# APPENDIX 21-B
# ARCHAEOLOGICAL IMPACT ASSESSMENT, FINAL REPORT – HERITAGE INSPECTION PERMIT 2012-0192

Seabridge Gold Inc.

SEABRIDGE GOLD

# KSM PROJECT
# Archaeological Impact Assessment, Final Report
## *Heritage Inspection Permit 2012-0192*

*Public Version*

Rescan™ Engineers & Scientists

Rescan™ Environmental Services Ltd.
Rescan Building, Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

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# Executive Summary

Rescan Environmental Services Ltd. (Rescan) was retained by Seabridge Gold Inc. (Seabridge) to conduct an Archaeological Impact Assessment (AIA) for revised portions of the proposed KSM Project (the Project). This report presents the final results of the AIA.

The Project is a proposed open pit and underground mine located in northwestern British Columbia approximately 65 km north of Stewart along sections of Teigen, Sulphurets, and Treaty Creek valleys and the Unuk River valley. The majority of the KSM Project was previously assessed under the *Heritage Conservation Act* (*HCA;* 1996) Heritage Inspection Permit 2008-0128, including the mine pits, associated mining facilities, ancillary buildings, transmission lines, access roads, construction camps, and fish habitat compensation areas. The revised Project components included new and realigned transmission lines and access roads, roadside development areas, camps and other mine facilities.

The AIA was conducted in accordance with the British Columbia *HCA* Heritage Inspection Permit 2012-0192, issued by the Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (Archaeology Branch). The objective of this AIA was to identify and evaluate archaeological sites located within revised portions of the proposed Project footprint. During the AIA, 2,037 shovel tests were conducted at 122 locations. Three new archaeological sites were recorded: HcTo-1, HdTk-4, and HdTo-7. There are also 34 previously recorded sites in the Project area. Historical and recent land use features, primarily related to twentieth century prospecting and mineral exploration, were also recorded during the AIA; however, as these features post-date 1846, they are not protected by the *HCA*.

Sites HcTo-1, HdTk-4, HdTo-7, HdTn-1, and HdTn-2 are in direct conflict with the currently proposed Project footprint. Avoidance through Project redesign is the preferred management recommendation. If avoidance is not possible, mitigation measures, to be determined in consultation with the Archaeology Branch, are recommended. Mitigation may include systematic data recovery, construction monitoring, and/or capping. Any alteration to these sites would require *HCA* Section 12 Site Alteration permits issued by the Archaeology Branch.

No further archaeological assessment is recommended for the assessed areas of the proposed footprint. Any revisions to the proposed Project footprint should be reviewed by a qualified professional archaeologist, and, if necessary, an AIA should be conducted.

Even the most thorough study may not identify all archaeological resources that may be present and the Project's archaeological chance find procedure should continue to be followed during construction. All Project staff should be made familiar with the procedure and protocols for managing the known archaeological sites and any "chance finds" that may occur during construction.

The management options and recommendations presented above are subject to review and acceptance by the Archaeology Branch.

# Acknowledgements


**CREDITS**

| | |
|---|---|
| **Permit Holder** | Sean McKnight, B.A., RPCA |
| **Field Directors** | Lisa Seip, M.A., RPCA, CAHP<br>Sean McKnight, B.A., RPCA<br>Daniel Walker, M.A., RPCA<br>Vanessa Neuman, B.A.<br>Kay Farquharson, B.A. |
| **Field Archaeologists** | Michael Campbell, B.A. |
| **Field Technicians** | Scott Williams (Gitanyow First Nation)<br>Guy Morgan (Gitanyow First Nation)<br>Brenton Williams (Gitanyow First Nation)<br>John McNeil (Gitanyow First Nation)<br>Robert Burns (Gitxsan First Nation)<br>Lorne Williams (Gitxsan First Nation)<br>Deeper Dennis (Tahltan Nation)<br>Nancy Nole (Tahltan Nation) |
| **Report Authors** | Kay Farquharson, B.A.<br>Michael Campbell, B.A.<br>Dan Walker, M.A., RPCA<br>Sean McKnight, B.A., RPCA<br>Lisa Seip, M.A., RPCA |
| **Senior Reviewer** | Lisa Seip, M.A., RPCA, CAHP |

# Archaeological Impact Assessment, Final Report
# *Heritage Inspection Permit 2012-0192*

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# Glossary and Abbreviations

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

| | |
|---|---|
| **AIA** | Archaeological Impact Assessment |
| **Angular Fragments** | A soil description for a mix of rubble and blocks greater than 2 mm. |
| **Archaeology Branch** | Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations |
| **BC** | British Columbia |
| **Blocks** | A soil description for angular rocks/particles greater than 256 mm. |
| **Boulders** | A soil description for rounded and subrounded rocks/particles greater than 256 mm. |
| **BP** | Years before present (1950 AD) |
| **CCAR** | Coulter Creek Access Road |
| **Clay** | A soil description for extremely fine particles, less than 0.002 mm, exuding little or no water and forming a thread when rolled between the fingers. |
| **CMT** | Culturally modified tree |
| **Cobbles** | A soil description for rounded and subrounded rocks/particles between 64 and 256 mm. |
| **CWH** | Coastal Western Hemlock (ecological zone) |
| **DBS** | Depth below surface |
| **ESSF** | Engelmann Spruce – Subalpine Fir (ecological zone) |
| **GIS** | Geographic Information System |
| **GPS** | Global Positioning System |
| **Gravel** | A soil description for a mix of boulders, cobbles, and pebbles greater than 2 mm. |
| **HBC** | Hudson's Bay Company |
| ***HCA*** | *Heritage Conservation Act* (1996) |
| **KSM** | Kerr-Sulphurets-Mitchell |

| | |
|---|---|
| **LiDAR** | Light Detection and Ranging |
| **MH** | Mountain Hemlock |
| **Mixed Fragments** | A soil description for a mix of rounded and angular rocks/particles greater than 2 mm. |
| **NTS** | National Topographic System |
| **Pebbles** | A soil description for rounded and subrounded rocks/particles between 2 and 64 mm. |
| **Project, the** | The KSM Project |
| **PTMA** | Processing and Tailing Management Area |
| **RAAD** | Remote Access to Archaeological Data online application |
| **Rescan** | Rescan Environmental Services Ltd. |
| **Rubble** | A soil description for angular rocks/particles between 2 and 256 mm. |
| **Sand** | A soil description for fine to medium size particles between 2 and 0.06 mm of naturally occurring material of rock and mineral particles with a coarse feeling. |
| **Seabridge** | Seabridge Gold Inc. |
| **Silt** | A soil description for fine particles between 0.06 and 0.002 mm. |
| **TCAR** | Treaty Creek Access Road |
| **THREAT** | Tahltan Heritage Resource Environmental Assessment Team |
| **TMF** | Tailing Management Facility |
| **Treaty OPC** | Treaty Creek Ore Preparation Complex |
| ***wilp*** | The *wilp* is a basic matrilineal kinship unit among some First Nations in northwestern British Columbia. |
| **XRF** | X-Ray Fluorescence Spectrometry. A non-destructive method used to determine the elemental composition of natural and man-made materials, such as obsidian, to aid in determining its source. |

# 1. Introduction[1]

## 1.1 Project Proponent

Seabridge Gold Inc. (Seabridge) is the proponent for the proposed KSM Project (the Project), a gold, copper, silver, molybdenum mine.

## 1.2 Project Location

The Project is located in the coastal mountains of northwestern British Columbia. It is approximately 950 km northwest of Vancouver and 65 km northwest of Stewart, within 30 km of the British Columbia–Alaska border (Figure 1.2-1).

## 1.3 Project Overview

The Project is located in two geographical areas: the Mine Site and Processing and Tailing Management Area (PTMA), connected by twin 23-km tunnels, the Mitchell-Treaty Twinned Tunnels (Figure 1.3-1). The Mine Site is located south of the closed Eskay Creek Mine, within the Mitchell, McTagg, and Sulphurets Creek valleys. Sulphurets Creek is a main tributary of the Unuk River, which flows to the Pacific Ocean. The PTMA is located in the upper tributaries of Teigen and Treaty creeks. Both creeks are tributaries of the Bell-Irving River, which flows to the Nass River and into the Pacific Ocean. The PTMA is located about 19 km southwest of Bell II on Highway 37.

The Mine Site will be accessed by a new road, the Coulter Creek Access Road, which will be built from km 70 on the Eskay Creek Mine Road. This road will follow Coulter and Sulphurets creeks to the Mine Site. The PTMA will also be accessed by a new road, the Treaty Creek Access Road, the first 3-km segment of which is a forest service road off of Highway 37. The Treaty Creek Access Road will parallel Treaty Creek.

Four deposits will be mined at the KSM Project—Kerr, Sulphurets, Mitchell, and Iron Cap—using a combination of open pit and underground mining methods. Waste rock will be stored in engineered rock storage facilities located in the Mitchell and McTagg valleys at the Mine Site. Ore will be crushed and transported through one of the Mitchell-Treaty Twinned Tunnels to the PTMA. This tunnel will also be used to route the electrical power transmission lines. The second tunnel will be used to transport personnel and bulk materials. The Process Plant will process an average of 130,000 tpd of ore to produce a daily average of 1,200 t of concentrate. Tailing will be pumped to the Tailing Management Facility from the Process Plant. Copper concentrate will be trucked from the PTMA along highways 37 and 37A to the Port of Stewart, which is approximately 170 km away via road.

[1] The Public Version of this report has had some information removed to protect the locational information of archaeological sites. Additional information can be obtained from the complete version of this report which is on file with the BC Archaeology Branch. In addition, the organization of the Introduction of this report has been revised.


Figure 1.2-1

## KSM Project Location

PROJECT # 868-017-01 GIS No. KSM-15-175 May 30, 2012

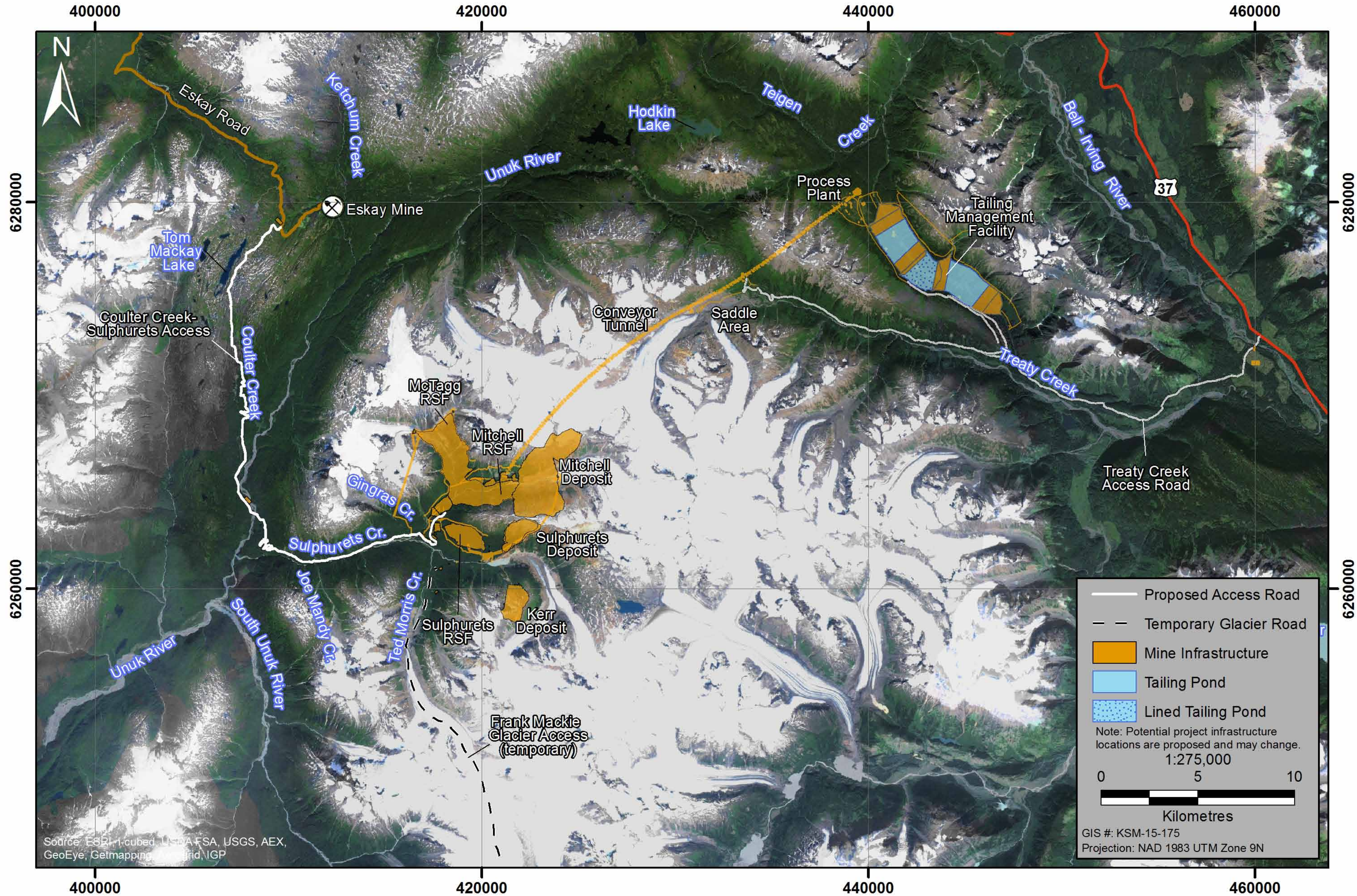


Figure 1.3-1

# KSM Project Layout

SEABRIDGE GOLD
KSM PROJECT

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Figure 1.3-1

The mine operating life is estimated at 51.5 years. Approximately 1,800 people will be employed annually during the Operation Phase. Project Construction will take about five years, and the capital cost of the Project is approximately US$5.3 billion.

## 1.4 Study Overview

Rescan Environmental Services Ltd. (Rescan) was retained by Seabridge to conduct an Archaeological Impact Assessment (AIA) for the Project. The majority of the Project footprint was assessed and reported on under *Heritage Conservation Act* (*HCA;* 1996*)* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). Subsequent to *HCA* Heritage Inspection Permit 2008-0128, changes were made to the Project design and *HCA* Heritage Inspection Permit 2012-0192 was issued to focus on new and revised elements of the Project footprint not previously assessed. This report presents the final results of the AIA conducted in 2012 under *HCA* Heritage Inspection Permit 2012-0192.

This AIA was conducted in accordance with *HCA* Heritage Inspection Permit 2012-0192, issued by the Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (Archaeology Branch). The permit application was referred to the following First Nations by the Archaeology Branch for review: Tahltan Nation, Gitanyow First Nation, Gitxsan First Nation, and the Skii km Lax Ha. As the Project is within the Nass Area, as defined by the *Nisga'a Final Agreement Act* (2000), the permit application was also referred to the Nisga'a Nation for review.

This AIA was not designed to address issues of traditional Aboriginal use and does not constitute a traditional use study. This report was written without prejudice to issues of Aboriginal rights and/or title. For more comprehensive information on recent, historic, and traditional land use in the Project area, the reader is directed to separate Project reports on traditional and ecological knowledge and use, as well as land and resource use.

The layout of this report is as follows: Section 1 describes the Project, the study objectives, potential effects on archaeological sites, First Nations and Nisga'a Nation communications, and any archaeological issues raised during consultation; Section 2 describes the Project setting, including the paleoenvironment, effects of volcanism, biogeoclimatic zones, ethnographic background, historic background and built heritage, palaeontology, and previous archaeological research; Section 3 describes the methodology used for this study; Section 4 describes the results of the archaeological assessments conducted; Section 5 describes identified heritage concerns; Section 6 provides an evaluation of archaeological site significance; Section 7 discusses the assessment of impact potential and management recommendations; Section 8 provides a discussion and conclusions of the study; and Section 9 is an evaluation of the research conducted.

Assessment area photos are provided in Appendix A; shovel test descriptions are in Appendix B; maps showing the locations of shovel tests and pedestrian survey are provided in Appendix C; the results from the snow and ice patch survey are provided in Appendix D; maps illustrating archaeological sites in relation to the Project footprint are provided in Appendix E; Nisga'a Nation boundaries and asserted traditional territory boundaries of First Nations in relation to the Project area are presented in Appendix F; archaeological site data are provided in Appendix G;

and Appendix H contains a report evaluating the archaeological potential in ice patches and glaciers in the study area.

## 1.5 Study Objectives

The primary objectives of this AIA were to:

- identify and evaluate any archaeological sites located within and adjacent to the impact zone of proposed Project development;
- identify and assess possible impacts of proposed development on any identified archaeological sites;
- provide recommendations regarding the need for and scope of any further archaeological investigations prior to initiation of any proposed development; and
- recommend viable alternatives for managing adverse effects.

## 1.6 Potential Effects on Archaeological Sites

Developments that involve the movement, excavation, or disturbance of soils have the potential to affect archaeological materials, if present. Project activities that could potentially negatively affect archaeological sites are anticipated to include the clearing and grading of roads and transmission line right-of-ways; clearing, grading, and excavation of building foundations and footings; earth moving and blasting during mine construction; and inundation of the TMF.

## 1.7 First Nations and Nisga'a Nation Communications

On May 15, 2012, the Archaeology Branch forwarded a copy of the *HCA* permit application for the Project to the following groups: the Gitxsan Treaty Office, Nisga'a Lisims Government, Tahltan Central Council, the Skii km Lax Ha Nation, Wilp Spookw/ Guuhadakw/Yagosip, and Wilp GwininNitzw of the Gitxsan for their review and comments. On June 19, 2012, the Archaeology Branch issued *HCA* Heritage Inspection Permit 2012-0192 and forwarded a copy to the groups listed above. A copy of the final permit report will also be sent to the groups listed above. Members from the First Nations and the Nisga'a Nation were invited to participate in fieldwork. Individuals who participated in the fieldwork are listed in the Acknowledgments section.

### 1.7.1 Tahltan Archaeological Issues Raised during Consultation

The Tahltan have identified a number of archaeological issues that are considered priorities for archaeological studies conducted in their traditional territory (Appendix F-2). These archaeological issues include (1) ice patch and glacier sites; (2) cave and rock shelter sites; (3) cairns; (4) trails; (5) ancient continental movement of obsidian from *Ah-zeeth-zaa* (Mount Edziza); (6) cultural history, including radiocarbon dating, obsidian hydration, tephra layers; and (7) regional archaeology (Asp 2006; THREAT 2011). In August 2012, a meeting was held with members of THREAT (Vera Asp, Jerry Asp, and Naline Morin) to discuss the incorporation of traditional knowledge data in the study.

# 2. Project Setting

This section describes the Project setting, including an overview of the geological and ecological processes that formed the current landscape, the cultural and historical setting, and the archaeological background[2]. This information was reviewed prior to the field component of the AIA to help inform the field assessments.

## 2.1 Natural Setting

The Project is located in the Coast Mountain Range within the Canadian Cordilleran physiographic region of British Columbia (Demarchi 2011) and falls primarily within three biogeoclimatic zones: Coastal Western Hemlock, Mountain Hemlock, and Engelmann Spruce – Subalpine Fir (Meidinger and Pojar 1991). The Project area is characterized by a rugged and mountainous topography formed through tectonic, volcanic, and glacial processes. Higher elevations remain heavily glaciated, with unglaciated terrain varying from subalpine meadows, parkland, and wetlands, to barren alpine environments. On the forested mountain slopes, glacier-fed run-off drainages have incised narrow, steep-walled gullies that feed into broad, U-shaped valleys.

## 2.2 Paleoenvironment

The current ecological environment began to take shape following the Wisconsinan Glaciation of the Late Pleistocene epoch. During the glacial maximum the Cordilleran ice sheet was up to 2 km thick with only small ice-free islands (nunataks) protruding. The nunataks, however, would not have supported much in the way of flora and fauna during this period (Fladmark 2001). As the climate warmed in the early Holocene, deglaciation began and resulted in a redeposition of the materials previously collected by the glaciers as they scoured the landscape. The resulting moraines and outwashes are still evident within the Project area.

As the glaciers receded, flora and later fauna began to inhabit the newly revealed lands. By 9,500 BP the ice sheets were roughly at their present sizes, and pioneer plant species well-adapted to a cool, dry environment (e.g., lodgepole pine, shrubs, and willow) initially thrived (Clague 1989). This initial advance was reinforced between 8,200 and 3,500 BP with the diversity of flora increasing as Sitka spruce, mountain and western hemlock, and alder became established in new areas (Heusser 1960) This increase in diversity was likely aided by a warming trend between 7,000 and 5,000 BP, the Hypsithermal Interval, that saw temperatures rise to approximately 2 to 3ºC warmer than the current climate (Fladmark 1985). This led to a further retreat of the glaciers that allowed subalpine parklands to expand to previously treeless higher elevations. Over the past 5,000 years following the Hypsithermal Interval, the Neoglacial Period experienced fluctuating temperatures and an overall cooling trend. This cooling trend culminated with the Little Ice Age (1250 to 1850 AD), which resulted in a major advance of glaciers, some entirely filling the coastal bays and fjords in southeast Alaska (Fladmark 2001). During the past 150 years a warming trend has again sent these glaciers into retreat.

[2] This section draws largely from the Project Setting section outlined in Seip et al. 2012.

## 2.3 Effects of Volcanism

In addition to the glacial activity, the other major force to shape the Project area has been tectonic forces, most powerfully illustrated by volcanism. The Project is located within the Stikine Volcano Belt in the active Iskut River area that consists of a complex of eight recent volcanic centres, with at least 12 volcanic flows dating between 70,000 and 150 B.P. (Table 2.3-1; Wood and Kienle 1992; Hauksdottir, Enegren, and Russell 1994; Hickson and Edwards 2001; Geological Survey of Canada 2010). As the Iskut River Cone, Lava Fork and Second Canyon Cone volcanoes have been active during the Holocene and altered the landscape, waterways, and fisheries, they have likely had a significant impact on the prehistory of the area.

### Table 2.3-1. The Iskut River Group of Volcanoes

| Volcano | Last Eruption | Distance from the Project |
|---|---|---|
| Lava Fork | Holocene (~150 BP) | 24 km southwest |
| Iskut River Cone | Holocene (< 2,555 BP) | 8 km northwest |
| Cone Glacier | Holocene | 9 km west |
| Second Canyon Cone | Holocene | 17 km southwest |
| Snippaker Creek | Holocene | 20 km west |
| Cinder Mountain | Pleistocene | 6 km west |
| King Creek | Pleistocene | 10 km west |
| Tom Mackay Creek | Pleistocene | 8 km northwest |

**Source: Geological Survey of Canada (2010).**

Lava Fork is believed to be the youngest volcano in Canada, last erupting approximately 150 years ago. At least three flows of lava occurred, spreading south down the Lava Fork and Blue River valleys for approximately 20 km. The resulting damming created a number of lakes, including Blue Lake in Alaska and Lava Lake in British Columbia. The first canyon on the Unuk River was formed at its confluence with the Blue River by the river's subsequent erosion through the lava. The second and third canyons upstream were similarly caused by damming from undated lava flows from the Second Canyon Cone (Geological Survey of Canada 2010).

The Iskut River Cone has produced at least 10 lava flows since 70,000 BP. Specific flows have been dated to 6,500 to 6,800 BP, 5,600 BP, and 3,800 BP. Additionally, two flows post-date 2,555 BP, but have not been absolutely dated (Ian Hayward and Associates Ltd. 1982; Geological Survey of Canada 2010). The vents are on the south side of the Iskut River, near its confluence with Forrest Kerr Creek. Lava flows stretched 20 km down the Iskut River and dammed the river and several of its tributaries. The Iskut River Canyon, located approximately 10 km northwest of the Project area, was formed when the river cut a narrow gorge through the lava dam.

## 2.4 Biogeoclimatic Zones

The Project area falls primarily within three biogeoclimatic zones: Coastal Western Hemlock, Mountain Hemlock, and Engelmann Spruce – Subalpine Fir. For specific information on to the flora and fauna in the Project area, please refer to the *2009 Vegetation and Ecosystems Mapping*

*Baseline Study* (Rescan 2010a) and *2009 Wildlife Characterization Baseline Study* (Rescan 2010b), prepared for the Project.

Lower elevations along the Unuk River, Sulphurets Creek, and the adjacent valley-bottoms fall within the Coastal Western Hemlock (CWH) zone. The CWH zone is characterized by a dense canopy of western hemlock, with black cottonwood present in poorly drained areas and floodplains. This canopy keeps the forest floor relatively clear of snow most of the year. Of the three zones, CWH's climate is most heavily influenced by coastal marine factors, resulting in proportionately less precipitation falling as snow (up to 50% of the 1,000 to 4,400 mm annual precipitation). Wildlife in this zone is diverse and may include black-tailed deer, black bear, grizzly bear, mountain goat, and grey wolf, as well as a large variety of birds such as owls, Stellar's jay, woodpeckers, grouse, and common raven. Both fresh and anadromous fish species are present in the region, including chinook and sockeye salmon, rainbow and lake trout, and Dolly Varden (Meidinger and Pojar 1991).

The Mountain Hemlock (MH) zone is found southwest of Tom Mackay Lake and along the Unuk River and Sulphurets Creek Valley walls. Mountain hemlock, amablis fir, and yellow cedar are the dominant tree species, with some subalpine fir. With increasing elevation, the forest cover decreases, and subalpine parkland with patchy distribution of trees becomes common. The MH zone has a short growing season with 700 to 5,000 mm of annual precipitation, 20 to 70% of which falls as snow. Wildlife is less diverse than in other zones due to its typically steep rugged landforms and glaciers. Large mammals are generally restricted to south facing outcrops or subalpine parklands, and may include grizzly bear and mountain goat. Birds in the MH zone include golden eagles, ptarmigans, owls, woodpeckers, and various other smaller species (Meidinger and Pojar 1991).

The Engelmann Spruce – Subalpine Fir (ESSF) zone is located upstream of the Unuk River and along the valleys of the upper Nass watershed (e.g., Treaty and Teigen creeks). This zone covers a similar elevation range as the MH zone, but because it is located further inland, the climate is drier and more continental. The ESSF zone is characterized by long cold winters with a short growing season. Engelmann spruce and subalpine fir are the dominant tree species. Half of the annual precipitation (700 to 2,200 mm) falls as snow, and the climate is colder compared to the CWH and MH zones. This results in a deeper snow pack, often several metres thick. Black bear, grizzly bear, and moose are common in this zone, especially in subalpine parkland areas, and some fur-bearing species such as marten, fisher, wolverine, and red squirrel are also found here. Additionally, mountain goats and golden eagles are common to the ESSF but are typically found along south-facing terrain (Meidinger and Pojar 1991).

## 2.5 Ethnographic Background

The Archaeology Branch identified the following First Nations with an interest in the AIA study area: Tahltan Nation, Gitanyow First Nation, Gitxsan First Nation, and the Skii km Lax Ha (see Appendix F). The Project also falls within the Nass Area as defined by the *Nisga'a Final Agreement Act* (2000), where the Nisga'a Nation has treaty rights (see Appendix F).

### 2.5.1 Gitxsan

The Gitxsan, centred on the Skeena River, practiced a subsistence pattern focused on intense salmon harvesting during the summer months. Being located in a transitional area between coast and interior, Gitxsan subsistence strategies differed from more coastal groups, with an increased reliance on hunting and trapping of inland game (e.g., moose, mountain goat, marmot, grizzly bear, black bear, and beaver) and the intensive gathering of plant resources (Halpin and Seguin 1990).

Gitxsan oral history describes their origins at a village called *Temlaxam*, reportedly near the confluence of the Skeena and Bulkley rivers. The Gitxsan abandoned Temlaxam and dispersed after a series of environmental catastrophes befell the village. Early historical accounts and oral histories describe the Gitxsan as organized into seven tribes, each having a different winter village, most located along the banks of the upper Skeena River. These villages were *Gitwangak* (*Kitwanga*), *Gitanyow* (*Kitwancool*),[3] *Kitsegyukla* (*Gitksigyukla*), *Gitanmaax* (Hazleton), *Kispiox*, *Kuldo*, and *Kisgaga'as*.

Additional information can be found in the following sources: Adams (1973), Barbeau (1929, 1950a, 1950b), Benyon (2000), Berthiaume (1999), Daly (2005), Drucker (1965), Duff (1964), Garfield (1931, 1939), Gitxsan Chief's Office (2012), Halpin (1973), Halpin and Seguin (1990), Inglis et al. (1990), MacDonald and Cove (1987), Miller (1997), Miller and Eastman (1984), People of 'Ksan (1980), Seguin (1984, 1985), Shortridge (1919), and Sterritt et al. (1998).

### 2.5.2 Ski km Lax Ha

The *Xskiigmlaxha* (Ski km Lax Ha) are described in many historic and ethnographic accounts as a northern house of the Gitxsan (Sterritt et al. 1998). These accounts suggest that Wilp Ski km Lax Ha belongs to the *Lax Ganeda* (Frog Clan), whose descendants trace their lineage to the village of *Ts'imanluuskeexs* near Bowser Lake and later the village of Kuldo (Sterritt et al. 1998). However, the Skii km Lax Ha Nation claim a Tset'saut ancestry (described below), and consider themselves as a vestige of the Tsetsaut Raven clan (Rescan 2009).

### 2.5.3 Nisga'a

The Nisga'a traditionally inhabited the Nass River watershed (Marsden et al. 2002). The annual eulachon fishery on the Nass River allow the Nisga'a to produce eulachon oil, a highly-valued trade item that in historic times was moved inland along "grease trails" and exchanged with interior peoples. In historical times, Nisga'a villages consisted of rows of small longhouses situated along the Nass River. Today, there are four main Nisga'a villages: *Gingolx* (Kincolith), *Laxgaltsap* (Greenville), *Gitwinksihlkw* (Canyon City), and New Aiyansh.

Additional information can be found in the following sources: Barbeau (1950a, 1950b), Drucker (1965), Duff (1964), Garfield (1931, 1939), Halpin (1973), Halpin and Seguin (1990), Inglis et al. (1990), MacDonald and Cove (1987), McNeary (1976), Miller (1997), Miller and Eastman (1984), Sapir (1915, 1920), Seguin (1984, 1985), and Sterritt et al. (1998).

[3] Today, the Gitanyow First Nation and Gitxsan First Nation are separate political groups.

### 2.5.4 Tahltan

In the early historical period the Tahltan, an Athapaskan speaking people, were organized as seasonally mobile bands with a seasonal round adapted to the abundant and predictable food resources the Stikine River afforded them; in particular, five species of salmon. The traditional territory of the Tahltan encompasses the upper Stikine River watershed, including the Spatsizi Plateau, the Dease Lake basin, and portions of the Tuya, Tahltan, Klappan, and Iskut watersheds (MacLachlan 1981). Many Tahltan lived along the banks of the Stikine River during the summer months, harvesting and drying the fish. Salmon cannot proceed past the Stikine Canyon upstream from Telegraph Creek, and as a result the Stikine-Tahltan river confluence was a focal point of the Tahltan seasonal round. Following a September trading visit by the Tlingit, Tahltan families would disperse to the highlands to hunt and trap a variety of game, and to gather plant resources. Winters were spent at established winter camps, usually situated within sheltered valleys (Albright 1982, 1984).

Additional information can be found in the following sources: Dawson (1887), Emmons (1911), Friesen (1985), Hodge (1912), Jenness (1927), McIlwraith (2007), Morice (1893), Teit (1906, 1912, 1956), Thompson (2007), Thorman (n.d.), and White (1913).

### 2.5.5 Tset'saut

During the early historic period an Aboriginal group known as the Tset'saut occupied portions of the Project area; however, by the early twentieth century they had suffered catastrophic population losses and by most accounts had ceased to exist as a distinct group (Duff 1981). The Tset'saut were an Athapaskan-speaking people who once occupied the area "in and around the headwaters of the Nass, Skeena, and Stikine Rivers, at Meziadin Lake, and on the Unuk River, Observatory Inlet, Portland Canal, and Behm Canal" (Sterritt et al. 1998). Alternatively, Duff (1981), describes the Tset'saut as occupying the land east of Behm Canal, the upper half of Portland Canal, and most of the Unuk River watershed, but not the Bowser and Meziadin lakes area.

The Tset'saut practiced a highly mobile subsistence strategy focused on inland game, primarily marmot (Duff 1981). Travel was on foot or snowshoe, with men often travelling alone away from the main camps to hunt and trap. The Tset'saut were reportedly attacked and exploited by their neighbours in early historic times. The demise of the Tset'saut during the 1800s also roughly coincides with the most recent eruption of the Lava Forks volcano on the Unuk River. Due to the rapid population loss during the nineteenth century, comparatively little ethnographic information was recorded about the Tset'saut. Ethnographic information on the Tset'saut can be found summarized in the following sources: Boas (1895, 1896, and 1897), Dangeli (1999), Duff (1959, 1981), Emmons (1911), Sterritt et al. (1998), and Rescan (2009).

## 2.6 Historic Background and Built Heritage

### 2.6.1 Early European Contact

Initial European exploration of British Columbia was made by Russian, Spanish, and English maritime expeditions along the west coast during the 1700s (Hayes 1999; Bown 2008). In 1799 the Russians established Novo Archangelesk near the present-day town of Sitka, Alaska.

This trading post served first as the headquarters of the Russian-American Company and later as the capital of Russian America. In 1833, Fort Dionysius was established near the mouth of the Stikine River and was a major fur trading centre providing European goods that were traded for furs and then transported inland. In 1834, the Hudson's Bay Company (HBC) established a trading post, Port Simpson (Lax Kw'alaams), north of Prince Rupert. Nearby Aboriginal people began to congregate around the fort, and the population soon numbered in the thousands (Large 1957). With Russian influence on the fur trade waning in 1840, the operation of Fort Dionysius was taken over by the HBC and renamed Fort Stikine. It was renamed Fort Wrangell following the American purchase of Alaska from Russia in 1867. In 1914, the HBC post at Port Simpson burned to the ground and, as the heyday of the fur trade had passed, the fort was not rebuilt (Meilleur 1980).

### 2.6.2 History of Mineral Exploration in the Project Area

In northwestern British Columbia, a series of gold rushes began in the mid-nineteenth century. The Cassiar Gold Rush of the 1870s led to the report of placer gold on the Unuk River, but at that time these reports did not garner much attention (Mertie 1921). Then, in the early 1880s, prospectors spent several years extracting gold from the gravels of Sulphide (Sulphurets) Creek. To access their claims, they blazed a foot trail along the north bank of the Unuk River to Burroughs Bay (Wright 1907). The 1935 *Minister of Mines Annual Report* states that a prospector named O'Hara was the first person to find placer gold in 1893. He was followed by Ketchikan-based prospectors during the 1890s, including John W. Daily (also spelled Daley, Daly), F. E. Gringras, H. W. Ketchum, Lee Brant, and C. W. Mitchell (BC 1936).

In response to the Klondike Gold Rush of 1897, a telegraph line from Ashcroft, British Columbia, to the gold fields of the Yukon was constructed by the Dominion Government, partially following the route of the incomplete Collins Telegraph Line, abandoned during the 1860s. The Dominion Yukon Telegraph Line was completed in 1901 and remained in operation until the 1930s (Newman 1995; Miller 2004). For additional information on the Dominion Yukon Telegraph Line, refer to Sections 2.8.

Between 1900 and 1903, the Unuk River Mining and Dredging Co. ran an extensive prospecting and placer mining operation at two claims located on Sulphurets Creek and on the south fork of the Unuk River. Developments on these properties included a stamping mill, the excavation of tunnels, a camp on Unuk River near the British Columbia-Alaska border, and 35 miles of trail cut and 30 tonnes of ore prepared for shipment (BC 1902, 1904, 1936). Additional work in the Unuk and Sulphurets valleys during this period included prospecting and claim staking; excavation of additional tunnels and open cuts; and the construction of cabins, blacksmith shops, and ore bins on the properties. H. W. Ketchum, who had been prospecting the Unuk River annually since the 1890s, also cut a number of trails. Early reports on the resource potential of the Unuk watershed were generally favourable, although the high water levels, typical of the glacially fed streams, were reported to be an impediment to summer prospecting (BC 1904). A further impediment that would delay the establishment of large-scale operations in the area was the difficulty of transportation into the region. An attempt by John W. Daily to establish a wagon road that generally followed the route of an old foot trail blazed by prospectors in the 1880s was never finished: it ended several kilometres northeast of the international border and skipped two difficult sections where sheer bluffs abut the Unuk River (BC 1904, 1920, 1921, 1936). Attempts to import additional machinery to the Globe and Cumberland claims along this trail apparently met with failure, as later reports describe that pieces of equipment were found abandoned along the road and left to rust (BC 1936).

During the period between 1904 and 1928 only limited prospecting was done in the Unuk River region; however, there is some indication that prospectors continued to access the Unuk to run traplines (BC 1921). Although dredging leases had been secured for large areas of the Unuk and Sulphurets rivers, there is no indication that these were being worked during this time (BC 1912). The rough terrain and the "transportation problem" (BC 1904) up the Unuk was repeatedly identified as the primary impediment (BC 1906, 1918, 1926).

A regional survey in 1920 by the British Columbia Department of Mines scouted potential access routes and determined that a road south to Portland Canal would be impossible to build due to continuous glaciers and, although other passes into the Bell-Irving and Iskut River valleys from the Unuk River valley were widely known, repairing and completing the wagon road up the Unuk River was determined to be the only feasible option, (BC 1921). Despite the favourable geology, abundant fast flowing water for running machinery, and good spruce and hemlock timber, the road never materialized.

In the fall of 1928, claims were staked along the north side of Treaty Creek (formerly 20 Mile Creek), east of the Unuk River. The claims were accessed from the south via trails from Meziadin Lake and the Nass River Valley. However, as the assay results proved to be low grade ore, the claims were subsequently abandoned (BC 1930, 1931).

Beginning in 1929, renewed interest in the mineral potential of the Unuk River watershed resulted in an influx of Ketchikan- and Stewart-based prospectors, including Tom McQuillan, T. Terwilligen, Arthur Skelhorne, and the brothers Bruce and Jack Johnston. By 1932, the old wagon road was brushed out and cable crossings were built to facilitate access (BC 1933). The prospectors staged their work from Ketchikan, travelling by boat to Harvey Matney's ranch at the head of Burroughs Bay (Matney Ranch). There they hired flat-bottomed river boats to travel up the navigable portion of lower Unuk River. Beyond that point, a series of trails and cable crossings were used to access the claims further up the Unuk River (BC 1936).

In 1932, the Mackay Syndicate, based out of the Premier Mine to the south of the Project area, successfully landed a plane on Tom Mackay Lake, near their mineral claims in the region (BC 1935, 1936). An assay outfit was flown in, and they began an exploration program that included excavation of open cuts and prospecting with encouraging results (BC 1936). However, for reasons that are not described in the Minister of Mines annual reports, possibly the onset of World War II, prospecting in the region came to a halt in 1940 (BC 1941, 1942).

### 2.6.3 Recent History

The Stewart-Cassiar Highway (Highway 37), which runs east of the Project area, was built during the 1960s and 70s. The Bell II Crossing gas station and store, located near the second highway crossing of the Bell-Irving River, was established in 1979. Later additions have included a lodge and restaurant (Bell 2 Lodge 2009).

The first parks in the region were established in the 1970s, including Misty Fjords National Monument, southwest of the Project area in Alaska (established 1978), and the Ningunsaw Ecological Reserve in British Columbia (established 1975). In 2001, Ningunsaw Provincial Park, adjacent to the Ningunsaw Ecological Reserve and Border Lake Provincial Park along the Unuk River at the British Columbia-Alaska border, was established according to the Cassiar-Iskut-Stikine Land and Resource Management Plan (BC Parks 2009).

## 2.7 Palaeontology

Geologic mapping of the Project area at a scale of 1:100,000 was undertaken by Alldrick et al. (2006). Dominantly marine, deltaic metasediments, and sub-marine metavolcanics of the Triassic to Jurassic age occur in the Project area. Alldrick et al.'s map outlines the boundaries of the Bowser Lake Group (Middle to Upper Jurassic), Hazelton Group (Lower to Middle Jurassic), and the Upper Triassic Stuhini Group. The map indicates localities where micro fossils and macro fossils have been observed in sediments of the Bowser Lake Group in the region.

All fossil locations recorded by Alldrick are at least 10 km from the proposed Project footprint. Since 2004, specific helicopter-supported paleontological field trips targeting potential fossils in the Bowser and Sustut basins were undertaken jointly by the Geological Survey of Canada, the Geological Branch of the British Columbia Ministry of Energy, Mines and Petroleum Resources, the Royal British Columbia Museum, and Simon Fraser University. Numerous significant fossil finds—such as dinosaur foot prints, turtle shells, and fern and ginko leaves—were made in sediments of the Bowser Basin (Evenchick et al. 2005). No significant fossils have been identified within the Project area.

While the depositional environment of Mesozoic rocks in the Project area had the potential for preserving fossils, at least three tectonic events reworked the sediments. The structural phases were expressed by folding, faulting, and thrusting affecting all formations of pre-Quaternary age. These geological events suggest that it is unlikely that undisturbed macro fossils of significant size will be located within the Project footprint (G. Jacob, pers. comm.).

## 2.8 Previous Archaeological Research

Previous archaeological investigations in northwestern British Columbia have been undertaken for mining, forestry, hydroelectric projects, and other developments. Several large-scale research projects have also been conducted along major rivers (Stikine, Tahltan, Iskut, Nass, and Klappan) and within Mount Edziza Provincial Park. As a result, hundreds of archaeological sites have been recorded in the region; however, prior to the AIAs conducted for this Project, very little archaeological investigation had been conducted in the archaeological study area.

Between 2008 and 2011, an AIA was undertaken for the Project, conducted under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). During the assessment, 20 archaeological sites were recorded in relation to the Project footprint as previously proposed, including proposed access roads, mine pits, mine site facilities, tailings management facilities, construction camps, and fisheries compensation areas (see Section 5.2).

Other previous archaeological investigations most relevant to the Project include an assessment of the Sulphurets Property Access Roads Development (Bussey 1987a, 1987b), the assessment of the Eskay Creek Mine Project (Rousseau 1990), and the Iskut Mine Access Road Development (Brolly 1990).

Studies which have helped to inform and describe the archaeological environment in the broader region include Albright (1980, 1982, 1983, 1984); Apland (1980); Balcom (1986); Bussey (1985); Engisch and Bible (2009); Engisch et al. (2008); Engisch et al. (2011); Fladmark (1984, 1985); French (1980); Friesen (1983, 1985); Hall and Prager (2004, 2006); Ham (1987, 1988); Hrychuk et al. (2008); Jackman and Craig (2011); Magne (1982); Marshall, Marr, and Palmer (2008); Marshall and Palmer (2010); Pegg and Dodd (2007); Seip, Farquharson, and McKnight (2009); Seip and McKnight (2009); Seip, Farquharson, et al. (2012); Seip, McKnight, et al. (2011); Seip, Walker, et al. (2012); Walker and McKnight (2011); Warner and Magne (1983); Wilson (1984); and Wilson et al. (1982). Additional unpublished archaeological work near the study area has been conducted under permits 2006-0223, 2007-0163, 2007-0200, and 2007-0258. Data on the Remote Access to Archaeological Data (RAAD) online application and other publically available information on these projects were reviewed when practicable.

See Section 5.2 for previously recorded archaeological sites within the AIA study area.

## 2.9 Designated Heritage Sites

The Regional District of Kitimat-Stikine's Community Heritage Register was reviewed to identify any designated heritage sites in within the AIA study area. Two designated heritage sites, the Yukon Telegraph Line and the Simon Gunanoot Gravesite on Bowser Lake, are in the AIA study area.

The Yukon Telegraph Trail extended through British Columbia from Ashcroft to Atlin. The portion of the trail which passes through the Regional District of Kitimat-Stikine is approximately 500 km long, extending from Moricetown to Telegraph Creek. The trail, which is overgrown in places, contains the remains of telegraph wire, line maintenance cabins, and other historic artifacts (Regional District of Kitimat-Stikine 2010). The portion of the line which is of interest for this study ran along the northern side of the Bell-Irving River valley from Rochester Creek to Snowbank Creek where it turned north towards Echo Lake (see Section 2.6.2 for more information). In addition, two telegraph cabin sites have been designated as archaeological sites: HeTk-3 and HeTl-2 (see Section 5.2 for more information).

The Simon Gunanoot Gravesite is a remote site located on Graveyard Point on the eastern shore of Bowser Lake. The site includes weathered wooden remains of a memorial structure and a cache. The site is historically significant as it is the place where Simon Gunanoot was buried upon his death in 1933 (Regional District of Kitimat-Stikine 2011). The site has also been designated as archaeological site HcTj-1 (see Section 5.2 for more information).

Neither the Simon Gunanoot Gravesite (HcTj-1) nor the Yukon Telegraph Trail is located near the Project footprint, and these sites are not at risk of impact.

# 3. Methodology

This AIA was conducted in accordance with *HCA* Heritage Inspection Permit 2012-0192, issued by the Archaeology Branch, and the *British Columbia Archaeological Impact Assessment Guidelines* (Archaeology Branch 1998).

## 3.1 Background Research

Prior to conducting field assessments, background information was first reviewed for the study area and surrounding region. This particular avenue of investigation focused on examining documentary data including ethnographic, historic, and archaeological studies, reports, and records. Environmental baseline studies conducted for the Project by Rescan, including the *2009 Vegetation and Ecosystems Mapping Baseline* Study (Rescan 2010a), *2009 Wildlife Characterization Baseline Study* (Rescan 2010b), *2009 Soils and Terrain Baseline Study* (Rescan 2010c), and *2011 Fish and Fish Habitat Baseline Report* (Rescan 2012a), were also reviewed. In addition, Appendices F and L of the Nisga'a Final Agreement (1999) were reviewed as part of the AIA.

## 3.2 Assessment of Archaeological Site Potential

Terrestrial landforms and features, as well as accessibility to potential resources that may have been conducive for human habitation, were considered when determining archaeological site potential. Specific factors included proximity to existing water sources or relic water courses, slope and aspect, food resource values (i.e., ungulate ranges, fish, berries), forest cover, local and traditional knowledge (when available), proximity to previously recorded archaeological or traditional land use sites, the possible use of an area as a travel corridor, the presence of ice patches, and the presence of microenvironmental features that are often associated with archaeological sites (such as terraces, hillocks/knolls, and breaks-in-slope). Factors thought to constrain archaeological potential include unbroken slope, steep or rough terrain, poorly drained ground, and massive disturbance areas, such as avalanche chutes.

Special attention was paid to examining high altitude areas (especially along glacial margins, snow and ice patches, and within passes) for surficial finds.

A GIS-based model of archaeological potential in the upper Bell-Irving Watershed (Pegg and Dodd 2007) covers a portion of the Project area. This model was reviewed and informed the assessment of archaeological potential for the Project; however, the model was not relied upon exclusively, and the archaeological potential of the Project was determined using the methodology described above.

## 3.3 Field Methods

Field methods employed during this AIA were consistent with those outlined in the permit application for *HCA* Heritage Inspection Permit 2012-0192. Assessments of the proposed development areas carried out under this permit took place during the 2012 field season and included pedestrian surveys and subsurface shovel testing as a means of identifying archaeological sites.

Pedestrian archaeological surveys focused primarily on the areas within the proposed development that were identified as having moderate or higher potential for the presence of archaeological resources. Examination consisted of a combination of systematic and judgementally selected pedestrian survey traverses. Crew spacing during the pedestrian survey was determined based on terrain and visibility constraints, as well as the assessed archaeological potential of the area being examined, with crew spacing being generally 5 to 20 m apart. When considered appropriate, additional survey routes followed spatially restricted topographic features.

Ground surfaces were examined for trails, structures, artifacts, depressions, and other evidence of past human settlement and land use. Tree throws and snow/ice patches were also visually examined for such evidence. Standing trees, fallen logs, and stumps were examined for cultural modification. Bedrock exposures and boulders were inspected for pictographs and petroglyphs, as well as for the possible presence of seams of flakable lithic raw materials. Talus slopes, caves, or rock crevices encountered during surveys were also examined for the possible presence of burials or other cultural materials.

Previous work in the area suggests that the majority of the sites present in the area are small lithic scatters. Therefore, the subsurface testing strategy was created to identify sites consisting of as little as four artifacts per m in a 100 $m^2$ site. Subsurface testing (shovel testing) took place in areas identified during the field assessment as having potential for buried archaeological material. Such areas included remnant river terraces, prominent knolls, and areas near trails and/or along the banks of streams. Shovel testing was also conducted to determine the vertical and horizontal extent of any identified archaeological deposits, and to identify the nature, composition, and integrity of subsurface deposits.

The number and location of shovel tests was judgementally determined on a case-by-case basis, dependent on ground cover, terrain, density of bush/forest, and development boundaries. For landforms with moderate and high potential for buried archaeological remains, sufficient shovel testing was conducted to achieve a test density that met or exceeded four tests per 100 $m^2$, with tests generally spaced approximately 5 m apart, where practicable. Areas of low potential were judgementally and/or randomly tested at a lower density. Each shovel test location was evaluated, taking into account the expected site type (target site area and artifact density) and the test location information (tested area, test size, and number of tests). This information was used to determine the level of confidence in locating a potential site in the test area.

Shovel tests were at least 35 cm by 35 cm in size and penetrated both A and B soil horizons, and depending on the nature of the sediment accumulation continued until unweathered C horizon sediments or bedrock was encountered. Back dirt from tests was examined manually or screened through 6 mm mesh.

Site boundaries were defined on the basis of natural, observed, and/or arbitrary limits:

- Natural boundaries were those defined by the extent of associated landforms (e.g., terrace or ridge) or a limited natural feature (e.g., stream), as appropriate.
- Observed boundaries were those determined on the basis of the extent of archaeological materials or features, as observed in surface exposures, or through subsurface testing. If subsurface testing was used to determine site boundaries, shovel testing was conducted in cardinal directions emanating from the initial positive shovel test at 3 m to 5 m intervals until at least two negative shovel tests were completed. If necessary, additional shovel tests (meeting four tests per 100 $m^2$ standard) were conducted to establish complete coverage of the landform and/or the area on which the site is situated. The extent of associated landforms and areas of archaeological potential, as well as the distribution of identified archaeological materials, shall be explicitly considered in defining sites containing discontinuous buried archaeological deposits. This may also include the extent of observed archaeological potential as assessed in the field.
- Arbitrary boundaries were those which reflect artificial and/or administrative boundaries, such as property lines, cutblock boundaries, drill pad site boundaries, or the presence of existing impacts or developments.

Both positive and negative shovel tests were sequentially numbered and the location of each shovel test was plotted on a site map. Each test location was described in terms of its area, terrain, and defining soil characteristics. Artifacts and any other cultural materials encountered in shovel tests were collected. Artifacts identified on the surface during pedestrian surveys were also recorded, photographed, and collected. In cases of extensive surface lithic scatters, only diagnostic artifacts and formed tools were collected and recorded in reference to a local datum.

All identified archaeological sites were recorded in field notes, photographed, and mapped by hip chain and compass (or equivalent method). UTM coordinates were also taken by GPS at the site. The locations of all sites have been plotted onto the development plan and National Topographic System (NTS) maps. All archaeological sites were recorded on British Columbia Archaeological Site Inventory Forms to be entered into the Provincial Heritage Register Database. No human remains or culturally modified trees (CMTs) that pre-date 1846 AD were recorded during the surveys conducted.

## 3.4 Significance Evaluation

The significance of sites recorded under this permit was determined using the criteria for site evaluation found in the *British Columbia Archaeological Impact Assessment Guidelines, Appendix D* (Archaeology Branch 1998). The scientific, public, ethnic, economic, and historic (if applicable) significance of each identified site was addressed when possible. As no previously unrecorded CMTs were located, no CMT evaluations were required for this project.

## 3.5 Data Analysis Methods and Techniques

All collected artifacts have been catalogued, described, and compared to existing regional typologies. Any formed tools encountered were described, documenting shape, raw material, and manufacturing attributes. Appropriate metric attributes of artifacts were also recorded when warranted. Lithic debitage was quantified and classified according to raw material and stage of manufacture. No faunal materials were identified.

## 3.6 Curation

As per *HCA* Heritage Inspection Permit 2012-0192, subsequent to the completion of the final permit report, artifacts collected during this AIA and a copy of the final report will be sent to the Royal British Columbia Museum in Victoria, British Columbia.

# 4. Results

The majority of the Project footprint was assessed and reported under *HCA* Heritage Inspection Permit 2008-0128, and details pertaining to those assessments can be found in Seip et al. 2012. This section presents the results of the AIA conducted under *HCA* Heritage Inspection Permit 2012-0192 and provides general descriptions of the environment associated with the new and revised elements of the Project footprint not previously assessed (Figure 1.3-1). For reporting purposes, this results section is divided into the following subsections: Treaty Creek Transmission Line and Switching Station, Roadside Development Areas (borrow areas, waste areas, log landings), Construction and Permanent camps, Treaty OPC, East Catchment Diversion Tunnel Portal Access Road, Mine Area Water Treatment and Energy Recovery Facility, Borrow Pit and Till Stockpile near Sulphurets-Ted Morris Creek, and the Snow and Ice Patch Survey.

During this AIA, a total of 2,037 shovel tests were conducted at 122 locations. Assessment area photographs are provided in Appendix A, a table containing details on shovel test locations can be found in Appendix B, and detailed maps of the survey and shovel test locations can be found in Appendix C. Project-related acronyms used in this section are defined in the Glossary and Abbreviations section.

The Project area is characterized by steep topography with loose talus resulting from rockslides and slumps. Large portions of the Project are located on steep slopes. Slope class mapping generated from Light Detection and Ranging (LiDAR) and TRIM data was reviewed for the Project area to assist in the assessment of archaeological potential. The study area has been divided into six slope classes. Slope Class 4 (moderately sloping) is the most common slope class, representing 35% of the study area. Classes 5 and 6, described as moderately steep and steep slope classes, respectively, represent approximately 26 and 17% of the study area, respectively. These three slope classes make up about 78% of the study area. Approximately 45% of the slopes in the study area are greater than 50%. Only a small portion of the study area (approximately 1%), is classified as level to very gentle slope (Class 1; Rescan 2010c). In addition, baseline data for other sciences such as fisheries, wildlife, and vegetation, as well as land use and social data, were also reviewed for the Project area (Rescan 2010a, 2010b, 2010c, 2012a, 2012b, 2012c).

## 4.1 Treaty Creek Transmission Line and Switching Station

Portions of the Treaty Creek Transmission Line and the associated Treaty Creek Switching Station, which would tie into the Northwest Transmission Line currently under construction, were assessed under *HCA* Heritage Inspection Permit 2012-0192. The results of these assessments are described below.

### 4.1.1 Treaty Creek Transmission Line

The Treaty Creek Transmission Line alignment, which is 30.03 km long, runs south from the proposed Treaty Creek Switching Station on the eastern side of the Bell Irving River, turns southwest and runs through the Treaty Creek valley before turning north where is passes along the western side of the TMF valley before terminating at the Treaty OPC. The Treaty Creek

Transmission Line will parallel the Treaty Creek Access Road for the majority of its route. Realigned portions of the proposed alignment were subject to assessment during the 2012 field season under *HCA* Heritage Inspection Permit 2012-0192 focussing on areas with low to moderate slope. In areas subject to assessment, an approximately 50 m wide corridor was pedestrian surveyed. For ease of reporting, the alignment has been divided into two sections: Treaty Creek Switching Station to North Treaty Creek (Section 4.1.1.1), and North Treaty Creek to the Treaty OPC (Section 4.1.1.2).

#### 4.1.1.1 Transmission Line: Switching Station to North Treaty Creek

This segment of the transmission line runs south above and to the east of the Bell-Irving River and Highway 37, crosses the highway, turns southwest and then runs west along the northern side of the Treaty Creek valley before it crosses North Treaty Creek and turns north (Figures C-4, C-5, and C-6 in Appendix C). The terrain through this segment of transmission line is variable, with the alignment passing through a series of sloped to hummocky cutblocks on either side of the Bell-Irving River (Plates A.1.-1 and A.1-2), steeply sloped terrain along much of the northern side of Treaty Creek (Plate A.1-3), and a large, prominent ridge north of the Treaty Creek confluence with Todedada Creek (Plate A.1-4). Vegetation varies with a relatively young primary and secondary growth forest of alder, poplar, spruce, fir, and hemlock in cutblocks, slide alder and devil's club on steep side slopes, and a mature hemlock and fir forest with a blueberry and moss understory along the prominent ridge feature.

Much of this segment of transmission line closely parallels the Treaty Creek Access Road (TCAR) which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). With the exception of the previously assessed areas, the assessment conducted within this segment of transmission line during the 2012 field season focused on areas of low to moderate slope which were considered to have archaeological potential. These areas were subject to systematic pedestrian survey and shovel testing was conducted in areas of archaeological potential (Appendix B-3 and B-4 and Figures C-4, C-5, and C-6 in Appendix C). One archaeological site, HdTk-4, was recorded along a large, prominent ridge north of the confluence of Treaty and Todedada creeks (Map C-5 in Appendix C; see Section 5.1 for additional information). Shovel testing was also conducted within the cutblocks on either side of the Bell-Irving River which indicated that no intact soil deposits were present due to extensive ground disturbance.

#### 4.1.1.2 Transmission Line: North Treaty Creek to Treaty Ore Preparation Complex

This segment of the transmission line runs north from Treaty Creek and along the western side of the North Treaty Creek valley until it terminates at the Treaty OPC (Figures C-1, C-3, and C-4 in Appendix C). The terrain through this segment of transmission line is variable, with the alignment passing through steeply sloped terrain along much of the western side of the North Treaty Creek valley and TMF area (Plate A.1-5) before it levels out on a subalpine bench with numerous bedrock ridges which trend northwest-southeast with marshes and small ponds between the ridges and minor drainages passing through the area (Plate A.1-6). Vegetation throughout the steeply sloped areas consists of a mature forest of hemlock and fir with a dense understory of devil's club and slide alder while the vegetation on the subalpine bench consists of patches of fir and hemlock, with willow and alder in marshier areas, and an understory of blueberry and moss.

Much of this segment of transmission line closely parallels the Treaty Creek Spur Road, a branch of the TCAR. The assessment conducted within this segment of transmission line during the 2012 field season was conducted in conjunction with the assessment of portions of the access road which focused on areas which had low to moderate slope which were considered to have archaeological potential (see Section 4.2). These areas were subject to systematic pedestrian survey and shovel testing was conducted in areas of archaeological potential on a narrow bench above North Treaty Creek (Appendix B-3 and B-4 and Figures C-1, C-3, and C-4 in Appendix C). No archaeological materials were identified. The portion of transmission line which passes through the Treaty OPC was largely previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and a small portion was assessed during the 2012 assessment of the Treaty OPC (see Section 4.4). No archaeological materials were identified.

### 4.1.2 Treaty Creek Switching Station

Two different footprints for the Treaty Creek Switching Station were assessed during the course of the 2012 field season under *HCA* Heritage Inspection Permit 2012-0192.

The currently proposed footprint for the Treaty Creek Switching Station is located east of the Bell-Irving River and Highway 37 and north of Skowill Creek, totalling 6.00 hectares (Plate A.1-1 in Appendix A; Figure C-6 in Appendix C). The substation is located in a large cutblock which has been extensively impacted by logging. The terrain throughout the footprint is variably sloped with some areas of breaks-in-slope, some small ponds and marshes, and numerous relict logging roads which are now overgrown. Vegetation consists of a relatively young primary and secondary growth forest of alder, poplar, spruce, fir, and hemlock with an understory of fireweed, thimbleberry, and moss. The area was assessed by systematic pedestrian survey and shovel testing (Appendix B-3 and B-4 and Figure C-6 in Appendix C). Shovel testing indicated that no intact soil deposits were present due to extensive ground disturbance. No archaeological materials were identified.

A second switching station footprint was also assessed but is no longer under consideration. It was located southeast of the current substation footprint, east of the Bell-Irving River and Highway 37, south of Skowill Creek and north of Glacier Creek (Plate A1.1-2 in Appendix A; Figure C-6 in Appendix C). The substation was located in a large cutblock which had been extensively impacted by logging. The terrain was variably sloped with some areas of breaks-in-slope, small ponds, some ridged areas, and numerous overgrown logging roads. Vegetation consisted of a relatively young forest of alder, poplar, fir, spruce, and hemlock with an understory of fireweed, thimbleberry, and moss. The area was assessed by systematic pedestrian survey (Figure C-6 in Appendix C). No archaeological materials were identified.

## 4.2 Roadside Development Areas

The proposed Coulter Creek and Treaty Creek access roads were previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). In 2012, 290 new roadside development areas (borrow areas, waste areas and log landings) totalling 164.38 hectares were added to the Project footprint alongside the assessed road corridors. These new areas were assessed under *HCA* Heritage Inspection Permit 2012-0192.

Because large portions of both the Coulter Creek and Treaty Creek access roads pass through steep terrain and along steep-sided valleys, slope class was used as the primary assessment tool to identify roadside development areas having archaeological potential. Roadside developments which contained a slope of less than 26 % were generally considered to have some archaeological potential and were the focus of the field assessment. Roadside developments which contained a slope of greater than 26 % were generally considered to have lower archaeological potential. However, other factors that influence archaeological potential were also considered (see Section 3.2), and the potential of all 290 roadside development areas were assessed in field. The results of the assessment are described below.

### 4.2.1 Coulter Creek Access Road – Roadside Development Areas

The proposed Coulter Creek Access Road (CCAR) was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 and details pertaining to the assessment of the road alignment can be found in Seip et al. 2012. However, a brief description of the terrain through which the CCAR passes is provided here to set the context for the roadside development areas. The CCAR alignment, which is approximately 35 km long, begins at the existing Eskay Mine Access Road, travels south down the Coulter Creek valley, crosses the Unuk River and then travels east along the northern side of Sulphurets Creek to Mitchell Creek where it terminates at the Mine Site (Figures C-7 to C-11 in Appendix C). From the Eskay Mine Access Road the CCAR travels past Tom Mackay Lake through a high hummocky subalpine plateau with long northeast-southwest trending exposed bedrock ridges with vegetation of fir and hemlock and an understory of mountain heather. From the plateau, the terrain begins its descent to the Unuk River, with the alignment passing through the Coulter Creek drainage which is rolling and sloped with areas of dense hemlock and fir and an understory of blueberry, devil's club, and skunk cabbage. The terrain east of the Unuk River, along the Sulphurets Creek valley, is steep with few areas of breaks-in-slope and a dense forest of hemlock with an understory of blueberry, devil's club, and slide alder.

A total of 141 potential borrow, waste, and log landing areas were identified along the CCAR. Due to the uneven and often steep terrain through which the road alignment passes, many of these roadside development areas were considered to have generally low archaeological potential. Slope class, as noted above, was used as a tool to identify roadside development areas which may contain areas level enough to contain archaeological potential. Appendix B-1 summarizes the roadside development areas along the CCAR as well as their general location, size, associated slope class, terrain, and assessment results. Appendices B-3 and B-4 summarize shovel test locations and soil stratigraphy. Plates A.2-1 through A.2-9 illustrate the representative terrain found at these roadside development areas. One archaeological site, HdTo-7 was identified northwest of Log Landing 500 within the CCAR right-of-way (see Section 5.1 for more information). In addition, two historic features were identified: trap-trees within Waste Area 440. These historic features are not protected by the *HCA* and will not be discussed further.

### 4.2.2 Treaty Creek Access Road – Roadside Development Areas

The proposed TCAR was previously assessed under *HCA* Heritage Inspection Permit 2008-0128, and details pertaining to the assessment of the road alignment can be found in Seip et al. 2012. However, a brief description of the terrain through which the TCAR passes is provided here to set the context for the roadside development areas. The TCAR alignment begins at Highway 37, just south of Glacier Creek, and travels west along the northern side of the Treaty Creek valley for approximately 33 km, to the end of the valley (Figures C-2 to C-6 in Appendix C). The Treaty Creek Spur Road, which is approximately 12 km long, runs from near the confluence of Treaty and North Treaty creeks, turning north and then northwest from the main TCAR, and travelling along the western side of the North Treaty Creek valley, above the TMF until its terminus at the Treaty OPC (Figures C-2 to C-6 in Appendix C). Terrain near the Bell-Irving River consists of hummocky, poorly drained cutblocks. As the alignment travels west, the valley becomes narrower and steeper, eventually ending in a recently deglaciated area of exposed bedrock and scree slopes.

A total of 149 borrow, waste, and log landing areas were identified along the TCAR. Due to the uneven and often steep terrain through which the road alignment passes, many of these roadside development areas were considered to have generally low archaeological potential. Slope class, as noted above, was used as a tool to identify roadside development areas which may contain areas level enough to contain archaeological potential. Appendix B-2 summarizes the roadside development areas along the TCAR as well as their general location, size, associated slope class, terrain, and assessment results. Appendices B-3 and B-4 summarize shovel test locations and soil stratigraphy. Plates A.2-10 through A.2-15 illustrate the representative terrain found at these roadside development areas. No archaeological materials were identified.

## 4.3 Construction and Permanent Camps

Fourteen construction and/or permanent camp locations and associated infrastructure currently under consideration for the Project were assessed, totalling approximately 79 hectares. The results of these assessments are described below.

It should be noted that the currently proposed camp locations differ from the previously assessed camp locations reported under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012); however, some have the same numerical designation and/or general location. The currently proposed camp locations were reviewed during this assessment to determine if additional fieldwork was required. In several instances, footprint revisions were minor and fell within previously assessed areas.

### 4.3.1 Camp 1: Granduc Staging Camp

Proposed Camp 1: Granduc Staging Camp is located to the east of the Bowser River, northwest of the Granduc Mine and the receding toe of the Berendon Glacier, and north of Summit Lake (Plate A.3-1 in Appendix A; Figure C-12 in Appendix C). The camp and associated helicopter pad, approximately 5.5 hectares in size, are situated within the Tide Lake Flats, the bed of a former proglacial lake which was originally dammed by the Frank Mackie Glacier (Clague and Mathews 1992). The terrain is a level plain of extinct lake floor with sedimentary deposits and little to no soil development. Vegetation consists of dense alder with some fir. The area was considered to have low archaeological potential, given that the lake was emptied around 1930 AD when its glacial dam was breached (Clague and Mathews 1992). The camp area and associated helicopter pad were subject to systematic pedestrian survey to confirm the assessment and no suitable areas were identified for shovel testing. No archaeological materials were identified.

### 4.3.2 Camp 2: Ted Morris Camp

Proposed Camp 2: Ted Morris Camp is located to the south of Sulphurets Creek, east of Ted Morris Creek and west of the existing KSM Exploration Camp (Figure C-11 in Appendix C). The camp area and associated helicopter pad, approximately 4.0 hectares in size, are located in an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and no further work was required for this camp location.

### 4.3.3 Camp 3: Eskay Staging Camp

Proposed Camp 3: Eskay Staging Camp is located to the west of the Eskay Creek Road and northeast of Tom Mackay Lake and is approximately 3.0 hectares in size (Plate A.3-2 in Appendix A; Figure C-7 in Appendix C). Terrain in the area consists of a series of long northeast-southwest trending subalpine ridges which run through this area with small marshy and seasonally wet areas between them. Vegetation along the ridges consists of subalpine fir, hemlock, juniper, heather, and grasses with willow and sedges found in the marshy areas. The camp and associated helicopter pad are situated in a low area between ridges and north of a small pond. The northern end of the helicopter pad has been previously impacted during the construction of a road, associated with the Eskay Creek Mine, which was used to transport tailings to Tom Mackay Lake during the mines operation. The camp area and associated helicopter pad were subject to systematic pedestrian survey and shovel testing (Appendix B-3 and B-4 and Figure C-7 in Appendix C). No archaeological materials were identified.

### 4.3.4 Camp 4: Mitchell North Camp

Proposed Camp 4: Mitchell North Camp is located above and north of Mitchell Creek and to the east of its confluence with McTagg Creek, and is approximately 5.0 hectares in size (Plate A.3-3 in Appendix A; Figure C-10 in Appendix C). The terrain is variably sloped and undulating with some areas which are seasonally wet and marshy. Vegetation consists of a moderately dense overstory of mature hemlock and some fir with a dense understory of devil’s club, blueberry, and moss. The camp area and associated helicopter pad were assessed by systematic pedestrian survey. No suitable areas for shovel testing were identified. A portion of the helicopter pad footprint was also previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). No archaeological materials were identified.

### 4.3.5 Camp 5: Treaty Plant Camp

Proposed Camp 5: Treaty Plant Camp is located above and to the west of South Teigen Creek, and is approximately 4.0 hectares in size (Figure C-1 in Appendix C). Terrain in the area consists of a series of long northwest-southeast trending subalpine ridges which run through this area. Between these ridges, the terrain is sloped and consists of poorly drained marshes and seasonally wet areas. Vegetation along the ridges consists of subalpine fir, hemlock, juniper, heather, and grasses with willow and sedges found in the marshy areas. The camp and helicopter pad footprint is located in an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). No archaeological materials were identified.

### 4.3.6 Camp 6: Treaty Saddle Camp

Proposed Camp 6: Treaty Saddle Camp is located above and north of Treaty Creek and east of the glacier at the end of the valley, and is approximately 5.5 hectares in size (Figure C-2 in Appendix C). Terrain in the area is rugged and rocky with very little soil formation due to recent glacial retreat. Vegetation consists of slide alder with some isolated stands of subalpine fir between large expanses of exposed bedrock. The camp area and associated helicopter pad are located in an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and no further work was required for this camp location.

### 4.3.7 Camp 7: Unuk North Camp

Proposed Camp 7: Unuk North Camp is located west of the Unuk River and north of its confluence with Sulphurets Creek, and is approximately 6.5 hectares in size (Plate A.3-4 in Appendix A; Figure C-8 in Appendix C). The terrain is rugged and consists of a series of long steep-sided northwest-southeast trending ridges between which are poorly drained marshes. Vegetation consists of a dense overstory of hemlock and some fir with an understory of devil's club, blueberry, and moss with skunk cabbage in marshy areas. The camp area and associated helicopter pads were subject to systematic pedestrian survey and shovel testing was conducted on ridge tops with archaeological potential (Appendix B-3 and B-4 and Figure C-8 in Appendix C). No archaeological materials were identified.

### 4.3.8 Camp 8: Unuk South Camp

Proposed Camp 8: Unuk South Camp is located east of the Unuk River and north of its confluence with Sulphurets Creek, and is approximately 3.5 hectares in size (Figure C-8 in Appendix C). The terrain is rugged and consists of a series of long steep-sided northwest-southeast trending ridges between which are poorly drained marshes. Vegetation consists of a dense overstory of hemlock and some fir with an understory of devil's club, blueberry, and moss with skunk cabbage in marshy areas. The camp area and associated helicopter pad are located in an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and no further work was required for this camp location.

### 4.3.9 Camps 9 and 10: Mitchell Initial and Secondary Camps

Proposed Camp 9 and 10: Mitchell Initial and Secondary Camps are located above and east of Mitchell Creek and north of its confluence with Sulphurets Creek (Plate A.3-5 in Appendix A; Figure C-10 in Appendix C). These camp footprints, which are approximately 8.0 hectares in size, are divided into three sections in close proximity to each other, with Camp 9 to the north and Camp 10 to the south with a shared helicopter pad between them. The terrain is variably sloped with some areas of breaks-in-slope resulting in seasonally wet and marshy areas. Vegetation consists of a dense overstory of mature hemlock with an understory of blueberry, devil's club, and moss. The camp areas and associated helicopter pad were assessed by systematic pedestrian survey and shovel testing was conducted in areas with archaeological potential (Appendix B-3 and B-4 and Figure C-10 in Appendix C). No archaeological materials were identified.

### 4.3.10 Camp 11: Treaty Creek Marshalling Camp

Proposed Camp 11: Treaty Creek Marshalling Camp is located above and south of the Bell-Irving River, north of its confluence with Treaty Creek (Plate A.3-6 in Appendix A; Figure C-6 in Appendix C). The camp, which is approximately 19.0 hectares in size, is located in a cutblock which has been previously impacted by logging. The terrain is hummocky with some small ponds and marshes found throughout the footprint. Vegetation consists of a relatively young primary and secondary growth forest of alder, poplar, spruce, fir, and hemlock with an understory of fireweed, thimbleberry, and moss. The camp area and associated helicopter pad were assessed by systematic pedestrian survey and shovel testing was conducted (Appendix B-3 and B-4 and Figure C-6 in Appendix C). No archaeological materials were identified and it was determined that no intact soil deposits were present due to extensive ground disturbance.

### 4.3.11 Camp 12: Temporary Road Access Camp

Proposed Camp 12: Temporary Road Access Camp is located between the Bell-Irving River to the west and Highway 37 to the east and immediately south of Glacier Creek, and is approximately 9.0 hectares in size (Figure C-6 in Appendix C). The terrain is low lying, hummocky, and uneven with numerous active braided creek channels overlooked by a higher terrace that terminates in a cutbank. Vegetation consists of spruce, poplar, and cottonwood with an understory of devil's club, ferns, alder, and berry bushes. The camp area falls entirely within an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and no further work was required for this camp location.

### 4.3.12 Mitchell Operations Camp

The proposed Mitchell Operations Camp is located above and north of Sulphurets Creek and to the west of its confluence with Gringras Creek, and is approximately 4.0 hectares in size (Plate A.3-7 in Appendix A; Figure C-9 in Appendix C). The terrain is variably sloped with some areas of breaks-in-slope which are seasonally wet and marshy areas and other areas of small dry benches. Vegetation consists of a dense overstory of mature hemlock with an understory of blueberry, devil's club, and moss. The camp area and associated helicopter pad were assessed by systematic pedestrian survey and shovel testing was conducted in areas with archaeological potential (Appendix B-3 and B-4 and Figure C-9 in Appendix C). A small portion of the camp footprint was also previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012). No archaeological materials were identified.

### 4.3.13 Treaty Operating Camp

The proposed Treaty Operating Camp is located above and to the west of South Teigen Creek, immediately northwest of the proposed Camp 5, and is approximately 1.5 hectares in size (Figure C-1 in Appendix C). Terrain in the area consists of a series of long northwest-southeast trending subalpine ridges which run through this area. Between these ridges, the terrain is sloped and consists of poorly drained marshes and seasonally wet areas. Vegetation along the ridges consists of subalpine fir, hemlock, juniper, heather, and grasses with willow and sedges found in the marshy areas. The camp footprint is located in an area which was previously assessed under *HCA* Heritage Inspection Permit 2008-0128 (Seip et al. 2012) and no further work was required for this camp location.

## 4.4 Treaty Ore Preparation Complex

Much of the Treaty OPC footprint was previously assessed and reported under *HCA* Heritage Inspection Permit 2008-0128; details pertaining to those assessments can be found in Seip et al. 2012. However, revisions and additions to the infrastructure layout in this area which fall outside of the previously assessed area were subject to assessment during the 2012 field season.

The Treaty OPC, which is approximately 400 hectares in size, is located on a subalpine bench above and northwest of the TMF (Plate A.4-1 in Appendix A; Figure C-1 in Appendix C). The terrain in this area is generally level with numerous bedrock ridges trending northwest to southeast with marshes, small ponds, and minor drainages found between these ridges. Vegetation consists of patches of fir and hemlock, with willow and alder in marshier areas, and an understory of blueberry and moss. The area was assessed by systematic pedestrian survey and shovel testing was conducted in areas which had archaeological potential (Appendix B-3 and B-4 and Figure C-1 in Appendix C). No archaeological materials were identified.

## 4.5 East Catchment Diversion Tunnel Portal Access Road

Situated at the northern end of the TMF on the eastern side of the valley, a proposed short and winding access road, the East Catchment Diversion Tunnel Portal Access Road, would provide access between the Treaty OPC on the west side of the valley to a portal on the eastern side of the valley (Plates A.5-1 and A.5-2 in Appendix A; Figure C-1 in Appendix C). Terrain at the eastern end of the road is very steep. As the access road passes into the valley bottom, the terrain becomes hummocky with areas of small uneven irregular benches. Vegetation consists of a mature overstory of hemlock and some fir with an understory of blueberries moss and in some steeper areas slide alder and willow. The proposed road alignment, which is approximately 3.3 km in length, was subject to systematic pedestrian survey and shovel testing was conducted in areas considered to have archaeological potential (Appendix B-3 and B-4 and Figure C-1 in Appendix C). No archaeological materials were identified.

## 4.6 Mine Site Water Treatment and Energy Recover Facility

The Mine Site Water Treatment and Energy Recovery Facility, which is approximately 10.5 hectares in size, is located above and east of the confluence of Mitchell and Sulphurets creeks (Plate A.6-1 in Appendix A; Figure C-11 in Appendix C). The terrain in the area consists of a number of prominent, relatively level, stepped terraces moving up and away from the creek confluence and trending northwest-southeast. Vegetation consists of a mature overstory of hemlock and fir with an understory of blueberries, some devil's club, and moss. The area was subject to systematic pedestrian survey and shovel testing was conducted in areas considered to have archaeological potential (Appendix B-3 and B-4 and Figure C-11 in Appendix C). One archaeological site, HcTo-1, was identified within this development component (see Section 5.1 for more information).

## 4.7 Borrow Pit and Till Stock Pile – Sulphurets-Ted Morris Creeks Area

Situated on a terraced area immediately to the south of Sulphurets Creek and to the east of its confluence with Ted Morris Creek are a proposed borrow pit and till stock pile area, and is approximately 70.5 hectares in size (Plate A.7-1 in Appendix A; Figure C-11 in Appendix C). The terrain has a number of prominent, relatively level stepped terraces with relict stream channels which pass through the area. Vegetation consists of a mature overstory of hemlock and fir with an understory of blueberries, some devil's club, and moss. The area was subject to systematic pedestrian survey and shovel testing was conducted in areas considered to have archaeological potential (Appendix B-3 and B-4 and Figure C-11 in Appendix C). No archaeological materials were identified.

## 4.8 Snow and Ice Patch Survey

In the Yukon, Northwest Territories, and Alaska, archaeologists have had success in identifying well-preserved artifacts associated with snow and ice patches, including wooden dart and arrow shafts and hafting elements. These types of artifacts are otherwise largely absent from archaeological assemblages in the subarctic (Andrews, MacKay, and Andrew 2012; Dixon, Manley, and Lee 2005; Farnell et al. 2004; Hare et al. 2004; Hare et al. 2012; VanderHoek et al. 2012). The Tahltan Archaeological Standards (THREAT 2011) specifically describe the importance of snow and ice patch sites to them and several snow and ice patch sites have been identified in British Columbia, most notably Kwäday Dän Ts'ìnchi (Beattie et al. 2000). However, less systematic investigation focusing on these types of sites has occurred in British Columbia.

Dixon, Manley, and Lee (2005) note that "most glaciers and ice patches do not contain archaeological remains." The highest potential for sites occurs on ice or debris-covered ice within or close to caribou habitat, as "some glaciers and aniuvat are used extensively during the summer by caribou to seek relief from heat and insects. When they melt, areas used by caribou and other large mammals can take on a distinctive brown coloration as a result of fecal material aggregating on the surface. Brown ice can indicate locales where hunters could predictably locate game. Thus, melting brown ice can hold greater potential for the discovery of archaeological remains related to human activity compared to uncolored or differently colored ice" (Dixon, Manley, and Lee 2005). Although the Project falls outside the range of the Woodland caribou, there is the potential that other animals, such as mountain goats, Stone sheep or marmots, may have utilized ice patches in a similar manner to caribou, and thus ice patch sites similar to those in Yukon, Northwest Territories, and Alaska could be present.

The AIA study area is a heavily glaciated, mountainous region with numerous snow and ice patches (Appendix G). To address whether there is potential for this type of archaeological site in the Project area, 43 snow and ice patches were inspected by pedestrian survey from August 25 to 26, 2012, during the period when there was near maximum annual snow melt (Table D-1 and Figures D-1 and D-2 in Appendix D). Survey areas were selected based on proximity to the Project footprint and the assessed archaeological potential of the areas. No cultural, paleobotanical or paleontological materials were identified during the ice patch survey. Two recent/historic features were recorded: a topographic survey cairn and a surveyor's campsite, including a stone circle (Figure D-1 in Appendix D). These are 20th century land use features that included pieces of canvas tarp typically used by surveyors to demarcate their survey cairns with a large "X" that is visible in aerial photographs. These historic features are not protected by the *HCA* and will not be discussed further.

# 5. Identified Heritage Concerns

Three new archaeological sites were recorded during this AIA, bringing the total number of recorded archaeological sites in the permit study area to 37 (Figure 5-1, Appendix E). All archaeological sites within the study area are discussed below, including the three newly recorded sites (Section 5.1) and previously recorded sites (Section 5.2).

## 5.1 Archaeological Sites Recorded under *HCA* Heritage Inspection Permit 2012-192

Three new archaeological sites were recorded during this AIA under *HCA* Heritage Inspection Permit 2012-0192 (Figure 5-1, Appendix E). Site maps, photos, and artifact catalogues for the archaeological sites recorded during this AIA are presented in Appendix G.

### 5.1.1 HcTo-1

Archaeological site HcTo-1 is a subsurface lithic scatter located 900 m east of the confluence of Sulphurets and Mitchell creeks. (Figure 5-1, Appendix G-1). It is situated on a terrace 700 m south of Mitchell Creek and 200 m north of Sulphurets Creek. The site measures 85 m (northwest to southeast) by 15 m (northeast to southwest) and was identified through three positive tests, out of a total of 186 tests, along the terrace. Site boundaries were determined through a combination of shovel testing and topography. Seven utilized flakes, two retouched flakes, one notched flake, and 238 pieces of debitage were recovered (all black obsidian). Three artifacts from this site were sent for X-Ray Fluorescence Spectrometry (XRF) analysis. All three pieces originate from obsidian quarries within the Mount Edziza Volcanic Complex, approximately 110 km north-northwest of the site. One piece was determined to have originated from obsidian Flow 3 while the other two pieces original from a flow not currently documented in the SFU Archaeology obsidian reference collection (see Appendix C). The general stratigraphy of the site consists of 6 cm of litter mat, followed by 5 cm of light grey silt, followed by 12 cm of reddish-brown sand, followed by 5 cm of brown sand with pebbles and cobbles. Artifacts were recovered between 6 and 11 cm depth below surface (DBS). Site HcTo-1 is interpreted as a temporary camp and retooling site, with an assemblage consisting largely of utilized flakes and late-stage reduction flakes.

### 5.1.2 HdTk-4

Archaeological site HdTk-4 is a subsurface lithic find located on a ridge at the southwest end of a prominent hill on the north side of Treaty Creek valley, 1.3 km north of its confluence with Todedada Creek (Figure 5-1, Appendix G-2). The site measures 10 m (north to south) by 10 m (east to west) and was identified through one positive test, out of a total of 29 tests, along the ridge. Site boundaries were determined through a combination of shovel testing and topography. The stratigraphy of the positive test consists of 2 cm of moss, followed by 8 cm of grey silt, followed by 1 cm of orange-brown silt with gravel, followed by bedrock at 11 cm. A layer of rocks was usually encountered around 20 cm DBS. Artifacts were recovered between 2 and 6 cm DBS. Site HdTk-4 is interpreted as a retooling site, with an assemblage consisting of a single

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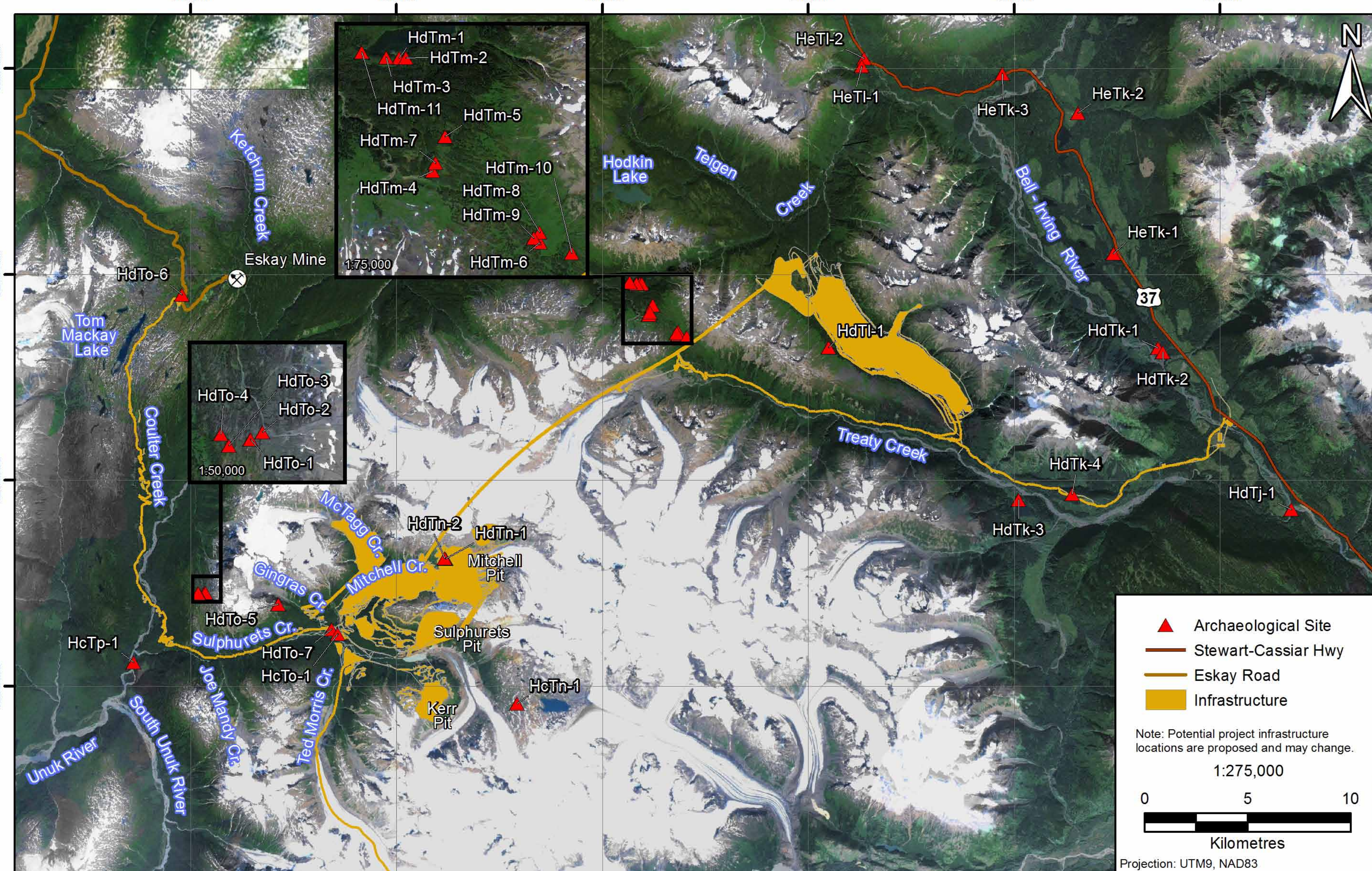


Figure 5-1

SEABRIDGE GOLD
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## Identified Archaeological Sites

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tertiary obsidian flake. The artifact from this site was sent for XRF analysis and was determined to have originated from Flow 3, an obsidian quarry within the Mount Edziza Volcanic Complex, approximately 115 km northwest of the site (see Appendix C).

### 5.1.3 HdTo-7

Archaeological site HdTo-7 is a subsurface lithic scatter located 700 m northeast of the confluence of Sulphurets and Mitchell creeks (Figure 5-1, Appendix G-3). It is situated on a terrace 100 m east of Mitchell Creek and 300 m north of Sulphurets Creek.

The site measures 8 m (north to south) by 15 m (east to west) and was identified through two positive tests, out of a total of 109 tests, along the terrace. Site boundaries were determined through a combination of shovel testing and topography. One unifacial end-scraper, three utilized flakes, and 11 pieces of debitage (all black obsidian), and 18 pieces of reddish-brown material (possibly ochre) were recovered. Two artifacts from this site were sent for XRF analysis and were determined to have originated from Flow 3, an obsidian quarry within the Mount Edziza Volcanic Complex, approximately 110 km northwest of the site (see Appendix C). The general stratigraphy of the site consists of 13 cm of litter mat, followed by 8 cm of light grey fine sand, followed by 7 cm of compact reddish sand, terminating at compact grey-green sand. Artifacts were recovered between 13 and 21 cm DBS. Site HdTo-7 is interpreted as temporary camp and/or retooling site.

## 5.2 Previously Recorded Archaeological Sites

Previously recorded archaeological sites within the study area were identified through a search of RAAD. A total of 34 previously recorded archaeological sites have been identified in the area and are briefly described in Table 5.2-1. Where sites are in proximity to the Project footprint, they are illustrated in Figure 5-1 and Appendix E. Of these, 20 sites were recorded during work previously conducted for the Project under *HCA* Heritage Inspection Permit 2008-0128. Detailed descriptions of previously recorded sites can be found in the associated permit report and/or site form referenced below and available from the Archaeology Branch.

### Table 5.2-1. Previously Recorded Archaeological Sites

| Borden Number | Site Type | General Location | Reference |
|---|---|---|---|
| HcTj-1 | Historic burial | North shore of Bowser Lake | Marshall, Marr, and Palmer 2008 |
| HcTn-1 | Lithic scatter | West of Brucejack Lake | Walker and McKnight 2011 |
| HcTp-1 | Historic trapline cabin | East bank of Unuk River | Brolly 1990 |
| HdTj-1 | Treaty Creek Site | Bell-Irving River/Treaty Creek confluence | Nisg̱a’a Final Agreement Act |
| HdTk-1 | Village site | East bank of Oweegee Creek | Hrychuck, Zoffman, and Butte 2008 |
| HdTk-2 | Historic burial | Oweegee Creek | Hrychuck, Zoffman, and Butte 2008 |

(continued)

## Table 5.2-1. Previously Recorded Archaeological Sites (completed)

| Borden Number | Site Type | General Location | Reference |
|---|---|---|---|
| HdTk-3 | Lithic scatter | North of Gilbert Lake | Marshall, Marr, and Palmer 2008 |
| HdTl-1 | Lithic scatter | North fork of Treaty Creek | Seip et al. 2012 |
| HdTm-1 | Lithic scatter | West Teigen Lake | Seip et al. 2012 |
| HdTm-2 | Lithic scatter | Near West Teigen Lake | Seip et al. 2012 |
| HdTm-3 | Lithic scatter | West Teigen Lake | Seip et al. 2012 |
| HdTm-4 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-5 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-6 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-7 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-8 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-9 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-10 | Lithic scatter | Valley between Treaty Creek and West Teigen Lake | Seip et al. 2012 |
| HdTm-11 | Lithic scatter | Southwest of West Teigen Lake | Seip et al. 2012 |
| HdTn-1 | Lithic scatter | North of Mitchell Creek | Seip et al. 2012 |
| HdTn-2 | Lithic scatter | North of Mitchell Creek | Seip et al. 2012 |
| HdTo-1 | Lithic scatter | Southwest of John Peaks | Seip et al. 2012 |
| HdTo-2 | Lithic scatter | Southwest of John Peaks | Seip et al. 2012 |
| HdTo-3 | Lithic scatter | Southwest of John Peaks | Seip et al. 2012 |
| HdTo-4 | Petroform | Southwest of John Peaks | Seip et al. 2012 |
| HdTo-5 | Lithic scatter | Southeast of John Peaks | Seip et al. 2012 |
| HdTo-6 | Lithic scatter | Tom Mackay Creek | Seip et al. 2012 |
| HeTk-1 | Lithic scatter | East of the Bell-Irving River near Highway 37 | Marshall, Marr, and Palmer 2008 |
| HeTk-2 | Lithic scatter | South of Hodder Creek | Site form from HCA permits 2007-200 and 2007-258 |
| HeTk-3 | Bell-Irving Telegraph Cabin | North of the Bell-Irving River, near Bell II Lodge | Site form from HCA permits 2007-200 and 2007-258 |
| HeTl-1 | Culturally Modified Tree | Near confluence of Snowbank and Teigen creeks | Marshall, Marr, and Palmer 2008 |
| HeTl-2 | Snowbank Creek Telegraph Cabin | Confluence of Snowbank and Teigen creeks | Site form from HCA permits 2007-200 and 2007-258 |
| HfTm-2 | Lithic scatter | West of Highway 37 near Beaverpond Creek | Site form from HCA permits 2007-200 and 2007-258 |
| HfTm-3 | Lithic scatter | South of Beaverpond Creek | Site form from HCA permits 2007-200 and 2007-258 |

# 6. Evaluation of Archaeological Site Significance

The purpose of the archaeological site significance evaluations is to provide an assessment of the relative significance of the three new archaeological sites identified within the Project area. The significance assessment results for the Project are presented in Table 6-1 below. In addition, the assessments of archaeological site significance for sites previously recorded are provided in Table 6-2.

### Table 6-1. Assessment of Archaeological Site Significance — Sites Recorded under HCA Heritage Inspection Permit 2012-0192

| Site # | Scientific Significance | Public Significance | Ethnic Significance | Economic Significance | Historic Significance | Overall Rating |
|---|---|---|---|---|---|---|
| HcTo-1 | Moderate | Low | High | Low | N/A | Moderate |
| HdTk-4 | Low | Low | High | Low | N/A | Low |
| HdTo-7 | Moderate | Low | High | Low | N/A | Moderate |

### Table 6-2. Assessment of Archaeological Site Significance — Previously Recorded Sites

| Site # | Scientific Significance | Public Significance | Ethnic Significance | Economic Significance | Historic Significance | Overall Rating |
|---|---|---|---|---|---|---|
| HcTj-1 | Low | Moderate | High | Low | High | High |
| HcTn-1 | Moderate | Low | High | Low | N/A | Moderate |
| HcTp-1 | Low | Moderate | High | Moderate | Moderate | Moderate |
| HdTk-1 | High | Moderate | High | Low | High | High |
| HdTk-2 | Low | Low | High | Low | Moderate | Low |
| HdTk-3 | Low | Low | High | Low | N/A | Low |
| HdTl-1 | Low | Low | High | Low | N/A | Low |
| HdTj-1 | Low | High | High | Moderate | High | High |
| HdTm-1 | Moderate | Low | High | Low | N/A | Moderate |
| HdTm-2 | Low | Low | High | Low | N/A | Low |
| HdTm-3 | Moderate | Low | High | Low | N/A | Moderate |
| HdTm-4 | Low | Low | High | Low | N/A | Low |
| HdTm-5 | Low | Low | High | Low | N/A | Low |
| HdTm-6 | High | Low | High | Low | N/A | High |
| HdTm-7 | Moderate | Low | High | Low | N/A | Moderate |
| HdTm-8 | Low | Low | High | Low | N/A | Low |
| HdTm-9 | Low | Low | High | Low | N/A | Low |
| HdTm-10 | Low | Low | High | Low | N/A | Low |
| HdTm-11 | Low | Low | high | Low | N/A | Low |

**(continued)**

## Table 6-2. Assessment of Archaeological Site Significance — Previously Recorded Sites (completed)

| Site # | Scientific Significance | Public Significance | Ethnic Significance | Economic Significance | Historic Significance | Overall Rating |
|---|---|---|---|---|---|---|
| HdTn-1 | Low | Low | High | Low | N/A | Low |
| HdTn-2 | Low | Low | High | Low | N/A | Low |
| HdTo-1 | High | Low | High | Low | N/A | High |
| HdTo-2 | Low | Low | High | Low | N/A | Low |
| HdTo-3 | Low | Low | High | Low | N/A | Low |
| HdTo-4 | High | Moderate | High | Low | N/A | High |
| HdTo-5 | Low | Low | High | Low | N/A | Low |
| HdTo-6 | Low | Low | High | Low | N/A | Low |
| HeTk-1 | Low | Low | High | Low | N/A | Low |
| HeTk-2 | Low | Low | High | Low | N/A | Low |
| HeTk-3 | Low | High | High | Moderate | High | High |
| HeTl-1 | Low | Low | High | Low | N/A | Low |
| HeTl-2 | Low | High | High | Moderate | High | High |
| HfTm-2 | Low | Low | High | Low | N/A | Low |
| HfTm-3 | Low | Low | High | Low | N/A | Low |

**Source: Seip et al.( 2012).**

Sites identified in the Project area were assessed using the checklist of criteria for site evaluation presented in the *British Columbia Archaeological Impact Assessment Guidelines* (Archaeology Branch 1998). These guidelines define five heritage significance evaluation categories for archaeological sites: scientific, public, ethnic, economic, and historic (where applicable). Each identified site was assessed and rated as having a high, moderate, or low significance value. The definitions of each type of significance assessment are as follows:

1. Scientific Significance — The potential of a site to provide information that could enhance our understanding of British Columbia's heritage resources, particularly its ability to contribute to various scientific disciplines, and its ability to contribute to an understanding of local and regional prehistory. For lithic sites, key considerations are the presence of unique or temporally-sensitive artifact types, density and variety of archaeological material, and the potential for multi-components or datable material. Disturbed sites are generally rated as having low scientific significance.
2. Ethnic Significance — The importance, significance, or value of a site as perceived by an ethnically distinct community or group.
3. Public Significance — The potential a site has to enhance public awareness, interest, understanding, or appreciation of British Columbia's prehistoric or historic past, such as its interpretive, education, and recreational potential.

4. Economic Significance — The potential for a site to contribute or generate monetary benefits or employment through its development and use as a public recreational or educational facility.
5. Historic Significance — The degree to which a site represents or relates to important historical individuals or events.

Site HcTo-1 is assessed to have moderate scientific significance. The site consists of a subsurface lithic scatter that includes a small number of utilized and retouched flakes, and a dense scatter of debitage from Shovel Test 32. The presence of tools and a dense scatter of debitage suggest that the site may have the potential to contribute new data that adds to our understanding of the region's prehistory.

Site HdTk-4 is assessed to have low scientific significance. The site consists of a single flake from a shovel test. Low density lithic scatters are a relatively common site type and there is limited new information that can be obtained from such sites.

Site HdTo-7 is assessed to have moderate scientific significance. The site consists of a subsurface lithic scatter that includes an end scraper, a small number of utilized flakes, and scatters of debitage. The end scraper is one of the only formed tools that has been recovered from this region to date. Additionally, small pieces of ochre were recovered from Shovel Test 1. The presence of ochre is particularly noteworthy as this is a relatively uncommon find in this region and is sometimes used to infer decorative or ceremonial activities.

The public and economic significance for these sites is assessed as being low as currently the Project area is primarily accessible by helicopter. It is anticipated that if the proposed roads to the Project are built, public access would be limited. However, in rating the public and economic significance, it is assumed that at some point in the future there may be an increase in public access as well as the value of the sites, both from cultural heritage and economic perspectives.

The ethnic significance is assumed to be high for all sites as the Project area is subject to several overlapping First Nations traditional territories and no single "ethnic value" for the sites is likely to be achieved.

# 7. Assessment of Impact Potential and Management Recommendations

The AIA identified 37 archaeological sites in the Project area, including 3 new sites and 34 previously recorded sites (Figure 5-1 and Table 7-1). This section assesses potential impacts to these sites to determine if their integrity will be altered by the Project, and provides site-specific and general management recommendations for the Project.

## Table 7-1. Assessment of Potential Impacts to Archaeological Sites

| Site # | Site Type | Nearest Project Component | Distance to Project Component (m) | Type of Impact | Potential Impact | Probability of Impact |
|---|---|---|---|---|---|---|
| HcTj-1 | Historic burial | Treaty Creek Transmission Line | 18,365 | None | None | Low |
| HcTn-1 | Artifact find | Kerr Pit Access Road | 3,112 | None | None | Low |
| HcTo-1 | Lithic scatter | Mine Area Water Treatment and Energy Recovery Facility | 1 | Direct | Construction | High |
| HcTp-1 | Historic trapline cabin | Coulter Creek Access Road | 1,583 | None | None | Low |
| HdTj-1 | Treaty Creek Site (Nisg̲a'a Final Agreement) | Camp 11 - Treaty Road Marshalling Yard | 4,425 | None | None | Low |
| HdTk-1 | Village site | Treaty Creek Switching Station | 2,741 | None | None | Low |
| HdTk-2 | Historic burial | Treaty Creek Switching Station | 2,428 | None | None | Low |
| HdTk-3 | Lithic scatter | Laydown Area – Log Landing | 762 | None | None | Low |
| HdTk-4 | Artifact find | Treaty Creek Transmission Line | 9 | Direct | Construction | High |
| HdTl-1 | Lithic scatter | Treaty Creek Transmission Line | 348 | Indirect | Increased human presence | Moderate |
| HdTm-1 | Lithic scatter | Saddle Car Wash | 3,861 | None | None | Low |
| HdTm-2 | Lithic scatter | Saddle Car Wash | 3,820 | None | None | Low |
| HdTm-3 | Lithic scatter | Saddle Car Wash | 3,960 | None | None | Low |
| HdTm-4 | Lithic scatter | Saddle Car Wash | 2,374 | None | None | Low |
| HdTm-5 | Lithic scatter | Saddle Car Wash | 2,655 | None | None | Low |
| HdTm-6 | Lithic scatter | Saddle Car Wash | 889 | None | None | Low |
| HdTm-7 | Lithic scatter | Saddle Car Wash | 2,437 | None | None | Low |

**(continued)**

## Table 7-1. Assessment of Potential Impacts to Archaeological Sites (completed)

| Site # | Site Type | Nearest Project Component | Distance to Project Component (m) | Type of Impact | Potential Impact | Probability of Impact |
|---|---|---|---|---|---|---|
| HdTm-8 | Lithic scatter | Saddle Car Wash | 1,022 | None | None | Low |
| HdTm-9 | Lithic scatter | Saddle Car Wash | 959 | None | None | Low |
| HdTm-10 | Lithic scatter | Saddle Car Wash | 817 | None | None | Low |
| HdTm-11 | Lithic scatter | Saddle Car Wash | 4,197 | None | None | Low |
| HdTn-1 | Lithic scatter | Mitchell Pit | 0 | Direct | Construction | High |
| HdTn-2 | Lithic scatter | Mitchell Pit | 0 | Direct | Construction | High |
| HdTo-1 | Lithic scatter | Coulter Creek Access Road | 2,121 | None | None | Low |
| HdTo-2 | Lithic scatter | Coulter Creek Access Road | 2,242 | None | None | Low |
| HdTo-3 | Lithic scatter | Coulter Creek Access Road | 1,926 | None | None | Low |
| HdTo-4 | Petroform | Coulter Creek Access Road | 1,917 | None | None | Low |
| HdTo-5 | Lithic scatter | Portal | 1,134 | None | None | Low |
| HdTo-6 | Lithic scatter | Coulter Creek Access Road | 316 | Indirect | Increased human presence | Moderate |
| HdTo-7 | Lithic scatter | Coulter Creek Access Road | 0 | Direct | Construction | High |
| HeTk-1 | Lithic scatter | Treaty Creek Switching Station | 7,439 | None | None | Low |
| HeTk-2 | Lithic scatter | East Diversion Pond | 12,019 | None | None | Low |
| HeTk-3 | Bell-Irving Telegraph Cabin | East Diversion Dam Spillway | 11,886 | None | None | Low |
| HeTl-1 | Culturally Modified Trees | Ultimate North Dam Closure Spillway | 9,283 | None | None | Low |
| HeTl-2 | Snowbank Creek Telegraph Cabin | Ultimate North Dam Closure Spillway | 9,681 | None | None | Low |
| HfTm-2 | Lithic scatter | East Catchment Diversion Tunnel Portal Access Road | 22,475 | None | None | Low |
| HfTm-3 | Lithic scatter | East Catchment Diversion Tunnel Portal Access Road | 22,587 | None | None | Low |

The site-specific assessment of impact potential is presented in Table 7-1. Developments that involve excavation, movement, or disturbance of soils have the potential to impact archaeological materials, if present. Increased human presence in an area can also result in impact to sites. The assessment of impacts to archaeological sites considers the potential magnitude, duration, severity, frequency, rate of change, cumulative effect, and range of the effects.

The archaeological site impacts have been assessed using the currently proposed Project footprint (see Appendix E). Sites anticipated to be directly impacted by the Project are within 50 m of the Project footprint, and the probability of impact to these sites from Project construction is high. Archaeological sites that are 50 to 500 m from the Project footprint are at low to moderate risk of impact due to potential for indirect impacts from increased human presence near the sites and sites beyond 500 m are at no risk for impacts.

## 7.1 Site Specific Management Recommendations

Site-specific management recommendations are presented below and should be reviewed and considered prior to initiation of any land-altering development activities. Avoidance of archaeological sites is the preferred management recommendation. To ensure avoidance is achieved, Project staff should be educated about this requirement, and sites should be marked as No Work Zones on Project construction maps. Where avoidance is not possible, any alteration to an archaeological site protected under the *HCA* would require a Section 12 Site Alteration Permit from the Archaeology Branch. Additional mitigation measures (e.g., systematic data recovery) may also be required and would be determined in consultation with the Archaeology Branch. For sites beyond 500 m from proposed Project developments no impacts are anticipated and no further work is required. It is recommended that these sites be marked as No Work Zones on development maps. For the seven sites with anticipated impacts, recommendations are provided below.

***Sites HdTl-1 and HdTo-6***

These sites are located outside of the current Project footprint and are not at risk of direct impact from the Project. However, the Project could result in increased human presence in the area which may result in indirect impact to the sites. It is recommended that Project staff be educated on the proper protocols for managing the known archaeological sites in the Project area and that the site areas are marked as No Work Zones on Project construction maps. If the Project footprint changes and approaches any of these sites, further work may be required.

***Sites HcTo-1, HdTk-4, HdTn-1, HdTn-2 and HdTo-7***

These sites are in direct conflict with the proposed Project footprint, including the Mine Area Water Treatment and Energy Recovery Facility (HcTo-1), the Treaty Creek Transmission Line (HdTk-4), the Mitchell Pit (HdTn-1 and HdTn-2), and the CCAR (HdTo-7). Avoidance through Project redesign is the preferred management recommendation. If avoidance is not possible mitigation measures, to be determined in consultation with the Archaeology Branch, are recommended. Mitigation may include systematic data recovery; construction monitoring, and/or capping. Any alteration to these sites would require Section 12 Site Alteration permits issued by the Archaeology Branch.

## 7.2 General Project Recommendations

No further archaeological assessment is recommended for the currently proposed Project footprint. Any revisions to the currently proposed Project footprint should be reviewed by a qualified professional archaeologist. Even the most thorough study may not identify all archaeological resources that may be present and an Archaeological Chance Find Procedure should be implemented prior to the commencement of ground altering activities. All Project staff should be familiarized with the procedure and the protocols for managing the known archaeological sites and any chance finds that may occur during construction.

The management options and recommendations presented above are subject to review and acceptance by the Archaeology Branch.

# 8. Discussion and Conclusions

Prior to the AIA conducted for the Project under *HCA* Heritage Inspection Permit 2008-0128, little archaeological research had been conducted in this region. The work conducted under *HCA* Heritage Inspection Permit 2012-0192 adds to the body of archaeological knowledge with three additional archaeological sites recorded during 2012.

The three new sites identified are lithic scatters, largely composed of tertiary debitage and utilized/retouched flakes. However, site HdTo-7 included an end scraper, and is to date the only formed tool found during the archaeological investigations for the Project. The end scraper is morphologically similar to those identified by Fladmark near Mount Edziza (1985) and attributed to the Ice Mountain Microblade Industry. No projectile points and no radiocarbon samples were recovered at any of the sites. Six pieces of obsidian were subject to XRF analysis to assist in determining the origin of the raw material. All pieces originate from obsidian quarries within the Mount Edziza Volcanic Complex, over 100 km to the northwest of the Project. The majority of material sent for analysis was sourced to obsidian Flow 3, while two pieces originate from a flow not currently documented in the SFU Archaeology obsidian reference collection.

The majority of the artifacts recovered during the 2012 field season came from a single shovel test at HcTo-1, where 235 flakes were identified in one test. By comparison, site HdTk-4, situated on a discrete ridge assessed as having high potential, contained a single tertiary flake despite extensive testing, suggesting that the distribution and density of lithic materials may be highly unpredictable on such landforms. That there were only 5 positive shovel tests out of 2,037 tests conducted during the 2012 field season indicates that a relatively high level of effort is required to identify the sites that are present in the region.

# 9. Evaluation of Research

The field methods employed during this AIA are described in the permit application for *HCA* Heritage Inspection Permit 2012-0192 and in Section 3 of this report. These methods included pedestrian survey, shovel testing, and visual inspection of tree throws and ground surface exposures in areas assessed to have archaeological potential. Shovel testing was implemented as a site discovery technique in areas assessed to have potential for buried deposits. A total of 2,037 shovel tests were conducted at 122 locations during this study. Additionally, surface exposures and tree throws were also examined. Using these methods, three new prehistoric archaeological sites were discovered.

The Archaeology Branch's Site ID Probability Calculator (Archaeology Branch, pers. comm.) was used to evaluate the methodology employed at the shovel test locations, and the mean confidence over all shovel test locations was calculated. For all 122 shovel test locations, 100 $m^2$ sites with at least four artifacts per square metre have been identified with a mean confidence of over 90%.

The field methodology is assessed as having been suitable for achieving the objectives of the AIA for the Project, based on the survey and shovel testing methodology employed and the success of the AIA at identifying small and sparse sites. The AIA results are commensurate with what is considered typical and expected given the study area's location and environment.

# 10. Closing

This report was prepared by Rescan Environmental Services Ltd. on behalf of Seabridge Gold Inc. and for the use of the Archaeology Branch of the Province of British Columbia. Any use, reliance, or decisions made by third parties based on this report are the sole responsibility of such third parties.

This study was not designed to address issues of traditional Aboriginal use and does not constitute a traditional use study. This report was written without prejudice to issues of Aboriginal rights and/or title.

We trust that the information contained in this report is sufficient for your present needs.

Sincerely,

Rescan Environmental Services Ltd.

<u>Originals Signed</u>
Kay Farquharson, B.A.
Archaeologist

and

<u>Originals Signed</u>
Sean McKnight, B.A. RPCA
Archaeologist

Reviewed by:

Lisa Seip, M.A. RPCA CAHP
Senior Archaeologist

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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# APPENDIX A
# ASSESSMENT AREA PHOTOS

# Appendix A. Assessment Area Photos

## A.1 Treaty Creek Transmission Line and Switching Station

**Plate A.1-1. Terrain and vegetation found within the currently proposed Treaty Creek Switching Station and along the transmission line alignment, looking southwest toward the Bell-Irving River.**

**Plate A.1-2. Typical terrain and vegetation found within the previously proposed substation and along the currently proposed transmission line, which is no longer under consideration. Looking northwest across assessment area.**

**Plate A.1-3. Typical terrain through steeply sloped areas of the transmission line on the northern side of Treaty Creek. Looking north across alignment.**

**Plate A.1-4. Typical terrain along the top of the prominent ridge north of the confluence of Treaty and Todedada creeks. Looking east along the alignment at Shovel Test Location 117.**

**Plate A.1-5. Typical steep terrain along the western side of North Treaty Creek, looking northwest.**

**Plate A.1-6. Typical terrain where the Treaty Creek Transmission Line passes through the Treaty Ore Preparation Complex, looking north.**

## A.2 Roadside Development Areas

**Plate A.2-1. Terrain along the proposed Coulter Creek Access Road at proposed Waste Area 463, looking north.**

**Plate A.2-2. Terrain along the proposed Coulter Creek Access Road at proposed Waste Area 461, looking south-southeast.**

**Plate A.2-3. Terrain along the proposed Coulter Creek Access Road at proposed Borrow Area 551, looking west.**

**Plate A.2-4. Terrain along the proposed Coulter Creek Access Road at proposed Borrow Area 542, looking southeast.**

**Plate A.2-5. Terrain along the proposed Coulter Creek Access Road at proposed Log Landing 516, looking east.**

**Plate A.2-6. Terrain along the proposed Coulter Creek Access Road at proposed Log Landing 500, looking southeast.**

**Plate A.2-7. Terrain along the proposed Coulter Creek Access Road at proposed Log Landing 522, looking southwest.**

**Plate A.2-8. Terrain along the proposed Coulter Creek Access Road at proposed Borrow Area 541, looking northwest.**

**Plate A.2-9. Terrain along the proposed Coulter Creek Access Road at proposed Borrow Area 553, looking south.**

**Plate A.2-10. Terrain along the proposed Treaty Creek Access Road at proposed Borrow Area 343 and Shovel Test Location 85, looking east.**

**Plate A.2-11. Terrain along the proposed Treaty Creek Access Road at proposed Borrow Area 341, looking northeast.**

**Plate A.2-12. Terrain along the proposed Treaty Creek Access Road at proposed Log Landing 393, looking north.**

**Plate A.2-13. Terrain along the proposed Treaty Creek Access Road at proposed Waste Area 587 and Shovel Test Location 99, looking north.**

**Plate A.2-14. Terrain along the proposed Treaty Creek Spur Road at proposed Log Landing 577, looking south.**

**Plate A.2-15. Terrain along the proposed Treaty Creek Spur Road at proposed Waste Area 618, looking west.**

## A.3 Construction and Permanent Camps

**Plate A.3-1. Camp 1: Granduc Staging Camp looking west across extinct lake bed toward Bowser River.**

**Plate A.3-2.  Shovel testing at Camp 3: Eskay Staging Camp, looking north.**

**Plate A.3-3.  Typical terrain found at Camp 4: Mitchell North Camp, looking south.**

**Plate A.3-4. Typical terrain found at Camp 7: Unuk North Camp, looking east from a steep-sided ridge to a skunk cabbage marsh.**

**Plate A.3-5. Typical terrain found at Camp 9 and 10: Mitchell Initial and Secondary Camps, looking northeast.**

**Plate A.3-6. Typcial terrain found at Camp 11: Treaty Creek Marshalling Camp, looking northeast.**

**Plate A.3-7. Typical terrain found at the Mitchell Operations Camp location, looking northwest.**

## A.4 Plant Site Area

**Plate A.4-1. Typical terrain of marshy areas between linear bedrock ridges found throughout the Plant Site area, looking north.**

## A.5 Access Road at Northern End of TMF

**Plate A.5-1. Typical steep terrain along eastern end of proposed access road at the northern end of the TMF, looking south.**

**Plate A.5-2. Terrain along proposed access road at the northern end of the TMF area, at Shovel Test Location 41, looking east.**

## A.6 Mine Site Water Treatment and Energy Recovery Facility

**Plate A.6-1. Typical terrain within the Mine Site WTF, at Shovel Test Location 75, looking north.**

## A.7 Borrow Pit and Till Stokepile – Sulphurets-Ted Morris Creeks Area

**Plate A.7-1. Terrain on the terraces above and south of Sulphurets Creek, looking north across STL 9 toward Sulphurets Creek.**

## A.8 Snow and Ice Patch Survey

**Plate A.8-1. Inspecting the edge of an ice patch during the snow and ice patch survey conducted in August 2012.**

**Plate A.8-2.  Surveying a snow patch during the snow and ice patch survey conducted in August 2012.**

# APPENDIX B
# SHOVEL TEST LOCATIONS TABLES

# Appendix B. Shovel Test Locations Tables

Appendix B has been removed from the public version of this report to protect the locational information of archaeological sites outlined in the table. Additional information can be obtained from the complete version of this report which is on file with the BC Archaeology Branch.

# APPENDIX C
# SHOVEL TEST LOCATION AND SURVEY MAPS

PUBLIC VERSION

PROJECT # 868-017-29-01 GIS No. KSM-02-100 October 18, 2012

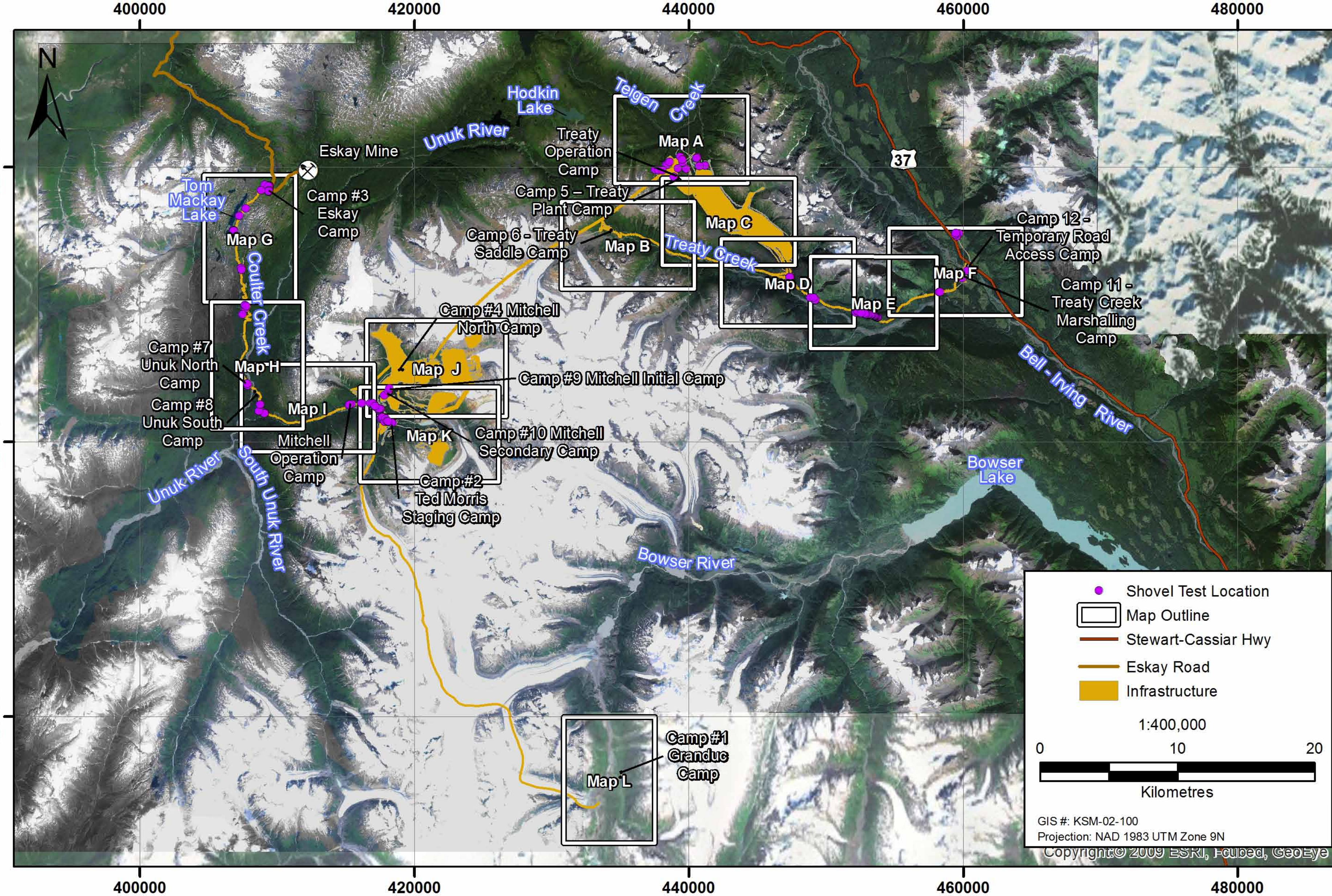


Figure C

SEABRIDGE GOLD
KSM PROJECT

Overview of Survey and Shovel Test Locations

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# Appendix C. Shovel Test Location and Survey Maps

Appendix C has been removed from the public version of this report to protect the locational information of archaeological sites illustrated on the figures. Additional information can be obtained from the complete version of this report which is on file with the BC Archaeology Branch.

# APPENDIX D
# SNOW AND ICE PATCH SURVEY RESULTS

## Table D-1. Results of Snow and Ice Patch Survey

| Snow Patch ID | Location | Snow Patch Size (m) | Results | E | N |
|---|---|---|---|---|---|
| SP1 | Proposed Sulphurets Mine Pit | 30 x 190 | No cultural materials, paleobotanical or paleontological remains observed. | 422111 | 6263618 |
| SP2 | Proposed Sulphurets Mine Pit | 30 x 600 | No cultural materials, paleobotanical or paleontological remains observed. | 421901 | 6263569 |
| SP3 | Proposed Sulphurets Mine Pit | 50 x 240 | No cultural materials, paleobotanical or paleontological remains observed. | 421028 | 6263610 |
| SP4 | Proposed Sulphurets Mine Pit | 5 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 420786 | 6263584 |
| SP5 | Proposed Sulphurets Mine Pit | 30 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 420705 | 6263545 |
| SP6 | Proposed Sulphurets Mine Pit | 50 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 420620 | 6263497 |
| SP7 | Proposed Sulphurets Mine Pit | 30 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 420541 | 6263399 |
| SP8 | Proposed Sulphurets Mine Pit | 30 x 30 | No cultural materials, paleobotanical or paleontological remains observed. | 420512 | 6263391 |
| SP9 | Proposed Sulphurets Mine Pit | 20 x 500 | No cultural materials, paleobotanical or paleontological remains observed. | 420437 | 6263659 |
| KP1 | Proposed Kerr Mine Pit | 30 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 422031 | 6258978 |
| KP2 | Proposed Kerr Mine Pit | 15 x 30 | No cultural materials, paleobotanical or paleontological remains observed. | 422046 | 6259101 |
| KP3 | Proposed Kerr Mine Pit | 50 x 80 | No cultural materials, paleobotanical or paleontological remains observed. | 422040 | 6259139 |
| KP4 | Proposed Kerr Mine Pit | 30 x 30 | No cultural materials, paleobotanical or paleontological remains observed. | 422056 | 6259244 |
| KP5 | Proposed Kerr Mine Pit | 30 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 422317 | 6259421 |
| KP6 | Proposed Kerr Mine Pit | 20 x 100 | No cultural materials, paleobotanical or paleontological remains observed. | 422399 | 6259481 |
| KP7 | Proposed Kerr Mine Pit | 40 x 60 | No cultural materials, paleobotanical or paleontological remains observed. | 422308 | 6259542 |
| JP1 | John Peaks, near sites HdTo-1 to 4 | 20 x 20 | No cultural materials, paleobotanical or paleontological remains observed. | 410986 | 6263111 |
| JP2 | John Peaks, near sites HdTo-1 to 4 | 15 x 15 | No cultural materials, paleobotanical or paleontological remains observed. | 410972 | 6263161 |
| JP3 | John Peaks, near sites HdTo-1 to 4 | 30 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 410916 | 6263269 |
| JP4 | John Peaks, near sites HdTo-1 to 4 | 50 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 410891 | 6263341 |
| JP5 | John Peaks, near sites HdTo-1 to 4 | 90 x 80 | No cultural materials, paleobotanical or paleontological remains observed. | 411000 | 6263460 |
| JP6 | John Peaks, near sites HdTo-1 to 4 | 30 x 40 | No cultural materials, paleobotanical or paleontological remains observed. | 411021 | 6263532 |
| JP7 | John Peaks, near sites HdTo-1 to 4 | 5 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 411003 | 6263602 |
| JP8 | John Peaks, near sites HdTo-1 to 4 | 10 x 220 | No cultural materials, paleobotanical or paleontological remains observed. | 410993 | 6263642 |
| JP9 | John Peaks, near sites HdTo-1 to 4 | 10 x 40 | No cultural materials, paleobotanical or paleontological remains observed. | 410418 | 6264272 |
| JP10 | John Peaks, near sites HdTo-1 to 4 | 10 x 10 | No cultural materials, paleobotanical or paleontological remains observed. | 410401 | 6264139 |
| TP1 | Treaty Creek valley | 5 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 444107 | 6279002 |
| TP2 | Treaty Creek valley | 10 x 80 | No cultural materials, paleobotanical or paleontological remains observed. | 444216 | 6279041 |
| TP3 | Treaty Creek valley | 15 x 30 | No cultural materials, paleobotanical or paleontological remains observed. | 444258 | 6278945 |
| TP4 | Treaty Creek valley | 50 x 180 | No cultural materials, paleobotanical or paleontological remains observed. | 444076 | 6278826 |
| TP5 | Treaty Creek valley | 10 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 444158 | 6278631 |
| TP6 | Treaty Creek valley | 30 x 150 | No cultural materials, paleobotanical or paleontological remains observed. | 439132 | 6275591 |
| TP7 | Treaty Creek valley | 50 x 300 | No cultural materials, paleobotanical or paleontological remains observed. | 439185 | 6275471 |
| TP8 | Treaty Creek valley | 20 x 300 | No cultural materials, paleobotanical or paleontological remains observed. | 439728 | 6275230 |
| TP9 | Treaty Creek valley | 40 x 170 | No cultural materials, paleobotanical or paleontological remains observed. | 440110 | 6275214 |
| TP10 | Treaty Creek valley | 20 x 130 | No cultural materials, paleobotanical or paleontological remains observed. | 441124 | 6274745 |
| TP11 | Treaty Creek valley | 50 x 80 | No cultural materials, paleobotanical or paleontological remains observed. | 437552 | 6276957 |
| TP12 | Treaty Creek valley | 30 x 70 | No cultural materials, paleobotanical or paleontological remains observed. | 437664 | 6276783 |
| TP13 | Treaty Creek valley | 30 x 70 | No cultural materials, paleobotanical or paleontological remains observed. | 437816 | 6276773 |
| TP14 | Treaty Creek valley | 30 x 800 | No cultural materials, paleobotanical or paleontological remains observed. | 438109 | 6276577 |
| PP1 | Proposed Tunnel Portal area | 60 x 300 | No cultural materials, paleobotanical or paleontological remains observed. | 432545 | 6276199 |
| PP2 | Proposed Tunnel Portal area | 40 x 250 | No cultural materials, paleobotanical or paleontological remains observed. | 432653 | 6276316 |
| PP3 | Proposed Tunnel Portal area | 50 x 50 | No cultural materials, paleobotanical or paleontological remains observed. | 432660 | 6276473 |

# PUBLIC VERSION

PROJECT # 868-017-29 GIS No. KSM-02-097a October 30, 2012

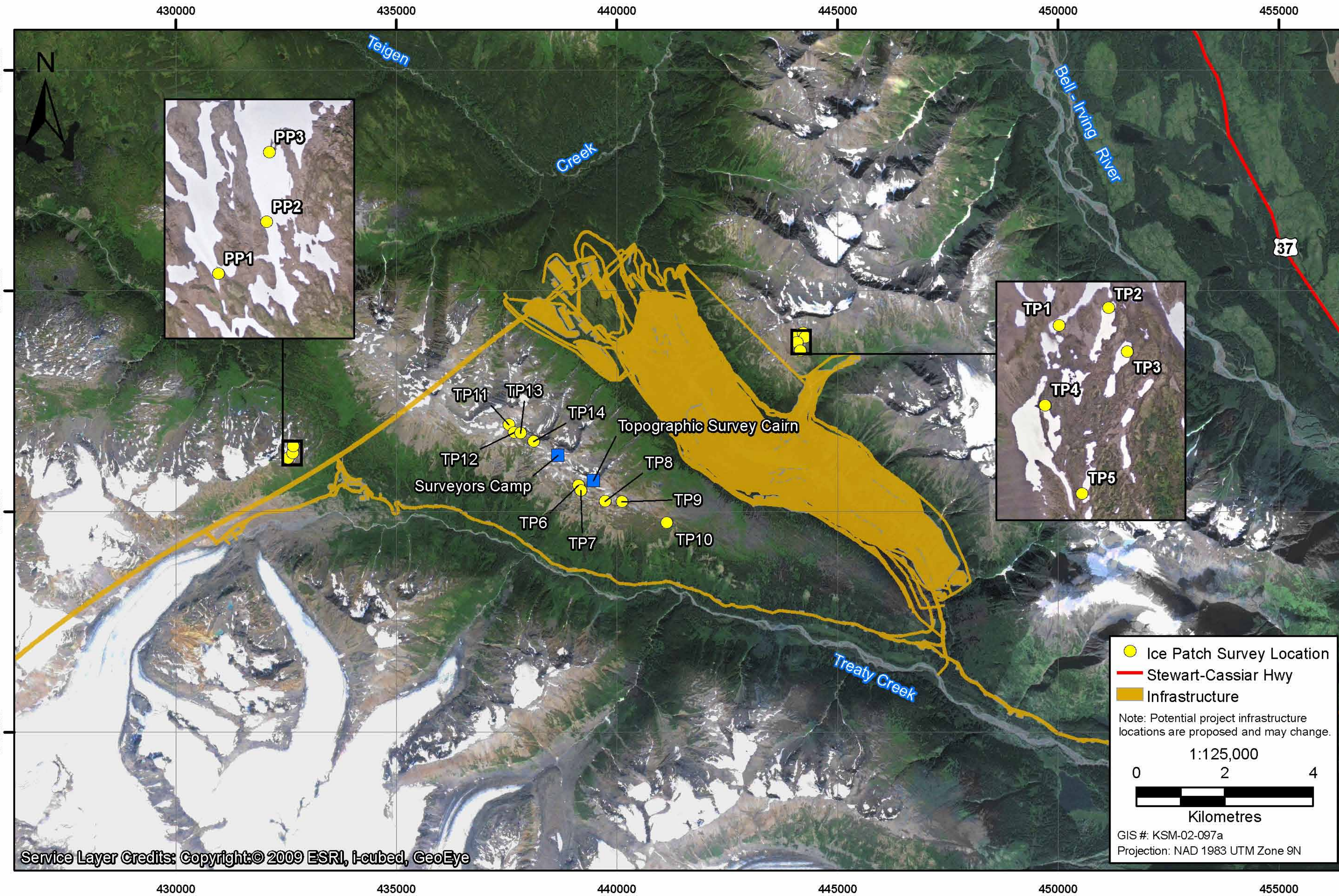


Figure D-1

SEABRIDGE GOLD
KSM PROJECT

## Snow and Ice Patch Survey

Figure D-1

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# PUBLIC VERSION

*PROJECT #* 868-017-29 *GIS No.* KSM-02-097b October 22, 2012

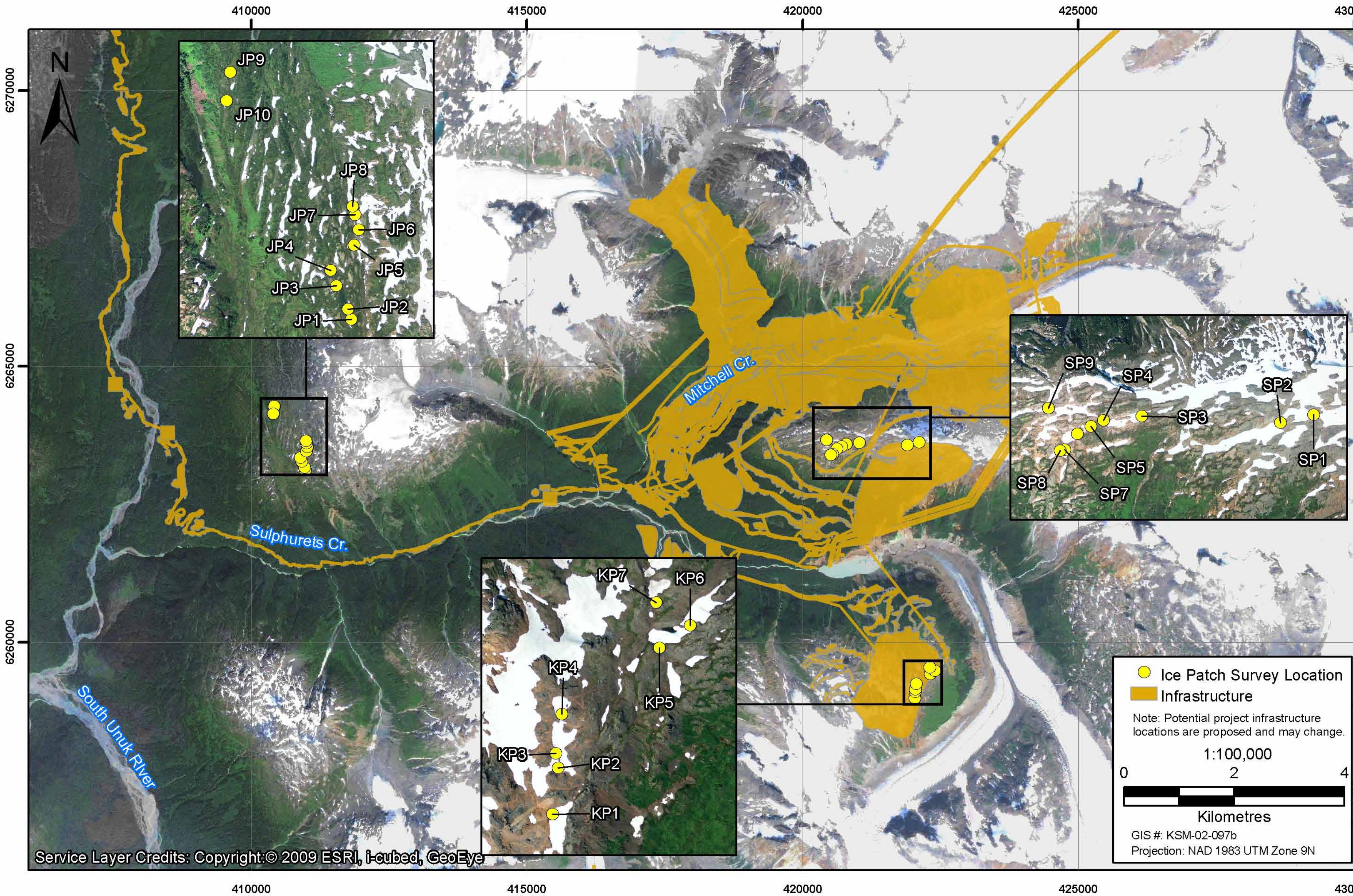


Figure D-2

SEABRIDGE GOLD
KSM PROJECT

## Snow and Ice Patch Survey

Figure D-2

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# APPENDIX E
# ARCHAEOLOGICAL SITES IN RELATION TO THE PROJECT (MAPS)

# PUBLIC VERSION

*PROJECT #* 868-017-29 *GIS No.* KSM-02-101 October 22, 2012

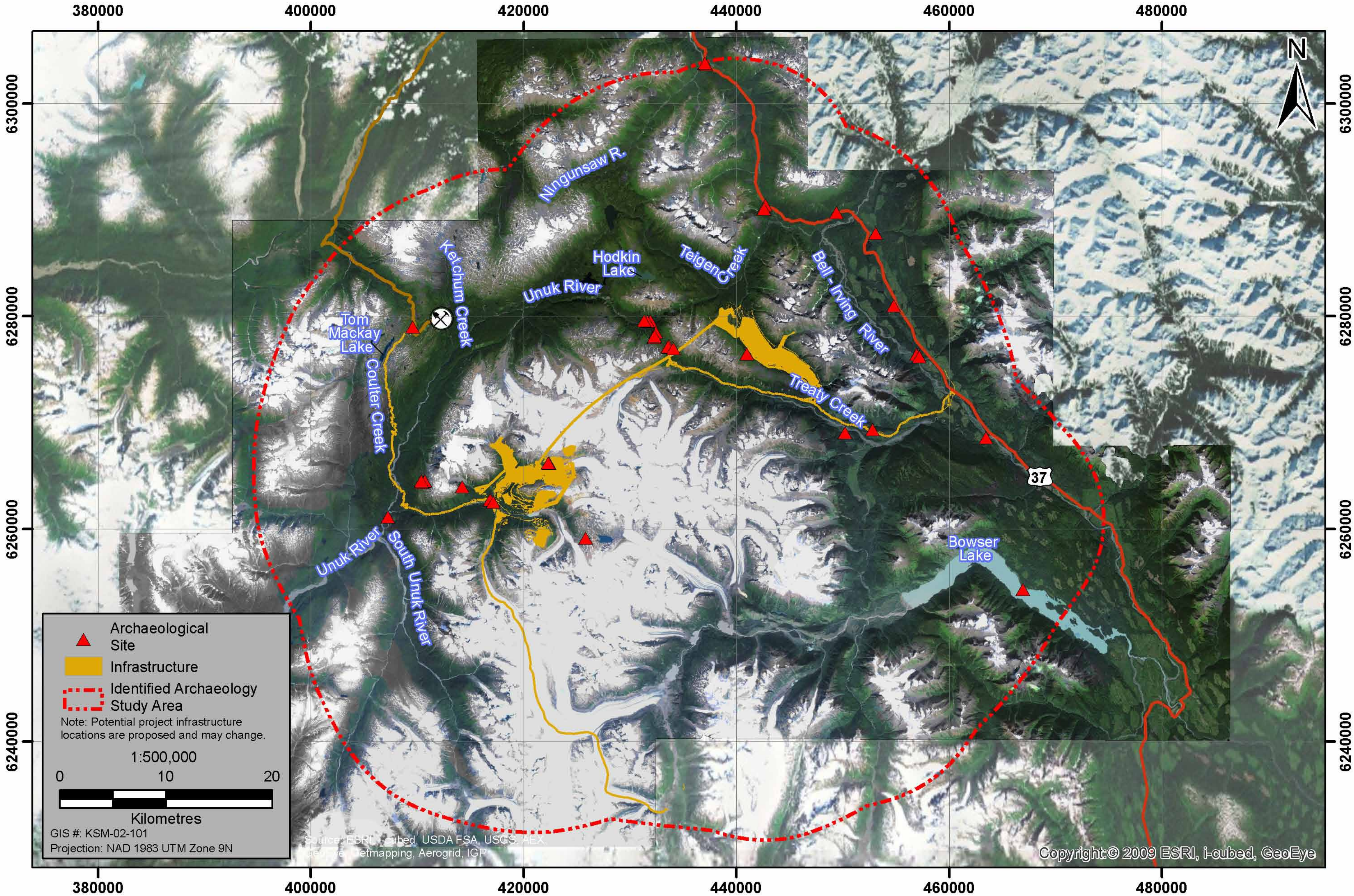


Figure E

## Archaeological Sites in Relation to Proposed Developments

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# Appendix E. Archaeological Sites in Relation to the Project (Maps)

Appendix E has been removed from the public version of this report to protect the locational information of archaeological sites illustrated on the figures. Additional information can be obtained from the complete version of this report which is on file with the BC Archaeology Branch.

# APPENDIX F
# NISGA'A NATION BOUNDARIES AND ASSERTED BOUNDARIES OF FIRST NATIONS WITHIN THE KSM STUDY AREA

# PUBLIC VERSION

*PROJECT #* 868-017-29-01 *GIS No.* KSM-02-096a December 14, 2012

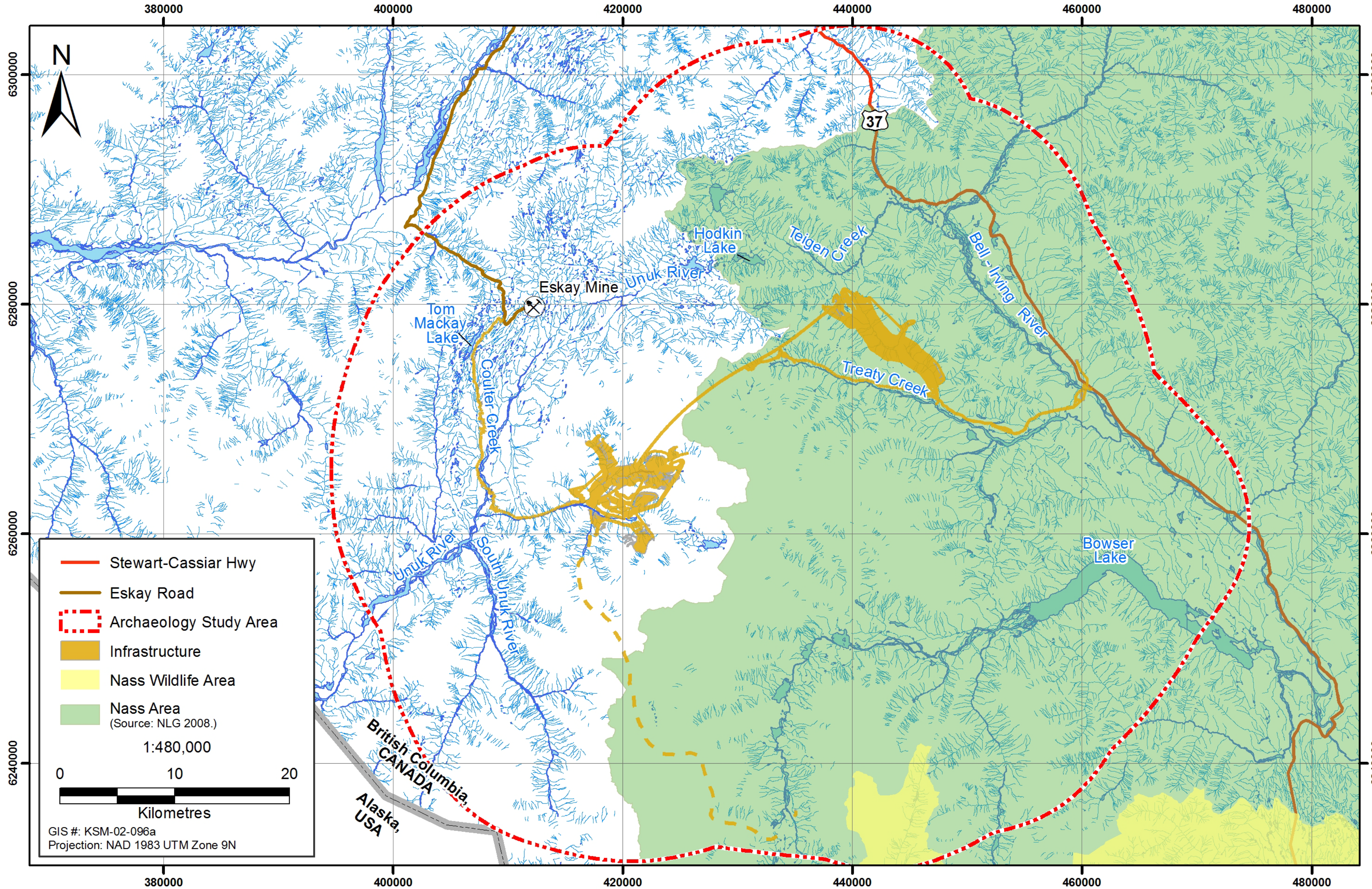


Figure F-1

SEABRIDGE GOLD
KSM PROJECT

## Proposed KSM Project in Relation to Nass Area and Nass Wildlife Area

Figure F-1

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*PROJECT #* 868-017-29-01 *GIS No.* KSM-02-096b December 14, 2012

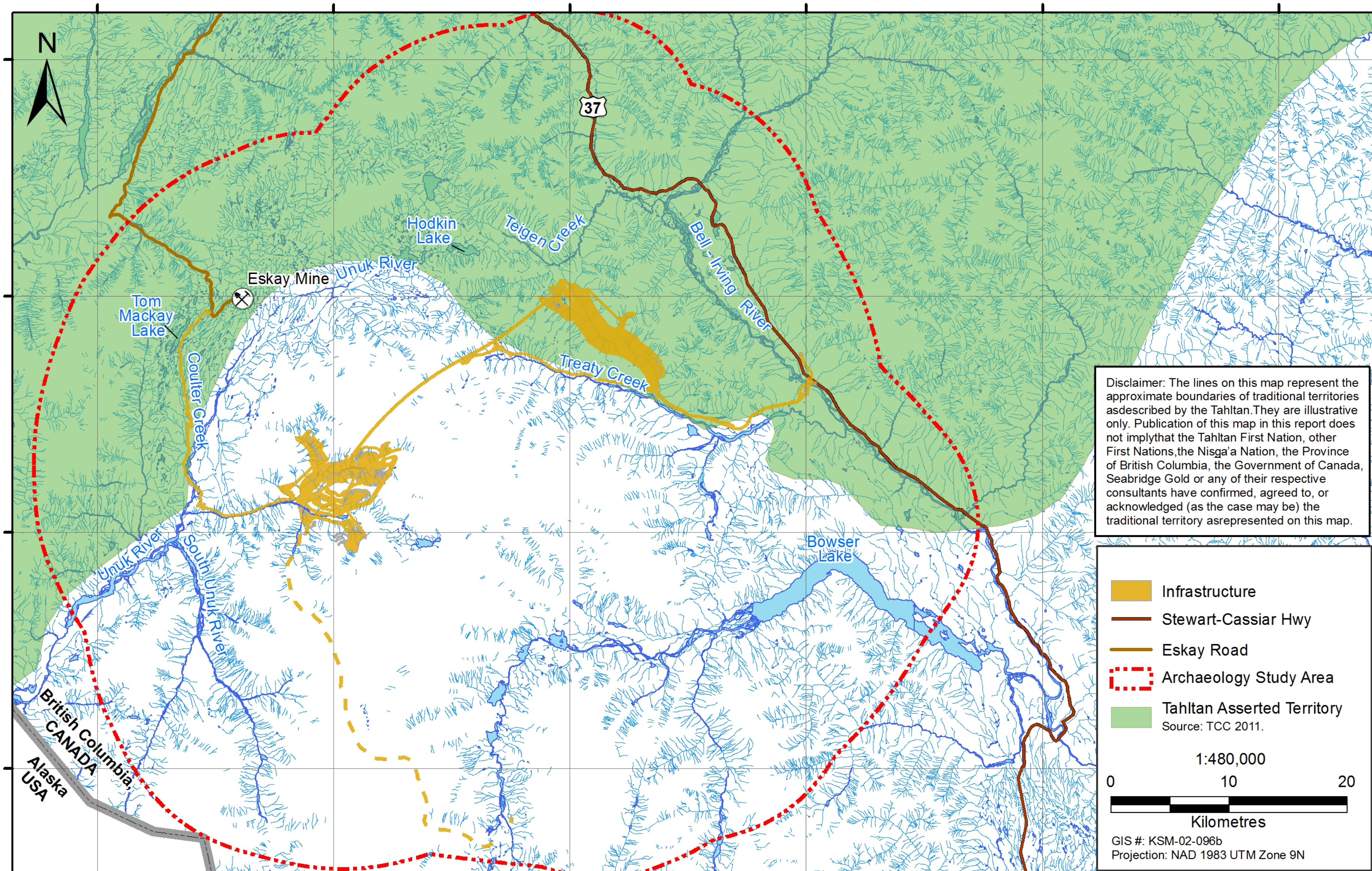


Figure F-2

# Proposed KSM Project and Tahltan Asserted Territory

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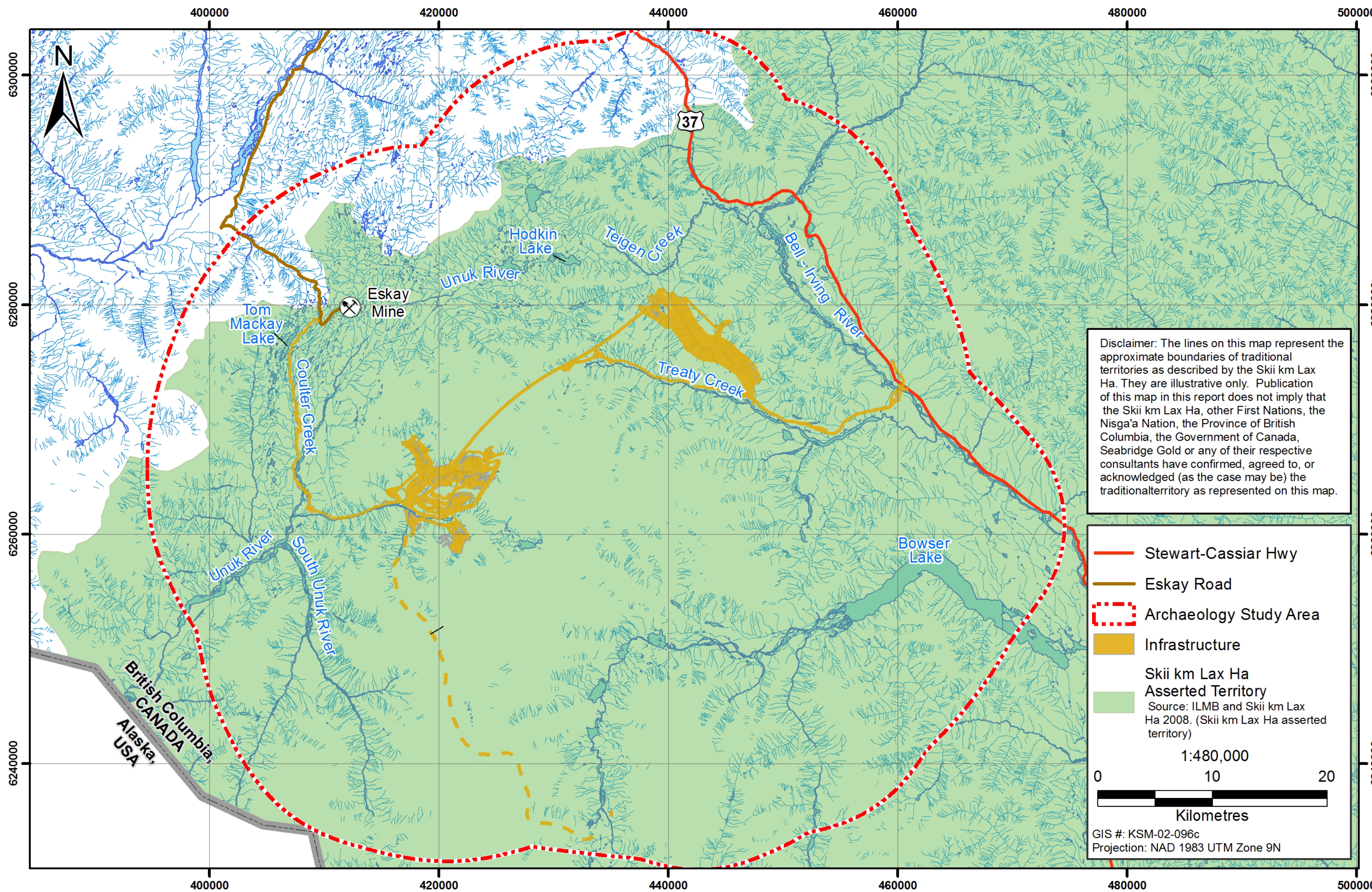


Figure F-3

SEABRIDGE GOLD
KSM PROJECT

## Proposed KSM Project and Skii km Lax Ha Asserted Territory

Figure F-3

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PUBLIC VERSION

PROJECT # 868-017-29-01 GIS No. KSM-02-096d December 14, 2012

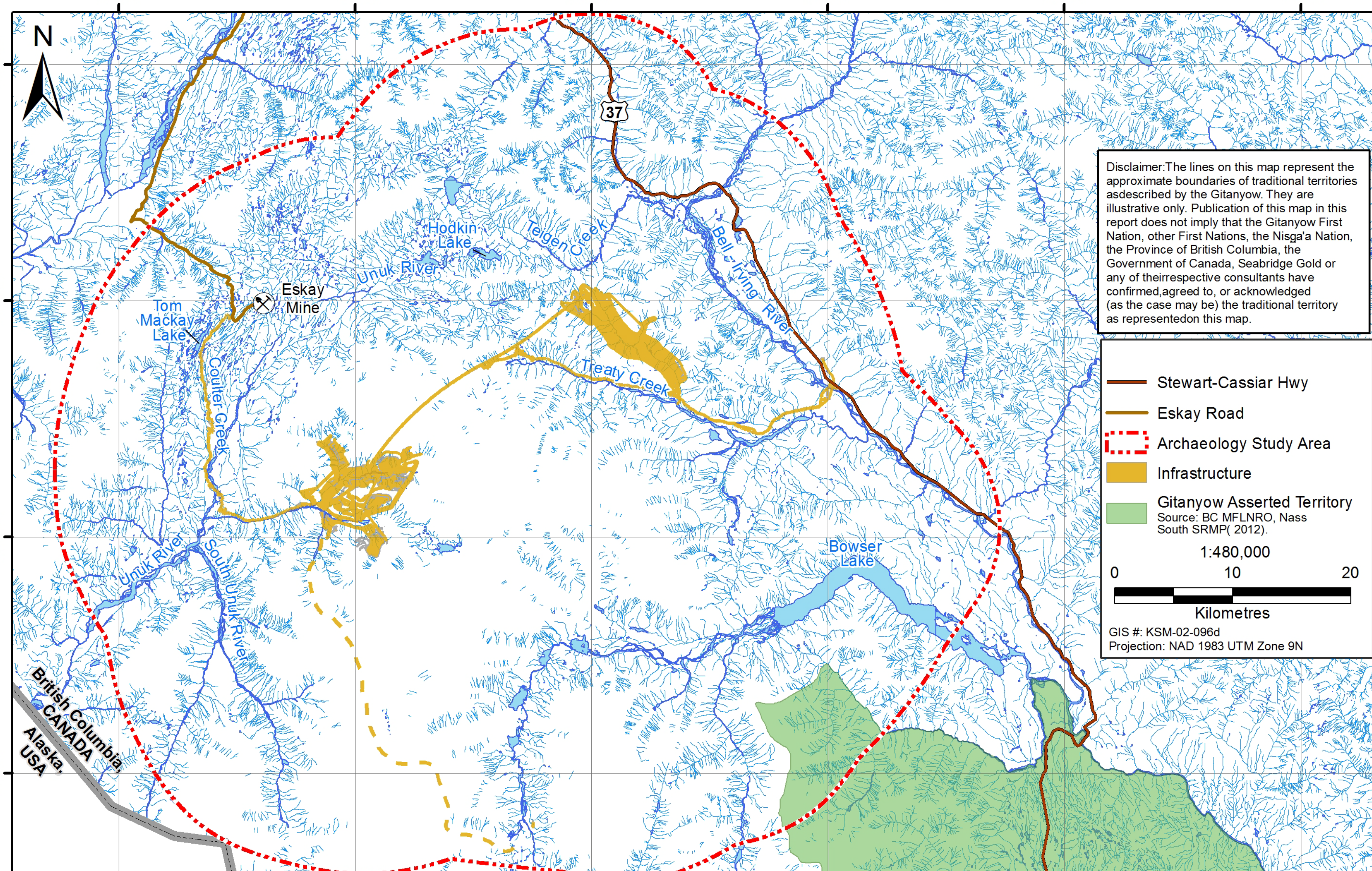


Figure F-4

# Proposed KSM Project and Gitanyow Asserted Territory

Figure F-4

SEABRIDGE GOLD
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# PUBLIC VERSION

*PROJECT #* 868-017-29-01 *GIS No.* KSM-02-096e December 14, 2012

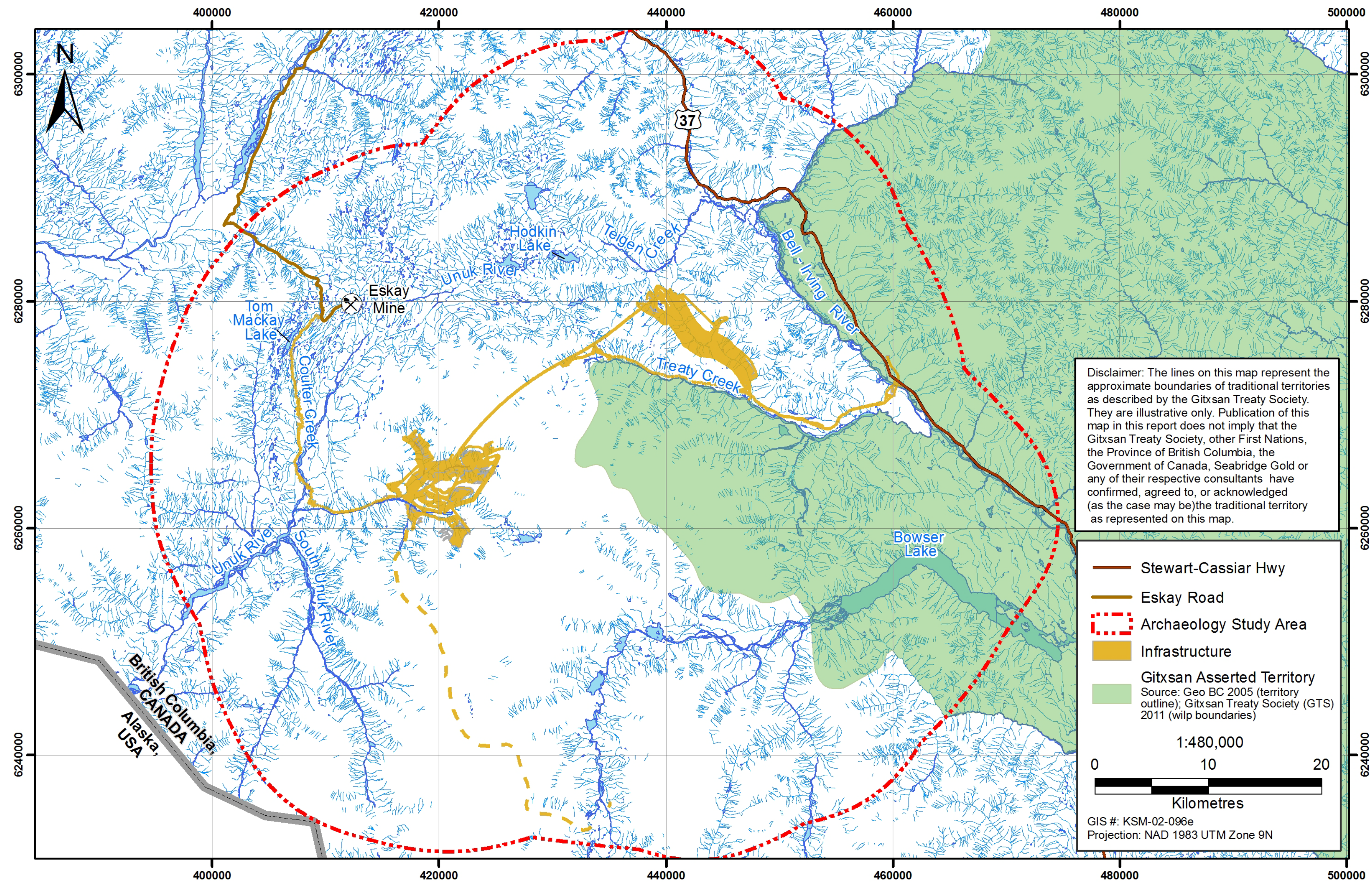


Figure F-5

SEABRIDGE GOLD
KSM PROJECT

## Proposed KSM Project and Gitxsan Asserted Territory

Figure F-5

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# APPENDIX G
# ARCHAEOLOGICAL SITE DATA

# Appendix G. Archaeological Site Data

Appendix G has been removed from the public version of this report to protect the archaeological site information outlined in this section. Additional information can be obtained from the complete version of this report which is on file with the BC Archaeology Branch.

# APPENDIX H
# MEMORANDUM: GLACIERS AND ARCHAEOLOGY, JOSEPH M. SHEA, PH.D.

| MEMORANDUM | |
|---|---|
| Re: | Glaciers and Archaeology |
| Project: | KSM |
| Author: | Joseph M. Shea |
| Date: | 20 December 2011 |
| Attention: | Lisa Seip, Greg Norton |

## Statement of Qualifications:

I am currently a post-doctoral researcher at the University of British Columbia. My research focuses on glaciers in western North America, and in particular the relation between glaciers, climate, and hydrology. I received my PhD in 2010 from the University of British Columbia, and my M.Sc. (Geography) from the University of Calgary in 2004. My undergraduate degree was completed at McMaster University (Honours B.Sc. Geography, Minor in Geology) in 2001. I have worked as a glacier consultant with Rescan Environmental Ltd. since 2008.

## 1 Introduction

The Kerr-Stewart-Mitchell study area is a heavily glaciated region that contains numerous alpine glaciers and evidence for human activities (personal communication, L. Seip). Proposed ice roads or other glacier-based activities within the study area raise the possibility that archaeological materials may be found on or in close proximity to glaciated or recently deglaciated terrain. This memorandum examines (1) the differences between "ice patches" and "glaciers", (2) the potential for finding archaeological materials during glacier road construction, (3) an assessment of the travel risks associated with searching for archaeological remains on glaciers within the project area, and (4) the glacial history of the project area for the past 15000 years.

## 2 "Ice Patch" versus Glacier

Recent archaeological finds on and around ice patches in Tatsenshini-Alsek Park in northwest British Columbia (Beattie et al., 2000), the Mackenzie Mountains of the southern Yukon (e.g. Farnell et al., 2004; Hare et al., 2004; Dove et al., 2005) and southern Norway (Nesje et al., 2011) have demonstrated the possibility of recovering archaeological artifacts from retreating ice bodies. It is important to recognize that there are significant differences between "ice patches" and "glaciers", though both are part of the continuum of semi-permanent ice features in high alpine or high latitude environments.

### *2.1 Ice patches*

Ice patches are perennial snow features that persist for greater than two consecutive years, and they consist of snow and firn (multi-year snow) in their upper layers, and ice in their deeper layers. The ice layers are formed by the compaction of snow from subsequent accumulations, which generate overburden pressures. Ice patches are generally found in sheltered high-latitude or high-altitude environments where summer melt conditions are frequently insufficient for melting the previous winters snow accumulation, and they may range in length from 100 to 1000 m, and in depth from 10 to 80 m (Meulendyk, 2010). They typically form on north or east-facing leeward slopes, or in small gullies or depressions, which receive both greater snow accumulations and lower amounts of solar radiation than the surrounding terrain. Ice patches are not sufficiently large enough (or on steep enough slopes) to generate internal flow dynamics. Ice patches are often described as glaciers in the literature, which adds some small measure of confusion to this issue.

### 2.2 Glaciers

In contrast, glaciers are perennial snow and ice features that persist for greater than two years, and where mass is transferred between accumulation areas and ablation (melt) areas through sliding, ice deformation, or bed deformation. Glacier ice is formed in the same way as ice patches, and each layer of ice represents an annual layer of snow that has been compressed into ice by subsequent accumulations. Glacier velocities are typically greatest at the surface and in the interior regions of a glacier. At the base of the glacier and along the edges, frictional forces between the sliding/deforming ice mass are greater, and thus flow velocities are reduced. On larger glaciers (greater than 1 $km^2$), these processes are highly erosive and destructive, as evidenced by the scoured bedrock surfaces typically found in the forefield of retreating glaciers, the massive morainal deposits, and large glacial erratic boulders that can be transported significant distances from their origin by glacier ice.

### 2.3 *Archaeological recovery from glaciers and ice patches*

It is my opinion that the potential for recovering archaeological artifacts or human remains is greater for ice patches than it is for glaciers, primarily due to the lack of internal deformation or sliding on ice patches, and for the greater likelihood of human activities (e.g. hunting, travel) on or near ice patches. In the southwest Yukon, for example, ice patches are thought to provide cariboo a source of freshwater and respite from insects, indicating that they would have been good hunting grounds. Organic matter deposited on the surface of ice patches, provided it is buried rapidly and protected from the elements, can be preserved for over 8000 years (Farnell et al., 2004).

However, it is recognized that human remains and archaeological artifacts may also be recovered from glaciers. The famous iceman “Otzi” was recovered from a glacier in the Tyrolean Alps, but preservation of the body for 5200 years and subsequent discovery was only made possible by a remarkable series of coincidences. First, the Iceman is believed to have died on bare permafrost ground at 3200 m, during a relatively warm period. Subsequent burial by winter snows only reached a maximum thickness of between 5 and 25 m. Due to his location on a thinly glaciated saddle, the body was protected from glacier flow by two rock ridges (Sjøvold, 1996), though the body was compressed significantly by the overburden pressure of the glacier.

Human remains (named Kwädąy Dän Ts'ìnchį, or “long ago person found”), were recovered from the edge of a small glacier in Tatshenshini-Alsek Park, in northwest British Columbia. Initial reports suggested that the individual was preserved after falling into a crevasse (Science, 1999), but it was later established that he likely died on the surface and was subsequently buried by snow and incorporated into the glacier ice (Beattie, 2000). Again, this individual was preserved primarily due to the remarkable coincidence of weather conditions at and immediately after the time of deposition, and his location near the edge of the glacier where ice flow and deformation was minimal.

## 3 Archaeological potential of project area glacier roads

The Kerr-Stewart-Mitchell study area is heavily glacierized, with large glaciers and icefields extending from mountain top elevations to nearly 900 m above sea level (asl). The Mackie Glacier, site of a proposed ice road, is nearly 2 km across at its terminus, and is fed by multiple high-elevation accumulation basins.

To assess the potential for finding archaeological artifacts or human remains on or near glaciers, several factors should be considered (e.g. Dixon et al., 2005) :

1. The potential for human activity. Evidence of human activity, animal occurrences or trails near the proposed mine developments should indicate that the area is more likely

to contain archaeological artifacts

2. The preservation environment. The margins of glaciers will be the most likely place to find artifacts, and in particular near or above the elevation of the end-of-summer snowline. At low elevations, winter snowfalls will not be sufficient to preserve organic matter through the summer. Conversely, winter snowfall accumulations at high elevations can be greater than 6 m (Rescan, 2010) and the overburden pressure will likely destroy soft organic matter. Areas exposed to meltwater percolation or surface streams will also not be good candidates for preservation.
3. The possible travel environment. Materials deposited on the glacier surface will travel down-glacier, but as this will bring them from zones of preservation to zones of degradation. Scavengers in the environment may also remove many traces of human remains on the surface of the glacier, through stone or bone artifacts may still be preserved. Any victim falling into a crevasse on an active glacier would likely be very poorly preserved, due to the internal deformation of ice and the grinding action of the glacier over the bedrock.

It is my opinion that the probability of finding archaeological materials or human remains on the surface of the active glacier or in the immediate forefield of the glacier are very low. It is more likely that artifacts or remains might be recovered on or near stagnant ice bodies (remnant glaciers, small ice patches, or stagnant ice-cored lateral moraines) at elevations that are near or above the current end-of-summer snowline elevation.

# 4 Glacier travel risks

Glacier travel contains many risks that inexperienced or ill-prepared travellers may not be able to mitigate, and these risks vary with the season of travel, location on the glacier, and weather conditions.

Glacier travel hazards include:

- crevasses (may be visible, or hidden by snow)
- unstable snow bridges spanning crevasses
- seracs and icefalls (falling ice blocks)
- slips and falls (and self-inflicted injuries from crampons and ice axes)
- hypothermia and frostbite (year-round)
- snow and/or ice avalanches
- glacial moraines (steep and unstable rocky debris)
- whiteouts (navigation)
- rockfalls (from melting debris)

Travelling in glacier terrain requires a well-prepared and well-trained rope team, route-finding experience, and a thorough knowledge of crevasse rescue techniques. Rapidly changing weather conditions and frequent whiteouts or poor visibility on glaciers require that all team members be comfortable with unplanned overnight stays.

# 5 Regional glacier change history

There appears to be little direct research related to the glacial history of the project area. This section broadly describes glacier activity in western North America over the past 25,000 years, which can be grouped into four periods: the Last Glacial Maximum, the Hypsithermal, Neoglaciation, and the present. Where relevant, inferences to regional conditions have been made. A timeline summarizing the main points in this section is given in Figure 1.

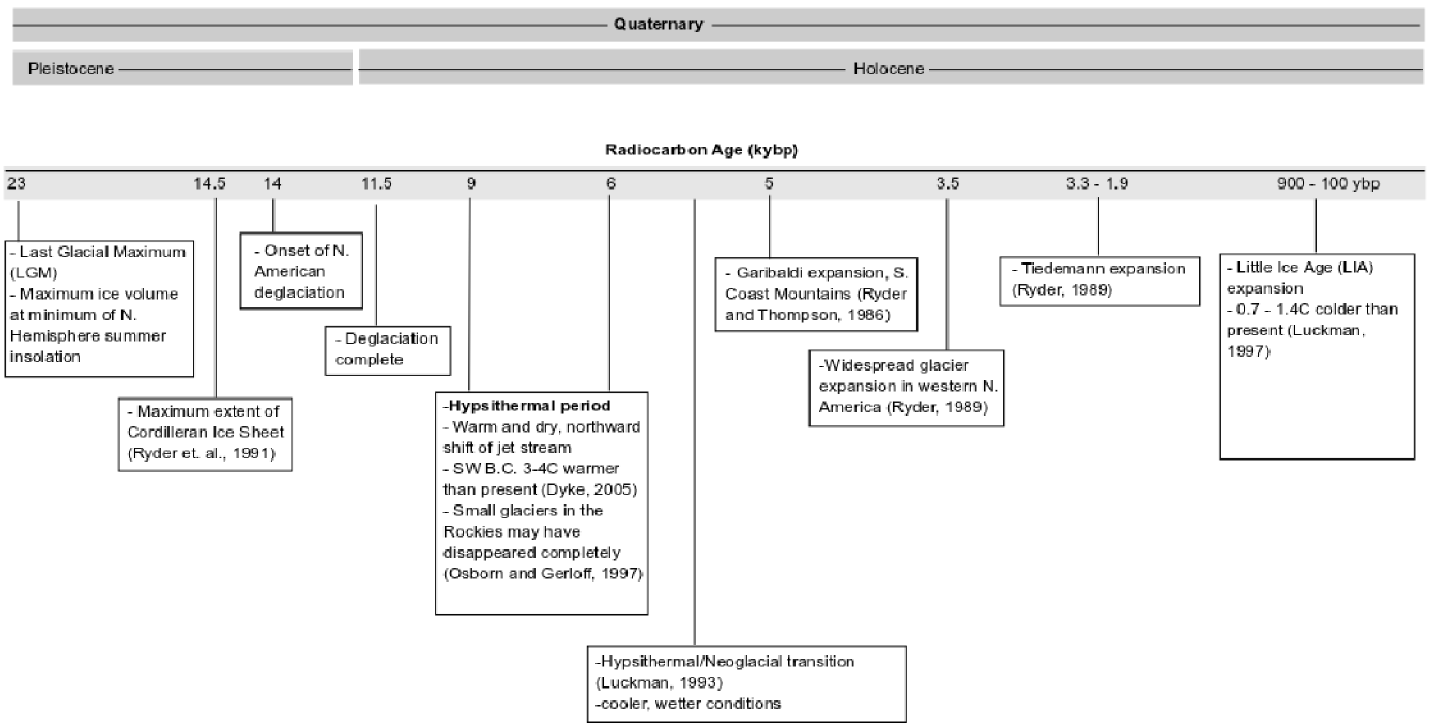



**Figure 1:** Summary timeline of glacial history for western Cordillera.

## *5.1 The Last Glacial Maximum (25 kyr – 14 kyr BP)*

During the Last Glacial Maximum (LGM) period, or the last great glaciation of the Pleistocene period approximately 25 000 years before present (yr BP), large ice sheets covered much of the northern Hemisphere. Growth and decay of ice sheets through the Quaternary period were driven primarily through orbital changes, which affect the amount of incoming solar radiation (insolation) received during the summer melt season. Maximum ice volumes during the LGM occurred at the trough of summer insolation in the northern hemisphere (Clark et al., 2009).

At the height of the LGM, much of Canada was covered by the Laurentide Ice Sheet, which originated in northeast Canada. The Cordilleran Ice Sheet, which coalesced from mountain glaciers in the Coast Mountains and the Rockies, covered most of British Columbia, and extended out over Vancouver Island and Haida Gwaii (Figure 1; Clague and James, 2002). Available evidence suggests that the Cordilleran Ice Sheet reached its maximum extent around 14.5 kyr BP (Ryder et al., 1991).

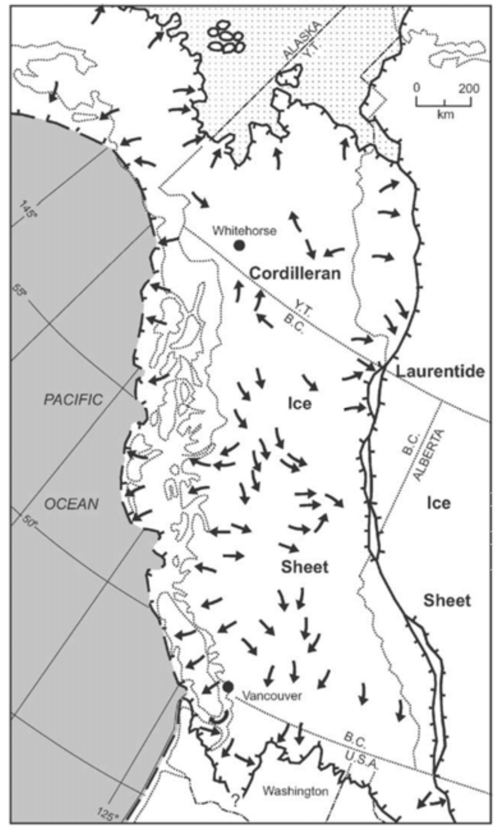



**Figure 2:** Maximum extent of the Cordilleran Ice Sheet during the Last Glacial Maximum, approximately 18 – 15 kyr BP (adapted from Clague and James, 2002)

## *5.2 Deglaciation (14 kyr – 10 kyr)*

Cordilleran ice sheet decay began at approximately 14 kyr BP (Ryder et al., 1991), due in part to increases in summertime insolation (Clark et al., 2009). Ice sheet instabilities developed in response to increased sea levels, and marine-terminating glaciers along the west coast rapidly calved back to protected bays. By approximately 11.5 kyr BP, deglaciation was essentially complete (Ryder et al., 1991), and a rapid deglaciation is supported by observed rates of uplift in southwestern B.C. (Clague and James, 2002).

## *5.3 Hypsithermal (9 kyr – 6 kyr)*

Following the deglaciation of the Cordilleran Ice Sheet, evidence exists for active alpine glaciation and stagnant glacier tongues in in interior valleys (Clague and James, 2002). The transition to a warm and dry period known as the Hypsithermal occurred by ca. 9 kyr BP. A northward shift of the jet stream resulted in warmer temperatures across much of British Columbia and the Yukon. Temperatures in southwestern British Columbia, for example, were approximately 3-4C warmer than present during the Hypsithermal (Dyke, 2005). Warm temperatures likely resulted in the significant retreat of alpine ice masses in northwestern British Columbia during this period, which may be relevant for archaeological studies. Small glaciers in the Canadian Rockies, for example, may have disappeared completely (Osborn and Gerloff, 1997).

## *5.4 Neoglaciation (6 kyr – 0.1 kyr BP)*

The period subsequent to the Hypsithermal, known as the Neoglacial, was characterized by cooler and wetter conditions (Luckman, 1993, Mann and Hamilton, 1995) and glacier expansions throughout the western Cordillera. Several phases of glacier expansion in this period have been identified:

- The “Garibaldi” expansion occurred between 6 kyr and 5 kyr BP (Ryder and Thompson, 1986)
- The “Tiedemann” advance occurred between 3.3 and 1.9 kyr BP (Ryder and Thompson, 1986)
- The “Little Ice Age” advance, which was initiated prior to approximately 750 years BP (Jackson et al., 2008). Greatest glacier extents during the Holocene occurred during the Little Ice Age between 240 and 100 years BP.
- Temperatures reconstructed from tree ring data at the Columbia Icefield suggest that average temperatures during the Little Ice Age were 0.7 – 1.4 C cooler than the 1961-1990 mean.
- At the project site, evidence for relatively recent Little Ice Age glacier extents are highly visible: polished bedrock in the glacier forefield; large, fresh lateral and terminal moraines; vegetation trimlines.

### *5.5 Little Ice Age – Present*

Since end of the Little Ice Age, rapid increases in temperature have resulted in dramatic reductions in mountain glacier volumes worldwide. The greatest changes, however, have occurred at lower elevations, with significant downwasting (lowering of the glacier surface elevation due to melt) and simultaneous glacier retreat. At long-term glacier mass balance sites, slight thickening or little to no change has been observed at the highest elevations (Dyurgerov and Meier, 2000) despite the mean temperature increases, which suggests that current glacier conditions at these elevations might not be much different from those observed during the past 1000 years. This point may have direct relevance on the likelihood of finding archaeological materials at high elevations.

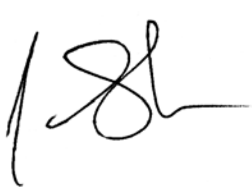
## 6 Summary

In heavily glaciated regions, the probability of finding human remains or archaeological materials on the surface of an actively moving alpine glacier is small. While warmer conditions and reduced glacier extents between 6000 and 9000 years BP may have allowed for greater human activity in the study area, subsequent glacier advancement during the late Holocene (3000 – 100 years BP) would likely remove any traces left in the current glacier forefields . If any evidence of human activity is to be found, it is my opinion that it will most likely be located on or adjacent to small or stagnant glaciers in the study area, at an elevation that permits preservation of organic materials, and in sheltered recesses or depressions.

## 7 Closure

This memorandum was prepared for Rescan Environmental Ltd. The materials within this document reflect my judgement and opinion in light of information available at the time of preparation. I accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

Yours sincerely,



Joseph Shea, M.Sc., PhD

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# APPENDIX I
# XRF ANALYSIS

# Simon Fraser University
# Department of Archaeology
# X-Ray Fluorescence Report

***Dr. Rudy Reimer- Simon Fraser University Department of Archaeology***

*Abstract: Six artifacts from three sites (HcTo1, HdTk4 and HTo7) submitted for energy dispersive X-Ray fluorescence element analysis. The samples were prepared and analyzed at the Department of Archaeology, Simon Fraser University, Burnaby BC. All samples assign to a single source-Mount Edziza but from multiple flows.*

## Analytical Methods

X-Ray Fluorescence (XRF) is a nondestructive technique that is well suited to the trace element analysis of obsidian and other materials. This analysis used a Bruker Tracer III-V+ portable XRF spectrometer. The system is equipped with a Peltier cooled Ag-free SiPIN, resolution ~175eV @ 5.9 KeV in an area of 12 mm. The tube's power supply driven by a 40 kV 1mA with a range of 4 to 40 kV. For major and trace elements including Rb, Sr, Y, Zr, and Nb reported in Table 1. I used a filter made of 0.003'' Cu, 0.001'' Ti and 0.012 Al with instrument power settings at 40 kV and 13 micro amps with no vacuum system (i.e. not analyzing light elements). These settings allow X-rays from 17-40 keV to reach the sample, thus efficiently exciting elements from Fe to Mo. These elements are the most useful to identify the origins of igneous rock such as obsidian. All samples ran for a total of 180 seconds, ensuring accurate and precise calculation of elemental peak data.

## Results of XRF Analysis

Diagnostic trace element values most common to characterize obsidian are compared directly to those for known and previously known obsidian sources in the Simon Fraser University, Department of Archaeology reference collection and other known obsidian source values reported in the literature and unpublished elemental data collected through the analysis of other labs. Artifacts are correlated to a parent obsidian sources or geochemical group if elemental values fall within two or three standard deviations of analytical uncertainty, in this case two (95%), of the known upper and lower limits of chemical variability of known sources (Figures 1). Further statistical testing of characterization testing used principle component analysis (Figure 2) of all ten elements examined in this study that confirms characterization results in Figure 1. PCA accounts for 80.8% of the variability in all source and artifact samples. One geochemical group shown in Figure 1 correlated with known obsidian sources correlate. Mount

Edziza source materials are open squares and colored dots within and outside the Edziza source group are artifacts. Results of analysis demonstrate that four assign to a documented flow on the Mount Edziza Source of northwestern British Columbia, with two originating from a flow no longer present in the source collection library- but likely originate from Mount Edziza (Carlson 1994; Fladmark 1984, 1986; Godfrey-Smith 1986; Moss et al. 1992).

Table 1. Elemental concentrations for samples, note high Zr concentrations.

| Artifact | Mn | Fe | Zn | Ga | Th | Rb | Sr | Y | Zr | Nb |
|---|---|---|---|---|---|---|---|---|---|---|
| HcTo1-7 | 378 | 17940 | 200 | 17 | 24 | 177 | 3 | 102 | 1015 | 113 |
| HcTo1-1 | 261 | 15450 | 168 | 22 | 18 | 159 | 4 | 93 | 892 | 101 |
| HdTk4-1 | 564 | 29537 | 346 | 16 | 33 | 245 | 4 | 131 | 1157 | 121 |
| HdTo7-1 | 488 | 21793 | 229 | 22 | 26 | 212 | 4 | 122 | 1149 | 132 |
| HdTo7-4 | 379 | 21211 | 225 | 22 | 28 | 212 | 5 | 122 | 1145 | 128 |
| HcTo1-13 | 439 | 25082 | 282 | 26 | 31 | 242 | 4 | 130 | 1168 | 133 |

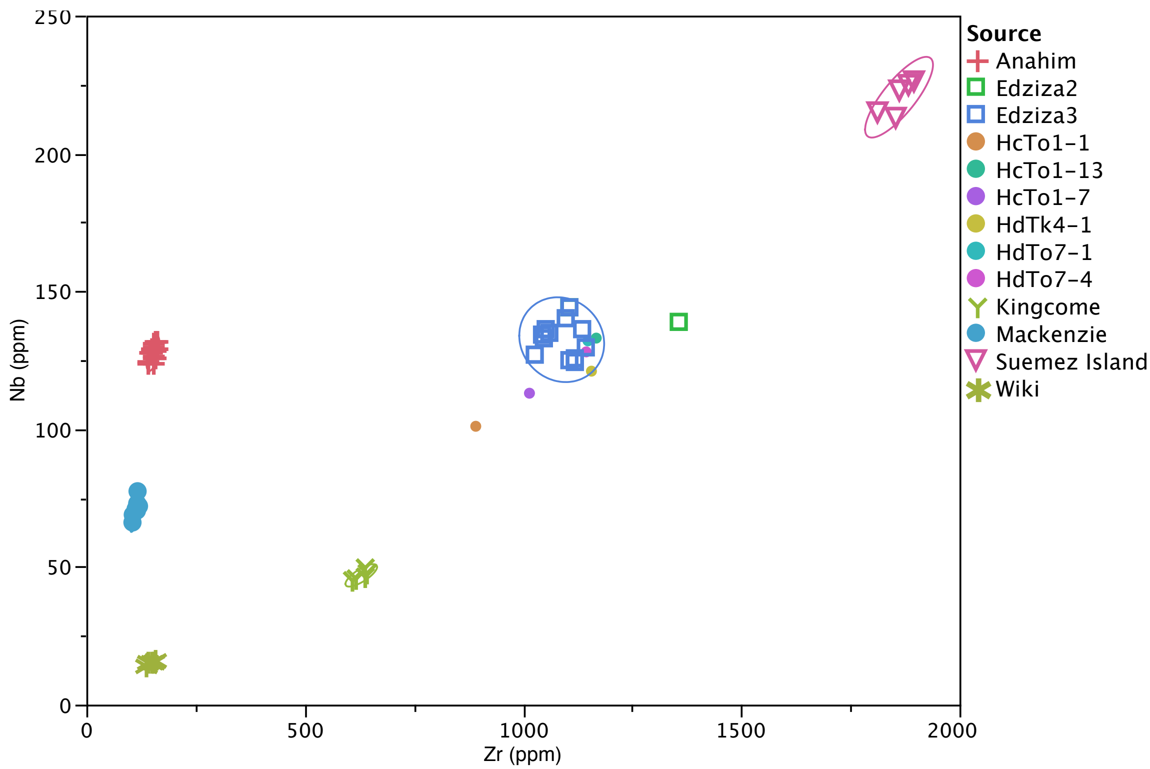


Figure 1. Biplot of Zr and Nb for all samples. Note four samples match closely to Edziza, while two are distant. Likely these materials are from another flow on Edziza.

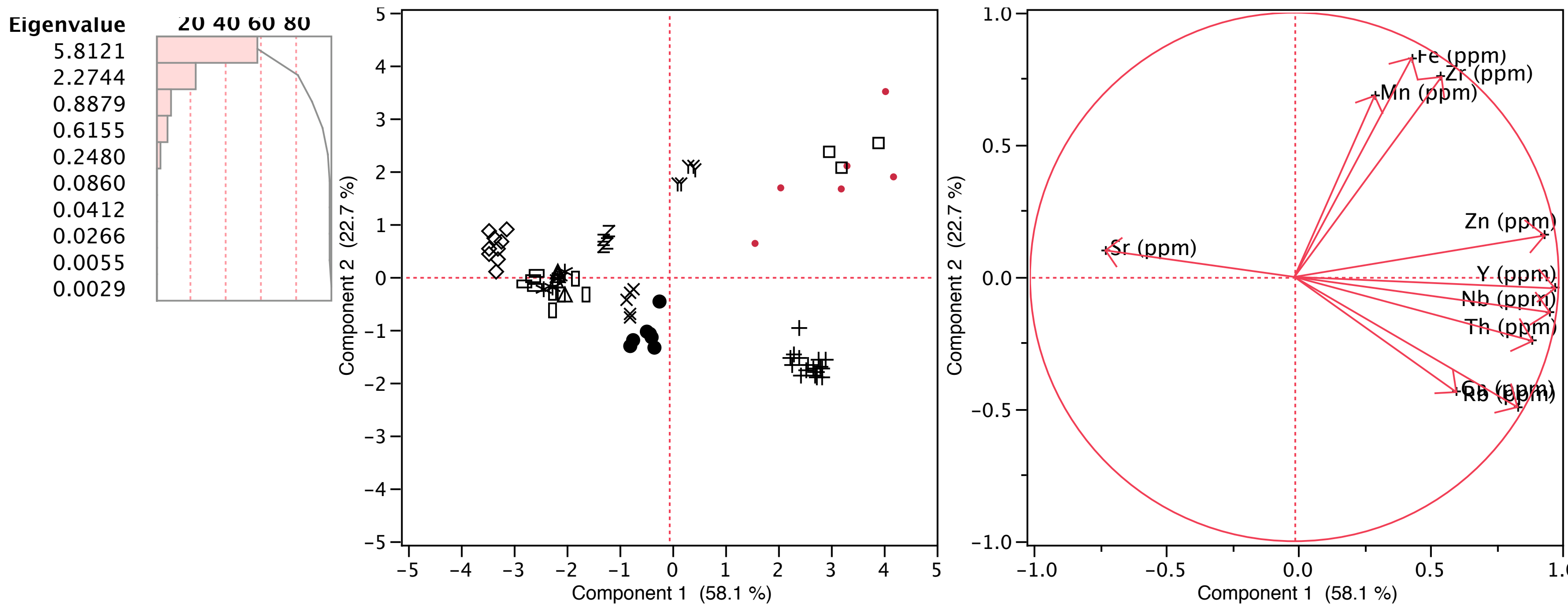


Figure 2. PCA of six samples in this analysis, note the high Zr values drive the separation of materials to the upper right.

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