Ecological Landscape Classification and Rare Plant Assessment Report for the Clinton Creek Mine Site

(Photo: L. Turney)

Prepared for:

Government of Yukon, Assessment and Abandoned Mines

Box 2703, Whitehorse Yukon Y1A 2C6

Prepared by:

ARDEA BIOLOGICAL CONSULTING
Smithers, BC

Ecological Logistics & Research Ltd.
121D Platinum Road
Whitehorse, Yukon Y1A 5M3

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Contributors

The Ecological Landscape Classification and Rare Plant Assessment project was managed by Ecological Logistics & Research Ltd. (ELR), in collaboration with Ardea Biological Consulting Ltd. (Ardea), with support from Irene Ronalds, R.P.Bio., Palmer Environmental Consulting Group Inc. (Palmer) and Lee Mennell. The following were involved in ensuring the success of this project:

Project Management	Chris Jastrebski, R.P.Bio. (ELR); Laurence Turney, R.P.Bio. (Ardea)
Photo Interpretation and Polygon Delineation	Bioterrain: Courtenay Brown, G.I.T. (Palmer) ELC: Irene Ronalds, R.P.Bio.
Field Program	ELC Program: Laurence Turney, R.P.Bio.; Irene Ronalds, R.P.Bio,; Bioterrain: Courtenay Brown, G.I.T. Rare Plants: Lee Mennell (ELR)
Data Entry and Compilation	Courtenay Brown, G.I.T.; Irene Ronalds, R.P.Bio.; Lee Mennell; Lis Rach (Ardea) and Jennifer Atkins (Ardea)
Spatial Data Analysis and Mapping	Laurence Turney, R.P.Bio.; Lis Rach
Authorship	Laurence Turney, R.P.Bio.; Irene Ronalds, R.P.Bio.; Robin McKillop, P.Geo. (Palmer)
Review	Chris Jastrebski, R.P.Bio.

Disclaimer

This report has been prepared by the authors under the direction of Ardea Biological Consulting Ltd. (Ardea) for the Government of Yukon, Assessment and Abandoned Mines. (the Client) to provide bioterrain, ecological land classification, soils and rare plants information for the abandoned asbestos mine at Clinton Creek. The information contained in this report has been obtained and prepared in accordance with generally accepted biological survey standards and is intended for the exclusive use of the Client. The information contained in this report is dependent on the conditions at the time and any recommendations or conclusions are based on the author's best judgement at the time of preparation. The Client acknowledges that ecological conditions can change over time and that the conclusions and recommendations outlined in this report are time sensitive.

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ARDEA BIOLOGICAL CONSULTING
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

INTRODUCTION

The Clinton Creek Mine Site is a former asbestos mine, located approximately 75 km northwest of Dawson City and is within the Traditional Territory of the Tr'ondëk Hwëch'in. The mine was an open pit operation, owned and operated by Cassiar Asbestos Corporation Limited for 10 years from 1967 to 1978. Approximately 16 million tonnes of serpentinite rock containing 940,000 tonnes of white asbestos (known as chrysotile) was removed from three pits at the mine site (EMR 2016a).

In 1974, portions of a 60 million tonne waste rock pile on the south slope above Clinton Creek slid into the Clinton Creek valley, blocking the creek and creating a lake (Hudgeon Lake) in the valley upstream of the slide. This lake is anoxic at lower depths due to decomposing vegetation at the lake bottom, with fish unable to survive in the lower depths. Approximately 10 million tonnes of tailings from the mine operation were piled near Wolverine Creek and in 1974 these tailings slid into the creek, partially blocking the creek and creating several small ponds. Tailings have continued to erode and wash downstream, and in 1985 the north portion of the tailings deposit slid, restricting Wolverine Creek again (EMR 2016b).

During the late 1970s and early 1980s, the mine owner attempted to stabilize the property by constructing rock weirs, reinforcing the Clinton Creek channel and installing culverts and a gravel shield to protect the Hudgeon Lake outlet from erosion. As well, a rock channel and weirs were completed to redirect the flow of Wolverine Creek over the tailings slump. Clinton Creek broke through the reinforced channel in 1982 and it was reconstructed but a significant flood event in 1997 destroyed the channel and weir structures. During 2002, under the emergency section of the Federal Waters Act, the federal government installed gabion baskets (rock-filled mesh cages) to stabilize the Clinton Creek steam channel below Hudgeon Lake (EMR 2016a and 2016b).

Additional gabion structures were constructed and installed In 2003 and 2004 to reduce erosion and stabilize Clinton Creek. A high flow event in 2010 caused damages to the gabions and partial repairs were conducted in 2011, with a final structure repaired in 2015 by the Government of Yukon (EMR 2016b).

Currently, public access to the Clinton Creek mine site is restricted based on the recommendations of a 2012 comprehensive engineering review, which identified the site as unstable and posing a threat to human health and safety. A locked gate is installed at the mine site entrance, as well as warning signs notifying that access is prohibited (EMR 2016b).

As outlined on the EMR website (EMR 2016c), planning for the remediation of the Clinton Creek site is underway with several technical studies completed and underway. The objectives for the remediation project have been agreed to by the Government of Yukon, Government of Canada, and Tr'ondëk Hwëch'in and include:

1. Protect human health and safety;
2. Protect the environment, including land, air, water, fish and wildlife;
3. Return and/or retain the site to a state that supports community and traditional land uses;
4. Maximize local, First Nation and Yukon socio-economic benefits from the Clinton Creek project; and,
5. Minimize project related liability, risk and costs.

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Project Objectives

To aid in the selection of a closure option for a management approach for remediation of the Clinton Creek site, additional studies of existing vegetation communities and vegetation were contracted in 2016. The objectives of the studies conducted were to:

1. Identify and map vegetation communities within the Clinton Creek mine area following existing Yukon Ecological Land Classification (ELC) mapping standards;
2. Identify soil characteristics within the vegetation communities identified and mapped;
3. Complete a rare plant survey within the Clinton Creek mine area to identify any potential rare plants or potential areas that may contain them; and,
4. Complete soils and vegetation trace metals analyses on selected plant species and soils collected from the Clinton Creek mine area to document existing conditions.

In 2019, additional ecological field work was carried out to collect data to map some additional areas for habitat suitability mapping; to check and verify the ELC mapping; to update the ecosite classification to a new published classification for the area (Environment Yukon 2019) and to better describe the vegetation regenerating on the mine disturbance areas.

This report updates the previous report and provides the findings of the 2016 and 2019 field programs to map the vegetation communities within the Clinton Creek area. The report also summarizes the findings of the 2016 rare plants assessment, soils classification and plant metals analysis.

Ecological Landscape Classification

The Yukon Ecological Land Classification (ELC) Program has been evolving since 2002 and in 2013 published a five-year strategic plan that identified three main areas for the program: establish frameworks, develop standards and increase services (ELCSC 2013). During this period, mapping projects (e.g. Lipovsky and McKenna 2005, McKenna *et al.* 2010, Grods *et al.* 2012, Roberts and Turney 2012) had been completed at regional and local scales using draft and available existing Yukon guidelines/standards (e.g. Francis and Steffen 2003, Flynn and Francis 2011), but primarily following existing standards for Terrestrial Ecosystem Mapping (TEM) from British Columbia (RIC 1998a and 1998b).

When the Clinton Creek ELC was initiated in 2016, the Yukon ELC had undergone significant development with an increasing number of guidance documents available, with the most recent being the *Yukon Ecological and Landscape Classification and Mapping Guidelines (Ver. 1.0)* (Environment Yukon 2016b). At that time, the ecosites of the Klondike plateau had not yet been classified, so Ardea developed draft ecosites and descriptions based on their field plots and following the available guidelines. In 2019, Environment Yukon published the Field Guide for Ecosite Identification (Part 3) for the Klondike Plateau Boreal Low Subzone (BOLkp) (Environment Yukon 2019), in which Clinton Creek is located. This new field guide was used in the 2019 field assessments to re-assess the ecosystem information and harmonize the 2016 classification with the 2019 ecosite descriptions.

To help understand the development of the Clinton Creek ELC, a summary of the frameworks and standards available from the Yukon ELC used in the Clinton Creek ELC are provided below.

The National Ecological Framework (NEF) is a Canada-wide ecological system based on biophysical properties of large terrestrial units with similar ecological features, integrating climate, physiography landform and vegetation (ESWG 1995). The NEF provides for three levels of classification; ecozones, ecoregions, and ecodistricts. Descriptions of ecozones and

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

ecoregions for the Yukon provided in Ecoregions of the Yukon Territory (Smith *et al.* 2004), with digital polygons of the ecozones and ecoregions available from Geomatics Yukon (Geomatics Yukon 2016). The Clinton Creek site is located within the Boreal Cordillera Ecozone, in the Klondike Plateau Ecoregion, near the border of the Mackenzie Mountains and Yukon Plateau-North Ecoregions (Geomatics Yukon 2016). A proposed revision to the Ecoregions of Yukon (ELCTWG 2014), has proposed that the Mackenzie Mountains and Yukon Plateau-North ecoregions be adjusted and a new ecoregion proposed (McQuesten Highlands), which would be northwest of the Clinton Creek site.

The Yukon Bioclimate Ecosystem Classification (YBEC) Framework has both climate and site-level classification, but differs from the NEF in considering climate as the primary influence on regional vegetation ecosystem distribution and development. Areas that are influenced by similar regional climates are classified into a hierarchy of bioclimatic units, the broadest being the Bioclimatic Region and the finest level described is the Bioclimatic subzone (Figure 1) (Environment Yukon 2016b).

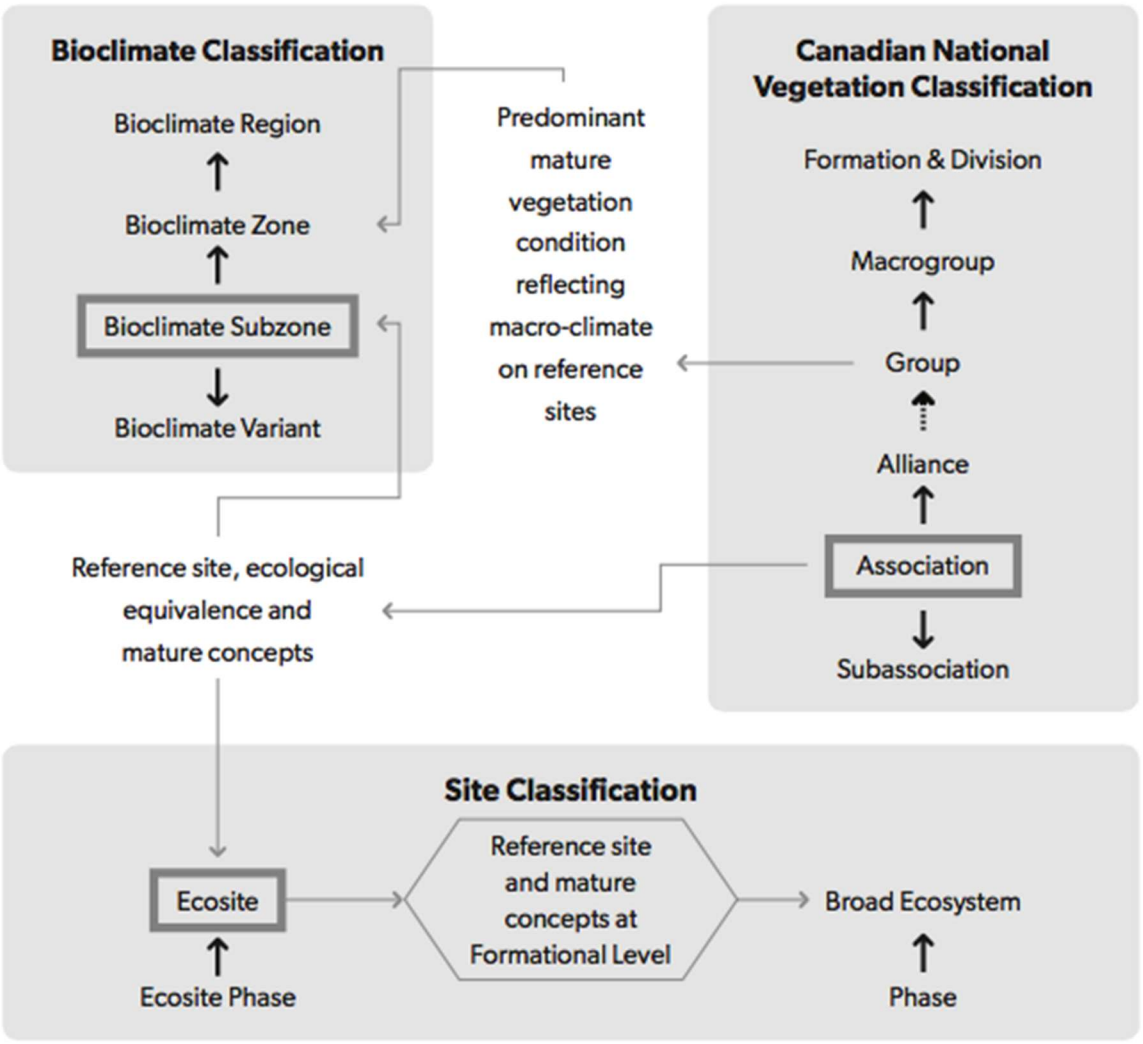

Figure 1. Structure of the Yukon Bioclimate Ecosystem Classification system (from Environment Yukon 2016b).

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Within each Bioclimate Subzone, a suite of ecosystems or 'ecosites' can be described, each with similar site conditions as expressed by soil moisture and soil nutrient conditions reflected on the landscape. Ecosites provide detailed descriptions of ecological conditions, understory vegetation, and local site characteristics. These local scale ecosites are derived by the collection and interpretation of data from individual site assessments and are considered stable and enduring. A finer detailed level of the ecosite is the "ecosite phase" reflecting the current vegetation characteristics of the ecosite as seral or structural stages (Environment Yukon 2016b).

Use of terms Ecosite and Ecosystem

Within this report, the term ecosite is used as outlined in *Yukon Ecological and Landscape Classification and Mapping Guidelines* (Environment Yukon 2016b) for a mapping unit that describes a combination of plant associations, soils, terrain and climate. It is analogous to the term ecosystem unit, which is a term used in the *Standards for Terrestrial Ecosystem Mapping British Columbia* (RIC 1998a). The term ecosystem is used in a more generic sense in this report to describe the combinations of plant associations, soils, terrain and climate that were actually found on the ground.

STUDY AREA

Location and Extent

The Clinton Creek mine site is located approximately 75 km northwest of Dawson City along Clinton Creek, which is a tributary of Fortymile River, which enters the Yukon River approximately 80 km downstream of Dawson City (Figure 2).

Access to the site is from Dawson City along the Top of the World Highway to the Clinton Creek road and across Fortymile River. The mine site is approximately 1.5 km upstream of Fortymile River, with the open pit and waste-rock piles along the south side of Clinton Creek and the old mill site, tailings area and abandoned airstrip on the north side.

The study area for the ELC mapping and rare plant surveys includes the abandoned airstrip, mine areas, access road, as well as a buffer of between 250 and 350 m around those areas (see Figure 2). The total area mapped following the 2016 field season was 1,615.6 ha, but this was reduced to 1,432.3 ha for the final mapping in 2019.

Regional Climate

The climate for the Clinton Creek area is described as strongly continental with very cold winters and relatively warm summers (Smith *et al.* 2004). The nearest regional weather station providing long term weather data is located at the Dawson City airport, approximately 75 km southeast of the Clinton Creek mine site. Temperatures range widely through the year, with daily averages ranging from -26.0°C in January to 15.7°C in July (Environment Canada 2016).

Mean annual precipitation for the area is 324.4 mm, with 38% falling as snow (averaging 166.5 cm annually), and the remaining 62% falling as rain. Precipitation occurs primarily from May to December, with peak volumes falling in July and August (Environment Canada 2016).

Daylight hours vary sharply with time of year, with the highest levels of daylight occurring around the summer solstice, and the lowest levels of daylight occurring around the winter solstice. Clinton Creek does not experience full 24-hour daylight or 24-hour darkness, but in the months around the summer solstice there are more than 21 hours of daylight, while the months around the winter solstice frequently experience less than 4 hours of daylight a day (WeatherSpark 2016).

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

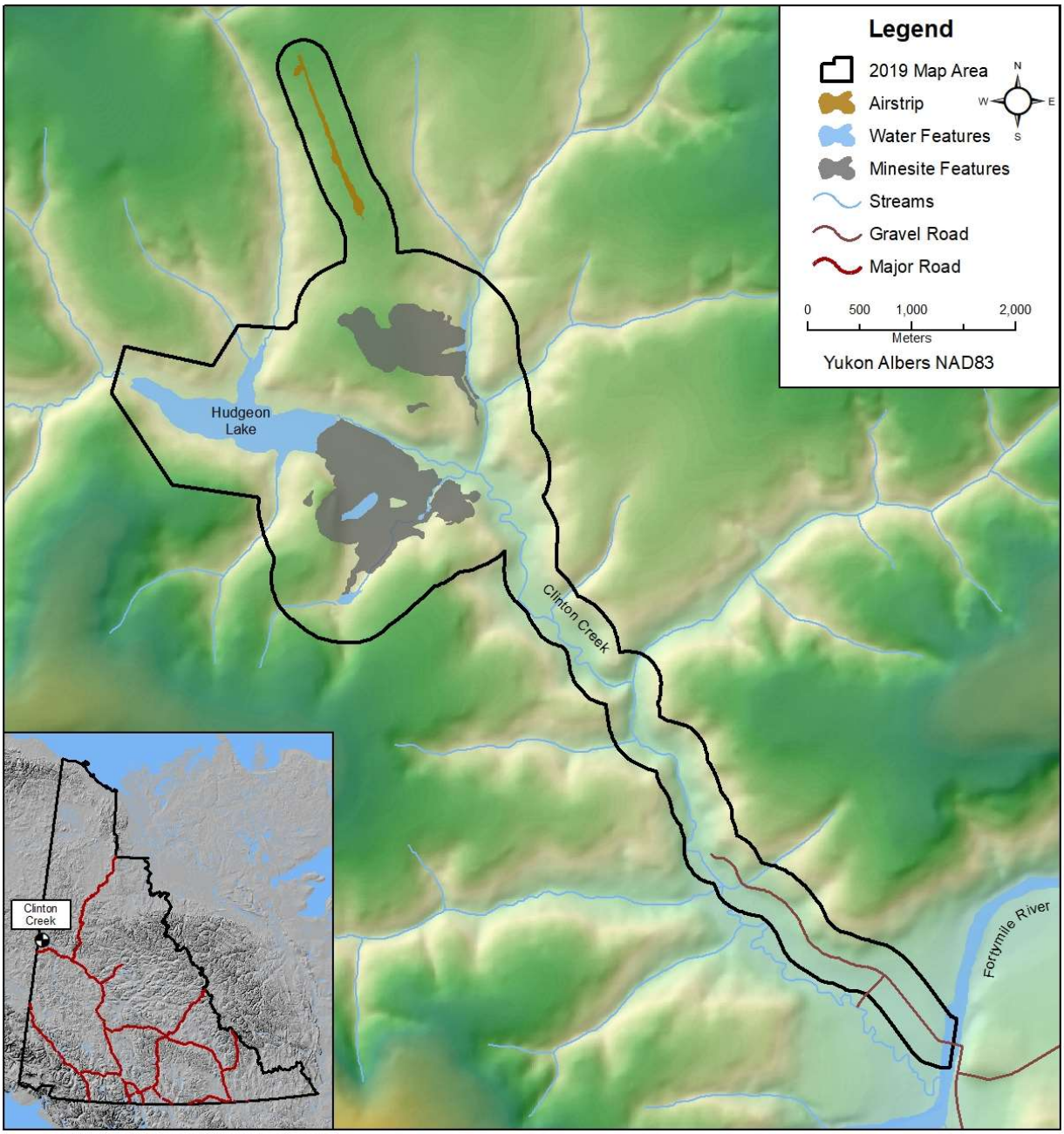

Figure 2. Location of the Clinton Creek site.

Physiography and Geology

The abandoned Clinton Creek mine is located in the Klondike Plateau physiographic region, in the Omineca morphologic belt. The Klondike Plateau physiographic region is one of several remnant unglaciated erosion surfaces dissected by steep valleys in the northwest region of the Omineca Belt (McKenna and Smith 2004). The unglaciated plateaux of this ecoregion have been exposed to the elements for approximately 15 million years, and have thus undergone extensive weathering and dissection (Smith *et al.* 2004). Paleozoic-aged metamorphic, volcanic and ultramafic rocks underlie the study area, the most extensive of which belong to an unnamed Carboniferous- to Permian-aged (353 to 250 million years ago) unit comprising basalt, diorite,

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

gabbro, greenstone, argillite, siltstone, tuff, dunit, periodite and serpentinite (Gordey and Makepeace 2003).

A combination of fluvial erosion, eolian deposition and colluviation are largely responsible for the character the landscape exhibits today. Streams and rivers cut a dendritic to structurally-controlled drainage network, which formed deep, V-shaped valleys and relatively steep hillsides. Mass wasting has occurred through regular colluvial processes (e.g., creep, landslides), as well as periglacial activity (e.g., solifluction, slopewash). Wind-blown silt and very fine sand were deposited across the region during the last glaciation, when katabatic winds draining off the ice sheets to the south and east picked up material from the outwash plains at their termini. Surficial geology generally comprises variable thicknesses of colluvium and weathered bedrock deposits; a cap of variably-thick organic material is ubiquitous on permafrost slopes (Smith *et al.* 2004). The deposits associated with modern fluvial activity, remnant glaciofluvial terraces, and pockets of re-sedimented eolian materials (loess) are present in lesser amounts.

Permafrost

Permafrost is extensive throughout the Klondike Plateau (Heginbottom 1995), including within the Clinton Creek study area. At a local scale, its distribution is related to slope aspect, angle and shape, soil texture and moisture, and the thickness and type of organic cover (Williams 1995, Williams and Burn 1996). Elevation exhibits less of an obvious control on the distribution of permafrost in the study area, largely due to the extreme temperature inversions that develop for prolonged periods in winter and drop valley temperatures tens of degrees below adjacent uplands. Permafrost is most common on north-facing slopes with thick organic cover and in fine-textured colluvial aprons widespread in toe-slope positions (Bond and Lipovsky 2011, McKillop *et al.* 2013). Permafrost may be absent from deposits of any aspect if surficial materials are sufficiently well-drained (Smith *et al.* 2004).

Active layer thickness varies spatially and temporally, typically reaching a maximum of up to about 2 m by end of summer (Smith *et al.* 2004, Bond and Lipovsky, 2011). The thinnest active layers are typically encountered in areas with the thickest organic covers and lowest solar insolation (McKillop *et al.* 2013). The ice content of permafrost is also highly variable within the region. Pore ice is common in all areas with permafrost, but segregated and massive ice occur in some valley-bottom settings based on recognizable expressions of thermokarst.

Soils

Soil development within the Clinton Creek study area largely reflects the drainage and nutrient regimes, as well as the local stability, of different settings. Areas of shallow permafrost and high water-tables result in very poorly to imperfectly drained soils, in which Cryosols and Gleysols predominate. Areas recurrently disturbed by periglacial or fluvial processes exhibit Regosolic soils. Brunisols are more common on well drained hillsides and ridge or spur crests.

Ecology and Vegetation

The vegetation within the Clinton Creek study area have been influenced by the climatic and physiographic conditions of the area. These forested areas are prone to wildfire, temperature extremes and permafrost, creating a mosaic of closed and open coniferous and mixed forests (Environment Yukon 2016a). White spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) forests are found throughout the study area on southern aspects and level moist sites, while black spruce (*Picea mariana*) and Alaska birch (*Betula neoalaskana*) are found on cooler, north-facing permafrost affected slopes (Grods *et al.* 2012).

Floodplain forests along larger creek and river valleys (e.g. Fortymile River) provide the most productive sites in the study area, containing large diameter white spruce and balsam poplar (*Populus balsamifera*). Wetland communities, including swamps, marshes, fens and bogs, and

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

occasional shallow water ponds, form due to poor drainage, permafrost and active streams (Grods *et al.* 2012).

Dry, south-facing slopes are prone to moisture deficits and frequent fires, creating small grassland, talus and shrublands dominated by common juniper (*Juniper comminus)* and stunted trembling aspen.

METHODS

Acquisition and Preparation of Digital Data

During the project initiation period, digital mapping data was obtained from the Client (ELR) as well as searches of available data from the Geomatics Yukon website (www.geomaticsyukon.ca /data) were completed. The available satellite imagery outlined in Table 1 were acquired along with digital features such as watercourses, waterbodies, contours and digital elevation models and hillshade models.

Table 1. Available satellite imagery for the Clinton Creek area.

Image Name	Pixel Size (m)	Cloud Cover (%)	Source	Sensor
GeoEye_ClintonCk_MineSite_26July2012	0.5	15	Assessment and Abandoned Mines	GeoEye-1
QuickBird_ClintonCK_beta_01Sep2008[1]	0.6	0		QuickBird
GeoEye_Klondike_90_2_0-2_15July2009_utm7	0.5	0	Yukon Geological Survey / Geomatics Yukon	GeoEye-1
GeoEye_Klondike_90_3_top_15July2009_utm7[1]	0.5	0		GeoEye-1

Note: 1) Not obtained until October 2016 for use in ecosite interpretation

Airphotos (Table 2) were obtained as digital scans from the Yukon Energy, Mines and Resources Library (EMRL) and processed by Alberta Geomatics & Mapping Consultants Inc. (AGMC) as digital stereo aerial photos for use in digital stereo photo-interpretation software (i.e. PurVIEW).

Table 2. Airphotos scanned for bioterrain and ECL photo interpretation.

Roll	Line	Photo #	# Photos	Year	Scale
127995	N/A	88-95	8	1993	1:20,000
A28355	L-65	60-62	3	1998	1:25,000

Pre-Field Activities

Bioterrain Classification

A review of available information pertinent to bioterrain mapping within the Clinton Creek area was completed. The review included available bedrock and surficial geology mapping; permafrost probability mapping; the *Soil Landscapes of Canad*a; and Klondike Plateau ecoregion characterizations (Smith *et al.* 2004).

Preliminary bioterrain polygons were mapped by Courtenay Brown within the study area at a scale of 1:10,000, using stereoscopic aerial photography and/or satellite imagery using a PurVIEW softcopy photo-interpretation workstation. Polygons were delineated based on surficial materials, textures, surface expressions, geomorphological processes and surface drainage, with additional consideration for aspect and slope morphology (i.e., position, shape and steepness). On-site symbols were used to identify any important point or linear features too small to be mapped as polygons. Mapping protocols generally followed the *Terrain Classification System for British Columbia* (Howes and Kenk 1997) and the *Yukon Ecological and Landscape Classification and Mapping Guidelines (Ver. 1.0)* (Yukon Environment 2016b).

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Ecosystem Classification

Prior to initiation of the ecosystem classification work, available information on potential ecosystems within the study area were reviewed. These reports included descriptions of the Klondike Plateau ecoregion in *Ecoregions of the Yukon Territory, Biophysical Properties of Yukon Landscapes* (Smith *et al.* 2004), *Bioclimate, Ecodistrict and Ecologically Significant Features Mapping for the Dawson Planning Region, Yukon* (McKenna *et al.* 2010), the digital Broad Ecosystem Units - West Central Region (Geomatics Yukon 2016), and *Regional Ecosystems of West-Central Yukon, Part 1: Ecosystem Descriptions* (Grods *et al.* 2012).

Laurence Turney and Irene Ronalds worked with the bioterrain mapper, reviewing the initial bioterrain polygons delineated to identify important ecological features to adjust the terrain polygon boundaries. Once the initial bioterrain polygons were identified, they were adjusted and/or divided to delineate preliminary terrestrial and wetland ecosites and vegetation associations using a PurVIEW-enabled, softcopy photo-interpretation workstation and the available digital airphotos and/or satellite imagery. The preliminary ecosite classifications and descriptions were based on vegetation patterns, slope, aspect and the bioterrain information and followed those identified in Grods *et al.* (2012).

Following field work in 2019, field data from 2016 and 2019 was reviewed and harmonised with the *Field Guide to Ecosite Identification – Part 3 Klondike Plateau Boreal Low Subzone (BOLkp)* (Environment Yukon 2019). All ecosite descriptions were updated to conform to the new field guide for the BOLkp (Appendix D). For each ecosite, the site description reflects the new classification as well as any anomalies unique to the Clinton Creek mapping area.

Rare Plants Survey

Prior to the rare plant field survey, a list of potential rare plant species that could occur in the Clinton Creek study area was created from review of the *Yukon Conservation Data Centre* (CDC); checklists for *Reportable, Watched and Tracked Plant Species* (Environment Yukon 2016c, 2016d) and *Rare Plant Information Sheets* (Yukon CDC). Searches of the Committee on the Status of Wildlife in Canada (COSEWIC 2016) and the *Species at Risk (SARA) Public Registry* (Environment Canada 2016b) were also completed to identify any potential plant species at risk in the area. Based on these reviews of potential rare plant species and a review of the potential habitats within the Clinton Creek area, a list of rare plant species within two general habitat types where rare plant species could be found was identified (Table 3).

Table 3. Potential rare plants to search for in two general habitat types found within the Clinton Creek.

Habitat Type	Common Name	Scientific Name
Dry Rocky Exposed Slope Habitats	Green Spleenwort	*Asplenium trichomanes-ramosum*
	Murray's draba	*Draba murrayi*
	Dawson Wallflower	*Erysimum angustatum*
	Coffee creek Scorpionweed	*Phacelia mollis*
	Macouns Podistera	*Podistera macounii*
	Yukon Podistera	*Podistera yukonensis*
Moist Riparian Areas / Wetlands	Spiked Saxifrage	*Micrantes spicata*
	Williams Catchfly	*Silene williamsii*
	Spotted Lady Slipper	*Cypripedium guttatum*

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Vegetation Trace Metals Sampling

Plant species important to First Nations or wildlife were chosen for trace metals analysis. These plants include willow (important for moose feeding), berries (important food for First Nations and bears) and medicinal plants important to First Nations (see Uprety *et al.* 2012, Turner 2014, Jernigan 2014).

Vegetation trace metals samples targets were based on Health Canada (2011) recommendations. A target of five to ten plant species and a minimum of three trace metal plant samples collected for each species of interest for a total of up to 30 plant samples. Composite samples were planned for, taken from three (3) to five (5) plants, consisting of new growth (leaves and stems) or berries. A minimum of 30 g of leafy material or berries was to be collected in each sample.

Field Assessments

Bioterrain and Ecosystem Classification

The primary bioterrain and ecosystem field assessments were done by Courtenay Brown, Laurence Turney and Irene Ronalds from August 10 to 15, 2016. Assessment methods followed the methodologies outlined in the BC *Field Manual for Describing Terrestrial Ecosystems* (BCMFR and BCMOE 2010). The crew walked transects across the mapped area, conducting plots within homogenous bioterrain or ecosystem types as required. All plots were 400 m^2 and were standardized as 20 m x 20 m plots. Where ecosites or terrain features occurred as narrow bands, plots were made to fit the terrain or ecological community type and retain a size of 400 m^2. A combination of full, site visit and visual plots were completed using the methods outlined in BCMFR and BCMOE (2010) and the appropriate field card.

Preliminary terrain polygons were reviewed and classified based on the criteria outlined in Howes and Kenk (1997) using visual assessments at each plot. Shallow soil pits (<1 m) were dug with a spade to obtain terrain and soil classification data. This data was used to classify soils based on the *Canadian System of Soil Classification (3rd Edition)* (SCWG 1998) to at least the Great Group level. Photographs were taken at all sites and of any additional noteworthy geomorphological features.

To aid in soil classification, soil samples were collected from the soil pits of representative soil types for nutrient and trace metals analysis, as well as particle size classification and proportions. Soils samples were collected using a stainless-steel trowel that was disinfected with alcohol and distilled water between soil pits. Samples were obtained from the rooting layer and placed in a new zip-lock storage bag, labelled with the plot number, date and time collected. Samples were placed in a cooler at the end of the day with ice or cooler packs.

Terrestrial and wetland ecosystem plots were selected in homogenous areas within the preliminary mapped polygons. Since most wetlands and many terrestrial areas commonly occur as complexes of community types, homogenous plots ensured that the plot sites were useful for ecosite classification. Digital geo-referenced photographs representing the ecosystem plots and soil pits were taken, a ribbon was used to mark the plot centre, and the location was recorded as UTM coordinates using a handheld GPS. Terrestrial and wetland ecosystems were classified using available guides and previous studies (e.g. Yukon Environment 2016a, Ronalds *et al.* 2016, McKenna *et al.* 2010, Grods *et al.* 2012, MacKenzie and Moran 2004, Bond *et al.* 1992).

Additional field sampling was conducted by Laurence Turney and Irene Ronalds from July 24 to 27, 2019 to allow mapping of some additional areas, harmonize the previous ecosystem data to the 2019 field guide (Environment Yukon 2019) and better describe the regenerating vegetation on the mine disturbance areas.

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

All data cards for both the 2016 and 2019 field sessions were reviewed and corrected if required at the end of each field day.

Rare Plants Survey

Rare plant surveys followed the methods outlined by the Alberta Native Plant Council (ANPC 2000) and Penny and Klinkenberg (2011). Surveys were completed by Lee Mennell in conjunction with the bioterrain and ecosystem field assessments from August 12th to 15th, 2016.

At each survey/sampling location, field notes were taken to ensure that a summary of the habitat characteristics and the associated plant species were recorded. If a rare plant or suspected rare plant was observed, a description of the species observed, the number of individuals or area they are contained in and general condition/health of the population was recorded. Rare plants were identified in-situ and were not removed from the site. The location of all sample plots was recorded as UTM coordinates using a hand-held GPS unit, and geo-referenced photographs taken of the survey area and any plant species of interest.

Vegetation Trace Metals Sampling

Vegetation trace metals sampling was completed at sites where sufficient amounts of plants or berries important to First Nations or wildlife were available. At each sampling site, composite samples were collected by taking clippings from up to five plants, each located within the sample site and growing under similar conditions (moisture, aspect, slope, sunlight, vigor etc.). Although composite samples have lower variability than individual samples, for many plants, insufficient plant material or berries can be collected from an individual plant, and a composite sample is required and was considered to be more representative of what would be consumed by humans or browsing wildlife.

Sampling personnel wore disposable, powder-free nitrile gloves and all vegetation samples were collected in new zip-lock storage bags, labelled with the plot number, date and time collected and the plant species collected. Samples were not washed. Clippers used in the collection were decontaminated with alcohol and water prior to and between sampling each species and between plots. Vegetation was clipped using stainless steel clippers directly into sample bags, so that vegetation handling was minimized. All samples were stored in coolers during the sample day with ice and frozen once the crews returned to camp.

Post Field Activities

Bioterrain and Ecosystem Classification

All data cards were entered into the BC standardized plot card system VPro for data management and analyses of the bioterrain, ecosite, soils and vegetation plot data. All of the plot data were reviewed to detect anomalous terrain, ecosite, vegetation or soil coding errors and corrected. Plot locations were mapped and verified by the team members that conducted the plot and the field photos were organized by plot.

The preliminary bioterrain and ecosystem mapping polygons were updated and refined based on the results of the field program data from 2016 and 2019, with changes to polygon boundaries and attributes completed as necessary. Bioterrain and ecosite (both terrestrial and wetland) unit descriptions developed in 2016, were updated to reflect the new ELC for the BOLkp. In most cases the ecosite groups developed in 2016 fit quite well with the new classification. The new classification provides a much more comprehensive classification for wetland sites.

Once a final polygon and attribute database was completed for the bioterrain and ecosite layers, bioterrain and ecosite maps were produced at a 10:000 scale with appropriate labels. Area summaries for bioterrain and ecosite types were also completed.

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Rare Plant Surveys

All field notes, photos and plot locations related to the rare plants survey were reviewed and organized for data analysis and compilation. Plot data was entered into an Excel spreadsheet and locations of known or potential rare plants were mapped and a summary of the survey methods and results prepared.

Trace Metals and Particle Size Analyses

Chain-of-custody (COC) documents were filled out prior to shipping of the soils and vegetation samples and the COC accompanied the samples to the lab. Soils samples were shipped by air to Pacific Soils Analysis Inc. in Vancouver, BC for trace metal and particle size analyses, while vegetation samples were shipped by air to Maxxam Analytics in Vancouver, BC for trace metals analysis. Confirmation of the samples being received at the lab were obtained within 24 hours of receipt and results of the analyses were received within 30 days of sample receipt.

Soils analyses were completed using a variety of standard laboratory methods outlined in Appendix A (Table A-1) along with the Reportable Detection Limits (RDLs). Vegetation trace metals were analyzed using *Collision/Reaction Cell Inductively Coupled Plasma Mass Spectrometry* (CRC ICPMS) to assess concentrations of 31 trace metals in the plant tissues. The trace metal names, symbols and the wet and dry weight RDLs for the metals assessed for the plant tissues are provided in Appendix A (Table A-2).

RESULTS

Survey Intensity

A total of 78 plots were completed from August 10 to 15, 2016, and an additional 79 plots were completed from July 24 to 28, 2019 within the Clinton Creek study area to collect bioterrain, soils and ecosystem data for the bioterrain and ELC mapping (Figure 3). A total of 60 polygons were reviewed, with several ecosystems reviewed within some polygons, for a 22.5% polygon visitation rate. This translates to a survey intensity (SI) level of less than 2 under the Yukon guidelines (Environment Yukon 2016b). The number of full, ground and visual plots was 4:57:96, which translates to a ratio of 3:36:60. The Yukon SI ratio for level 2 is 5:30:65, suggesting we have exceeded the ground and visual plot requirement, but were slightly below the requirement for full plots. The plot inspection rate for the Yukon SI level 2 is between 30 and 100 ha/inspection. Taking into account the change in study area boundary in 2019, our plot inspection rate was 18 ha/inspection, which is at the Yukon SI 1 level.

Overall, we feel that we have met or exceeded the Yukon SI level 2 requirements. Although more plots within some areas of the study area would have increased the survey intensity, we completed plots in a wide range of ecosystem types across the study area and collected sufficient data to accurately complete the bioterrain and ELC mapping.

Bioterrain Classification

Bioterrain classification from the air-photos resulted in a total of 378 polygons being delineated, which resulted in classification of eleven (11) general bioterrain units. Table 4 briefly outlines the units and the bioterrain labels that match those units using standard codes from Howes and Kenk (1997) along with corresponding *landform-soil type* (LST), outlined in McKillop *et al*. (2013). Appendix B provides more detailed descriptions of the major bioterrain units mapped.

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Table 4. Bioterrain units identified within the Clinton Creek study area from the 2016 mapping.

Bioterrain Unit	Observed Bioterrain Labels	Landform-Soil Type (LST)	Unit Area (ha)
Bedrock	Rh, Rk, Ru	LST 1	3.1
Weathered Bedrock	Dv, rDv, szrDv	LST 1	124.4
Thin Colluvial veneer	Cx, szCx	LST 12	41.4
Colluvial veneer	Cv, srzCV, szrCv, zrCv, zsrCv	LST 3 (permafrost)	324.6
	Cv, szrCv, zrCv	LST 4 (permafrost)	112.7
	Cv, rszCv, rzCv, srCv, zrCv	LST 11 (no permafrost)	188.7
Colluvial blanket	Cb	LST 5 (permafrost)	120.5
	Cb	LST 10 (no permafrost)	31.4
Colluvial deposits (> 1 m)	Ca, zrCa, Cf,	LST 6	40.1
Eolian deposits	Ev, szEv, zEb, zEk, zEt	n/a	43.4
Fluvial deposits	Fp, sFf, FAf, Fap, Fav, szFAp, zpsFAp, FGj, FGk, FGt, FGua,	LST 8	118.5
Organic material	O, eO, uOv	LST 7	49.3
Anthropogenic	Aa, Ab, Ah, Aj, Aju, Ak, Ap, As, At, Ath, Ats, Au, Aua, szAb, szAv	n/a	327.5
Waterbody (lake or pond)	N	n/a	89.9
		Total Area (ha)	***1,615.6***

Over half (53% [859.5 ha] of the bioterrain units in the study area were classified as colluvial materials with the majority (667.4 ha) of those being relatively thin veneers (i.e. Cv types). Approximately 127.5 ha of the study area was classified as bedrock terrain, while 327.5 ha was classified as Anthropogenic. Permafrost was identified in 1,061.6 ha (65.7%) of the study area, in a wide range of aspects and elevations.

A bioterrain map, outlining the bioterrain units shown in Table 4Table 4 is provided in Appendix C.

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

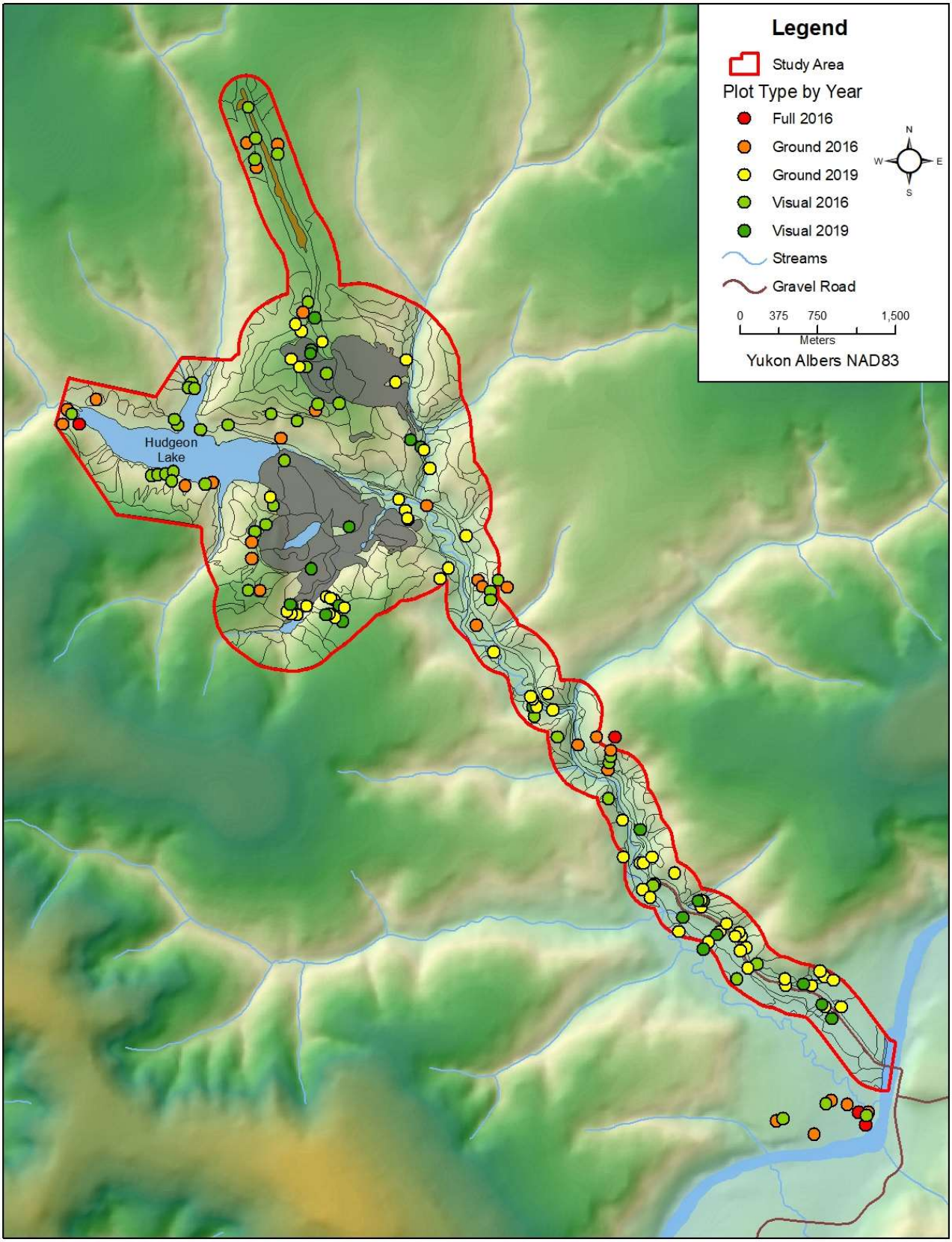

Figure 3. Locations of full, ground and visual plots within the Clinton Creek study area.

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Ecosystem Classification

A summary of the ecosites of the Clinton Creek study area is outlined in Table 5, with more detailed descriptions provided in Appendix D.

Table 5. Ecosites of the Clinton Creek study area.

Map Code	Old Code	Name	Description	SMR[1]	SNR[2]
Upland Forest Ecosites					
11	JS	Prickly Saxifrage – Lichen Rock Outcrop	Restricted to steep, warm aspects on thin rubbly colluvial veneers or bedrock. Common juniper, soapberry and shrubby cinquefoil are typical. Purple reedgrass and kinnikinnick common.	0-1	A-B
21	AP	Trembling Aspen - Purple Reedgrass	Deciduous forests found on steep, south-facing aspects, dominated by trembling aspen with occasional large white spruce. Shrub layer contains soapberry and common juniper; often good cover of purple reedgrass, pumpelly brome and altai fescue.	2-3	B-D
21	SP	White Spruce - Purple Reedgrass	Submesic to xeric conifer-dominated forest that occurs on steep, warm aspect slopes on rocky colluvial veneers. White spruce and trembling aspen, with soapberry and prickly rose shrub layer. Grasses dominate the herb layer.	2-3	B-D
01	BA	Alaska birch - Sitka Alder	Broadleaf forests that occur on cool, moderately steep north-facing slopes, often on thaw-flow events. Abundant leaf litter, seepage and soil creep create a rich, moist environment. Alaska birch and Sitka alder form a dense canopy and shrub layer, with limited herbs and mosses.	3-4	B-D
01	SS	White spruce – Aspen – Lowbush Cranberry	Mesic forests that occur on a variety of sites including permafrost-free slopes, steep north aspects and neutral aspects. A mix of white and black spruce dominate, with Alaska birch common. Shrub layer includes willows, prickly rose; moss layer is thick step and feathermosses.	3-4	B-C
31	SL	White Spruce - Labrador Tea - Feathermoss	Widespread in the study area on moderate to imperfectly drained colluvium with permafrost within 50 cm of the surface. An open canopy of white and black spruce with some Alaska birch. Shrub layer contains Labrador tea and a thick feathermoss layer insulating the soil.	5-6	A-C
32	SW	SbSwW – Horsetail Forest	An uncommon ecosite in the study area, found at the base of warm colluvial slopes with seepage. Large white spruce with an open shrub layer of Scouler's willow, prickly rose and highbush cranberry. Meadow horsetail, step moss and feathermoss blanket the forest floor.	5-6	C-D
Floodplain Ecosites					
41	BH	Balsam Poplar – Riparian Forest	Floodplain forests with large balsam poplar. The understory contains high cover of prickly rose, red-osier dogwood and highbush cranberry. Meadow horsetail is common.	5	D-E
40	SH	White Spruce – Riparian Forest	Floodplain forests with large white spruce on elevated microsites. Open understory of Scouler's willow, prickly rose and highbush cranberry. Horsetails, step moss and feathermoss blanket the forest floor.	4-5	C-E
42	RA	River Alder Riparian	Low bench floodplain tall alder shrubland that is inundated during spring freshet. Presence of river alder, willows, and bluejoint reedgrass characterize the site.	5-6	D-E

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Map Code	Old Code	Name	Description	SMR[1]	SNR[2]
Wetland Ecosites					
B03	BB	Black Spruce - Labrador Tea - Bog	This bog forest is found on cold, very poorly drained organic soils (>40 cm) over permafrost. Primarily black spruce, but some white spruce in canopy. Shrub layer includes Labrador tea, velvet-leaved blueberry and lingonberry. Sedges and peat moss are common, with cryoturbation resulting in hummocks, where lichens are common.	6-7	A-B
F05	BF	Black spruce – Tussock Sedge Fen	Poor fen forest found in frost-prone basins with organic veneers over frozen fluvial deposits on permafrost. Water table is close to surface. Trees are stunted black spruce at very low density, with green alder and scrub birch, Labrador tea common in the shrub layer. Bigelow's and soft-leaved sedge are common, along with cloudberries. The moss layer is well developed with step moss, feathermoss and sphagnum present.	6-8	B-C
S01	WS	Willow - Bluejoint Reedgrass Swamp	A swamp wetland type, these occur along creeks with surface and sub-surface flooding. Alaska willow is the common shrub. The herb layer is primarily bluejoint reedgrass and common horsetail, along with variegated scouring rush.	6-7	D-E
S02		River Alder Swamp	The River Alder Swamp unit occurs on low bench floodplain sites that experience more prolonged water saturation than River Alder Riparian.	6-7	D-E
S07		Black Spruce – Labrador Tea Swamp	These swamps occur on gentle to steep slopes, on cool to neutral aspects, where seepage over permafrost occurs. Peaty surface horizon is generally less than 30 cm thick. Black spruce, Labrador tea, and a mixed groundcover of peat moss, feathermosses and brown mosses are typical.	5-6	B-C
S08		SbSw – Red Bearberry – Brown Moss Swamp	These swamps occur on moist to wet terraces, and on cooler-aspect lower and toe slopes. Open stands of stunted black spruce and white spruce are typical.	5-7	C
M01	SE	Beaked sedge - Water sedge Marsh	A marsh type that is uncommon in the study area, found on the edges of ponds. Water and beaked sedge are prominent with a minor herb layer which includes Scheuchzer's cotton grass.	8	D
M10	BM	Bluejoint Marsh	A marsh type that develops on poorly drained loamy or sandy fluvial deposits with a fluctuating water table. Bluejoint reedgrass is the dominant cover.	6-7	D-E
Water					
LA	LA	Lake	A naturally occurring static body of water, greater than 2 m deep in some portion. The boundary for the lake is the natural high-water level.		
OW	OW	Shallow Open Water	A wetland composed of permanent shallow open water and lacking extensive emergent plant cover. The water is less than 2 m deep.		
PD	PD	Pond	A small body of water greater than 2 m deep, but not large enough to be classified as a lake (e.g., less than 50 ha).		
RI	RI	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial.		
Sparsely-vegetated					
CB	CB	Cutbank	A part of a road corridor or river course situated upslope of the road or river, which is created by excavation and/or erosion of the hillside.		
ES	ES	Exposed Soil	Any area of exposed soil that is not included in any of the other definitions. It includes areas of recent disturbance, such as mud slides, debris torrents, avalanches, and human-made disturbances (e.g., pipeline rights-of-way) where vegetation cover is less than 5%.		

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Map Code	Old Code	Name	Description	SMR[1]	SNR[2]
GB	GB	Gravel Bar	An elongated landform generated by waves and currents and usually running parallel to the shore. It is composed of unconsolidated small rounded cobbles, pebbles, stones, and sand.		
MU	MU	Mudflats	Flat plain-like areas dominated by fine-textured sediments. These areas are found in association with freshwater, saltwater or estuarine bays (at low tide), lakes, ponds, rivers and streams.		
TA	TA	Talus	Angular rock fragments of any size accumulated at the foot of steep rock slopes as a result of successive rock falls. It is a type of colluvium		
Anthropogenic					
AA	AA	Abandoned Airstrip	An area that was cleared and the ground compacted for the use of airplanes but is regenerating either naturally or through reclamation activities.		
MI	MI	Abandoned Mine	An area that was used for the extraction of mineral ore and other materials but is no longer active. Reclamation activities may have been initiated.		
MS	MS	Rubbly Mine Spoils	Discarded overburden or waste rock moved so that ore can be extracted in a mining operation.		
RM	RM	Reclaimed Mine	A mined area that has plant communities composed of a mixture of agronomic or native grasses, forbs, and shrubs.		
RP	RP	Road	An area cleared and compacted for the purpose of transporting goods and services by vehicles.		
RR	RR	Rural	Any area in which residences and other human developments are scattered and intermingled with forest, range, farm land, and native vegetation or cultivated crops.		
TS	TS	Mine Tailings	Solid waste materials directly produced in the mining and milling of ore.		

Notes: 1) SMR = Soil Moisture Regime; 2) SNR = Soil Nutrient Regime

For each map polygon, up to 3 ecosites were described using a decile system. Each ecosite was described according to structural stage, and whether it is broadleaf dominated (B), conifer dominated (C), or mixed forest (M). Polygon attributes also include bioterrain and drainage. A total of 372 polygons were described. Table 6 shows the distribution and areal extent of ecosites by structural stage within the Clinton Creek study area.

Six upland ecosites were identified, making up the majority (54.9%) of the Clinton Creek study area. The most common ecosite identified was 31 SbSw – Red Bearberry Forest (old map code: SL), classified in 123 polygons and making up 16.9% (273.4 ha) of the study area. The 01 ASW – Lowbush Cranberry Forest (old map code: SS) ecosite was the second most common, classified in 150 polygons and making up 16.8% (271.4 ha) of the study area. Broadleaf dominated 01 types (old map code BA) made up 2.6% (42.6 ha) of the study area. The submesic 21 A – Kinnikinnick Woodland (old map code: AP) was common on south-facing slopes. Ecosite 21 also supported Spruce – Trembling aspen – Purple reedgrass dominated vegetation associations. Ecosite 11 Prickly Saxifrage – Lichen Rock Outcrop (old map code: JP) occurred to a limited extent on dry rocky outcrops and scree slopes.

Floodplain ecosite vegetation associations were only a small component of the study area, making up only 6.1% (99.3 ha) of the total area. Three floodplain sites: 40 White spruce - Horsetail - Feathermoss (old map code: SH); 41 Balsam poplar - Prickly rose - Horsetail (old map code: BB), and 42 River Alder Riparian, of which ecosite 40 was the most common (61.3 ha or 3.8% of the study area).

Ecosite S07 Black spruce – Labrador Tea Swamp was a common wetland type on cool lower slope colluvial aprons. Ecosite B03 Black spruce - Labrador tea - Sphagnum Bog (old map code: BB) occurred to a lesser extent in poorly drained depressions and occasionally on very cool north aspect slopes. Ecosite F05 Black spruce – Tussock Sedge – Fen was identified in X

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

polygons, which was 4.3% of study area (70.1 ha). The remaining vegetation associations: M01 Beaked sedge - Water sedge Marsh (old map code: SE) and S01 Willow - Bluejoint Reedgrass Swamp (old map code: WS) were uncommon, with only five (5) and nine (9) polygons classified respectively, representing 0.1% (2.0 ha) and 0.5% (7.6 ha) of the study area.

Water and non-vegetated ecosites types were relatively limited in the study area classified as 6.3% (101.5 ha) and 1.7% (26.8 ha) respectively. Hudgeon Lake was the largest water feature making up 4.5% (73.4 ha) of the study area. Anthropogenic units were the third most common ecosites classified in the Clinton Creek study area accounting for 14.9% (240.4 ha), which is expected given the project objectives. The Abandoned Mine (map code: MI) ecosite (including the mine milling site and open pit complexes) made up 4.3% (69.7 ha) of the study area, while Rubbly Mine Soils and Mine Tailings (map codes: MS and TS) accounted for 4.7% (75.8 ha) and 2.7% (44.0 ha) of the study area respectively.

The 1:10,000 scale ELC map of the ecosite vegetation associations is presented in Appendix E.

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Table 6. Vegetation association structural stages and areas within the Clinton Creek study area.

Type	Eco Code	Name	Structural Stage[1]															Ecosite Area (ha)
			n/a	1	2a	2b	3	3a	3b	3d	4a		4b	5	6	7	8	
Upland Ecosites	11	Common juniper - Purple reedgrass													1.1			***1.1***
	11	Common juniper - Arctic poppy										6.5	2.4		0.7	2.9		***12.5***
	21	Trembling aspen - Purple reedgrass			2.0				3.5	1.3		9.2	16.9	45.0	9.2	6.7		***93.8***
	21	White spruce - Trembling aspen - Purple reedgrass			5.7					0.6	4.5	29.7	6.8	16.3	23.6	78.1	37.5	***202.7***
	01	White spruce - Alaska birch - Step moss									0.9	8.4		49.3	6.7	1.9		***67.1***
	01	Alaska birch - Sitka alder									2.8	5.6	1.9	34.4	52.8	130.4	53.2	***281.2***
	31	White spruce - Labrador tea - Feathermoss									3.4	9.4	0.4	62.4	99.4	130.4	0.5	***306.0***
	32	White spruce - Willow - Horsetail									0.5	1.3	0.4	0.8	12.0	25.4	4.2	***44.7***
Floodplain Ecosites	40	White spruce - Horsetail - Feathermoss							0.3					1.1	14.1	8.6	0.2	***24.3***
	41	Balsam poplar - Prickly rose - Horsetail												4.2	4.1			***8.3***
	42	River Alder Rpiarian										15.1	1.2	1.0				***17.3***
Wetland Ecosites	B03	Black spruce - Labrador tea - Sphagnum Bog										12.0	1.1		1.7		0.2	***15.0***
	F05	Black spruce - Sedge - Stepmoss Fen										0.6	11.1		1.0			***12.7***
	S01	Willow - Bluejoint reedgrass Swamp											2.6					***2.6***
	S02	River Alder Swamp										0.1						***0.1***
	S07	Black Spruce - Labrador Tea Swamp										55.5		10.4	9.8			***75.7***
	S08	SbSw – Read Bearberry – Brown Moss Swamp										20.7			3.7			***24.4***

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Type	Eco Code	Name	Structural Stage[1]														Ecosite Area (ha)
			n/a	1	2a	2b	3	3a	3b	3d	4a		4b	5	6	7	8	
	M01	Beaked sedge - Water sedge Marsh				0.7			0.4									***1.1***
	M10	Bluejoint Marsh			0.8													***0.8***
Water	LA	Lake	74.1															***74.1***
	OW	Shallow Open Water	2.2															***2.2***
	PD	Pond	7.8															***7.8***
	RI	River	6.3															***6.3***
Sparsely-vegetated	CB	Cutbank							2.4									***2.4***
	ES	Exposed Soil		0.7	3.1			0.4										***4.3***
	GB	Gravel Bar		0.2	1.2			0.1										***1.5***
	MU	Mudflats		0.1	0.2													***0.3***
Anthropogenic	AA	Abandoned Airstrip		3.5									3.5					***7.0***
	MI	Abandoned Mine			0.5													***0.5***
	MS	Rubbly Mine Spoils			36.8													***36.8***
	RM	Reclaimed Mine			30.8				13.0									***43.8***
	RP	Road		10.1								0.3	0.3	0.4				***11.1***
	RR	Rural					0.1											***0.1***
	TS	Mine Tailings			29.2								12.7					***41.9***
Total Area (ha)			***90.4***	***14.6***	***110.2***	***0.7***	***0.1***	***0.6***	***19.6***	***1.9***	***12.2***	***174.4***	***61.3***	***225.3***	***240.6***	***384.5***	***95.9***	***1,432.3***

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Soil Classification

Soil classification information is provided in the ecosite vegetation association descriptions found in Appendix D and summarized below in Table 7.

Table 7. Soils identified for the ecosite vegetation associations in the Clinton Creek study area.

Type	Map Code	Name	Soil Classification
Upland Forest Ecosites	11	Common juniper - Purple reedgrass	Soils are typically very rapidly-drained Eutric or Melanic Brunisols with thin Moder humus forms, and are permafrost-free. Soil pH is alkaline.
	21	Trembling aspen - Purple reedgrass	Soils are rapidly-drained Eutric or Melanic Brunisols with Moder or Mull humus forms, and are permafrost-free. Soil pH is alkaline.
		White spruce - Trembling aspen - Purple reedgrass	
	01	White spruce - Alaska birch - Step moss	Soils are Brunisolic, and typically have Mor humus forms of about 10 cm.
	01	Alaska birch - Sitka alder	Soils are typicaly silty Humic Regosols. Abundant leaf litter accumulation and decomposition, seepage, and soil creep contribute to a rich to very rich nutrient regime.
	31	White spruce - Labrador tea - Feathermoss	Soils are Gleysolic and Cryosolic, with thick Mor humus forms. The ecosite is often affected by cryoturbation and cold-air drainage.
	32	White spruce - Willow - Horsetail	Soils are typically moderately-well drained Brunisols with Mor or Moder humus forms.
	40	White spruce - Horsetail - Feathermoss	Soils are typically well-drained Cumulic Regosols with thin buried humic layers.
	41	Balsam poplar - Prickly rose - Horsetail	Soils are typically moderate to imperfectly-drained Gleyed Cumulic Humic Regosols. Abundant leaf litter decomposition, subsurface seepage and flood deposition all contribute to a rich to very rich nutrient regime.
	42	River Alder Riparian	Soils are typically sandy in texture and are classified as Regosols or Cumulic Regosols.
Wetland Ecosites	B03	Black spruce - Labrador tea - Sphagnum Bog	Soils are Organic Cryosols or Gleysolic Turbic Cryosols. Seepage is generally evident within 30 cm of the soil surface. Soil pH is neutral due to the influence of bedrock.
	F05	Black spruce - Sedge - Stepmoss Fen	Soils are Organic Cryosols with the water table typically within 25 cm of the soil surface. Occasional silt layers within the surface organics indicate water movement and occasional flooding.
	S01	Willow - Bluejoint reedgrass Swamp	Soils are silty to sandy textured Gleyed Cumulic Regosols with some humic layer development from fine root decomposition. Soil pH is neutral to alkaline.
	S02	River Alder Swamp	Soils are sandy to loamy, and Gleysolic due to prolonged water saturation. Humic layer development may occur due to decomposition of fine roots.

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Type	Map Code	Name	Soil Classification
	S07	Sb – Labrador Tea Swamp	Poorly drained Cryosols with shallow active layer seepage over permafrost. May have peaty horizons up to 30 cm thick.
Wetland Ecosites	S08	SbSw – Red Bearberry – Brown Moss Swamp	Very poorly drained Turbic Cryosols with shallow active layer seepage over permafrost. May have peaty horizons up to 30 cm thick
	M01	Beaked sedge - Water sedge Marsh	Standing water is near the ground surface. a thin peaty veneer overlaid a Humic Gleysol.
	M10	Bluejoint Marsh	Poorly drained loamy and sandy fluvial deposits with fluctuating water table. Gleysolic soils.

Rare Plant Surveys

A total of 19 dedicated rare plant survey plots were completed with the study area, with approximately 12.7 km of walking transects also conducted between sites and investigating potential target habitat types (see Table 3). In addition to the dedicated rare plant surveys, searches for rare plant species were conducted during the full and ground plots and any unusual or unknown species were reviewed to ensure they were not rare species. The locations of the full, ground and rare plant survey plots, as well as the rare plant survey transects are provided in Figure 4.

During the surveys only one rare plant species was positively identified and one potential species. The identified species was Williams Catchfly (*Silene williamsii*) and was found on a dry, sparsely vegetated grass slope on the east side of Clinton Creek. The potential rare species was a Spotted Lady Slipper (*Cypripedium guttatum*), although most likely it was a more common Sparrow's Egg Lady Slipper (*Cypripedium passerinum*). This specimen was found alongside a small stream (Figure 4)

Soil and Vegetation Laboratory Analyses

The results of the soil samples laboratory analyses were used to help complete the soils classification for the ecosite vegetation associations and are presented in Appendix G (Tables G-1 and G2). No additional data analysis was conducted of the results at this time.

The results of the vegetation trace metals analysis are presented in Appendix G (Tables G-3 and G4). No additional data analysis was conducted of the results at this time.

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

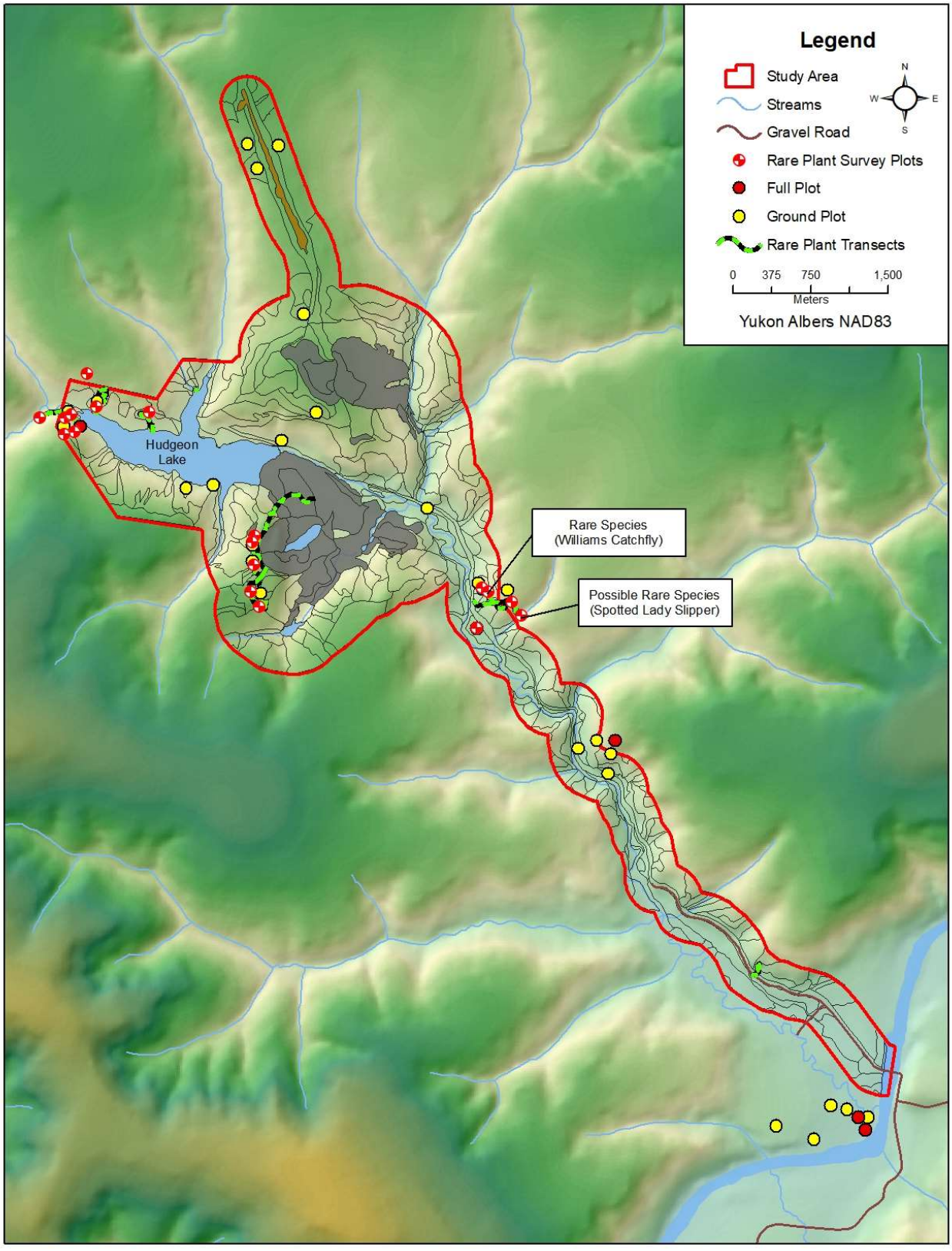

Figure 4. Locations of rare plant, full and ground plots, and rare plant survey transects within the Clinton Creek study area.

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

APPENDIX A: SOIL AND VEGETATION ANALYSES METHODS

Table A-1. Analyses methods and Reportable Detection Limits (RDL) for soil samples.

Analysis	Analysis Method	Soil RDL
pH	Determined potentiometrically using a Radiometer pH meter on a 1:1 soil to distilled water slurry	0.1
Electrical Conductivity	Determined on a Radiometer Conductivity cell using a 1:1 soil to distilled water slurry	0.03 mmhos/cm
Total Carbon (C)	Determined directly on a LECO CR 12 Carbon Analyser	0.1%
Organic Carbon (C)	Determined the Walkley-Black wet oxidation methods	0.2%
Total Nitrogen (N)	Determined colorimetrically using a Technicon Autoanalyser on a semi-micro Kjedlahl digest	0.02%
Available Phosphous (P)	Determined colorimetrically using the ascorbic acid color development method on a 1:10 soil to Bray (NH4F) extract	2 ppm
Avaialble Potassium (K)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to ammonium acetate extract	3 ppm
Available Calcium (Ca)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to ammonium acetate extract	50 ppm
Available Magnesium (Mg)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to ammonium acetate extract	10 ppm
Available Sodium (Na)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to ammonium acetate extract	2 ppm
Available Copper (Cu)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to 0.1 N HCl extract	0.2 ppm
Available Zinc (Zn)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to 0.1 N HCl extract	0.2 ppm
Available Iron (Fe)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to 0.1 N HCl extract	10 ppm
Available Manganese (Mn)	Determined by a Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to 0.1 N HCl extract	3 ppm

Table A-2. Trace metals assessed and Reportable Detection Limits (RDL) in dry and wet weight plant tissues.

Trace Metal	Symbol	Plant Tissue Dry Weight RDL (mg/kg)	Plant Tissue Wet Weight RDL (mg/kg)
Aluminum	Al	<1.0	<0.20
Antimony	Sb	<0.0050	<0.0010
Arsenic	As	<0.050	<0.0050
Barium	Ba	<0.10	<0.010
Beryllium	Be	<0.10	<0.0020
Bismuth	Bi	<0.10	<0.020
Boron	B	<2.0	<0.40

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Trace Metal	Symbol	Plant Tissue Dry Weight RDL (mg/kg)	Plant Tissue Wet Weight RDL (mg/kg)
Cadmium	Cd	<0.010	<0.0020
Calcium	Ca	<10	<2.0
Chromium	Cr	<0.20	<0.010
Cobalt	Co	<0.020	<0.0040
Copper	Cu	<0.050	<0.010
Iron	Fe	<10	<1.0
Lead	Pb	<0.010	<0.0020
Magnesium	Mg	<10	<2.0
Manganese	Mn	<0.10	<0.020
Mercury	Hg	<0.010	<0.0020
Molybdenum	Mo	<0.050	<0.010
Nickel	Ni	<0.050	<0.010
Phosphorous	P	<10	<2.0
Potassium	K	<10	<2.0
Selenium	Se	<0.050	<0.010
Silver	Ag	<0.020	<0.0040
Sodium	Na	<10	<2.0
Strontium	Sr	<0.10	<0.010
Thallium	Tl	<0.0020	<0.00040
Tin	Sn	<0.10	<0.020
Titanium	Ti	<1.0	<0.050
Uranium	U	<0.0020	<0.00040
Vanadium	V	<0.20	<0.020
Zinc	Zn	<0.20	<0.040

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

APPENDIX B: GENERAL BIOTERRAIN UNIT DESCRIPTIONS

Description of Bioterrain Units

The following bioterrain unit descriptions follow those provided in Howes and Kenk (1997) and the *landform-soil site types* (LSTs) outlined in McKillop *et al.* (2013).

Bedrock (~LST 1)

Although bedrock (R) is typically close to the surface in the Clinton Creek study area, bedrock exposure is rare. Bedrock exposures resulting from human disturbance have been categorized as anthropogenic due to their unnatural origins, surface expressions and drainages. Where exposed bedrock has been mapped, drainage is rapid and no slope processes are noted. Bedrock type is variable in the study area, and fine-grained foliated rock types may be vulnerable to failure in the form of rock slides and ongoing raveling if disturbed. Bedrock of all types exposed in road cuts and by mining activities may also present a source area for episodic rock fall, where slopes are sufficiently steep.

Weathered bedrock (~LST 1)

Areas mapped as dominantly weathered bedrock (D) are generally less than 1 m thick and located on slopes no steeper than 15%. The characteristics of permafrost are particularly variable in these units, and depend largely on slope, aspect and thickness of organic cover. The drainage of weathered bedrock deposits ranges from well to poor and is related to the presence of permafrost. Fine-grained, foliated rocks underlie the study area and, as such, weathered bedrock typically has a texture of sandy to silty rubble. Stability concerns and active geomorphic processes are uncommon in weathered bedrock units due to gentle slopes, topographic position and limited thicknesses of unconsolidated material.

Thin colluvial veneer (~LST 12)

Areas where colluvial (C) materials are generally no thicker than 20 cm are mapped as thin colluvial veneers (Cx). The textures of thin colluvial veneers are dominated by rubble due to their proximity to the underlying bedrock. Permafrost is typically absent in these units, which almost always have southerly aspects, and their slopes are generally at least 60%. Mappable geomorphic processes are generally absent from these well- to rapidly-drained units.

Colluvial veneer (~LST 3 or ~LST4 (permafrost) and ~LST 11 (no permafrost))

The most common units in the study area are those dominated by colluvial (C) veneers (less than 1 m thick, Cv); they comprise a variable proportion of rubble set in a matrix of silt and sand, reflecting the weathering characteristics of the underlying bedrock. The slopes of colluvial veneers are highly variable in the Clinton Creek study area, ranging from 5% to 65%. Permafrost is typically present on gentle to steep, north-facing slopes in moderately to poorly drained deposits; permafrost is typically absent on south-facing slopes mantled in moderately- to rapidly-drained materials. Evidence of thaw flow slides (mostly active layer detachments) and slopewash is present in approximately one-third of colluvial veneers underlain by permafrost. Permafrost-free colluvial veneers are generally stable, but may be subject to debris slides and gullying.

Colluvial blanket (~LST 5 (permafrost) and ~LST 10 (no permafrost))

Colluvial (C) blankets are mapped where deposits are thicker than 1 m (Cb) yet still have their surface expression controlled by underlying bedrock. Colluvial blankets are fairly extensive on lower slopes where gradients are less than 25%, and are typically associated with significant organic enrichment where permafrost is present. Permafrost-free colluvial blankets are also

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present in the study area, but with a very limited extent. Permafrost-free colluvial blankets are generally moderately- to well-drained and are not associated with any geomorphic processes that are able to be mapped.

Thick colluvial deposits (~LST 6)

Thick colluvial deposits occur on gentles slopes, generally less than 15%, where materials are sufficiently thick to mask the topography of underlying bedrock. Permafrost is almost always near-surface in these units, and drainage ranges from poor to imperfect, resulting in significant organic enrichment. Geomorphic processes are relatively uncommon in these units, except in response to anthropogenic disturbance, which increases their vulnerability to failures and thaw subsidence.

Eolian deposits (no reliable LST equivalent)

Re-sedimented eolian (E) materials, comprising silt and very fine sand (loess), are relatively common in the study area, occurring on slopes from 10 to 50%. Most form caps on terrain underlain by permafrost, but they are too thin or discontinuous to map. Where surface expression and/or field observations revealed appreciable thicknesses of loess, such areas were mapped dominantly as eolian veneers or blankets; their gently sloping settings suggest either an *in situ* or re-sedimented character. Thicker accumulations of loess (e.g., terrace), exhibiting primary depositional structures and no inclusions of slopewash or other material, were interpreted as *in situ*. Small debris slides were noted in some loess-rich areas, but mostly in association with road construction and/or poor management of surface runoff. Permafrost may be absent, at depth or near-surface in eolian materials.

Fluvial deposits (~LST 8)

Fluvial materials (F), which locally may include patches of remnant glaciofluvial (FG) materials, are dominantly sandy and range from poorly- to well-drained. These units have slopes of less than 5% and are primarily mapped at the southeast end of the study area, where the modern drainage of Clinton Creek meets remnant glaciofluvial terraces along Fortymile River. They also includes the scattered deposits of larger, active tributary streams (FA). Permafrost may be present in these units near surface or at depth. Meander adjustments (-M and –I) and inundation (-U) are possible factors to consider.

Organic material (~LST 7)

Organic (O) materials in the study area are generally less than 2 m thick (Ov or Ob) and almost always associated with underlying permafrost. They are most widespread, and thickest, on low-gradient fluvial or re-sedimented eolian deposits. Permafrost is typically close to ground surface, and slopes are less than 2%. Standing water is common in organic units due to elevated water tables, and these units may be subject to thermokarst. The texture of organic material is generally mesic or fibric, with some areas of humic texture where decomposition is more advanced. Drainage is typically poor to very poor.

Anthropogenic disturbance (no LST equivalent)

Areas mapped as anthropogenic (A) are by far the most varied in the study area, and include re-worked materials with slopes ranging from level to vertical (in the case of bedrock cuts). Anthropogenic units include terraced bedrock (e.g., walls of open pit), waste rock and tailings piles, stockpiles of excavated or compacted surficial materials, and refuse associated with former mine activity. Textures and stability concerns are highly variable. Rockfall and debris slides are active in anthropogenic units that have been over-steepened or that have undergone erosion by flowing water due to a lack of maintenance. Permafrost has aggraded into some of

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the thickest anthropogenic accumulations on northerly aspects and initiated downslope rock creep, with cracked and rippled surface expressions much like a rock glacier.

Water features (no LST equivalent)

Areas mapped as lakes, ponds and shallow open water were given a bioterrain symbol ”N” to signify a water body.

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APPENDIX C: GENERAL BIOTERRAIN UNIT MAP

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Clinton Creek Mine Site
Environmental Baseline

General Bioterrain Map

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Legend

- Bedrock
- Weathered Bedrock
- Thin Colluvial Veneer
- Colluvial Veneer
- Colluvial Blanket
- Colluvial Deposits
- Eolian Deposits
- Fluvial Deposits
- Organic Material
- Anthropogenic
- Watebody
- Permafrost

Elevation

High : 1900

Low : 250

Streams

N
W E
S

Full Plot Ground Plot Visual Plot

Map Source Notes:
Natural features from Yukon Government.
Bioterrain classificaiton data by Palmer Environmental Consulting Group Inc. and Ardea Biological Consulting Ltd. Smithers, BC. March 2017.

0 750 1,500
Meters

NAD83 Datum Yukon Albers Projection
Map Scale 1:20,000

APPENDIX D: ECOSITE VEGETATION ASSOCIATION DESCRIPTIONS

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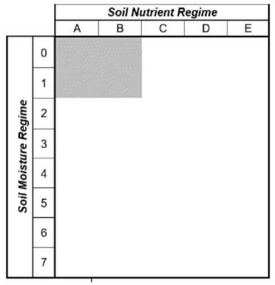
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**11 – Clad02**	**JS**	**Prickly Saxifrage – Lichen Outcrop/ Talus**	

Site Photo CC23

Soil Pit Photo

The Prickly Saxifrage – Lichen Outcrop ecosite is associated with moderate to steep bedrock outcrops and talus slopes with limited soil thickness. Soils are typically very rapidly-drained Eutric or Melanic Brunisols with thin Moder humus forms, and are permafrost-free.
The soil pH is alkaline.



Drought-tolerant cryptograms and herbs dominate. Common juniper (*Juniperus communis*), with occasional stunted white spruce (*Picea glauca*) characterize these slopes. Herb, moss and lichen cover is sparse. Purple reedgrass may have about 3-5 % cover. Herbs that occur here at low cover include Arctic poppy (*Papaver radicatum*), alpine cliff-fern (*Woodsia alpina),* prickly saxifrage *(Saxifraga tricuspidata),* Yukon harebell *(Campanula aurita), and* mountain death-camas (*Zygadenus elegans*).

The Prickly Saxifrage – Lichen Outcrop ecosite typically occurs in association with ecosite 21 Aspen – Kinnikinnick Woodland on warm aspects above the Clinton Creek access road.

SITE INFORMATION	
Elevation (masl)	
Slope	Moderate to steep
Aspect	S
Slope Position	MD, UP
Structural Stage	4b
Surficial Material	Cx
Drainage	x
Soil texture	Fragmental
Seepage	no
Permafrost	no
Humus form	Moder
SMR	0-1
SNR	A- B

Plot Numbers
Clad02 CC023, CC024, CC025, IR079

Tree Layer (0)	Shrub Layer (15-25)	Herb Layer (1-5)	Moss Layer (0-1)
	Juniper communis, Potentilla sp., Picea glauca, Betula neoalaskana	*Papaver radicatum Calamagrostis purpurea, Woodsia alpina, Dryopteris gragrans, Saxifraga tricuspidata, Campanula aurita, Zygadenus elegans*	*Cetraria tilesi, Caldina spp., Cladonia spp.*

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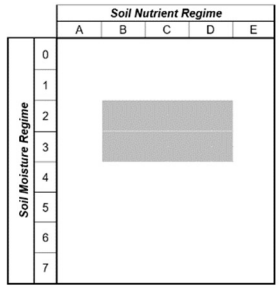
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**21 – A04/02**	**AP**	**Trembling aspen – Kinnikinnick Woodland**	

Site Photo

Soil Pit Photo

The **Trembling aspen - Kinnikinnick Woodland** ecosite is associated with moderate to steep, south-facing slopes, and steep east- and west-facing slopes. These ecosystems occur on silty colluvial veneers over bedrock. Soils are rapidly-drained Eutric or Melanic Brunisols with Moder or Mull humus forms, and are permafrost-free. Soil pH is alkaline.



Trembling aspen (*Populus tremuloides*) typically dominates the canopy, although white spruce is common. White spruce is actually dominant in some older stands, likely due to the exclusion of fire along the mine access road – these sites are differentiated from those of 01 by the dominance of purple reedgrass in the understory. Soapberry (*Shepherdia canadensis*), prickly rose (*Rosa acicularis*), and common juniper (*Juniperus communis*) are usually present and can have moderate cover. Dwarf shrubs, primarily kinnikinnick (Arctostaphylos uva-ursi), and grasses, primarily purple reedgrass (*Calamagrostis purpurea*), have moderate to high cover. Moss and lichen cover is negligible.

Within the study area these sites are common on south-facing slopes above Hudgeon Lake and along the Clinton Creek access road.

SITE INFORMATION	
Elevation (masl)	
Slope	Moderate to steep
Aspect	S
Slope Position	MD, UP
Structural Stage	4a, 4b, 5, 6
Surficial Material	Cv, Ev
Drainage	r
Soil texture	CSI, SS
Seepage	no
Permafrost	no
Humus form	Mull, Moder
SMR	2-3
SNR	B-D

Plot Numbers by Vegetation Association:

A02 CC019,

A04 CC033, IR003,

ASw07 – CC014, IR015, CC028, LT-VIS1

ASw05 dry waste rock IR030, IR031, IR032, IR037

Sw only (At dead) CC046, IR003

ASwW03 CC015, CC018, CC023, CC025, CC028, CC046

Tree Layer (8-35)	**Shrub Layer** (15-40)	**Herb Layer** (40-55)	**Moss Layer** (0-10)
Populus tremuloides, Picea glauca, Betula neoalaskana	*Shepherdia canadensis, Juniper communis, Rosa acicularis, Dasiflora fruticose, Viburnum edule, Salix spp.*	*Calamagrostis purpurea, Arctostaphylos uva-ursi, Galium boreale, Mertensia paniculata, Festuca altaica, Aster sibirica*	*Hylocomium splendens, Pleurozium schreberi, Cladina mitis, Cladonia rangiferina*

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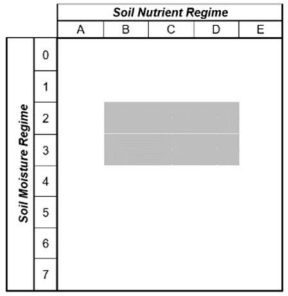
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**21 – Asw07, ASwW03, ASw05, Sw**	**SP**	**21**	**$ White spruce - Trembling aspen - Purple reedgrass**

Site Photo

Soil Pit Photo

White spruce - Trembling aspen - Purple reedgrass vegetation associations seral forests are of Ecosite 21 occur on warm-aspects, typically on rocky colluvial veneers over bedrock. Soils are well- to rapidly-drained Eutric and Melanic Brunisols with Moder and Mul humus forms, and are permafrost-free.



White spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) tend to dominate. Stands often include a component of Alaska birch (*Betula neoalaskana*). Shrub cover includes soapberry (*Shepherdia canadensis)* and prickly rose (*Rosa acicularis*); and, some sites have common juniper (*Juniperus communis*). Cover of purple reedgrass (Calamagrostis purpurea), pumpelly brome (*Bromus arcticus*) and altai fescue (*Festuca altaica*) may be up to 30% in open stands. Moss and lichen cover are negligible.

White spruce - Trembling aspen - Purple reedgrass seral forests occur north of Hudgeon Lake and Clinton Creek.

SITE INFORMATION	
Elevation (masl)	
Slope (%)	Mod-Steep
Aspect (º)	S
Slope Position	MD, UP
Structural Stage	5, 6, 7, 8
Surficial Material	Cv, Ev
Drainage	w-r
Soil texture	CSI, CLS
Seepage	no
Permafrost	no
Humus form	Moder
SMR	2-3
SNR	B-D

Plot Numbers

ASw07 CC028, LT-VIS1, CC014, IR015

Sw only (At dead) CC046, IR003

ASwW03 CC015, CC018, CC025,

ASw05 dry waste rock IR030, IR031

Tree Layer (35-45)	Shrub Layer (30-40)	Herb Layer (40-55)	Moss Layer (0-10)
Picea glauca, Populus tremuloides, Betula neoalaskana	*Shepherdia canadensis, Juniper communis, Rosa acicularis, Viburnum edule, Salix spp.*	*Calamagrostis purpurea, Bromus arcticus, Linnaea borealis, Mertensia paniculata, Festuca altaica,*	*Hylocomium splendens, Pleurozium schreberi, Cladina mitis*

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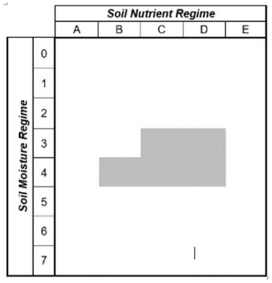
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**01**	**SS**	**White spruce – Aspen – Lowbush Cranberry Forest**	

Site Photo

Soil Pit Photo

White spruce – Aspen – Lowbush Cranberry Forest occurs on moderate to strong mid slopes, and occasionally on level sites. Soils are well to moderately well drained, and have a mesic moisture regime. Brunisols, with Mor humus forms of 10 cm or more, are typical.



Stands are often of mixed overstorey, with white spruce (*Picea glauca)*, black spruce (*Picea mariana*), Alaska birch (*Betula neoalaskana)* and/or trembling aspen *(Populus tremuloides*). The field guide for the BOLkp lists 22 different vegetation associations that may occur on this ecosite, 10 of which were described by the field work.. For mapping purposes The understorey is variable and often includes low cover of willows (*Salix spp*.), prickly rose (*Rosa acicularis*), and lowbush cranberry (Vaccinium vitis-idaea). Labrador tea (*Rhododendron groenlandicum)* is absent or at low cover. The forest floor is well-carpeted by step moss (*Hylocomium splendens*) and red-stemmed feathermoss (*Pleurozium schreberi*), often with reindeer lichens (*Cladina* spp.).

Note: Young regenerating stands following clearing or terrain slumping have a high cover of Alaska birch, balsam poplar and green alder (Alnus viridis) described by 01 – W25 on the next page.

SITE INFORMATION	
Elevation (masl)	450 - 600 m
Slope	Gentle to Steep
Aspect	Variable
Slope Position	MD, UP
Structural Stage	5, 6, 7, 8
Surficial Material	Cv
Drainage	x
Soil texture	CSI, CLS
Seepage	no
Permafrost	no
Humus form	Mor
SMR	3-4
SNR	B-D

Plot Numbers

SbSwW21 CC008, CC009, CC030, CC027

SbSw30 CC012, IR016

SbSw22 CC007, IR026

ASw27 CC006, IR001

Sw27 CC017, CC020, IR002

Sw29 CC021, IR042, IR043, IR044

W25 mine site waste rock IR029

SwW28 (Alnuvir) IR039

Tree Layer (35 - 55)	**Shrub Layer** (20 - 35)	**Herb Layer** (5 - 20)	**Moss Layer** (55 - 65)
Picea glauca, Picea mariana, Betula neoalaskana, Populus balsamifera	*Rhododendron groenlandicum, Salix Bebbiana, Salix spp., Rosa acicularis*	*Vaccinium vitis-idaea, Geocaulon lividum, Mertensia paniculata, Lycopodium clavatum, Epilobium angustifolium*	*Pleurozium schreberi, Hylocomium splendens, Cladina rangiferina,*

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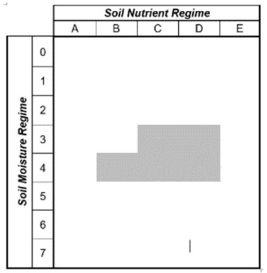
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**01 – W25, A29**	**BA**	**White spruce – Aspen – Lowbush Cranberry Forest**	**$ Alaska birch / Alder – Prickly rose**

Site Photo

Soil Pit Photo

The **Alaska birch / Alder – Prickly rose** vegetatiuon association occurs on mesic sites that have been modified by disturbance, typically thaw flow events have occurred as a result mining activity. Abundant leaf litter accumulation and decomposition, seepage, and soil creep contribute to a rich to very rich nutrient regime. Soils are typicaly silty Humic Regosols.



Alaska birch (*Betula neoalaskana*) forms a densely foliated forest canopy, accompanied by Sitka alder (*Alnus sinuata*) and sometimes trembling aspen (*Populus tremuloides*). Herb, moss and lichen covers are scant on account of the deep leaf litter.

Alaska birch - Sitka alder seral forests occur on slumping terrain and in gullies south of Hudgeon Lake, adjacent the mine pit, and south of Clinton Creek.

SITE INFORMATION	
Elevation (masl)	400-450 m
Slope	Moderate
Aspect	N
Slope Position	MD, Gully
Structural Stage	4, 5, 6
Surficial Material	Cx/D, E
Drainage	w-i
Soil texture	CSl
Seepage	yes
Permafrost	no
Humus form	Moder
SMR	3-4
SNR	C-D

Plot Numbers
W25 CC035, CC040
A29 CC013

Tree Layer (50-65)	Shrub Layer (20-35)	Herb Layer (1-4)	Moss Layer (1-5)
Betula neoalaskana, Populus tremuloides	*Alnus sinuata, Ribes triste, Rosa acicularis*	*Calamagrostis canadensis, Picea glauca,*	*(Hylocomium splendens)*

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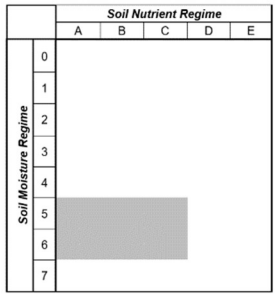
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**31 – Sb32**	**SL**	**White spruce - Labrador tea - Feathermoss**	

Site Photo

Soil Pit Photo

White spruce - Labrador tea - Feathermoss forests are widespread in the study area, occurring on moderate- to imperfectly-drained colluvium where permafrost is typically present within 50 cm of the soil surface. Soils are Gleysolic and Cryosolic, with thick Mor humus forms. The ecosite is often affected by cryoturbation and cold-air drainage.



The open canopy is dominated by white spruce (*Picea glauca*) and black spruce (*Picea mariana*), with occasional Alaska birch (*Betula neoalaskana*). Labrador tea (*Rhododendron groenlandicum*) has 5% cover or more, and northern Labrador tea (*Rhododendron decumbens*) may also be present. Crowberry (*Empetrum nigrum*) and mountain cranberry (*Vaccinium vitis-idaea)* are prominent in the herb layer. The forest floor is usually well-carpeted by moss and reindeer lichen, typically with red-stemmed feathermoss (*Pleurozium*), step moss (*Hylocomium splendens*), and *Cladina spp.,* that act as an insulating blanket keeping the soil cold. Where this ecosite occurs on seepage slopes, the forest canopy is very open and trees may appear askew from vertical.

This ecosite is common on north-facing slopes, and on gently sloping terrain throughout the study area, especially on the west side of Clinton Creek.

SITE INFORMATION	
Elevation (masl)	300-650 m
Slope	Gentle
Aspect	N
Slope Position	MD, UP
Structural Stage	5, 6, 7, 8
Surficial Material	Ev, Cv, Dv,
Drainage	x
Soil texture	CSI
Seepage	yes
Permafrost	yes
Humus form	Mor
SMR	5-6
SNR	A-C

Plot Numbers

Sb32 CC010, CC022, CC027, CC039, CC041, CC-VEG2, CC029, IR023, IR048

Sw31 CC026, IR004, IR007

SbSw31 IR009, IR022, IR024, IR069

Tree Layer (15-30)	Shrub Layer (15-35)	Herb Layer (25-35)	Moss Layer (85- 95)
Picea glauca, Picea mariana, Betula neoalaskana	*Rhododendron groenlandicum, R. decumbens, Salix spp., Rosa acicularis*	*Empetrum nigrum, Vaccinium vitis-idaea, Mertensia paniculata, Arctostaphylos rubra, Geocaulon lividum, Carex lugens*	*Pleurozium schreberi, Hylocomium splendens, Cladina mitis, Cladonia rangiferina, Peltigera aphthosa, Aulacomnium palustre*

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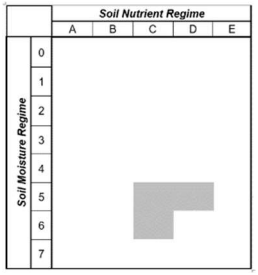
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**32 – SbSwW34, SwB35**	**SW**	**SbSwW – Horsetail Forest**	

Site Photo

Soil Pit Photo

The **SbSwW – Horsetail Forest** ecosite occurs on mesic to moist (subhygric) sites with a medium to rich nutrient regime. The site is found on moisture-receiving, gentle to moderate, middle to toe slopes and gully locations that have some drainage. Soils are typically moderately-well drained Brunisols with Mor or Moder humus forms.



Stands are characterized by relatively large white spruce (*Picea glauca),* and may contain black spruce *(Picea mariana),* and Alaska birch *(Betula neoalaskana)*. An open understory of Scouler's willow (*Salix scouleriana*), prickly rose (*Rosa acicularis*) and highbush cranberry (*Viburnum edule*) is typical. Horsetails are typically present in the herb layer. Small amounts of tall bluebells (*Mertensia paniculata*), and alpine hedysarum (*Hedysarum alpinum*) may also occur. Step moss (*Hylocomium splendens*) and red-stemmed feathermoss (*Pleurozium schreberi*) blanket the forest floor.

This ecosite occurs at the base of slopes above Clinton Creek.

SITE INFORMATION	
Elevation (masl)	300-400 m
Slope (%)	5-25%
Aspect (º)	S
Slope Position	Toe
Structural Stage	5, 6, 7, 8
Surficial Material	Cv
Drainage	m
Soil texture	CLS
Seepage	yes
Permafrost	no
Humus form	Mor-Moder
SMR	5-6
SNR	C-D

Plot Numbers

SbSwW34 CC016, IR007, IR021

SwB35 IR043, IR046

Tree Layer (35-45)	**Shrub Layer** (30-40)	**Herb Layer** (40-55)	**Moss Layer** (0-10)
Picea glauca, Betula neoalaskana	*Rosa acicularis, Salix scouleriana, Viburnum edule*	*Equisetum pratense, Delphinium glaucum, Mertensia paniculata, Galium boreale, Hedysarum alpinum*	*Hylocomium splendens, Pleurozium schreberi, Climacium dendroides*

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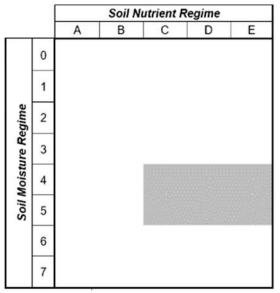
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**40 – Sw36**	**SH**	**Sw – Riparian Forest**	

Site Photo

Soil Pit Photo

The **Sw – Riparian Forest** ecosite is found on moderately well- to well-drained fluvial parent materials that flood for short durations, but are primarily influenced by subsurface water. This influx of nutrients results in a medium to rich nutrient regime. Soils are typically well-drained Cumulic Regosols with thin buried humic layers.



Relatively large white spruce (*Picea glauca)* grow on elevated microsites. An open understory of Scouler's willow (*Salix scouleriana*), prickly rose (*Rosa acicularis*) and highbush cranberry (*Viburnum edule*) is typical. Meadow horsetail (*Equisetum pratense*) is prevalent in the herb layer, along with small amounts of tall larkspur (*Delphinium glaucum)*, tall bluebells (*Mertensia paniculata*), and alpine hedysarum (*Hedysarum alpinum*). Step moss (*Hylocomium splendens*) and red-stemmed feathermoss (*Pleurozium schreberi*) blanket the forest floor.

White spruce - Horsetail - Feathermoss floodplain forest occurs adjacent Clinton Creek and Fortymile River.

SITE INFORMATION	
Elevation (masl)	300-400 m
Slope (%)	0
Aspect (º)	n/a
Slope Position	Level
Structural Stage	5, 6, 7, 8
Surficial Material	F, F(A)
Drainage	w
Soil texture	S
Seepage	yes
Permafrost	no
Humus form	Moder
SMR	4-5
SNR	C-E

Plot Numbers
CC001

Tree Layer (20 - 40)	**Shrub Layer** (5 - 18)	**Herb Layer** (45 - 65)	**Moss Layer** (65 - 80)
Picea glauca, Betula neoalaskana	*Rosa acicularis, Salix scouleriana, Viburnum edule*	*Equisetum pratense, Delphinium glaucum, Mertensia paniculata, Galium boreale, Hedysarum alpinum*	*Hylocomium splendens, Pleurozium schreberi, Climacium dendroides*

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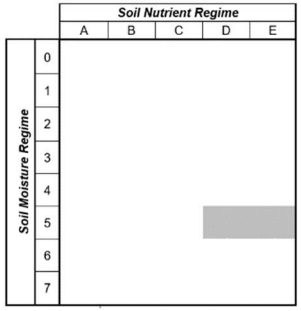
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**41 – B23**	**BH**	**B – Riparian Forest**	

Site Photo

Soil Pit Photo

The **B – Riparian Forest** ecosite is found in slightly lower, moister floodplain site positions than ecosite 40 Sw – Riparian forest, and have more frequent flooding. Soils are typically moderate to imperfectly-drained Gleyed Cumulic Humic Regosols. Abundant leaf litter decomposition, subsurface seepage and flood deposition all contribute to a rich to very rich nutrient regime.



Relatively large balsam poplar (*Populus balsamifera*) grow on elevated microsites. A thick understory of prickly rose (*Rosa acicularis*), Red-osier dogwood (*Cornus stolonifera*) and highbush cranberry (*Viburnum edule*) is typical. Meadow horsetail (*Equisetum pratense*) is prevalent in the herb layer, along with bluejoint reedgrass (*Calamagrostis canadensis*). The moss layer is generally lacking due to the abundant leaf fall.

Balsam poplar - Prickly rose - Horsetail floodplain forest occurs to a limited extent adjacent to Fortymile River and to Clinton Creek.

SITE INFORMATION	
Elevation (masl)	350-400 m
Slope (%)	0
Aspect (º)	999
Slope Position	LV
Structural Stage	4, 5, 6, 7
Surficial Material	F(A)f, F(A)p
Drainage	w
Soil texture	S
Seepage	yes
Permafrost	no
Humus form	Mull
SMR	5
SNR	D-E

Plot Numbers
CC002, IR013

Tree Layer (20 - 40)	Shrub Layer (45-70)	Herb Layer (15-25)	Moss Layer (1-5)
Populus balsamifera, Betula neoalaskana	*Rosa acicularis, Salix scouleriana, Viburnum edule, Cornus stolonifera*	*Equisetum pratense, Calamagrostis canadensis, Mertensia paniculata, Galium boreale*	*Brachythecium sp., Mnium sp.*

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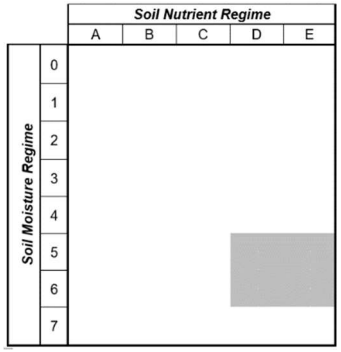
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**42 – Alin30**		**River Alder Riparian**	

Site Photo

Soil Pit Photo



The River Alder Riparian ecosite is a low bench floodplain ecosite, found on fluvial parent materials. These sites are inundated during spring freshet and typically experience 20 to 40 days of flooding. Soils are typically sandy in texture and are classified as Regosols or Cumulic Regosols. Humus development is weak due to scouring and recurrent sediment deposition.

These ecosystems have a tall shrub structure dominated by river alder (Alnus incana) and willows (Salix spp.). Salix drummondiana is common. The herb layer may include horsetails (Equisetum pretense, E. arvense), Northern grass-of-Parnassus (Parnassia palustris), bluejoint reedgrass (Calamagrostis canadensis), and other species tolerant of flooding.

This ecosite forms a narrow band along Wolverine Creek below the tailings failure. The wide floodplain at the confluence of Wolverine and Clinton Creek is dominated by this ecosite.

SITE INFORMATION	
Elevation (masl)	350 – 450 m
Slope (%)	0
Aspect (º)	NA
Slope Position	Level
Structural Stage	4a
Surficial Material	F
Drainage	p
Soil texture	sandy
Seepage	yes
Permafrost	
Humus form	
SMR	5-6
SNR	D-E

Plot Numbers
IR077

Tree Layer (0)	**Shrub Layer** (45-70)	**Herb Layer** (25-50)	**Moss Layer** (0-40)
	Alnus incana, Salix drummondiana	*Equisetum pratense,Parnassia palustris, Calamagrostis canadensis, Taraxicum officionale*	*Brachythecium sp., Aulacomnium palustre, Marchantia polymorpha*

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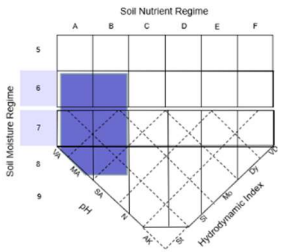
2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**B03 Sb44**	**BB**	**Sb – Lagrador Tea Bog**	

Site Photo

Soil Pit Photo

The **Black spruce - Labrador Tea - Bog** ecosite occurs on cold, very-poorly drained permafrost soils. This ecosite primarily develops on more than 40 cm of poorly decomposed peat. Soils are Organic Cryosols or Gleysolic Turbic Cryosols. Seepage is generally evident within 30 cm of the soil surface. Sloping bogs are included in this class. In the study area these sites have a neutral pH due to the influence of bedrock.



The open canopy is typically comprised of stunted black spruce (*Picea mariana),* although white spruce (*Picea glauca*) may also occur. Characteristic understorey species are Labrador tea (*Rhododendron groenlandicum*), velvet-leaved blueberry (*Vaccinium myrtilloides*), and lingonberry (*Vaccinium vitis-idaea*). Sedges such as Bigelow's sedge (*Carex lugens*) typically occur at low to moderate abundance. Peat mosses (*Sphagnum* spp.) form an insulating blanket. Where cryoturbation results in hummock formation a variety of lichen species may occur on the frost hummocks.

Black spruce - Labrador tea – Sphagnum Bogs occur in the frost prone basins south of Hudgeon Lake and Clinton Creek, and along all parts of the rolling plateau, as well as at lower elevations in proximity to Forty Mile River.

SITE INFORMATION	
Elevation (masl)	300-650 m
Slope (%)	Gentle
Aspect (º)	Cool
Slope Position	TO, LW, LV
Structural Stage	4a
Surficial Material	Ca, Cv, Ef, Ov/Ca
Drainage	v
Soil texture	CSI, SIS
Seepage	yes
Permafrost	yes
Humus form	Fibrimor
SMR	6-7
SNR	A-B

Plot Numbers
IR017, IR020

Tree Layer (1 - 4)	**Shrub Layer** (20 - 35)	**Herb Layer** (25 - 45)	**Moss Layer** (75 - 95)
Picea mariana, Picea glauca,	*Rhododendron groenlandicum, Rhododendron tomentosum, Salix spp., Betula glandulosa, Vaccinium uliginosum, Vaccinium myrtilloides*	*Carex lugens, Trichoflorum alpinum, Rubus chamaemorus, Vaccinium vitis-idaea, Carex scirpoidea, Calamagrostis stricta*	*Sphagnum spp., Aulacomnium palustre, Pleurozium schreberi, Hylocomium splendens,, Cladina mitis, C. rangiferina, Flavocetraria nivalis, F. cucullata*

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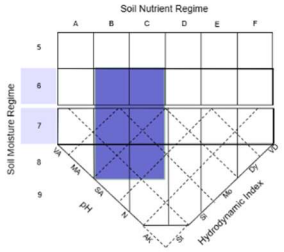
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**F05 – Sb51, Sb52**	**BF**	**Sb – Tussock Sedge - Fen**	

Site Photo

Soil Pit Photo

The **Sb – tussock sedge fen** ecosite is a treed fen that occurs primarily on level to gently sloping hygric to subhygric sites underlain by shallow permafrost. Soils are typically Organic Cryosols with seepage often present on top of the active layer.



Black spruce is shrub-like in stature and low in cover. Green alder (*Alnus crispa)*, Scrub birch (*Betula glandulosa*), and Labrador tea (*Rhododendron groenlandicum*) are common. Spruce muskeg sedge (*Carex lugens*), soft-leaved sedge (*Carex disperma*) and cloudberry (*Rubus chamaemorus)* are prominent. Red bearberry *(Arctostaphylos rubra*) and bog cranberry *(Vaccinium microcarpum)* are also present. Step moss (*Hylocomium splendens*) and red-stemmed feathermoss (*Pleurozium schreberi*) occur along with sphagnum mosses (*Sphagnum* spp.).

SITE INFORMATION	
Elevation (masl)	280-600 m
Slope (%)	0
Aspect (º)	999
Slope Position	DP
Structural Stage	4b
Surficial Material	Ov/Fp
Drainage	v-p
Soil texture	Fibric
Seepage	yes
Permafrost	yes
Humus form	Fibrimor
SMR	6-8
SNR	B-C

Plot Numbers
CC003, CC004
IR011, IR078

Tree Layer (0)	Shrub Layer (20 - 30)	Herb Layer (45-65)	Moss Layer (25-45)
	Picea mariana, Alnus crispa, Salix planifolia, Betula glandulosa, Rhododendron groenlandicum, R. decumbens, Vaccinium uliginosum	*Carex lugens, C. disperma, Vaccinium vitis-idaea, V. microcarpum, Rubus chamaemorus, Arctostaphylos rubra*	*Hylocomium splendens, Pleurozium schreberi, Aulacomnium palustre, Sphagnum capillacium*

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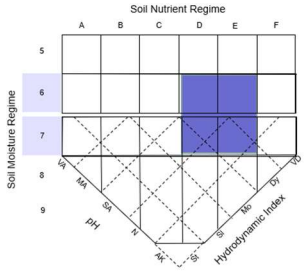
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**S01 Wetland**	**WS**	**Willow – Bluejoint Swamp**	

Site Photo

Soil Pit Photo

The **Willow – Bluejoint Swamp** ecosite occurs to a limited extent along creeks with subsurface and above surface flooding. Soils are silty to sandy textured Gleyed Cumulic Regosols with some humic layer development from fine root decomposition. Soil pH is neutral to alkaline.



The shrub layer typically consists of Alaska willow (*Salix alaxensis var longistylis*). Bluejoint reedgrass (*Calamagrostis Canadensis*) and common horsetail (*Equisetum arvense*) are prominent. Variegated scouring-rush (*Equisetum variegatum*) has up to 10% cover. Water mosses are present at low cover.

SITE INFORMATION	
Elevation (masl)	To 1200 m
Slope (%)	gentle
Aspect (º)	no aspect
Slope Position	LV, TO, DP
Structural Stage	4a, 4b
Surficial Material	F
Drainage	Dynamic
Soil texture	S
Seepage	yes
Permafrost	yes
Humus form	Hydromull
SMR	6-7
SNR	D-E

Plot Numbers
CC031

Tree Layer (0)	Shrub Layer (30-45)	Herb Layer (80-95)	Moss Layer (1-5)
	Salix alaxensis var. longistylis, (Populus balsamifera), (Alnus rugosa), (Rubus idaeus)	*Calamagrostis canadensis, Equisetum arvense, E. variegatum*	*Plagiomnium spp.*

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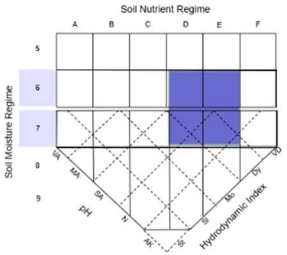
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**S02 Wetland**		River Alder Swamp	

Site Photo

Soil Pit Photo

The **River Alder Swamp** ecosite occurs on hygric to subhygric low bench floodplains sites with more prolonged water saturation than ecosite 42. Soil texture is typically sandy to loamy. Soils are classified as Gleysols or Gleyed Cumulic Regosols, or Static or Turbic Cryosols. Some soil humic layer development may be present from fine root decomposition. Soil pH is neutral to alkaline.



River alder (*Alnus incana*) and willows (*Salix alaxensis var longistylis*) characterize these swamps. Common understorey species include bluejoint reedgrass (*Calamagrostis Canadensis*) and common horsetail (*Equisetum arvense*).

SITE INFORMATION	
Elevation (masl)	To 1200 m
Slope (%)	gentle
Aspect (º)	no aspect
Slope Position	LV, TO, DP
Structural Stage	4a, 4b
Surficial Material	F
Drainage	Dynamic
Soil texture	S
Seepage	yes
Permafrost	yes
Humus form	Hydromull
SMR	6-7
SNR	D-E

Plot Numbers
CC031

Tree Layer (0)	Shrub Layer (30-45)	Herb Layer (80-95)	Moss Layer (1-5)
	Salix alaxensis var. longistylis, (Populus balsamifera), (Alnus rugosa), (Rubus idaeus)	*Calamagrostis canadensis, Equisetum arvense, E. variegatum*	*Plagiomnium spp.*

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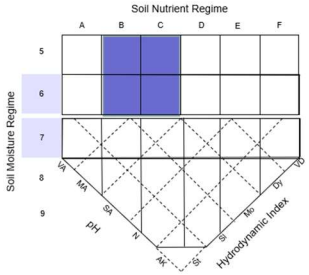
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**S07**		**Black spruce – Labrador Tea Swamp**	

Site Photo CC034 Sb36

Soil Pit Photo

The **Sb – Labrador Tea Swamps** ecosite occurs on gentle to steep slopes on cool to neutral aspects, where seepage over permafrost occurs. These sites have peaty surface horizons less than 30 cm thick. Soils have a shallow active layer (<70cm) over permafrost and are classified as Cryosols.



Black spruce and Labrador tea (*Rhododendron groenlandicum, R. tomentosum*), characterize this site, with a mixed groundcover that includes peatmosses. Associated species include willows (*Salix spp.*), lowbush cranberry (*Vaccinium vitis-idaea*) and mosses characterize the site. Associated species include crowberry (*Empetrum nigrum*), bluejoint reedgrass (*Calamagrostis canadensis*), spruce muskeg sedge (*Carex lugens*), feathermosses (*Hylocomnium splendens, Pleurozium schreberi*) and brown mosses (*Aulacomnium splendens, Tomentypnum nitens*). Cover of green alder (*Alnus viridis*) increases after fire.

SITE INFORMATION	
Elevation (masl)	280-600 m
Slope (%)	0
Aspect (º)	999
Slope Position	DP
Structural Stage	4b
Surficial Material	Ov/Fp
Drainage	v-p
Soil texture	Fibric
Seepage	yes
Permafrost	yes
Humus form	Fibrimor
SMR	5-6
SNR	B-C

Plot Numbers
Sb34 CC029, CC034, IR005, IR049,

Tree Layer (0)	Shrub layer (50)	Herb layer (15)	Moss layer (99)
	Picea mariana, Alnus viridis, Salix planifolia, Betula glandulosa, Rhododendron groenlandicum, R. decumbens	*Equisetum pretense, Rubus chamaemorus, vaccinium vitis-idaea*	*Hylocomnium splendens, Peltigera canina*

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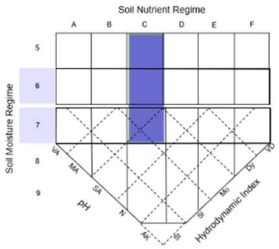
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**S08 – SbSw32**	**BF**	**SbSw – Red Bearberry - Brown Moss Swamp**	

Site Photo

Soil Pit Photo

The **SbSw – Brown moss Swamp** ecosite occurs on moist to wet sites on level terraces, and on cooler-aspect lower and toe slopes. These sites are imperfectly to poorly drained and typically have shallow soils over permafrost. A peaty surface horizon (< 30 cm) over loamy and silty mineral soil is typical. Soils are classed as Turbic Cryosols.



Open stands of stunted black spruce and or white spruce are typical. Red bearberry (Arctous rubra), glow moss (Aulacomnium palustre) and golden fuzzy fen moss (Tomenthypnum nitens) are key indicator species. Willows, Labrador tea (Rhododendron groenlandicum), crowberry (Empetrum nigrum), blueberry (Vaccinium uliginosum), bluejoint reedgrass (Calamagrostis canadensis), and low cover of spruce muskeg sedge (Carex lugens) commonly occur.

This ecosite generally has higher cover of Labrador tea and or bluejoint reedgrass than S07. The ecosite typically occurred on wetter sites than that of S07 in the study area.

SITE INFORMATION	
Elevation (masl)	280-600 m
Slope (%)	0
Aspect (º)	999
Slope Position	DP
Structural Stage	4b
Surficial Material	Ov/Fp
Drainage	v-p
Soil texture	Fibric
Seepage	yes
Permafrost	yes
Humus form	Fibrimor
SMR	5-7
SNR	C

Plot Numbers
CC045, IR064

Tree Layer (0)	Shrub layer (50)	Herb layer (15)	Moss layer (99)
	Picea mariana, Salix planifolia, Betula glandulosa, Rhododendron groenlandicum, R. decumbens, Vaccinium uliginosum	*Arctostaphylos rubra, Calamagrostis canadensis, Carex lugens, Vaccinium vitis-idaea, V Rubus chamaemorus,*	*Tomenthypnum nitens, Sphagnum sp*

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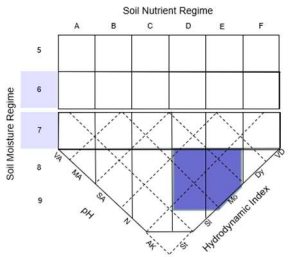
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**M01**	**SE**	**Beaked – Water Sedge Marsh**	

Site Photo

Soil Pit Photo

The **Beaked – Water Sedge Marsh** ecosite occurs on hydric to subhydric lacustrine or fluvial parent materials. The water table on these sites remains close to the ground surface for most of the year. Soils are a Humic Gleysols.



Water sedge (*Carex aquatilis*) and/or beaked sedge (*Carex utriculata)* are dominant. Other minor herb cover includes Scheuchzer's cotton-grass (*Eriophorum Scheuchzeri).*

Several marshes were observed near small ponds and along old backchannels of Clinton Creek.

SITE INFORMATION	
Elevation (masl)	
Slope (%)	0
Aspect (º)	n/a
Slope Position	DP
Structural Stage	3b
Surficial Material	Lp / Fp
Drainage	v
Soil texture	-
Seepage	-
Permafrost	yes
Humus form	-
SMR	8-9
SNR	D-E

Plot Numbers
CC011, CC044

Tree Layer (0)	Shrub Layer (0)	Herb Layer (80-90)	Moss Layer (0)
		Carex aquatilis, Carex utriculata, Eriophorum Scheuchzeri	

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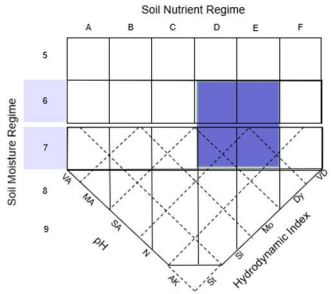
Bioclimatic Zone	Ecosite	Old Code	Ecosite	$ Vegetation Association
BOL	**M10 Wetland**	**BM**	**Bluejoint Marsh**	

Site Photo

The **Bluejoint Marsh** ecosite develops on poorly drained loamy and sandy fluvial deposits. The water table typically fluctuates on these sites. Soils are Gleysols.



Bluejoint reedgrass (Calamagrostis Canadensis) is the dominant cover, although water sedge may also occur, along with minor cover of other sedges and herbs.

This ecosite was observed at the north end of Hodgeon Lake at the creek outflow.

SITE INFORMATION	
Elevation (masl)	To 1200 m
Slope (%)	gentle
Aspect (º)	no aspect
Slope Position	LV, TO, DP
Structural Stage	4a, 4b
Surficial Material	Fp
Drainage	Dynamic
Soil texture	S
Seepage	yes
Permafrost	yes
Humus form	Hydromull
SMR	6-7
SNR	D-E

Plot Numbers
CC032

Tree Layer (0)	Shrub Layer (0)	Herb Layer (80-95)	Moss Layer (0)
		Calamagrostis canadensis, Beckmania syzigachne, Rorripa palustris	

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Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

APPENDIX E: ECOLOGICAL LANDSCAPE CLASSIFICATION MAP

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Clinton Creek Mine Site Environmental Baseline

Ecological Landscape Classification Map

ARDEA BIOLOGICAL CONSULTING

Legend

Elevation

High : 1900

Low : 250

Features

- Lakes/Ponds
- Airstrip (Abandoned)
- Mine
- Streams

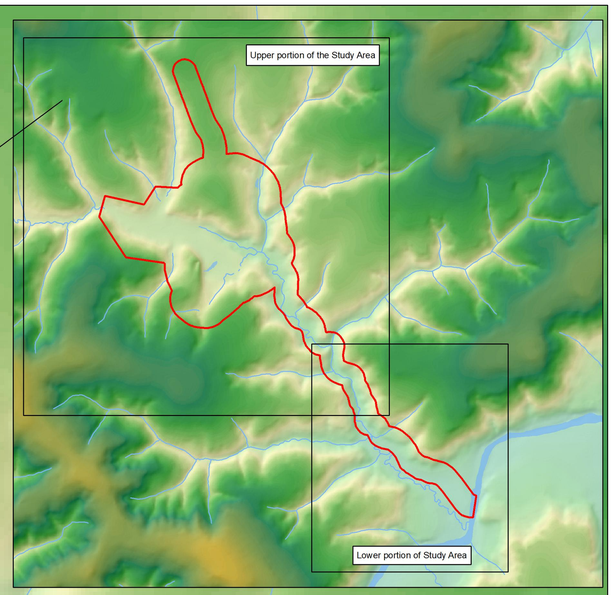
N W E S

0 525 1,050

Meters

NAD83 Datum Yukon Albers Projection
Map Scale 1:10,000

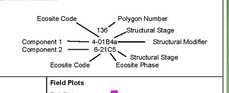
Map Source Notes:
Natural features from Yukon Government.
Ecosite classificaitons data by Ardea Biological Consulting Ltd.
Smithers, BC. January 2020.



This project provides detailed ecosystem mapping of the Clinton Creek Mine Site located in west central Yukon. Mapping was completed following the methods outlined in *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) and the *Yukon Ecological and Landscape Classification and Mapping Guidelines (Ver. 1.0)* (Yukon Environment 2016).

Bioclimate Zone and Subzone Label

Ecosite Unit Label



Map Boundaries

- Ecosite Unit
- Study area boundary

Field Plots

- Full Plots
- Ground Plots
- Visual Plots

Bioclimate Subzone

BOL kp Boreal Low Klondike Plateau

BOH kp: Boreal High Klondike Plateau

Structural Stage

Code	Structural Stage									
n/a	No structural stage									
1	Non-vegetated (< 5% cover)									
2	Sparse/Cryptogram	2a	Sparse (5-10% cover)	2b	Byroid dominated	2c	Lichen dominated			
3	Herb	3a	Forb dominated	3b	Graminoid dominated	3c	Aquatic	3d	Dwarf shrub	
4	Shrub	4a	Tall Shrub (> 2 m)	4b	Low Shrub (< 2m)					
5	Pole/Sapling (>5m tall, usually greater than 15-20 yrs old)									
6	Young Forest (self-thinning has begun)									
7	Mature Forest (mature trees, well-developed understory)									
8	Old Forest (old trees with complex structure)									

Ecosite Phase

Code	Description
C	Coniferous forest (> 75% of total tree cover is coniferous)
B	Broadleaf (> 75% of total tree cover is broadleaf)
M	Mixed (neither coniferous or broadleaf account for > 75% of total tree cover)

BOL/BOH kp Boreal Low / Boreal High Transition – Klondike plateau subzone

	Map Code	Old Code	Vegetation Association	Site Description	SMR	SNR
Upland Forest Ecosites	11	JS	Prickly Saxifrage – Lichen Rock Outcrop	Restricted to steep, warm aspects on thin rubbly colluvial veneers or bedrock. Common juniper, soapberry and shrubby cinquefoil are typical. Purple reedgrass and kinnikinnick common.	0-1	A-B
	21	AP	Trembling Aspen - Purple Reedgrass	Deciduous forests found on steep, south-facing aspects, dominated by trembling aspen with occasional large white spruce. Shrub layer contains soapberry and common juniper; often good cover of purple reedgrass, pumpelly brome and altai fescue.	2-3	B-D
	21	SP	White Spruce - Purple Reedgrass	Submesic to xeric conifer-dominated forest that occurs on steep, warm aspect slopes on rocky colluvial veneers. White spruce and trembling aspen, with soapberry and prickly rose shrub layer. Grasses dominate the herb layer.	2-3	B-D
	01	BA	Alaska birch - Sitka Alder	Broadleaf forests that occur on cool, moderately steep north-facing slopes, often on thaw-flow events. Abundant leaf litter, seepage and soil creep create a rich, moist environment. Alaska birch and Sitka alder form a dense canopy and shrub layer, with limited herbs and mosses.	3-4	B-D
	01	SS	White spruce – Aspen – Lowbush Cranberry	Mesic forests that occur on a variety of sites including permafrost-free slopes, steep north aspects and neutral aspects. A mix of white and black spruce dominate, with Alaska birch common. Shrub layer includes willows, prickly rose; moss layer is thick step and feathermosses.	3-4	B-C
	31	SL	White Spruce - Labrador Tea - Feathermoss	Widespread in the study area on moderate to imperfectly drained colluvium with permafrost within 50 cm of the surface. An open canopy of white and black spruce with some Alaska birch. Shrub layer contains Labrador tea and a thick feathermoss layer insulating the soil.	5-6	A-C
	32	SW	SbSwW – Horsetail Forest	An uncommon ecosite in the study area, found at the base of warm colluvial slopes with seepage. Large white spruce with an open shrub layer of Scouler's willow, prickly rose and highbush cranberry. Meadow horsetail, step moss and feathermoss blanket the forest floor.	5-6	C-D
Floodplain Ecosites	41	BH	Balsam Poplar – Riparian Forest	Floodplain forests with large balsam poplar. The understory contains high cover of prickly rose, red-osier dogwood and highbush cranberry. Meadow horsetail is common.	5	D-E
	40	SH	White Spruce – Riparian Forest	Floodplain forests with large white spruce on elevated microsites. Open understory of Scouler's willow, prickly rose and highbush cranberry. Horsetails, step moss and feathermoss blanket the forest floor.	4-5	C-E
	42	RA	River Alder Riparian	Low bench floodplain tall alder shrubland that is inundated during spring freshet. Presence of river alder, willows, and bluejoint reedgrass characterize the site.	5-6	D-E
Wetland Ecosites	B03	BB	Black Spruce - Labrador Tea - Bog	This bog forest is found on cold, very poorly drained organic soils (>40 cm) over permafrost. Primarily black spruce, but some white spruce in canopy. Shrub layer includes Labrador tea, velvet-leaved blueberry and lingonberry. Sedges and peat moss are common, with cryoturbation resulting in hummocks, where lichens are common.	6-7	A-B
	F05	BF	Black spruce – Tussock Sedge Fen	Poor fen forest found in frost-prone basins with organic veneers over frozen fluvial deposits on permafrost. Water table is close to surface. Trees are stunted black spruce at very low density, with green alder and scrub birch. Labrador tea common in the shrub layer. Bigelow's and soft-leaved sedge are common, along with cloudberries. The moss layer is well developed with step moss, feathermoss and sphagnum present.	6-8	B-C
	S01	WS	Willow - Bluejoint Reedgrass Swamp	A swamp wetland type, these occur along creeks with surface and sub-surface flooding. Alaska willow is the common shrub. The herb layer is primarily bluejoint reedgrass and common horsetail, along with variegated scouring rush.	6-7	D-E
	S02		River Alder Swamp	The River Alder Swamp unit occurs on low bench floodplain sites that experience more prolonged water saturation than River Alder Riparian.	6-7	D-E
	S07		Black Spruce – Labrador Tea Swamp	These swamps occur on gentle to steep slopes, on cool to neutral aspects, where seepage over permafrost occurs. Peaty surface horizon is generally less than 30 cm thick. Black spruce, Labrador tea, and a mixed groundcover of peat moss, feathermosses and brown mosses are typical.	5-6	B-C
	S08		SbSw – Red Bearberry – Brown Moss Swamp	These swamps occur on moist to wet terraces, and on cooler-aspect lower and toe slopes. Open stands of stunted black spruce and white spruce are typical.	5-7	C
	M01	SE	Beaked sedge - Water sedge Marsh	A marsh type that is uncommon in the study area, found on the edges of ponds. Water and beaked sedge are prominent with a minor herb layer which includes Scheuchzer's cotton grass.	8	D
	M10	BM	Bluejoint Marsh	A marsh type that develops on poorly drained loamy or sandy fluvial deposits with a fluctuating water table. Bluejoint reedgrass is the dominant cover.	6-7	D-E
	B03	BB	Black Spruce - Labrador Tea - Bog	This bog forest is found on cold, very poorly drained organic soils (>40 cm) over permafrost. Primarily black spruce, but some white spruce in canopy. Shrub layer includes Labrador tea, velvet-leaved blueberry and lingonberry. Sedges peat moss are common, with cryoturbation resulting in hummocks, where lichens are common.	6-7	A-B

Aquatic and non-vegetated sites

	Map Code	Vegetation Association	Description
Water Ecosites	LA	Lake	A naturally occurring static body of water, greater than 2 m deep in some portion. The boundary for the lake is the natural high-water mark.
	OW	Shallow Open Water	A wetland composed of permanent shallow open water and lacking extensive emergent plant cover. The water is less than 2 m deep.
	PD	Pond	A small body of water greater than 2 m deep, but not large enough to be classified as a lake (e.g., less than 50 ha).
	RI	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial.
Non-vegetated Ecosites	CB	Cutbank	A part of a road corridor or river course situated upslope of the road or river, which is created by excavation and/or erosion of the hillside.
	ES	Exposed Soil	Any area of exposed soil that is not included in any of the other definitions. It includes areas of recent disturbance, such as mud slides, debris torrents, avalanches, and human-made disturbances (e.g., pipeline rights-of-way) where vegetation cover is less than 5%.
	GB	Gravel Bar	An elongated landform generated by waves and currents and usually running parallel to the shore. It is composed of unconsolidated small rounded cobbles, pebbles, stones, and sand.
	MU	Mudflats	Flat plain-like areas dominated by fine-textured sediments. These areas are found in association with freshwater, saltwater or estuarine bays (at low tide), lakes, ponds, rivers and streams.

Anthropogenic sites

	Map Code	Vegetation Association	Description
Anthropogenic Sites	AA	Abandoned Airstrip	An area that was cleared and the ground compacted for the use of airplanes but is regenerating either naturally or through reclamation activities.
	MI	Abandoned Mine	An area that was used for the extraction of mineral ore and other materials but is no longer active. Reclamation activities may have been initiated.
	MS	Rubbly Mine Spoils	Discarded overburden or waste rock moved so that ore can be extracted in a mining operation. Reclamation activities may have been initiated.
	RP	Road	An area cleared and compacted for the purpose of transporting goods and services by vehicles.
	RR	Rural	Any area in which residences and other human developments are scattered and intermingled with forest, range, farmland, and native vegetation or cultivated crops.
	TS	Mine Tailings	Solid waste materials directly produced in the mining and milling of ore. Reclamation activities may have been initiated.

APPENDIX F: RARE PLANT ASSESSMENT RESULTS

Table F-1. Rare plant plot data.

Plot ID	RP-001	Date	August 12, 2016
Location	Rock outcrop, steep slope with unstable talus		
UTM Location	0514946 E, 7146358 N (Zone 8)		
Plot Description	Open rock talus, sparsely vegetated		
Trees	*Betula Neoalaskana, Betula occidentalis, Picea glauca*		
Shrubs	*Juniperus communis*		
Forbs	*Saxifraga tricuspidata, Minuartia yukonensis, Saxifraga reflexa, Papaver macounii, Solidago simplex, Woodsia glabella, Gymnocarpium dryopetris*		
Graminoids	*Calamagrostis purpurescens*		
Moss and Lichens	*Cladina mitis, Cetraria icelandica, Flavocetraria nivalis and cucculata sp.*		
Rare Plants	None		
Plot ID	RP-002	Date	August 12, 2016
Location	Top of hillside		
UTM Location	0515009 E, 71446331 N (Zone 8)		
General Description	Levels on top of hill to open dry gravel and rocky area sparsely vegetated with grass, Forbs and shrubs grading into forest		
Trees	*Picea glauca, Betula neoalaskana, Populus tremuloides* (Adjacent forest edge)		
Shrubs	*Shepherdia canadensis, Rosa acicularis, Juniperus communis, Arctostaphylos uva-ursi, Empetrum nigrum, Vaccinium ulignosum, Rhododendron groenlandicum, Vaccinium vits -idaea*		
Forbs	*Geocaulon lividum,, Conioselinum cnidiifolium, Papaver macounii, Silene menziessii / williamsii, Minuartia yukonensis*		
Graminoids	*Calamagrostis purpurescens*		
Moss and Lichens	None		
Rare Plants	*Silene williamsii* (tentative ID based on size of seed head)		
Plot ID	RP-003	Date	August 12, 2016
Location	Open south facing hilltop above small creek valley, on the opposite side of previous survey site		
UTM Location	0515247 E, 7146263 N (Zone 8)		
Plot Description	Rocky, gravel hilltop opening in mixed spruce and poplar forest.		
Trees	*Populus tremuloides* (sparse, stunted and dead)		
Shrubs	*Arctostaphylos uva-ursi, Juniperus communis, Rosa acicularis*		
Forbs	*Achellia millefolium, Saxifrage tricuspidata, Saxifraga reflexa*		
Graminoids	*Calamagrostis purpurescens*		
Moss and Lichens	None		
Rare Plants	None		

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Plot ID	RP-004	Date	August 12, 2016
Location	Creek gully 100m south of above location		
UTM Location	No UTM		
Plot Description	Small muddy turbulent stream, appears to often flood, riparian zone has large build up of woody debris, and many plants along the creek banks appear flattened or torn out by flood water, fresh evidence of large water flow		
Trees	*Picea glauca, Populus tremuloides, Betula neoalaskana*		
Shrubs	*Rosa acicularis, Viburnum edule, Salix* spp., *Alnus* spp.		
Forbs	*Cypripedium passerinum, Mertensia paniculata, Chamerion angustifolium*		
Graminoids	None		
Moss and Lichens	None		
Rare Plants	Potential rare species Spotted Lady Slipper (*Cypripedium guttatum*); no flowers only seed head, species most likely Sparrow's Egg Lady Slipper (*Cypripedium passerinum*)		
Plot ID	RP-005	Date	August 13, 2016
Location	Clinton Lake, variety of plots accessed by boat		
UTM Location	0510868 E, 7147902 N (UTM 8)		
Plot Description	Wet north facing slope bog with sparse open black spruce forest and sporadic birch		
Trees	*Picea mariana, Betula neoalaskana, Betula occidentalis*		
Shrubs	*Alnus* spp*., Rhododendron groenlandicum, Salix arctica, Salix glauca, Dasispora fruticosa, Vaccinium ulignosum*		
Forbs	*Saussurea angustifolia, Tofielda pusilla, Rumex arcticus, sparse Papaver maccounii*		
Graminoids	*Carex* sp*p., Festuca altaica*		
Moss and Lichens	*Cladina mitis, Cetraria icelandica, Flavocetraria nivalis, Flavocetraria cucculata* (large moss hummocks, some sphagnum and common lichens)		
Rare Plants	None		
Plot ID	RP-006	Date	August 13, 2016
Location	Upslope rocky outcrop in the slope bog		
UTM Location	0510823 E, 7147323 N (UTM 8)		
Plot Description	Habitat cluster of birch trees on rocky outcrop; Mosses and lichen within the rocks and ferns in crevices		
Trees	*Betula neoalaskana, Picea mariana*		
Shrubs	*Rhododendron groenlandicum, Rosa acicularis, Alnus* spp*., Salix* spp*.,Viburnum edule, Vaccinium vits-idaea*		
Forbs	*Minuartia yukonesis, Chamerion angustifolia, Rumex arcticus, Papaver macounii, Anemone parviflora, Boschniakia rossica*		
Graminoids	*Calamagrostis purpurescens, Festuca altaica, Woodsia glabella*		
Moss and Lichens	None		
Rare Plants	None		

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Plot ID	RP-007	Date	August 13, 2016
Location	Small open basin or draw from converging seepages between slightly higher ridges		
UTM Location	0510729 E, 7147292 N (UTM 8)		
Plot Description	Open water seepage with small pools surrounded by a wet area of bog		
Trees	Predominately *Picea mariana* with patch of *Picea glauca* on higher ground		
Shrubs	*Andromedia polifolia, Salix bebbiana, Salix planifolia, Salix* spp.		
Forbs	*Equisetum arvense, Petasites frigida*		
Graminoids	None		
Moss and Lichens	*Sphagnum* spp.		
Rare Plants	None		
Plot ID	RP-008	Date	August 13, 2016
Location	Lower slope above creek delta area, open and somewhat drier habitat		
UTM Location	0510713 E, 7147451 N (UTM 8)		
Plot Description	Turfy open tundra-like habitat with wet pockets and some rock outcrops with sparse and widely separated trees		
Trees	*Picea mariana*		
Shrubs	*Alnus* spp*., Rhododendron groenlandicum, Salix arctica, Salix glauca, Dasispora fruticosa, Vaccinium ulignosum, Betula occidentalis, Betula glandulosum*		
Forbs	*Saussurea angustifolia, tofielda pusilla, Silene repens, Papaver macounii*		
Graminoids	*Carex* spp*., Festuca altaica*		
Moss and Lichens	Common lichens *Cladina mitis, Cetraria icelandica, Flavocetraria nivalis, Flavocetraria cucculata*		
Rare Plants	None		
Plot ID	RP-009	Date	August 13, 2016
Location	Wetland Creek mouth mud and silt delta		
UTM Location	0510769 E, 7147488 N (UTM 8)		
Plot Description	Shallow grade silt and mud delta primarily covered with willow and grasses		
Trees	Pioneer tree species *Populus balsaamifera*		
Shrubs	*Salix alaxensis, Salix glauca, Salix planifolia, Alnus* spp.		
Forbs	Large showy prominent *Solidago canadensis* throughout delta, *Equisetum* spp. possibly *Hyemale* spp*., Comarum palustre (Potentilla palustre), Lesqueralla arctica, Epilobium palustre, Ranunculus hyperboreas*		
Graminoids	*Calamagrostis canadensis, Calamagrostis stricta, Carex* spp.		
Moss and Lichens	None		
Rare Plants	None		

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Plot ID	RP-010	Date	August 13, 2016
Location	West tributary in creek valley located upstream of delta		
UTM Location	0510470 E, 7147412 N (UTM 8)		
Plot Description	Forested riparian area, with dense large willow/alder thickets; Zone along creek has signs of repeated flooding including log jams, log piles, silted old creek channels, large numbers of dead standing spruce trees and woody debris in stream; Extensive well used moose trails; Wildlife camera in plot		
Trees	*Betula neoalaskana, Picea glauca*		
Shrubs	*Salix* spp., *Alnus* spp., *Viburnum edule, Rosa acicularis*		
Forbs	None		
Graminoids	*Puccinelia* spp., *Calamagrostis canadensis*		
Moss and Lichens	None		
Rare Plants	None		
Plot ID	RP-011	Date	August 13, 2016
Location	Forested south facing hillside above Lake		
UTM Location	0511001 E, 7147597 N (UTM 8)		
Plot Description	Steep open forested slope		
Trees	*Picea glauca, Populus balsamifera, Populus tremuloides*		
Shrubs	*Shepherdia canadensis, Viburnum edule, Arctostaphylos uva-ursi, Rosa acicularis*		
Forbs	*Aster sibiricus, Galium boreale, Conioselinum cnidiifolium*		
Graminoids	*Calamagrostis purpurescens*		
Moss and Lichens	None		
Rare Plants	None		
Plot ID	RP-012	Date	August 13, 2016
Location	Open south facing sandy/ gravel hilltop, with some rock outcrop		
UTM Location	0511516 E, 7147607 N (UTM 8)		
Plot Description	Steep upper slope with rock, debris and gravel and some open un-vegetated patches		
Trees	*Populus tremuloides* on lower portions		
Shrubs	*Arctostaphylos uva-ursi, Rubus idaeus, Juniperus communis, Rosa acicularis*		
Forbs	*Chamerion angustifolium, Solidago multradiata, Campanula aurita.* Invasive weeds on open dirt slopes: *Taxaracum* spp*., Sonchus* spp*.*		
Graminoids	Calamagrostis purpurescens		
Moss and Lichens	None		
Rare Plants	None		

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Plot ID	RP-013	Date	August 14, 2016
Location	South-west ridge behind open pit		
UTM Location	0512690 E, 7146564 N (UTM 8)		
Plot Description	Re-vegetating slide area with 50% vegetation cover including sapling trees and shrubs; difficult to tell if slide is naturally occurring or due to the close proximity to the open pit mine area		
Trees	*Populus tremuloides, Populus balsamifera, Betula neoalaskana, Picea glauca*		
Shrubs	*Salix* spp.		
Forbs	Weedy pioneer species *Taxaracum* spp., Trifolium pratense		
Graminoids	None		
Moss and Lichens	None		
Rare Plants	None		
Plot ID	RP-014	Date	August 14, 2016
Location	Boggy black spruce forest on north facing slope adjacent slide area with a predominately moss understory		
UTM Location	0512674 E, 7146496 N (UTM 8)		
Plot Description	Wet black spruce forest		
Trees	*Picea mariana, Betula neoalaskana*		
Shrubs	*Betula glandulosa, Rosa acicularis, Rhododendron groenlandicum, Vaccinium vite-vitis, Spirea beauverdiana*		
Forbs	*Rumex arcticus,, Equisetum sylvaticum, Geocaulon lividum, Rubus chamaemorus*		
Graminoids	None		
Moss and Lichens	*Spaghnum* spp.		
Rare Plants	None		
Plot ID	RP-015	Date	August 14, 2016
Location	Birch Forest with some evidence of disturbance possibly related to mine activity; Old cat trail, rough roads and overgrown ditching		
UTM Location	0512720 E, 7146280 N (UTM 8)		
Plot Description	Drier rocky ground with understory predominately leaf litter, woody debris, abundant mushrooms and sparse forb and shrubs		
Trees	*Betula neoalaskana* (possibly *papyifera*), *Populus balsamifera*		
Shrubs	*Alnus* spp., *Rosa acicularis, Ribes lacustre*		
Forbs	*Mertensia paniculata*		
Graminoids	None		
Moss and Lichens	None		
Rare Plants	None		

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Plot ID	RP-016	Date	August 14, 2016
Location	South inclined black spruce and mixed willow forest		
UTM Location	0512832 E, 7145890 N (UTM 8)		
Plot Description	Dense early succession black spruce forest		
Trees	*Picea mariana, Populus tremuloides, Populus balsamifera*		
Shrubs	*Salix* spp. (probably *bebbiana*) *Vaccinium vits-idaea, Rhododendron groenlandicum, Rosa acicularis*		
Forbs	*Geocaulon lividum*		
Graminoids	None		
Moss and Lichens	*Cladina Mitis, Flavocetraria nivalis, Flavocetraria cucculata*		
Rare Plants	None		
Plot ID	RP-017	Date	August 14, 2016
Location	Wetland Pond beside access road		
UTM Location	No UTM		
Plot Description	Small pond with marshy edges		
Trees	None		
Shrubs	None		
Forbs	*Geum Macrophyllum, Comarum palustre (Potentilla palustre), Epilobium sp., Parnassia palustris*		
Graminoids	*Carex aquatilis, Carex utriculata*		
Moss and Lichens	None		
Rare Plants	None		
Plot ID	RP-018	Date	August 14, 2016
Location	Wetland bog / fen adjacent to Clinton Creek		
UTM Location	514941 E, 7145969 N (UTM 8)		
Plot Description	Wide level bog with open water pools throughout; Stunted and widely spaced trees along raised ridge adjacent to the creek		
Trees	*Picea mariana, Picea glauca*		
Shrubs	*Stunted Salix* spp., *Betula glandulosum, Rhododendron groenlandicum, Chamaedaphne calyculata, Arctostaphylos rubra, Salix myrtlifolia, Dasiphora fruticosa, Vaccinium ulignosum*		
Forbs	*Rubus chamaemorus, Oxycoccus microcarpus*		
Graminoids	*Sedge* spp.		
Moss and Lichens	*Sphagnum* spp. on hummocks		
Rare Plants	None		

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Plot ID	RP-019	Date	August 14, 2016
Location	Hillside Aspen Forest		
UTM Location	0518089 E, 7143118 N (UTM 8)		
Plot Description	Dry aspen forest on south facing slope		
Trees	*Picea glauca, large Populus tremuloides*		
Shrubs	*Rosa acicularis, Shepherdia canadensis, Arctostaphylos uva-ursi*		
Forbs	*Aster sibiricus, Chamerion angustifolium, Galium boreale*		
Graminoids	*Calamagrostis purpurscens*		
Moss and Lichens	None		
Rare Plants	None		

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APPENDIX G: SOILS AND VEGETATION SAMPLES LABORATORY ANALYSES RESULTS

Table G-1. Results of laboratory analyses of Clinton Creek soils samples.

Sample ID	pH	Estimated Electrical Conductivity (mmhos/cm)	Total Carbon (C) (%)	Organic Carbon (C) (%)	Total Nitrogen (N) (%)	Carbon / Nitrogen (ratio)	Phosphorous (P) (ppm)	Potassium (K) (ppm)	Calcium (Ca) (ppm)	Magnesium (Mg) (ppm)	Sodium (Na) (ppm)	Copper (Cu) (ppm)	Zinc (Zn) (ppm)	Iron (Fe) (ppm)	Manganese (Mn) (ppm)
CC - 014	5.5	0.26	1.51	2.6	0.05	30.2	7	57	650	265	12	2.9	1.6	55	21
CC - 016	6.1	0.24	2.67	4.6	0.08	33.4	5	27	1800	560	31	3.6	1.6	140	97
CC - 020	4.6	0.28	1.86	3.2	0.07	26.6	7	53	400	250	12	2.5	1.4	135	40
CC - 022	5.7	0.26	6.38	11.0	0.29	22.0	25	65	2550	670	20	4.9	10.5	185	185
CC - 029	6.4	0.30	7.42	12.8	0.34	21.8	4	33	2400	1950	15	0.4	2.9	16	107
CC - 030	5.9	0.70	5.80	10.0	0.22	26.4	5	105	1700	1400	26	3.6	3.0	945	330
CC - 031	7.2	0.54	3.25	5.6	0.12	27.1	6	19	2150	395	15	5.5	9.9	540	328
CC - 033	7.6	0.38	1.74	3.0	0.08	21.8	3	47	3400	380	24	3.7	0.9	40	108
CC - 036	5.6	0.34	8.58	14.8	0.36	23.8	3	43	2950	540	28	5.7	5.3	345	215
CC - 040	6.5	0.38	13.92	24.0	0.52	26.8	3	51	6500	750	30	0.5	1.3	55	19
CC - 041	5.0	0.22	2.44	4.2	0.05	48.8	3	435	1450	280	15	2.0	1.4	170	13
Mineral Lick	7.8	4.60	1.39	2.4	0.06	23.2	7	510	2000	750	660	0.5	1.2	40	107

Table G-2. Results of particle size analyses of Clinton Creek soils samples.

Sample ID	>2mm (%)	<2mm (%)	Sand (%)	Silt (%)	Clay (%)
CC - 014	67.6	32.4	68.5	24.5	7.0
CC - 016	48.0	52.0	24.6	67.5	7.9
CC - 020	53.7	46.3	48.1	46.2	5.7
CC - 022	58.0	42.0	34.4	51.3	14.3
CC - 029	59.8	40.2	55.3	35.6	9.1
CC - 030	65.9	34.1	36.5	57.9	5.6

Sample ID	>2mm (%)	<2mm (%)	Sand (%)	Silt (%)	Clay (%)
CC - 031	6.2	93.8	72.2	25.4	2.4
CC - 033	23.1	76.9	22.2	69.2	8.6
CC - 036	59.8	40.2	43.5	43.4	13.1
CC - 040	9.6	90.4	5.7	54.1	40.2
CC - 041	23.8	76.2	16.4	71.4	12.2
Mineral Lick		100.0	20.8	77.2	2.0

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Table G-3. Results of trace metals analysis on vegetation samples (dry weight analysis).

Total Metals by ICPMS	UNITS	Sample ID									
		CC031	**CC042**	**CC045**	**CCVEG1**	**CC044**	**CCVEG4**	**CCVEG5**	**CC044**	**CC011**	**CCVEG3**
		Salix planifolia	*Salix planifolia*	*Salix planifolia*	*Salix planifolia*	*Salix alaxensis*	*Salix alaxensis*	*Salix alaxensis*	*Carex utriculata*	*Carex utriculata*	*Shepherdia canadensis*
Total Aluminum (Al)	mg/kg	6.8	4.7	5.1	4.7	3.4	4.1	3.5	29.7	2.5	6.3
Total Antimony (Sb)	mg/kg	0.0163	0.0089	0.0149	0.0268	0.0111	0.0109	0.0289	0.0215	0.0073	0.0102
Total Arsenic (As)	mg/kg	<0.050	<0.050	<0.050	0.136	<0.050	<0.050	0.116	0.184	0.067	<0.050
Total Barium (Ba)	mg/kg	124	32.2	187	10.8	47.2	25.9	7.32	51.1	48.2	72.5
Total Beryllium (Be)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Bismuth (Bi)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Boron (B)	mg/kg	13.7	40.6	15.0	14.6	162	14.2	68.8	8.8	33.9	98.9
Total Cadmium (Cd)	mg/kg	1.49	2.61	2.88	3.62	2.86	2.07	1.88	0.018	0.015	8.84
Total Calcium (Ca)	mg/kg	15000	16900	14800	14500	14200	13000	9430	4450	5360	16800
Total Chromium (Cr)	mg/kg	<0.20	<0.20	<0.20	<0.20	0.23	<0.20	<0.20	0.41	<0.20	<0.20
Total Cobalt (Co)	mg/kg	1.45	0.510	0.642	0.329	4.73	0.165	0.951	0.072	0.034	1.04
Total Copper (Cu)	mg/kg	8.22	2.85	6.47	6.21	11.0	5.58	8.30	3.19	1.68	4.57
Total Iron (Fe)	mg/kg	56	35	37	57	48	65	72	91	44	50
Total Lead (Pb)	mg/kg	0.030	0.022	0.073	0.067	0.095	0.039	0.142	0.084	0.034	0.072
Total Magnesium (Mg)	mg/kg	3960	8280	3910	4190	10100	4660	10300	3180	3160	6910
Total Manganese (Mn)	mg/kg	80.6	196	114	130	96.8	83.6	62.0	204	706	85.1
Total Mercury (Hg)	mg/kg	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	<0.010	0.010	<0.010	<0.010
Total Molybdenum (Mo)	mg/kg	0.218	0.480	1.07	0.680	0.414	1.26	0.498	1.17	0.459	2.32
Total Nickel (Ni)	mg/kg	12.2	7.01	10.2	1.17	31.0	3.58	10.1	0.465	0.892	13.8
Total Phosphorus (P)	mg/kg	4120	1430	3260	3740	2490	2280	3990	2240	1670	4120
Total Potassium (K)	mg/kg	13200	5710	11200	14600	6390	15600	10200	15400	10600	9100
Total Selenium (Se)	mg/kg	<0.050	0.134	0.255	0.660	0.228	9.12	0.409	<0.050	0.633	0.131
Total Silver (Ag)	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Sodium (Na)	mg/kg	92	<10	19	37	28	23	87	83	12	42

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Total Metals by ICPMS	UNITS	Sample ID									
		CC031	CC042	CC045	CCVEG1	CC044	CCVEG4	CCVEG5	CC044	CC011	CCVEG3
		Salix planifolia	*Salix planifolia*	*Salix planifolia*	*Salix planifolia*	*Salix alaxensis*	*Salix alaxensis*	*Salix alaxensis*	*Carex utriculata*	*Carex utriculata*	*Shepherdia canadensis*
Total Strontium (Sr)	mg/kg	76.3	59.4	91.5	50.1	70.8	44.2	64.8	17.8	69.1	63.9
Total Thallium (Tl)	mg/kg	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0081	<0.0020	0.0056	0.0022
Total Tin (Sn)	mg/kg	<0.10	<0.10	<0.10	0.12	<0.10	<0.10	0.18	<0.10	<0.10	<0.10
Total Titanium (Ti)	mg/kg	<1.0	<1.0	<1.0	<1.0 (1)	<1.0	<1.0	<1.0	1.1	<1.0	<1.0
Total Uranium (U)	mg/kg	<0.0020	<0.0020	<0.0020	0.0117	<0.0020	0.0025	0.0025	0.0047	<0.0020	<0.0020
Total Vanadium (V)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Total Zinc (Zn)	mg/kg	209	184	105	334	56.9	64.5	238	27.8	27.4	266

Table G-4. Results of trace metals analysis on vegetation samples (wet weight analysis).

Total Metals by ICPMS	UNITS	Sample ID						
		CCVEG3	CC011	CC043	CCVEG6	CC029	CC034	CCVEG2
		Salix glauca	*Shepherdia canadensis*	*Shepherdia canadensis*	*Shepherdia canadensis*	*Vaccinium uliginosum*	*Vaccinium vitis-idaea*	*Vaccinium vitis-idaea*
Total Aluminum (Al)	mg/kg	1.43	4.95	0.96	0.89	0.38	1.21	1.94
Total Antimony (Sb)	mg/kg	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Arsenic (As)	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	0.0238	<0.0050	<0.0050
Total Barium (Ba)	mg/kg	2.49	0.807	0.042	0.832	0.738	1.03	1.46
Total Beryllium (Be)	mg/kg	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Total Bismuth (Bi)	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Boron (B)	mg/kg	3.78	2.39	2.16	3.12	2.06	1.46	1.31
Total Cadmium (Cd)	mg/kg	0.0040	0.0038	0.0280	0.0092	0.0188	<0.0020	<0.0020
Total Calcium (Ca)	mg/kg	408	261	504	350	146	134	127
Total Chromium (Cr)	mg/kg	0.076	0.046	0.021	0.023	<0.010	<0.010	0.024
Total Cobalt (Co)	mg/kg	0.0067	0.0048	<0.0040	<0.0040	<0.0040	<0.0040	0.0045
Total Copper (Cu)	mg/kg	1.20	0.664	1.29	1.28	0.605	0.426	0.506

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2175 Millar Rd. ♦ Smithers, BC ♦ V0J 2N6
Ph. (250) 847-9772 ♦ e-mail: Laurence@ardea.ca

Total Metals by ICPMS	UNITS	Sample ID						
		CCVEG3	**CC011**	**CC043**	**CCVEG6**	**CC029**	**CC034**	**CCVEG2**
		Salix glauca	*Shepherdia canadensis*	*Shepherdia canadensis*	*Shepherdia canadensis*	*Vaccinium uliginosum*	*Vaccinium vitis-idaea*	*Vaccinium vitis-idaea*
Total Iron (Fe)	mg/kg	6.5	10.0	7.6	6.3	1.8	1.4	1.9
Total Lead (Pb)	mg/kg	0.0039	0.0068	0.0032	0.0077	<0.0020	<0.0020	<0.0020
Total Magnesium (Mg)	mg/kg	228	115	171	141	129	76.9	87.8
Total Manganese (Mn)	mg/kg	3.46	2.07	3.86	2.58	4.60	37.7	36.5
Total Mercury (Hg)	mg/kg	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Total Molybdenum (Mo)	mg/kg	1.14	0.399	0.704	2.54	0.152	0.010	0.073
Total Nickel (Ni)	mg/kg	1.64	0.612	0.744	0.611	0.405	0.131	0.189
Total Phosphorus (P)	mg/kg	459	271	632	515	132	107	153
Total Potassium (K)	mg/kg	2310	1840	2180	2140	1000	774	938
Total Selenium (Se)	mg/kg	0.058	<0.010	0.089	0.556	<0.010	<0.010	<0.010
Total Silver (Ag)	mg/kg	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Total Sodium (Na)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total Strontium (Sr)	mg/kg	1.70	1.02	1.13	1.25	0.275	0.168	0.226
Total Thallium (Tl)	mg/kg	<0.00040	<0.00040	0.00097	<0.00040	<0.00040	<0.00040	<0.00040
Total Tin (Sn)	mg/kg	<0.020	0.032	0.024	0.042	<0.020	<0.020	0.029
Total Titanium (Ti)	mg/kg	<0.050	0.221	<0.050	<0.050	<0.050	<0.050	<0.050
Total Uranium (U)	mg/kg	<0.00040	0.00047	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Total Vanadium (V)	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Zinc (Zn)	mg/kg	2.72	1.30	3.44	2.53	3.22	0.985	1.15

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