

Privileged & Confidential Draft for Discussion

High Lake Project: Fish Habitat No Net Loss Plan



Prepared for
Zinifex

Submitted by
Gartner Lee Limited

June 2007



Gartner Lee

**Privileged & Confidential
Draft for Discussion**

High Lake Project: Fish Habitat No Net Loss Plan

Prepared for
Zinifex

In association with
LGL Limited

June 2007

Reference: **GLL 71-009-1**

Distribution:
Zinifex
Gartner Lee Limited





Gartner Lee Limited



June 29, 2007

Mr. Andrew Mitchell
Project Manager
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401 – 1113 Jade Court
Thunder Bay, ON P7B 6M7

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Dear Mr. Mitchell:

Re: GLL 71009-1 – High Lake Project: Fish Habitat No Net Loss Plan

Please find enclosed a draft of the No Net Loss Plan for High Lake which addresses compensation measures for impacts to fish habitat. This report has been produced in draft in anticipation of dialogue with the Department of Fisheries and Oceans Canada. Following their amendment/approval of the compensation measures proposed herein, we would produce the final report.

Please contact the undersigned with any questions or comments you may have regarding this portion of the project.

Sincerely,
Gartner Lee Limited

Gordon G. Stewart, M.Sc.
Senior Environmental Scientist

Executive Summary

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Project Background

The proposed High Lake mine development site is situated within approximately 50 km of the Arctic coast in the Coronation Gulf area and is a polymetallic deposit of base and precious metals including copper, zinc, gold and silver. As part of the overall mine plan, a dock facility will be constructed at Grays Bay to service the operations of the High Lake mine. An all-season mine road extending from High Lake to Grays Bay will also be required for transporting metal concentrate from the mine to the dock and for the transport of supplies to support the mining operation.

Regulatory Context

The Federal Department of Fisheries and Oceans *Policy for the Management of Fish Habitat's* guiding principle for achieving their conservation goal is for there to be no net loss of the productive capacity of fish habitat. The preference for achieving no net loss are to apply mitigation measures such as relocation or redesign to avoid impacts to fish habitat. If impacts cannot be completely avoided by mitigation measures the *Fisheries Act* allows for the harmful alteration, disruption, or destruction of fish habitat through authorization by the Minister of Fisheries; however, the policy requires that habitat replacement or enhancement be applied to achieve no net loss.

The High Lake project will result in an impact to fish habitat. The majority of these impacts can be mitigated, but in some cases, habitat loss will need to be compensated for. It is proposed that this compensation occur at a ratio of 2:1, and is addressed in this No Net Loss Plan.

The approach taken in compiling the No Net Loss Plan for the High Lake Project is one consistent with precedent set by previous studies of similar scope and magnitude including Diavik Diamonds project, Meadowbank Gold project and Doris North project.

Habitat Impacts

The removal of marine fish habitat associated with the dock footprint is permanent. This area will be completely and permanently covered by the dock's sheetpile cellular structure and infill.

Impacts from lake and stream infilling associated with road construction are considered an impact to freshwater fish habitat and involve installation of culverts or fill at five watercourse crossings.

Analysis

For the marine environment, the Valued Ecosystem Component identified was Arctic char, and its use of the habitat in the impacted area consisted of foraging and migrating. A general marine habitat suitability rating system based on heterogeneity of substrate and benthic biota was utilized to quantify habitat impacts and compensation.

Habitat Suitability Indices were developed for freshwater Valued Ecosystem Components, lake trout and Arctic char, to determine the suitability of existing freshwater habitat. Five habitat types

were quantified based on habitat characteristics of Arctic waterbodies and life cycle needs of identified fish species: spawning; nursery; rearing; foraging; migration. Modelled suitability values were converted to Habitat Units, which are weighted values that represent the quantity and quality of a habitat. Because they are weighted, Habitat Units can be compared, and thus are used in determining how much and what type of habitat is lost or needs to be compensated for.

Compensation

A total of 0.65 ha of predominantly low quality Arctic char foraging and migratory marine habitat will be lost through construction of the dock. However, the loss of 0.06 ha of habitat will be mitigated through the burial of the structural elements of the dock with granular material during closure. The overall net area of habitat impacted is 0.59 ha. The proposed compensation for the marine habitat includes placement of large, non-acid generating boulders and rock on the surface of the dock fill slope up to the highest tide level, as well as placement of coarse substrates at depths of 5–10 m near the dock site, creating 1.18 ha of high-medium quality habitat.

In the freshwater environment, impacted stream habitat consists of 0.23 ha/6.8 Habitat Units of lake trout and Arctic char rearing and migratory habitat. Impacted lake habitat consists of 0.28 ha/11.6 Habitat Units ha of lake trout and Arctic char foraging and rearing habitat as well as Arctic char nursery habitat along the west shore of the lake. The total impact to freshwater habitat is 0.51 ha/18.4 Habitat Units. Compensation includes development of spawning habitat within L800 wherein there will be a net gain of 0.69 ha/47.2 Habitat Units.

Overall, marine habitat will be compensated for at a ratio of 2:1 ha. Freshwater habitat will be compensated for at a ratio of 3.2:1 Habitat Units and 1.9:1 ha.

Monitoring

Monitoring of marine habitat compensation success will be conducted annually during summer for five years following dock construction. Monitoring of freshwater habitat compensation success will occur over several years. During the first two years annual studies will involve direct visual observations of habitat use during summer and stability of artificial spawning beds, followed by monitoring of fish production.

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1. Introduction

1.1 Background

The proposed High Lake mine development site is situated within approximately 50 km of the Arctic coast in the Coronation Gulf area and is a polymetallic deposit of base and precious metal deposits including copper, zinc, gold and silver (Figure 1). The long term objective of the High Lake Project is to construct the additional infrastructure necessary to mine and process the defined mineral resource. As part of the overall mine plan, a dock facility will be constructed at Grays Bay to service the operations of the High Lake mine. Ocean-going vessels will be loaded with metal concentrate for transport to markets and will be off-loaded with supplies and equipment necessary for the mining operation at High Lake. An all-season mine road extending from High Lake to Grays Bay will also be required for transporting metal concentrate from the mine to the dock and for the transport of supplies to support the mining operation. A winter road between the High Lake and Grays Bay will be required during the construction phase of this Project.

An overview schedule for the construction, operation, closure and reclamation phases of the project can be summarized as follows:

- Construction: anticipated to begin in 2008 and last two years;
- Operation: anticipated to begin in 2010 and last 14 years; and
- Closure and Reclamation: anticipated to begin in 2024 and last about 3 years.

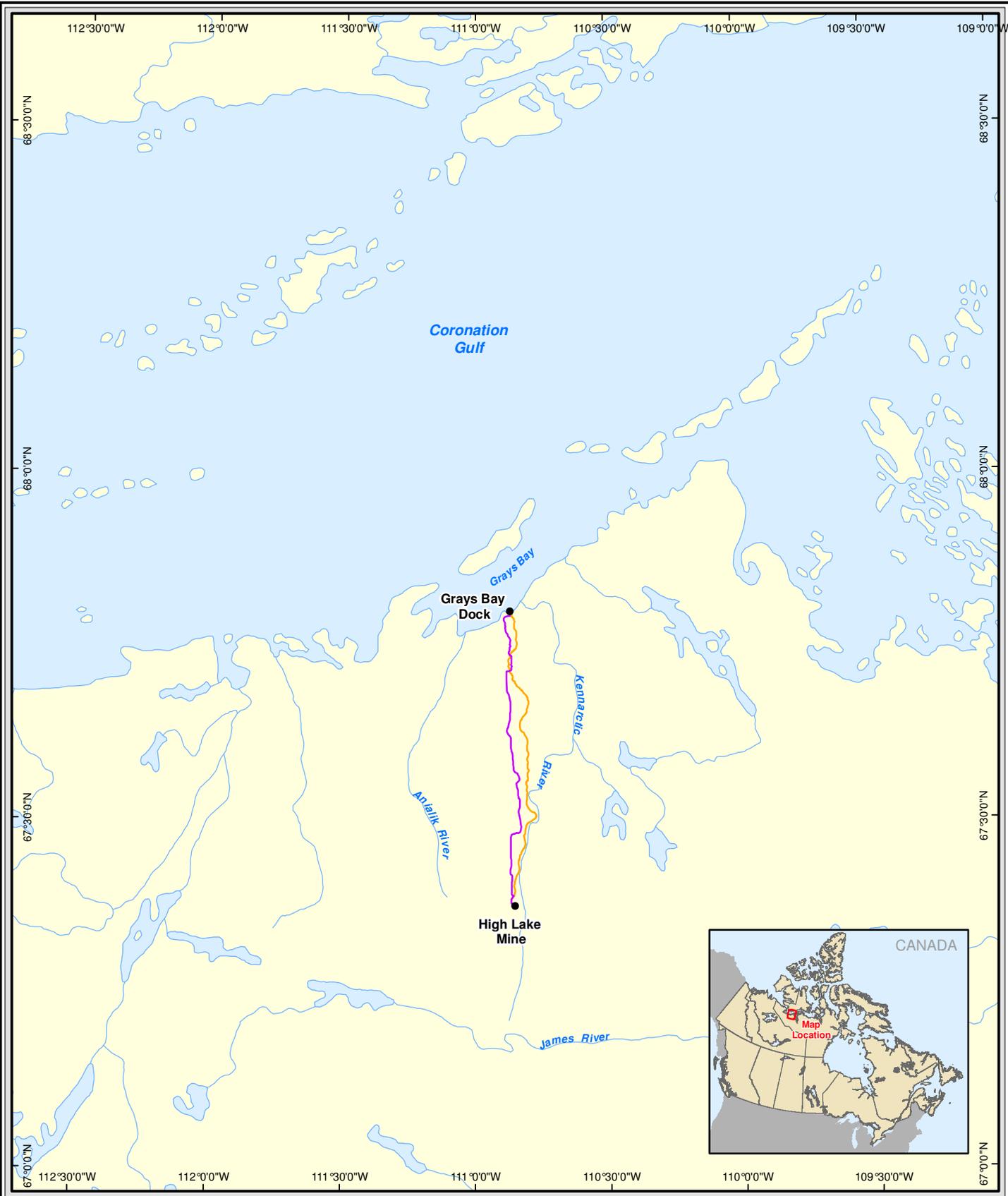
Alternatives for the project have been assessed pursuant to paragraph 16(1) (e) of the *Canadian Environmental Assessment Act* (CEAA). Alternative means are defined as various options that may be technically and economically feasible and that can be used to carry out the project. Of particular relevance to this report are the following and their reasons for inclusion in the assessment:

- **Dock Site**
 - Dock siting – closest site, due north of High Lake mine site is most practical and has feasible access for shipping in Grays Bay; and
 - Dock structure – cellular sheetpile structure requires least seafloor preparation and is most cost-effective.
- **Access Roads**
 - Main access road – all-season road is safe, practical and most cost-effective; and
 - Access road route – direct shortest route is considered to be least affected by difficult ground conditions.

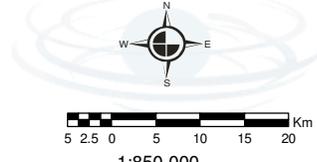
In February 2007, TBT Engineering compiled the High Lake Project Alternative Route Options Comparison Study with the specific intention of conducting and presenting an options analysis of the routing of a specific section of the road alignment. This report is included in Appendix 1. The recommended option for road routing, based on this analysis, is included in the discussion herein.

File Location: E:\GIS\GIS_projects\2007\High_Lake\71009_01_Crossings\By1_NetLoss_May07\71009_01_By1_Fig01_ProjLocation.mxd

Date Revised: June 28, 2007
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Map Sources/Notes:
- Base mapping provided by ESRI World Data and Maps.



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- Legend
- Project Site
 - Winter Road
 - All-Season Road
 - Watercourse
 - Waterbody



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Project: High Lake - No Net Loss Plan
Location: High Lake, Nunavut

Project Location



Figure 1
Version 1

1.2 Regulatory Framework

The federal *Fisheries Act* states “no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish and fish habitat” (Section 35(1)) (Department of Fisheries and Oceans 1985). Only under the authorization of the federal Minister of Fisheries and Oceans under Section 35(2) are exceptions made to Section 35(1). Under the *Fisheries Act* fish are defined as:

Parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine mammals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine mammals” (Sections 2 a, b, and c),

and fish habitat is defined as;

“Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life process” (Section 34).

Fish habitat is therefore considered to encompass “freshwater, estuarine and marine environments that directly or indirectly support fish stocks or fish populations that sustain, or have the potential to sustain, subsistence, commercial or recreational fishing activities” (DFO 1985). Fish habitats may also include habitats that could sustain a new fishery in the future and/or those that do not directly support fish but provide nutrient, food supplies, and water quality to areas downstream that do support fish (DFO 1986).

The Federal Department of Fisheries and Oceans (DFO) *Policy for the Management of Fish Habitat* provides several specific goals, the first one being Conservation of Fish Habitat. The guiding principle for achieving the conservation goal is for there to be no net loss of the productive capacity of fish habitat. The preferences for achieving no net loss are to apply mitigation measures such as relocation or redesign to avoid impacts to fish habitat. If impacts can not be completely avoided by mitigation measures the *Fisheries Act* allows for the harmful alteration, disruption, or destruction (HADD) of fish habitat through authorization by the Minister of Fisheries, however the policy requires that habitat replacement or enhancement be applied to achieve no net loss.

Authorization for a HADD is provided under Section 35(2) of the *Fisheries Act*. The Authorization will include details of the appropriate habitat compensation measures that will be required to achieve no net loss of fish habitat. The primary DFO hierarchy for creating new habitat is as follows (DFO 1986):

- Create similar habitat at or near the development site within the same ecological unit;
- Create similar habitat in a different ecological unit that supports the same stock or species;
- Increase the productive capacity of existing habitat at or near the development site (within same ecological unit)

- Increase the productive capacity of a different ecological unit that supports the same stock or species
- Increase the productive capacity of existing habitat that supports a different species of fish either on or off site.

DFO follows a decision framework for the determination and authorization of HADD of fish habitat (DFO 1998). Steps in this framework include:

- Reviewing the project scope and background fish and fish habitat data at, and adjacent to, the project site
- Assess potential impacts to fish and fish habitat productive capacity (HADD determination)
- Determine level of protection required in terms of habitat productive capacity currently within the area (e.g. critical, important, marginal habitats)
- For projects that cannot be relocated, redesigned or mitigated, compensation plans are reviewed
- A decision by DFO for an Authorization triggers an environmental review pursuant to the CEAA.

The amount and type of habitat compensation will depend on several factors including: temporal duration, magnitude of HADD, spatial extent, and existing productive capacity. For example, sensitive habitats may require more compensation than marginal ones.

The proponent must comply with the terms and conditions as stated in the DFO Authorization or risk enforcement by DFO pursuant to the *Fisheries Act*.

1.3 Approach and Objectives

As discussed in Volume 5 of the High Lake Project Proposal (Wolfden Resources Inc. 2006), the potential to impact fish populations and habitat arising from the Project exists. The majority of project effects relevant to fish and fish habitat will be mitigated through project design. The remaining effects are addressed through discipline-specific mitigation.

1.3.1 Mitigation

Mitigation refers to measures that are incorporated into the project to remove, or reduce potential impacts. Two types of mitigation are identified: mitigation by design and discipline-specific mitigation.

1.3.1.1 Mitigation by Design

From the initial design stages of the High Lake Project, significant efforts have been made to maximize the integration of mitigation measures into the design of the Project. The following principles, relevant to fish and fish habitat, were used in guiding the design of the High Lake Project:

Minimize Project Disturbance Footprint by:

- minimizing the number of drainage areas affected by the Project infrastructure, buildings and activities; and
- minimizing disturbance outside of the High Lake drainage area.

Implement Best Mine Management and Design Practices by:

- reducing effects of drainage basin drawdown or flooding on spawning habitat;
- protecting aquatic habitat using best practices in design and construction of all structures in marine and fresh waters (i.e., sediment control, explosives detonation);
- protecting water quality of fish habitat by carrying out any required water treatment at or close to source;
- incorporating elders' recommendations into the design and monitoring of the Project, where feasible;
- incorporating best design practices for northern climates and permafrost conditions;
- restoring surface water flows to pre-mining conditions to the maximum extent possible.

1.3.1.2 Discipline-Specific Mitigation

Discipline-specific mitigations reduce or remove impacts associated with fish health, populations and habitat resulting from project activities. Discipline-specific mitigation techniques include:

- Regulatory compliance with the federal Fisheries Act; and
- Compilation of a No Net Loss Plan, presented herein.

1.3.2 No Net Loss Planning

The approach taken in compiling the No Net Loss Plan for the High Lake Project is one consistent with precedent set by previous studies of similar scope and magnitude including Diavik Diamonds project, Meadowbank Gold project and Doris North project. It addresses the effects of the preferred alternatives as outlined in Section 1.1. The overall objective is to ensure there is no net loss of habitat following the closure phase of the project.

A No Net Loss (NNL) Plan is a component of a project proposal wherein the project will have an impact on fish habitat. A NNL Plan is designed to meet DFO's goal of fish habitat conservation. It describes fish habitat within project area, summarizes habitat mitigation measures, includes

assessment of type and extent of habitat that cannot be protected by mitigation (i.e. quantify the HADD) and provides the compensation plan to off-set the HADD and achieve NNL.

Following habitat analysis as part of the baseline environmental programs, and project design, various options for compensation were investigated and discussed with project scientists and engineers, local community members and regulators. Accordingly, recommended compensation measures were selected and are presented in this NNL Plan, based on the following factors governing the design of habitat compensation measures:

- Type of habitat effected;
- Quality of habitat effected;
- Location of habitat effected;
- Proximity of materials required for compensation construction; and
- Invasiveness of construction technique.

1.4 Study Area

1.4.1 Marine

The Local Study Area (LSA) for marine aquatic organisms and habitat is where immediate direct and indirect effects of the Project could potentially occur. This includes the footprint of the dock and the barge landing sites, with a 500 m buffer around the dock site and a 100 m buffer around the barge landing sites (Figure 2).

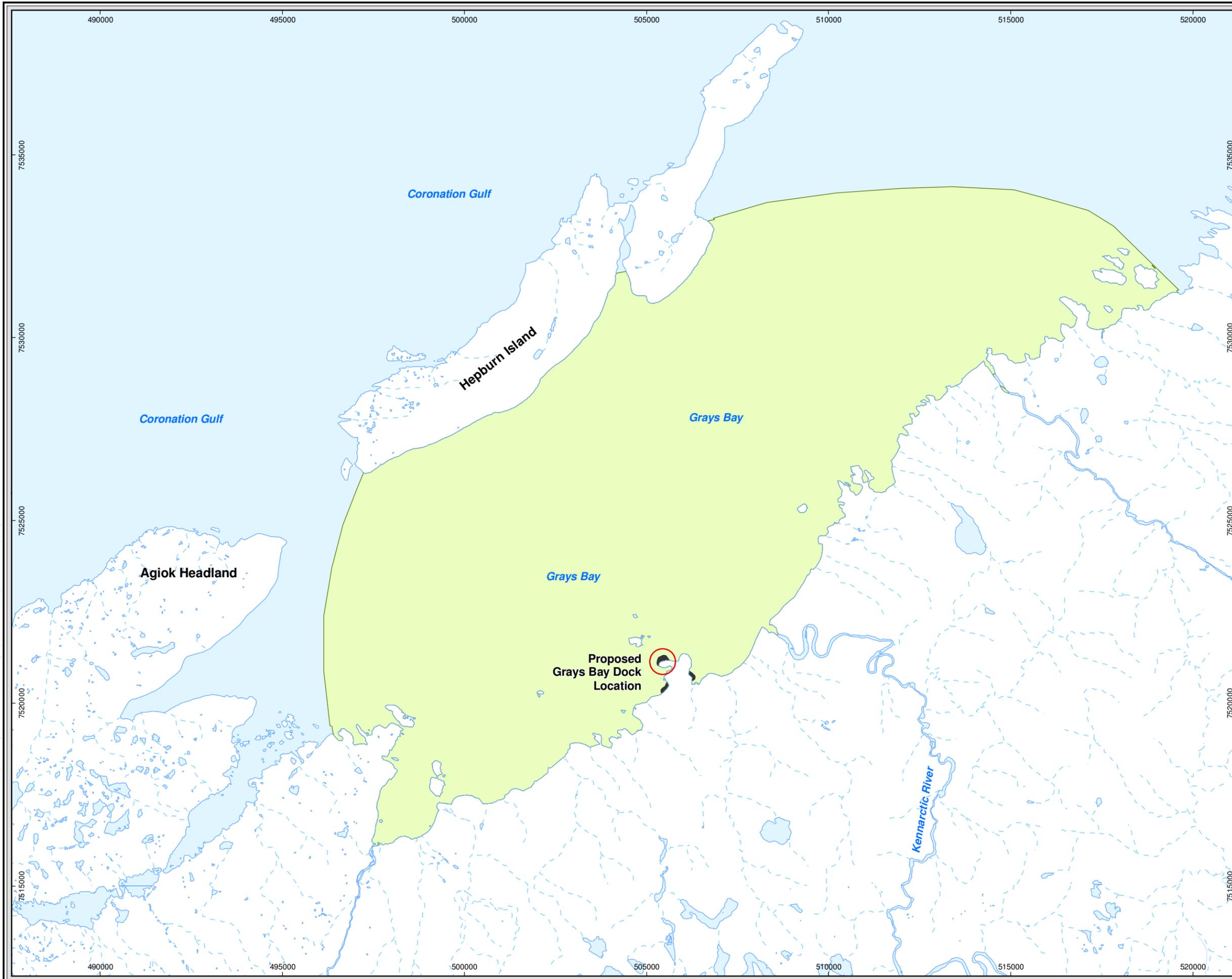
The Regional Study Area (RSA) is used to assess indirect impacts that may extend beyond the LSA. The RSA for marine aquatic organisms and habitat is Grays Bay, where the Project may have impacts beyond the immediate area of the dock site (Figure 2).

1.4.2 Freshwater

The LSA for freshwater aquatic organisms and habitat has been defined as any sub-drainage that contains a proposed component of mine infrastructure including camps, mills, roads and airstrips, and is considered as two separate areas: the High Lake Site and the Road Corridor. Relevant to this report is the Road Corridor Study Area, as impacts resulting in a HADD occur only in association with the all season road. The Road Corridor LSA includes 1 km on either side of the proposed alignment (Figure 3).

The RSA associated with the Road Corridor is the same as the LSA.

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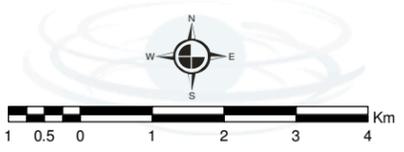


Legend

- Local Study Area
- Regional Study Area
- Waterbody
- Watercourse



Map Sources/Notes:
- Local and regional study areas provided by LGL.
- NTDB base data at 1:250,000 scale provided by Natural Resources Canada.



File Name: 71009_01_By1_Fig02_Marine_LSA.mxd
Reviewed By: RP Prepared By: MP
Date Issued: June, 2007 Project Number: 71-009-01

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Project: High Lake - No Net Loss Plan
Location: High Lake, Nunavut

Marine Local and Regional Study Areas

2. Project Activities

2.1 Marine

2.1.1 Overview of Grays Bay Dock Site

Grays Bay is located on the Coronation Gulf about 50 km north of the High Lake mine site and about 2.5 km west of the mouth of the Kennarctic River. A bathymetric survey conducted in the summer of 2004 confirmed that safe navigational access for shipping from Coronation Gulf into Grays Bay is feasible. The Grays Bay dock will service the High Lake mine site, providing a facility for loading concentrate onto ships and for receipt of general cargo and fuel.

During the construction phase temporary facilities at the Grays Bay dock site will occupy a total Project disturbance footprint of approximately 25 ha. Throughout the operation phase, the Grays Bay dock and associated facilities will occupy an area of approximately 10 ha.

2.1.2 Dock Facility

The dock facilities at Grays Bay will accommodate single ships of up to approximately 50,000 Dead Weight Tonnage (DWT), which requires a water depth at low tide of approximately 15 m. The dock will also handle freight barges. The operating platform of the dock will be made of a reinforced concrete deck supported by sheet-pile cells. The main dock will be approximately 100 m long and will run parallel to the shoreline and be connected to the shoreline by a short causeway built of blasted rock fill. The conveyor and ship-loader will be supported on structural framework that can move on the deck of the dock, allowing uniform loading of the ship holds. During operation, no dredging activity for maintenance of appropriate water depths at the dock is expected to be required.

The construction contract for the docking facilities at Grays Bay will be awarded to a marine construction firm that is experienced in building arctic dock facilities. A preliminary evaluation of several wharf construction methods used successfully in the arctic has been carried out. This work indicates that a cellular sheet pile type of substructure would be suitable for the Grays Bay site.

The main buttress of this type of dock comprises a line of circular sheet pile enclosed cells, backfilled with rock fill. The cells would be founded on the ocean bottom following preparation of the seabed to provide a stable, safe base for the cells. Based on preliminary geotechnical investigations consisting of depth sounding, geophysical survey boreholes and diving inspections, it is assumed that ~250 m³ of rock excavation entailing two to three months of drilling and blasting activity, and dredging will be required to flatten the seabed prior to erection of the cells and backfilling. It is anticipated that mechanical dredging/excavating will be used, either with a long-stick backhoe or a clam dredge. Dredged material and blasted rock will be deposited in the area

between the sheet pile cells and the shoreline, such that erodible materials are encapsulated by non-erodible materials.

During the construction phase, prior to completion of the dock structure and permanent facilities, a shore landing area approximately 800 m south of the proposed dock site will be used.

2.1.3 Potential Effects and Mitigation

Four types of disturbance at or near the dock site could affect marine habitat. The first results in a direct loss of habitat, and the other three may result in harmful alteration or destruction:

- Dock construction will cause a loss of marine habitat in the dock footprint.
- Drilling, blasting, and dredging will result in an increase in turbidity and sedimentation.
- Onshore construction may cause elevated sediment levels in the water and on marine habitat (substrate and sessile organisms).
- Beaching of the barges and placement of loading ramps, which also increases turbidity and sedimentation, may disturb the nearshore substrate at the barge landing sites.

Direct habitat loss associated with the dock footprint will be compensated for through habitat creation as outlined in this plan.

Turbidity and sedimentation associated with drilling, blasting, and dredging will be mitigated through implementation of a sediment control plan and employment of sediment control measures such as the deployment of a floating boom draped with a silt curtain and an anchor chain pouch resting on the seabed. The area of marine habitat within the silt curtain but outside of the dock footprint would be temporarily impacted by silt produced by construction of the dock, including drilling and blasting but primarily dredging. This effect will be temporary, will not harm benthic biota, and will be small in comparison to that occurring naturally; silt-laden freshwater plumes arising from large river systems flowing into the bay frequently affect the entire Grays Bay marine environment. As such, benthic flora and fauna are well adapted to frequent and unpredictable sedimentation.

Onshore activities may introduce sediment directly into the sea or into surface drainages causing elevated sediment levels in the water and on marine habitat (substrate and sessile organisms). Effects will be mitigated through implementation of a sediment control plan and employment of sediment control measures.

Beaching of the barges and placement of loading ramps during construction and operation will disturb low-quality marine habitat within the barge landing area. The substrate in that area potentially would be subjected to disturbance when barges (two trips with a total of six barges during construction, and 4 to 6 bulk carriers during operations) are beached and access ramps installed. This will be a temporary impact on marine habitat availability, occurring only while barge landings are taking place. Sessile biota do not occur in water depths <2 m, so the only effect on

marine fish and habitat will be temporary sedimentation. Effects will be localized and mitigated through implementation of a sediment control plan.

2.1.4 Need for Habitat Compensation

The removal of marine habitat by the dock footprint is permanent, beginning with construction of the dock and continuing through the Operations, Closure, and Post-closure phases. This area will be completely and permanently covered by the dock (sheetpile cellular structure and infill). Habitat compensation will be required.

Impacts from dredging and blasting would be very local and of short duration, occurring only during a short period of time in the initial construction phase. Effects of barge landings, turbidity in the water, and sedimentation on the substrate will be restricted largely to the Construction Phase. Temporary sedimentation is not considered harmful alteration or destruction of marine habitat, and therefore is not discussed further in this document.

2.2 Freshwater

2.2.1 Overview of Mine Site

Three mineral deposits containing concentrations of copper, zinc, gold and silver have been investigated at the High Lake mine site. Preliminary mine plans indicate that two of the deposits can be mined most efficiently by open pit excavation initially, followed by underground mining accessed from the bottom of each pit. The third deposit, the West Zone, will be mined entirely underground. The High Lake Project has been designed to minimize the overall Project disturbance footprint. To the extent practical, the mine site infrastructure has been sited within the High Lake drainage area.

Four dams are required for tailings containment in High Lake. The proposed dams will serve to prevent uncontrolled release of water from the High Lake drainage area to the Kennarctic River or adjacent lakes to the south.

The north end of High Lake will act as the primary polishing pond. It will be subdivided from the main body of the impoundment structure by a filter berm that will retain solids but allow water to pass through. A second polishing pond will be constructed adjacent to a small pond north of High Lake. Water meeting discharge criteria will be released into the Kennarctic River basin during the open water season.

A fifth dam will be required in order to divert the outflow of Contact Lake towards the Kennarctic River, to prevent any seepage flows between Contact Lake and adjacent watercourses, and to preclude any passage of fish from Contact Lake.

The water supply will be obtained locally from both L4 and L5, large lakes northwest of High Lake. Withdrawal rates will change seasonally and will be limited to 5% or less of the lake volume.

2.2.2 Overview of All-Season Road

The High Lake mine site will be serviced in the long term by a 53 km long all-season road extending from the High Lake mine site to the Grays Bay dock. The all-season road will be designed and constructed as a single-lane, two-way road with pull-outs approximately every kilometre to facilitate passing. Based on an average disturbance width of about 22 m, the total disturbance footprint for the all-season road is expected to be approximately 119 ha.

The selected route was identified following studies in 2004 and 2005 of potential dock facility locations, environmentally significant features, potential aggregate borrow deposits and consideration of cost factors (length and ground conditions). Construction of the all-season road will occur in Years minus 1 and minus 2. Minor variations in the actual roadway alignment may be necessary to ensure design geometrics are achieved.

The proposed route was chosen to minimize impacts to environmentally sensitive areas while ensuring a safe roadway alignment and suitable foundation. The aquatics and archaeology teams worked closely with the engineers in the preliminary design of the road alignment. There are 13 stream crossings and one lake encroachment along the proposed route of the all-season road. (Henceforth, the lake encroachment will be referred to as a crossing; therefore there are considered to be 14 crossings in total). Twelve of these crossings are considered fish habitat and are discussed below.

Following project completion, the all-season road will be decommissioned by the removal of culverts and bridge structures to restore natural drainages. Appropriate erosion and sediment control measures will be utilized during the removal of these structures and all work shall be timed to minimize negative impacts to fisheries. The road will be reclaimed to stable conditions and pre-existing natural drainage patterns will be restored wherever possible. Road surfaces will be loosened to promote revegetation.

2.2.3 Potential Effects and Mitigation

There are four pathways that may result in physical alterations to fish habitat during construction and operation of the Project:

- Surface disturbance causing sedimentation,
- Water withdrawal from lakes,
- Channel diversions, and
- Stream and lake infilling.

Sedimentation is caused by silt and particulate matter, mobilized by surface water or construction activities, falling out of suspension into interstitial spaces on the lake and stream bottom. Filling interstitial spaces reduces habitat suitability. Water withdrawal from lakes reduces lake volume, decreasing the area of submerged, ice-free substrate suitable for spawning and nursery habitat. Stream diversions occurring as a component of project design can effect fish migration through a direct loss of migratory habitat or creating new migratory routes as existing channels are blocked and flows are diverted elsewhere. Stream and lake infilling due to all season road construction can result in the direct removal of fish habitat as culvert or road base materials are placed within the wetted.

Sedimentation will be mitigated through implementation of a sediment control plan and employment of sediment control measures. Water withdrawal effects will be mitigated through compliance with DFO's protocol for winter water withdrawal in the Northwest Territories (DFO 2005). Channel diversions and dam construction occur outside the extent of fish habitat, limited to streams and lakes that are not considered to be fish-bearing. Lake infilling associated with tailings deposition in High Lake is not considered an impact to fish habitat as the lake is not fish-bearing. Accordingly, these effects are all mitigated and are not considered impacts to fish habitat, and therefore are not discussed further in this document.

2.2.4 Need for Habitat Compensation

Impacts from lake and stream infilling associated with road construction are considered an impact to fish habitat. Table 1 outlines fisheries values found at each road crossing. Twelve out of fourteen crossings were found to have fish and/or fish habitat. Impacts to habitat at seven crossings were mitigated by design; road crossings entail either a bridge or an open-bottom culvert wherein all construction occurs outside of the channel and there is no disturbance of the stream. Five remaining crossing require culverts or fill, and so are considered an impact to fish habitat. Habitat compensation for these is required.

High Lake Project
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Table 1. Summary of Fisheries Values and Compensation at Road Crossing Sites

Road Crossing	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Type of watercourse	Stream	Stream	Stream	Stream	Lake	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Sampled for Fish	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fish Habitat Present	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Fish Captured	Y	Y	Y	N	-	N	Y	Y	N	Y	N	Y	Y	Y
Road Crossing Structure	Culvert	Bridge	Open-bottom Culvert	Bridge	Fill	Culvert	Bridge	Culvert	Bridge	Culvert	Culvert	Bridge	Culvert	Bridge
Mitigated/Impacted	Impacted	Mitigated	Mitigated	Mitigated	Impacted	-	Mitigated	Impacted	Mitigated	Impacted	-	Mitigated	Impacted	Mitigated

3. Habitat Assessment Methodology

3.1 Habitat Classification

Habitat composition was determined from field observations including underwater video, bathymetry, direct measurement, and aerial photo interpretation. It was determined that marine and lake habitat type and quality is strongly related to water depth.

Marine habitat classification was based on a rating system that considered substrate and the presence of biota.

Stream habitat classification was based on the following:

- **Morphology:** presence and type of barriers;
- **Flow:** presence, frequency and longevity;
- **Cover:** percent; and
- **Access:** connection to summer and winter habitat.

Lake habitat classification was based on the following:

- **Substrate:** composition and heterogeneity;
- **Depth:** shallow, moderate and deep; and
- **Morphology:** littoral, pelagic and littoral proximal to pelagic.

3.2 Fish Species Selection

3.2.1 Marine

Arctic char (*Salvelinus alpinus*) was the most abundant fish species caught in Grays Bay during 2004 and 2005 baseline studies, and it was the most numerous harvested fish recorded in the Kitikmeot region. Arctic char are amphidromous fishes, which spawn and overwinter in rivers and streams, but migrate out into coastal waters for several months each summer to feed. They are transient at the dock site, and use the area only for forage and a migration corridor during the migration into and out of the Kennarctic River. Average annual catch recorded for Kugluktuk between 1996–1997 and 2001–2002 was 8518 fish (Priest and Usher, 2004).

Arctic cisco (*Coregonus autumnalis*) was the only other fish that was relatively abundant in Grays Bay during baseline studies. It is an anadromous species, spawning, hatching and initially rearing in freshwater river systems before migrating to sea where they spend most of their lives before returning to their natal streams as adults to spawn. Arctic cisco are considered anadromous because, although they overwinter in major river systems, they are believed to remain in brackish water deltas and do not move far upriver into strictly freshwater habitats (Craig, 1989a). In other

locations, Arctic cisco support subsistence fisheries, e.g., the Mackenzie River (Fabijan, 2000) and Alaska (Craig, 1989b), but are rarely reported in Kitikmeot region (Priest and Usher, 2004).

Based on literature and analysis of ~3 h of videotape that covered the dock footprint thoroughly, there were no marine fish species that were abundant there. Only two fish, both spatulate sculpins (*Icelus spatula*), were taken in bottom trawls that covered ~10,000 m² near the dock site in Grays Bay in 2005.

In the High Lake project Environmental Impact Statement (Wolfden Resources Inc. 2006), Arctic char is the only fish species in the marine environment that was considered to be a valued ecosystem component (VEC). It is a VEC because:

- It is a good indicator species of overall health of the marine ecosystem as a top predator; and
- The health and abundance of Arctic char was identified as an important issue by communities/Elders.

Accordingly, Arctic char habitat is considered in compiling the marine habitat compensation.

3.2.2 Freshwater

Scott and Crossman (1973) indicate that broad whitefish (*Coregonus nasus*), anadromous and resident Arctic char, lake trout (*Salvelinus namaycush*), Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*) and Northern pike (*Esox lucius*) are likely to be found within the study area.

Baseline sampling conducted throughout the Kennarctic River watershed resulted in the capture of only four species of fish: Arctic char (AC), lake trout (LT), slimy sculpin (CCG) and ninespine stickleback (*Pungitius pungitius*, NSB). All four of these fish species can be found in the impacted watercourses.

In the High Lake project Environmental Impact Statement, Arctic char and lake trout are the fish species in the freshwater environment identified as VECs. They are considered VECs because:

- The resources are important to the surrounding Inuit communities;
- Fish habitat is protected under the federal Fisheries Act;
- There is a tradition of assessing fish and fish habitat for similar projects; and
- They are identified as important resources by regulators and project scientists.

Accordingly, Arctic char and lake trout habitat are considered in compiling the freshwater habitat compensation.

3.3 Habitat Suitability Models

3.3.1 Marine

For the marine environment, where the only VEC identified was Arctic char, and its use of the habitat consisted only of foraging and migrating, a general marine habitat suitability rating system based on heterogeneity of substrate and benthic biota was deemed appropriate. Homogeneous substrate was considered to be low quality habitat, and heterogeneous substrate was considered to be high quality habitat, as presented in Table 2.

3.3.2 Freshwater

Based on a review of literature and existing NNL Plans compiled for studies in Northern Canada, and consultation with scientists, it has been determined that either no Habitat Suitability Indices (HSIs) exist, or where existing, HSIs are not suitable for application in the arctic environment. Accordingly, the approach taken in this plan is based on precedent wherein the HSIs developed and presented herein are based directly on HSIs developed for the following projects, of similar nature and scope: Diavik Diamonds Project (Diavik Diamonds Inc. 1998), Meadowbank Gold Project (Cumberland Resources Ltd. 2005) and Doris North Project (Golder Associates 2005).

Models developed to determine the suitability of an existing freshwater habitat for both lake trout and Arctic char is presented in Table 3 and Table 4, respectively.

As illustrated in Tables 3 and 4, five habitat types are listed and quantified according to their components, based on habitat characteristics of arctic waterbodies and life cycle needs of fish: spawning; nursery; rearing; foraging; migration. Spawning, nursery, rearing and foraging habitat for Arctic char and lake trout can be found in lakes. The streams impacted provide only rearing and migration habitat, as the streams are ephemeral, and the VECs are not typically stream-spawning species. Based on the suitability and importance of an attribute to a habitat type, ratings were assigned. Characteristics of each habitat type per species are described below. Habitat features included in the model are limited to physical characteristics, as habitat impacts are limited to physical alteration of habitat.

3.3.2.1 Spawning

Spawning habitat includes areas used by fish for the specific act of spawning, occurring at a depth below average ice thickness and is limited to lakes. Preferred lake trout spawning habitat is a boulder-dominant substrate occurring at a moderate depth proximal to pelagic areas. Similarly, preferred Arctic char spawning habitat occurs at moderate depth proximal to pelagic areas, but with a cobble-dominant substrate. Spawning occurs at a depth not less than 2 m due to ice presence to 2 m thickness during winter months. Incubating eggs require ice-free water for survival.

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Table 2. Marine Habitat Quality, Grays Bay

Habitat Quality Rating	Depth (m)	Substrate	Biota
Low	0-2, >10	Bedrock/large boulders, or silt with widely scattered small rocks	Few
Medium	10-May	Fines with small cobble and gravel patches	Some
High	05-Feb	Heterogeneous large rock	Some, much seaweed

High Lake Project
No Net Loss Plan

Table 3. Habitat Suitability Index for Lake Trout

Attribute	Class	Detail	Spawning	Nursery	Rearing	Foraging	Migration
Substrate-Composition	Lentic	Boulder	4	4	2	2	-
		Boulder/Cobble	3	3	4	4	-
		Boulder/Fine	2	2	2	2	-
		Boulder/Cobble/Fine	2	2	3	2	-
		Fine/Boulder	1	1	1	1	-
		Fines	0	0	1	0	-
Substrate-Heterogeneity	Lentic	>80% Dominant Substrate	2	2	2	2	-
		60-80% Dominant Substrate	3	3	2	2	-
		<60% Dominant Substrate	4	4	2	2	-
Depth	Lentic	Shallow (0-2 m)	0	0	4	3	-
		Moderate (2-6 m)	4	4	4	3	-
		Deep (>6 m)	1	1	2	2	-
Morphology	Lentic	Littoral	1	1	2	2	-
		Littoral proximal to pelagic	4	4	4	2	-
		Pelagic	1	1	2	2	-
	Lotic	No barriers to migration	-	-	-	-	4
		Barriers during low flow years	-	-	-	-	2
		Barriers present, only passable during extremely high water conditions	-	-	-	-	1
Barriers present, not passable to fish	-	-	-	-	0		
Flow	Lotic	Present annually in a defined channel	-	-	-	-	4
		Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	2
		Insufficient flow to allow fish passage	-	-	-	-	0
Stream Longevity	Lotic	>8 weeks	-	-	4	-	-
		4-8 weeks	-	-	2	-	-
		<4 weeks	-	-	0	-	-
% Cover	Lotic	>75%	-	-	2	-	-
		25-75%	-	-	4	-	-
		10-25%	-	-	2	-	-
		0%	-	-	0	-	-
Access	Lotic	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4
		Not connected to suitable habitat	-	-	-	-	0

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above Average
- 4 Excellent

High Lake Project
No Net Loss Plan

Table 4. Habitat Suitability Index for Resident Arctic Char

Attribute	Class	Detail	Spawning	Nursery	Rearing	Foraging	Migration
Substrate-Composition	Lentic	Boulder	1	1	2	2	-
		Boulder/Cobble	2	2	4	4	-
		Boulder/Fine	1	1	1	2	-
		Boulder/Cobble/Fine	2	2	3	4	-
		Fine/Boulder	0	0	1	1	-
		Fines	0	0	1	1	-
Substrate-Heterogeneity	Lentic	>80% Dominant Substrate	-	-	-	-	-
		60-80% Dominant Substrate	-	-	-	-	-
		<60% Dominant Substrate	-	-	-	-	-
Depth	Lentic	Shallow (0-2 m)	0	2	4	4	-
		Moderate (2-6 m)	4	4	4	4	-
		Deep (>6 m)	2	2	2	2	-
Morphology	Lentic	Littoral	2	2	2	2	-
		Littoral proximal to pelagic	4	4	4	2	-
		Pelagic	2	2	2	2	-
	Lotic	No barriers to migration	-	-	-	-	4
		Barriers during low flow years	-	-	-	-	2
		Barriers present, only passable during extremely high water conditions	-	-	-	-	1
Barriers present, not passable to fish	-	-	-	-	0		
Flow	Lotic	Present annually in a defined channel	-	-	-	-	4
		Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	2
		Insufficient flow to allow fish passage	-	-	-	-	0
Stream Longevity	Lotic	>8 weeks	-	-	4	-	-
		4-8 weeks	-	-	2	-	-
		<4 weeks	-	-	0	-	-
% Cover	Lotic	>75%	-	-	2	-	-
		25-75%	-	-	4	-	-
		10-25%	-	-	2	-	-
		0%	-	-	0	-	-
Access	Lotic	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4
		Not connected to suitable habitat	-	-	-	-	0

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

3.3.2.2 *Nursery*

Nursery habitat includes areas used by developing embryos and young of the year (YOY), occurring at a depth below average ice thickness and in the immediate vicinity of spawning habitat. Nursery habitat preferences for lake trout is the same as that for spawning as the YOY stay in the same locale following emergence. Arctic char YOY, however, move into the shallow water following emergence.

3.3.2.3 *Rearing*

Rearing habitat includes areas used by sub-adult fish other than YOY for foraging and refuge, occurring at all water depths in both lakes and streams. Rearing habitat preferences for lake trout include boulder-dominant substrates at shallow to moderate depths, proximal to pelagic areas, where cover for juveniles is plentiful. Arctic char prefer boulder-cobble substrates at shallow to moderate depths, proximal to pelagic areas.

3.3.2.4 *Foraging*

Foraging habitat includes areas used by adult fish for feeding or periods between feeding, occurring at all water depths. Foraging preferences for lake trout include boulder-cobble substrate at all depths throughout. Arctic char prefer foraging in boulder-cobble-fine substrate at shallow to moderate depths.

3.3.2.5 *Migration*

Migratory habitat includes areas used by juvenile and adult fish for an extended movement from one place to another via a stream corridor, followed by a return trip to the locale previously occupied. Migratory habitat is most suitable for both lake trout and Arctic char where no barriers exist, flows are present annually in a defined channel, and provide a connection to suitable seasonal habitat.

3.3.2.6 *Model Application*

In applying the model to an existing waterbody or area of habitat, the ratings of the attributes exhibited by the area being assessed would be assigned to that habitat. A sum of the rating values for the habitat area assessed, multiplied by the area assessed equals the number of Habitat Units (HUs) for that area. Habitat units are a weighted value that represent the quantity and quality of a habitat. Because they are weighted, HUs can be compared, and thus are used in determining how much and what type of habitat is lost or needs to be compensated for. For example (simplified), a greater area (6) of lesser quality habitat (2) could be compensated for by enhancing/creating a smaller area (3) of higher quality habitat (4). Either way, the HU value is 12, and the productive capacity of the habitat is increased.

4. Habitat Evaluation

4.1 Marine

Observation of habitat during baseline studies concluded that in deeper water (>10 m) in the area of impact, there was a silt substrate with widely scattered small rocks on the surface. Numerous siphon holes of infaunal bivalves were evident. At the greatest depths (>20 m), brittle stars and large bivalve siphons (likely *Mya truncata*) were abundant and there appeared to be a mat of filamentous algae on the sediment surface. In somewhat shallower water (~10–20 m), sea urchins (*Strongylocentrotus* sp.) were numerous, large starfish (*Urasterias lincki*) were less numerous but common, and crabs (probably snow crab, *Chionoecetes opilio*) were seen in low numbers on most transects. In some areas, there were patches of cerianthid anemones.

As water depth decreased from 20 to 10 m, there were increasing amounts of gravel and rock with generally the same fauna. Further inshore (<5 m depth), rocks and boulders covered the bottom completely, with patches of seaweed (*Fucus* sp.) and filamentous algae attached to them, in some places widely scattered and in others very dense. In very shallow water (<2 m), the substrate was bedrock or large boulders, and the only biota visible was filamentous algae.

The area of each type marine habitat quality impacted by the dock footprint is presented in Table 5. A total of 0.65 ha of predominantly low quality Arctic char foraging and migratory habitat will be lost through construction of the dock. However, the loss of 0.06 ha of high quality habitat will be mitigated through the burial of the structural elements of the dock with granular material during closure. The overall net area of habitat impacted is 0.59 ha.

4.2 Freshwater

Watercourses impacted by all-season road construction include both a lake and four streams (5 crossings in total). The lake provides spawning, nursery, rearing and foraging habitat, while the streams provide rearing and migratory habitat. As such, the lake and streams are discussed separately below. However, overall freshwater impacts and compensation are discussed together in a subsequent section. Habitat suitability model results for each site can be found in Appendix B.

4.2.1 Lake Crossing L800 (AS5)

This road crossing occurs along the west shore of lake L800 wherein the proposed road traverses the shoreline and passes through a section of the western end of the lake. L800 has a surface area of 27 ha and a volume of 2,118,199 m³. Overall, substrate throughout the lake consists of equal portions of boulders at lake edges and on the slope of lake shelf, and fines, predominantly in depositional areas. Cobbles and bedrock are found infrequently throughout the lake.

High Lake Project
No Net Loss Plan

Table 5. Marine Habitat Area in the Dock Footprint

Habitat Quality Rating	Area Impacted (ha)
Low	0.36
Medium	0.1
High	0.19
Total	0.65

Fish presence studies have not been carried out, however, based on regional observations, it is likely that the lake supports a population of lake trout. For the purposes of compensation planning and in the absence of sampling results, it is assumed that the lake supports both freshwater VECs identified in the High Lake Project Proposal: resident Arctic char and lake trout (Wolfden Resources Inc. 2006). Inlet and outlet streams are ephemeral and are not directly connected to any fish-bearing waterbodies. Therefore, the fish population in the lake is considered isolated.

Based on bathymetric data collected in 2005, lake depths in the area of impact do not exceed 2.0 m. The substrates in this area are predominantly fines and boulders with infrequent cobbles. Habitat values in the area of impact are limited to seasonal lake trout rearing and foraging (5.4 HU), and Arctic char nursing, rearing and foraging (6.25 HU) Table 6 outlines the habitat quality and extent of the area of impact on L800. Figure 4 illustrates the road crossing location and design details, while Figure 5 illustrates the habitat detail for the lake.

4.2.2 Stream Crossings

All Season Road Crossing #1 (AS1)

During baseline sampling in 2005, the stream at AS1, was observed to flow through an undefined channel ranging in wetted width from 3 to 24 m, with a mean depth of 0.4 m in June and 0.3 m in August. Substrate consisted predominantly of fines. Watershed area upstream of the proposed crossing is 377 ha and discharge was measured at 0.26 m³/sec in June and 0.08 m³/sec in August. Lake trout and ninespine stickleback were captured during electrofishing.

The loss of 0.004 ha of habitat here will be mitigated through the installation of culverts below grade, with a natural substrate fill throughout the culvert.

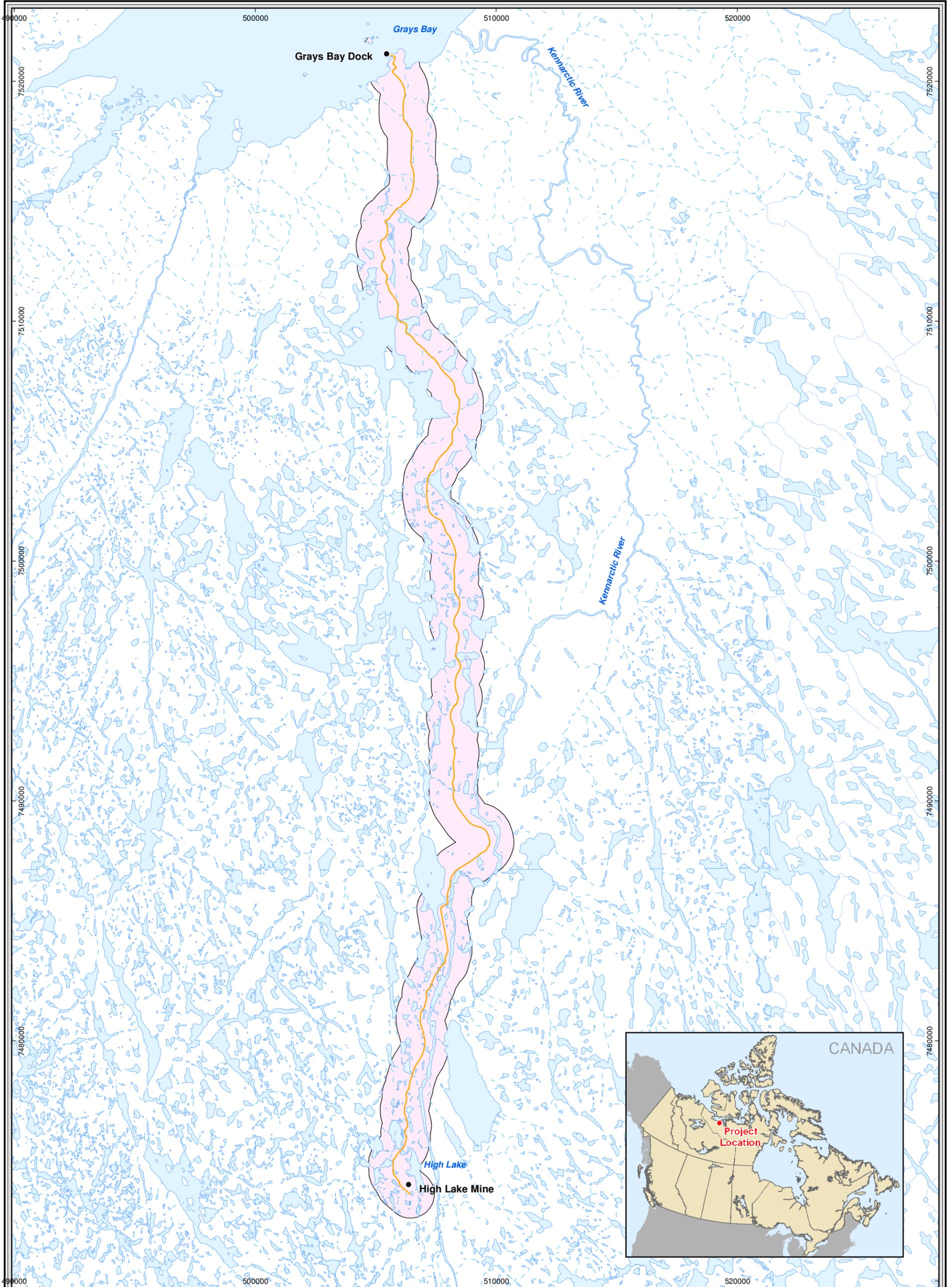
Habitat values in the area of impact are limited to seasonal lake trout and Arctic char rearing and migration (0.33 HU each). Table 6 outlines the habitat quality and extent of the area of impact on the stream at AS1. Figure 6 illustrates the road crossing location and design details

All Season Road Crossing #8 (AS8)

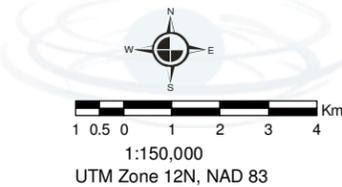
The stream at AS8 was short (90 m), connecting two lakes, and was generally undefined with immeasurable discharge between lakes. Watershed area upstream of the proposed crossing is 229 ha. During baseline sampling in 2005, channel wetted widths ranged from 21 to 68 m, while the average depth in June was 0.5 m and in August was 0.3 m. Substrate consisted of predominantly of boulders. During electrofishing, ninespine stickleback were captured at this location.

The loss of 0.0038 ha of habitat will be mitigated through the installation of culverts below grade, with a natural substrate fill throughout the culvert.

Habitat values in the area of impact are limited to low value seasonal lake trout and Arctic char rearing and migration habitat (2.02 HU each). Table 6 outlines the habitat quality and extent of the area of impact on the stream at AS8. Figure 7 illustrates the road crossing location and design details.



Map Sources/Notes:
- NTDB base data at 1:250,000 scale provided by Natural Resources Canada.



- Legend**
- Project Site
 - All-Season Road
 - Freshwater LSA and RSA
 - Watercourse
 - Waterbody

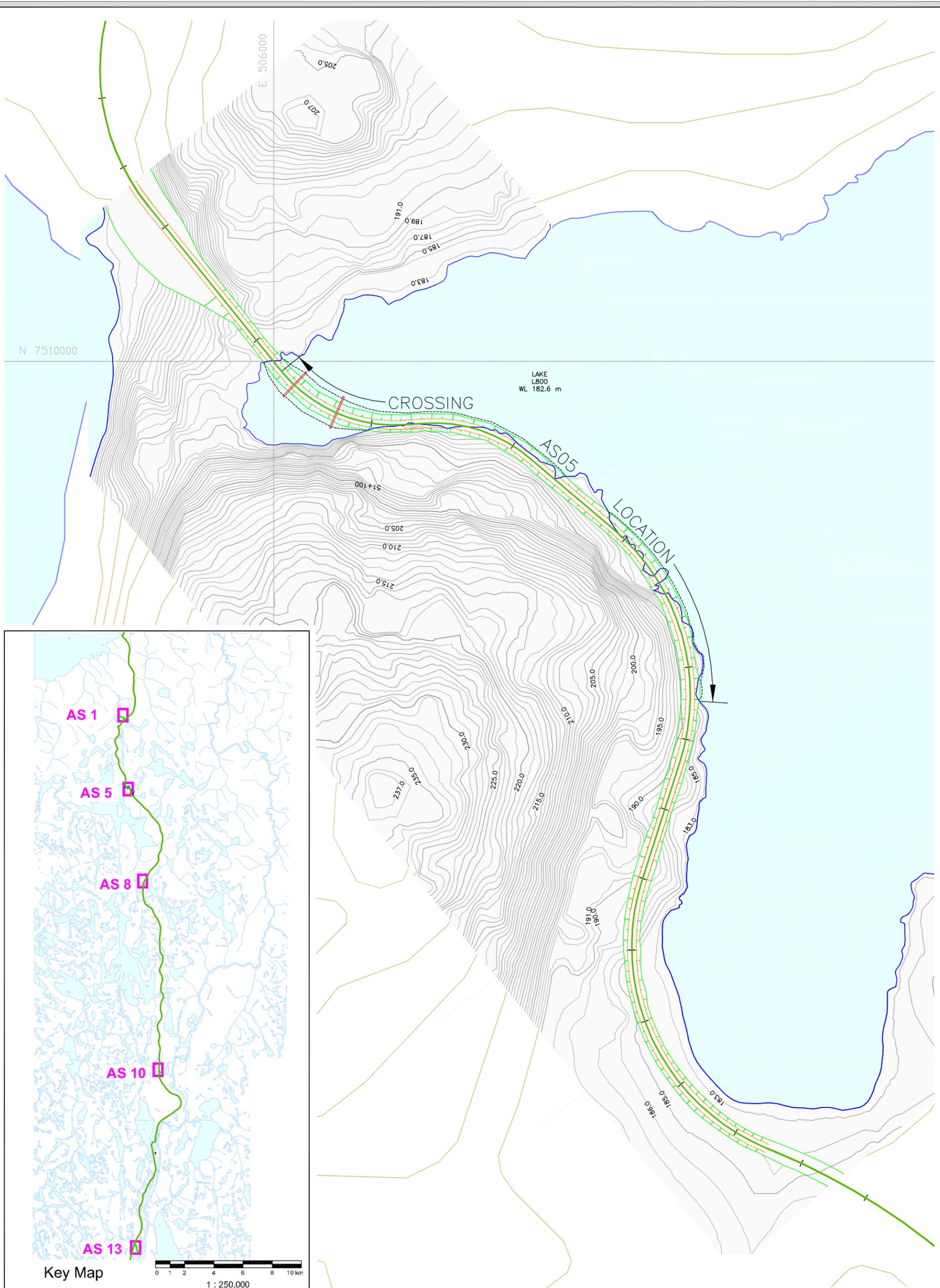
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Date Issued: June, 2007 Project Number: 71-009-01

Zinifex
Project: High Lake - No Net Loss Plan
Location: High Lake, Nunavut

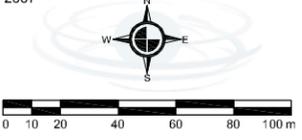
**Freshwater Regional and Local
Study Area**

 **Gartner Lee**

Figure 3
Version 1



Map Sources / Notes:
 Road Crossing details provided by TBT Engineering. Files
 AS01 May 07.dwg AS08 MAY 07.dwg AS10-5 MAY 07.dwg AS13-5 MAY 07.dwg
 dated May, 2007



1 : 2500
 UTM Zone12N, NAD83
 File Name: 71009_01_By1_Fig04-09_Crossing_AS-5-1-8-10-13.dwg
 Reviewed by: SH Prepared by: PW
 Date Issued: June, 2007 Project Number: 71-009

Legend

- | | |
|--|--|
| Detailed Survey by McElhanney - 2004 | Proposed Crossing Facilities |
| — Index Contour (Contour Interval 2.5m) | — Culvert |
| — Intermediate Contour (Contour Interval 0.5m) | - - - Silt Fence |
| Contours from NTDB 1:50,000 scale data | → Direction of Flow |
| — Contour Interval 10m | — Proposed All Season Road Centre Line |

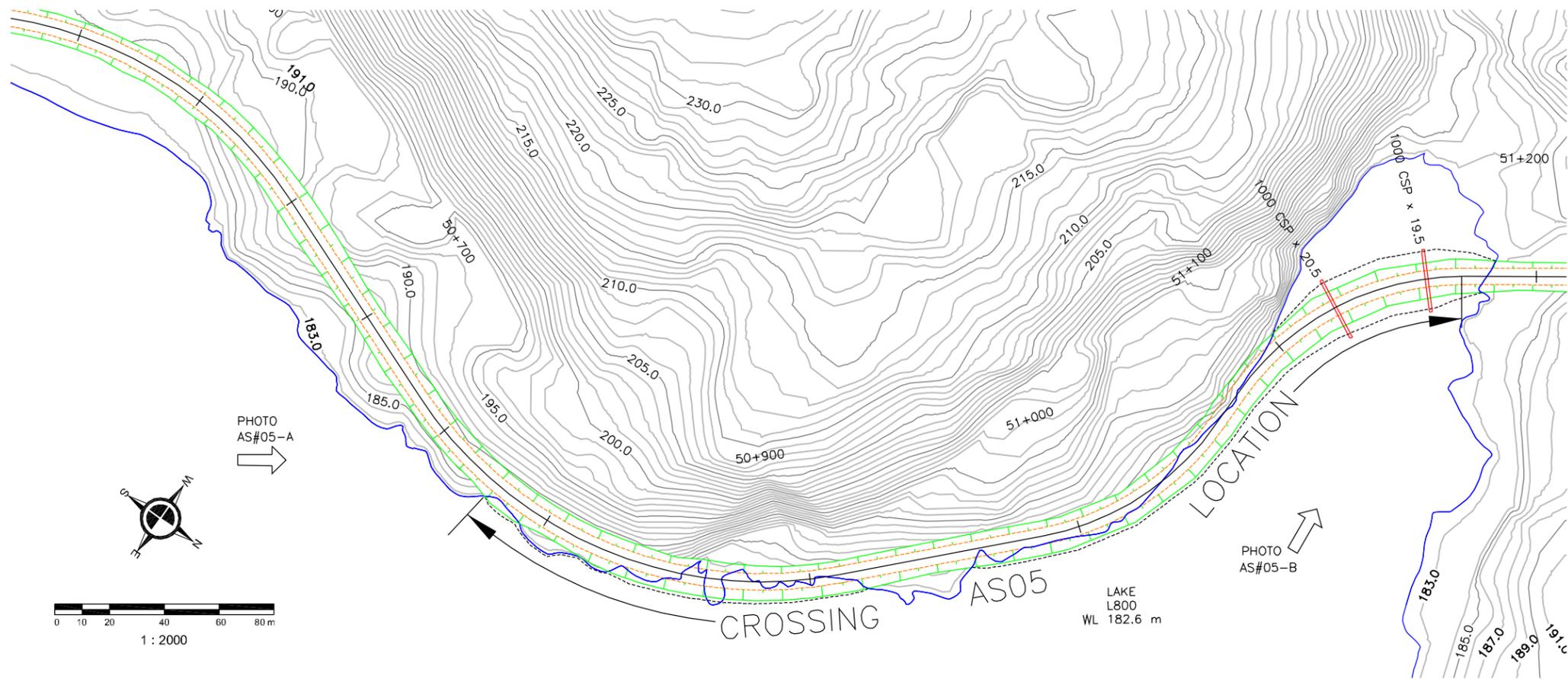
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Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

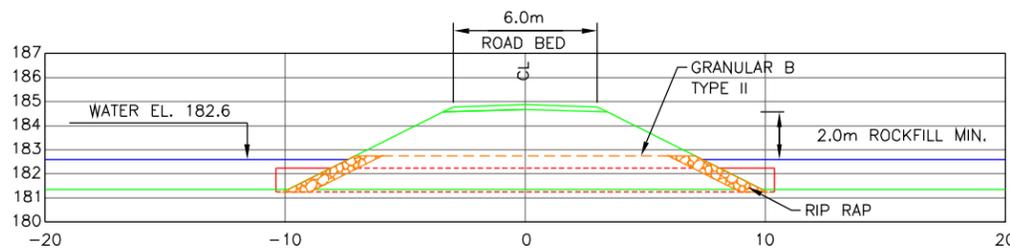
Crossing AS 5 (L800)



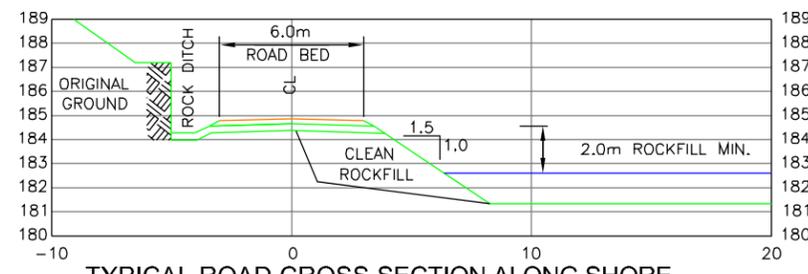
Figure 4a
Version 1



WATER CROSSING - PLAN VIEW
SCALE 1:2000



TYPICAL CULVERT CROSS SECTION
SCALE 1:300



TYPICAL ROAD CROSS SECTION ALONG SHORE
SCALE 1:300



PHOTO AS#05-A - LOOKING NORTHWEST



PHOTO AS#05-B - AERIAL VIEW NW CORNER LAKE L800

Map Sources / Notes:
Drawing by TBT Engineering, Dated April 20, 2007 "Water Crossing
Location Plan AS#05, Figure 15 - Project No. 05-160



SCALE: AS SHOWN

File Name: 71009_01_By1_Fig04b_AS05_Crossing.dwg
Reviewed by: SH Prepared by: NT/MP
Date Issued: June, 2007 Project Number: 71-009

Legend

Proposed Crossing Facilities
 Culvert

Zinifex

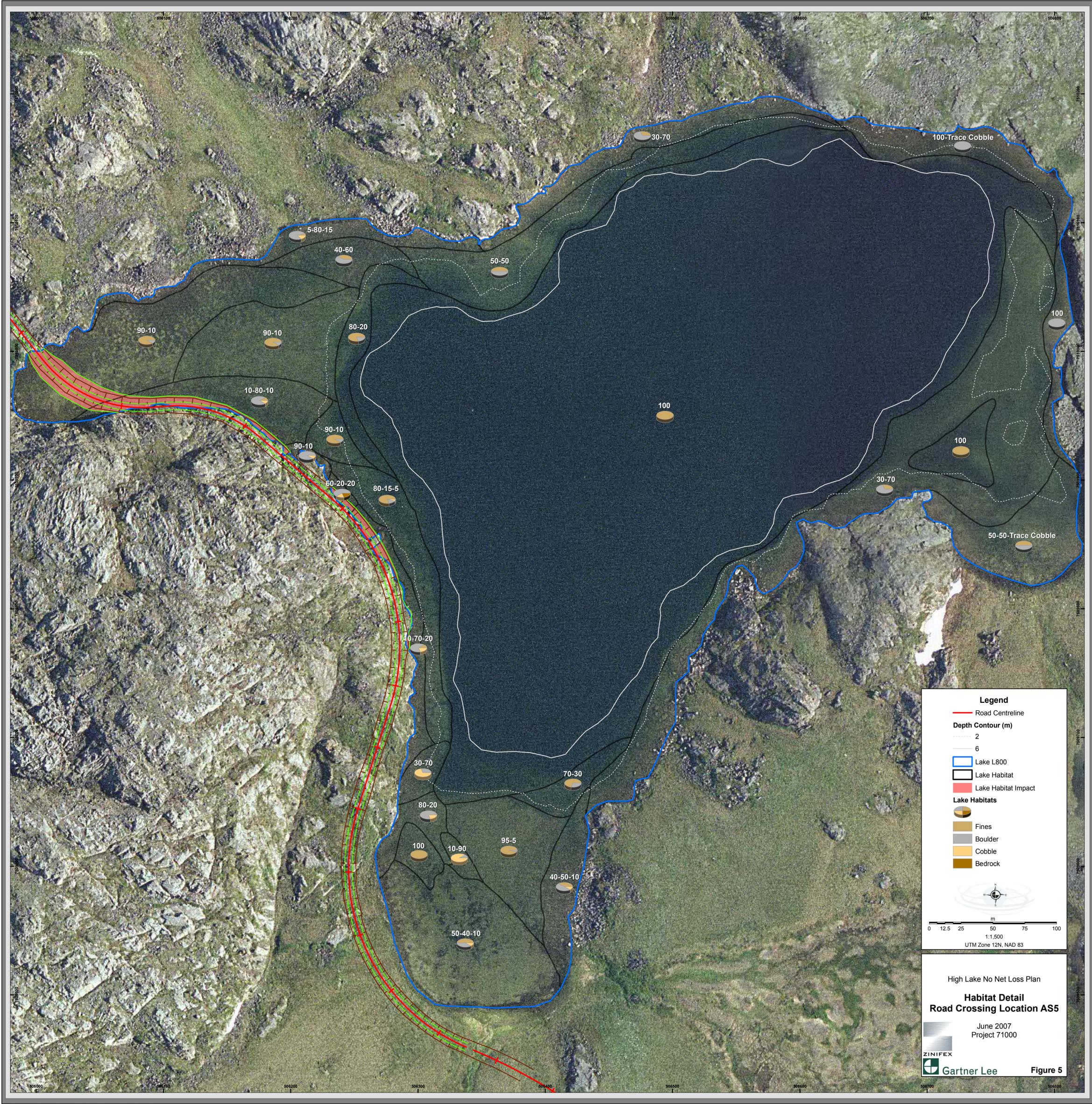
Project: High Lake No Net Loss Plan
Location: High Lake, Nunavut

**Water Crossing
Location Plan AS 05**



Figure 4b
Version 1

Date Plotted: June 28, 2007 File Location: E:\GIS\GIS_proj\Y2007\High_Lake\71009_01_Crossings\By1_NoNetLoss_May07\71009_01_By1_Fig04b_AS05_Crossing.dwg

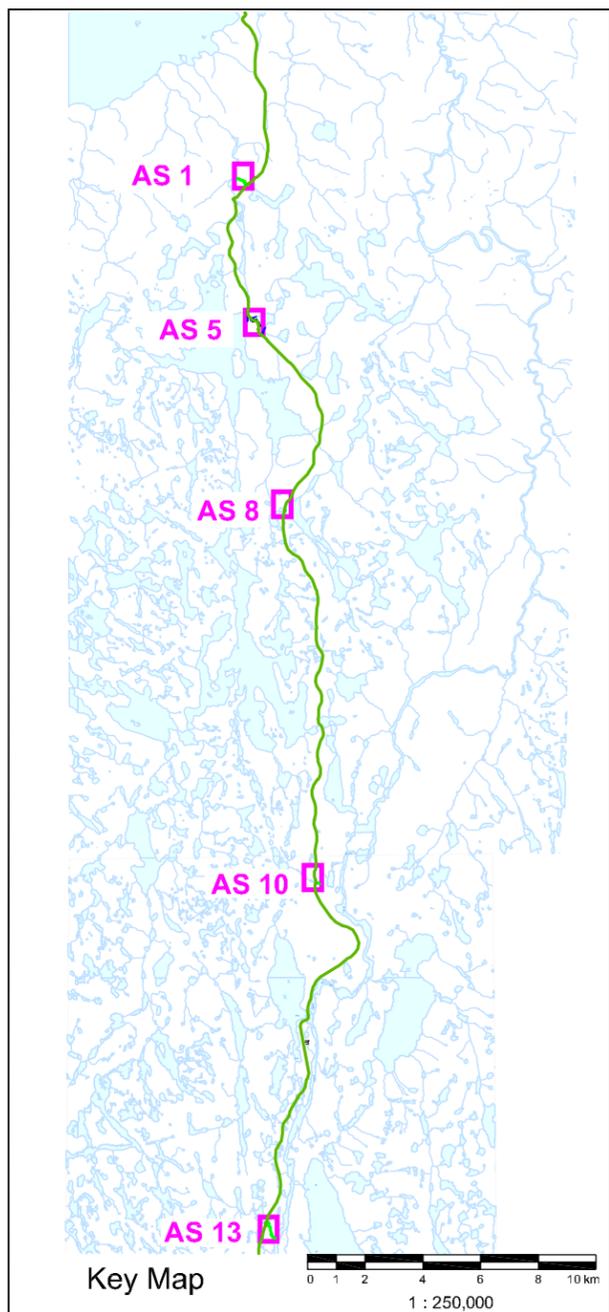


Legend

- Road Centreline
- Depth Contour (m)
 - 2
 - 6
- Lake L800
- Lake Habitat
- Lake Habitat Impact
- Lake Habitats
 - Fines
 - Boulder
 - Cobble
 - Bedrock

Scale: 0 12.5 25 50 75 100 m
1:1,500
UTM Zone 12N, NAD 83

High Lake No Net Loss Plan
Habitat Detail
Road Crossing Location AS5
 June 2007
 Project 71000
 ZINIFEX
 Gartner Lee **Figure 5**



Map Sources / Notes:
 Road Crossing details provided by TBT Engineering. Files AS01 May 07.dwg AS08 MAY 07.dwg AS10-5 MAY 07.dwg AS13-5 MAY 07.dwg dated May, 2007

1 : 2500
 UTM Zone12N, NAD83

File Name: 71009_01_By1_Fig04-09_Crossing_AS-5-1-8-10-13.dwg
 Reviewed by: SH Prepared by: PW
 Date Issued: June, 2007 Project Number: 71-009

- Legend**
- Detailed Survey by McElhanney - 2004
 - Index Contour (Contour Interval 2.5m)
 - Intermediate Contour (Contour Interval 0.5m)
 - Contours from NTDB 1:50,000 scale data
 - Contour Interval 10m
- Proposed Crossing Facilities**
- Culvert
 - - - Silt Fence
 - Direction of Flow
 - Proposed All Season Road Centre Line

Zinifex

Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

Drainage at Crossing AS 1

Figure 6a
 Version 1

Date Plotted: June 28, 2007 File Location: E:\GIS\GIS_proj\Y2007\High_Lake\71009_01_Crossings\By1_NoNetLoss_May07\71009_01_By1_Fig06b_AS01_Crossing.dwg

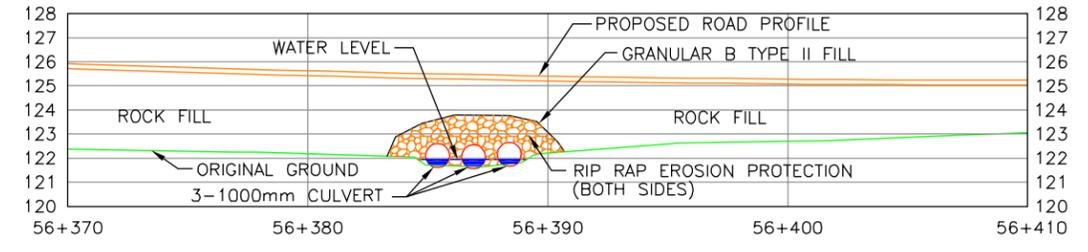
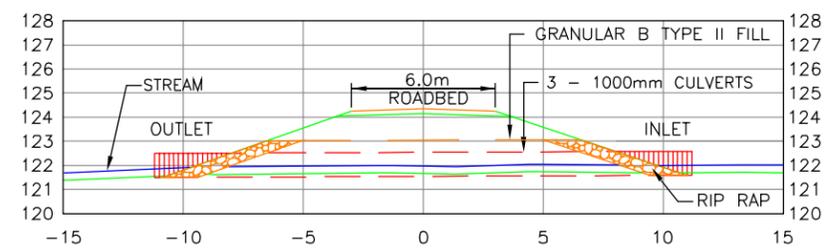
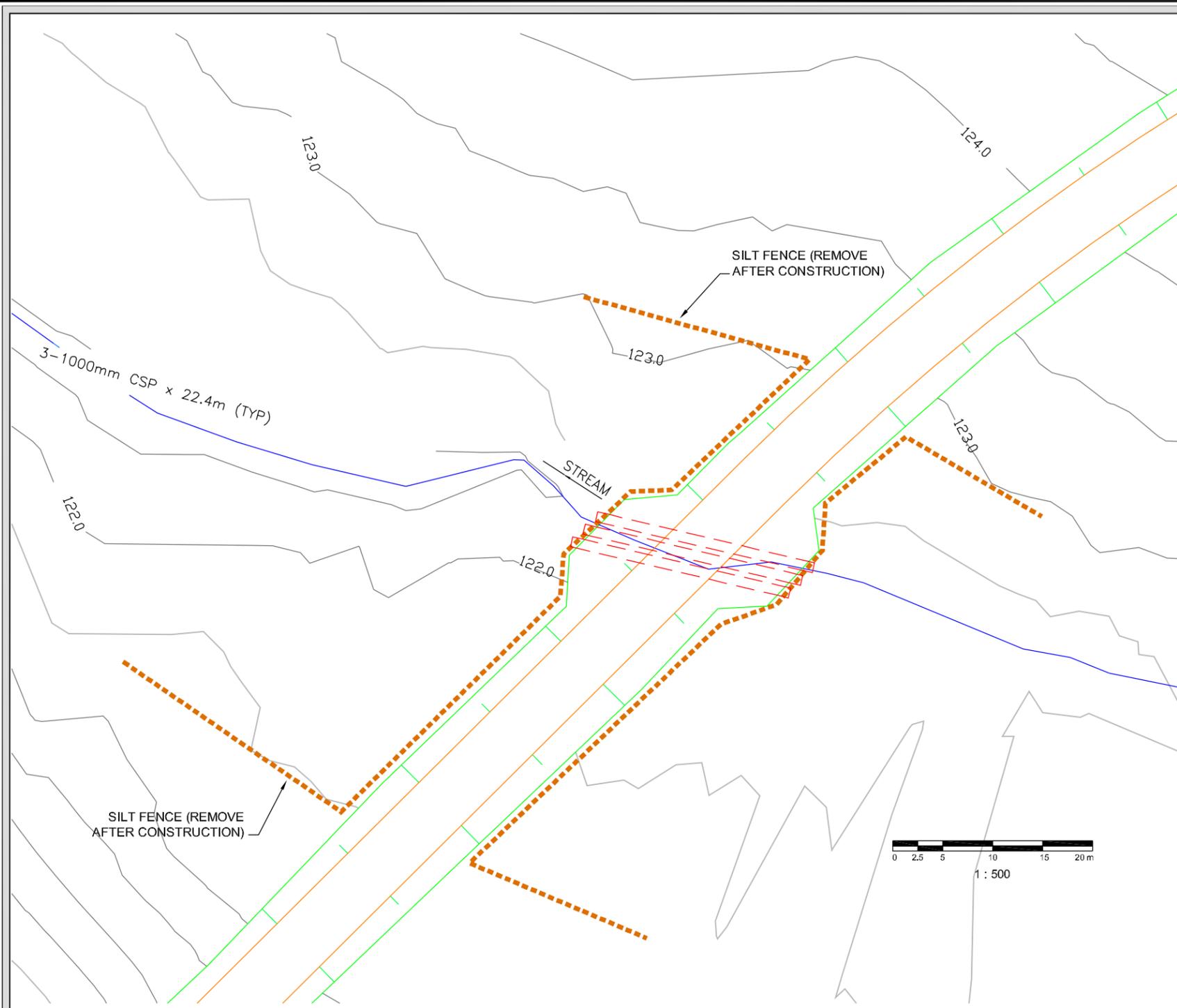


PHOTO AS#01 - LOOKING DOWNSTREAM WESTERLY

Map Sources / Notes:
Drawing by TBT Engineering, Dated April 20, 2007 "Water Crossing Location Plan AS#01, Figure 01 - Project No. 05-160"



SCALE: AS SHOWN

Legend

- Proposed Crossing Facilities
- - - - - Culvert
 - - - - - Silt Fence

File Name: 71009_01_By1_Fig06b_AS01_Crossing.dwg
Reviewed by: SH Prepared by: NT/MP
Date Issued: June, 2007 Project Number: 71-009

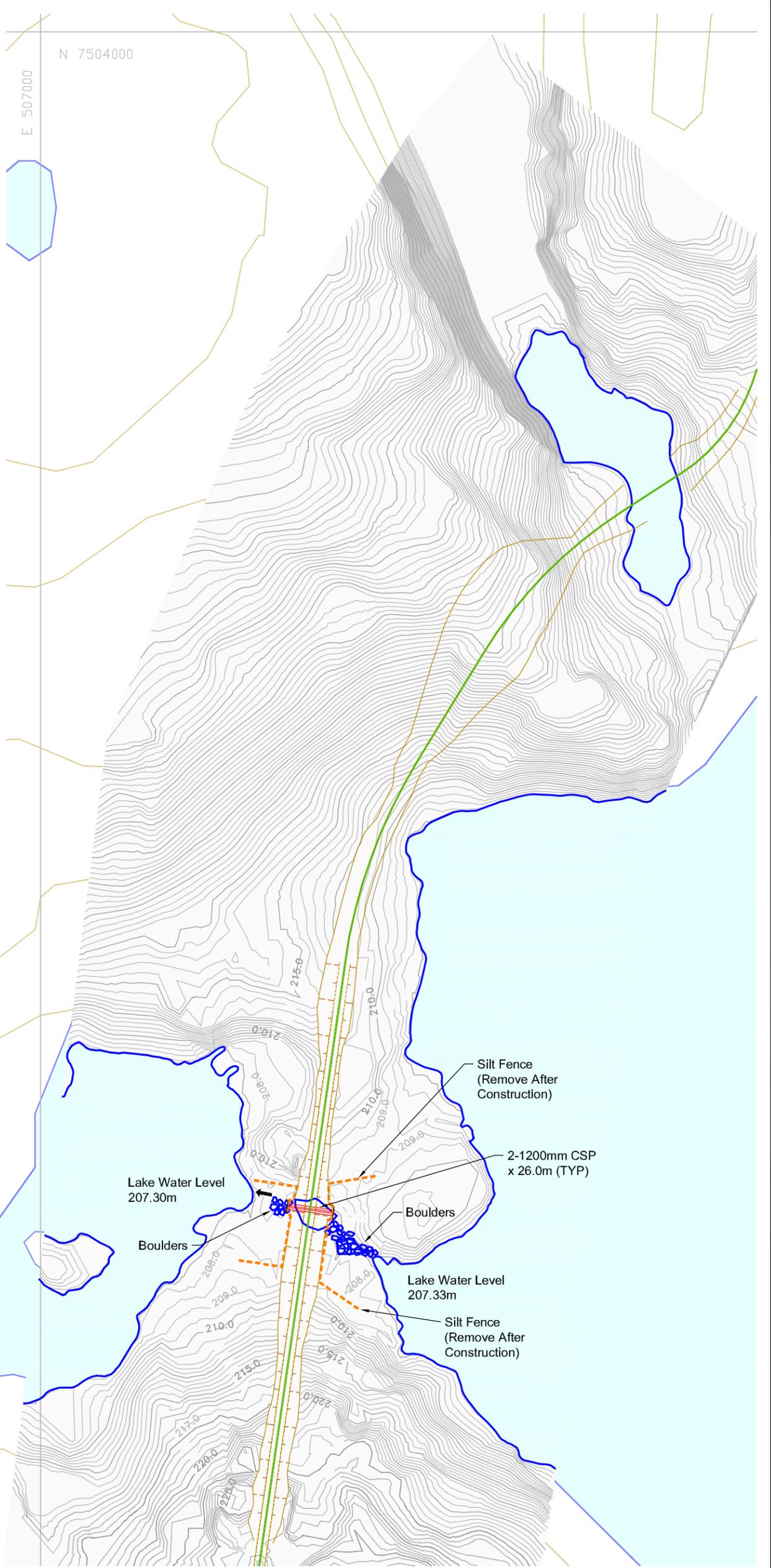
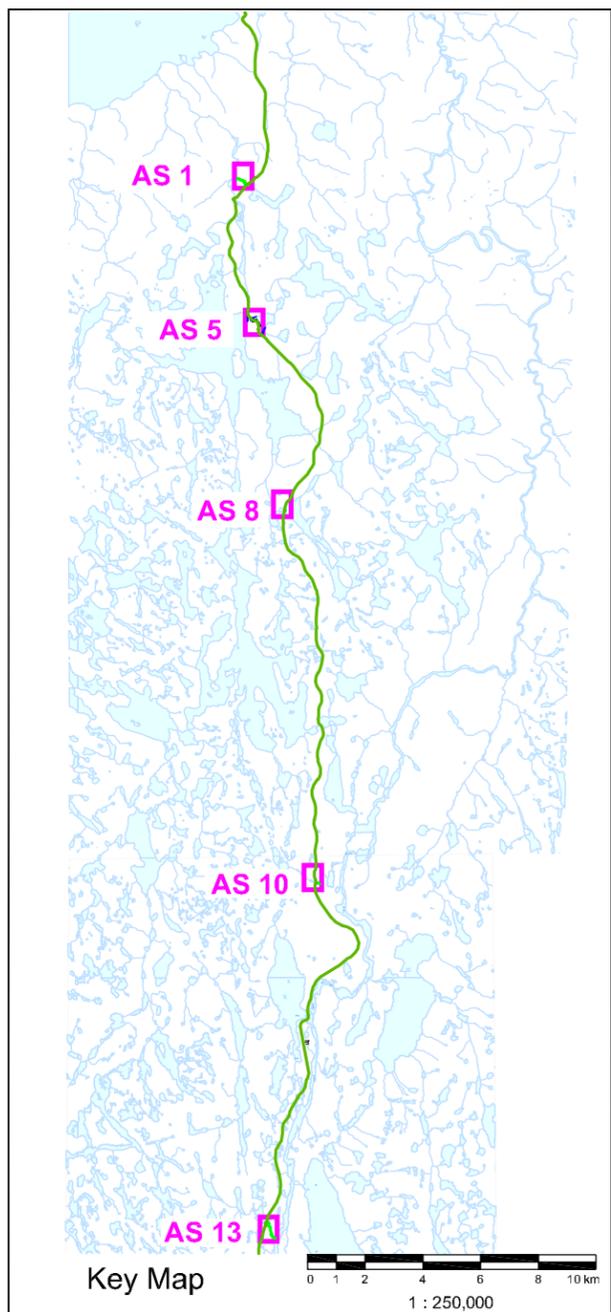
Zinifex

Project: High Lake No Net Loss Plan
Location: High Lake, Nunavut

Water Crossing Location Plan AS 01



Figure 6b
Version 1



Map Sources / Notes:
Road Crossing details provided by TBT Engineering. Files
AS01 May 07.dwg AS08 MAY 07.dwg AS10-5 MAY 07.dwg AS13-5 MAY 07.dwg
dated May, 2007



1 : 2500
UTM Zone12N, NAD83

File Name: 71009_01_By1_Fig04-09_Crossing_AS-5-1-8-10-13.dwg
Reviewed by: SH Prepared by: PW
Date Issued: June, 2007 Project Number: 71-009

Legend

Detailed Survey by McElhanney - 2004

- Index Contour (Contour Interval 2.5m)
- Intermediate Contour (Contour Interval 0.5m)

Contours from NTDB 1:50,000 scale data

- Contour Interval 10m

Proposed Crossing Facilities

- Culvert
- - - Silt Fence
- ➔ Direction of Flow
- Proposed All Season Road Centre Line

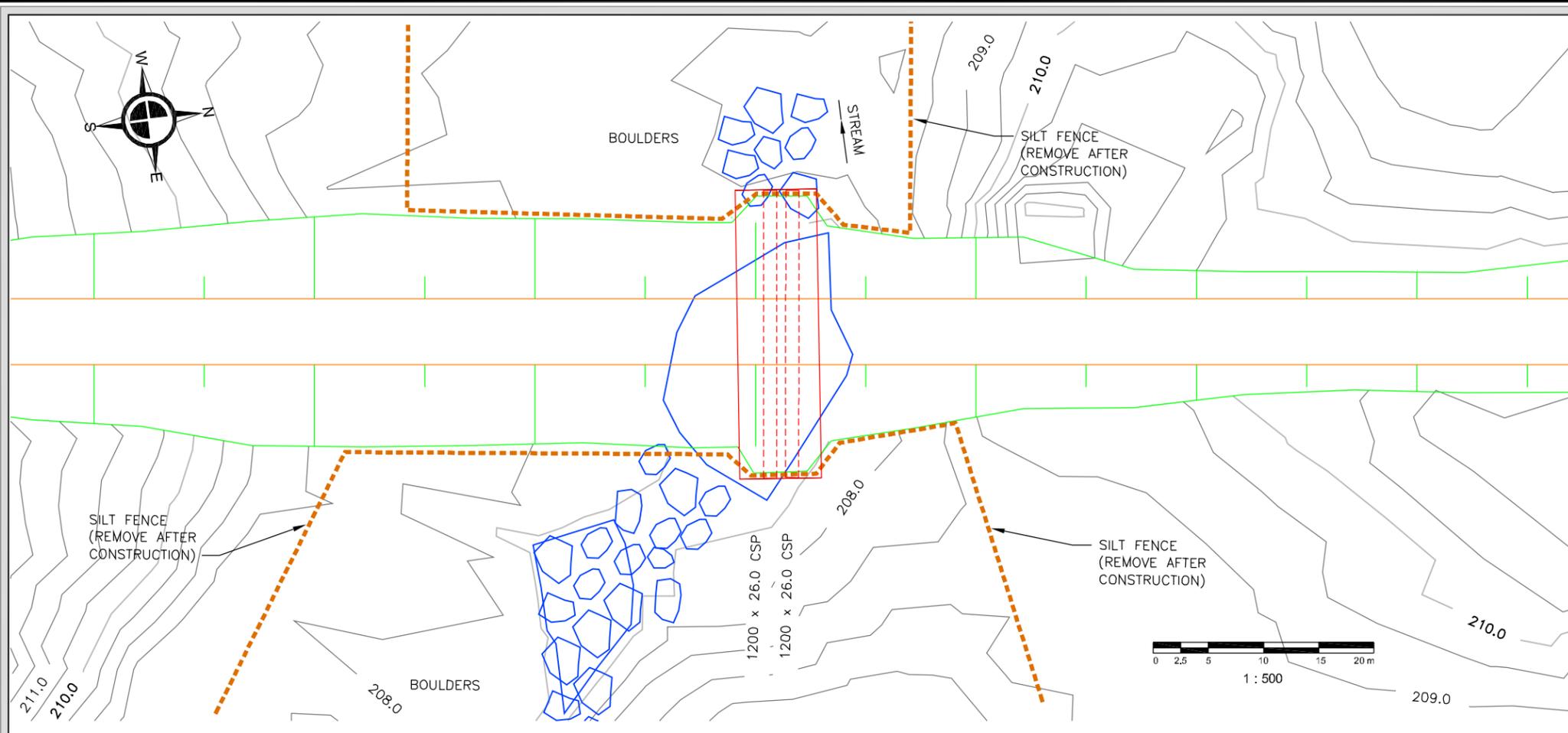
Zinifex

Project: High Lake - No Net Loss Plan
Location: High Lake, Nunavut

Drainage at Crossing AS 8



Figure 7a
Version 1



WATER CROSSING - PLAN VIEW

SCALE 1:500



PHOTO AS#8 - LOOKING EAST

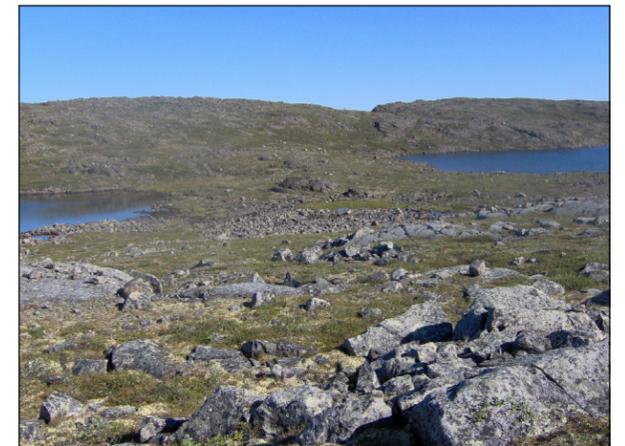
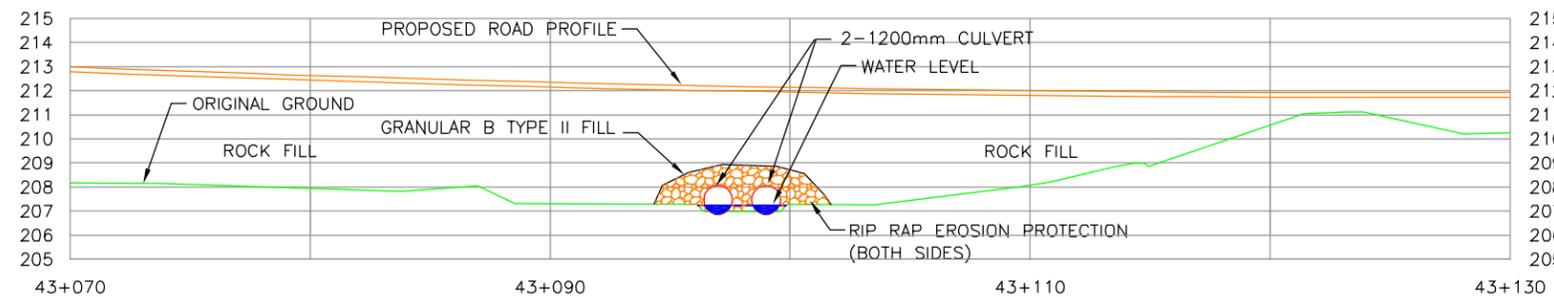
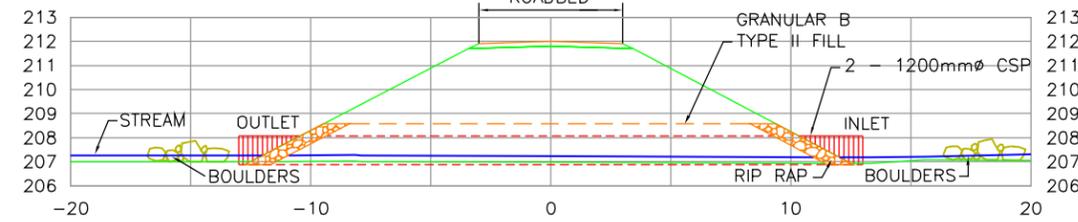


PHOTO AS#8 - LOOKING NORTH



ROAD CL PROFILE - ELEVATION VIEW

SCALE 1:300



CULVERT CL CROSS-SECTION

SCALE 1:300

Map Sources / Notes:
 Drawing by TBT Engineering, Dated April 20, 2007 "Water Crossing
 Location Plan AS#08, Figure 11 - Project No. 05-160



SCALE: AS SHOWN

File Name: 71009_01_By1_Fig07b_AS08_Crossing.dwg
 Reviewed by: SH Prepared by: NT/MP
 Date Issued: June, 2007 Project Number: 71-009

Legend

- Proposed Crossing Facilities
- - - - - Culvert
 - - - - - Silt Fence

Zinifex

Project: High Lake No Net Loss Plan
 Location: High Lake, Nunavut

**Water Crossing
 Location Plan AS 08**



Figure 7b
 Version 1

Date Plotted: June 28, 2007 File Location: E:\GIS\GIS_proj\Y2007\High_Lake\71009_01_Crossings\By1_NoNetLoss_May07\71009_01_By1_Fig07b_AS08_Crossing.dwg

All Season Road Crossing #10 (AS10)

The stream at AS10 was sampled only in August 2005 as high flows and ice present in the channel precluded sampling in June. The active channel was undefined and ranged in wetted width from 32 to 45 m with an average depth of 0.2 m. Substrate was predominantly boulder and discharge in August was measured at 0.12 m³/sec. Watershed area upstream of the proposed crossing is 1,027 ha. Only slimy sculpin were captured during electrofishing.

The loss of 0.0099 ha of habitat will be mitigated through the installation of culverts below grade, with a natural substrate fill throughout the culvert.

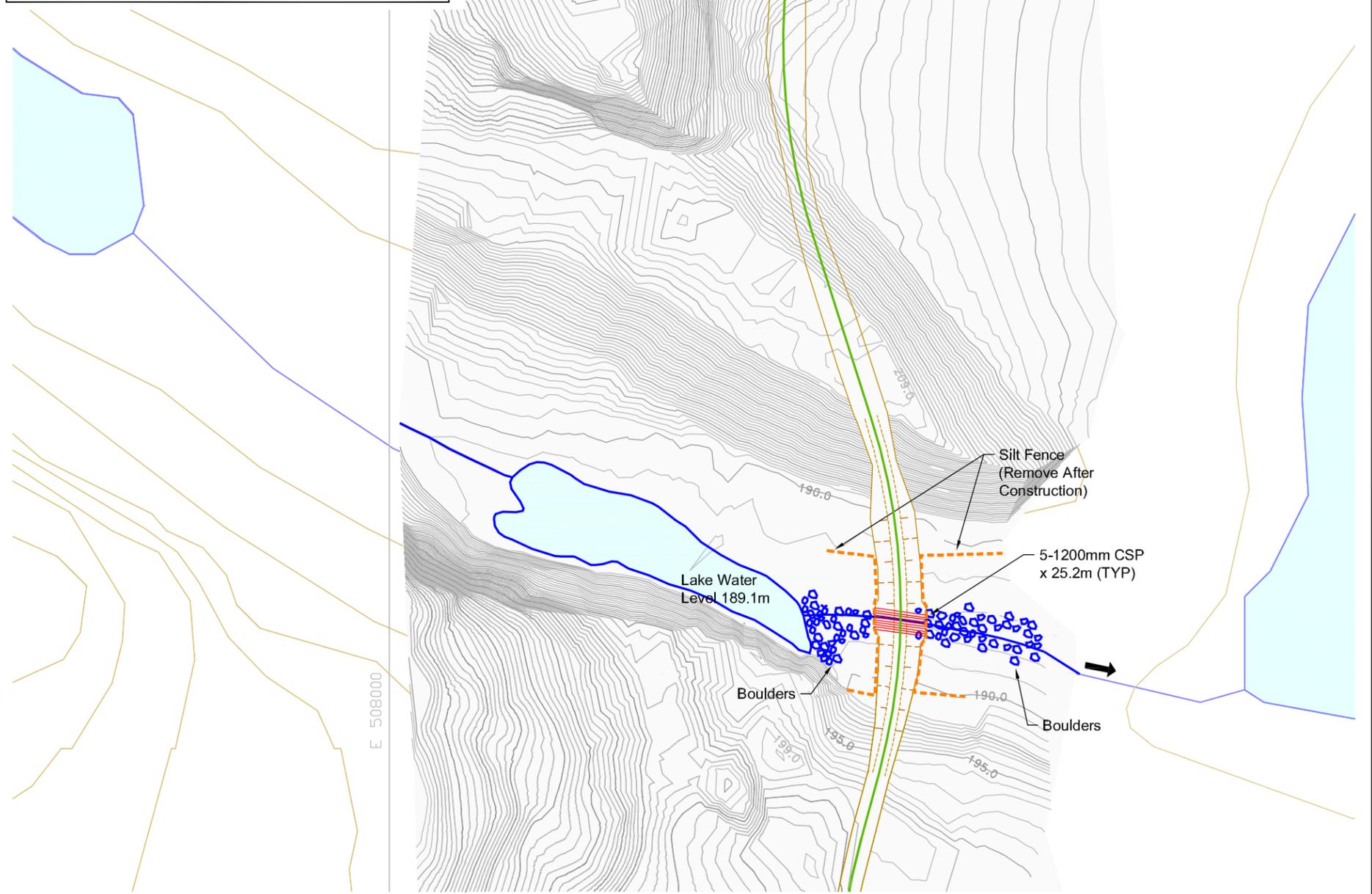
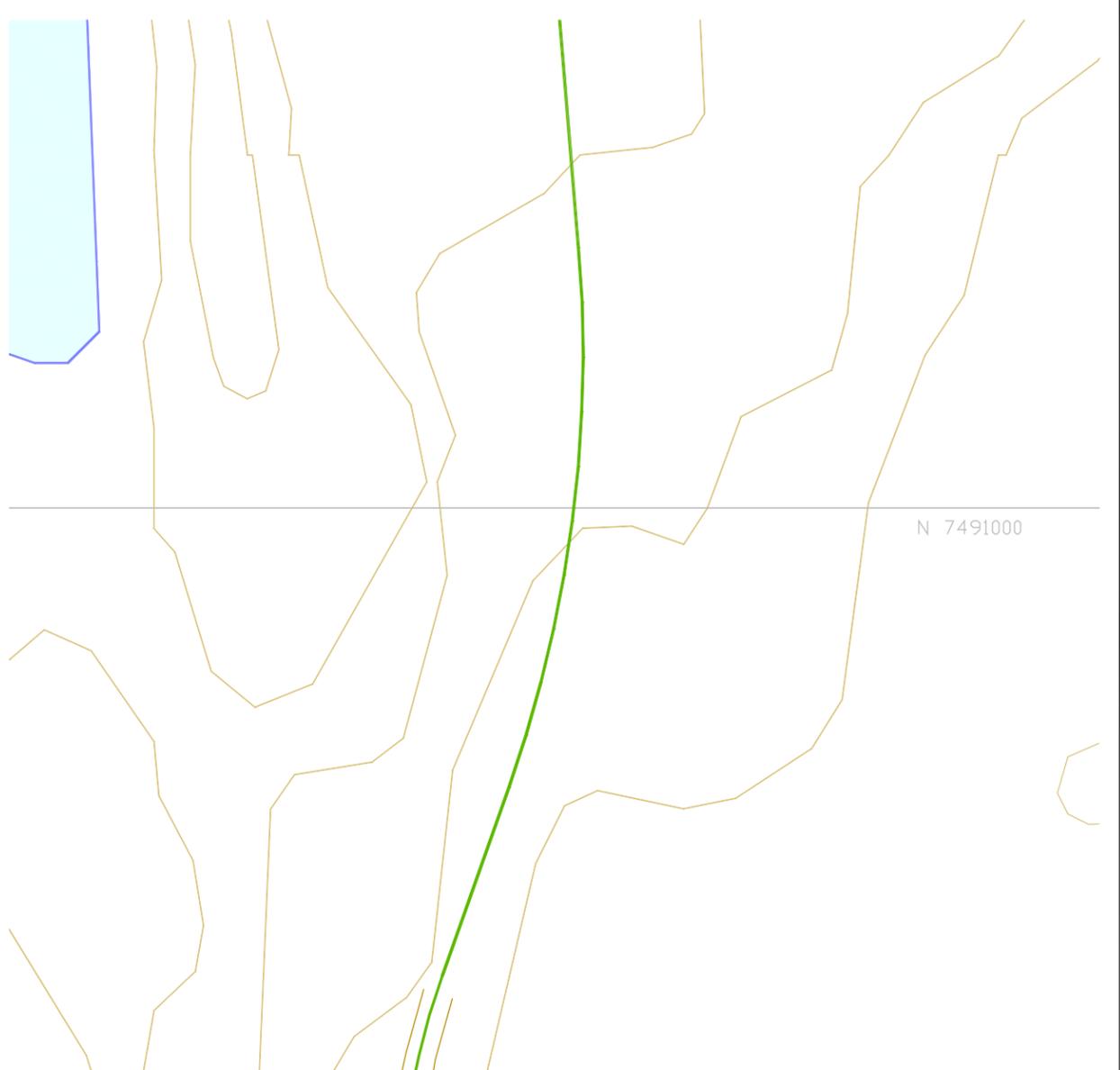
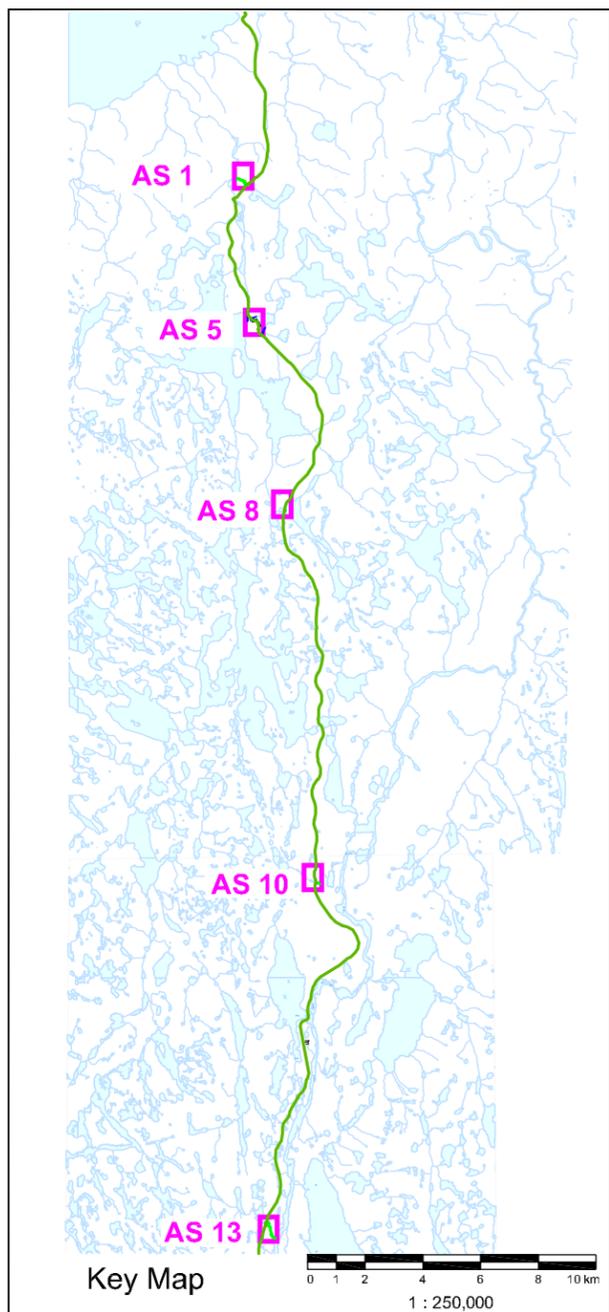
Habitat values in the area of impact are low quality and limited to seasonal lake trout and Arctic char rearing and migration (0.86 HU each). Table 6 outlines the habitat quality and extent of the area of impact on the stream at AS10. Figure 8 illustrates the road crossing location and design details.

All Season Road Crossing #13 (AS13)

The stream at AS13 flows from a lake directly to the Kennarctic River. However, falls located approximately 200 m downstream of the lake preclude upstream migration of fish. The channel was braided throughout, ranging in wetted width from 4 to 23 m, with an average depth of 0.3 m in June and 0.2 m in August 2005. In June, discharge was 0.55 m³/sec and in August it was 0.07 m³/sec. Substrate consisted of boulder, cobble and gravel throughout. Lake trout and Arctic char were captured during electrofishing.

The loss of 0.0077 ha of rearing habitat will be mitigated through the installation of culverts below grade, with a natural substrate fill throughout the culvert.

Habitat values in the area of impact are limited to high quality seasonal lake trout and Arctic char rearing (0.17 HU each). Table 6 outlines the habitat quality and extent of the area of impact on the stream at AS13. Figure 9 illustrates the road crossing location and design details.



Map Sources / Notes:
 Road Crossing details provided by TBT Engineering. Files
 AS01 May 07.dwg AS08 MAY 07.dwg AS10-5 MAY 07.dwg AS13-5 MAY 07.dwg
 dated May, 2007

1 : 2500
 UTM Zone12N, NAD83

File Name: 71009_01_By1_Fig04-09_Crossing_AS-5-1-8-10-13.dwg
 Reviewed by: SH Prepared by: PW
 Date Issued: June, 2007 Project Number: 71-009

Legend	
Detailed Survey by McElhanney - 2004	
	Index Contour (Contour Interval 2.5m)
	Intermediate Contour (Contour Interval 0.5m)
Contours from NTDB 1:50,000 scale data	
	Contour Interval 10m
Proposed Crossing Facilities	
	Culvert
	Silt Fence
	Direction of Flow
	Proposed All Season Road Centre Line

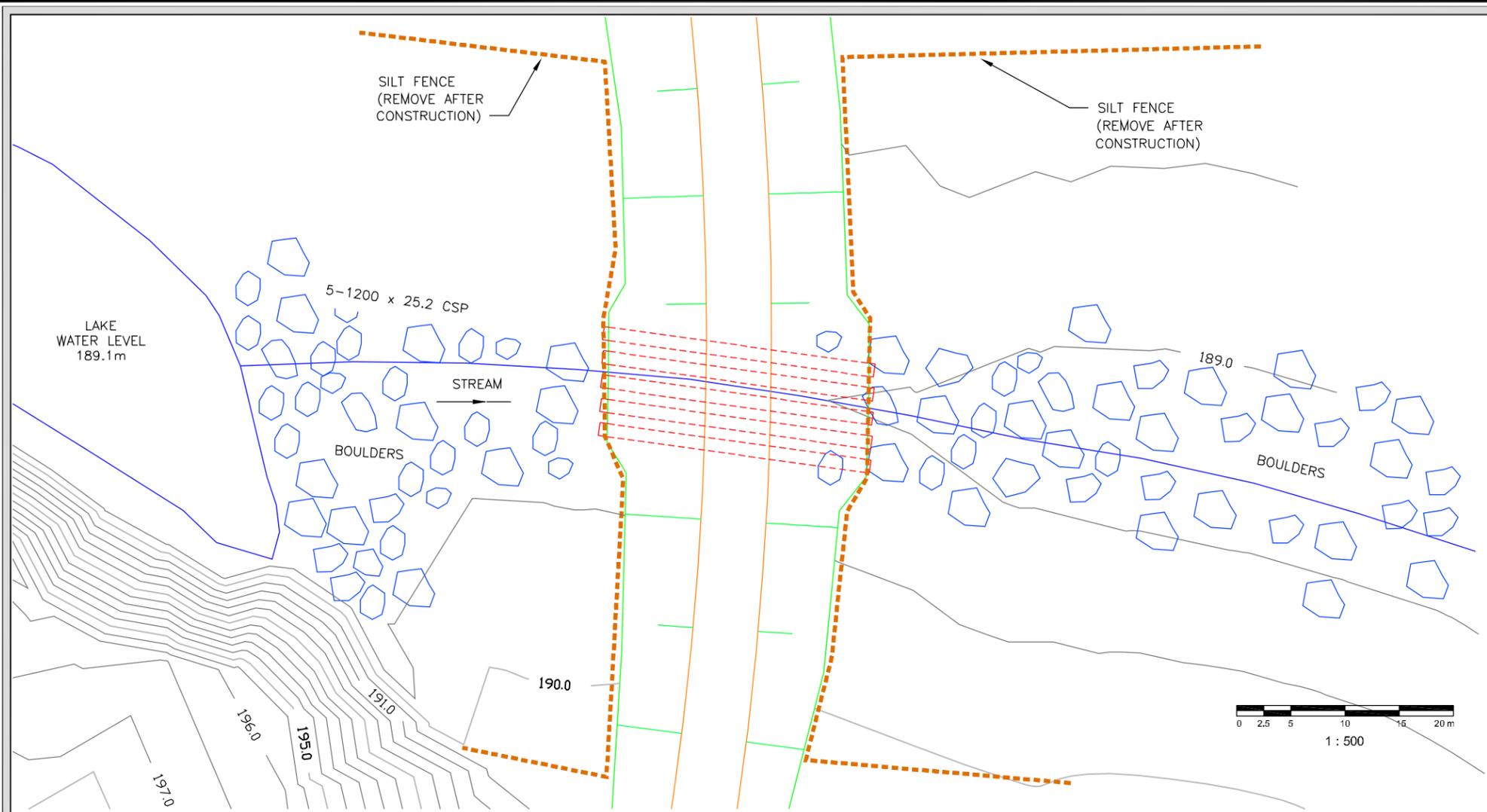
Zinifex

Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

Drainage at Crossing AS 10

Figure 8a
 Version 1

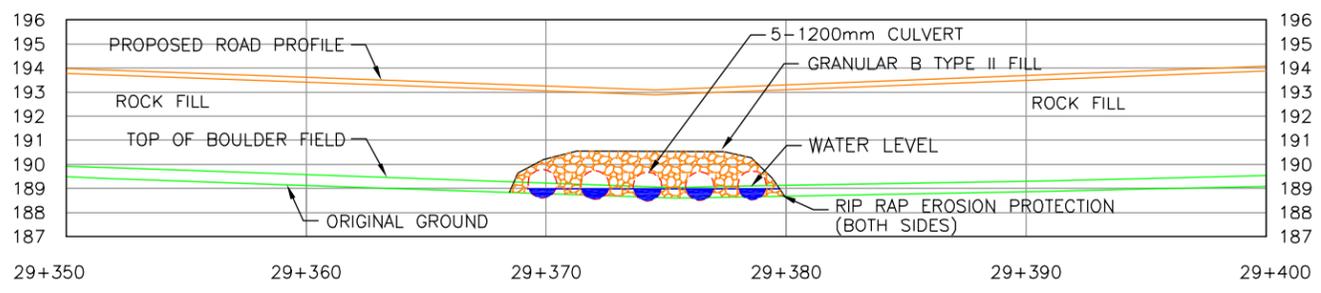
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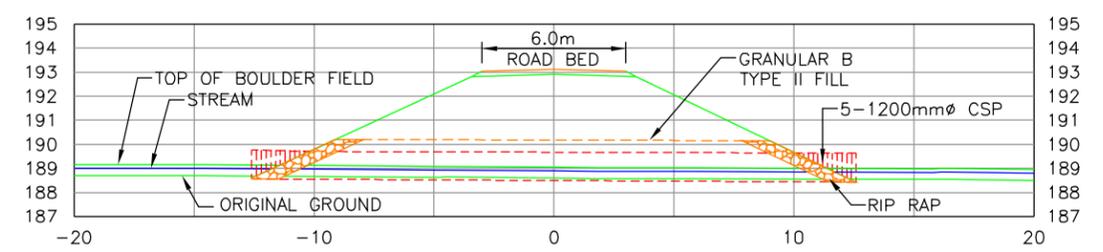
WATER CROSSING - PLAN VIEW
SCALE 1:500



PHOTO AS#10 - LOOKING WESTERLY UPSTREAM TOWARDS LAKE



ROAD CL PROFILE - ELEVATION VIEW
SCALE 1:300



CULVERT CL CROSS-SECTION
SCALE 1:300

Map Sources / Notes:
Drawing by TBT Engineering, Dated April 20, 2007 "Water Crossing
Location Plan AS#10, Figure 15 - Project No. 05-160



Legend

- Proposed Crossing Facilities
- - - - - Culvert
 - - - - - Silt Fence

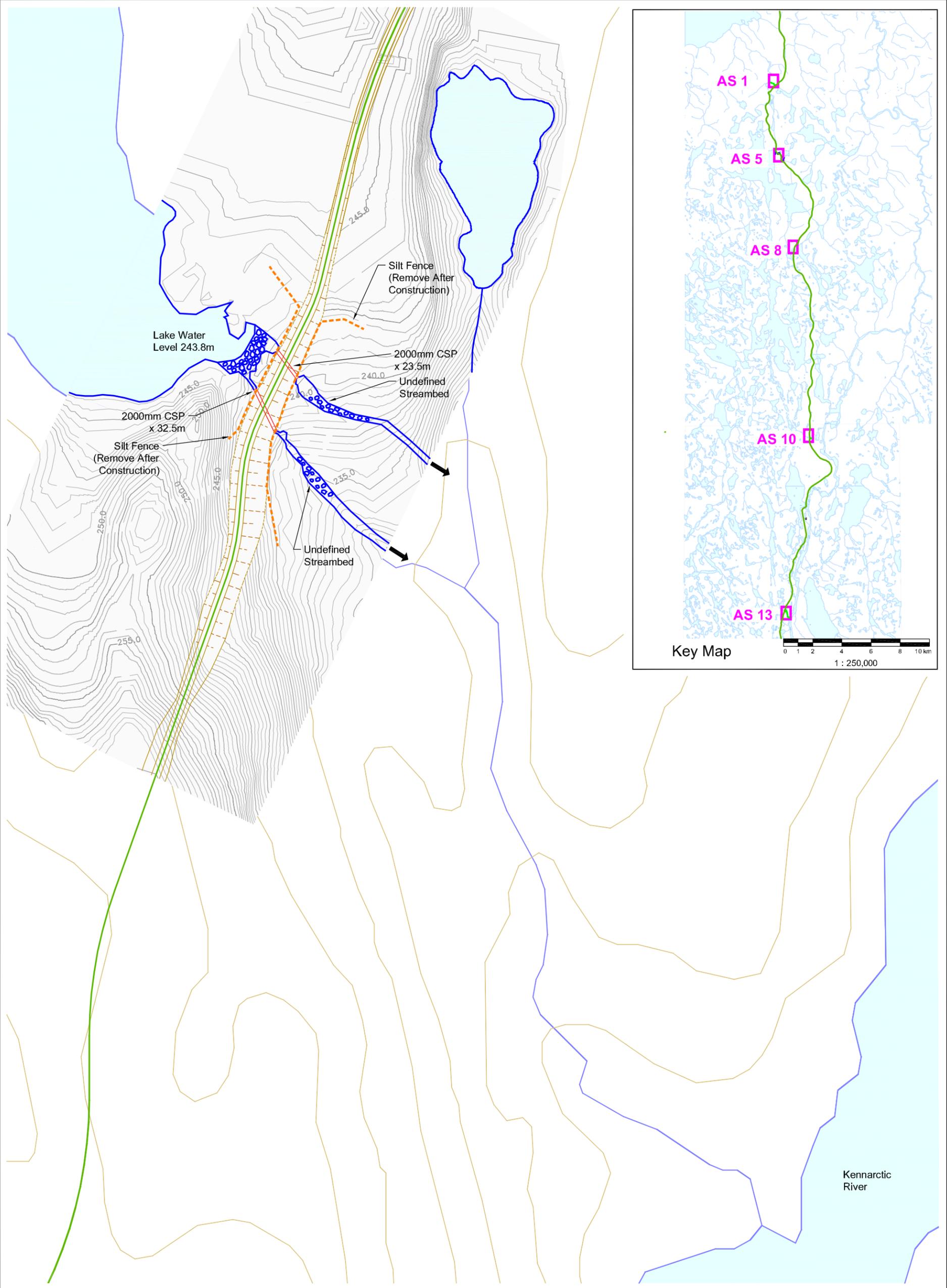
Zinifex

Project: High Lake No Net Loss Plan
Location: High Lake, Nunavut

**Water Crossing
Location Plan AS 10**

File Name: 71009_01_By1_Fig08b_AS10_Crossing.dwg
Reviewed by: SH Prepared by: NT/MP
Date Issued: June, 2007 Project Number: 71-009





Map Sources / Notes:
 Road Crossing details provided by TBT Engineering. Files
 AS01 May 07.dwg AS08 MAY 07.dwg AS10-5 MAY 07.dwg AS13-5 MAY 07.dwg
 dated May, 2007

1 : 2500
 UTM Zone12N, NAD83

File Name: 71009_01_By1_Fig04-09_Crossing_AS-5-1-8-10-13.dwg
 Reviewed by: SH Prepared by: PW
 Date Issued: June, 2007 Project Number: 71-009

Legend

Detailed Survey by McElhanney - 2004

- Index Contour (Contour Interval 2.5m)
- Intermediate Contour (Contour Interval 0.5m)

Contours from NTDB 1:50,000 scale data

- Contour Interval 10m

Proposed Crossing Facilities

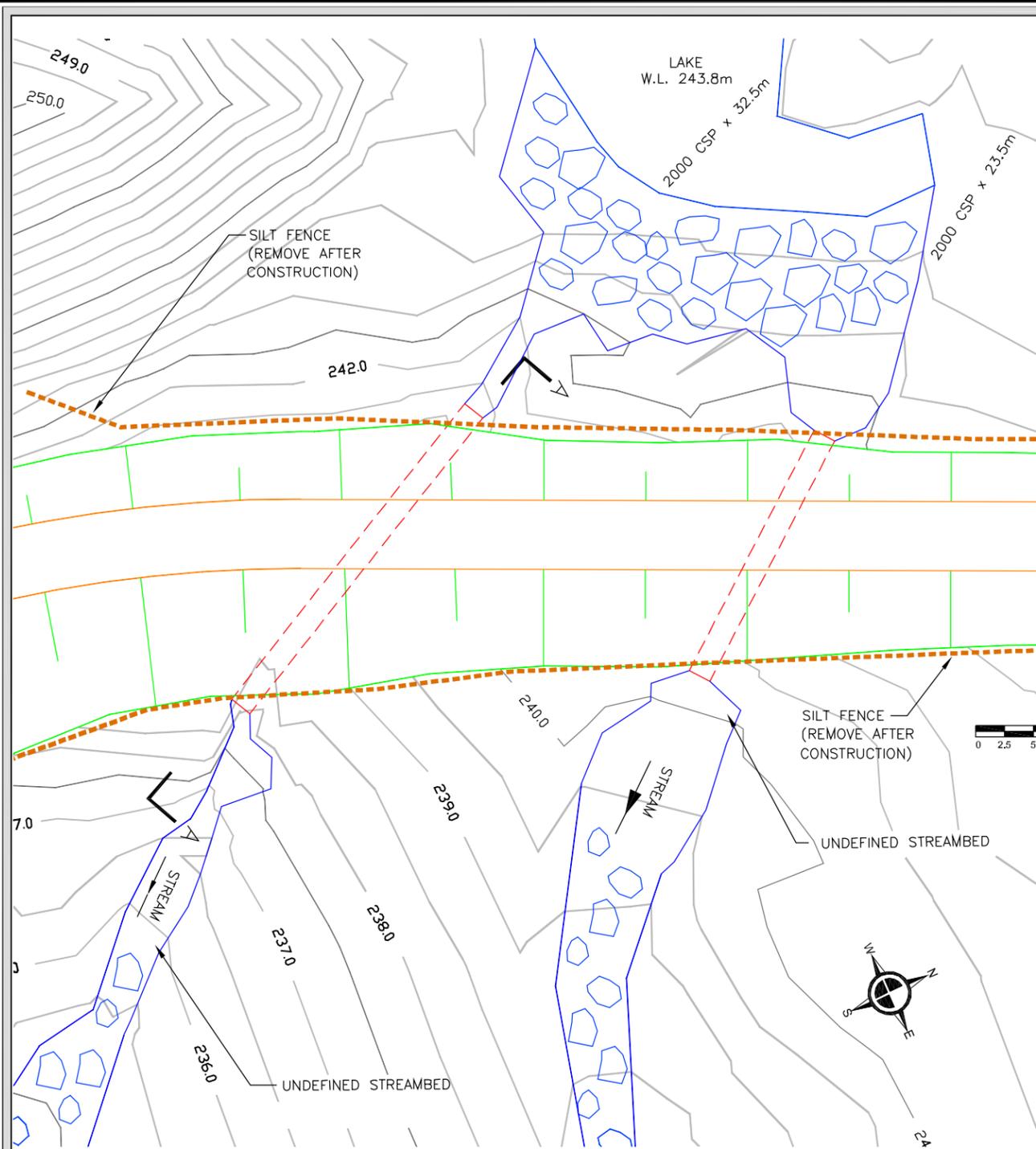
- Culvert
- - - Silt Fence
- ➔ Direction of Flow
- Proposed All Season Road Centre Line

Zinifex

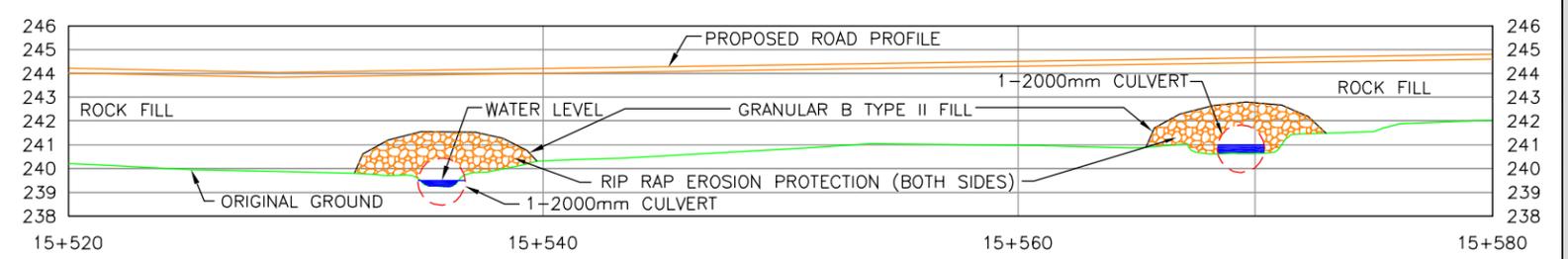
Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

Drainage at Crossing AS 13

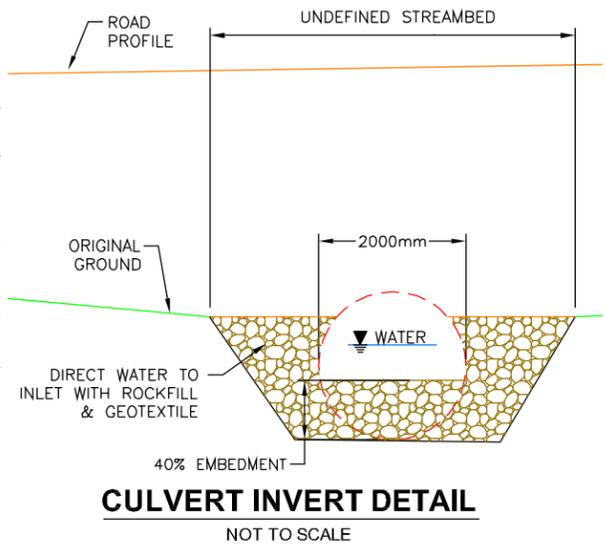
Figure 9a
 Version 1



WATER CROSSING - PLAN VIEW
SCALE 1:500



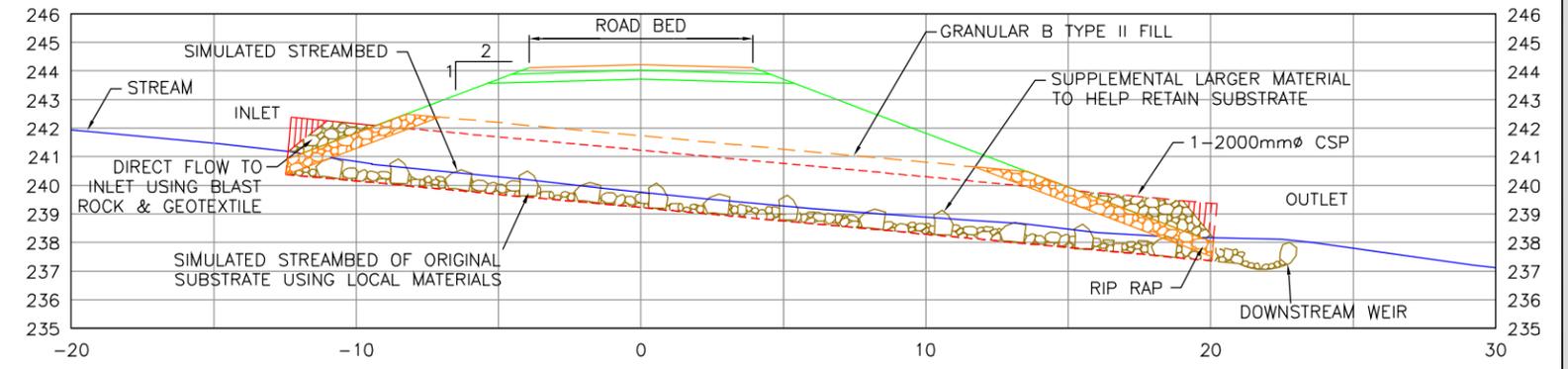
ROAD CL PROFILE - ELEVATION VIEW
SCALE 1:300



CULVERT INVERT DETAIL
NOT TO SCALE



PHOTO AS#13 - LOOKING UPSTREAM AT UNDEFINED STREAMBED.



CULVERT CL CROSS-SECTION A-A
SCALE 1:250

Map Sources / Notes:
Drawing by TBT Engineering, Dated April 20, 2007 "Water Crossing
Location Plan AS#13, Figure 20 - Project No. 05-160



SCALE: AS SHOWN

File Name: 71009_01_By1_Fig09b_AS13_Crossing.dwg
Reviewed by: SH Prepared by: NT/MP
Date Issued: June, 2007 Project Number: 71-009

Legend

- Proposed Crossing Facilities
- - - - - Culvert
 - - - - - Silt Fence

Zinifex

Project: High Lake No Net Loss Plan
Location: High Lake, Nunavut

**Water Crossing
Location Plan AS 13**



Figure 9b
Version 1

High Lake Project
No Net Loss Plan

Table 6. Summary of All (marine and freshwater) Areas Impacted and Mitigated

Aquatic Environment Watercourse/Site ID		Freshwater					Marine Dock Site
		AS1	AS5	AS8	AS10	AS13	
Total Area of Watercourse	Length (m)	510	-	90	211	750	-
	Ave. C. Width (m)*	14.6	-	46.4	32.7	9.6	-
	Area (m ²)	7446	4520	4176	6900	7200	-
Total Area Assessed	Length (m)	200	-	60	200	200	-
	Ave. C. Width (m)	14.6	-	46.4	32.7	9.6	-
	Area (m ²)	2920	4520	2784	6540	1920	6500
Total Area Impacted	Length (m)	25	-	25	25	30	-
	Ave. C. Width (m)	14.6	-	46.4	32.7	9.6	-
	Area (m ²)	365	2840	1160	818	288	6500
Total Area Mitigated	Area (m ²)	41	0	38	99	77	600
Net Area Impacted	Area (m ²)	324	2840	1122	719	211	5900
	Area (ha)	0.03	0.28	0.11	0.07	0.02	0.59
HU Impacted (negative HU value)	LT	-0.33	-5.40	-2.02	-0.86	-0.17	-
	AC	-0.33	-6.25	-2.02	-0.86	-0.17	-

* Average Channel Width (m).

5. Habitat Compensation

As discussed in Section 1.2, DFO's No Net Loss Principle strives for no net loss in the productive capacity of fish habitat (DFO 1986). While some of the impacts to fish habitat arising from the project will be mitigated, compensation is required for those works resulting in a HADD. For the High Lake project, a compensation ratio target has been set at 2:1 habitat gained to habitat lost.

According to DFO's hierarchy for creating new habitat in order to achieve a NNL following a HADD, compensation works associated with the project will occur as follows:

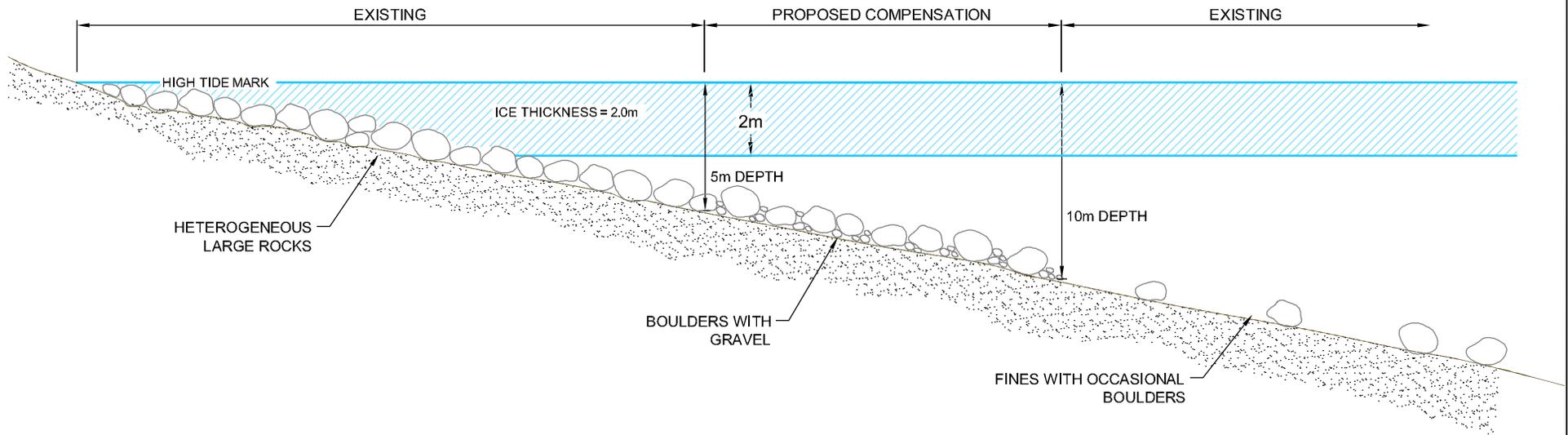
- **Marine:** Create similar habitat at or near the development site within the same ecological unit (*dock area, Grays Bay*); and
- **Freshwater:** Increase the productive capacity of existing habitat at or near the development site within same ecological unit (*Lake L800*).

5.1 Marine

The proposed compensation for the marine habitat impact specifies large, non-acid generating (NAG) boulder and rock for the surface of the dock fill slope up to the highest tide level, as illustrated in the conceptual drawing in Figure 10. In addition, further coarse substrates ranging from large boulder, rip-rap, and gravel will be in placed in depths 5–10 m near the dock site. That depth range was chosen because the habitat quality there is low or medium. Water depths 0–2 m, although of low quality, are in the ice scour zone, and any material placed there likely would not persist. Depths 2–5 m are already high-quality habitat. Depths >10 are low quality habitat, but the sediment is soft and deep (>1 m), and the amount of fill required would be excessive.

Materials used for construction of compensatory habitat will be derived locally. During dock and road construction, blasting will occur. Clean, suitable blast rock and locally obtained gravels (washed esker material) will be placed in areas delineated for compensation immediately following construction. It is proposed that the materials be placed in the appropriate areas from the barge, which will be on site during construction, as this will facilitate the easiest access to water depths of 5-10 m. This approach will ensure efficient use of resources materials, machinery and personnel, as all will be present on site for construction.

The net loss of marine habitat was calculated as 0.59 ha because of the dock construction. At a ratio of 2:1, approximately 1.18 ha of habitat of high-medium quality should be created. The introduced substrate will be laid in areas east and west of the dock structure from the 5-m depth contour out to the 10-m depth contour, such that ~1.18 ha of bottom will be covered (Figure 11).



Map Sources / Notes:
 Conceptual cross-section developed with reference to bathymetry at Grays Bay dock. Slopes and dimensions are approximate only. Dock fill slope surface to be covered with boulders to high tide mark.

CONCEPTUAL CROSS-SECTION
 NOT TO SCALE

Legend

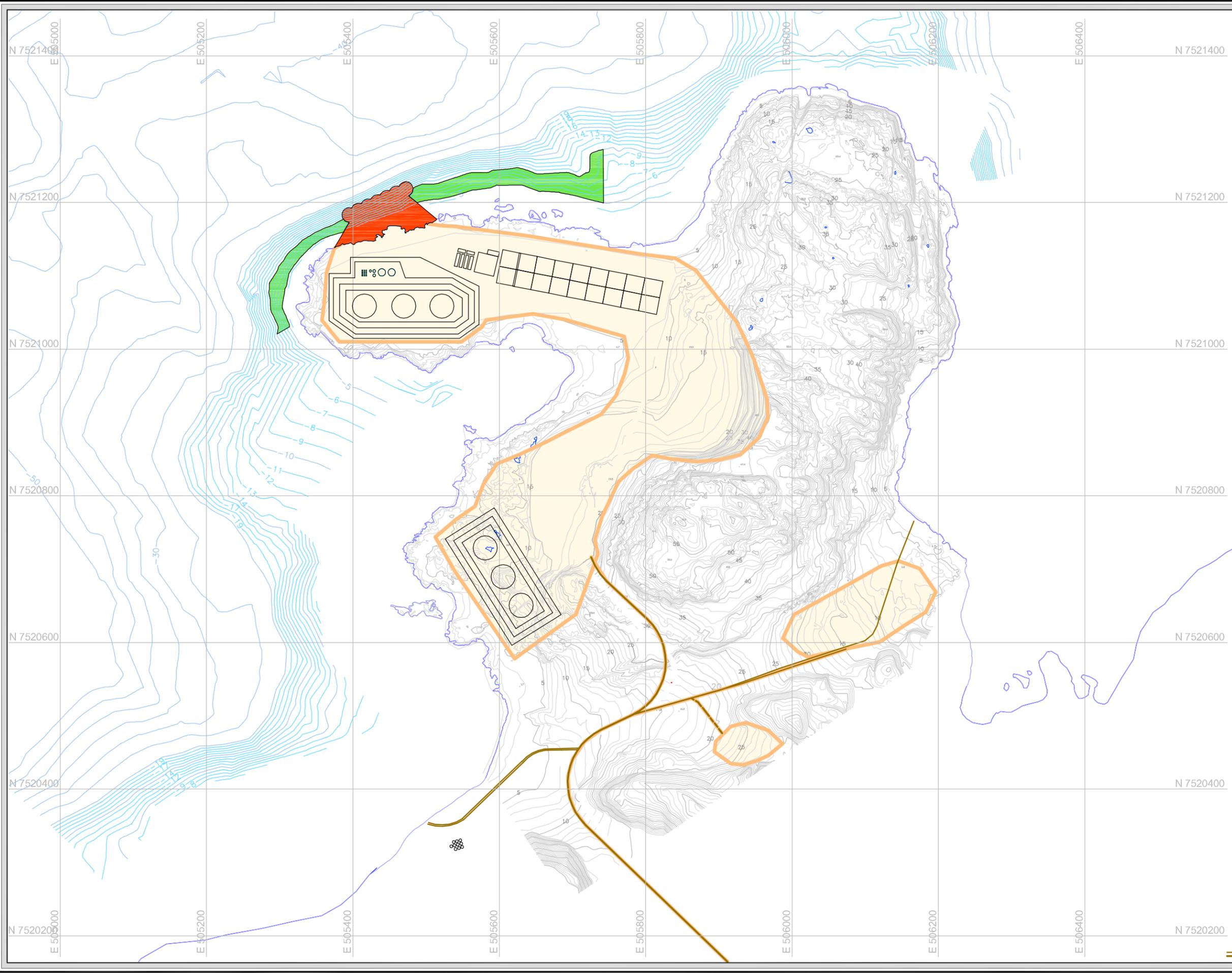
-  Boulders
-  Fines / Bedrock
-  Ice

File Name: 71009_01_By1_Fig10_Marine_CrossSection.dwg
 Reviewed by: RP Prepared by: MP/PW
 Date Issued: June, 2007 Project Number: 71-0009-01

Zinifex
 Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

**Conceptual Cross-Section for
 Construction of Marine Habitat
 Compensation**

Date Plotted: June 28, 2007 File Location: E:\GIS\GIS_proj\Y2007\High_Lake\71009_01_Crossings\By1_NoNetLoss_May07\71009_01_By1_Fig11_Marine_Habitat_Compensation.dwg



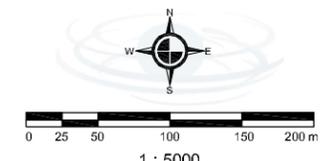
Legend

-  Ground Contours (1m)
-  Bathymetric Contours (1m)
-  Road
-  Habitat Loss
-  Preferred Habitat Compensation Area
-  Dock Facilities Footprint



Map Sources / Notes:

- Ground contours by Wardrop
- Bathymetry data from Challenger Geomatics, Dec. 2004
- Habitat loss and compensation areas by LGL



UTM Zone 12N, NAD83

File Name: 71009_01_By1_Fig11_Marine_Habitat_Compensation.dwg
 Reviewed by: RP Prepared by: MP
 Date Issued: June, 2007 Project Number: 71-009-01

Zinifex

Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

Location of the Habitat Compensation Area - Grays Bay



Figure 11
Version 1

5.2 Freshwater

The goal of the freshwater compensation plan is to develop spawning habitat within L800, as regionally, suitable spawning habitat is limiting in lakes. L800 was selected, because it is within LSA; it is next to the proposed all-season road (i.e., easy access for machinery required to complete compensation, and available materials) and the lake is already being impacted by the road alignment.

5.2.1 Rationale for Spawning Habitat Construction

Artificial reefs have been used since the 1800s as a fisheries management tool in both the freshwater and marine environments (Stone, 1985). The first use of artificial reefs to enhance lake trout reproduction in inland lakes was in the 1950s (Fitzsimons, 1996). Martin (1955) created three artificial spawning grounds in Algonquin Park, Ontario, using waste rock from Feldspar mine. Hacker (1962) was also successful in constructing productive spawning beds at Green Lake in Wisconsin, noting that angularity of the substrate was important for protection against egg predators. Swanson (1982) used artificial turf as a substrate to incubate lake trout eggs that were stripped from adults collected from Lake Superior. He estimated that the 50,000 eggs incubated on the 30 cm by 90 cm turf sandwiches had the potential to produce 25 spawning pairs. Fitzsimons (1996) found that artificial reefs for lake trout use should be located close to shore in areas with sufficient but not excessive currents. The reefs should be constructed of 10-20 cm cobble with the depth of interstices of at least 1 m but preferably greater and with a maximum width at the top of the reef of 4 m and a slope from 30° to 45°.

Recent literature reviews on the spawning requirements of lake trout suggest that further study of artificial spawning areas is required. The ability of artificial spawning areas to increase fish abundance and biological productivity has received considerable attention although less is known about their ability to function as spawning substrates particularly for lake trout (Fitzsimons, 1996). DeRoche (1969) pointed out that although artificial spawning beds have their merit, more research is required to evaluate habitat preferences on a site-by-site basis because construction of such spawning areas requires a considerable amount of time and money. Machniak (1975) states that artificial spawning beds can compensate for degraded or destroyed spawning beds. However, these are not always appropriate, particularly where lake trout exhibit strong homing tendencies.

Overall, the literature suggests that the best habitat for lake trout is clean, boulder-dominated substrate at depths of 2 to 10 m with direct exposure to prevailing winds and waves. Conversely, literature regarding Arctic char spawning requirements and artificial reef construction is limited. Therefore, the freshwater habitat compensation strategy is based on spawning habitat requirements for lake trout.

5.2.2 Compensation Site Selection

Results of baseline studies were used to determine what habitat in lake L800 was limiting and which areas would be good candidates for creating spawning habitat. Areas with a slope of 10-20% at depths of 3 – 10 m were determined using GIS modelling and bathymetry data (Figure 12). These areas were intersected with lake substrate data to determine the portion of fines, cobble and boulders in each area (Table 7). The aggregate data indicated that the selected areas were dominated by fines, making them ideal locations for creating artificial spawning grounds. After reviewing the slope, depth and substrate conditions (Figure 12 and Table 7), three areas (A, B, C) suitable for developing spawning habitat were identified (Figure 13).

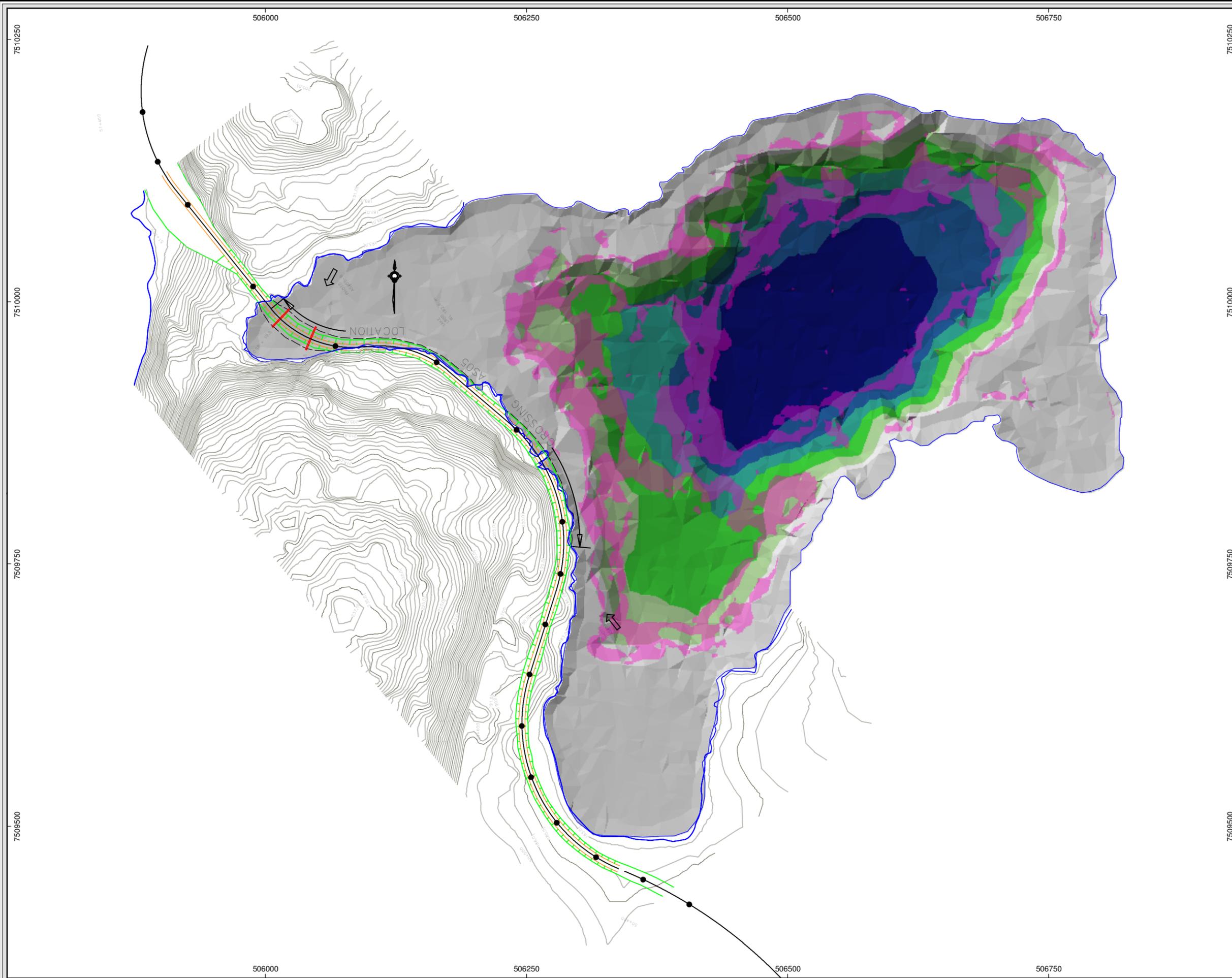
5.2.3 Compensation Design and Implementation

Compensation in Areas A, B and C will result in creation of 0.97 ha of artificial spawning habitat, which will increase the existing spawning habitat in the lake by approximately 4%. Increasing the area of substrate suitable for spawning will also increase nursery, rearing and foraging habitat values for both species, which in turn increases the overall value of the habitat.

The cross-section shown in Figure 14, illustrates the approach to developing this habitat. Habitat compensation construction is proposed to occur during the winter while the lake is frozen and after all-season road construction is completed. Boulder/cobble substrate (20-50 cm, NAG, angular rock) will be placed on the ice, within the areas identified in Figure 13. Once placed on the ice it is hypothesized that the boulder/cobble substrate will become imbedded in the ice, due to its weight and thermal capacity. During spring break-up, the substrate will be released into the lake and fall into place on the lake bottom.

Other options for compensation methodology were investigated, including construction of the spawning habitat in the summer. However, this option is more difficult, logistically, and more expensive. Summer construction involves a barge and tug on the lake, which is not logistically feasible at this location. Instead, preparation for winter construction will occur in the summer.

It is estimated that approximately 0.477 ha at Site A, 0.239 ha at Site B and 0.249 ha at Site C of substrate (20-50cm, angular, NAG rock) will be placed at each location. Rock will be located near the lake, as blasting is required to construct the road on the western side of the lake. Sites A, B and C will be delineated during summer months with buoys. These buoys will become locked in the ice and serve as markers for substrate placement on the ice in the winter. Following road construction, locally derived materials will be stock-piled adjacent to the site in order to facilitate easy installation and minimize winter hauling. The substrate will be transported to each Area by truck. Allowances will be made for the thickness of ice and the position in which the rock will fall during the spring. Slope/gradient of each location will be considered to give some latitude for potential movement in the ice.



Legend

- Edge of L800
- Slope 10-20%

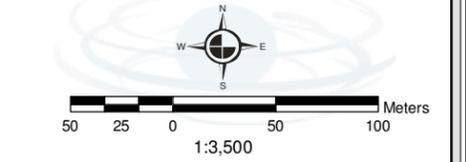
Depth (m)

- 0-4
- 4-8
- 8-12
- 12-16
- 16-20
- >20



Map Sources/Notes:

- Bathymetry collected by Gartner Lee, summer 2005.
- Road alignment by TBT Engineering, dated April 2007.
- Ground surface contours by McElhaney Ltd.



UTM Zone 12N, NAD 83
 File Name: 71009_01_By1_Fig12_L800_Slope_Depth.mxd
 Reviewed By: RP Prepared By: MP
 Date Issued: June 2007 Project Number: 71009-01

Zinifex

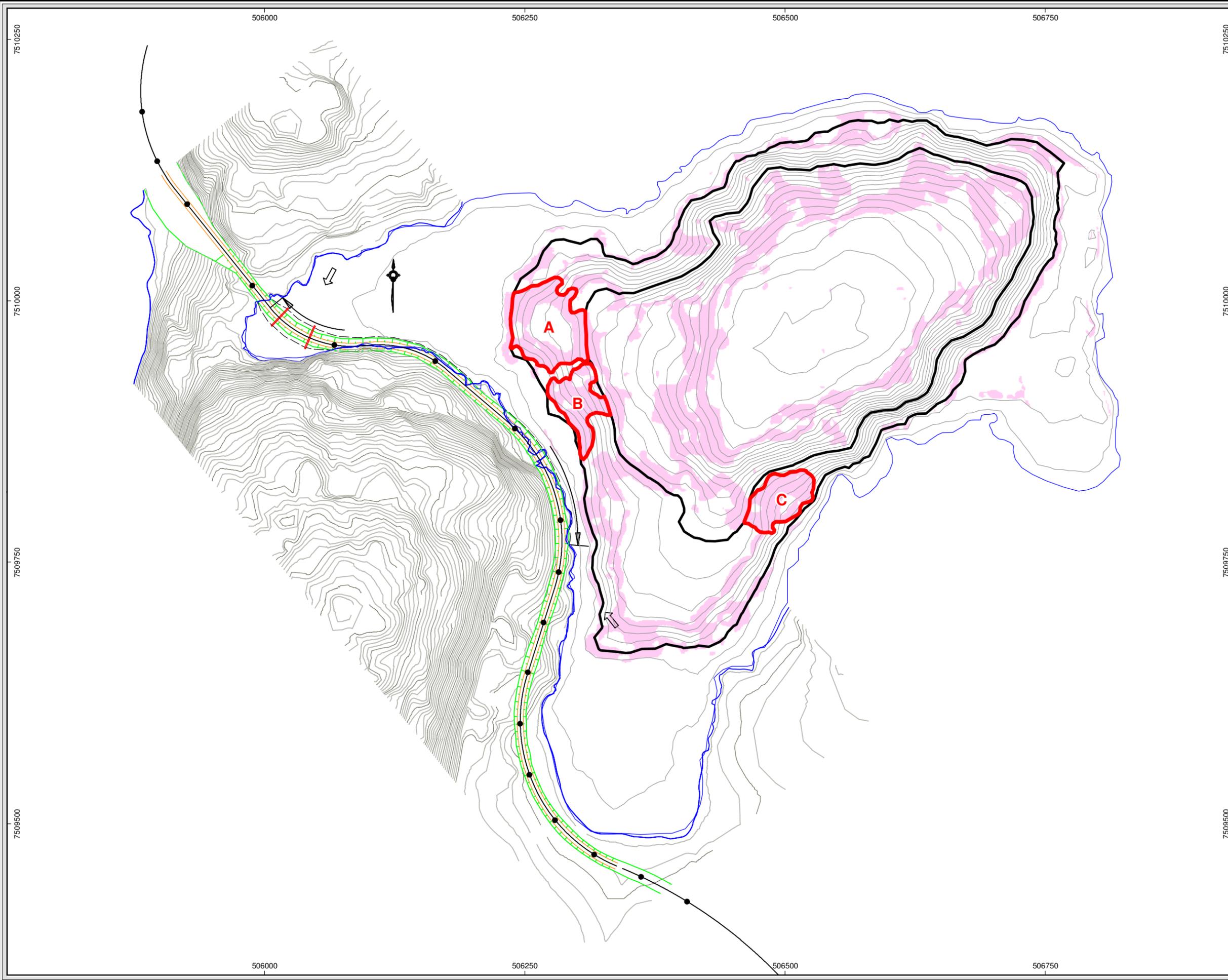
Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

**L800 - Slope and Depth
 Classification**

Gartner Lee

Figure 12
Version 1

Date Revised: June 27, 2007
Date Plotted: June 28, 2007
File Location: E:\GIS\GIS_proj\2007\High_Lake\71009_01_Crossings\By1_NoNetLoss_May07\71009_01_By1_Fig13_L800_EnhancementAreas.mxd



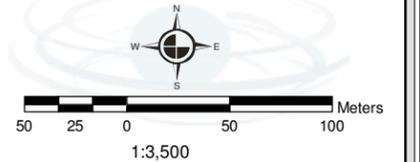
- Legend**
- Edge of L800
 - All Area with Slope 10-20%
 - Potential Habitat Enhancement Area
 - 3m and 10m Depth Contours
 - Depth Contours (1m interval)

Potential Habitat Enhancement Area:
 A - 0.48 ha
 B - 0.24 ha
 C - 0.25 ha

Notes:
 - Area A contains a 'hole' with 0.13 ha of lake bottom sloped 2.5-10%.
 - Area C is immediately adjacent to a steep drop-off.



Map Sources/Notes:
 - Bathymetry collected by Gartner Lee, summer 2005.
 - Road alignment by TBT Engineering, dated April 2007.
 - Ground surface contours by McElhanney Ltd.



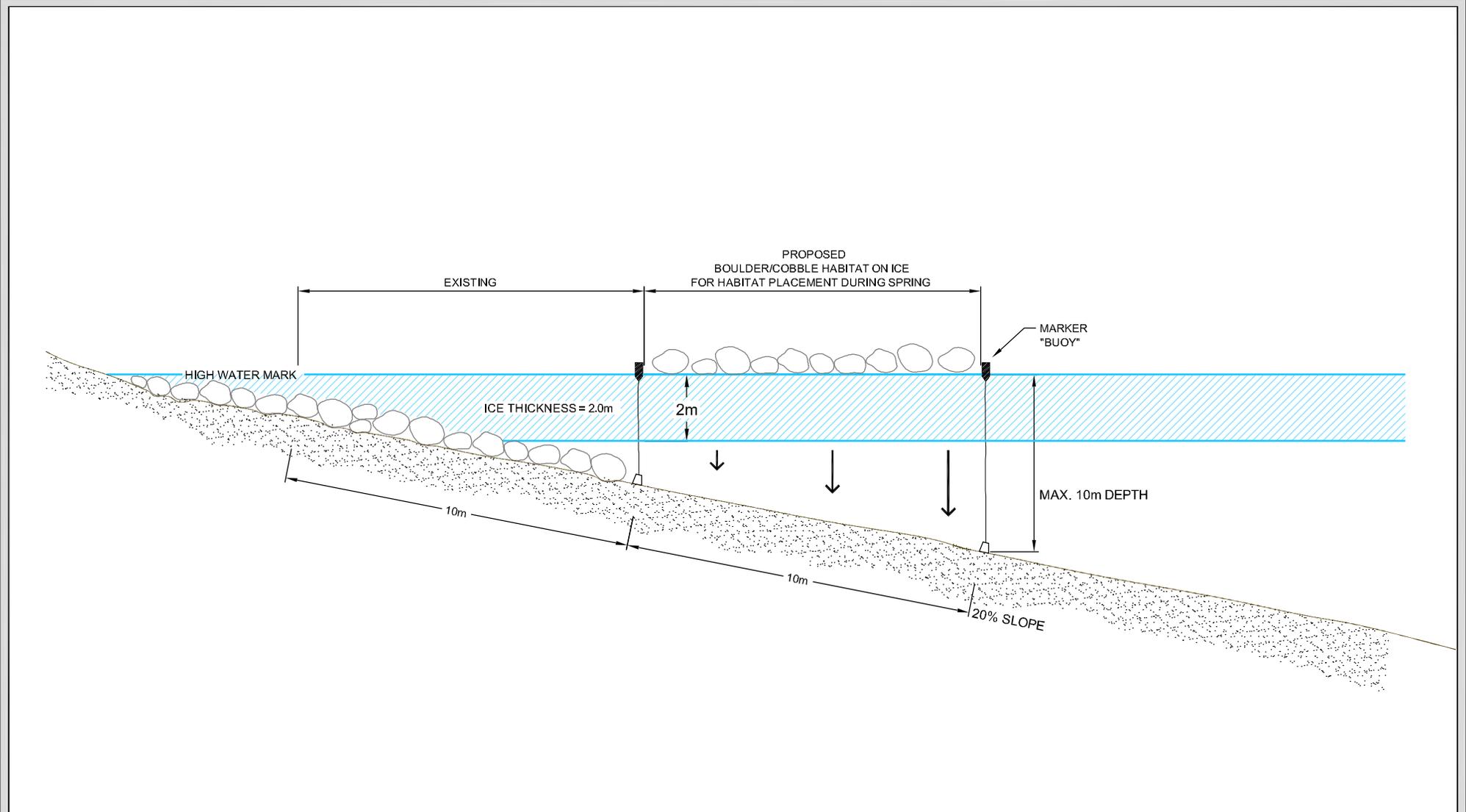
File Name: 71009_01_By1_Fig13_L800_EnhancementAreas.mxd
 Reviewed By: RP Prepared By: MP
 Date Issued: June 2007 Project Number: 71009-01

Zinifex

Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

L800 - Habitat Enhancement Areas

Figure 13
Version 1



Map Sources / Notes:
 Conceptual cross-section developed with approximate parameters from L800. Slopes and dimensions are approximate only.

CONCEPTUAL CROSS-SECTION
 NOT TO SCALE

- Legend**
-  Boulders
 -  Fines
 -  Ice

File Name: 71009_01_By1_Fig14_L800_CrossSection.dwg
 Reviewed by: RP Prepared by: MP/PW
 Date Issued: June, 2007 Project Number: 71-0009-01

Zinifex
 Project: High Lake - No Net Loss Plan
 Location: High Lake, Nunavut

Conceptual Cross-Section for Construction of Artificial Spawning Grounds - Freshwater Habitat

High Lake Project
No Net Loss Plan

Table 7. Existing Habitat Conditions in Compensation Areas, L800

Dominant Depth Substrate (m)	Area A		Area B		Area C	
	%	Area (ha)	%	Area (ha)	%	Area (ha)
Boulder	4	0.017	1	0.002	0	0.000
Cobble	0	0.000	0	0.000	0	0.000
Fines	96	0.460	99	0.236	100	0.249
Total	100	0.477	100	0.239	100	0.249

5.3 No Net Loss Summary

Overall, the High Lake project will result in an impact to fish habitat. The majority of these impacts can be mitigated, but in some cases, impacted habitat will need to be compensated for. It is proposed that this compensation occur at a ratio of 2:1.

In the marine environment, impacted habitat consists of 0.59 ha of foraging and migratory Arctic char habitat arising from dock construction. This habitat will be compensated for by creating similar habitat at or near the dock site. Compensation measures include construction of 1.18 ha of habitat by placing coarse substrate at a depth of 5-10 m. As summarized in Table 8, this results in an overall net gain of 0.59 ha of marine habitat.

In the freshwater environment, impacted stream habitat consists of 0.23 ha of lake trout and Arctic char rearing and migratory habitat. This translates into 6.8 HUs. Impacted lake habitat consists of 0.28 ha of lake trout and Arctic char foraging and rearing habitat as well as Arctic char nursery habitat along the west shore of the lake, which translates to 11.6 HUs. The total impact to freshwater habitat is 18.4 HU. See Appendix C for compensation area habitat unit calculations.

Habitat units were used in order to assign a level of quality to compensatory habitat to ensure that not only would the spacial extent of the habitat be compensated for at a ratio of 2:1, but that habitat quality would also be compensated for at a ratio of 2:1, ensuring the no net loss of productive capacity of habitat will occur. As summarized in Table 8 there will be a net gain of 0.69 ha and 47.2 HU freshwater habitat.

Overall, habitat will be compensated for at a ratio of 3.2:1 HU and 1.9:1 ha. While the aerial value of 1.9:1 does not meet the 2:1 goal, it should be noted that the ratio based on habitat quality, HU, exceeds the 2:1 goal resulting in a net gain of productive capacity. Further, it should be noted that habitats used by both lake trout and Arctic char were assessed and compensated for exclusive of the other species, even though habitat use by each species overlaps. Therefore, the values presented herein are deemed appropriate in order to achieve no net loss of productive capacity of fish habitat.

High Lake Project
No Net Loss Plan

Table 8. Habitat Compensation Summary

Aquatic Environment Watercourse			Freshwater					Marine Dock Site	Total
			AS1	AS5	AS8	AS10	AS13		
Impacted (includes mitigated)	HU	LT	-0.33	-5.40	-2.02	-0.86	-0.17	-	-8.78
		AC	-0.33	-6.25	-2.02	-0.86	-0.17	-	-9.63
		Total	-0.66	-11.65	-4.04	-1.72	-0.34	-	-18.41
	Hectares	Total	-0.03	-0.28	-0.11	-0.07	-0.02	-0.59	-1.10
Compensated	HU	Total	0	58.87	0	0	0	-	58.87
	Hectares		0	0.97	0	0	0	1.18	2.15
Net	HU (impacted+compensated)		-0.66	47.22	-4.04	-1.72	-0.34	-	40.46
	Hectares		-0.03	0.69	-0.11	-0.07	-0.02	0.59	1.05

6. Monitoring

It is recognized that the monitoring component of this project is extremely important and will require input from the DFO. Therefore the programs outlined below are considered preliminary and will be modified as the project progresses.

6.1 Marine

Habitat monitoring will be conducted annually for five years following dock construction, during summer. A remotely-operated video camera will be towed from a boat slowly in a zig-zag pattern over the entire area of the habitat constructed. The survey should only be conducted when visibility conditions in the water are suitable. Video will be recorded on a high definition-capable video camera. The video will subsequently be reviewed by marine biologists to assess whether the habitat quality remains the same, and how well biota is becoming established in the compensation area.

6.2 Freshwater

It is anticipated that monitoring of compensation success will occur over several years. During the first two years annual studies during summer will involve direct visual observations of habitat use and stability of artificial spawning beds. Data collection will focus on adult fish using the spawning grounds to confirm exact sites of egg deposition. After "Year 2 of monitoring, options to determine the most effective method (e.g., eggs nets, emergence traps, pails, bags, trays or pumps) of monitoring the fish production (egg deposition, egg viability, emergence success, etc.) from each spawning site will be discussed with DFO and industry experts.

7. Conclusions

The following conclusions regarding the no net loss of fish habitat in relation to the High Lake Project can be drawn:

- A total of 1.10 ha of fish habitat (marine and freshwater) will be impacted by the Project.
- Impacts arise from dock and all season road construction.
- Fish species impacted include amphidromous and resident Arctic char and lake trout.
- Marine habitat loss includes 0.59 ha Arctic char foraging and migratory habitat.

- Freshwater habitat loss includes 0.51 ha/18.4 HU of Arctic char and lake trout foraging, rearing and migratory habitat.
- Marine habitat is compensated for by constructing 1.18 ha medium to high quality habitat on site, through coarse rock placement at a moderate depth (2:1 compensation).
- Freshwater habitat is compensated for by constructing 0.97 ha/58.9 HU of artificial spawning grounds in the same ecological unit (3.2:1 HU, 1.9:1 ha compensation)
- Overall compensation measures result in no net loss of productive capacity of fish habitat.

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Appendix A

**High Lake Project, Alternative Route
Options Comparison Study, Water
Crossing AS05 (TBT Engineering
2006)**



TBT ENGINEERING

HIGH LAKE PROJECT

Alternative Route Options Comparison Study

Water Crossing AS#05

TBTE # 05-160

Nunavut, Canada

June 2007

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1.0 INTRODUCTION

TBT Engineering has been requested by Wolfden Resources Inc. to develop an Alternative Route Options Comparison Study Report for the identified water crossing AS#05 located at Lake L800 along the proposed all season road from High Lake Mine to Grays Bay Dock.

Concerns have been raised by the Department of Fisheries concerning the in-water construction at Crossing AS#05 and the potential impact to fish habitat. A study was requested to develop alternative route options avoiding AS#05 and to compare the new alternate alignments with the original crossing detail.

Presently the preliminary road design directly crosses the Lake L800 using rock fill material placed along the lake bottom to create a road bed foundation.

Four route alignment options were completed for the study. The first option is the most recent version of the original crossing design for AS#05 which uses a rock fill embankment to span Lake L800. Options 2 to 4 have been developed to avoid the AS#05 crossing at Lake L800 using routes that travel around the west and east sides of the lake.

Each Alignment Option was developed to specifications outlined in the Preliminary Design Criteria Report developed by TBT Engineering for the High Lake all season road. Alignment Plans and profiles were created using Land Development Desktop, with cut/fill volumes determined and tabulated for each. New water crossings encountered along these routes were also identified.

This report provides a summary of these route options and a recommendation based on constructability, cost, maintenance and environmental impact.

2.0 PROJECT BACKGROUND

TBT Engineering (TBTE) was commissioned by Wolfden Resources Inc. to provide roadway and infrastructure engineering services for the development of an all-season road extending approximately 53 kilometres from Grays Bay to High Lake Mine.

The all-season road is classified as a private resource development low-volume road. The design consists of a 6.0m roadway width for a one-lane, two way road. The traffic will mainly consist of A or B train trucks with an anticipated frequency of 6 to 12 trips per day. Other anticipated road traffic includes light vehicles and road maintenance equipment.

A preliminary design report was completed for the all season road in 2006. Fifteen water crossings were identified along the proposed alignment. Conceptual crossing plans were developed using data provided by Gartner Lee and by field information gathered by TBTE during the initial route study in 2004.

After a preliminary review of the conceptual water crossing plans by the Department of Fisheries, an alternative route options comparison study was requested for crossing AS#05.

3.0 ROUTE SELECTION

Preliminary alternative alignments were developed from examination of air photos, existing digital mapping and gathered information from 3 site investigations conducted from 2004 to 2006. Routes were chosen to best avoid existing water bodies, large rock faces and outcrops and to use terrain best suited for road construction. The preliminary alignments were then digitized in Land Development Desktop and placed over existing 3d digital terrain data. Profiles were generated for each alignment and revisions were made where existing terrain was determined to be impractical for road design. Of the multiple preliminary alignments developed, 4 options were selected for detailed study.

See Enclosure 1 detailing the location of the selected route options.

4.0 ALTERNATIVE ROUTE OPTIONS

Description - Option 1

Alignment Option 1 has been developed as an updated revision of the original AS#05 crossing design previously submitted. Changes made to the original crossing design were based on additional information gathered during the 2006 field investigations conducted by TBT Engineering.

The alignment is 3.34 km in length and follows a route along the west side of Lake L800. The route follows a northwesterly path towards Lake L800 where it curves around the lake approximately 20m up from the shore. At approximately the half way point of the lake, the alignment starts to follow the shore edge. Rock fill will be used to create a road embankment along the shore edge and will continue along the shore westerly. The alignment would then curve north, directly crossing Lake L800 using additional clean rock fill. The route then proceeds overland, northerly following marine deposit/bedrock terrain reconnecting to the existing road alignment.

Enclosures 2 and 3 detail the alignment location, profile and typical sections of alternative Option 1.

Design Constructability & Maintenance - Option 1

The alignment for Option 1 was developed to safely cross Lake L800 meeting road design requirements while providing drivability, ease of construction and reduced maintenance for the all-season haul road.

Design - Option 1

The route for Option 1 was selected to avoid the high volume rock cuts that would be encountered along the bedrock outcrop along the west half of Lake L800 and to follow a route along the marine/bedrock deposit area starting at the northwest end of Lake L800. The marine/bedrock deposit area continues northerly and provides a natural path for road design by avoiding large rock formations and water bodies to the east and west. Along this route the alignment follows a gradual descent northerly with a maximum grade of 4% at 13.4 m vertical climb. The largest vertical climb along the alignment is 41.4 m with a varying grade of 2.5 to 4%. The gradual descent encountered allows for safer all season usage by both general and haul type vehicles. The alignment consists of 15 horizontal and 11 vertical curves in total. Multiple horizontal curves were required due to the alignment following the shore edge.

Constructability - Option 1

Constructability of the proposed alignment has been rated at medium complexity due to the rock embankment fill requirement water crossing AS#05. The crossing will require specific staging to ensure that disturbances to the water course will be minimized and that the construction details be followed to ensure an adequate foundation for road construction. Rock blasting is moderate with 2 medium volume cut sections located along the marine/bedrock deposit zone. Due to the short length of the cut zones and with fill requirements directly adjacent these cut areas are considered medium to low complexity.

Cut/fill volumes for Option 1 are in balance with slight cut volume surplus and waste marine deposits. See Table 1 for quantities.

Table 1 – Cut/Fill Volumes – Option 1 = 3.34 km

Finished Grade Volume					
Station		Cut Volume (m³) Bedrock	Cut Volume (m3) Marine Deposits	Fill Volume (m3)	Terrain
49+629	50+400		179	6492	Marine
50+400	51+590	9790		44338	Rock
51+590	52+967		185370	25794	Marine
Total=		9,790	185,549*	76,624	

* Marine with anticipated underlying bedrock.

The total costs for construction are assessed at \$3,793,000 for the 3.34 kilometer distance including the water crossing AS#05 and are based on costs that include labour, equipment and materials. These costs have been developed for study purposes only. Finalized costing will be developed during detailed design.

Maintenance - Option 1

Specific maintenance requirements for Option 1 regarding the design specifications are considered as low cost. The primary maintenance issue for Option 1 is the potential for additional rock fill that may be required to be placed along the road embankment at Crossing AS#05 due to future settlement. Due to the open terrain encountered for Option 1 it is expected that minimum issues concerning snow drift will be encountered. Only general snow clearing is expected. Grades along the alignment are relatively flat and it is expected that only typical road sanding will be required during winter months to ensure traction.

Environmental Impact - Option 1

The Environmental impact of Option 1 would be considered as high due to water crossing AS#05. The alignment has been revised from previous submissions to reduce impact within the watercourse. The southern crossing of Lake L800 as shown in the original alignment has been eliminated. Construction however will still take place for approximately 370m within Lake L800 with construction encountered along shoreline and through the lake. The shoreline construction will potentially result in the loss of fish rearing and foraging habitat during ice-off periods. It is expected that there will be no spawning habitat loss. In-water construction will take place in water depths of less than 2 metres where for part of the year would be frozen to lake bottom and not support fish life.

Benefits to the Option 1 alignment in regards to the environment would be limited blasting of rock along Lake L800 preventing entry of errant blast material into the watercourse.

The total construction footprint area for Option 1 is 7.99 hectares in size and is measured from the cut/fill limits along the road.

Description - Option 2

Option 2 has been developed as an alternative alignment to Option 1 and avoids the water crossing AS#05 by following a westerly route along Lake L800.

The alignment is 3.34 km in length and follows a route along the west side of Lake L800.

The route follows the same alignment as Option 1 for approximately the first 400 metres traveling in a northwesterly direction over marine deposits and underlying bedrock. The route continues in a northwesterly direction then curves around Lake L800 approximately 40 to 60 metres west of shore. Significant rock blasting will be required along the section of the alignment for road bed construction and placement. Blasting would continue for approximately 600m but will result in a route that avoids crossing AS#05. The alignment continues northerly following a marine deposit/bedrock channel reconnecting to the

existing road alignment. A non fish bearing water crossing will be encountered at approximately 1.5 kms from the start of the alignment.

Enclosures 4 and 5 detail the alignment location, profile and typical sections of alternative Option 2.

Design Constructability & Maintenance - Option 2

The alignment for Option 2 was developed to avoid crossing AS#05 by following an alignment to the west of Lake L800. The alignment was developed to meet road design requirements and follow a route that would limit the expected rock cut requirements along the west side of Lake L800.

Design - Option 2

The route for Option 2 was selected to avoid the water crossing AS#05 by developing a route that would traverse to the west of Lake L800 through bedrock outcrop formations. This route will require significant rock cut but will allow the alignment to avoid Lake L800 while connecting to the marine/bedrock deposit area starting at the northwest end of Lake L800. The marine/bedrock deposit area continues northerly and provides a natural path for road design by avoiding large rock formations and water bodies to the east and west. The profile along the alignment consists of varying grades following a general descent northerly. Due to the compromised location of the alignment, the profile does encounter a section of 10% grade at a vertical climb of 21.1 metres. The largest vertical climb along the alignment is 39.5 m with a varying grade of 4 to 10%. These factors will moderately affect the drivability of the alignment causing reductions in climbing speed and increased driver awareness during descents.

The alignment consists of 13 horizontal curves and 11 vertical curves in total. Multiple horizontal curves were required to avoid Lake L800.

Constructability - Option 2

The constructability rating for Option 2 has been rated as high complexity due to the substantial rock blasting that would be encountered along the west side of Lake L800. Staging will be required for removal and piling of blast rock due to the significant surplus volume generated. During blasting, monitoring must be provided to ensure that blast material does not enter the surrounding water bodies. Blasting must also be monitored around the shore of Lake L800 and an unnamed lake to the west of the alignment due to the potential for breaching of Lake L800 causing draining. The change in elevation between these lakes is 20.8m with only 80m horizontal separating the lakes. Blasting around the lake must ensure that no fracturing of the underlying bedrock will occur.

There are 2 medium cut areas encountered along the northern portion of the alignment north of Lake L800. These cut areas are of medium/low complexity due to the short length of blast zone and adjacent fill zones requiring the generated rock volume. Cut fill volumes for Option 2 are not balanced due to a large surplus cut volume in both bedrock and marine deposits. See Table 2 for quantities.

Table 2 – Cut/Fill Volumes – Option 2 = 3.38 km

Finished Grade Volume					
Station		Cut Volume (m³) Bedrock	Cut Volume (m3) Marine Deposits	Fill Volume (m3)	Terrain
49+629	50+400		52902	3654	Marine
50+400	51+450	219748		23522	Rock
51+450	52+991		82797	28502	Marine
Total=		219,748	135,699*	55,678	

* Marine with anticipated underlying bedrock.

The total costs for construction are assessed at \$6,994,000 for the 3.38 kilometer distance and are based on costs that include labour, equipment and materials. These costs have

been developed for study purposes only. Finalized costing will be developed during detailed design.

Maintenance - Option 2

Annual maintenance requirements for Option 2 are considered as low to medium cost due to grades and cut areas along the route. Specific monitoring of the vertical grades will be required during winter months due to snow and ice conditions causing traction and safety issues. However the grades are not considered significant due to moderate vertical climb that will be encountered. The rock cuts along the alignment have been created to reduce snow drift issues however additional plowing/monitoring will still be expected along the west side of Lake L800. For the remaining portions of the alignment only general snow clearing is expected to be encountered.

Environmental Impact - Option 2

The environmental impact of Option 2 is considered as medium due to the potential due to large rock blast and construction requirements along the west and northwest portions of Lake L800.

Option 2 avoids the water crossing AS#05 with an alignment that follows the west side of Lake L800. However, in avoiding water crossing AS#05, extensive rock blasting, hauling of blast materials and construction along the west and northwest shore of Lake L800 will be encountered. These construction requirements for Option 2 have potential for serious environmental impact within Lake L800 if proper construction practices are not followed.

Monitoring will be required to ensure that environmental effects will be minimized and deleterious substances are prohibited from entering Lake L800. Additional pre-construction investigations will be required for design optimization to reduce the potential environmental impact to the lake.

All blasting will be conducted to the Guidelines for use of Explosives in or Near Canadian Fisheries Waters, Department of Fisheries, 1998.

A water crossing will be encountered at the northwest end of Lake L800 however it is not considered fish-bearing.

The footprint for Option 2 is 9.04 hectares in size and is measured from the cut/fill limits along the road.

Description - Option 3

Option 3 has been developed as an alternative alignment to avoid the water crossing AS#05 encountered in Option 1 by selecting a route to the east of Lake L800.

The length of the alignment is 3.49 km and follows a route along the east Lake L800.

The route was selected as a best fit alignment to avoid the highest rock outcrops and other nearby water bodies.

The alignment follows a northeasterly route to the south of Lake L800 then turns northwest following a direct route over bedrock outcrops for approximately 1.5kms. The route then turns westerly along a rock descent and over marine deposits to connect to the existing road alignment. The alignment does avoid Lake L800; however three other unidentified water crossings (streams) are encountered at approximately 0.4, 1.5 and 3.1 kms from the start of the alignment.

Enclosures 6 and 7 detail the alignment location, profile and typical sections of alternative Option 3.

Design Constructability & Maintenance - Option 3

The alignment for Option 3 was developed to avoid crossing AS#05. The route was chosen to divert the road to the east side of Lake L800 through the bedrock and marine terrain. A best fit alignment was developed using the most practical easterly route, however difficult terrain could not be avoided.

Design - Option 3

The route for Option 3 was developed to determine if a more acceptable alignment east of Lake L800 could be developed to avoid Lake L800. The alignment predominantly crosses bedrock outcrop areas which dominate the terrain east of Lake L800. The route followed areas of least grade variation however the terrain was in general found to be extremely difficult for route placement. The profile along the alignment consists of both significant climbs and descents. The maximum grade encountered along the alignment is 10% with a vertical climb of 42.5 m while the largest vertical climb along the alignment is 77.5 m with a varying grade of 5 to 10%. These factors will greatly affect the drivability of the alignment causing significant reductions in climbing speed and increased driver awareness during descents. Driving conditions during winter months must be actively monitored along this route due to ensure road safety. The alignment consists of 7 horizontal and 9 vertical curves in total. Three water crossings could not be avoided along the route and would require inspection to assess crossing and environmental parameters.

Constructability - Option 3

The constructability rating for Option 3 has been rated as high complexity due to the varying steep grade, very large cut/fill volumes and 3 high complexity water crossings. During construction large rock cuts will need to be developed that would allow the alignment to cross the difficult terrain. Approximately 500,000 m³ of rock shatter alone would be encountered. These volumes would require significant staging operations to aid in movement and placement of the generated blast rock. The water crossings encountered will be difficult to construct due to large fill placements required for the road. Fill placement height at the 3 water crossings are 8m, 14m and 15m respectively. Culvert

crossings may not be feasible due to the large footprints that would be caused by a general fill situation. The exact nature of the crossings is presently unknown due to the lack of field studies at these areas. Two of these crossings are assumed to be potential fish habitat as they are feeder streams for Lake L800.

See Table 3 for quantities.

Table 3– Cut/Fill Volumes – Option 3 = 3.49 km

Finished Grade Volume					
Station		Cut Volume (m³) Bedrock	Cut Volume (m3) Marine Deposits	Fill Volume (m3)	Terrain
49+630	50+300		14435	41088	Marine
50+300	53+119	367059		487110	Rock
Total=		367,059	14,435*	528198	

* Marine with anticipated underlying bedrock.

A 1.0 km all season access road will also need to be developed to access the Quarry Site located at the west of Lake L800.

The total costs for construction are assessed at \$10,868,000 for the 3.49 kilometer distance including the 3 additional water crossings, a 1.0 km quarry access road and are based on costs that include labour, equipment and materials. These costs have been developed for study purposes only. Finalized costing will be developed during detailed design.

Maintenance - Option 3

Annual maintenance requirements for Option 3 are considered as high cost due to grades and cut areas along the route requiring additional monitoring and service during the winter season. Specific monitoring of the vertical grades will be required during winter months due to snow and ice conditions causing traction and safety issues. The grades are considered very significant due to high vertical climb that will be encountered. The rock

cuts along the alignment may have potential infill issues to snow drift. Maintenance of snow fences and plowing/monitoring will be required at these locations to ensure road quality. For the remaining portions of the alignment only general snow clearing is expected to be encountered.

Environmental Impact - Option 3

The environmental impact for Option 3 is considered as high due to 3 new encountered water crossings and high cut fill volumes required for the alignment.

Option 3 avoids the water crossing AS#05 with an alignment that follows the east side of Lake L800. However, 3 new crossings could not be avoided and will require detailed investigations. The crossings will require significant detailing due to large fill placement requirements that must not enter the stream beds. Two of the crossings are thought to be potential fish habitat as they are feeder streams for Lake L800. Blasting will need to be monitored to ensure that no errant materials will enter watercourses. Many large cut/fill footprints will impact the existing terrain through terrain disturbance.

The footprint for Option 3 is 6.71 hectares in size and is measured from the cut/fill limits along the road.

Description - Option 4

Option 4 has been developed as an alternative alignment to avoid the water crossing AS#05 encountered in Option 1 by selecting a route to the east of Lake L800. The length of the alignment is 3.80 km and follows a route along the east Lake L800. The alignment follows a northeasterly route to the south of Lake L800 then proceeds westerly approximately 30 m from shore. The route then turns north following a rock descent then connects to the same alignment used by Options 1 and 2. This route avoids most of the large rock cuts encountered by Alignment Option 4. Two unidentified water crossings (streams) are encountered at approximately 0.4 and 1.5 kilometers from the start of the alignment.

Enclosure 8 and 9 detail the alignment location, profile and typical sections of alternative Option 4.

Design Constructability & Maintenance - Option 4

The alignment for option 4 was developed to avoid crossing AS#05. The route was chosen to divert to the east of Lake L800 and would follow a route around the east and north side of the lake. A best fit alignment was developed using the most practical route that would follow around Lake L800, however difficult terrain could not be avoided.

Design - Option 4

The route for Option 4 was selected to avoid the water crossing AS#05 by developing a route that would traverse easterly and along the northern shore of Lake L800 through bedrock outcrop formations. This route will require significant rock cut but will allow the alignment to avoid Lake L800 while connecting to the marine/bedrock deposit area north of Lake L800. The marine/bedrock deposit area continues northerly and provides a natural path for road design by avoiding large rock formations and water bodies to the east and west. The profile along the alignment consists of varying grades following a general descent northerly. Due to the compromised location of the alignment, the profile does encounter a section of 10% grade at a vertical climb of 39.6 metres. The largest vertical climb along the alignment is 58.2m with a varying grade of 5 to 10%. These factors will greatly affect the drivability of the alignment causing a reduction in climbing speed and require increased driver awareness during descents.

The alignment consists of 10 horizontal curves and 13 vertical curves in total. The alignment encountered 2 new unidentified water crossings that could not be avoided.

Constructability - Option 4

Constructability of the proposed alignment has been rated as high complexity due to significant rock/marine cuts, steep vertical grades and 2 unidentified water crossings.

Staging will be required for removal and piling of blast rock due to the significant surplus volume generated. Water crossings will be difficult to construct due to large fill placements required for the road. Fill placement height at the 2 water crossings are 8 and 14 m respectively. Culvert crossings may not be feasible at these locations due to the large footprints that would be caused by the general fill situation. The exact nature of the crossings is presently unknown due to the lack of field studies at these areas. However these crossings are assumed to be potential fish habitat due to the fact that they are feeder streams for Lake L800.

See Table 4 for Option 4 quantities.

Table 4 – Cut/Fill Volumes – Option 4 = 3.80 km

Finished Grade Volume					
Station		Cut Volume (m³) Bedrock	Cut Volume (m3) Marine Deposits	Fill Volume (m3)	Terrain
49+630	50+300		178939	1185	Marine
50+300	52+832	58090		25341	Rock
52+832	53+434		37806	9846	Marine
Total=		58,090	216,745	36,372	

* Marine with anticipated underlying bedrock.

A 1.0 km all season access road will also need to be developed to access the Quarry Site located at the west of Lake L800.

The total costs for construction are assessed at \$7,104,000 for the 3.80 kilometer distance including the 2 additional water crossings, a 1.0 km quarry access road and are based on costs that include labour, equipment and materials. These costs have been developed for study purposes only. Finalized costing will be developed during detailed design.

Maintenance - Option 4

Annual maintenance requirements for Option 4 are considered as medium cost due to grades and cut areas along the route requiring additional monitoring and service during the winter season. Specific monitoring of the vertical grades will be required during winter months due to snow and ice conditions causing traction and safety issues. The grades are considered significant due to high vertical climb that will be encountered. The rock cuts along the alignment may have potential infill issues to snow drift. Maintenance of snow fences and plowing/monitoring will be required at these locations to ensure road quality. For the remaining portions of the alignment only general snow clearing is expected to be encountered.

Environmental Impact - Option 4

The environmental impact for Option 4 is considered as high due to 2 new encountered water crossings and high cut fill volumes required for the alignment.

Option 4 avoids the water crossing AS#05 with an alignment that follows the east side of Lake L800. However, 2 new crossings could not be avoided and will require detailed investigations. The crossings will require significant detailing due to large fill placement requirements that must not enter the stream beds. The crossings are thought to be potential fish habitat due to the fact that they are feeder streams for Lake L800. Blasting will need to be monitored to ensure that no errant materials will enter watercourses. Many large cut/fill footprints will impact the existing terrain through terrain disturbance.

The footprint for Option 4 is 7.28 hectares in size and is measured from the cut/fill limits along the road.

5.0 OPTION COMPARISON

A summary of design data for the various alternative alignments is provided in Table 5.

Table 5 – Alternative Alignment Data Comparison

		ALTERNATIVE			
FACTORS	UNIT	OPTION	OPTION	OPTION	OPTION
		1	2	3	4
Number of Horizontal Curves	No.	15	13	7	10
Number of Vertical Curves	No.	11	11	9	13
Max Grade	%	4.0%	10.0%	10.0%	10.0%
Vertical climb at Max Grade	metres	13.4	21.1	42.5	39.6
Vertical climb (largest)	metres	41.4	39.5	77.3	58.2
Water Crossing	No.	1	1	3	2
Total Distance	km	3.34	3.38	3.49	3.80
Road Footprint	ha	7.99	9.04	6.71	7.28
Ease of Construction	good/med/poor	med	poor	poor	poor
Drivability	good/med/poor	high	med	low	low
Maintenance Costs	high/med/low	low	low	high	med
Environmental Concerns	high/med/low	high	med	high	high
Estimated Construction Cost	Millions	3.8	7.0	10.9	7.1

A relative rating format was created to subjectively review the 4 alignment options. The ratings were based on maintenance, ease of constructability, drivability, environmental and construction costs. A rated value was applied to each rating and then calculated for each option. Using the scoring system a finalized rating is applied to each option.

The Alternative Option Alignment Rating is provided in Table 6.

Table 6 – Alternative Option Rating Review

	Rated Value	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Ease of Constructability	30	20	10	10	10
Drivability	40	40	26	13	13
Maintenance Costs	20	20	20	6	13
Environmental Concerns	50	16	33	16	16
Estimated Construction Cost	60	60	33	21	29
Total Score	200	156	122	66	81

As indicated in Table 6, Option 1 has the best Rating (156) with Option 3 having the poorest subjective rating (66).

6.0 SUMMARY

Alternative routes avoiding AS#05 were generated at the most optimum locations. These options were developed to include construction information, environmental concerns, drivability and cost.

Based on the review of the 4 alignments TBTE recommends that Option 1 be selected at crossing AS#05. The crossing would remain at Lake L800 but other factors out weigh the potential crossing impact for Lake L800.

Prepared by:



C. Zappe, Sr Technician, Plans Supervisor
TBT Engineering

June 25, 2007

Date

Reviewed by:

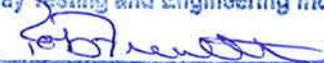


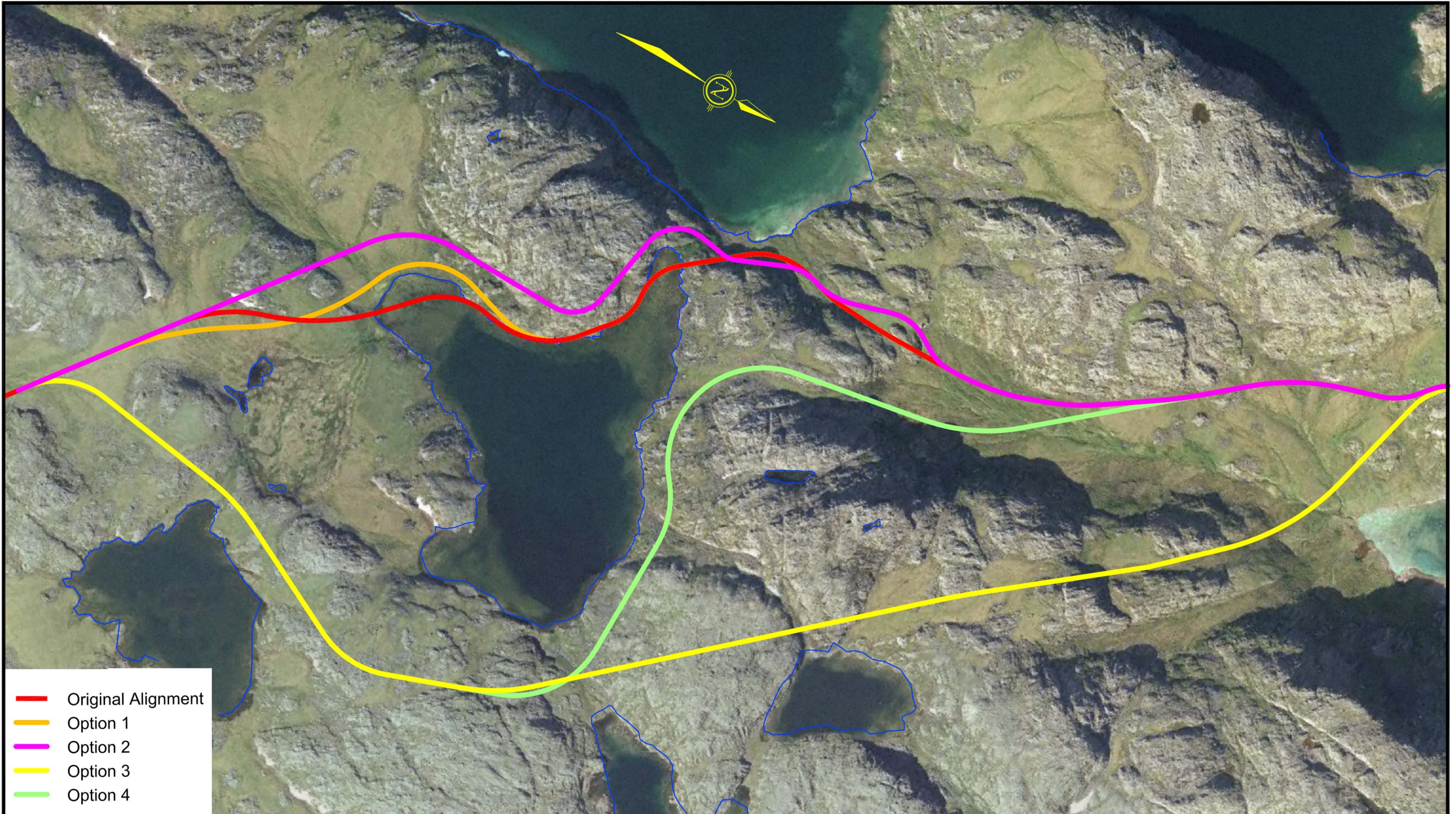
R. J. Frenette, P. Eng., President
TBT Engineering



June 25, 2007

Date

PERMIT TO PRACTICE
Thunder Bay Testing and Engineering Inc.
Signature 
Date <u>June 25, 2007</u>
PERMIT NUMBER: P 561
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU



- Original Alignment
- Option 1
- Option 2
- Option 3
- Option 4

DATE	REVISION	BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTIONS

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

HIGH LAKE, NUNAVUT

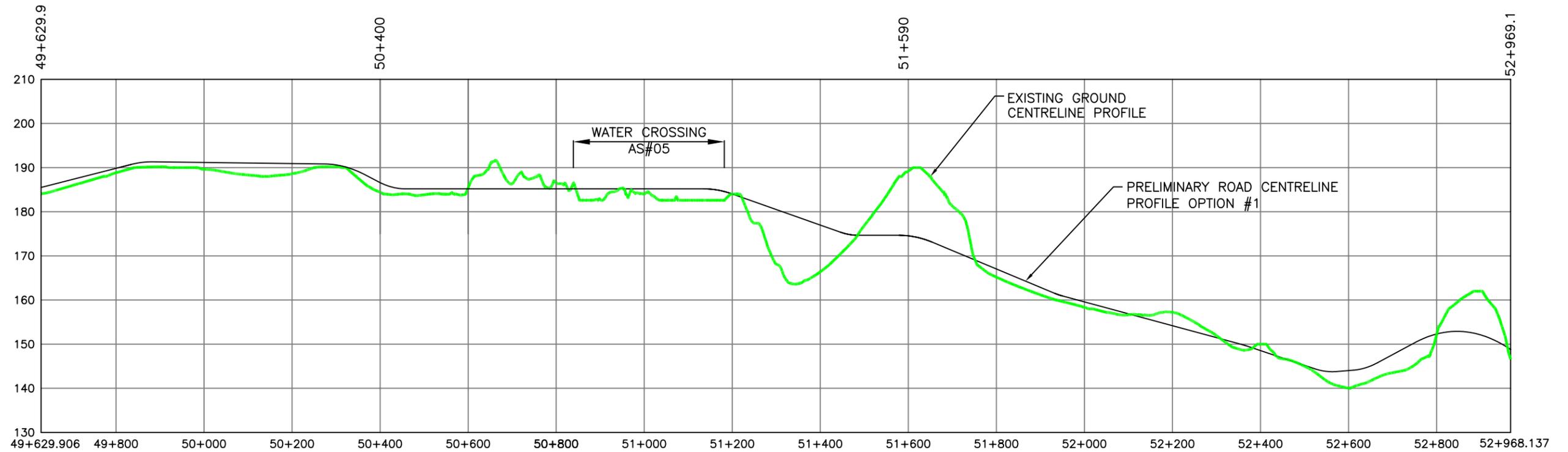
TBT ENGINEERING

CLIENT:
WOLFDEN
 Resources Inc.

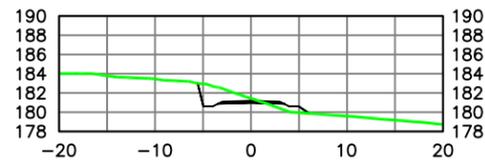
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: NTS	ENCLOSURE 1

CAD REF: INC. ARS11.PRM

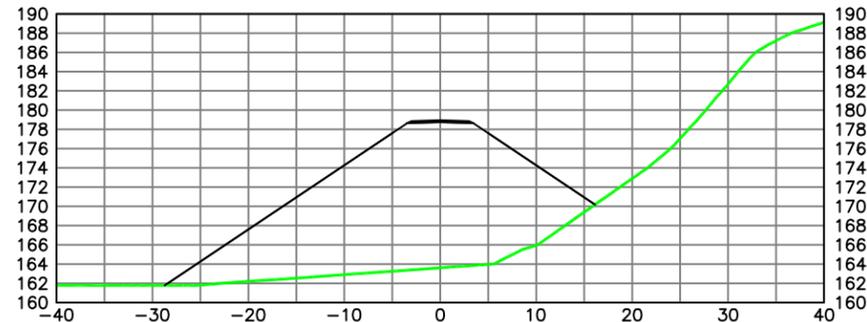
SURFACE MATERIAL AND TOPOGRAPHY	MARINE DEPOSITS/BEDROCK	BEDROCK	MARINE DEPOSITS/BEDROCK
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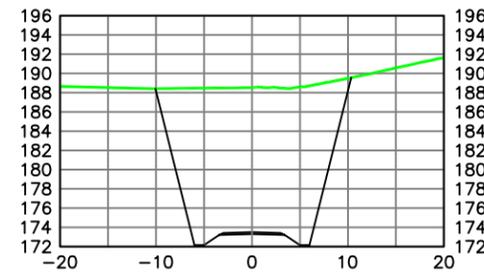
PROFILE
 SCALE 1:10,000 HORIZ.
 1:1,000 VERT.



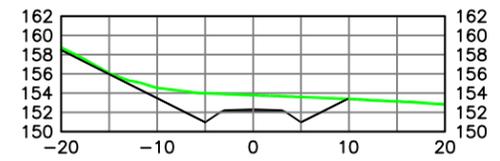
50+600



51+300



51+600



52+225

TYPICAL CROSS SECTIONS
 SCALE 1:750 HORIZ.
 1:750 VERT.

DATE	REVISION	BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #1

PROJECT:
 ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

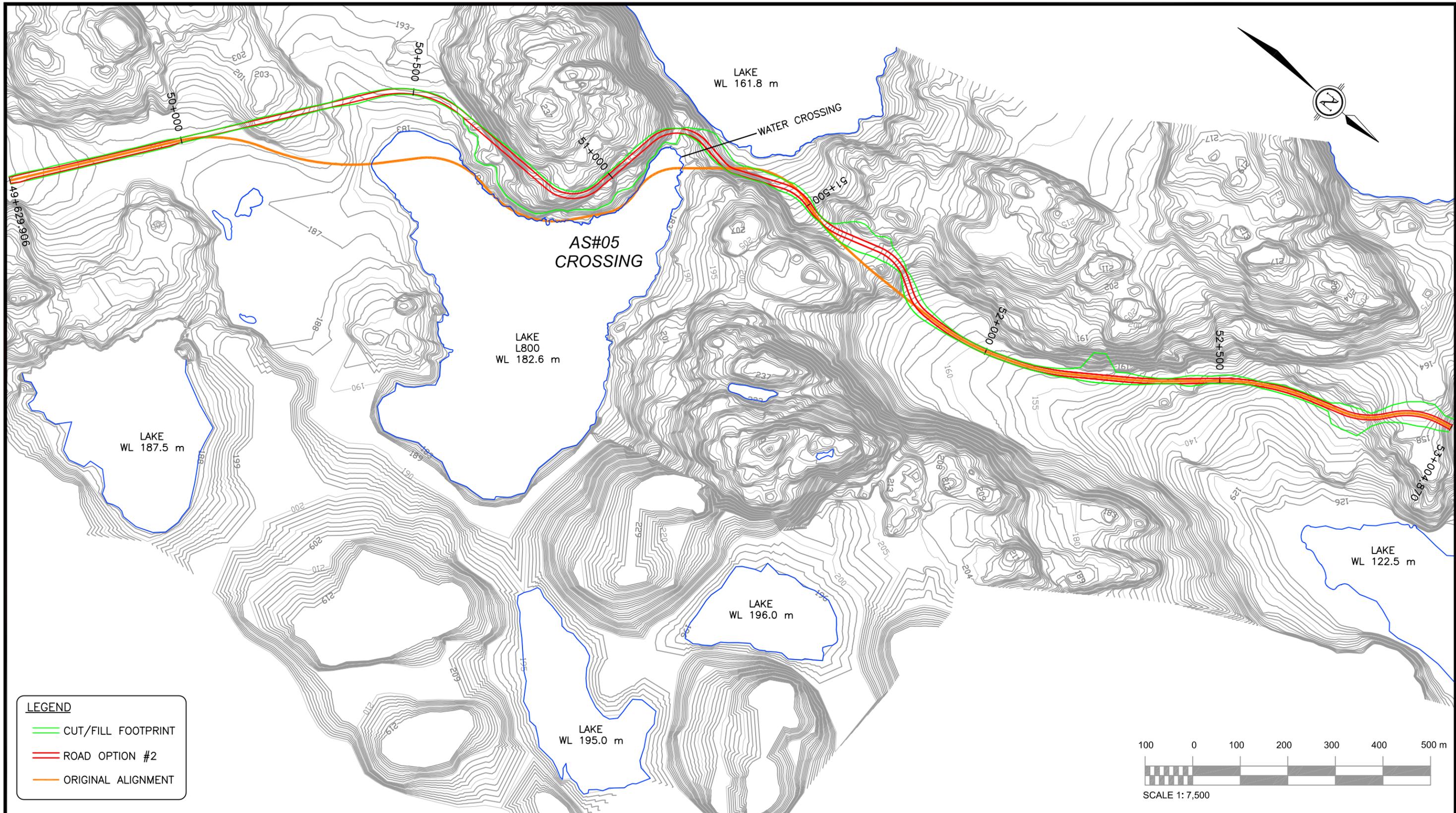
HIGH LAKE, NUNAVUT

TBT ENGINEERING

CLIENT:
WOLFDEN
 Resources Inc.

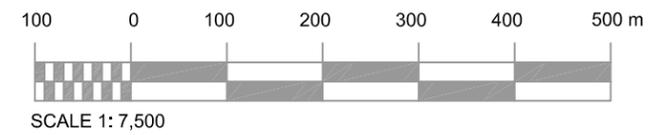
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: AS SHOWN	ENCLOSURE 3

CAD REF. NO.: AS-OPTIONS.TG



LEGEND

- CUT/FILL FOOTPRINT
- ROAD OPTION #2
- ORIGINAL ALIGNMENT



DATE	REVISION	CVZ	BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #2

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

HIGH LAKE, NUNAVUT

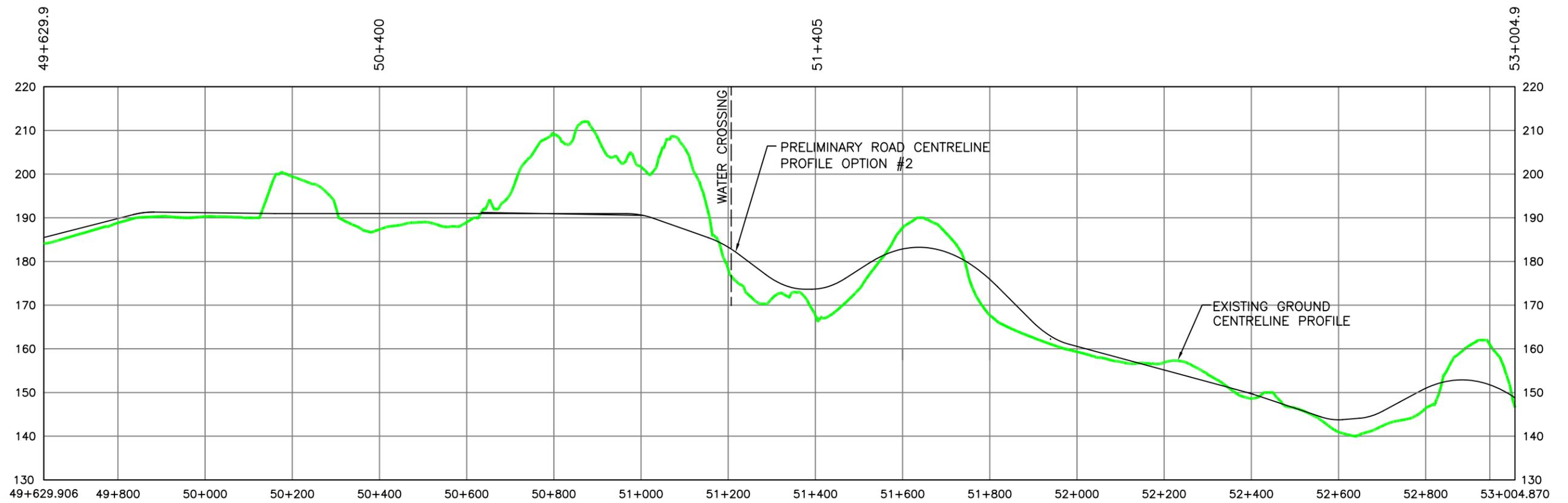
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CLIENT:
WOLFDEN Resources Inc.

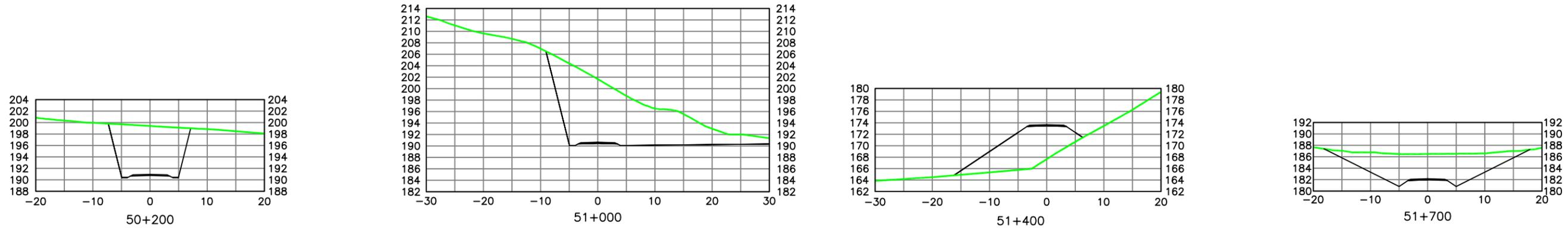
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: 1 : 7500	ENCLOSURE 4

CAD REF. NO.: AS-OPTION#2-IT

SURFACE MATERIAL AND TOPOGRAPHY	MARINE DEPOSITS/BEDROCK	BEDROCK	MARINE DEPOSITS/BEDROCK
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PROFILE
SCALE 1:10,000 HORIZ.
1:1,000 VERT.



TYPICAL CROSS SECTIONS
SCALE 1:750 HORIZ.
1:750 VERT.

DATE	REVISION	CVZ	BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #2

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

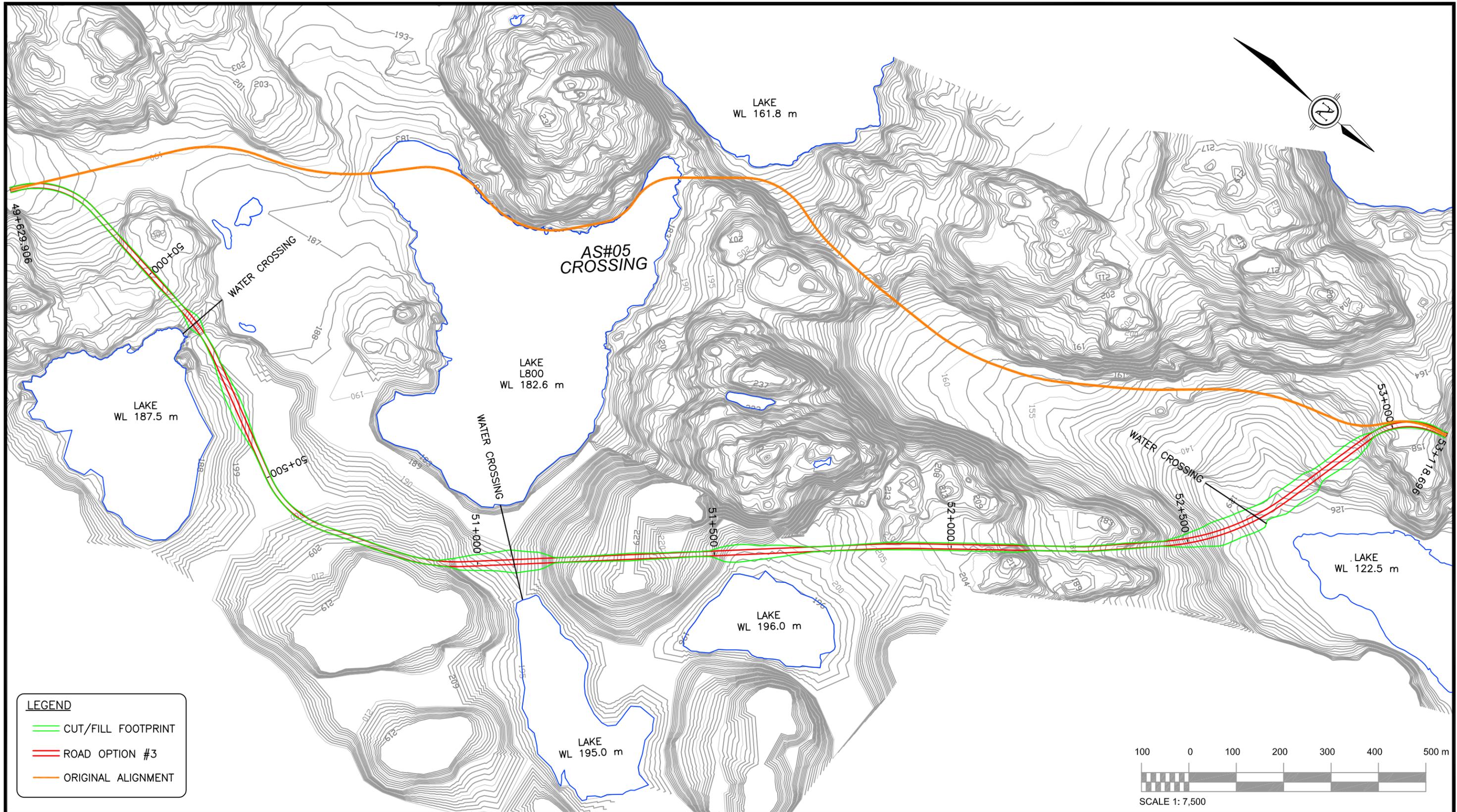
HIGH LAKE, NUNAVUT

TBT ENGINEERING

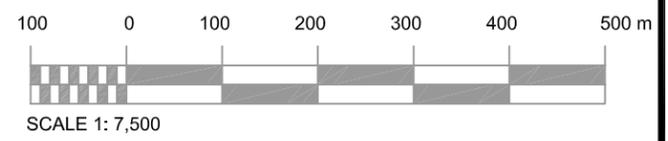
WOLFDEN
Resources Inc.

DRAWN BY: D.Mc	PROJECT NO. 05-160
APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: AS SHOWN	ENCLOSURE 5

CAD REF. NO.: AS#-OPTION#2.dwg



LEGEND	
	CUT/FILL FOOTPRINT
	ROAD OPTION #3
	ORIGINAL ALIGNMENT



DATE	REVISION	CVZ BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #3

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

HIGH LAKE, NUNAVUT

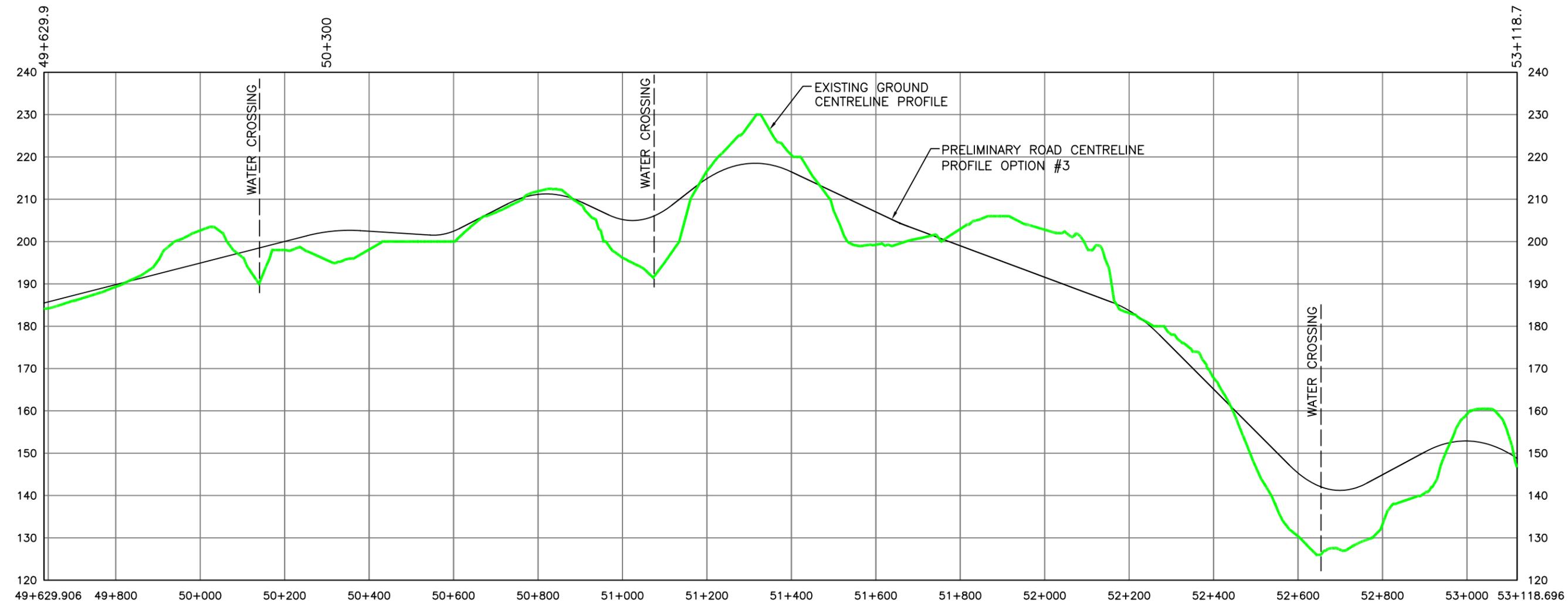
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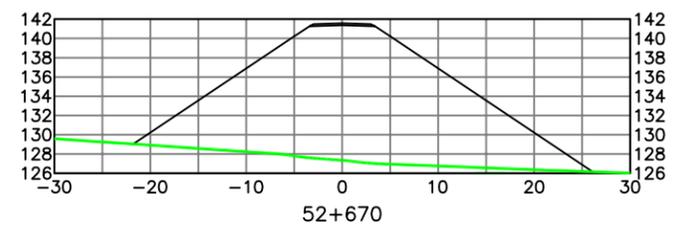
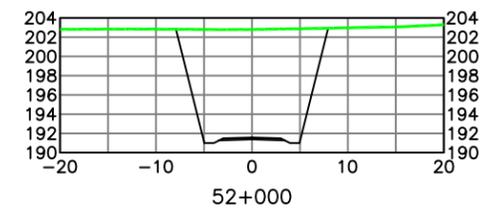
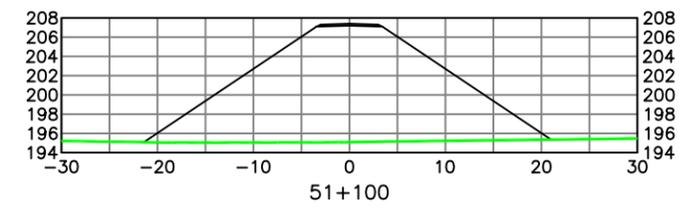
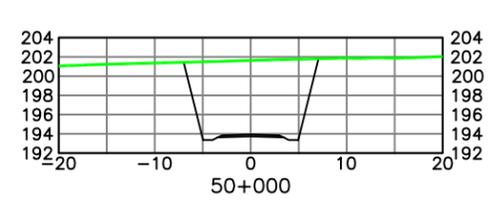
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: 1 : 7500	ENCLOSURE 6

CAD REF. NO.: AS-OPTION3 TO REV1

SURFACE MATERIAL AND TOPOGRAPHY	MARINE DEPOSITS/BEDROCK	BEDROCK
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PROFILE
 SCALE 1:10,000 HORIZ.
 1:1,000 VERT.



TYPICAL CROSS SECTIONS
 SCALE 1:750 HORIZ.
 1:750 VERT.

DATE	REVISION	BY

DWG. TITLE:
 AS#05 WATER CROSSING-ALIGNMENT OPTION #3

PROJECT:
 ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

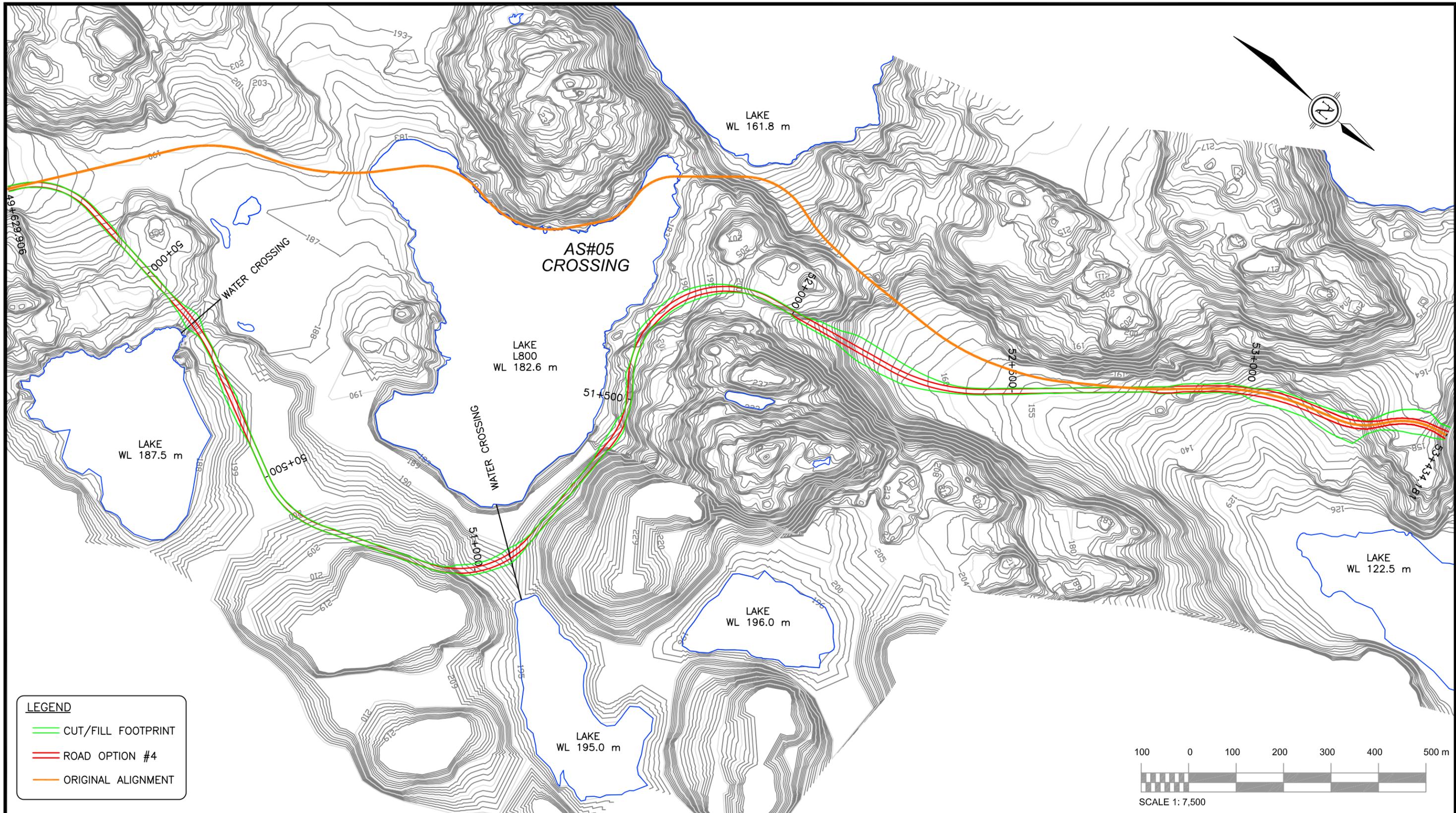
HIGH LAKE, NUNAVUT

TBT ENGINEERING

WOLFDEN
 Resources Inc.

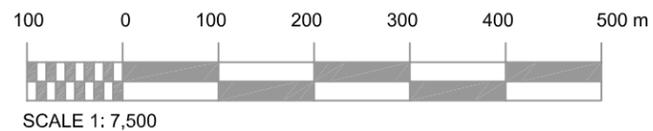
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: AS SHOWN	ENCLOSURE: 7

CAD REF. NO.: AS-OPTIONS TO REV1



LEGEND

- CUT/FILL FOOTPRINT
- ROAD OPTION #4
- ORIGINAL ALIGNMENT



DATE	REVISION	CVZ BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #4

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

HIGH LAKE, NUNAVUT

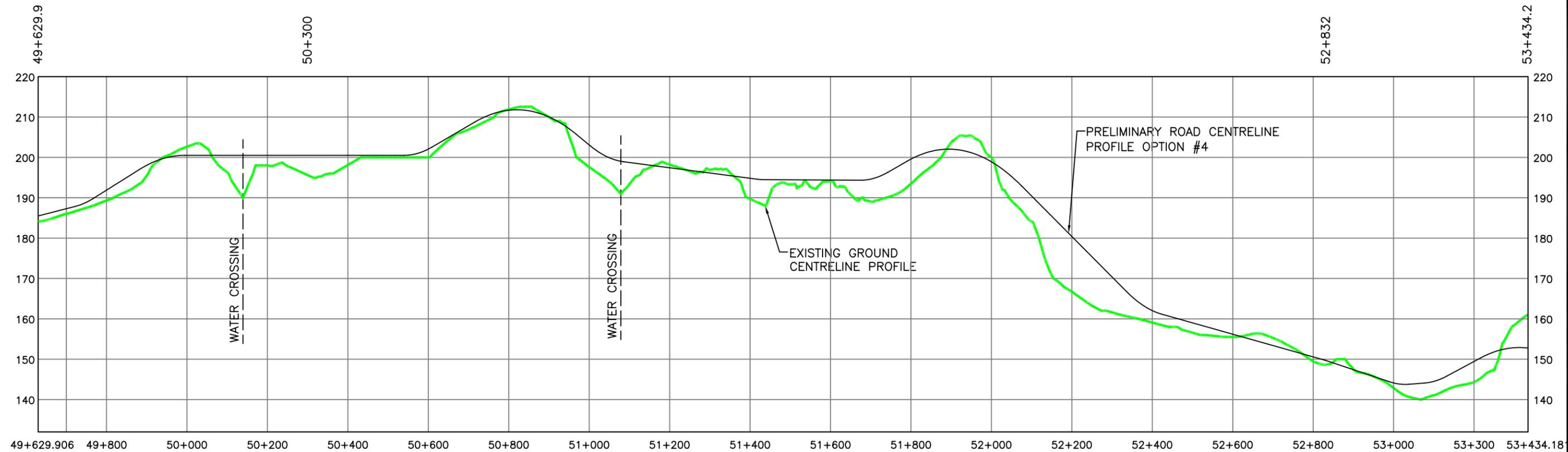
TBT ENGINEERING

CLIENT:
WOLFDEN Resources Inc.

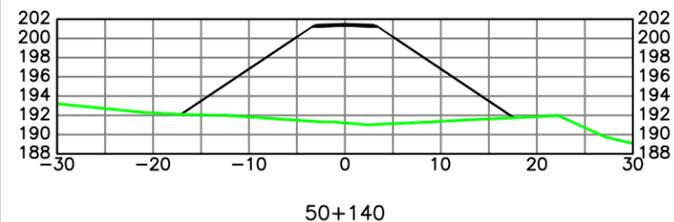
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APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: 1 : 7500	ENCLOSURE: 8

CAD REF. NO.: AS-OPTION 15

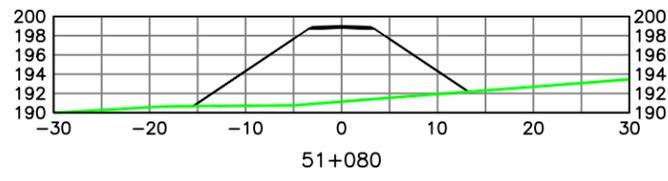
SURFACE MATERIAL AND TOPOGRAPHY	MARINE DEPOSITS	BEDROCK	MARINE DEPOSITS
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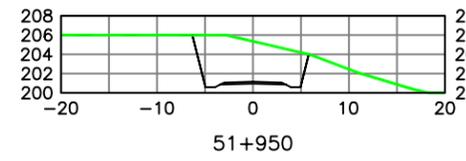
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 1:1,000 VERT.



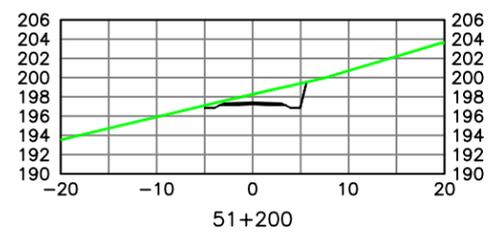
50+140



51+080



51+950



51+200

TYPICAL CROSS SECTIONS
 SCALE 1:750 HORIZ.
 1:750 VERT.

DATE	REVISION	BY

DWG. TITLE:
AS#05 WATER CROSSING-ALIGNMENT OPTION #4

PROJECT:
ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY

HIGH LAKE, NUNAVUT

TBT ENGINEERING

CLIENT:
WOLFDEN Resources Inc.

DRAWN BY: D.Mc	PROJECT NO. 05-160
APPROVED BY: C.Z.	DATE: FEB 13 2007
SCALE: AS SHOWN	ENCLOSURE 9

CAD REF. NO.: ASS-OPTIONS TO

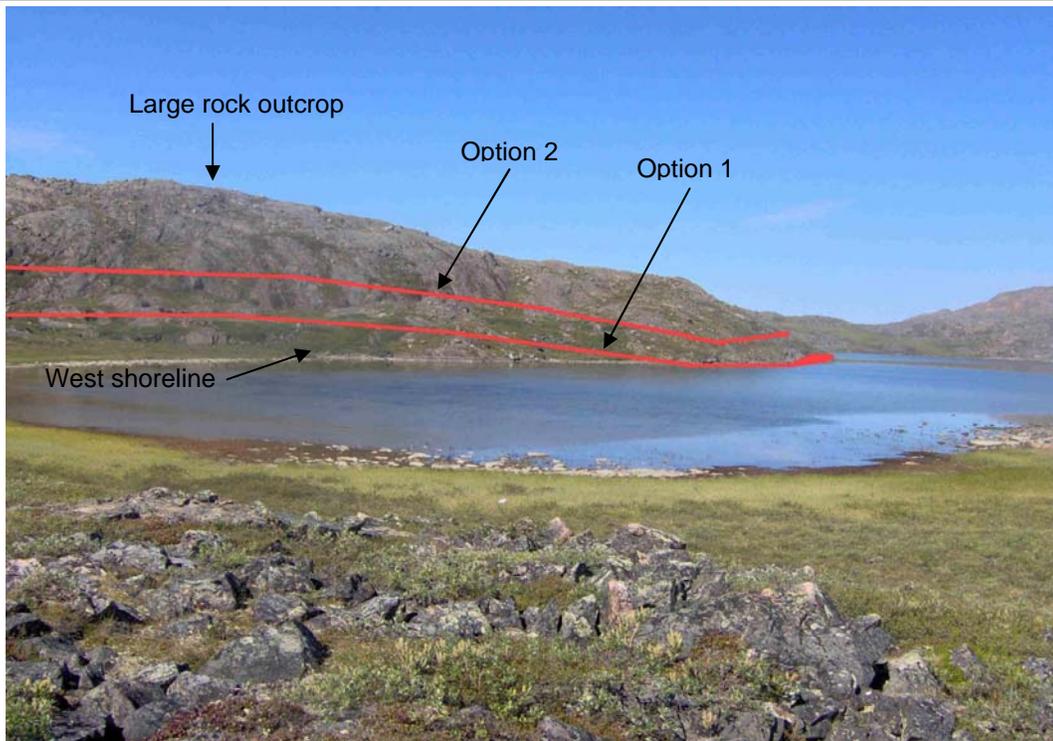


Photo: 1 Looking Northwest across Lake L800 towards rock outcrop at west shoreline (Options 1 & 2).

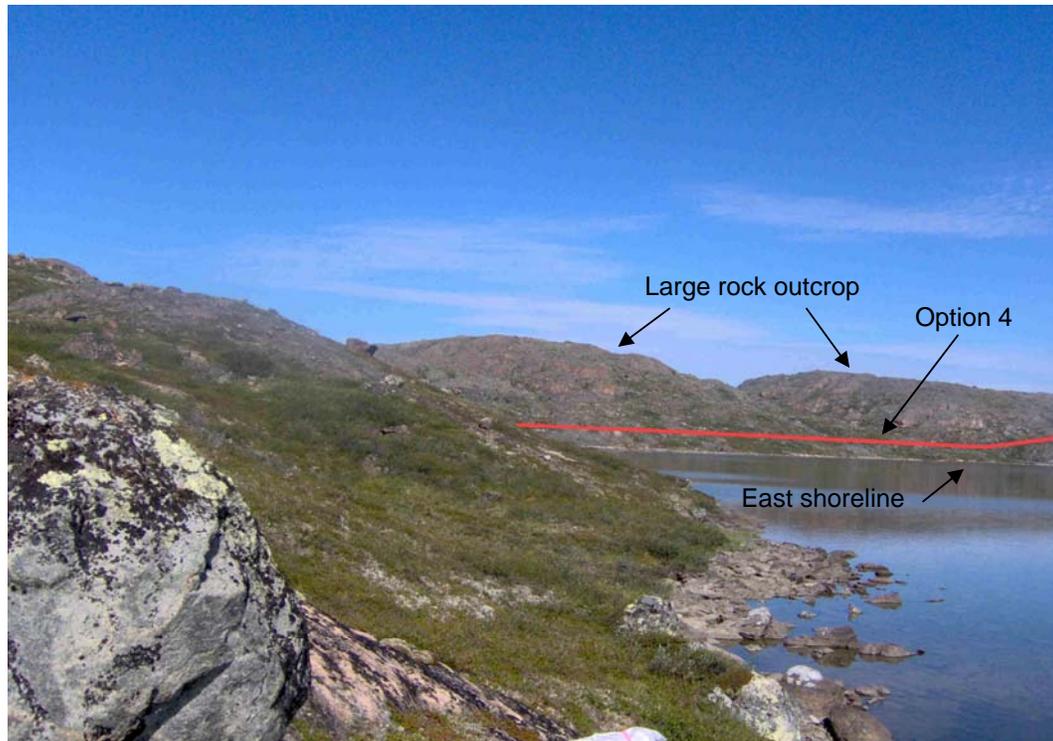


Photo: 2 Looking North across lake L800 towards rock outcrop at Northeast shoreline (Option 3).

TBTE REF. NUMBER: 05-160	ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY HIGH LAKE MINE PROJECT
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Date: Feb 13/07	LOCATION: Lake L800 AS#05 Crossing
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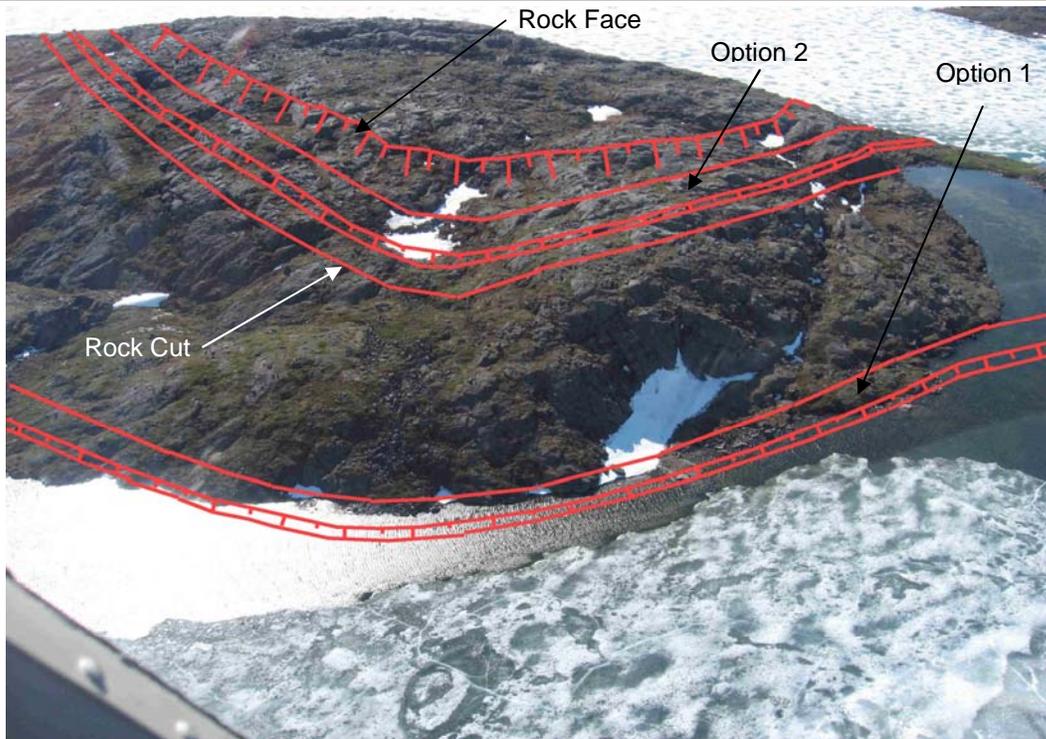


Photo: 3 North half of rock outcrop Lake L800 West side

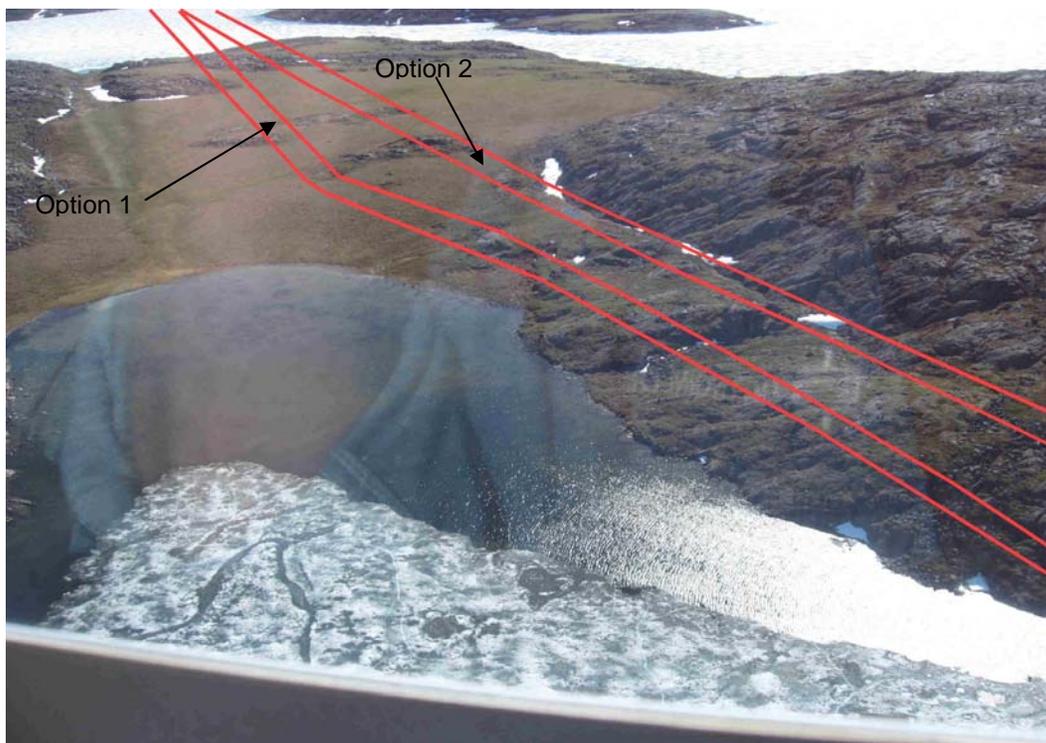


Photo: 4 South half of rock outcrop Lake L800 West side

TBTE REF. NUMBER: 05-160	ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY HIGH LAKE MINE PROJECT
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Date: Feb 13/07	LOCATION: Lake L800 AS#05 Crossing
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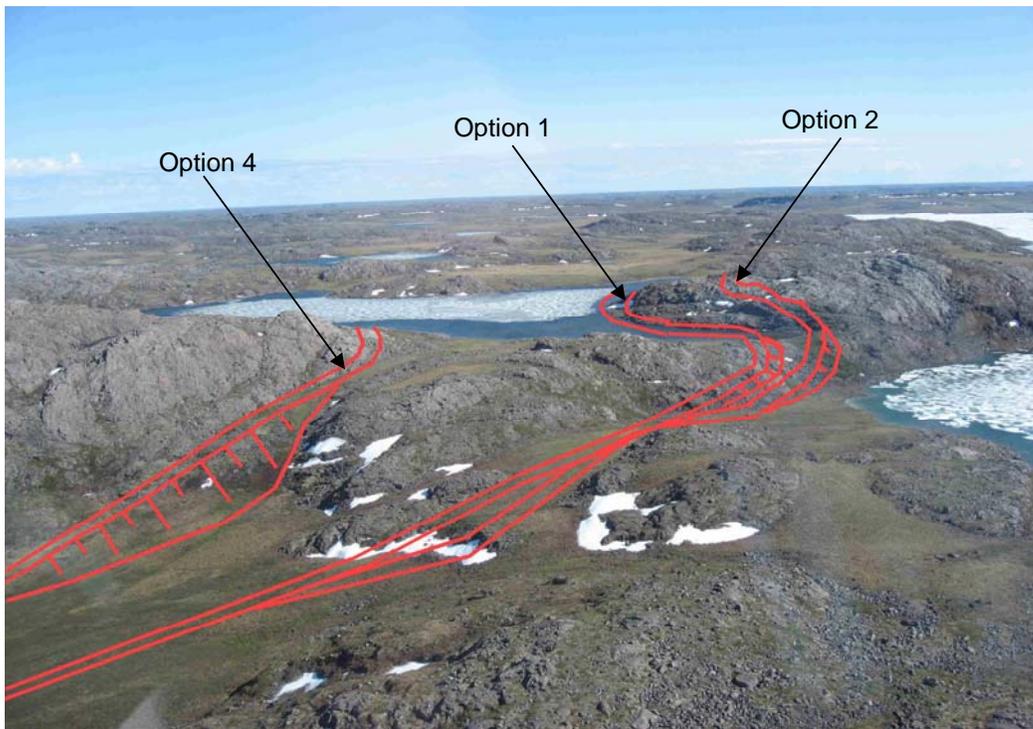


Photo: 5 Looking South towards Lake L800

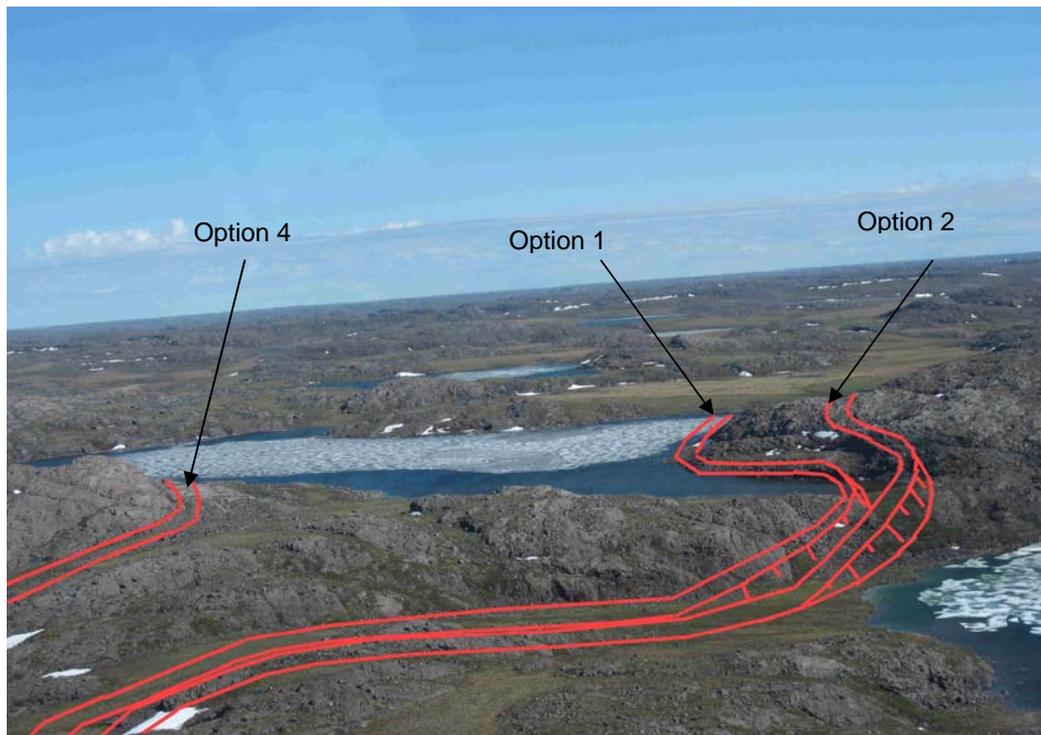


Photo: 6 Looking Southeast towards Lake L800

TBTE REF. NUMBER: 05-160	ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY HIGH LAKE MINE PROJECT
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Date: Feb 13/07	LOCATION: Lake L800 AS#05 Crossing
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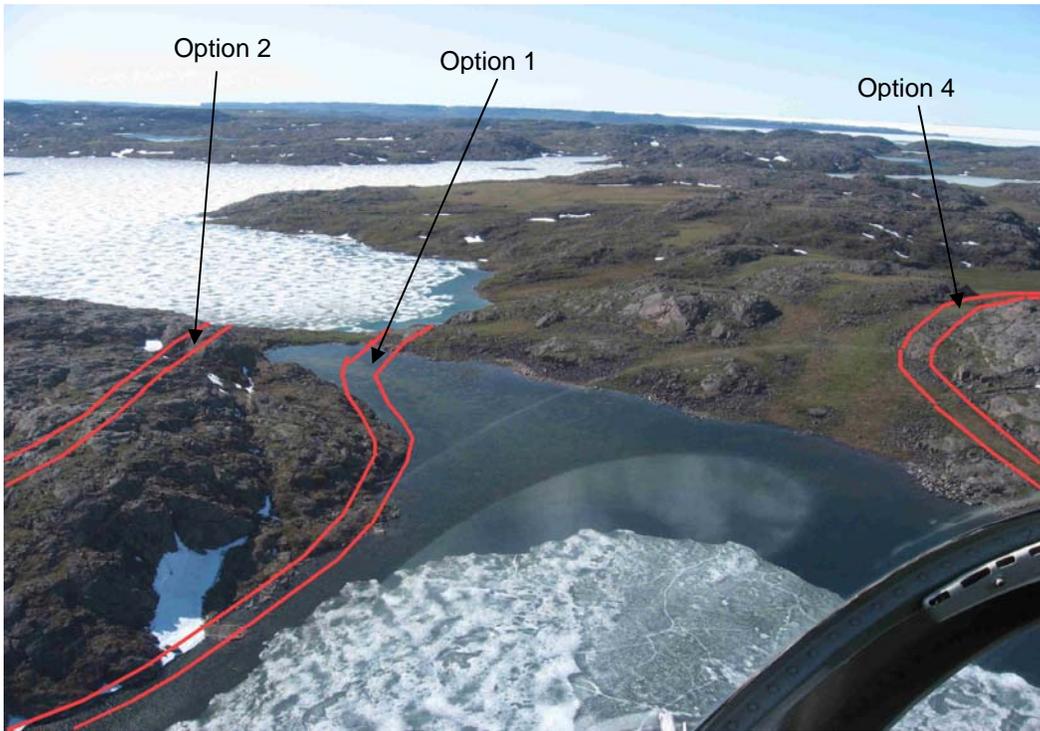


Photo: 7 Looking at Northwest end of Lake L800

TBTE REF. NUMBER: 05-160	ALTERNATIVE ROUTE OPTIONS COMPARISON STUDY HIGH LAKE MINE PROJECT
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Date: Feb 13/07	LOCATION: Lake L800 AS#05 Crossing
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Appendix B

Freshwater Habitat Suitability Models

High Lake Project
No Net Loss Plan
 Appendix B

Table B-1. Habitat Unit Determination for Road Crossing AS#1

Habitat Attribute Classification-Lake Trout		Area (ha)					0.033
Attribute	Detail	Spawning	Nursery	Rearing	Foraging	Migration	Total
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	4	-	-	4
	4-8 weeks	-	-	-	-	-	0
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	2	-	-	2
	25-75%	-	-	-	-	-	0
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	0	0
Total H S I		0	0	6	0	4	10
Total HU		0	0	0.32	0	0.22	0.33
Habitat Attribute Classification-Arctic Char		Area (ha)					0.033
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	4	-	-	4
	4-8 weeks	-	-	-	-	-	0
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	2	-	-	2
	25-75%	-	-	-	-	-	0
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	0	0
Total H S I		0	0	6	0	4	10
Total HU		0	0	0.32	0	0.22	0.33

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

High Lake Project
No Net Loss Plan
 Appendix B

Table B-2. Habitat Unit Determination for Road Crossing AS#5

Habitat Attribute Classification-Lake Trout						Area (ha)	0.284
Attribute	Detail	Spawning	Nursery	Rearing	Foraging	Migration	Total
Substrate-Composition	Boulder	-	-	-	-	-	0
	Boulder/Cobble	-	-	-	-	-	0
	Boulder/Fine	-	-	-	-	-	0
	Boulder/Cobble/Fine	-	-	-	-	-	0
	Fine/Boulder	1	1	1	1	-	4
	Fines	-	-	-	-	-	0
Substrate-Heterogeneity	>80% Dominant Substrate	-	-	-	-	-	0
	60-80% Dominant Substrate	3	3	2	2	-	10
	<60% Dominant Substrate	-	-	-	-	-	0
Depth	Shallow (0-2 m)	0	0	4	3	-	7
	Moderate (2-6 m)	-	-	-	-	-	0
	Deep (>6 m)	-	-	-	-	-	0
Morphology	Littoral	-	-	-	-	-	0
	Littoral proximal to pelagic	4	4	4	2	-	14
	Pelagic	-	-	-	-	-	0
Total H S I		0	0	11	8	0	19
Total HU		0	0	3.12	2.27	0	5.40
Habitat Attribute Classification-Arctic Char						Area (ha)	0.284
Substrate-Composition	Boulder	-	-	-	-	-	0
	Boulder/Cobble	-	-	-	-	-	0
	Boulder/Fine	-	-	-	-	-	0
	Boulder/Cobble/Fine	-	-	-	-	-	0
	Fine/Boulder	0	0	1	1	-	2
	Fines	-	-	-	-	-	0
Substrate-Heterogeneity	>80% Dominant Substrate	-	-	-	-	-	0
	60-80% Dominant Substrate	-	-	-	-	-	0
	<60% Dominant Substrate	-	-	-	-	-	0
Depth	Shallow (0-2 m)	0	2	4	4	-	10
	Moderate (2-6 m)	-	-	-	-	-	0
	Deep (>6 m)	-	-	-	-	-	0
Morphology	Littoral	-	-	-	-	-	0
	Littoral proximal to pelagic	4	4	4	2	-	14
	Pelagic	-	-	-	-	-	0
Total H S I		0	6	9	7	0	22
Total HU		0	1.70	2.56	1.99	0	6.25

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

High Lake Project
No Net Loss Plan
 Appendix B

Table B-3. Habitat Unit Determination for Road Crossing AS#8

Habitat Attribute Classification-Lake Trout		Area (ha)					0.112
Attribute	Detail	Spawning	Nursery	Rearing	Foraging	Migration	Total
Morphology	No barriers to migration	-	-	-	-	4	4
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	4	4
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	-	-	-	0
	4-8 weeks	-	-	2	-	-	2
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	-	-	-	0
	25-75%	-	-	4	-	-	4
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	6	0	12	18
Total HU		0	0	1.01	0	2.03	2.02
Habitat Attribute Classification-Arctic Char		Area (ha)					0.169
Morphology	No barriers to migration	-	-	-	-	4	4
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	4	4
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	-	-	-	0
	4-8 weeks	-	-	2	-	-	2
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	-	-	-	0
	25-75%	-	-	4	-	-	4
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	6	0	12	18
Total HU		0	0	1.01	0	2.03	2.02

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

High Lake Project
No Net Loss Plan
 Appendix B

Table B-4. Habitat Unit Determination for Road Crossing AS#10

Habitat Attribute Classification-Lake Trout		Area (ha)					0.072
Attribute	Detail	Spawning	Nursery	Rearing	Foraging	Migration	Total
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	2	2
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	2	2
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	-	-	-	0
	4-8 weeks	-	-	2	-	-	2
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	2	-	-	2
	25-75%	-	-	-	-	-	0
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	4	0	8	12
Total HU		0	0	0.41	0	0.82	0.86
Habitat Attribute Classification-Arctic Char		Area (ha)					0.072
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	2	2
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	2	2
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	-	-	-	0
	4-8 weeks	-	-	2	-	-	2
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	2	-	-	2
	25-75%	-	-	-	-	-	0
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	4	4
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	4	0	8	12
Total HU		0	0	0.41	0	0.82	0.86

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

High Lake Project
No Net Loss Plan
 Appendix B

Table B-5. Habitat Unit Determination for Road Crossing AS#13

Habitat Attribute Classification-Lake Trout		Area (ha)					0.021
Attribute	Detail	Spawning	Nursery	Rearing	Foraging	Migration	Total
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	4	-	-	4
	4-8 weeks	-	-	-	-	-	0
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	-	-	-	0
	25-75%	-	-	4	-	-	4
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	-	0
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	8	0	0	8
Total HU		0	0	0.49	0	0.00	0.17
Habitat Attribute Classification-Arctic Char		Area (ha)					0.021
Morphology	No barriers to migration	-	-	-	-	-	0
	Barriers during low flow years	-	-	-	-	-	0
	Barriers present, only passable during extremely high water conditions	-	-	-	-	-	0
	Barriers present, not passable to fish	-	-	-	-	-	0
Flow	Present annually in a defined channel	-	-	-	-	-	0
	Present in some years, sufficient to allow fish passage during peak flows	-	-	-	-	-	0
	Insufficient flow to allow fish passage	-	-	-	-	-	0
Stream Longevity	>8 weeks	-	-	4	-	-	4
	4-8 weeks	-	-	-	-	-	0
	<4 weeks	-	-	-	-	-	0
% Cover	>75%	-	-	-	-	-	0
	25-75%	-	-	4	-	-	4
	10-25%	-	-	-	-	-	0
	0%	-	-	-	-	-	0
Access	Connected to suitable year-round habitat or summer habitat with access to overwintering	-	-	-	-	-	0
	Not connected to suitable habitat	-	-	-	-	-	0
Total H S I		0	0	8	0	0	8
Total HU		0	0	0.49	0	0.00	0.17

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

Appendix C

Freshwater Habitat Suitability Models for Compensation Works

High Lake Project
No Net Loss Plan
Appendix C

Table C-1. Habitat Unit Determination for Compensation Area A

Habitat Attribute Classification-Lake Trout and Arctic Char Compensation							Area (ha)	0.477
Attribute	Detail	Spawning	Nursery LT	Nursery AC	Rearing	Foraging	Total	
Substrate-Composition	Boulder	-	-	-	-	-	0	
	Boulder/Cobble	3	3	2	4	4	16	
	Boulder/Fine	-	-	-	-	-	0	
	Boulder/Cobble/Fine	-	-	-	-	-	0	
	Fine/Boulder	-	-	-	-	-	0	
	Fines	-	-	-	-	-	0	
Substrate-Heterogeneity	>80% Dominant Substrate	-	-	-	-	-	0	
	60-80% Dominant Substrate	-	-	-	-	-	0	
	<60% Dominant Substrate	4	4		2	2	12	
Depth	Shallow (0-2 m)	-	-	-	-	-	0	
	Moderate (2-6 m)	3	3	3	3	3	15	
	Deep (>6 m)	-	-	-	-	-	0	
Morphology	Littoral	-	-	-	-	-	0	
	Littoral proximal to pelagic	4	4	4	4	2	18	
	Pelagic	-	-	-	-	-	0	
Total H S I		14	14	9	13	11	61	
Total HU		6.68	6.68	4.29	6.20	5.25	29.10	

Area x HSI = HU

HSI Ratings

- 0 Unsuitable
- 1 Below Average
- 2 Average
- 3 Above average
- 4 Excellent

High Lake Project
No Net Loss Plan
Appendix C

Table C-3. Habitat Unit Determination for Compensation Area B

Habitat Attribute Classification-Lake Trout and Arctic Char Compensation						Area (ha)	0.239
Attribute	Detail	Spawning	Nursery LT	Nursery AC	Rearing	Foraging	Total
Substrate-Composition	Boulder	-	-	-	-	-	0
	Boulder/Cobble	3	3	2	4	4	16
	Boulder/Fine	-	-	-	-	-	0
	Boulder/Cobble/Fine	-	-	-	-	-	0
	Fine/Boulder	-	-	-	-	-	0
	Fines	-	-	-	-	-	0
Substrate-Heterogeneity	>80% Dominant Substrate	-	-	-	-	-	0
	60-80% Dominant Substrate	-	-	-	-	-	0
	<60% Dominant Substrate	4	4		2	2	12
Depth	Shallow (0-2 m)	-	-	-	-	-	0
	Moderate (2-6 m)	3	3	3	3	3	15
	Deep (>6 m)	-	-	-	-	-	0
Morphology	Littoral	-	-	-	-	-	0
	Littoral proximal to pelagic	4	4	4	4	2	18
	Pelagic	-	-	-	-	-	0
Total H S I		14	14	9	13	11	61
Total HU		3.35	3.35	2.15	3.11	2.63	14.58

Area x HSI = HU

HSI Ratings

- 0 Unsuitable*
- 1 Below Average*
- 2 Average*
- 3 Above average*
- 4 Excellent*

High Lake Project
No Net Loss Plan
Appendix C

Table C-3. Habitat Unit Determination for Compensation Area C

Habitat Attribute Classification-Lake Trout and Arctic Char Compensation						Area (ha)	0.249
Attribute	Detail	Spawning	Nursery LT	Nursery AC	Rearing	Foraging	Total
Substrate-Composition	Boulder	-	-	-	-	-	0
	Boulder/Cobble	3	3	2	4	4	16
	Boulder/Fine	-	-	-	-	-	0
	Boulder/Cobble/Fine	-	-	-	-	-	0
	Fine/Boulder	-	-	-	-	-	0
	Fines	-	-	-	-	-	0
Substrate-Heterogeneity	>80% Dominant Substrate	-	-	-	-	-	0
	60-80% Dominant Substrate	-	-	-	-	-	0
	<60% Dominant Substrate	4	4		2	2	12
Depth	Shallow (0-2 m)	-	-	-	-	-	0
	Moderate (2-6 m)	3	3	3	3	3	15
	Deep (>6 m)	-	-	-	-	-	0
Morphology	Littoral	-	-	-	-	-	0
	Littoral proximal to pelagic	4	4	4	4	2	18
	Pelagic	-	-	-	-	-	0
Total H S I		14	14	9	13	11	61
Total HU		3.49	3.49	2.24	3.24	2.74	15.19

Area x HSI = HU

HSI Ratings

- 0 Unsuitable*
- 1 Below Average*
- 2 Average*
- 3 Above average*
- 4 Excellent*