-2. Fish Species Captured near Potential Areas of Impact in the George Property Area, 1990 to 2012

Waterbodies Sampled	Species						
	Lake Trout (*Salvelinus namaycush*)	**Round Whitefish** (*Prosopium cylindraceum*)	**Lake Whitefish** (*Coregonus clupeaformis*)	**Arctic Grayling** (*Thymallus arcticus*)	**Burbot** (*Lota lota*)	**Slimy Sculpin** (*Cottus cognatus*)	**Ninespine Stickleback** (*Pungitius pungitius*)
George Lake	X	-	-	X	-	X	-
Bob Lake	X	-	-	-	-	-	-
Lytle Lake	-	-	-	-	-	-	-
Occurrence Lake	-	-	-	X	-	-	-
George Outflow	X	-	-	X	X	X	-

Lytle Lake

The future development of Locale 1 Pit will result in the partial loss of Lytle Lake, equalling 1.53 ha of fish habitat (Appendix 2.2-5). No fish have been captured in Lytle Lake (Table 2.2-2; Appendix 2.2-1 and 2.2-2) and the shallow depth results in freezing to bottom during winter months. However, Lytle Lake may provide seasonal habitat for fish moving between George Lake and waterbodies lower in the watershed as Arctic Grayling have been captured both upstream in George Outflow and downstream in Occurrence and Sleigh lakes. Thus for the purposes of this draft plan, a conservative approach was taken and it was assumed that Arctic Grayling inhabit Lytle Lake during the summer months.

Occurrence Lake

The future development of Locale 2 Pit will result in the partial loss of Occurrence Lake, equalling 0.74 ha of fish habitat (Appendix 2.2-6). In 2013 only a single Arctic Grayling has been captured

(Table 2.2-2; Appendix 2.2-1 and 2.2-2). Occurrence Lake may provide seasonal habitat for fish moving between George Lake and waterbodies lower in the watershed. However, this lake is likely to freeze to bottom during winter owing to its shallow depth, and no overwintering habitat is available in this lake.

George Outlfow

The future development of Locale 1 Pit will result in the partial loss of George Outflow, equalling 0.41 ha of the section of stream adjacent to Lytle Lake (Appendix 2.2-7). Juvenile Lake Trout, Arctic Grayling, Slimy Sculpin and Burbot have been captured and observed using George Outflow in the section of stream nearest George Lake. No fish have been caught further downstream near Lytle Lake where substrate is mainly boulders and stream flow becomes subsurface after high freshet flow.

3. Fish Offsetting Options

Mitigation measures by Project design will be incorporated during Project development and construction to reduce the amount of fish habitat altered or lost. However, there are particular, unavoidable habitat losses requiring fish offsetting. Such offsetting options must follow a preferred hierarchy (DFO 2012):

1. Create or increase the productive capacity of like-for-like habitat in the same ecological unit.
2. Create or increase the productive capacity of unlike habitat in the same ecological unit.
3. Create or increase the productive capacity of habitat in a different ecological unit.

As a last resort, DFO may approve (a) offsetting options that use artificial production techniques to maintain one or more stocks of fish, (b) deferred offsetting, or (c) offsetting based on the restoration of chemically-contaminated sites.

Other, possibly more valuable, Fish Offsetting options may be available as the new Fisheries Protection Policy is implemented (DFO 2013a). These options may be developed with DFO and other stakeholders through the coming year.

Several Project activities outlined in Chapter 2 of this document will result in permanent alteration to, or destruction of, fish habitat. The offsetting strategy for each of these unavoidable losses is outlined below in Sections 3.1 and 3.2.

3.1 PROPOSED MARINE FISH OFFSETTING

Marine fish offsetting options accepted by DFO have historically employed either biological or physical (habitat) manipulation of the marine environment (Sikumiut 2011). Manipulation of the biological habitat primarily involves establishing nearshore aquatic vegetation (e.g., eelgrass) to serve as foraging, shelter, and/or nursery habitat for both fish and invertebrate species (CRD 2002; DFO 2004). This method has been somewhat effective in maintaining or increasing productivity at marine areas in southern Canadian latitudes, particularly in British Columbia (DFO 2006). However, re-vegetation has limited value in the Arctic, where ice scour in the nearshore marine environment prevents aquatic plant communities from becoming established (DFO 2009; Stephenson and Stephenson 1972).

Alternatively, physical manipulation, often in the form of creating artificial reefs, has been an acceptable and effective offsetting measure in the Arctic marine environment (DFO 1990; Rescan 2010b). Artificial reefs have the capacity to increase productivity in the nearshore environment by providing habitat for multiple trophic levels in the marine food web:

> *An artificial reef enhances fish aggregation and production habitat required by various invertebrates and fishes. Increased habitat complexity and heterogeneity of habitats created by the artificial reef provide a multitude of microhabitats for many invertebrates. These in turn provide food for fishes and many invertebrates. The reef also provides shelter for many fishes and motile invertebrates* (DFO 1990).

Following this model, two rock shoals are proposed to be constructed to ensure NNL of habitat by compensating for the 0.23 ha of nearshore marine habitat required to construct the marine jetty in Bathurst Inlet. The surface area of each of these rocky reefs will measure approximately 0.087 ha with the following dimensions: 45 m long, 15 m wide, and 1.5 m high with a 1:1 side slope. In addition to these rock shoals, the side slopes of the beach ramp and seasonal dock will provide an additional 0.100 ha of artificial reef. Therefore, this offsetting plan will result in a total of 0.274 ha of newly built rocky reef habitat after the loss of marine fish habitat due to construction of the marine ramp and seasonal dock, for a net increase of approximately 0.044 ha of high quality marine fish habitat in Bathurst Inlet (Table 3.1-1).

Table 3.1-1. Marine Fish Offsetting Habitat Budget

Type	Waterbody and Physical Works	Area (ha)
Loss	Bathurst Inlet; construction of rock jetty and associated in-water structures	0.230
Gain	Bathurst Inlet; creation of 2 offsetting reefs and side slopes of in-water ramps and landings	0.274
Ratio of Gain to Loss		**1.2 : 1.0**

Note:
This budget assumes the dimensions of ramps and landings as stated in Chapter 2 of this document. Offsetting is based on surface area of the rock jetty rather than habitat units because Habitat Suitability models for Arctic marine fish are not well developed.

The outer face of artificial reefs will be constructed of run-of-quarry rock (up to 0.5 m diameter) in order to form a complex three-dimensional microhabitat, with abundant interstitial spaces for fish, invertebrates and algae to colonize. Each of the two shoals will be laid down in water of approximately 3 m depth with a distance between reefs of approximately 20 m to minimize their effect on nearshore sediment transport (MHBL 2005).

The exact location of rock shoals will depend on final Project design, but the location is anticipated to be on the northeastern side of the bay located just south of the MLA (Figure 3.1-1). The final choice of locations will be aimed to minimize any potential negative impact that jetty traffic might have on offsetting reef habitat.

Timing of Construction: This offsetting project is unconstrained by the timing of mine operations; however, the schedule of rock shoal construction should coincide with the construction of the beach ramp and temporary dock.

3.2 PROPOSED FRESHWATER FISH OFFSETTING

The location of potential fish offsetting projects include the Rascal Outlet and Stream in the Goose Property area, a set of canyon lakes approximately 18 km northeast of the Goose Property area, and Bathurst Lake, which lies at the southern end of Bathurst Inlet and empties into the Inlet via the Western River (Figure 3.2-1; Table 3.2-1).

3.2.1 Rascal Lake to Goose Lake Stream Realignment Option

This proposed offsetting project involves the redirection of water from the eastern channel of the northern-flowing drainage from Rascal Lake into Goose Lake to be diverted wholly into the western channel, which flows through Gander Pond (Plate 3.2-1; Figure 3.2-2). Both channels currently drain northward from Rascal Lake into Goose Lake, with the eastern channel traversing the proposed airstrip and Main pit. This diversion will help minimize runoff from the Main pit from entering Goose Lake via the western channel. Moreover, the enhanced western Gander Pond channel will ensure the continued presence of a corridor for fish migration between Rascal Lake and Goose Lake, and it will provide enhanced spawning, foraging, and rearing habitat to the Arctic Grayling currently preferring this section of stream.

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Proposed Marine Shoal Locations, Back River Project, 2013

Figure 3.1-1

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Table 3.2-1. Freshwater Fish Offsetting Habitat Budget

Type	Waterbody	Physical Work	Area (ha)	Habitat Units	Population Size (95% CI)	Species Present
Loss	Llama Lake	Deposit Development	33.6	48.9	226 (4, 1794)	LKTR, RWF, SS
	Goose-Rascal Inflow	Deposit Development	0.44	0.77	NA	ARGR
	Lytle Lake	Deposit Development	1.53	0.99	NA	ARGR
	Occurrence Lake	Deposit Development	0.74	0.32	NA	ARGR
	George Outflow near Lytle Lake	Deposit Development	0.42	0.71	NA	ARGR , LKTR, SS, BB
Gain	Rascal Outlet and Stream	Enhancement	5.9	5.85	NA	ARGR
	Canyon Lakes	Enhancement; Deep Water Creation	9	24.7	NA	LKTR, ARGR, SS
	Bathurst Lake	Establish access for anadromous Arctic Char	8000	NA	NA	ARCH, LK, ARGR

Notes:
LKTR = Lake Trout, RWF = Round Whitefish, SS = Slimy Sculpin, ARGR = Arctic Grayling, ARCH = Arctic Char, BB = Burbot. NA= data not available.
See Appendix 3.2-1 and 3.2-2 for methods used to calculate Habitat Units. Species composition for Bathurst Lake has not been determined. Arctic Char and Lake Trout are thought to reside in Bathurst Lake based on the traditional knowledge report for the Back River Project (KIA 2012).

Table 3.2-2 presents a summary of the freshwater fish offsetting options currently being considered.

Table 3.2-2. Conceptual Fish Offsetting Project Summary

Offsetting Project	Biologically Feasible	Target Species	Offsetting Classification	Distance from Goose Property (km)	Value to Freshwater Fish and Fish Habitat
Rascal Lake to Goose Lake Stream Realignment (Section 3.2.1)	YES	Arctic Grayling	increase the productive capacity of like-for-like habitat in the same ecological unit	0	5.9 ha of spawning, rearing, foraging and migratory channel and off-channel habitat
Canyon Lakes Berm (Section 3.2.2)	YES	Lake Trout, Arctic Grayling	increase fish productivity in different ecological unit	18	2.9 ha of deep overwintering habitat, 0.3 ha spawning, 9 ha total area
Bathurst Lake Arctic Char Passage (Section 3.2.3)	YES	Arctic Char	increase fish productivity in different ecological unit	85	8000 ha of spawning and overwintering habitat

To achieve this offsetting, one large berm, or a series of small berms, will need to be constructed to divert flow away from the eastern channel and constrain the combined flow to fall within the existing topography of the western channel. It is recommended that the berm(s) be constructed at minimum of 31 m away from the existing and planned infrastructure.

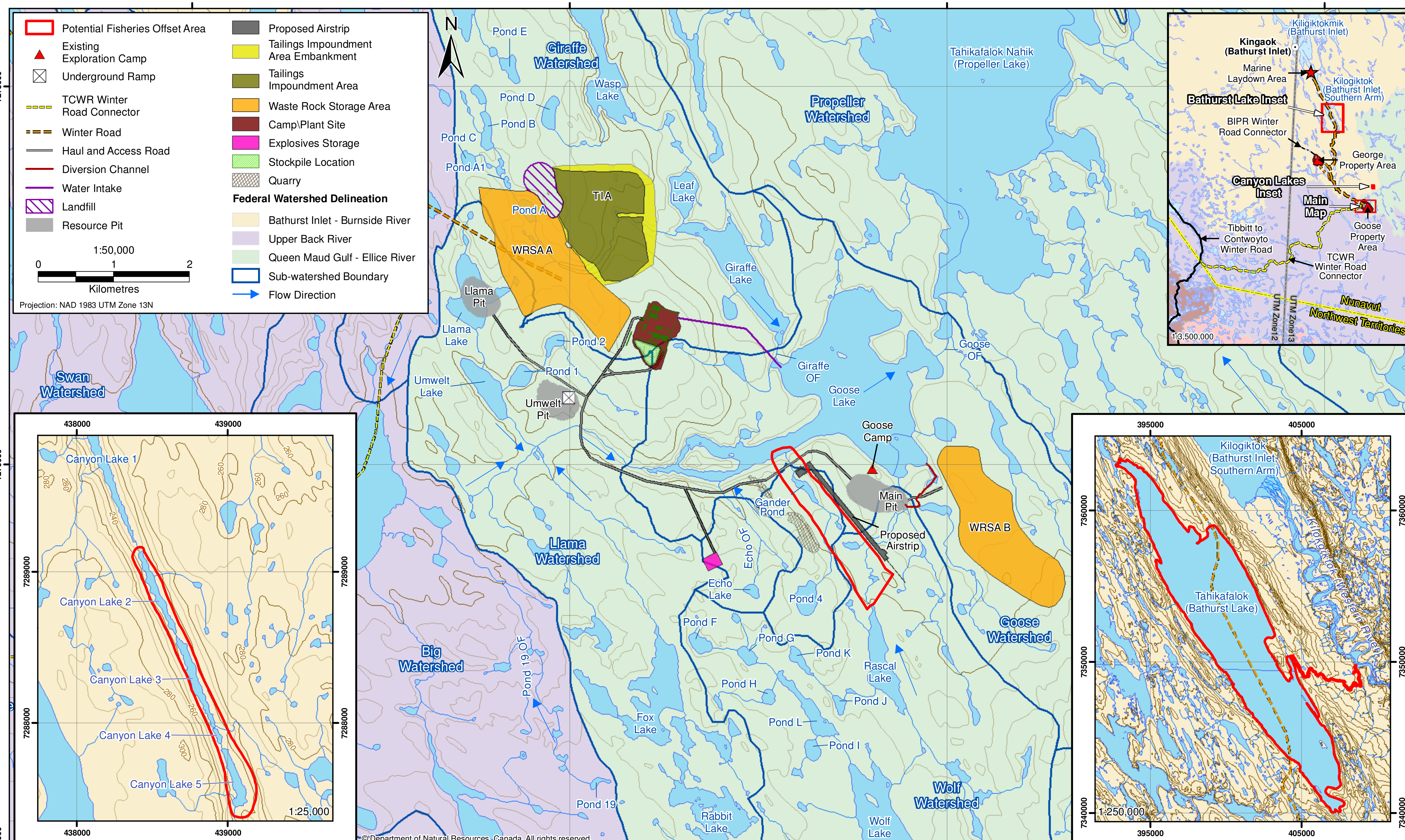

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Figure 3.2-1

Potential Fisheries Offset Areas, Back River Project, 2013

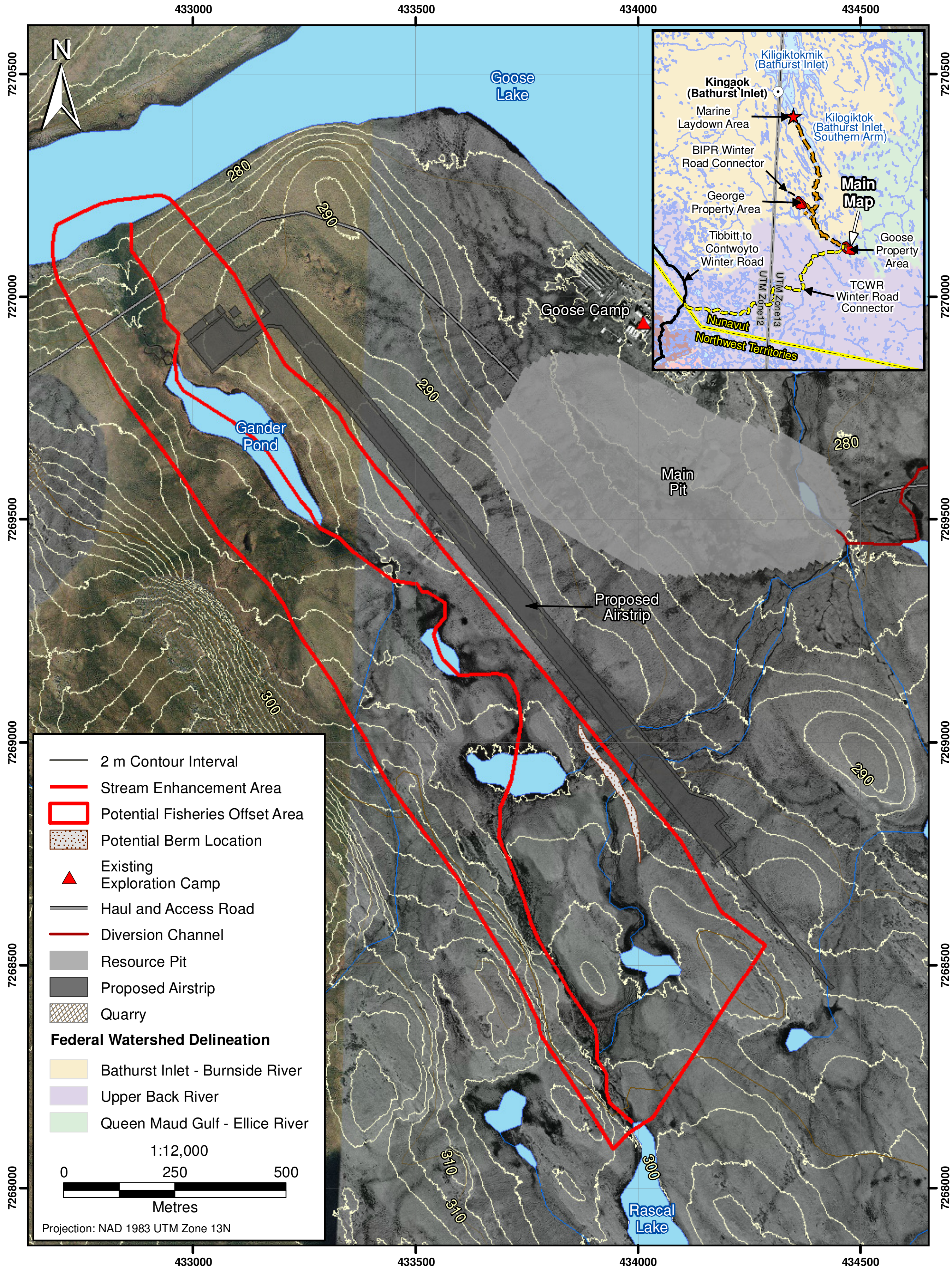

Figure 3.2-2

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Potential Fisheries Offset Area at Rascal Outlet and Stream, Back River Project, 2013

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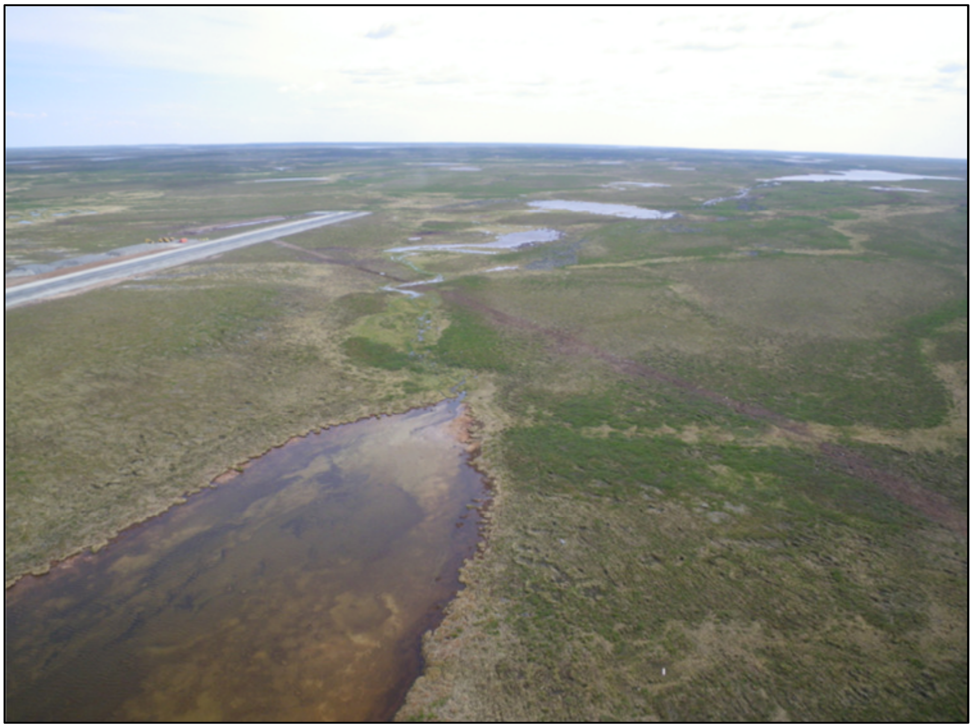

Plate 3.2-1. Site of the potential offsetting project in the western section of stream connecting Rascal Lake to Gander Pond (aerial view of Gander Pond in the foreground, looking south toward Rascal Lake at the top right). June 22, 2013.

In addition to enhancing the main stream channel with spawning gravel and cobble rock, the berm(s) will result in the development of multiple habitat types including shallow marsh and Arctic Graying rearing habitat. The total area of gained habitat for Arctic Grayling is estimated at 6.2 ha, including the enhanced stream and shallow wetlands (Appendix 3.2-3). It is expected that the consolidated flow will redefine the channels to ensure continuity and create additional habitat features. Based on field observations it is anticipated that gravel, suitable for Arctic Grayling spawning, will be exposed by the additional flow. If required, supplementary spawning gravel and cobble can be added to the new western channel using materials retrieved from appropriate sections of the eastern channel. The proposed substrate composition of newly created stream habitat is 50% cobble, 25% gravel, 15% boulder and 10% fines to facilitate spawning and rearing of Arctic Grayling (Hubert et al. 1985).

Value to Freshwater Fish and Fish Habitat**:** The enhanced western channel will be approximately 5.9 ha in area when including the small wetland area. This section of stream will maintain continuity of spawning, rearing, foraging, and migratory habitat for Arctic Grayling between Goose and Rascal lakes.

Timing of Construction**:** To avoid negatively impacting Arctic Grayling spawning in the stream between Goose and Rascal lakes, construction of the offset habitat will be required to take place prior to the loss of habitat associated with the airstrip, Main Pit, and haul road connecting Main Pit to the Goose Waste Rock Storage Area.

3.2.2 Canyon Lakes Berm Option

This proposed offsetting project involves creating additional 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, four lakes (Canyon Lakes 2 to 5; Figure 3.2-3) are proposed to be deepened by 3 m through the creation of a berm at the northern end of Lake 2 (Figure 3.2-3; Plate 3.2-2). The channels within the canyon appear to be confined within bedrock resulting in berm dimensions of approximately three metres high, 50 metres 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 by establishing a rocky shoal 50 m wide and 3 m deep at the up and downstream ends of the berm in Canyon Lakes 1 and 2, respectively.

Plate 3.2-2. Potential location of berm at the narrowing between Canyon Lakes 1 and 2. July 17, 2013.

***Value to Freshwater Fish and Fish Habitat*:** 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 (Appendix 3.2-3). In addition, this offsetting option will result in a 0.03 ha increase of Lake Trout spawning and rearing habitat through berm construction.

***Timing of Construction*:** This offsetting project is unconstrained by the timing of mine operations; however, in order to avoid affecting fish passage, water level and discharge in lakes downstream of the berm, the raising of the berm may need to be completed in stages. Additional baseline data is required prior to construction.

3.2.3 Bathurst Lake Arctic Char Passage Option

This proposed offsetting project involves opening up access to 8,000 ha in Bathurst Lake for anadromous Arctic Char to spawn and overwinter (Figure 3.2-4). Bathurst Lake currently contains a freshwater resident population of Arctic Char, along with Lake Trout and Arctic Grayling. Other species are likely to reside in the lake, but data on species composition is deficient and relies on anecdotal evidence from local fishermen.

There is an approximately 4 m high water fall located on the outlet channel of Bathurst Lake (Plate 3.2-3; UTM 13 W 0405475 m E 7349337 m N) connecting the lake to the Western River (Figure 3.2-4). The fall, located approximately 6.5 km upstream from the confluence with the Western River, inhibits upstream migration into the lake for all species, including anadromous Arctic Char. Anadromous Arctic Char are an important fish species, both culturally and economically, for Inuit resource users in Nunavut, with many populations experiencing heavy harvesting pressures (Roux et al. 2011). Thus, there is a high priority to implement mitigation strategies to offset impacts to existing *S. alpinus* populations, for example by creating new habitats for anadromous Arctic Char.

Plate 3.2-3. Bathurst Lake falls. June 15, 2013.

In addition to this main water fall barrier, there is minor cascade (Plate 3.2-4; UTM 13 W 0408105 m E 7348172 m N) located approximately 2.75 km upstream from the confluence with the Western River, which also presents a barrier for fish migration. The outfall channel from Bathurst Lake to the Western River is approximately 8.5 km in length total, 2 km of which occurs above the major fall and 6.5 km of which occurs below the major fall. The distance from (a) the confluence of the Bathurst Lake outlet channel and the Western River and (b) the point at which the Western River discharges into Bathurst Inlet is 13 km total. Therefore, in addition to the major falls and minor cascade, a grand total of 21.5 river km separates Bathurst Lake from Bathurst Inlet.

***Value to Freshwater Fish and Fish Habitat*:** Approximately 8,000 ha of spawning, rearing, and overwintering habitat could be accessible to anadromous Arctic Char from the Western River if the major falls and minor cascade were modified to be passable by this species. Opening up 8,000 ha would primarily provide extremely valuable spawning and overwintering habitat to Arctic Char residing in Bathurst Inlet and the Western River. As a secondary, passive consequence, 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.

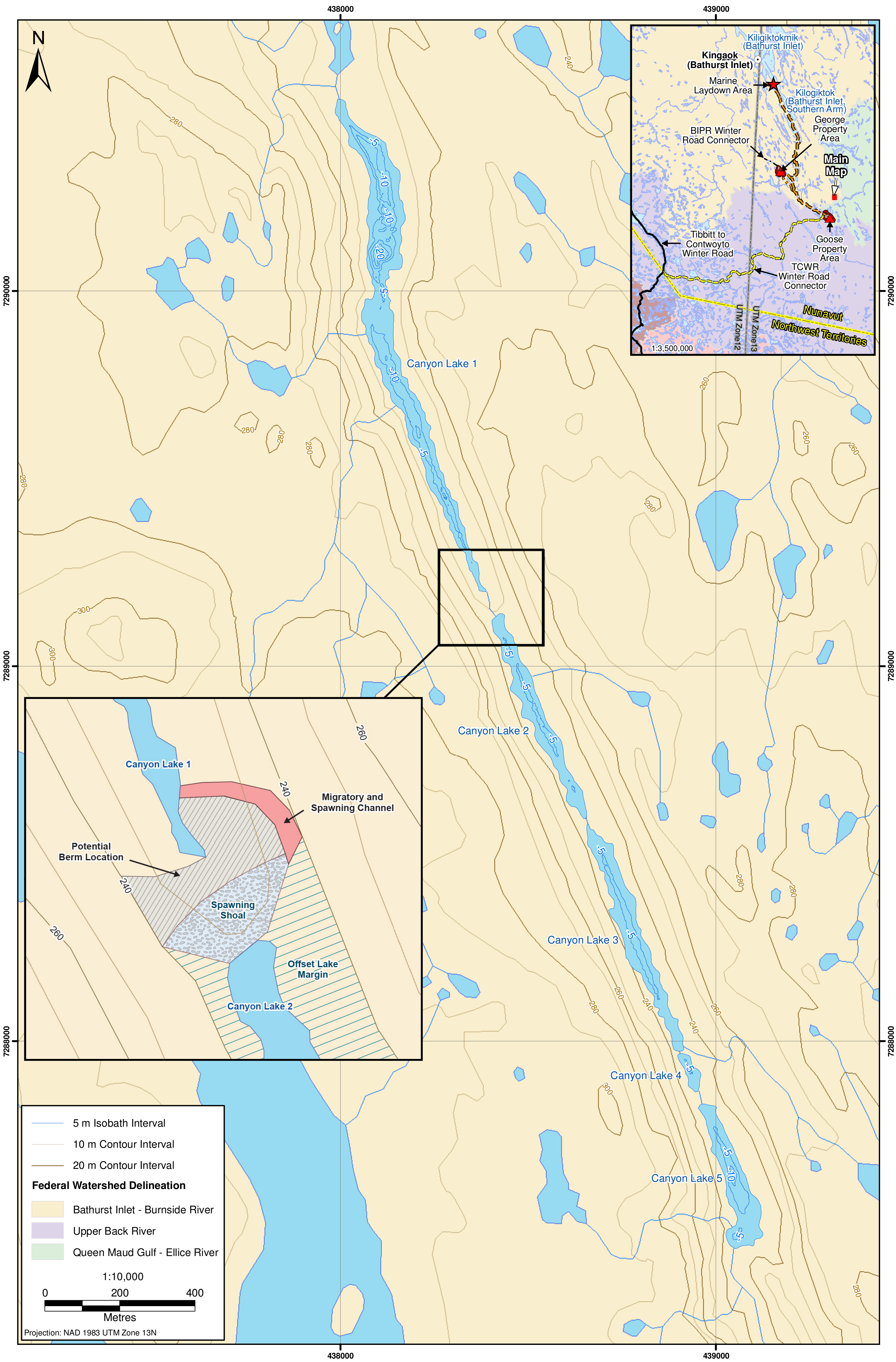

Figure 3.2-3

Potential Fisheries Offset Area at Canyon Lakes, Back River Project, 2013

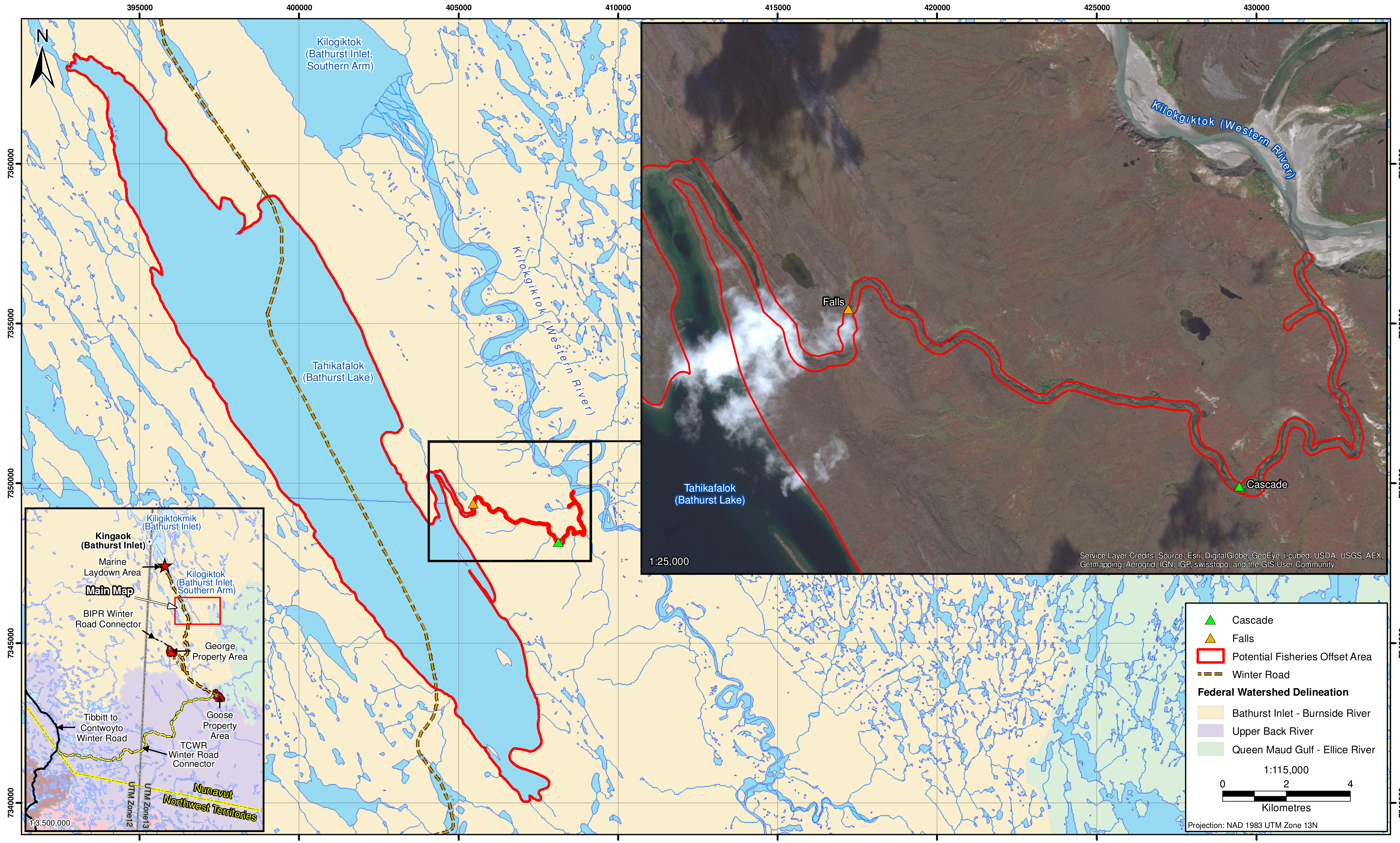

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Figure 3.2-4

Potential Fisheries Offset Area at Bathurst Lake, Back River Project, 2013

Plate 3.2-4. Cascade downstream of Bathurst Lake Outflow. June 15, 2013.

In the Canadian Arctic, distinct subspecies of Arctic Char may be either anadromous for their entire lives or 'freshwater resident' within single lakes throughout life. Moreover, up to four different ecomorphs of freshwater Arctic Char co-occur in some Arctic or sub-Arctic lakes (Skúlason and Smith, 1995). Within individual aquatic systems, these ecomorphs are often distinct from one another in terms of morphology, resource use, growth rate, physiology, and genetics (Gulseth and Nilssen, 2001; Johnston et al., 2004; Wilson et al., 2004).

Modifications to the main falls and minor cascade on the Bathurst Lake Outlet could pose potential risks to freshwater resident Arctic Char population(s) in Bathurst Lake. The reason for this is that freshwater residents are isolated and do not face competition for spawning sites and resources with anadromous members of the same species. An introduction of anadromous Arctic Char could negatively impact the population size or genetic integrity freshwater residents through competition for limited resources and gene flow through hybridization with freshwater residents.

Alternatively, 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). The monitoring program found in Section 4.2.3 identifies baseline data requirements to be addressed prior to construction of this offsetting program.

Collection of baseline data will help determine the value of introducing anadromous Arctic Char to Bathurst Lake compared to the risk of such an introduction to the freshwater resident population of Arctic Char currently inhabiting Bathurst Lake.

Timing of Construction: This offsetting project is unconstrained by the timing of mine operations; however, additional baseline data is required prior to construction.

4. Conceptual Compliance Monitoring Program

A compliance monitoring program will be implemented to determine if projects have been built as specified and approved, and that they are functioning effectively within the offsetting strategy. This will take place once the KIA and additional stakeholders have been consulted, the Final Fish Offsetting Plan has been approved by DFO, and the offsetting projects have been completed. The endpoint of this monitoring program will be to evaluate whether the offsetting projects are meeting the performance targets set out in the offsetting plan, and that the Project is successful in resulting in no net loss of fisheries productivity. In addition to monitoring offsetting projects, fish and fish habitat directly affected by the creation of Fish Offsetting Plan components will be monitored during construction to ensure that no additional effects are incurred on existing fisheries species.

The following Sections 4.1 and 4.2 outline the monitoring programs for the fish offsetting concepts outlined in chapter 3.

4.1 MARINE FISH OFFSET MONITORING

The marine offset monitoring plan is based upon the DFO approved plan for monitoring artificial marine shoals in a nearby project in Nunavut (Rescan 2010b). The two newly created artificial shoals would be placed on fine marine sediment and two natural rock shoals and two fine marine sediment sites will be chosen as control/reference sites.

The marine shoal monitoring program will assess the following according to the schedule set out in Table 4.1-1:

- Structural stability of artificial shoals.
- Sediment transport within the bay containing artificial shoals.
- Primary productivity.
- Invertebrate colonization and use.
- Fish use.

Table 4.1-1. Schedule of Marine Fish Offset Monitoring Program

	Sampling Locations		Monitoring Years (Post-construction)			
Sampling Program	**Artificial Marine Shoals**	**Reference Sites**	**Year 1**	**Year 2**	**Year 5**	**Year 6**
Physical parameters						
Stability of project works	X		X	X	X	X
Sediment transport	X		X	X	X	X
Biological parameters						
Primary productivity	X	X	X	X	X	X
Marine invertebrate use	X	X	X	X	X	X
Fish use	X	X	X	X	X	X

Physical Sampling

The physical conditions at the in-water infrastructure and offsetting sites will be monitored according to the schedule set out in Table 4.1-1. The structural stability of the jetty and rock shoals will be monitored visually and photographed to ensure that they are functioning as designed. Nearshore sediment transport around the jetty will be assessed using staff gauges installed at locations proximate to the shoals. Staff gauge data collected each sampling year will be compared to the first year of collection to document changes in sediment transport through time post-construction.

Biological Sampling

To evaluate the offsetting project's success for no net loss of fisheries productivity, primary production (as Chl *a*), algal community composition, invertebrate community composition and fish community composition will be compared to two reference habitat types (natural rocky shoals and fine marine sediments) using a Control-Impact design. The marine shoals will be considered successful once invertebrate and fish community structure and size are found to be: 1) greater than that found in reference fine sediment sites, or 2) indistinguishable to that found at reference rocky shoals.

4.2 FRESHWATER FISH OFFSET MONITORING

4.2.1 Rascal Lake to Goose Lake Stream Realignment Option

The proposed monitoring program includes measuring stream flow, temperature, water and sediment quality, primary productivity, benthic invertebrate community composition, and fish biology and habitat use. During the baseline year this data would be collected in both the enhanced western stream and the pre-construction eastern stream connecting Rascal Lake to Goose Lake.

A general schedule of sampling parameters is presented in Table 4.2-1. Not all parameters are scheduled to be sampled in each monitoring year, but rather at intervals which allow the stream community to establish and which promotes quantitative assessment of the offsetting program's effectiveness.

Table 4.2-1. Sampling Components and Frequency for the Rascal-Goose Stream Realignment Monitoring Program

Offsetting Project	Sampling Program	Baseline	Monitoring Years			
			Year 1	Year 2	Year 5	Year 6
Rascal Lake to Goose Lake Stream Realignment (Section 3.2.1)	**Physico-chemical parameters**					
	Stream flow	X	X	X	X	X
	Water quality[1]		X	X	X	X
	Sediment quality[1]		X	X	X	X
	Biological parameters					
	Primary productivity	X	X	X	X	X
	Benthic invertebrates	X	X	X	X	X
	Number of Arctic Grayling spawners[2]	X	X	X	X	X
	Visual counts of Arctic Grayling fry[2]	X	X	X	X	X
	Number of outmigrant Arctic Grayling[2]	X	X	X	X	X

Note: Monitoring of project construction is not included, but required for all projects;
[1] *Baseline data collected in 2013;*
[2] *Sampling of Arctic Grayling spawners and outmigrants will be done in both the eastern and western channels of the stream from Rascal to Goose Lake in the baseline sampling year;*

Physico-chemical Sampling

Stream Flow, Water Quality and Sediment

Stream velocity/depth measurements will be taken at the upstream and downstream ends of the enhanced stream to ensure the flow conditions are within the range of values to support the Arctic Grayling life cycle. In addition to measurements take at the outflow of Rascal Lake and inflow of Goose Lake, velocity measurements will be taken at multiple locations grouped by habitat type which will be determined post-construction.

Water temperatures will be monitored with stationary data loggers installed in the enhanced stream and wetland. Wetted and bankfull stream depth and width measurements will be taken at the outflow of Rascal Lake and inflow of Goose Lake. To ensure water and sediments fall within CCME guidelines for aquatic life, water and sediment quality will be monitored within the enhanced stream and wetland.

The schedule for each physic-chemical sampling event will be completed according to the schedule set out in Table 4.2-1.

Biological Sampling

Primary Productivity

Periphyton samples will be collected to determine the primary productivity (using Chl *a*) and community composition. Periphyton plates will be used at three sites: the outflow of Rascal Lake, the inflow of Goose Lake and at two locations within the enhanced wetland. Three replicates will be placed at each location. Samplers will be submerged at the end of July and recovered in late August or early September.

Benthic Invertebrates

Designated sampling locations for benthic invertebrate community structure will be located next to the locations selected for periphyton sampling stations. Benthic invertebrates will be collected using Hester-Dendy samplers to document invertebrate colonization. Samplers will be submerged at the end of July and recovered in late August or early September of each sampling year (Table 4.2-1). Three replicate samples will be collected within 15 m of each designated location.

Number and Biological Characteristics of Spawners

Spring migration of adult spawners through the enhanced stream will be enumerated using fish boxes according to the schedule set out in Table 4.2-1. In the enhanced stream, one fish box net will be located at the outlet of Rascal Lake, and another fish box net will be located at the inflow to Goose Lake. In addition, ratios of visual-survey-fish-counts to box-trap-counts will also be calculated to account for potential visual underestimation during the spring spawner surveys.

The fish boxes will be visited (by biologists) once each day during peak spawning migration and once every two days after peak migration. During each visit, all fish will be counted, identified to species, sub-sampled for length and weight, and released in the direction they were swimming. All Arctic Grayling ≥ 170 mm long will be tagged with a unique T-bar Floy Tag attached below the dorsal fin. Tagging of Arctic grayling will allow for evaluation of fish movement patterns and time spent rearing in the channel, and it will also provide further insights into the overwintering potential of Rascal Lake and Goose Lake.

Fish Surveys

Fish surveys will be conducted according to the schedule set out in Table 4.2-1. Emergent Arctic Grayling fry will be enumerated in mid-July to help determine if the enhanced stream diversion is being used successfully for spawning. Fry will be counted using walking surveys of the enhanced stream and the reference stream. Subsequent dipnet/pole seine surveys will used to determine fish-size-at-sampling-date. These data will allow for the direct comparisons of fry health and growth between the enhanced western channel and baseline measurements taken at the eastern channel. Electrofishing surveys also will be conducted to determine which fish species utilize the newly created habitat in the enhanced stream. These electrofishing surveys will take place in mid-August at the same locations as used for the dipnet/pole seine surveys, though additional fry length/weight measurements will be made during the electrofishing surveys.

Number and Biological Characteristics of Outmigrants

Juvenile fish movement through the enhanced stream prior to winter freeze-up will be monitored using fyke nets. Two nets will be installed from early July until mid-October: one at the outlet of Rascal Lake and a second located at the inflow to Goose Lake. All fyke nets will be visited (by biologists) once each day during peak outmigration, and once every two days after peak migration. During each visit, all fish will be counted, identified to species, sub-sampled for length and weight, and released in the direction they were swimming. Fyke nets will allow for the determination of stream residence time of fry and juvenile fish, as well as the total growth of fry during their stream residence.

<u>Evaluating Success of the Offsetting Project</u>

To evaluate the offsetting project's success for no net loss of fisheries productivity, primary production (as Chl*a*), periphyton community composition, invertebrate community composition and fish use parameters will be compared to baseline conditions using a Before-After/Control-Impact (BACI) design. Temporal trends in measured parameters will also be examined.

The offsetting project will be considered successful if parameters measured in the western stream are found to be: 1) greater than that found during baseline conditions in the western stream (before-after), 2) indistinguishable to that found during baseline conditions in the eastern stream (control-impact), and 3) improve over successive sampling intervals post-construction (trends through time).

4.2.2 Canyon Lakes Berm

The proposed monitoring program includes stability surveys, stream flow measurements, water and sediment quality, primary productivity, benthic invertebrate community composition, and fish community composition, biology and habitat use.

A general schedule of sampling parameters is presented in Table 4.2-2. Not all parameters are scheduled to be sampled in each monitoring year, but rather, at intervals which allow the ecological community to establish and which promotes quantitative assessment of the offsetting program's effectiveness. For example, the lake perimeter survey and bathymetry and habitat surveys are scheduled to occur twice in the monitoring period because changes in these parameters are not expected over short time scales.

<u>Physico-chemical Sampling</u>

Lake Perimeter Survey

The lake perimeter will be surveyed prior to berm construction and lake inundation to provide detailed information on the structure of the shoreline and newly created littoral habitat after lake expansion. The surveyed area will include the side slopes of canyon walls around the perimeter of the lake, so that shoreline stability can be monitored. All surveys will be tied in to local survey benchmarks.

Table 4.2-2. Sampling Components and Frequency for the Canyon Lakes Berm Monitoring Program

Offsetting Project	Sampling Program	Baseline	Monitoring Years			
			Year 1	Year 2	Year 5	Year 6
Canyon Lakes Berm (Section 3.2.2)	**Physico-chemical parameters**					
	Lake perimeter survey	X	X		X	
	Bathymetry[1] and habitat survey	X	X		X	
	Stability of berm		X	X	X	X
	Discharge and water level		X	X	X	X
	Water quality	X	X	X	X	X
	Sediment quality	X	X	X	X	X
	Biological parameters					
	Primary productivity	X	X	X	X	X
	Benthic invertebrates	X	X	X	X	X
	Fish community, population, biology	X	X	X	X	X
	Spawning survey			X	X	X

Note: Monitoring of project construction is not included, but required for all projects;
[1] Baseline data collected in 2013.

Bathymetry and Habitat Survey

Bathymetric surveys will be used to track subsurface stability of lake slopes and habitat features including spawning shoals. These surveys will be performed while following established transects. Sampling locations along transects will be closely spaced to provide accurate surveys with good data coverage.

Bathymetric assessments will be completed according to the schedule set out in Table 4.2-2. The frequency of surveys will be reassessed instability is observed.

Visual Stability Assessment

During each year of monitoring, a visual inspection of the berm will be completed. Detailed notes and photographs will be collected and compared to previous assessments. The berm will be assessed for all signs of structural instability. The stability of fish habitat features will be visually assessed and photographed.

Discharge and water level

A hydrometric monitoring station will be installed and operated throughout the year to track the water level and discharge rate of the lake.

Water and Sediment Quality

To ensure water quality and sediment quality fall within CCME guidelines for aquatic life after the lakes have been inundated, metal concentrations will be monitored within each canyon lake. One water quality station will be set up in each canyon lake and additional measurements of dissolved oxygen (DO) and temperature profiles will also be collected.

Biological Sampling

Primary Productivity

Periphyton samples will be collected to determine the primary productivity (using Chl *a*) and community composition. Periphyton plates will be used at three sites within each lake and within the stream channel created on the berm. Three replicates will be placed at each location. Samplers will be submerged at the end of July and recovered in late August or early September.

Benthic Invertebrates

Designated sampling locations for benthic invertebrate community structure will be located next to the locations selected for periphyton sampling stations. Hester-Dendy samplers will be used to provide results on short-term invertebrate colonization. Samplers will be submerged at the end of July and recovered in late August or early September of each sampling year (Table 4.2-2). Three replicate samples will be collected within 15 m of each designated location.

Fish Community, Population and Biology

The goal of fish community and biological sampling is to determine if fish productivity for targeted species (Lake Trout and Arctic Grayling) increases. To accomplish this, several community, population and individual level parameters will be assessed in each lake by stratified random gillnetting each sampling year (Table 4.2-2). Overall fish community and composition in each of the canyon lakes will be assessed using overall catch per unit effort (CPUE) and species relative species abundance. Population abundance and structure will be examined through species specific CPUE, and length and age frequency analysis. Fish health and condition will be examined using condition (i.e., weight-length regression) and external examination for deformities, eroded fins, lesions, and tumours (DELT).

Spawning Survey

A survey of Lake Trout spawning along the up and downstream edges of the constructed berm will be accomplished starting the second year post-construction. Spawning surveys will be conducted in September of each sampling year found in Table 4.2-2. Surveys will consist of underwater video capture, or snorkel survey, both at night and during daylight to document spawning, egg deposition, and substrate rubbing. Short-term gillnetting with small mesh gillnets will be used to confirm reproductive status of individuals caught on spawning sites. Egg nets or mats will be used to collect and enumerate the Lake Trout spawning.

Evaluating Success of the Offsetting Project

To evaluate the offsetting project's success for no net loss of fisheries productivity, primary production (as Chl *a*), periphyton community composition, invertebrate community composition and fish community, population and biology parameters will be compared to baseline conditions using a Before-After design and by examining temporal trends.

The offsetting project will be considered successful if post-construction parameters measured are found: 1) to be greater than that found during baseline conditions (before-after), or 2) to increase over successive sampling intervals post-construction (trends through time). In addition, successful Lake Trout spawning on newly created spawning habitat will also confirm the success of the offsetting project.

4.2.3 Bathurst Lake Arctic Char Passage

The proposed Bathurst Lake monitoring program includes stability surveys, stream flow measurements, primary productivity, benthic invertebrate community composition, fish community composition, and Arctic Char biology and monitoring of migratory patterns.

A general schedule of sampling parameters is presented in Table 4.2-3. All parameters are not scheduled to be sampled in each monitoring year, but rather, at intervals which allow ecological community to establish and promote quantitative assessment of the offsetting program's effectiveness.

Table 4.2-3. Sampling Components and Frequency for the Bathurst Lake Arctic Char Passage Monitoring Program

Offsetting Project	Sampling Program	Baseline	Monitoring Years			
			Year 1	Year 2	Year 5	Year 6
Bathurst Lake Arctic Char Passage (Section 3.2.3)	**Physical parameters**					
	Stability of project works		X	X	X	X
	Stream flow project works		X	X	X	X
	Biological parameters					
	Primary productivity (periphyton and phytoplankton) [1]	X	X	X	X	X
	Invertebrates (benthos and zooplankton) [1]	X	X	X	X	X
	Fish community structure[1]	X	X	X	X	X
	Arctic Char population structure[1]	X	X[2]	X[2]	X[2]	X[2]
	Number of migrant Arctic Char[1]	X	X	X	X	X

Note: Monitoring of project construction is not included, but required for all projects;
[1] *Baseline sampling for Bathurst Lake should be done a minimum of 2 years prior to construction to evaluate the programs potential for success;*
[2] *Morphological and genetic sampling of Arctic Char may be removed from monitoring years if no differences are found between freshwater resident and anadromous fish in baseline sampling.*

Physical Sampling

Stability of Project Works

The stability of all modifications to the falls and cascade will be surveyed starting in year 1 post-construction (Table 4.2-3). All surveys will provide photographs at standardized locations which are to be tied in to local survey benchmarks.

Stream Flow Project Works

To ensure the flow conditions are within the range of values to support the Arctic Char migration, stream velocity measurements will be taken at six locations: the outflow of Bathurst Lake, upstream and downstream of the construction sites (falls and cascade), and where the stream discharges into the Western River. In addition, wetted and bankfull stream depth and width measurements will be taken at each site to monitor stream morphology.

Biological Sampling

Primary Productivity

Periphyton samples will be collected to determine the primary productivity (using Chl *a*) and community composition. Periphyton plates will be used at four sites within the stream discharging Bathurst Lake to the Western River: 1) Bathurst Outflow, 2) downstream of the construction site at the falls, 3) downstream of the construction site at the cascade, and 4) upstream of the stream outlet to the Western River. Three replicates will be placed at each location. Samplers will be submerged at the end of July and recovered in late August or early September.

Phytoplankton biomass (measured as Chl *a* concentration) and Secchi depths (water clarity; open-water only) will be measured to assess any changes in Bathurst Lake primary production. Three replicate samples will be taken once per year in August at three station locations in Bathurst Lake, one station near the outflow and two stations located in open water.

Invertebrates: Benthos and Zooplankton

Lower trophic level sampling will be conducted at both stream and lake sites. Stream sampling locations for benthic invertebrate community structure will be positioned next to the locations selected for periphyton sampling stations. Hester-Dendy samplers will be used to provide results on short-term invertebrate colonization. Samplers will be submerged at the end of July and recovered in late August or early September of each sampling year (Table 4.2-3). Three replicate samples will be collected within 15 m of each designated location.

Lake benthic invertebrate community structure will be completed using an Ekman grab at five sites within Bathurst Lake during the month of August in sampling years (Table 4.2-3). Sampling sites will be located: one site within the bay at Bathurst Outflow and four sites chosen near Arctic Char spawning grounds.

Lake zooplankton community structure will be assessed by performing vertical zooplankton tows at the same three stations selected for phytoplankton sampling. For each sampling station, six zooplankton tows will be performed for a total of 18 samples per station. Sampling will be completed in August of each sampling year (Table 4.2-3) coinciding with phytoplankton sampling.

Fish Community Structure

To assess the fish community composition, species relative abundance and CPUE in Bathurst Lake, the stream connecting Bathurst Lake to the Western River, and the Western River, stratified random, non-lethal sampling will be conducted using a variety of gear types, including: gillnets, fyke nets, beach seines and minnow traps and electrofishing, where appropriate.

Biological sampling of 30 individuals of each species will also be conducted to determine the health, size and age structure of populations. This will include collecting data on individual length, weight, condition, age (from scales and fin rays), diet and trophic status (stable isotopes of Carbon and Nitrogen) and DELTs. More detailed biological data will be collected on incidental mortalities, including gonad and liver weight and removing otoliths for aging.

Community structure will be assessed in baseline and monitoring years according to the schedule set out in Table 4.2-3.

Arctic Char Population Structure

Additional data collected on Arctic Char is required to assess and monitor the population structure, morphology, migratory pattern, and population divergence of freshwater residents from Bathurst Lake and anadromous Arctic Char from the Western River. Data collected on Arctic Char captured during the stratified random sampling for fish community structure will be used. However, if sample sizes are insufficient to meet the statistical requirements additional sampling will be completed. A minimum of

30 individuals are required to examine change in mean length, however a minimum sample size of 100 is recommended to examine changes in size classes (Guy and Brown 2007).

In addition to length, weight, condition, age, diet and DELTs, morphological features known to distinguish freshwater resident from anadromous Arctic Char will be made. These measures include: relative body depth, relative head and eye sizes, and gill raker density (Skúlason and Smith 1995; Parsons et al. 2010).

Migratory history (i.e., anadromy or freshwater residence) and population (genetic) divergence of Arctic Char will be examined on samples from 15 randomly selected individuals from Bathurst Lake and in the Western River during baseline, and in Bathurst Lake and at the fish fence during monitoring years (see below). For each individual, migratory history will be assessed using the strontium/calcium (Sr/Ca) ratio found in otoliths. Analyses of the Sr/Ca ratio and the growth ring structure of Arctic Char otoliths allow fisheries biologists to distinguish lake resident from anadromous individuals, and to determine growth rates and life history characteristics (Radtke et al. 1996; Babaluk et al. 2001). Population genetic divergence will be assessed using fin tissue clips preserved in 95% ethanol and then genotyped at 12-18 microsatellite loci (Moore et al. *In Press*).

Arctic Char population structure will be assessed in baseline and monitoring years according to the schedule set out in Table 4.2-3. In the event that freshwater resident Bathurst Lake and anadramous Western River populations are not found distinguishable morphologically or genetically in baseline sampling, morphology and genetics may be removed from the sampling program in monitoring years.

Number of Migrant Arctic Char

The most effective measure of migration of Arctic Char into Bathurst Lake will be achieved by installing and monitoring a fish fence near the outflow of Bathurst Lake. This method involves enumerating adult Arctic Char passing through a fence and trap box over the migratory window from late July to early September in each monitoring year (Table 4.2-3).

Additional biological data will be collected from Arctic Char migrating through the fish fence. These include the marking of individuals with tagged with a unique pit or T-bar Floy Tag to identify and estimate survival in migrants returning in multiple years and non-lethal measurements of length, weight, age and DELTs to monitor changes in fish health.

<u>Evaluating Success of the Offsetting Project</u>

To evaluate the offsetting project's success for no net loss of fisheries productivity, primary production (as Chl *a*), periphyton community composition, invertebrate community will be compared to baseline conditions using a Before-After design and by examining temporal trends. The number, biology and health of migrants and stability of population structure in Bathurst Lake will be compared using a Before-After design and by examining temporal trends.

The offsetting project will be considered successful if: 1) an anadromous Arctic Char migration into Bathurst Lake is achieved over monitoring years and 2) the biology and health of Arctic Char in Bathurst Lake remains the same or improves over baseline conditions or with time (before-after). In addition, successful fish offsetting will be achieved if post-construction parameters of primary production and lower trophic level community structure are found to be: a) greater than that found during baseline conditions (before-after), or b) increase over successive sampling intervals post-construction (trends through time).

4.3 ADAPTIVE MANAGEMENT

Once the monitoring programs demonstrate that the enhanced features are functioning as intended no further monitoring obligations will occur. Any components of which do not function as intended may require additional monitoring and/or remedial activities until the offset habitat is demonstrated to be functioning as intended.

4.4 FISH-OUT PROGRAM

A fish-out program will be carried out for any lakes that are lost as a result of the Project. The fish-out program would follow DFO's *General Fish-Out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut* (Tyson et al. 2011). A fish-out or the removal of fish from a waterbody offers a unique opportunity to gather information on lake productivity and the fish community, as well as avoid any "wastage" by making the fish available for traditional use by local communities (Tyson et al. 2011).

The DFO fish-out program protocol is divided into three components:

1. Fish Community, this is divided into three phases:
    - Marking Phase (part of a mark-recapture study).
    - Catch-per-Unit-Effort (CPUE)/Recapture Phase.
    - Final Removal Phase.
2. Aquatic Biology and Limnology.
3. Habitat Inventory.

In addition to following the DFO protocols for a fish-out, Sabina would collaborate with communities to involve interested parties in the program with the possibility to distribute fish for human or dog consumption.

4.4.1 Fish Community

Marking Phase

The Marking Phase is the first part of a mark-recapture study that will provide a population estimate for large-bodied fish, and help determine the end-point of the fish-out program. The Marking Phase will occur prior to the fish-out, preferably the year prior to lake dewatering to ensure adequate sampling time. There will be one week of gillnetting after ice-off (June/July), using smaller mesh gillnets of short one-hour sets to reduce mortalities. Nets will be periodically moved to survey all available habitats. All captured fish will be live-released. Additional capture methods, such as angling, may be employed if the mortality rate using gillnets is too high during the marking phase. Captured fish will be identified to species, measured for fork length and weight, noted for any signs of injury/stress, and all healthy fish (Lake Trout and Round Whitefish) will receive a caudal fin clip and a numbered T-bar anchor tag inserted through the dorsal sinus under the base of the dorsal fin. Metals and contaminants will be assessed in a sub-sample of fish by taking a non-lethal tissue biopsy sample after anaesthetization to confirm if fish are safe for transfer or human and/or dog consumption.

CPUE/Recapture Phase

The CPUE/Recapture Phase involves intensively fishing Llama Lake and is the recapture portion of the mark-recapture study. Fishing will occur between July and August of the year that lake dewatering will occur. During this phase, the standard unit of fishing effort remains unchanged (e.g., the duration of net sets are the same). Gillnets (for larger fish) and minnow traps (for smaller fish) will be set for

24 hours. The standard gillnet gang used throughout the CPUE/Recapture Phase will include different mesh sizes to obtain all sizes of fish (e.g., 102 mm [4”], 76 mm [3”], 51 mm [2”], 38 mm [1.5”], 25 mm [1”], and 13 mm [0.5”]). Baited Gee minnow traps fish the littoral zone for smaller fish. The number of nets/traps will vary throughout the fishing period (generally increasing as catches decrease yet depends on crew size) and are set randomly in the lake (only in the littoral zone for the minnow traps). Ideally, the CPUE/Recapture Phase is completed when no fish are captured for 24-48 hours of continuous netting, nets are removed for 48 hours, and then re-deployed for 24-48 hours and fish are still not captured. All fish will be sacrificed, sampled, and distributed to members of the communities. All fish will be identified by species, given a unique fish number, measured for fork length and weight, and the presence of tags (and tag numbers) and fin clips recorded. If the population is large, the following sampling will occur for the first 50 individuals per 20 mm size class (smaller size classes for smaller fish): sex, maturity, reproductive status, ageing structures taken (e.g., otoliths, pectoral fin rays, and scales), note obvious internal and external deformities, erosions, lesions and tumours (DELTs), and collect biological tissues (e.g., gonads, livers, stomachs, muscle tissue (for contaminants and stable isotopes)). All food fish will be eviscerated and prepared to be sent to local communities.

Final Removal Phase

The Final Removal Phase involves capturing the remaining fish using all available gear (plus the same gear as before). This final phase can start once the CPUE Phase is completed (typically between August and September) and can occur when lake dewatering has begun. Biological sampling is the same as the CPUE Phase. The Final Removal Phase is complete when the majority of marked fish have been captured.

4.4.2 Aquatic Biology and Limnology

The Aquatic Biology and Limnology component of the fish-out program includes physical limnology measurements, water quality, chlorophyll *a*, and zooplankton samples. All samples will be collected three times during the fish-out program: July (before the fish-out), August, and September (before dewatering). Benthic invertebrate sampling will be collected once in August, from four different depth intervals and sampling methods will be the same as those outlined in the Aquatic Effects Monitoring Program (AEMP).

4.4.3 Habitat Inventory

The Habitat Inventory component will be conducted using bathymetry and littoral habitat surveys prior to the fish-out in July as well as an additional habitat survey after lake dewatering has begun (e.g., September) to confirm accuracy of the original survey.

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Appendix 2.1-1

Summary of Mean CPUE near the Marine Laydown Area, 2012

Appendix 2.1-1. Summary of Mean CPUE near the Marine Laydown Area, 2012

	Gillnet (no. fish/100 m^2/h)			Long Line (no. fish/number of pairs of hooks/h			Beach Seine (no. fish/100 m^2)			Crab trap (no. fish/day)			Minnow trap (no. fish/day)		
Species	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**
Arctic Cisco	6	1.36	0.53	2	0	0	10	0	0	12	0	0	28	0	0
Arctic Flounder	6	0.1	0.09	2	0	0	10	0.2	0.19	12	0.08	0.27	28	0	0
Broad Whitefish	6	0.07	0.06	2	0	0	10	0	0	12	0	0	28	0	0
Capelin	6	0	0	2	0	0	10	29.39	18.8	12	0	0	28	0	0
Fourhorn Sculpin	6	2	1.81	2	0	0	10	2.17	1.36	12	0	0	28	0.07	0.27
Pacific Herring	6	4.47	2.47	2	0	0	10	0	0	12	0	0	28	0	0
Rainbow Smelt	6	0.48	0.34	2	0	0	10	0	0	12	0	0	28	0	0
Saffron Cod	6	4.42	3.86	2	0.015	0.02	10	0	0	12	0	0	28	0	0
Slender Eelblenny	6	0.24	0.22	2	0	0	10	0.2	0.19	12	0	0	28	0	0
Starry Flounder	6	0.3	0.28	2	0	0	10	32.41	19.52	12	0	0	28	0	0
Ninespine Stickleback	6	0	0	2	0	0	10	0	0	12	0	0	28	0.04	0.19

Appendix 2.2-1

Summary of Mean CPUE in Waterbodies within the Goose and George Properties, 1990, 2010 and 2012

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Appendix 2.2-1. Summary of Mean CPUE in Waterbodies within the Goose and George Properties, 1990, 2010 and 2012

			Floating Gillnet (no. fish/100 m^2/h)					Sinking Gillnet (no. fish/100 m^2/h)					Minnow trap (no. fish/day)	
Property	Waterbody	Year	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	n	Slimy Sculpin
Goose	Llama Lake	2010	2	0	0.14 (0.19)	0.05 (0.07)	0	3	0	0.14 (0.16)	0	0	0	-
		2011	0	-	-	-	-	11	0	0.19 (0.19)	0.03 (0.09)	0	0	-
		2012	0	-	-	-	-	4	0	0.4 (0.20)	0.98 (0.46)	0	0	-
	Umwelt Lake	2010	1	0.09	0	0	0	2	0.2 (0.27)	0	0.06 (0.09)	0	0	-
		2011	0	-	-	-	-	4	0	0	0.14 (0.29)	0	0	-
		2012	0	-	-	-	-	6	0.07 (0.06)	0.05 (0.05)	0	0	0	-
	Goose Lake	2011	0	-	-	-	-	8	0	0.33 (0.46)	0	0	0	-
		2012	0	-	-	-	-	6	0	0.29 (0.13)	0	0	0	-
	Rascal Lake	2012	0	-	-	-	-	7	0	0.19 (0.08)	0	0	0	-
	Rascal-Goose Inflow	2012	0	-	-	-	-	0	-	-	-	-	0	-
	Llama-Umwelt Inflow	2012	0	-	-	-	-	0	-	-	-	-	0	-
	Pond 1	2011	0	-	-	-	-	2	0	0	0	0	9	0
	Pond 2	2011	0	-	-	-	-	0	-	-	-	-	10	0
	Pond A	2011	0	-	-	-	-	3	0	0	0	0	10	0
	Pond B	2011	0	-	-	-	-	3	0	0	0	0	10	0
	Pond C	2011	0	-	-	-	-	2	0	0	0	0	9	0
	Pond D	2011	0	-	-	-	-	3	0	0	0	0	9	0.11 (0.32)
	Pond E	2011	0	-	-	-	-	0	-	-	-	-	10	0
George	George Lake	1990	0	-	-	-	-	1	X	X	0	0	0	-
		2007	0	-	-	-	-		0	X	0	0		0
		2012	0	-	-	-	-	6	0	0.85 (0.67)	0	0	0	-
	Bob Lake	1990	0	-	-	-	-	1	0	0	0	0	0	-
		2007	0	-	-	-	-		0	X	0	0		0
	Occurrence Lake	2007	0	-	-	-	-		0	0	0	0		0
		2012	0	-	-	-	-	6	0	0	0	0	0	-
	Lytle Lake	1990	0	-	-	-	-	1	0	0	0	0	0	-
		2007	0	-	-	-	-		0	0	0	0		0
		2012	0	-	-	-	-	0	-	-	-	-	0	-
	Sleigh Lake	2012	0	-	-	-	-	0	-	-	-	-	0	-
	George Outflow	1990	0	-	-	-	-	0	-	-	-	-	0	-
		2007	0	-	-	-	-	0	-	-	-	-	0	-
		2012	0	-	-	-	-	0	-	-	-	-	0	-

Note: Each data cell shows mean CUPE followed by standard deviation in parenthesis. Electrofishing results are single observatations derived from the equation shown in the column header

n = number of nets set

dashes indicate data not available

X = fish were present, catch-per-unit-effort could not be determined from the source report (Sekerak 1990; Golder 2007)

Appendix 2.2-1. Summary of Mean CPUE in Waterbodies within the Goose and George Properties, 1990, 2010 and 2012

			Beach Seine (no. fish/100 m^2)						Electrofishing (no. fish/100 s)						Visual Observation	
Property	Waterbody	Year	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	Ninespine Stickleback	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	Burbot	Ninespine Stickleback	Arctic Grayling	Lake Trout
Goose	Llama Lake	2010	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2012	9	0	0	0.97 (0.83)	0.19 (0.12)	0	-	-	-	-	-	-	-	-
	Umwelt Lake	2010	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2012	2	4.53 (2.01)	0	0	0	0	-	-	-	-	-	-	-	-
	Goose Lake	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2012	12	0.06 (0.16)	0	1.92 (3.26)	0.04 (0.14)	0.19 (0.45)	-	-	-	-	-	-	-	-
	Rascal Lake	2012	4	0	1.00 (0.47)	0	0	0	-	-	-	-	-	-	-	-
	Rascal-Goose Inflow	2012	0	-	-	-	-	-	0	0	0	0.71	0	1.32	>300	0
	Llama-Umwelt Inflow	2012	0	-	-	-	-	-	1.19	0	0.11	0.65	0	0	>20	0
	Pond 1	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 2	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond A	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond B	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond C	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond D	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond E	2011	0	-	-	-	-	-	-	-	-	-	-	-	-	-
George	George Lake	1990	2	0	0	0	0	0	-	-	-	-	-	-	-	-
		2007		-	-	-	-	-	-	-	-	-	-	-	-	-
		2012	10	0	0	0	0.21 (0.45)	0	-	-	-	-	-	-	-	-
	Bob Lake	1990	2	0	0	0	0	0	-	-	-	-	-	-	-	-
		2007	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Occurrence Lake	2007		0	0	0	0	0	-	-	-	-	-	-	-	-
		2012	4	0	0	0	0	0	-	-	-	-	-	-	-	-
	Lytle Lake	1990	1	0	0	0	0	0	-	-	-	-	-	-	-	-
		2007	0	-	-	-	-	-	-	-	-	-	-	-	-	-
		2012	12	0	0	0	0	0	-	-	-	-	-	-	-	-
	Sleigh Lake	2012	12	0.29(0.62)	0	0	0	0	-	-	-	-	-	-	-	-
	George Outflow	1990	1	X	X	0	0	0	-	-	-	-	-	-	-	-
		2007	0	-	-	-	-	-	0.1	0	0	0.194	0.29	0	-	-
		2012	0	-	-	-	-	-	0	0.16	0	0	0	0	0	2

Note: Each data cell shows mean CUPE followed by standard deviation in parenthesis. Electrofishing results are single observatations derived from the equation shown in the column header

n = number of nets set

dashes indicate data not available

X = fish were present, catch-per-unit-effort could not be determined from the source report (Sekerak 1990; Golder 2007)

Appendix 2.2-2

Tabulated Fishing Effort and Catch Numbers between June and August, 2013

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Appendix 2.2-2. Tabulated Fishing Effort and Catch Numbers between June and August, 2013

			Floating Gillnet (# fish)					Sinking Gillnet (# fish)					Beach Seine (# fish)					
Property	Waterbody	Year	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	n	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	Ninespine Stickleback
Goose	Propellor	2013	2	0	1	0	0	1	0	3	0	0	-	-	-	-	-	-
	Ref. B	2013	2	0	1	0	0	2	0	3	5	0	-	-	-	-	-	-
	Giraffe	2013	2	0	2	0	0	2	0	7	2	0	-	-	-	-	-	-
	Goose	2013	2	0	0	0	0	2	0	3	0	0	-	-	-	-	-	-
	Propeller Lake	2013	6	0	2	4	0	5	0	1	0	0	-	-	-	-	-	-
	Canyon Lakes	2013	6	4	0	0	0	6	10	7	0	0	-	-	-	-	-	-
	Giraffe inflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Wasp inflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Umwelt-Goose	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gander pond outflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gander pond inflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Echo lake	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 1	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 2	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond D	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond E	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Llama-Umwelt	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lytle	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Occurrence	2013	2	0	0	0	0	2	0	0	0	0	-	-	-	-	-	-
George	Bob	2013	2	0	0	0	0	2	0	2	0	0	-	-	-	-	-	-
	Komatic	2013	1	0	4	0	0	2	0	6	0	0	-	-	-	-	-	-
	Ref. Q	2013	4	0	4	0	0	4	0		6	0	-	-	-	-	-	-
	George	2013	3	0	6	0	0	5	0	2	0	0	14	6	0	0	4	0
	McCoy	2013	4	0	3	0	0	4	0	6	0	0	-	-	-	-	-	-
	Lytle	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Occurrence	2013	2	1	0	0	0	1	0	0	0	0	-	-	-	-	-	-
	George inflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	George outflow	2013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Each data cell shows the total number of individuals caught.

The electrofishin effort is estimated from field notes, the final effort will be calculated when all data is analysed for the 2013 Baseline report.

Appendix 2.2-2. Tabulated Fishing Effort and Catch Numbers between June and August, 2013

Property	Waterbody	Year	Electrofishing (#. fish)							Visual Observation		Angling (# fish)			
			n (days)	Arctic Grayling	Lake Trout	Round Whitefish	Slimy Sculpin	Burbot	Ninespine Stickleback	Arctic Grayling	Lake Trout	n (days)	Arctic Grayling	Lake Trout	Round Whitefish
Goose	Propellor	2013	-	-	-	-	-	-	-	0	0	1	0	6	0
	Ref. B	2013	1	0	0	0	20	0	0	0	0	1	0	6	0
	Giraffe	2013	1	0	0	0	39	0	0	0	0	1	0	3	0
	Goose	2013	-	-	-	-	-	-	-	0	0	0	0	0	0
	Propeller Lake	2013	1	3	0	0	10	4	9	0	0	0	0	5	0
	Canyon Lakes	2013	-	-	-	-	21	2	1	0	0	0	2	1	0
	Giraffe inflow	2013	1.5	0	0	0	0	0	0	0	0	-	-	-	-
	Wasp inflow	2013	0.5	1	0	0	1	0	0	0	0	-	-	-	-
	Umwelt-Goose	2013	1	0	0	0	0	0	0	0	0	-	-	-	-
	Gander pond outflow	2013	1.5	1	0	0	1	1	14	0	0	-	-	-	-
	Gander pond inflow	2013	0.5	0	0	0	0	0	0	0	0	-	-	-	-
	Echo lake	2013	0.5	0	0	0	0	0	0	0	0	-	-	-	-
	Pond 1	2013	0.5	0	0	0	0	0	1	0	0	-	-	-	-
	Pond 2	2013	0.5	0	0	0	0	0	0	0	0	-	-	-	-
	Pond D	2013	0.5	0	0	0	0	0	0	0	0	-	-	-	-
	Pond E	2013	0.5	0	0	0	0	0	0	0	0	-	-	-	-
	Llama-Umwelt	2013	0.5	2	0	0	2	0	2	0	0	-	-	-	-
	Lytle	2013	0.5	0	0	0	0	0	0	0	0	0	0	0	0
	Occurrence	2013	0.5	0	0	0	0	0	0	0	0	0	0	1	0
George	Bob	2013	0.5	0	1	0	0	0	0	0	0	-	-	-	-
	Komatic	2013	1	0	2	0	34	0	0	0	0	-	-	-	-
	Ref. Q	2013	2	0	0	0	32	0	0	0	0	-	-	-	-
	George	2013	2	0	0	0	34	0	0	0	0	-	-	-	-
	McCoy	2013	1	0	0	0	22	0	0	0	0	-	-	-	-
	Lytle	2013	1	0	0	0	0	0	0	0	0	-	-	-	-
	Occurrence	2013	1	0	0	0	0	0	0	0	0	-	-	-	-
	George inflow	2013	0.5	10	1	0	3	0	0	0	0	-	-	-	-
	George outflow	2013	0.5	0	1	0	0	0	0	0	0	-	-	-	-

Note: Each data cell shows the total number of individuals caught.
The electrofishin effort is estimated from field notes, the final effort will be calculated when all data is analysed for the 2013 Baseline report.

Appendix 2.2-3

Habitat Unit Loss in Llama Lake

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Appendix 2.2-3. Habitat Unit Loss in Llama Lake

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering		Total	
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	WSA	SWHU
Lake Trout	Nearshore with fines (< 2.5 m)	5.85	0.00	0.0	0.00	0.0	0.25	1.5	0.00	0.0	1.5	0.6
	Nearshore with large substr. (< 4 m)	17.56	0.25	4.4	0.50	8.8	0.50	8.8	0.25	4.4	26.3	10.5
	Deepwater (> 4 m) plus > 2.5 with fines	13.17	0.25	3.3	0.25	3.3	0.50	6.6	0.75	9.9	23.1	9.2
	Lake Trout Total	**36.59**		**7.7**		**12.1**		**16.8**		**14.3**	**50.9**	**20.3**
Round Whitefish	Nearshore with fines (< 2.5 m)	5.85	0.00	0.0	0.00	0.0	0.25	1.5	0.00	0.0	1.5	0.9
	Nearshore with large substr. (< 4 m)	17.56	0.25	4.4	0.50	8.8	0.50	8.8	0.25	4.4	26.3	15.8
	Deepwater (> 4 m) plus > 2.5 with fines	13.17	0.25	3.3	0.25	3.3	0.25	3.3	0.75	9.9	19.8	11.9
	Round Whitefish Total	**36.59**		**7.7**		**12.1**		**13.5**		**14.3**	**47.6**	**28.5**
Grand Total		**36.59**		**15.4**		**24.1**		**30.4**		**28.5**	**98.4**	**48.9**

Notes: LT = Lake Trout, RW = Round Whitefish, HSI = Habitat Suitability Index, WSA = Weighted Suitable Area, SWHU = Species Weighted Habitat Units

Appendix 2.2-4
Habitat Loss in Rascal to Goose Stream

Appendix 2.2-4. Habitat Loss in Rascal to Goose Stream

Species	Habitat Type	Habitat Area (ha)	Spawning		Nursery		Rearing		Foraging		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Arctic Grayling	Organics	0	0.00	0.0000	0.25	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Gravel	0	1.00	0.0000	0.50	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Cobble	0.1365	0.00	0.0000	0.50	0.0683	1.00	0.1365	1.00	0.1365	0.341
	Boulder	0.0455	0.00	0.0000	0.25	0.0114	0.75	0.0341	0.75	0.0341	0.080
	Bedrock	0	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Bedrock/Boulder	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Bedrock/Cobble	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Organics	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines/Gravel	0	0.75	0.0000	0.75	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Fines/Cobble	0	0.00	0.0000	0.75	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Boulder	0	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Cobble/Boulder	0	0.00	0.0000	0.25	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Cobble	0	0.75	0.0000	0.50	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Boulder	0	0.50	0.0000	0.25	0.0000	0.75	0.0000	0.75	0.0000	0.000
Total Area		0.182									
Total HU											**0.421**

Notes: HSI = Habitat Suitability Index, WSA = Weighted Suitable Area

Appendix 2.2-5

Habitat Loss in Lytle Lake

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Appendix 2.2-5. Habitat Loss in Lytle Lake

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSU
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Arctic Grayling	Nearshore with fine sediment (< 2.5 m)	0.719	0.000	0.000	0.000	0.000	0.250	0.180	0.000	0.000	0.180
	Nearshore with large substrate (< 4 m)	0.811	0.000	0.000	0.500	0.405	0.500	0.405	0.250	0.000	0.811
	Deepwater (> 4 m) plus > 2.5 m with fine sedim	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.750	0.000	0.000
Total		1.530		0.000		0.405		0.585		0.000	0.991

*Notes: HSI = Habitat Suitability Index, WSA = Weighted Suitable Area, *Overwintering WSA set to zero because lake freezes to bottom in winter*

Appendix 2.2-6

Habitat Loss in Occurrence Lake

Appendix 2.2-6. Habitat Loss in Occurrence Lake

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Arctic Grayling	Nearshore with fine sediment (< 2.5 m)	0.562	0.000	0.000	0.000	0.000	0.250	0.141	0.000	0.000	0.141
	Nearshore with large substrate (< 4 m)	0.178	0.000	0.000	0.500	0.089	0.500	0.089	0.250	0.000	0.178
	Deepwater (> 4 m) plus > 2.5 m with fine sedime	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.750	0.000	0.000
Total		0.740		0.000		0.089		0.229		0.000	0.318

*Notes: HSI = Habitat Suitability Index, WSA = Weighted Suitable Area, *Overwintering WSA set to zero because lake freezes to bottom in winter*

Appendix 2.2-7

Habitat Loss in George Outflow

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Appendix 2.2-7. Habitat Loss in George Outflow

Species	Habitat Type	Habitat Area (ha)	Spawning		Nursery		Rearing		Foraging		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Arctic Grayling	Organics	0	0.00	0.0000	0.25	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Gravel	0	1.00	0.0000	0.50	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Cobble	0	0.00	0.0000	0.50	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Boulder	0.408	0.00	0.0000	0.25	0.1020	0.75	0.3060	0.75	0.3060	0.714
	Bedrock	0	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Bedrock/Boulder	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Bedrock/Cobble	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Organics	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines/Gravel	0	0.75	0.0000	0.75	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Fines/Cobble	0	0.00	0.0000	0.75	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Boulder	0.008	0.00	0.0000	0.50	0.0040	0.50	0.0040	0.50	0.0040	0.012
	Cobble/Boulder	0	0.00	0.0000	0.25	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Cobble	0	0.75	0.0000	0.50	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Boulder	0	0.50	0.0000	0.25	0.0000	0.75	0.0000	0.75	0.0000	0.000
Total Area		0.416									
Total HU											**0.714**

Appendix 3.2-1
Habitat Budget Methods

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Appendix 3.2-1. Habitat Budget Methods

HABITAT EVALUATION PROCEDURE (HEP)

For this conceptual compensation plan, HEP was utilized to construct a habitat budget (USFWS 1980). HEP is a generalized procedure for assessing habitat suitability in streams and lakes. By multiplying habitat area (measured in m^2) by a Habitat Suitability Index (HSI, no units), the HEP produces Habitat Units (HU) that are indices of both habitat quantity and quality. HU are the currency of habitat budgeting and compensation planning.

HEP is a tool for developing habitat budgets for compensation planning in Canada (e.g., Diavik 1998; BHP Billiton 2002; RL&L/Golder 2003; Rescan 2005; Rescan 2007; Rescan 2010). The HEP approach has two advantages. First, it provides an objective method to characterize the quality or importance of affected habitats to fish species and aquatic resources. Second, it allows standardization of habitat quality ratings relative to other habitats that have different physical characteristics (e.g., lakes versus streams). This facilitates comparisons among habitat types and ultimately allows affected habitats to be evaluated as a single group for the compensation calculation.

Where the Project causes a PAD, affected habitats are quantified and characterized in terms of their importance to fish. The compensation plan components are based on the type of habitat affected. Compensation of newly created habitat for lost habitat is based upon the estimation of HUs lost. Overall, the HEP is based upon the suitability of a habitat type to support different life history stages of a species. HSIs, derived primarily from scientific literature, are used to quantify the suitability of the habitat type to support each critical life history stage.

There are four steps in HEP that are followed in the development of a fish habitat compensation plan:

1. Initial scoping of the study area and relevant species. This includes brief reviews of the life histories of relevant species, followed by justification of the decision to base habitat compensation planning on certain species habitat requirements.
2. Utilization and/or development of HSI models for target fish species.
3. Habitat assessment of the Project area and of the proposed compensatory works.
4. Preparation of a budget of lost and gained HUs.

The ratio of compensation area to PAD area is dependent on the value of the habitat destroyed as well as the value of the proposed compensation habitat. For example, high quality habitat may require additional compensation area in order to ensure no net loss of productive capacity. Alternatively, low quality habitat may be replaced with a smaller area of higher quality habitat. The value of the habitat is multiplied by the area of the compensation or PAD to create HUs which are used to construct the habitat budget.

Multiple species may be affected by habitat loss or benefit from compensation projects, depending upon site specific habitat. For each water body, the number of HUs for each life stage within a species is calculated as the Weighted Suitable Area (WSA) for each habitat type. The WSA is the product of the surface area of the habitat type and the Habitat Suitability Index (HSI) for a particular life-stage. Surface area for each habitat was obtained using polygon area traced from habitat maps. The life-stage specific WSAs are then summed to obtain a total number of HUs for that species. This species specific HU is then weighted by the relative abundance of the species resulting in a Species Weighted Habitat Unit (SWHU). Finally, a grand total of the HUs affected is calculated for a water body by summing all SWHUs over all species in that waterbody. To be comparable with the HUs calculated for the compensated projects, all target species are included for HU calculation.

HABITAT SUITABILITY INDICES (HSI) MODEL

Model Selection

There are no established and uniformly accepted regional HSI models for northern Mining Projects. Each compensation project adjusts existing models to the specific habitat and fish species being negatively affected. For this conceptual compensation plan, the HSI models were adapted from three sources: the Doris North Project (Golder 2007); the Gahcho Kue Project (Golder 2012); and the Ekati Diamond Mine (Rescan 2010).

Habitat categories for lakes were taken from the Doris North model. Doris North's *No Net Loss Plan* refined the lake trout HSI model developed for the Diavik Diamond Project (1998) and also used in the Snap Lake Project (De Beers 2002). The Doris North HSI lake habitat model was determined to be most appropriate because, in addition to being close geographically, lakes within the Back River Project area are more biologically and physically similar to lakes within the Doris North Project area than other Project areas.

The HSI values for Lake Trout, Round Whitefish and Arctic Grayling were modified from Gaucho Kue (Golder 2012; Appendix 3.2-2 in this report). The Gaucho Kue Project developed HSI models for species occurring at northern mining projects in consultation with DFO. The models were updated primarily from those developed for Snap Lake. For habitats and species not included in the Snap Lake assessment, new HSI curves were developed based on general life history requirements for fish species in the north (Richardson et al. 2001).

Stream habitat types and HSI models for Arctic Grayling were developed from previously successful methods for northern mining projects (Debeers 2002; Diavik 1998; Evans et al. 2002; Golder 2012; Stewart et al. 2007).

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Appendix 3.2-2

Habitat Suitability Indices

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Appendix 3.2-2. Habitat Suitability Indices

Habitat Suitability Indices and Descriptions	
HSI Value	**Habitat Description**
1.00	Optimal
0.75	Above Average
0.50	Average
0.25	Below Average
0.00	**Unsuitable**

Note: HSI = Habitat Suitability Index

Lake Habitat Suitability Indices by Habitat Type					
Species	**Habitat Type**	**Spawning/Nursery**	**Rearing**	**Foraging**	**Overwintering**
Lake Trout	Nearshore with fine sediment (< 2.5 m)	0.00	0.00	0.25	0.00
	Nearshore with large substrate (< 4 m)	0.25	0.50	0.50	0.25
	Deepwater (> 4 m) plus > 2.5 m with fine sediment	0.25	0.25	0.50	0.75
Round Whitefish	Nearshore with fine sediment (< 2.5 m)	0.00	0.00	0.25	0.00
	Nearshore with large substrate (< 4 m)	0.25	0.50	0.50	0.25
	Deepwater (> 4 m) plus > 2.5 m with fine sediment	0.25	0.25	0.25	0.75
Arctic Grayling	Nearshore with fine sediment (< 2.5 m)	0.00	0.00	0.25	0.00
	Nearshore with large substrate (< 4 m)	0.00	0.50	0.50	0.25
	Deepwater (> 4 m) plus > 2.5 m with fine sediment	0.00	0.00	0.25	0.75

Stream Habitat Suitability Indices by Habitat Type					
Species	**Habitat Type**	**Spawning**	**Nursing**	**Rearing**	**Foraging (adult)**
Arctic Grayling	Organics	0.00	0.25	0.00	0.00
	Fines	0.00	1.00	0.00	0.00
	Gravel	1.00	0.50	0.25	0.25
	Cobble	0.00	0.50	1.00	1.00
	Boulder	0.00	0.25	0.75	0.75
	Bedrock	0.00	0.00	0.00	0.00
	Bedrock/Boulder	0.00	0.00	0.50	0.50
	Bedrock/Cobble	0.00	0.00	0.50	0.50
	Fines/Organics	0.00	1.00	0.00	0.00
	Fines/Gravel	0.75	0.75	0.25	0.25
	Fines/Cobble	0.00	0.75	0.50	0.50
	Fines/Boulder	0.00	0.50	0.50	0.50
	Cobble/Boulder	0.00	0.25	1.00	1.00
	Gravel/Cobble	0.75	0.50	1.00	1.00
	Gravel/Boulder	0.50	0.25	0.75	0.75

Source: Diavik 1998; Debeers 2002; Stewart et al. 2007; Golder 2013; Mainstream Aquatics 2004; Evans et al. 2002

Appendix 3.2-3

Habitat Gain in Proposed Rascal Lake to Goose Lake Stream Realignment

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Appendix 3.2-3. Habitat Gain in Proposed Rascal Lake to Goose Lake Stream Realignment.

A. Natural conditions at stream

		Habitat	Spawning		Nursery		Rearing		Foraging		Total
Species	Habitat Type	Area (ha)	HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	WSA
Arctic Grayling	Organics	0.000	0.00	0.0000	0.25	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines	0.181	0.00	0.0000	1.00	0.1810	0.00	0.0000	0.00	0.0000	0.181
	Gravel	0.013	1.00	0.0129	0.50	0.0065	0.25	0.0032	0.25	0.0032	0.026
	Cobble	0.039	0.00	0.0000	0.50	0.0194	1.00	0.0388	1.00	0.0388	0.097
	Boulder	0.026	0.00	0.0000	0.25	0.0065	0.75	0.0194	0.75	0.0194	0.045
	Bedrock	0	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Bedrock/Boulder	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Bedrock/Cobble	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Organics	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines/Gravel	0	0.75	0.0000	0.75	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Fines/Cobble	0	0.00	0.0000	0.75	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Boulder	0	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Cobble/Boulder	0	0.00	0.0000	0.25	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Cobble	0	0.75	0.0000	0.50	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Boulder	0	0.50	0.0000	0.25	0.0000	0.75	0.0000	0.75	0.0000	0.000
Total Area		0.2585									
Total HU											**0.349**

Notes: HSI = Habitat Suitability Index, WSA = Weighted Suitable Area, habitat in this section will be considered lost in calculation of total habitat gained.

B. Value of stream after enhancement

		Habitat	Spawning		Nursery		Rearing		Foraging		Total
Species	Habitat Type	Area (ha)	HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	WSA
Arctic Grayling	Organics	0.000	0.00	0.0000	0.25	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines	0.026	0.00	0.0000	1.00	0.0259	0.00	0.0000	0.00	0.0000	0.026
	Gravel	0.065	1.00	0.0646	0.50	0.0323	0.25	0.0162	0.25	0.0162	0.129
	Cobble	0.129	0.00	0.0000	0.50	0.0646	1.00	0.1293	1.00	0.1293	0.323
	Boulder	0.038775	0.00	0.0000	0.25	0.0097	0.75	0.0291	0.75	0.0291	0.068
	Bedrock	0	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Bedrock/Boulder	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Bedrock/Cobble	0	0.00	0.0000	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Organics	0	0.00	0.0000	1.00	0.0000	0.00	0.0000	0.00	0.0000	0.000
	Fines/Gravel	0	0.75	0.0000	0.75	0.0000	0.25	0.0000	0.25	0.0000	0.000
	Fines/Cobble	0	0.00	0.0000	0.75	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Fines/Boulder	0	0.00	0.0000	0.50	0.0000	0.50	0.0000	0.50	0.0000	0.000
	Cobble/Boulder	0	0.00	0.0000	0.25	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Cobble	0	0.75	0.0000	0.50	0.0000	1.00	0.0000	1.00	0.0000	0.000
	Gravel/Boulder	0	0.50	0.0000	0.25	0.0000	0.75	0.0000	0.75	0.0000	0.000
Total Area		0.2585									
Total HU											**0.546**

Note: Proposed enhancement will result in a substrate composition of 50% cobble, 25% gravel, 15% boulder and 10% fines

C. Value of new wetland

Gain of Habitat Units Calculated for Arctic Grayling in Rascal Lake to Goose Lake Stream Realignment Option										
	Habitat	Spawning/Nursery		Rearing		Foraging		Overwintering		Total
Habitat Type	Area (ha)	HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	WSA
Pond B										
Nearshore with fines (< 2.5 m)	0.00	0.00	0.0	0.00	0.0	0.25	0.0	0.00	0.0	0.0
Nearshore with large substr. (< 4 m)	5.65	0.00	0.0	0.50	2.8	0.50	2.8	0.25	0.0	5.7
Deepwater (> 4 m) plus > 2.5 with fines	0.00	0.00	0.0	0.00	0.0	0.25	0.0	0.75	0.0	0.0
Total HU	**5.65**		**0.0**		**2.8**		**2.8**		**0.0**	**5.7**

Note: Overwintering WSA was set to zero to reflect the high liklihood that ponds will freeze to bottom in winter

Appendix 3.2-4

Habitat Gain in Canyon Lakes Offset Project

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Appendix 3.2-4. Habitat Gain in Canyon Lakes Offset Project

Canyon Lake 2

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Lake Trout	Nearshore (< 4 m)	1.68	0.25	0.42	0.50	0.84	0.50	0.84	0.25	0.42	2.52
	Deepwater (> 4 m)	1.135	0.25	0.28375	0.25	0.28375	0.50	0.5675	0.75	0.85125	1.98625
	Lake Trout Total			0.70375		1.12375		1.4075		1.27125	4.50625
Arctic Grayling	Nearshore (< 4 m)	1.68	0.00	0	0.50	0.84	0.50	0.84	0.25	0.42	2.1
	Deepwater (> 4 m)	1.135	0.00	0	0.00	0	0.25	0.28375	0.75	0.85125	1.135
	Arctic Grayling Total			0		0.84		1.12375		1.27125	3.235
Total Area		2.815									
Total HU				0.70375		1.96375		2.53125		2.5425	**7.74125**

Canyon Lake 3

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Lake Trout	Nearshore (< 4 m)	2.14	0.25	0.535	0.50	1.07	0.50	1.07	0.25	0.535	3.21
	Deepwater (> 4 m)	1.1	0.25	0.275	0.25	0.275	0.50	0.55	0.75	0.825	1.925
	Lake Trout Total			0.81		1.345		1.62		1.36	5.135
Arctic Grayling	Nearshore (< 4 m)	2.14	0.00	0	0.50	1.07	0.50	1.07	0.25	0.535	2.675
	Deepwater (> 4 m)	1.1	0.00	0	0.00	0	0.25	0.275	0.75	0.825	1.1
	Arctic Grayling Total			0		1.07		1.345		1.36	3.775
Total Area		3.24									
Total HU				0.81		2.415		2.965		2.72	**8.91**

Canyon Lake 4

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Lake Trout	Nearshore (< 4 m)	0.41	0.25	0.1025	0.50	0.205	0.50	0.205	0.25	0.1025	0.615
	Deepwater (> 4 m)	0.075	0.25	0.01875	0.25	0.01875	0.50	0.0375	0.75	0.05625	0.13125
	Lake Trout Total			0.12125		0.22375		0.2425		0.15875	0.74625
Arctic Grayling	Nearshore (< 4 m)	0.41	0.00	0	0.50	0.205	0.50	0.205	0.25	0.1025	0.5125
	Deepwater (> 4 m)	0.075	0.00	0	0.00	0	0.25	0.01875	0.75	0.05625	0.075
	Arctic Grayling Total			0		0.205		0.22375		0.15875	0.5875
Total Area		0.485									
Total HU				0.12125		0.42875		0.46625		0.3175	1.33375

Appendix 3.2-4. Habitat Gain in Canyon Lakes Offset Project

Canyon Lake 5

Species	Habitat Type	Habitat Area (ha)	Spawning/Nursery		Rearing		Foraging		Overwintering*		Total WSA
			HSI	WSA	HSI	WSA	HSI	WSA	HSI	WSA	
Lake Trout	Nearshore (< 4 m)	1.84	0.25	0.46	0.50	0.92	0.50	0.92	0.25	0.46	2.76
	Deepwater (> 4 m)	0.59	0.25	0.1475	0.25	0.1475	0.50	0.295	0.75	0.4425	1.0325
	Lake Trout Total			0.6075		1.0675		1.215		0.9025	3.7925
Arctic Grayling	Nearshore (< 4 m)	1.84	0.00	0	0.50	0.92	0.50	0.92	0.25	0.46	2.3
	Deepwater (> 4 m)	0.59	0.00	0	0.00	0	0.25	0.1475	0.75	0.4425	0.59
	Arctic Grayling Total			0		0.92		1.0675		0.9025	2.89
Total Area		2.43									
Total HU				0.6075		1.9875		2.2825		1.805	6.6825

Notes: Habitat classification of bottom type has not been collected as of 2013 and the habitat classes rely on depth only, not substrate type.

Assumptions: the difference in elevation between lakes 2-3 is 0.5m. The elevation difference between lakes 2 and 4 and 2 and 5 has not been measured, but estimated at 1 m. Thus, a 3 m increase in depth at lake 2 will result in a 4 m depth overwintering habitat zone at the bathymetric contours of 1 m in lake 3, and 2 m in lakes 4 and 5.

This will need to be confirmed by surveying in canyon along length to deterime exact increase in habitat.