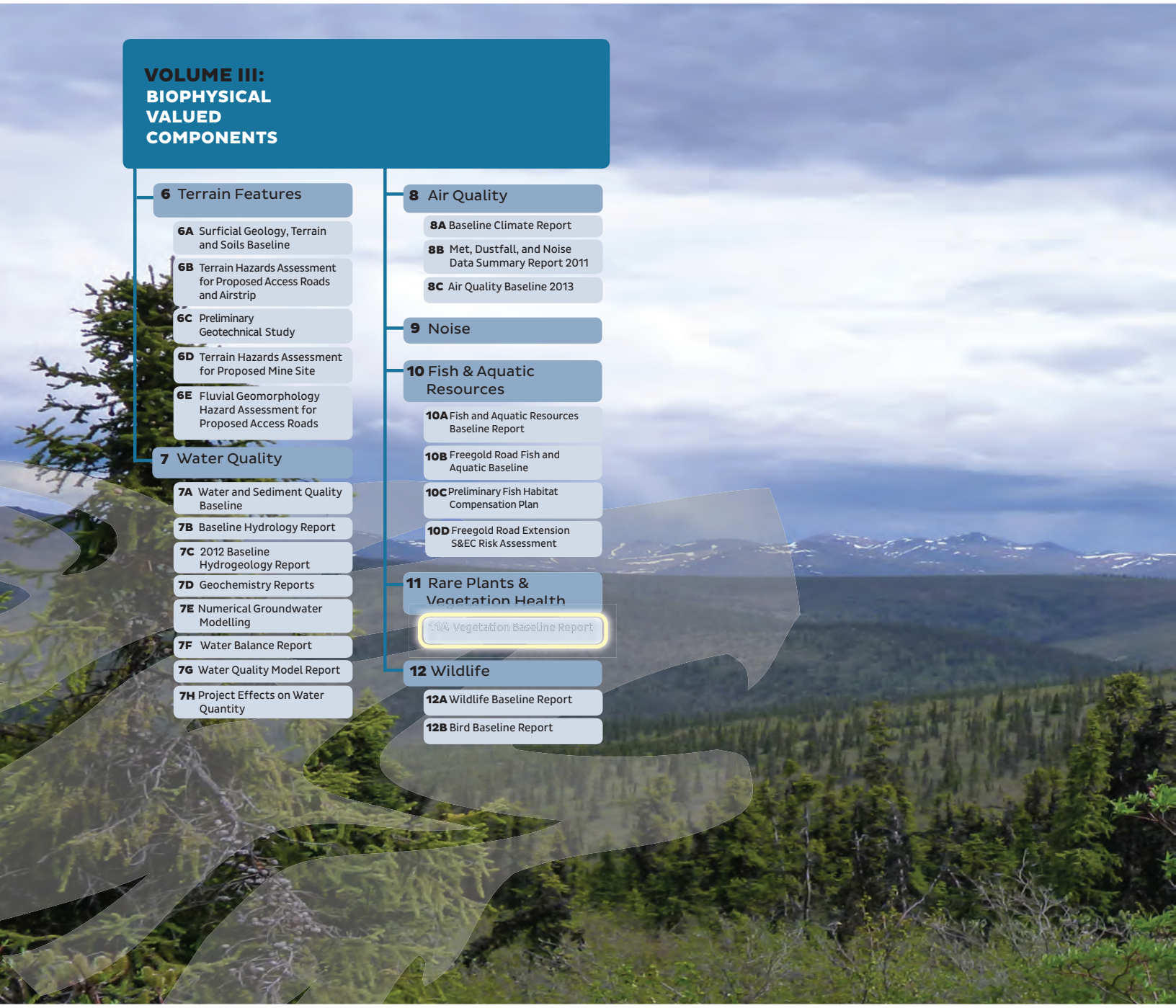
APPENDIX 11A: VEGETATION BASELINE REPORT



Casino Project: Vegetation Baseline Report

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2012 ENVIRONMENTAL EMPLOYER OF THE YEAR

EDI ENVIRONMENTAL DYNAMICS INC.

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EXECUTIVE SUMMARY

The Casino Project is a proposed 33 year operational mine located in central Yukon (YK). The Project includes the construction of mine facilities and an access road, mine operation and closure/reclamation. The Project proposes to mine a large porphyry copper-gold-molybdenum deposit that will be developed as an open pit and will process approximately 44 million tonne-per-annum (Mt/a). The objective of this vegetation baseline is to provide information on the existing vegetation, particularly a description of the ecological land classification vegetative characteristics, rare plants and baseline vegetation health. The baseline report will be used as a basis to assess effects of the Project and inform future vegetation monitoring initiatives.

Ecological Land Classification — Terrain mapping and ecological land classification (ELC) mapping was conducted in 2010 and 2011 to characterize the local landscape and provide a foundation for classification of local vegetation communities. This work will also be used as a basis for habitat classification for some wildlife species. The study area for the ELC mapping was approximately 881 km² and included alpine, subalpine, boreal high and boreal low bioclimate zones. Of the 27 ecosite categories, the predominant types include subalpine moist shrub, mixedwood forest, sparse coniferous forest, tall shrub, dry broadleaf forest and coniferous forest. Some of the less common ecosites include open bog, sloping grasslands and tors, which are characteristic features in unglaciated landscapes.

Rare Plants — During the 2010 and 2012 surveys, nine species of conservation concern were documented: *Artemisia laciniata*, *Botrychium alaskense*, *Cypripedium guttatum*, *Erigeron purpuratus*, *Helictotrichon hookeri*, *Koenigia islandica*, *Minuartia yukonensis*, *Phacelia mollis*, and *Silene williamsii*. *Phacelia mollis* was the only species found during both surveys. Of these nine species documented during the surveys, three are listed on the Yukon Conservation Data Centre (YCDC) Track list and five are on the Watch list. At the time of the surveys, *Erigeron purpuratus*, was on the Watch list, but has since been removed. The remaining species of conservation concern have low numbers of known populations in YK. In North America, four of the species are endemic to YK and Alaska (AK), which includes *Artemisia laciniata*, *Erigeron purpuratus*, *Phacelia mollis*, and *Silene williamsii*. Within YK, these four species (with the exception of *Erigeron purpuratus*, also known from northern YK) are restricted to the western part of the territory. *Botrychium alaskense* is only known to YK, AK, and British Columbia (B.C.), and is currently on the COSEWIC (Committee on the Status of Endangered Wildlife in Canada) candidate list, so may be reviewed more closely in the future (B. Bennett pers. comm. 2012). New locations discovered in 2010 and 2012 are important additions to the known distribution of these species.

Habitats where rare species occur were observed in the study area, and include very steep dry slopes supporting grass and forbs and/or open aspen, gravel bars subject to flooding, rock outcrops, and disturbed sites, including tailings and old roads. Some of the rare species found in the study area may be more common in YK than documented locations indicate, due to the large size of the Territory and the difficulty of access to remote areas. Any further information on additional populations of these species that are discovered in the project study area and surrounding areas during development would be very useful for the

YCDC to develop true status rankings for the species, as well as to assist land managers and planners to avoid uncertainties.

Vegetation Health — Baseline characterization of plant health was determined by collecting plant samples at sites both near and far away from the proposed potential disturbance area (PDA). The three genera of focus that were collected at each sample site, where present, were willow (*Salix* spp.), horsetail (*Equisetum* spp.), and lichen (*Cladina* spp.). Samples were collected from 62 sites located around the mine site, air strip and access, barge landing and access, and the Freegold Road extension. Samples were analyzed for metal levels in tissues by the inductively couples plasma technique, with mass spectroscopy (ICP-MS). No relationship was found between metal levels and proximity to the Casino Project site.

ACKNOWLEDGEMENTS

Ecological Land Classification Component — Information provided in the ELC section is based primarily on draft material prepared for the Casino Mining Corporation by AECOM (2010), with supplemental information from draft reports prepared by Summit Environmental Consultants (2010 & 2011).

Rare Plants — The initial author for the rare plant section of this report was Rhonda Rosie (edited by EDI). Thanks to Scott Casselman for providing comfortable and pleasant accommodations at the Casino camp during both surveys. Thanks also are due to Patsy, the camp cook in 2010, and to the other employees who helped make our stay enjoyable.

Thanks are due to Kaeli Stark of AECOM, Terra Blanchard (employee at the Casino camp), and to Anne MacLeod of EDI, for their companionship and assistance during the rare plant surveys, and also to the helicopter pilots Andy and Scott, of Capital Helicopters Inc. in Whitehorse, who competently ferried us around every day.

And thanks also go to Bruce Bennett and Randi Mulder of the YCDC in Whitehorse, for providing information and support before and after the surveys. And a special thanks to Bruce Bennett for confirming identifications of plants collected. Last, but not least, my great appreciation is extended to Casino Mining Corporation for making these rare plant surveys possible, so that knowledge of YK 's rare species can be expanded and improved.

Vegetation Health — Lori Carter thanks Scott Casselman and the other employees who made the stay at camp possible during the vegetation sampling field trip. Andy, of Capital Helicopters Inc., was also essential to the success of the field trip, landing as close as possible to our sample sites. Thanks also go to Brodie Smith (EDI) for her hard work and navigation skills during sampling and to Jackie Churchill (EDI) for help with sample site planning.

AUTHORSHIP

This report was prepared by EDI Environmental Dynamics Inc. and associated specialists. The individuals who contributed to this report included:

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1 INTRODUCTION

1.1 OVERVIEW

Casino Mining Corporation (CMC) is proposing to develop the Casino Project (the Project), a copper-molybdenum-gold mine at their Casino Mine property located at latitude 62° 44' N and longitude 138° 50' W, approximately 300 km northwest of Whitehorse, Yukon (Figure 2.1). The proposed Project will have a mine life of 33 years comprised of four phases: construction (3 years), operation (22 years), closure and decommissioning (3 years), and post closure (5 years). It is estimated that the Project will process approximately 44 million tonne-per-annum (Mt/a).

The primary components of the Project, as shown in Figure 2.1 are:

- Mine site — includes open pit; stockpiles for low grade ore, gold ore, topsoil and topsoil/overburden; a plant site; heap leach facility;
- Tailings management facility;
- Extension and upgrade of the Freegold Road (previously referred to as the Casino Trail) — the Freegold Road will be upgraded and extended to connect the mine site to Carmacks, Yukon. The existing 70 km of the Freegold Road will require upgrading and route adjustments to meet design standards. The final road will be approximately 200 km long and maintained as an all-season gravel road suitable for ore and fuel transport;
- Construction and operation of a new airstrip; and
- Access road and water pipeline to the Yukon River.

The Project area lies within the Dawson Range of the Klondike Plateau Ecoregion, in the Boreal Cordillera Ecozone (Smith et al. 2004). Elevations range from approximately 376 meters above sea level (masl) at the YK River to over 1,600 masl in the western portion of the Project area. The majority of the Project is within the boreal bioclimate zone, with areas of subalpine and alpine occurring mainly in the western portion of the study area.

The objective of this vegetation baseline report is to provide information on the existing vegetation, including a description of the ELC vegetative characteristics, a description of rare plants and baseline vegetation health. The baseline report will be used as a basis to assess effects of the Project and inform future vegetation monitoring initiatives.

2 STUDY AREAS

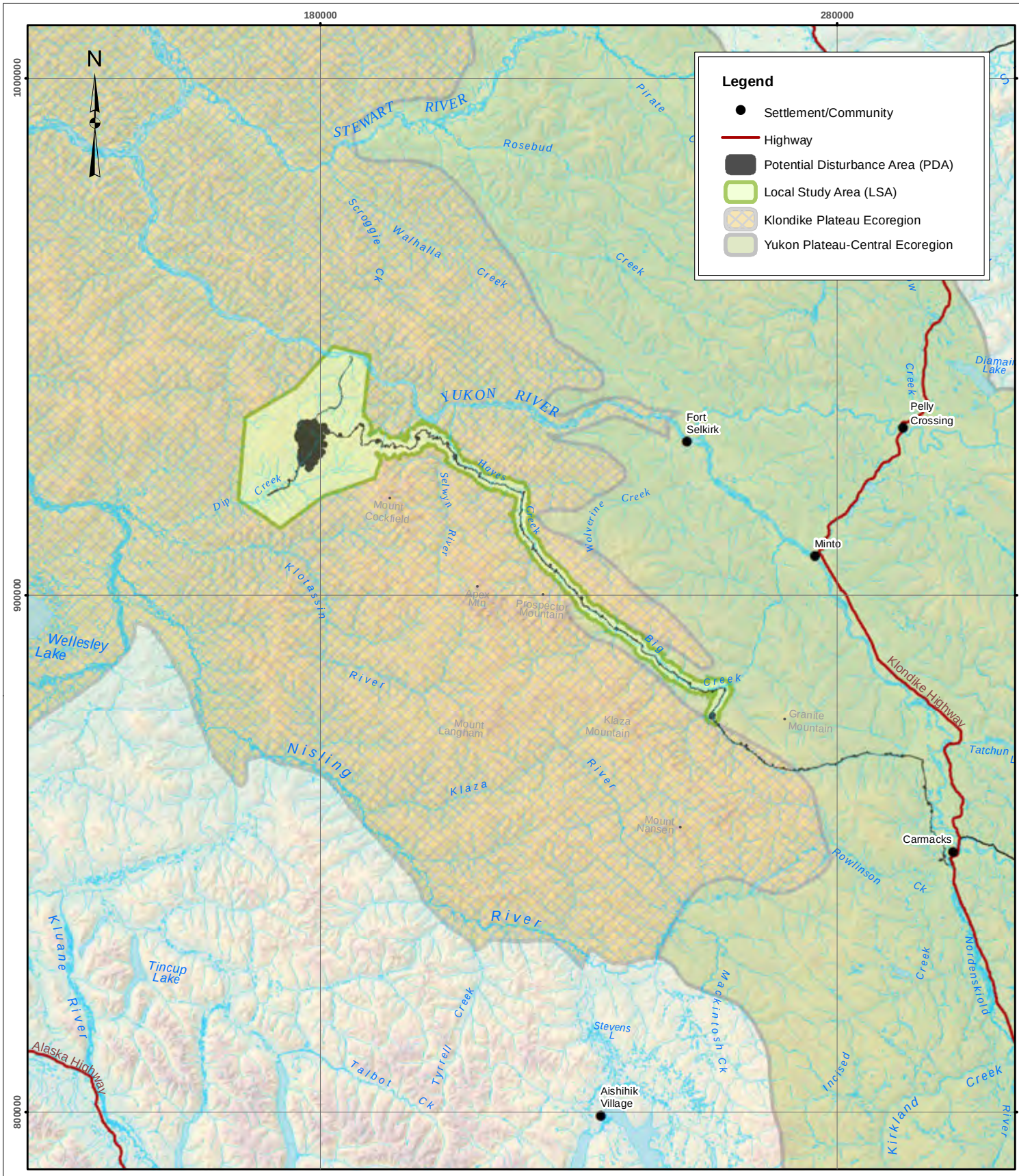
Baseline vegetation studies were conducted in the Local Study Area (LSA) of approximately 881 km². The LSA represents the diversity of landforms and soils, vegetation and wildlife habitats in the immediate Project area. The LSA includes two components: the Freegold Road extension and the mine site. The road portion of the LSA includes the 120 km length of the Freegold Road extension with approximately 1 km buffer on either side of the road alignment. The 1 km buffer was used for terrestrial ecosystem mapping and all terrain polygons within the 1 km buffer were mapped and vegetation types assigned to the polygon's extent, often outside of the 1 km buffer. The mine portion of the LSA encompasses the watersheds of Britannia Creek and its tributary Canadian Creek, as well as upper Dip Creek and its tributary Casino Creek. The YK River defines the northern boundary of the LSA. All proposed infrastructure is within the LSA associated with the mine, including the barge landing and access road, and airstrip and access road.

2.1 ECOLOGICAL DESCRIPTION

The Dawson Range is largely unglaciated, with few high-elevation areas comprised of glaciated features. The colluvial surface deposits have been deeply incised, forming steep-sided V-shaped valleys with small streams flowing northward and eastward to the YK River, or south to the Donjek River. The large landmass around Patton Hill, where the deposit is located, forms the divide between the two watersheds, and mostly lies in the subalpine and alpine bioclimate zones. Tors (outcroppings of resistant rock) and felsenmeer are common features on many high-elevation ridges. Lakes are absent and ponds are sparse. Wetlands are mainly limited to slope toes and valley floors and are generally small in size, with the exception of the Dip Creek area near its confluence with Casino Creek, Big Creek and Hayes Creek. The Dip Creek area has wetlands dominated with sedges and shrubs. Along the upper reaches of Big Creek and Hayes Creek, bogs and fens are common along the valley floors. Gravel bars are common features along the Yukon River, Hayes Creek, and Big Creek. Discontinuous permafrost underlies much of the Project area, but is absent from well-drained, dry slopes.

Vegetation in the boreal bioclimate zone consists mainly of open forest stands of white spruce (*Picea glauca*) and/or black spruce (*Picea mariana*). Mixed forests of aspen (*Populus tremuloides*) and/or birch (*Betula neoalaskana*) also occur and are common on well-drained slopes. Stunted aspen stands with associated grass and forb dominate steep dry slopes, and are common features in the area. Subalpine areas are dominated by open coniferous stands with a dense shrub layer. Low and dwarf shrubs dominate as elevation increases. Tors are common features, with graminoids and forbs present on ledges and in crevices. Alpine areas support mainly dwarf shrubs, forbs, mosses and lichens.

Fire is a common natural disturbance in the Klondike Plateau Ecoregion, and many forest stands show signs of previous burns. Fire sign was also noted on a number of steep dry slopes supporting open grass and forb vegetation and patches of aspen. Signs of human activity are common in the LSA, consisting mainly of dirt roads and trails, tailings and active mining/exploration operations, including the existing Casino exploration camp and airstrip. Other exploration sites were observed along the Freegold Road upgrade and extension corridor.



Notes:

1:250,000 Topographic Spatial Data, National Road Network, Ecoregions; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

PDA provided by Knight Piesold Ltd. 2013.

LSA developed by EDI and is based on boundary ELC vegetation data collected by AECOM and Summit Environmental Consultants and provided by Knight Piesold Ltd. 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Casino Project vegetation local study areas

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3 ECOLOGICAL LAND CLASSIFICATION

Vegetation sampling was conducted as part of a larger initiative for ELC mapping that was carried out by AECOM in 2010 at the mine and along the Freegold Road extension by Summit Environmental Consultants in 2010 and 2011. Methods used by those companies were submitted in draft reports to CMC. Relevant methods and results of the ELC mapping are summarized below.

3.1 VEGETATION PLOTS: MINE SITE

AECOM (2010) conducted vegetation work at the mine site in 2010. Based on a vegetation field manual made available to CMC, the following methods were followed for the vegetation component of the ELC mapping.

There is no standardized system for classifying vegetation or ELC mapping in the YK. The vegetation sampling strategy used to describe and map vegetation units for the Project was guided by the B.C. Terrestrial Ecosystem Mapping inventory standard for 1:20,000 scale mapping (Resource Inventory Committee [RIC] 1998). This system provides a uniform method of describing vegetation, soil and terrain characteristics based on air photo interpretation and field data collection. This method also provides a clear and comprehensive database, and is designed to be scientifically accurate and efficient, particularly for collecting data in remote locations with limited access.

Field sampling was required to develop descriptions for vegetation associations and ecological units and then to verify the ELC mapping. Based on the sampling protocol report prepared by AECOM (2010), field sampling at the mine site LSA included reconnaissance surveys, full plots (ecosystem field form), ground inspections and visual checks. Full plots provide the most comprehensive ecological data for a sample site. They are used to support development of ecosystem unit descriptions and summary statistics. Ground inspections are abbreviated plots that provide basic ecological data, some information for characterizing ecosystem attributes and are intended for confirmation of the identified ecosystem unit. Visual checks are the least detailed form of field data collection and were used either to verify the accuracy of the preliminary vegetation map or provide additional information with which to pre-type the site if the survey was in advance of map preparation.

Following a reconnaissance survey to assess the availability of different vegetation associations in the study area and pre-selected sites, field survey data were weighted in the following proportions:

- 70% visual checks;
- 20% ground inspections; and
- 10% full plots.

The combined sample density was to be one site for each square kilometer (km^2). A minimum of two to three full plots were required for each vegetation association within the Klondike Plateau Ecoregion, and where possible, 10 replicate full plots were sampled for each "ecosystem unit".

For both full plots and ground inspections, a 20 m x 20 m plot (400 m²) was established in an area of homogeneous vegetation of at least 30 m in diameter and located at least 20 m away from any disturbance or edge to avoid edge effects. Plot dimensions may have been altered to accommodate natural site dimensions (e.g., 10 m x 40 m), but the size of the plot should have been maintained. At each plot, an ecosystem field form was completed which includes site information, vegetation, soils, and mensuration characteristics. For vegetation associations with consistent internal patterns such as high-centered polygons and frost boil pattering, crews were instructed to ensure that the plots covered the range of variation on the site. The minimum unit size of a mapped vegetation association polygon is 1.0 ha, except for unique or linear terrain features such as pingos, tors and riparian areas

FULL PLOT VEGETATION SAMPLING

Full plots were located in homogeneous vegetation associations identified on pre-typed vegetation maps. Some vegetation association polygons were pre-selected during the reconnaissance survey to ensure the required distribution of field sampling points.

Shrub Layer — All shrub species within the plot were recorded, including percent cover and average height of each species. Species recorded in the shrub layer included all woody evergreen and woody deciduous plants. Four height classes were distinguished: ground cover shrubs between 1 cm and 20 cm tall; low shrubs between 20 cm and 200 cm tall; tall shrubs greater than 200 cm tall and less than 10 m tall; and trees greater than 10 m tall. If a shrub species occupied multiple layers, the percent cover and average height to the nearest 0.1 m was estimated for both shrub layers separately. Percent cover to the nearest one percent for species occupying less than ten percent of the plot was estimated. Percent cover to the nearest five percent for species occupying ten percent or more of the plot was estimated.

Ground Cover Layer — To survey the ground cover layer, a 20 m transect was set up through the center of the plot with 10 microplots evenly positioned along the transect (roughly one plot every 2 m). In all vegetation associations, a microplot (1 m x 1 m; Daubenmire frame) was used. All vegetation less than or equal to 20 cm tall including low shrubs (as many species as possible given the conditions) was recorded and the percent cover of each was estimated. For each microplot, the total percent cover of vascular plants, bryophytes, terrestrial lichens, litter, bare ground and water was estimated. Percent cover values were recorded to the nearest one percent for values between one and 10 percent, and to the nearest five percent for values greater than 10 percent. If any species accounted for 5 percent or more of the site, and positive identification to species level was not possible in the field, a representative sample was collected and identified later. If there were doubts about the identification of a dominant non-vascular species, samples were collected for later identification.

Tree Mensuration — Eight dominate trees within the main canopy were determined and sampled within the plot area. For each tree the species, height, diameter at breast height (DBH, 1.3 m), pathological indicators and damage (type and severity of damage) were recorded. One to two ages at DBH were gathered at each plot using a tree corer.

Following the collection of detailed vegetation information, the vegetation association at each site was confirmed based on draft vegetation association descriptions derived from the reconnaissance survey.

GROUND INSPECTIONS: VEGETATION SAMPLING

Ground inspections are abbreviated plots that provide basic ecological data, some information for characterizing ecosystem attributes and are intended for confirmation of the identified ecosystem unit.

Shrub Layer — Vegetation data collection for the shrub layer in ground inspections used the same method as that for full plots.

Groundcover Layer — In each plot the percent cover of all groundcover occupying three to five percent or more of the plot was estimated (so-called 'Dominants'). This includes all vegetation species less than or equal to 20 cm tall, including shrub species, tree species, other vascular plants (grasses, sedges, rushes and forbs), non-vascular plants (bryophytes and lichens), litter, bare ground and water.

Tree Mensuration — The eight dominate trees within the main canopy were sampled within the plot area. For each tree the species, height, DBH, pathological indicators and damage (type and severity of damage) was recorded. One or two ages at DBH were recorded using a tree corer.

VISUAL CHECKS

Visual checks are the least detailed form of field data collection and were used either to verify the accuracy of the preliminary vegetation map or provide additional information with which to pre-type the site if the survey was in advance of map preparation. Visual checks were conducted by landing briefly or hovering over a uniform vegetation association while surveyors recorded percent cover of dominant shrub and groundcover species. Surveyors also recorded the percent of bedrock, rocks/boulders, bare ground and water, vegetation association, UTM co-ordinates and any other relevant terrain information.

3.2 VEGETATION PLOTS: FREEGOLD ROAD EXTENSION

Summit Environmental Consultants (Summit) conducted the vegetation work along the Freegold Road extension. Based on draft reports submitted to CMC, the following methods were followed for the vegetation work component of the ELC.

In 2010, landform and terrain mapping was conducted for the proposed road corridor between the end of the existing Freegold Road and the proposed mine site. The landform polygons were first mapped on aerial photographs using PurView (a stereo imagery viewing program) according the most recent B.C. terrain mapping standards (Howes and Kenk 1997). The mapping considered regional surficial geology mapping completed by the YK government and terrain mapping completed by AECOM at the mine site.

The 2010 terrain mapping polygons provided the foundation for a preliminary terrestrial ecosystem mapping (TEM) based on detailed analyses of the alignment imagery using PurView to view the topographic data and extrapolate from ground surveys for major vegetation classifications. The major vegetation classifications

were based on the work conducted by AECOM at the mine site (described above). A vegetation interpreter and a surficial geologist completed an initial classification of the road LSA. Within each polygon, the primary (dominant), secondary and tertiary ecosystem types were identified during the desktop analyses based on 2010 field data. Through 2011 the polygons were verified on the ground to determine the accuracy of the desk-top analysis. The field surveys allowed the team to further stratify the polygons into primary, secondary and tertiary ecological communities within each broad ecosystem type.

3.3 ECOSITE CLASSIFICATION OVERVIEW

AECOM and Summit prepared summary tables of ecosystem types/ecosites in draft summary reports. A summary of those descriptions are provide in Table 3.1. A more detailed description of most of the ecosites is available in Attachment A. Illustrations of the ecosite polygons at the mine site are presented in Figure 3.1 to Figure 3.3, and samples of the Freegold Road extension are provided in Figure 3.4 to Figure 3.6. The two mapping programs were merged to provide an ecosite description of the entire LSA. Freegold road ecosites were clipped where they joined with the mine area mapped by AECOM. The clipped polygons were assumed to contain identical proportions of ecosites identified for the entire polygon from the original Summit Environmental Consultants mapping work.

Alpine bioclimate zone — The alpine bioclimate zone comprises ~6% of the LSA. The majority of this area is classed as felsenmeer (angular rock fragments, boulder fields over gently sloping ground with low vegetation cover). The portion of the LSA in this zone is also characterized by ground shrubs/sparse herb characterized by mountain-avens, bryophytes and lichens; and also by tors characteristic of an unglaciated landscape.

Subalpine bioclimate zone — The subalpine bioclimate zone comprises ~36% of the LSA and is comprised predominately of subalpine moist shrub (e.g., dwarf birch [*Betula glandulosa*]), wet shrub (e.g., spruce-shrub on steep north facing slopes) and tall shrub vegetation communities. There is also a small component of mid to high elevation dry shrub communities that include mountain cranberry (*Vaccinium vitis-idaea),* common bearberry (*Arctostaphylos uva-ursi*) and crowberry (*Empetrum nigrum*).

Boreal high bioclimate zone — Most of the LSA (56.2%) is in the Boreal high bioclimate zone. This zone contains the greatest diversity of ecosites, but is comprised mostly of sparse coniferous forest, mixedwood forest, and dry broadleaf forest. This bioclimate zone contains the dry, open south-facing slopes with vegetation dominated by low shrubs, forbs and graminoid species. Mixedwood forests, coniferous treed bogs and riparian ecosites are found in this bioclimate zone.

Others zones — Gravel bars, rock outcrops, open water and human-disturbed sites account for ~1% of the LSA. A small percentage (0.5%) of the LSA remained unclassified in Summit's work conducted along the Freegold Road extension portion of the LSA.

Table 3.1 Ecosite summary of the Casino Project's LSA

Code	Ecosystem name	Site description	SMR[a]	SNR[b]	Area (km²)	% of LSA
Alpine bioclimate zone						**5.95**
To	Tors	Protruding bedrock outcrops on mountain crests. Plant growth is mainly restricted to fractures and crevices where soil has accumulated.	1-3	A-B	2.70	0.30
Sd	Dryas/Sparse Herb	Occurs on plateaus and gentle slopes at high elevations. Structural development is limited by environmental conditions, and vegetation communities are mainly composed of mountain-avens, bryophytes and lichens.	2-4	B	15.16	1.71
Fe	Felsenmeer	Veneer of angular rock fragments/boulder fields over gently to moderately sloping ground. Vegetative cover is typically <40%, and includes dwarf shrubs, grasses, bryophytes, and lichens.	1-4	B	34.95	3.94
Subalpine bioclimate zone						**35.81**
Sx	Mid to High Elevation Dry Shrub	Dry, open south-facing low-middle elevation slopes with vegetation dominated by low shrub species including mountain cranberry, common bearberry, and crowberry.	3	B	9.31	1.05
Sm	Subalpine Moist Shrub	Low shrub community dominated by dwarf birch, willow, bog blueberry, mountain cranberry, Labrador tea, northern Labrador tea, and crowberry.	4-7	B-C	138.95	15.68
Sw	Mid to High Elevation Wet Shrub	Black spruce-shrub communities occurring on steep, north facing slopes at high elevations. Shrub species are similar to those found in the Subalpine Moist Shrub.	5-7	B-C	65.36	7.37
St	Tall Shrub	Tall (1–1.5 m) willow, dwarf birch, water birch communities on moderate to steep slopes at high elevations.	4-8	B-C	103.76	11.71
Boreal high bioclimate zone						**46.89**
Lx	Sloping Grassland	Dry, open south-facing low-middle elevation slopes with vegetation dominated by low shrubs, forbs, and graminoid species. Exposed mineral soil and organic matter accounts for >40% of ground cover.	2	B-C	7.74	0.87
Fbx	Dry Broadleaf Forest	Broadleaf forest ecosystem on upper-middle south or southwest-facing slopes. Trembling aspen dominates the canopy, and low shrub, forb, and grass species occur in the understory.	2-4	B-C	73.53	8.30
Fbw	Moist Broadleaf Forest	Broadleaf forest ecosystem on north-facing middle and lower slopes. Alaska birch dominates the canopy, and green alder, prickly rose, mountain cranberry, and currant/gooseberry species occur in the shrub layer.	3-5	C	25.87	2.92

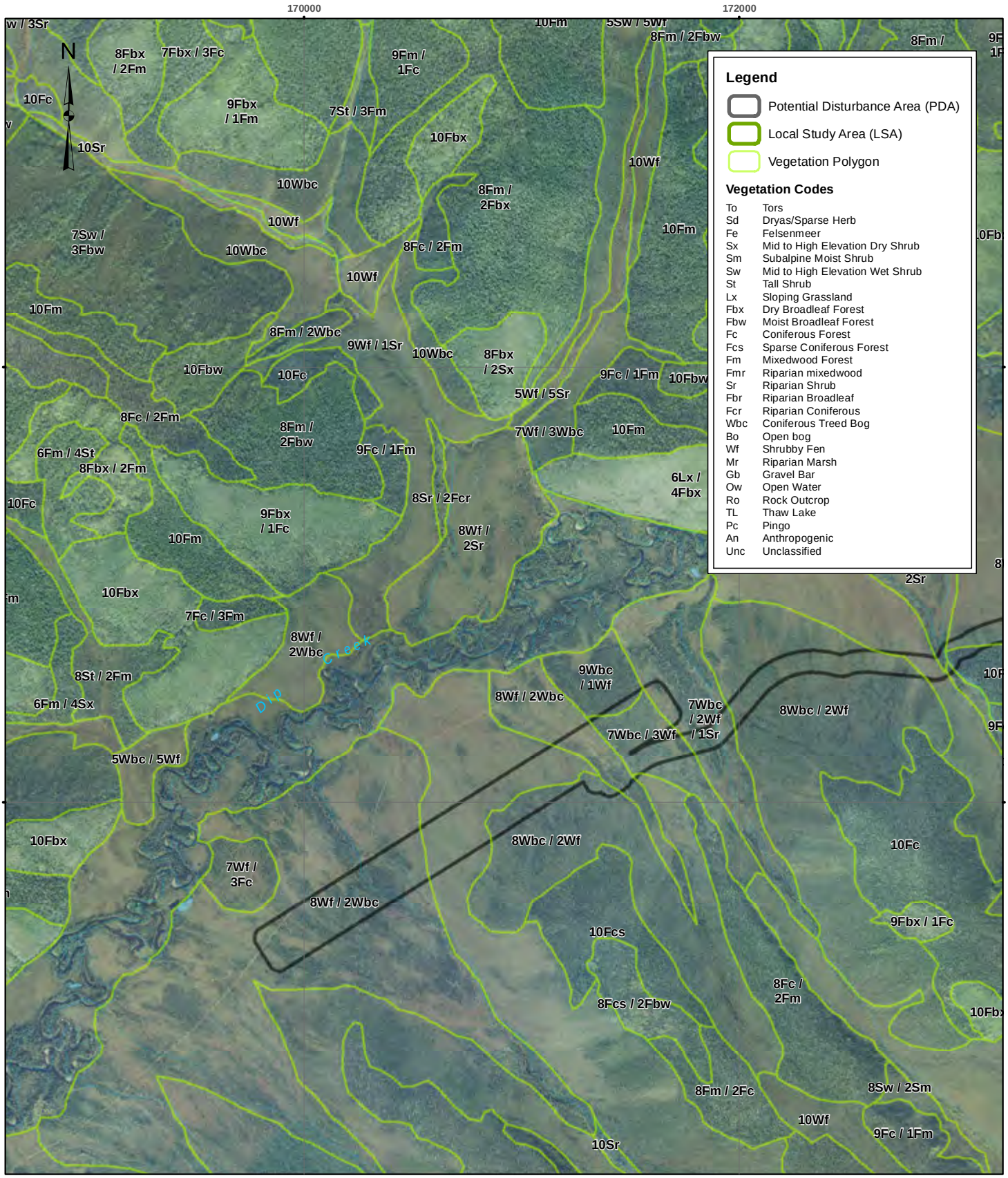
Code	Ecosystem name	Site description	SMR[a]	SNR[b]	Area (km²)	% of LSA
Fc	Coniferous Forest	Black spruce forest on north-facing slopes (and occasionally white spruce forest on south-facing slopes). Shrub species include Labrador tea, mountain cranberry, and prickly rose. Step moss and fruticose lichens are abundant in the bryophyte layer.	3-5	B-C	65.60	7.40
Fcs	Sparse Coniferous Forest	Sparse white spruce (sometimes black spruce) forest in middle and upper slope positions at various aspects. Shrub species include dwarf birch, Labrador tea, mountain cranberry, and willow species. Red-stemmed feathermoss and reindeer lichens are abundant in the bryophyte layer.	5-6	B-C	117.59	13.27
Fm	Mixedwood Forest	Mixedwood forest ecosystem on moderately steep slopes at various aspects. The canopy is co-dominated by white spruce and Alaska birch. Shrub species include Labrador tea, mountain cranberry, and willow species. Step moss is abundant in the bryophyte layer.	4-6	B-C	119.80	13.52
Fmr	Riparian Mixedwood	Mixedwood forest ecosystem adjacent and influenced by rivers, creeks, wetlands, etc.	-	-	5.40	0.61
Boreal low and boreal high bioclimate zone						**9.06**
Sr	Riparian Shrub	Occurs within floodplains and side channels of riverine habitats where seasonal flooding is common. Tall shrub community dominated by willow species.	4-6	C-D	8.37	0.94
Fbr	Riparian Broadleaf	Well-developed balsam poplar canopy on broad, level floodplains and side channels. Shrub species include prickly rose, grey alder, high bush cranberry, and red osier dogwood. Forb species include horsetail species, tall bluebells, and northern bedstraw.	4-5	D	3.28	0.37
Fcr	Riparian Coniferous	Tall white spruce forest on broad floodplains and side channels. Shrub species include willow, prickly rose, grey alder, and twinflower. Horsetail species, bluejoint reedgrass, and step moss are common in the understory.	4-5	C-D	15.47	1.75
Wbc	Coniferous Treed Bog	Discontinuous black spruce canopy over shallow organic soils on level and gently sloping terrain. Labrador tea, mountain cranberry, cloudberry, sweet coltsfoot, step moss, and peat moss are common in the understory.	6-7	B	22.53	2.54
Bo	Open bog	No description provided in Summit draft reports.			5.58	0.63
Wf	Shrubby Fen	Shrubby fen on level and gently sloping terrain. The tree canopy layer is absent, but the shrub layer is well-developed and includes dwarf birch, mountain cranberry, northern Labrador tea, leatherleaf and some black spruce. Cloudberry, sheathed cottongrass, and peat moss are common in the understory.	6-8	B-C	25.06	2.83
Mr	Riparian Marsh	No description provided in Summit draft report.	-	-	0.02	0.00

Code	Ecosystem name	Site description	SMR[a]	SNR[b]	Area (km²)	% of LSA
Sparsely vegetated, point features and anthropogenic sites						**1.30**
Gb	Gravel Bar	Coarse-textured gravels and sands deposited by fast-moving waters during flood events. Vegetation cover is sparse.	-	-	3.38	0.38
Ow	Open Water	Waterbodies (rivers, creeks, ponds, etc.).	n/a	n/a	0.74	0.08
Ro	Rock Outcrop	Rock outcrop, no vegetation	-	-	2.31	0.26
TL	Thaw Lake	Ground surface depressions, commonly filled with water, created by the thawing of ice-rich permafrost and associated soil subsidence (point features identified in terrain report).	n/a	n/a	0	0.00
Pc	Pingo	A mound of earth-covered ice, in this area formed in an 'open system' where groundwater discharge (seepage) through permafrost freezes and accumulates at or close to the ground surface; all pingos within the mapping area have at least partly collapsed.	n/a	n/a	0.05	0.01
An	Anthropogenic	Early successional weedy vegetation often with bare ground. Disturbances include placer mining, road construction, seismic activity etc.	n/a	n/a	5.09	0.57
Unclassified						**0.43**
n/a	n/a	Unclassified	-	-	3.84	0.43
Total Area					**882.04**	

Notes:

a SMR = Soil moisture regime, provided where data were available

b SNR = Soil nutrient regime, provided where data were available



Notes:

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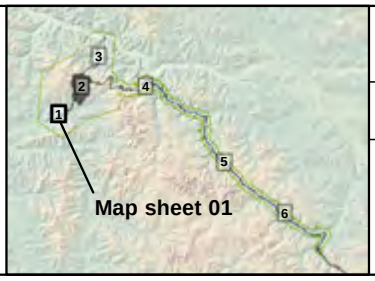

Airstrip vegetation polygons, map sheet 01

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MP/LG	MAS	02/10/2013	3.1

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Metres

Map scale 1:24,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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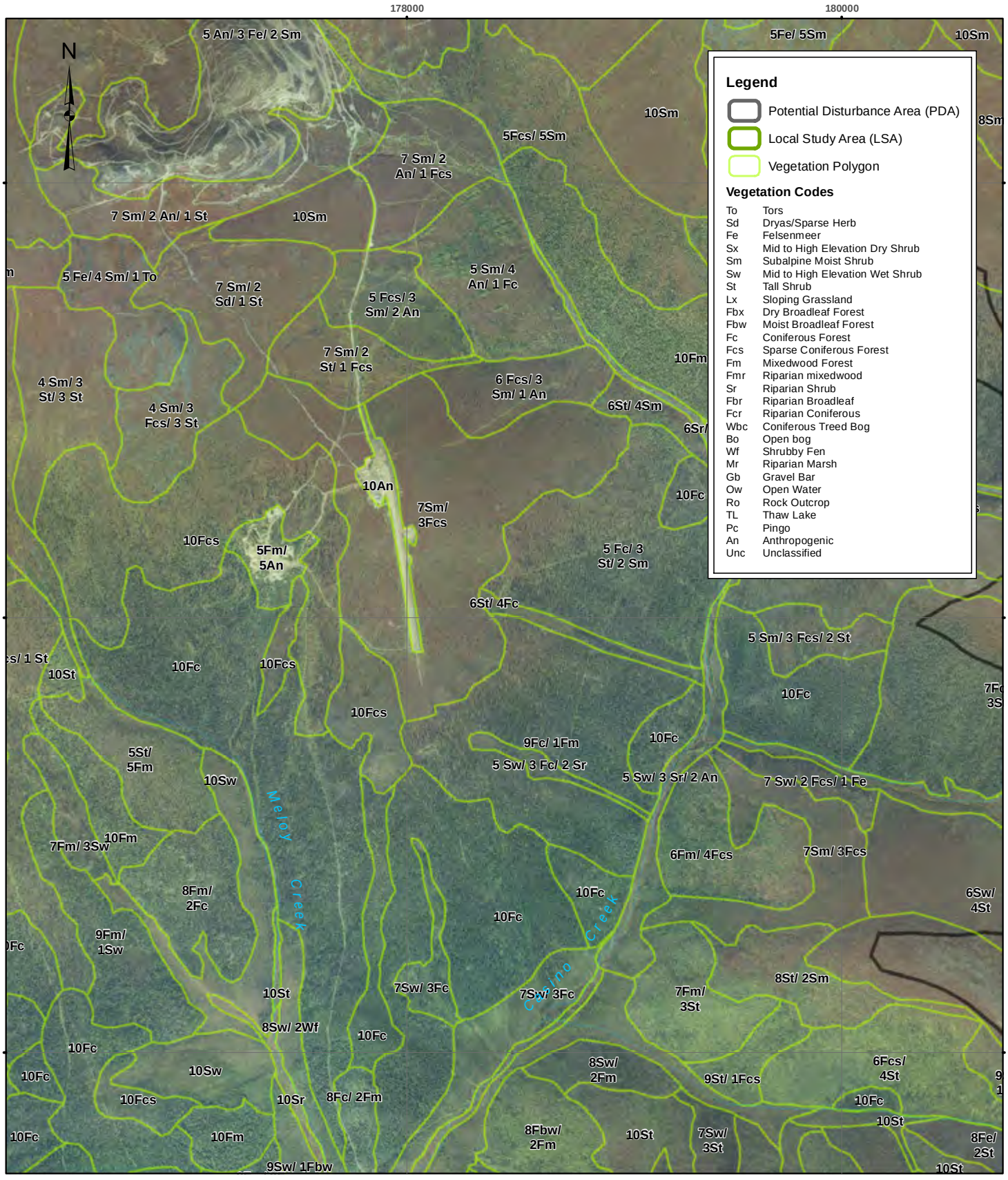

Notes:

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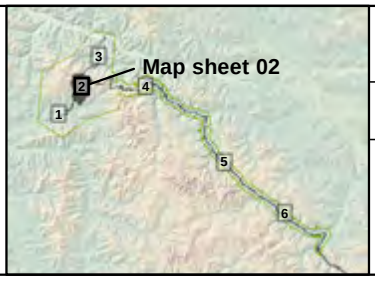
Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Mine Site vegetation polygons, map sheet 02

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Metres

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North American Datum 1983 CSRS Yukon Albers

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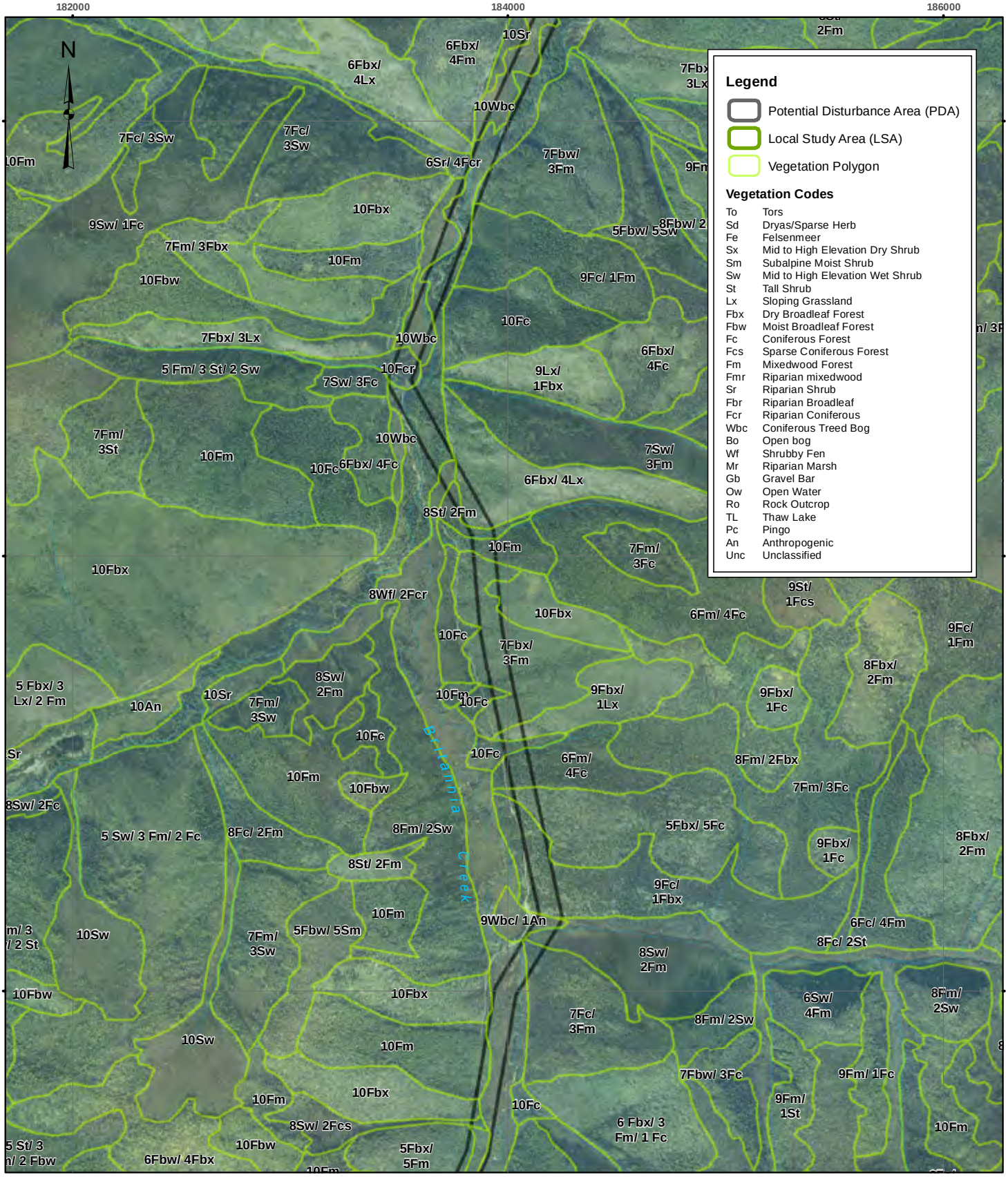

Notes:

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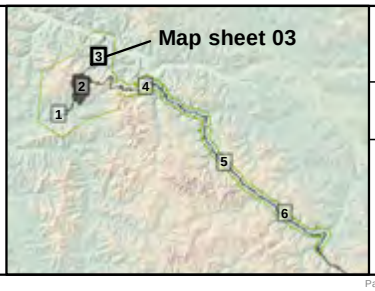
Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Yukon River Access Road vegetation polygons, map sheet 03

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MP/LG	MAS	02/10/2013	3.3

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Metres

Map scale 1:24,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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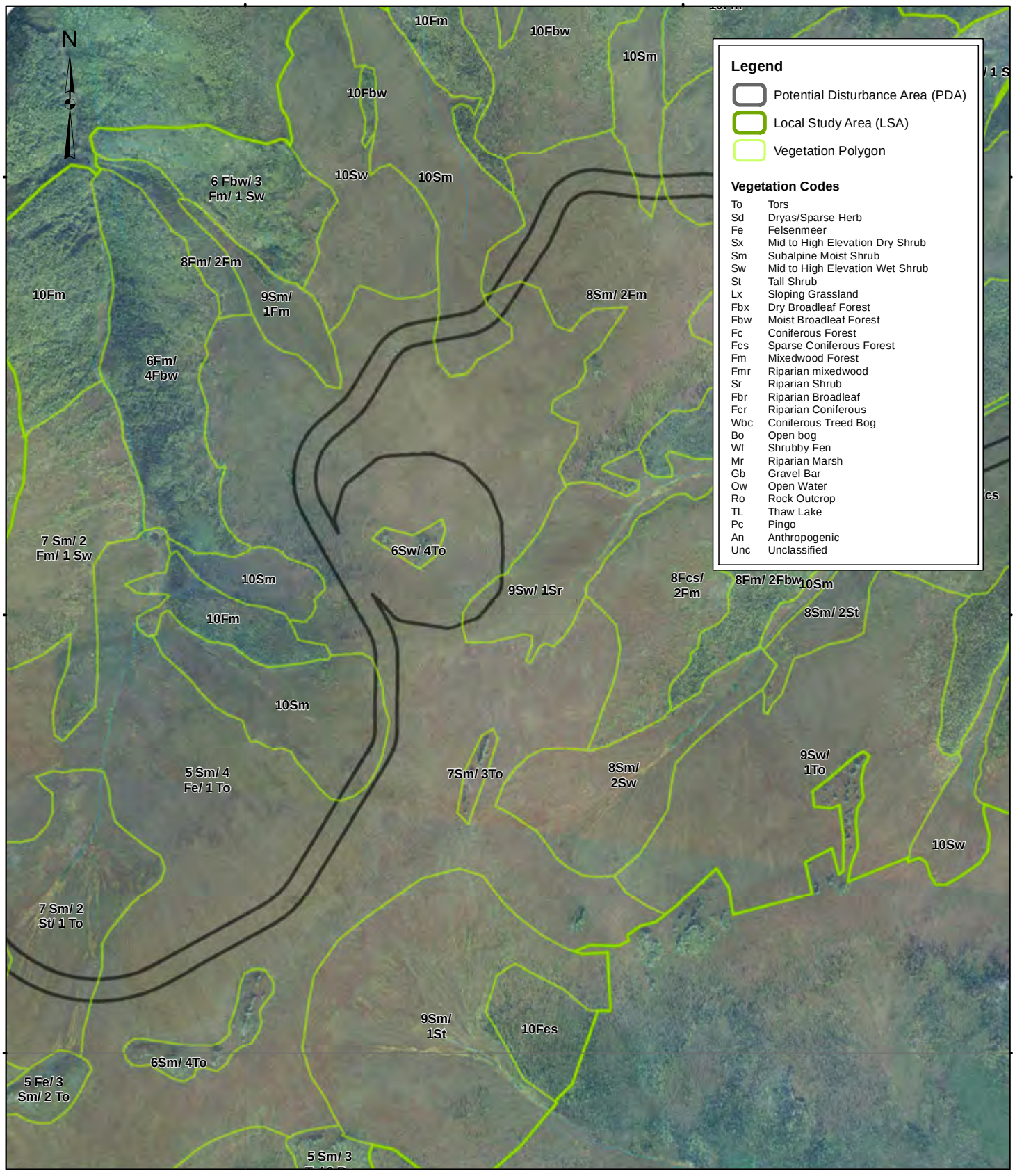

Notes:

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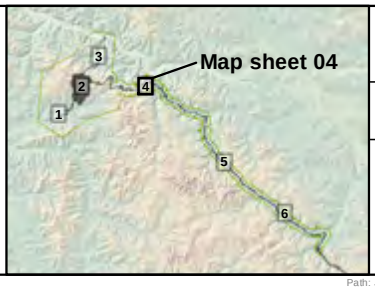
Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Freegold Road extension vegetation polygons, map sheet 04

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MP/LG	MAS	02/10/2013	3.4

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Metres

Map scale 1:24,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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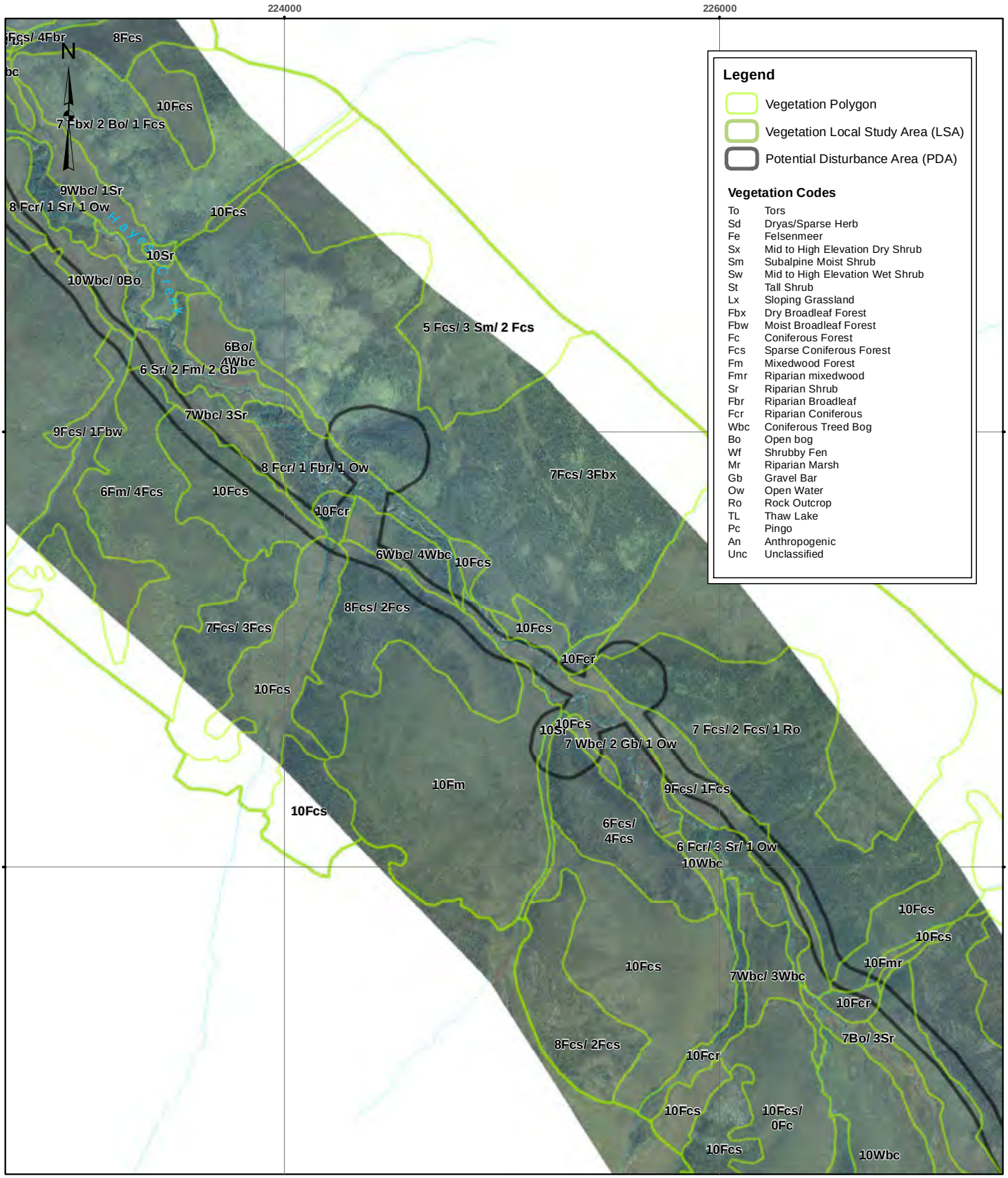

Notes:

PDA provided by Knight Piesold Ltd. 2013.

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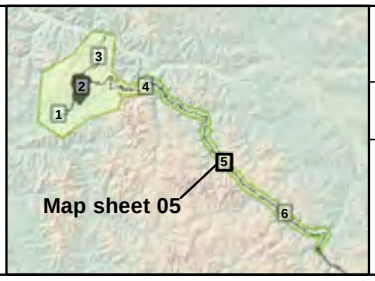
Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Freegold Road extension vegetation polygons, map sheet 05

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	02/10/2013	3.5

0 200 400 600 800 1,000
Metres

Map scale 1:24,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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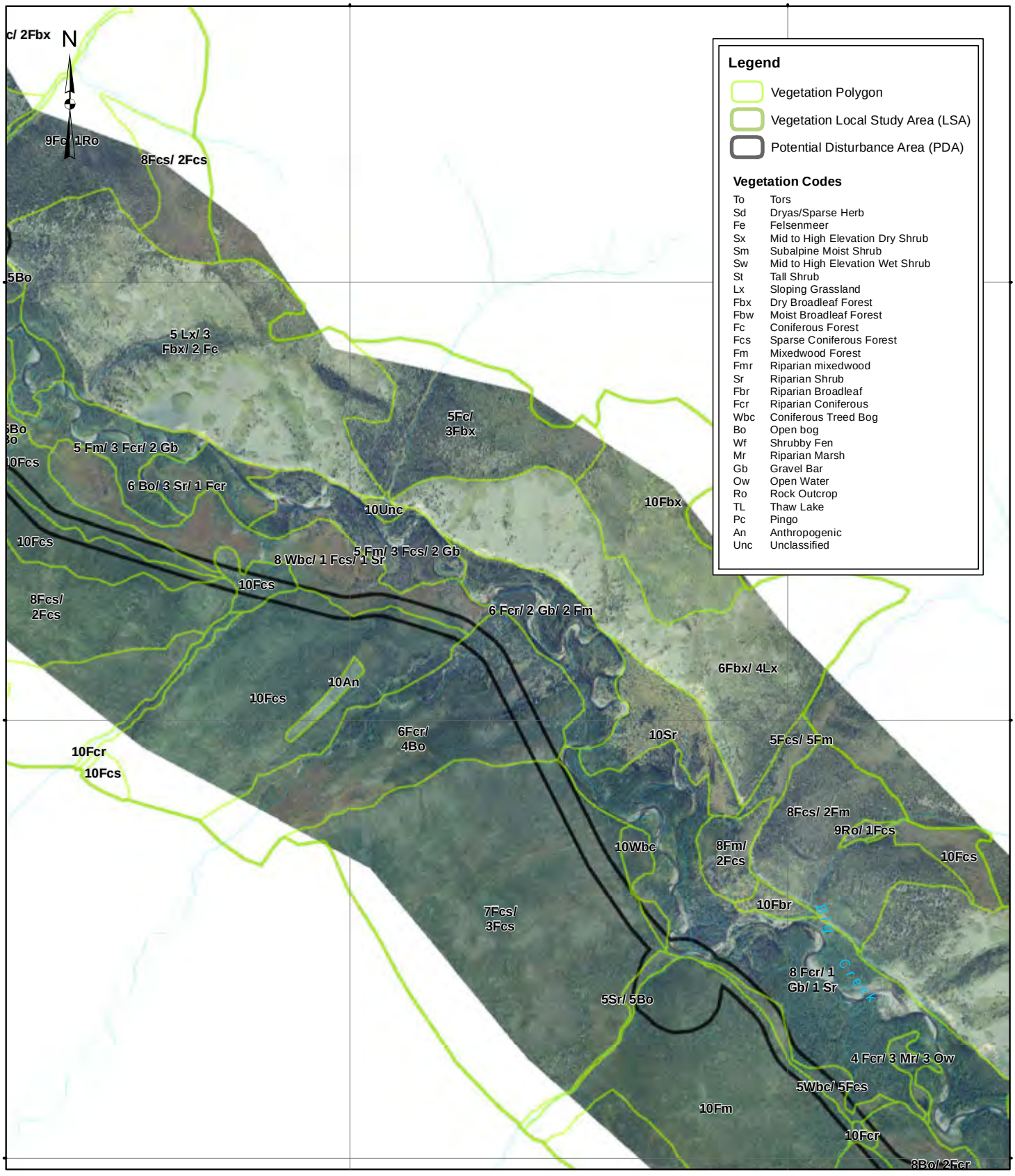

Notes:

PDA provided by Knight Piesold Ltd. 2013.

LSA developed by EDI and is based on boundary ELC vegetation data collected by AECOM and Summit Environmental Consultants and provided by Knight Piesold Ltd. 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Freegold Road extension vegetation polygons, map sheet 06

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	02/10/2013	3.6

0 200 400 600 800 1,000
Metres

Map scale 1:24,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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4 RARE PLANTS

During construction, the Project will require clearing of areas of vegetation. The area to be cleared is within the eastern edge of Beringia, so unique plants may exist in Project area. Rare vascular plants with territorial, national, or global conservation status are known to occur in the region, but there is limited information on the distribution and abundance of these plants. A baseline inventory of the distribution of rare plants near the proposed Project footprint is necessary to inform detailed Project design and to characterize the potential for the Project to affect the region's rare plant population.

A rare plant is defined as "one that has a small population within the area under consideration. It may be restricted to a small geographical area, where it may be locally common, or it may occur in low numbers over a wide area" (Douglas et al. 1981). A threatened species is defined as "a wildlife species (which includes plant species) that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction", and an endangered species is defined as "a wildlife species (which includes plant species) that is facing imminent extirpation or extinction" (SARA 2002).

Global species conservation ranks are provided by the International Union for Conservation of Nature (IUCN 2011) and by NatureServe (NatureServe 2010a). These are non-profit conservation organizations with international networks of natural heritage programs. Species rankings are assessed by species experts around the world, based on current knowledge of species population trends, including population size, range extent, area of occupancy, number and area of populations (occurrences), environmental specificity, whether or not the population size or area is declining or increasing, and what threats may affect the population (e.g. development, climate change) (NatureServe 2010b).

Each rare species is given a global rank (G-rank), a national rank (N-rank), and a sub-national rank (S-rank). Ranks are indicated on a scale from 1 to 5, with 1 signifying a "critically imperiled" species while 5 is a species that is "secure" throughout its range (NatureServe 2010a). Tables listing global, national and subnational ranks and their meanings are presented in Attachment B.

In Canada, these rankings are managed and maintained by NatureServe and Canada's independent conservation data centers for the ten provinces and YK. The YCDC in Whitehorse maintains existing rank status data, as well as a database of location information for the 309 YK vascular plant species designated as "rare" (YCDC 2012). In addition, these species have been assigned to either a Track or Watch list. Tracked are of greatest conservation concern in YK with a total of 98 species recorded in 2012 (YCDC 2012). Some Tracked species are also of global concern, mainly those species with restricted ranges, especially those known only from the YK. Tracked species also include native species not of global concern, but with limited distributions in the territory, and those which are associated with certain habitats of conservation concern, (e.g. hot springs). Watched species may also be of conservation concern; however, additional information on the occurrence and distribution of these species is needed to determine status and monitor trends in populations. In 2012 a total of 211 species were recorded in YK. The YCDC Track and Watch lists are periodically updated and are available online from the YCDC (YCDC 2012).

Some of the Tracked and Watched species are known from only one or very few locations in YK, while others are known from more locations but are limited to specific areas or habitats. However, given the large size of the YK and the difficulty of access to remote areas, it is likely that other populations of rare species have not yet been discovered, or have not been reported. The discovery and documentation of additional populations will help provide the rationale for changing species' status rankings (e.g. down-listing).

Rhonda Rosie (author of this section) was contracted by AECOM in August, 2010 and by EDI in July, 2012, to conduct rare vascular plant surveys for CMC at their Casino property 300 km northwest of Whitehorse and along the proposed Freegold Road extension east of the camp (Figure 2.1).

4.1 RARE PLANT SURVEY METHODS

Prior to 2010 & 2012 fieldwork, species of potential conservation concern in YK were provided by Randi Mulder of the YCDC in Whitehorse, YK, including rare status rankings and likely habitats. Species lists were used as a guide during the survey for stratifying the study area and prioritizing areas for more intensive searching.

Surveys were carried out August 16–27, 2010, and July 18–22, 2012, and were based out of the Casino property camp near the proposed mine site. In 2010, a full set of pre-classified aerial photos of the Project study area provided by AECOM were useful for assessing specific areas and vegetation communities likely to contain rare species. In 2012, a preliminary vegetation classification of the proposed road corridor was provided by EDI as an aid in stratification, in conjunction with Google Earth imagery. In addition, helicopter flights were conducted before fieldwork began to get overviews of the area and pinpoint sites for future ground searches. Access to sites in 2010 was by helicopter, vehicle, and on foot, and in 2012 by helicopter. Sites were selected based on their assumed potential to host rare species, and included dry steep slopes dominated by grasses and forbs, open aspen and/or white spruce forests, alpine and subalpine areas, rock outcrops, wetlands, disturbed sites, and riparian corridors. Other sites deemed representative of the vegetation of the entire study area were also selected to survey.

When a rare plant population was observed, location and elevation were recorded using a Garmin Oregon 550 Global Positioning System. In addition, habitat type, associated species, population size, phenology, and other relevant information were noted. Voucher specimens were collected, and/or photos taken, for each rare species.

Following fieldwork, specimens of rare and possibly rare species were sent to Bruce Bennett, Coordinator, YCDC in Whitehorse, YK, to confirm identification or for submission to experts in a particular genera (e.g. *Botrychium alaskense*, which was confirmed from a photo of the specimen [Farrar 2010]). Collected voucher specimens in 2010 were sent to the herbarium at the University of British Columbia (UBC), Vancouver, B.C., with the exception of *Botrychium alaskense*, which was sent to the herbarium at Agriculture and Agri-Food Canada in Ottawa. Specimens from the 2012 survey were sent to the UBC herbarium and B.A. Bennett herbarium in Whitehorse, YK.

4.2 RARE PLANT RESULTS

Populations of nine listed species were discovered during the two surveys, with rankings from S2 to S3S4: *Artemisia laciniata*, *Botrychium alaskense*, *Cypripedium guttatum*, *Koenigia islandica*, and *Phacelia mollis*, in 2010, and *Silene williamsii*, *Minuartia yukonensis*, *Erigeron purpuratus* and *Helictotrichon hookeri* with additional populations of *Phacelia mollis* were discovered in 2012. Of these nine species, *Botrychium alaskense*, *Artemisia laciniata*, and *Silene williamsii* are on the YCDC Track list and the remainders are on the Watch list. *Erigeron purpuratus* has since been removed from the Watch list; however, at the time of the survey it was included on the Watch lsit. *Scirpus hudsonianus* was also found during the 2010 survey, but has since been removed altogether from the YCDC Watch list and is no longer considered rare in YK. Locations and other data for rare plant locations in 2010 and 2012 are presented in Table 4.1 and Figure 4.1. Areas of likely habitat for rare plants within the LSA are also included in Figure 4.1 and are divided into areas of high, medium or low habitat potential. A list of all plants observed during the rare plant surveys are listed in Attachment C. Rare plant species summaries are provided below.

NatureServe global and sub-national rankings for these species are presented in Table 4.2 below, along with their status in bordering jurisdictions to provide additional context. Full descriptions of the rankings are provided in Attachment B. The territorial, national and global rankings are those currently listed for species by the YCDC. Differences in the 2010 and 2012 rankings are noted. Rankings in 2010 for other jurisdictions were obtained from the NatureServe website (NatureServe 2010a), and in 2012 from the most recent assessments provided by the provincial Conservation Data Centres in Alberta (AB) (Alberta Government 2012) and B.C. (Government of British Columbia 2012), the Northwest Territories (NWT) Department of Environment and Natural Resources (Working Group on General Status of NWT Species 2011), and the Alaska Natural Heritage Program (Alaska Natural Heritage Program 2012).

The YK status rankings are based mainly on the number of known occurrences of the species in the Territory, and do not reflect vulnerability or other criteria normally considered when assessing rankings (Bennett 2010). As knowledge of species' occurrences in YK increases over time, these rankings will be revised to reflect their true status as all factors will be considered.

Details describing the nine rare species observed during the 2010 & 2012 are provided below. Information included in this section is adapted from the following references: *Flora of North America* (Flora of North America Editorial Committee 1993+), *Flora of the Yukon Territory* (Cody 1996), *Vascular plants of continental NWT, Canada* (Porsild and Cody 1980), *Illustrated flora of British Columbia* (Douglas et al 1998–2002), published articles (Cody et al. 2002, 2003, 2004, 2005) reporting new species records for the YK, and from personal communications with Bruce Bennett and Randi Mulder of the YCDC in Whitehorse.

Table 4.1 Locations of rare plants found in the Casino Project LSA, 2010 and 2012.

Species name	Location	Habitat	Date	Lat.	Long.	Elevation (masl)
Artemisia laciniata	West side of Canadian Creek, near junction with Brttannia Creek	Steep grassy slope	2010/ 08/20	62.8060	-138.7544	716
Artemisia laciniata	West side of Canadian Creek, near junction with Brttannia Creek	Steep grassy slope	2010/ 08/21	62.8033	-138.7636	623
Artemisia laciniata	West side of Canadian Creek, near junction with Brttannia Creek	Disturbed soil along dirt road and dirt push-ups near Brittanica Creek at the Yukon River.	2010/ 08/21	62.8739	-138.6930	400
Artemisia laciniata	Near Victor Creek	Steep, dry, south-facing grassy slope	2010/ 08/22	62.6201	-138.7816	732
Botrychium alaskense	Stevenson Ridge east of Dip Creek	Steep dry southwest-facing slope, in sparse spruce/low shrubs/grass	2010/ 08/21	62.5846	-138.9146	1,223
Cypripedium guttatum	West side of Canadian Creek, near junction with Brttannia Creek	Top of steep grassy slope, in stunted aspen/kinnickinnick	2010/ 08/20	62.8067	-138.7545	770
Cypripedium guttatum	West side of Canadian Creek, near junction with Brttannia Creek	Base of a grassy slope, in open Picea glauca-Betula neoalaskana/grass etc.	2010/ 08/21	62.8029	-138.7601	584
Cypripedium guttatum	West side of junction of Casino and Dip Creeks	Under aspen near crest of slope; an old burn	2010/ 08/26	62.6489	-138.8713	800
Cypripedium guttatum	West side of junction of Casino and Dip Creeks	Steep south-facing slope with stunted aspen	2010/ 08/26	62.6478	-138.8705	760
Erigeron purpuratus	South side of Big Creek	Beside gravelly dirt road	2012/ 07/18	62.3451	-137.2409	660
Erigeron purpuratus	North side of Big Creek	Shallow gully on steep dry slope under open white spruce and grasses	2012/ 07/20	62.4406	-137.5796	906
Erigeron purpuratus	North side of Hayes Creek	Gravel bar	2012/ 07/21	62.7008	-138.2043	527
Helictotrichon hookeri	North side of Big Creek	Steep grassy slope	2012/ 07/18	62.3549	-137.2967	717
Helictotrichon hookeri	North side of Big Creek	Steep grassy slope	2012/ 07/20	62.4404	-137.5812	918

Species name	Location	Habitat	Date	Lat.	Long.	Elevation (masl)
Koenigia islandica	Along Casino Creek	Wet muddy old dirt road along Casino Creek, bordered by dense medium and tall shrub	2010/ 08/23	62.7183	-138.7817	867
Koenigia islandica	Along Casino Creek	Wet muddy old dirt road along Casino Creek, bordered by dense medium and tall shrub	2010/ 08/23	62.7188	-138.7816	870
Koenigia islandica	Along Casino Creek	Wet muddy old dirt road along Casino Creek, bordered by dense medium and tall shrub	2010/ 08/23	62.7189	-138.7815	873
Koenigia islandica	Along Casino Creek	Wet muddy old dirt road along Casino Creek, bordered by dense medium and tall shrub	2010/ 08/23	62.7195	-138.7813	873
Koenigia islandica	Along Casino Creek	Pocket of soil in small pile of disturbed rocks, along muddy old dirt road along Casino Creek, bordered by dense medium/tall shrub	2010/ 08/23	62.7251	-138.7820	907
Minuartia yukonensis	North side of Big Creek	Steep grassy slope	2012/ 07/18	62.3560	-137.2961	805
Minuartia yukonensis	North side of Big Creek	Steep grassy slope, under young aspens/forbs	2012/ 07/19	62.3764	-137.3737	839
Minuartia yukonensis	North side of Big Creek	Steep grassy slope	2012/ 07/19	62.4313	-137.5425	889
Phacelia mollis	South of Yukon River	Alpine dwarf shrub tundra; frost boils present	2010/ 08/20	62.7021	-138.7477	1,290
Phacelia mollis	West side of Canadian Creek, near junction with Brttannia Creek	Semi-barren stony-rocky soil tailings along the creek.	2010/ 08/21	62.8014	-138.7632	563
Phacelia mollis	West side of Canadian Creek, near junction with Brttannia Creek	Dry grassy slope, and in the placer tailings and aspen/ spruce/shrub woods at the base of the grassy slope	2010/ 08/21	62.8041	-138.7640	680
Phacelia mollis	Near Brittania Creek	Scattered on road near Brittania Creek, for at least 50 m along road	2010/ 08/23	62.8299	-138.7169	n/a
Phacelia mollis	Near Brittania Creek	Steep dry southwest-facing slope, under tall willow	2010/ 08/23	62.7788	-138.7309	765
Phacelia mollis	Near Casino Creek	Steep south-facing slope, in White Spruce forest	2010/ 08/26	62.7146	-138.7736	915
Phacelia mollis	Near Brittania Creek	Along stony dirt road near Brittania Creek, in push piles	2010/ 08/27	62.8180	-138.7212	500

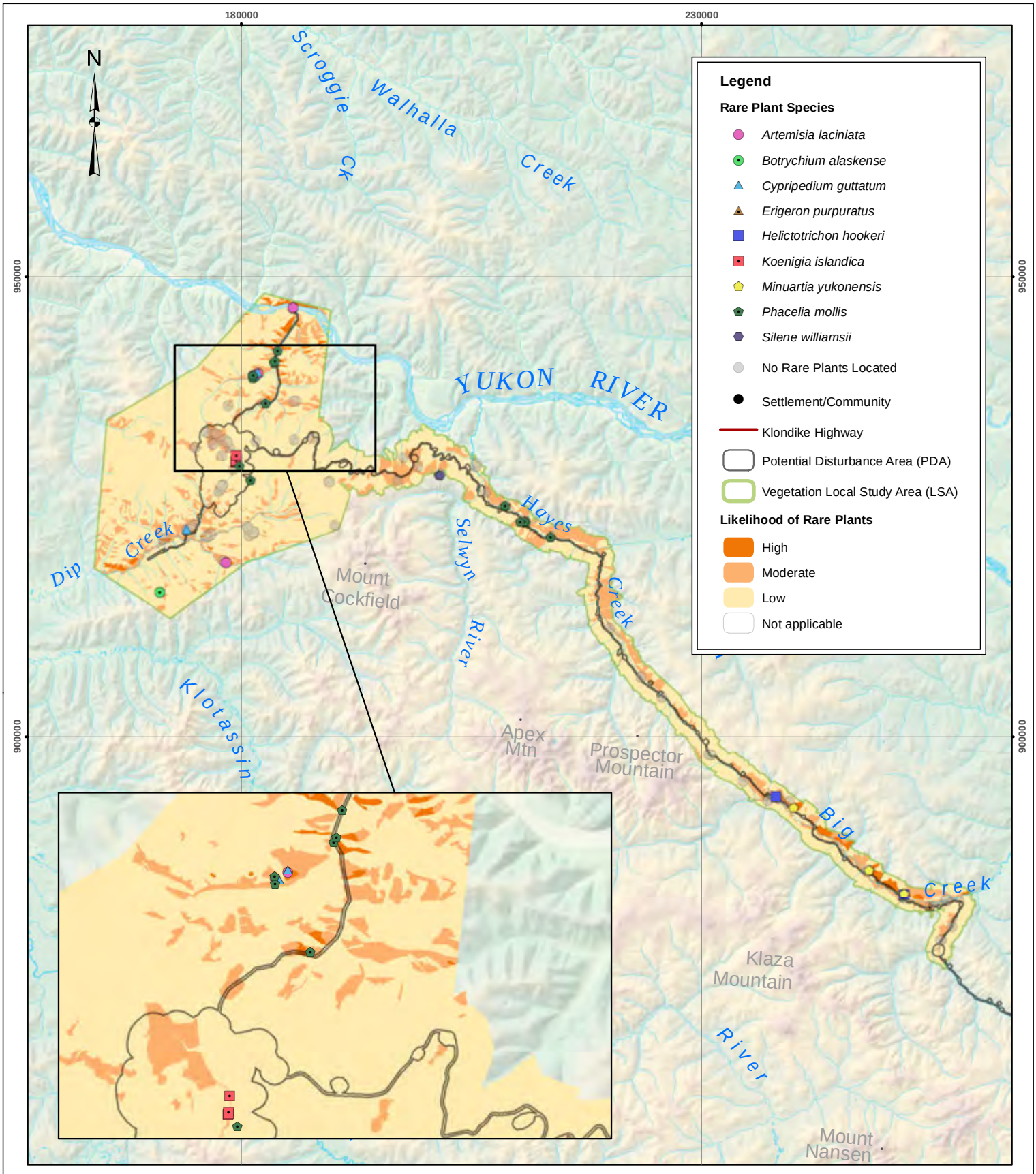
Species name	Location	Habitat	Date	Lat.	Long.	Elevation (masl)
Phacelia mollis	Near Brittania Creek	Open forest at base of steep slope	2010/ 08/27	62.8198	-138.7195	519
Phacelia mollis	North side of Hayes Creek	Gravel bar and adjacent cut-bank	2012/ 07/21	62.7008	-138.2043	527
Phacelia mollis	East side of Hayes Creek	Gravel bar	2012/ 07/21	62.6861	-138.1572	556
Phacelia mollis	West side of Hayes Creek	Gravel bar	2012/ 07/21	62.6872	-138.1595	546
Phacelia mollis	West side of Hayes Creek	Dry SW-facing slope along creek	2012/ 07/21	62.6861	-138.1687	561
Phacelia mollis	North side of Hayes Creek	Gravel bar	2012/ 07/21	62.6748	-138.1017	592
Phacelia mollis	East of Hayes Creek	Crevices and ledges of tor	2012/ 07/22	62.7248	-138.3491	1,256
Silene williamsii	East of Hayes Creek	Ledge of tor	2012/ 07/22	62.7244	-138.3468	527

Table 4.2 Global, national, and sub-national rankings of rare species from the LSA, 2010 and 2012[1].

Species	Global	National	YT	NWT[2]	BC	AB	AK
Artemisia laciniata	G4? (sic)	N1	S3 (was S1 in 2010)	Species not present	Species not present	Species not present	S3 (was S2 in 2010)
Botrychium alaskense	G4 (was G42G3 in 2010)	N1N3 (was NNR in 2010)	S2S3 (was S1S3 in 2010)	Species not present	S1S3	Species not present	S3 (was S2S3 in 2010)
Cypripedium guttatum	G5	N2	S2	Secure (was SNR in 2010)	Species not present	Species not present	S4
Erigeron purpuratus	G5	NNR	S3S4	Species not present	Species not present	Species not present	SNR
Helictotrichon hookeri	G5	N5	S2	May Be At Risk	S2S3	S5	Species not present
Koenigia islandica	G	N4 (was NNR in 2010)	S2	Sensitive (was SNR IN 2010)	S3S4	S1	SNR
Minuartia yukonensis	G3	N2N3	S2S3	Sensitive	Species not present	Species not present	S4 (final assessment yet to be made)
Phacelia mollis	G2G3	N2N3	S2S3	Species not present	Species not present	Species not present	S3 (was S2S3 in 2010)
Silene williamsii			S2S3	Species not present	Species not present	Species not present	SNR

[1] Yukon, National and Global rankings obtained from YCDC, January 2011 and July and October 2012; 2010 provincial rankings obtained from NatureServe Explorer Online (NatureServe 2010) in February 2011, and in September 2012 from the provincial Conservation Data Centres in Alberta and British Columbia, the NWT Department of Environment and Natural Resources, and the Alaska Natural Heritage Program.

[2] The NWT has not yet determined actual status rankings for these species. However, it has ranked them broadly as to possible risks affecting them, i.e. Undetermined, Secure, Sensitive, and May Be At Risk. For the species in the table above, definitions are as follows: Secure - species that are not believed to be at risk or sensitive; May be at risk - species that may be at risk of extirpation or extinction, and are therefore candidates for a detailed risk assessment. This category described species that have the highest priority for a detailed consideration; Sensitive - species that are not believed to be at risk of extirpation or extinction, but that may require special attention or protection to prevent them from becoming at risk. This category described species that have medium priority for further consideration (Carrière and Lange 2001). Further detailed assessment is required in order to assign S rankings (Working Group on General Status of NWT Species 2011).



Notes:

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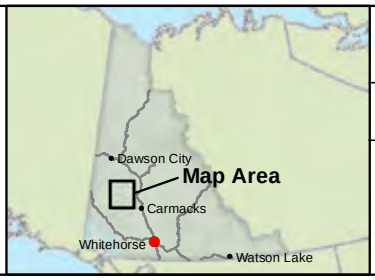
LSA developed by EDI and is based on boundary ELC vegetation data collected by AECOM and Summit Environmental Consultants and provided by Knight Piesold Ltd. 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Rare plant locations - 2010 and 2012

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	07/10/2013	3.1

0 5 10 15 20
kilometres

Map scale 1:560,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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4.2.1 *Artemisia laciniata* Willd. (Siberian wormwood)

Synonyms: *Artemisia macrobotrys*, *A. laciniatiformis*, *A. tanacetifolia*

Family: Asteraceae – Composite Family

This species is ranked as S3 (S1 in 2010) in YK, and is on the YCDC Track list. It is widespread in Asia, but in North America is known only from eastern AK and central YK (Minto and Five Finger Rapid areas). It was discovered in the Casino project area in early summer of 2010 by consultants from AECOM and Summit. These sites were revisited by Rhonda Rosie and Kaeli Stark (AECOM) to verify and further document the sites and populations.

Photo 1. ***Artemisia laciniata*** **(Siberian wormwood)**

Artemisia laciniata is a perennial, with a thick, simple or branched caudex and taproot. Stems are pubescent to glabrate, growing to about 5-15 cm high. Basal leaves are 5-20 cm long, with blades 2 to 3 times pinnately divided; stem leaves are smaller. The inflorescence is paniculate to spicate, with nodding sessile heads, with yellowish corollas.

Typical habitat for this species in YK is steep, dry, south and southwest-facing slopes that occur along the main creek valleys. These slopes support a variety of forbs, graminoids, and occasional sparse stunted aspen. Exposed soil is commonly found between plants on these slopes, and occasional small rock outcrops may also provide habitat. *Artemisia laciniata* was also found in recently disturbed soil along the sides of a dirt road near the Yukon River close to the mouth of Britannia Creek.

Artemisia laciniata was documented on three of nine typical steep dry slopes investigated by AECOM rare plant and Terrestrial Ecosystem Mapping (TEM) field crews. Populations varied from site to site, with one open slope hosting thousands of individuals scattered over most of the slope, while the other two slopes supported far fewer plants. Many of the plants were in fruit, with the rest in a vegetative state of clumps of basal leaves. In the disturbed area, a dozen or so plants were found, mostly in a vegetative state. The plant was not seen on similar steep grassy slopes visited during the 2012 survey along the proposed road access corridor.

The species appears to tolerate sites where some soil disturbance occurs, (i.e. exposed soil on very steep slopes), subject to downslope movement and surface frost heaving, as well as on the exposed soil along the road.

4.2.2 *Botrychium alaskense* Wagner and Grant (Alaska moonwort)

Family: Ophioglossaceae - Adder's Tongue Family

This species was first discovered in AK in 1999 and described in 2002 (Stensvold et al., 2002). It is ranked S2S3 (S1S3 in 2010) in YK, and is on the YCDC Track list. In AK it has been found in numerous sites in the southern third of the state, but in YK it is previously known from only five sites in four widely-separated areas in western YK. It has also been reported from B.C.

Photo 2. ***Botrychium alaskense*** **(Alaska moonwort)**

Botrychium alaskense is a perennial herb, with above-ground parts consisting of a stalked pinnate leaf-like sterile trophophore and a fertile sporophore head containing numerous globose spore-bearing sporangia. Below ground is a short rhizome and shallow roots. The life cycle consists of two stages, the above-ground spore-producing sporophyte and the below-ground egg and sperm-producing gametophyte. Fertilization results in the production of a below-ground sporophyte which eventually emerges above ground after several years.

In AK, *Botrychium alaskense* habitat includes "naturally or artificially disturbed meadows, roadsides, riverbars and infrequently mowed lawns and fields. At higher elevations it grows in riverine meadows, sandy fields and lightly vegetated scree slopes" (Farrar 2004).

The species was found in the LSA in 2010 by a member of the AECOM TEM crew on a steep, dry, southwest-facing slope at 1,223 m elevation, associated with low white spruce, aspen, and willows with a ground cover of low shrubs, ground shrubs, forbs and grasses, lichens and leaf litter. Individuals were growing singly in exposed soil and leaf litter. About half a dozen specimens were seen at the site, and one was collected for identification. At least one of the plants was fruiting abundantly.

Botrychium populations are unpredictable in their production of above-ground sporophytes (Ahlenslager and Potash 2007), and hence it is often difficult to assess their true population status. The plant was not seen in 2012 during the survey along the proposed road access corridor.

4.2.3 *Cypripedium guttatum* Sw. (spotted lady's-slipper)

Family: Orchidaceae - Orchid Family

This species is ranked S2 in YK and is on the YCDC Watch list. It is known from Asia, AK and NWT, as well as western and northern YK.

Photo 3. ***Cypripedium guttatum*** **(spotted lady's-slipper)**

Cypripedium guttatum is a perennial, with slender pubescent stems 10–20 cm high. Leaves are two, on the lower part of the stem. Flowers are solitary, white with purple blotches. Capsules are glandular-pubescent, drooping.

Typical habitat for this species is open forests on calcareous soil. It was found in four sites in the project study area in 2010. Three of these sites were on the upper slopes of steep dry south-facing slopes, under open stunted aspen with abundant common bearberry present in the understory. The fourth site occurred at the base of one of the slopes, in open white spruce-birch/grass-forbs/moss.

Two locations for this species were found in 2010 on the west side of Canadian Creek. The species had previously been reported from this area in 2010 by consultants from AECOM and Summit. The site was revisited by Rhonda Rosie and Kaeli Stark (AECOM) to assess and document the populations. Two patches were re-found on the upper slope of a steep, dry, south-facing slope in a stand of stunted aspen with an understory dominated by common bearberry, along with a few shrubs and forbs. One patch consisted of about three dozen individual plants, while the other patch consisted of approximately 300 plants. Only a small proportion of each patch was in fruit with a total of about two dozen individuals in fruiting stage.

The second site where *Cypripedium guttatum* was observed was along Canadian Creek at the base of another steep dry slope, in open white spruce and birch forset, with an understory of scattered shrubs, forbs, grasses and moss. Several small patches were observed, with a total of approximatley 45 plants, about half of which were in fruiting stage. Also found growing in association at this site were several patches of *Cypripedium passerinum* (not considered rare in YK).

Third and fourth observations of *Cypripedium guttatum* occurred on the mid and upper slope of a steep slope on the west side of Dip Creek near its junction with Casino Creek, growing under open aspen, with common bearberry and various forbs and grasses in the understory.

Dry slopes supporting aspen are common in the LSA, but the plant was not seen in 2012 in similar sites along the proposed road access corridor.

4.2.4 *Erigeron purpuratus* Greene (purple fleabane)

Family: Asteraceae - Composite Family

At the time of survey, this species was ranked S3S4 in YK and was included on the YCDC Watch list. It is known only from AK and YK; collections reported from B.C. and NWT have since been re-assigned to the closely related species *Erigeron denalii*. In YK, it has been found in southwest and west central parts, as well as northern YK, growing on sandy and gravelly stream beds and banks (Cody 1996). This species has now been removed from the Watch list.

Photo 4. ***Erigeron purpuratus*** **(purple fleabane)**

Erigeron purpuratus is a perennial, with a small taproot. Stems are erect, less than 14 cm tall, villous (hairy) with minute glands. Leaves are mainly basal, minutely glandular, and often hairy. Flowers are single, with white to pink or purplish ray flowers, and pink to purplish pappi (bristles attached to the seed).

Typical habitat includes stream banks, sand bars, gravel bars and gravelly slopes. In 2012, it was found on a gravelly old road, in a dry gully under open white spruce on a lower slope bordering Big Creek, and on a large gravel bar along Hayes Creek. Only a few plants were seen on the road and lower slope, but several dozen were seen growing scattered on gravel. Gravel bars are common features along Hayes and Big Creeks and it seems likely that the plant may present on at least some of the other bars that were not visited during the survey.

4.2.5 *Helictotrichon hookeri* (Scribn.) Henrard (spike-oat)

Synonym: *Avenula hookeri*

Family: Poaceae - Grass Family

This grass species is ranked S2 in YK and is on the YCDC Watch list. Its range includes most of Canada, as well as some of the western States. In YK, it is known from the south southern and from sites along the Klondike Highway east of the Casino study area, growing on dry grassy slopes.

Helictotrichon hookeri is a tufted perennial, to about 40 cm high. Leaves are mainly basal, short, flat or folded, with leaf margins faintly outlined in white. The seed-head is a panicle, 8-12 cm long, with 1–2 spikelets per branch. The seeds have a conspicuous bent, twisted, 1–1.5 cm long awn.

Typical habitat for this species is dry open forests and dry grassy slopes. In 2012 it was observed in the LSA on two steep dry grassy slopes bordering Big Creek valley along the proposed access road, where it was locally abundant, growing among other grasses (*Elymus* spp., *Bromus pumpellianus*, *Calamagrostis purpurascens*, etc.).

While it was only noted on two grassy slopes, it may well be present on other similar slopes not visited, due to the potential for occurrence in available habitat areas.

Photo 5. *Helictotrichon hookeri* (Scribn.) (spike-oat)

4.2.6 *Koenigia islandica* L. (Iceland purslane)

Family: Polygonaceae – Buckwheat Family

This circumpolar species is ranked S2 in YK, and is on the YCDC Watch list. It is also known from AK, AB, B.C., and the NWT. In YK it is known from a number of widely scattered sites throughout the Territory, as far north as the Arctic coast.

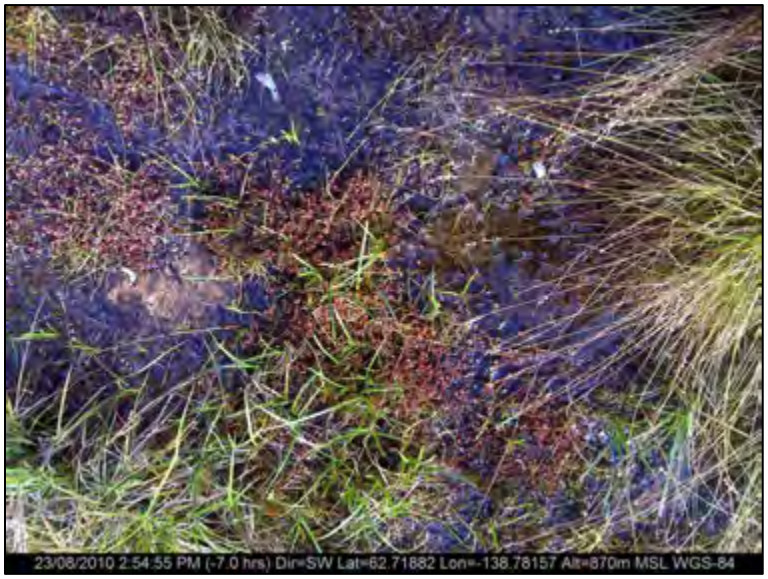


Photo 6. *Koenigia islandica* L. (Iceland purslane)

Koenigia islandica is a dwarf annual, growing to only 2-15 cm high. Stems are filiform, with few, often reddish, leaves. Flowers are few to several, borne in small terminal clusters above leafy bracts. The flowers lack petals, but the sepals are white, pink, or translucent.

Typical habitat for this species includes wet seepage or mossy sites, or wet sand or silt along creeks and lakes It is often found in moist alpine sites, such as snow patches, and along brooks and ponds.

In the LSA, a small patch of this species was found in 2010 in a wet muddy seepage area along an old dirt road along Casino Creek, associated with various sedges and a few forbs. Three other patches were found in similar seepage areas along the road farther upstream, and a small clump of plants was seen in a pocket of soil in a small pile of disturbed rocks along the creek. Each patch of *Koenigia islandica* contained dozens of individual plants, many in the fruiting stage.

The species was not seen elsewhere, but its annual habit and habitat requirements likely contribute to the unpredictability of its occurrence. As well, it may be overlooked due to its small size when present in low numbers. Porsild (1951) cited only two locations for it along the Canol Road and noted that "although many suitable places were seen, it was observed nowhere else."

Koenigia islandica was not encountered in 2012 during the survey along the proposed road access corridor.

4.2.7 *Minuartia yukonensis* Hultén (Yukon stitchwort)

Synonym: *Lidia yukonensis* (Hultén) Á. Löve & D. Löve

Family: Caryophyllaceae - Pink Family

At the time of surveys in 2010 and 2012 this species was ranked S2S3 in YK and was on the YCDC Watch list. It is also known from Asia, AK and NWT. In YK, it is found in a number of sites in west central and northern YK, and in the southwest of Kluane National Park.

Minuartia yukonensis is a perennial and mat-forming species, with a stout short taproot. Stems reach to 10–40 cm, with abundant thin, linear, hairless leaves. Flowers are white, 3–13 inches, open cymes, with prominently 3-nerved sepals. Capsules are narrow, longer than sepals.

Typical habitat for this species includes dry rocky meadows, and scree slopes into the alpine. In YK it has been found on dry grassy slopes in the lowlands and alpine slopes in a number of sites in western and northern YK.

In 2012 it was observed in the LSA on three dry steep grassy slopes along the north side of Big Creek, growing in scattered small clumps, but was not abundant. It is likely that the species occurs in other similar sites in the LSA, due to the potential for occurrence in available habitat areas.

Photo 7. ***Minuartia yukonensis*** **(Yukon stitchwort)**

4.2.8 *Phacelia mollis* Macbr. (MacBride's scorpion-weed)

Family: Hydrophyllaceae - Waterleaf Family

This species is endemic to AK and central and western YK. It is ranked S2S3 in YK, and is on the YCDC Watch list. It was previously observed in YK from about a half dozen sites in west central YK.

Photo 8. ***Phacelia mollis*** **Macbr. (MacBride's scorpion-weed)**

Phacelia mollis is a perennial with pubescent stems 15–50 cm high, with pubescent basal and cauline leaves. The inflorescence consists of few to numerous cymes with blue, lavender, or yellowish-white corolla tubes.

Typical habitat for this species is steep, dry, open slopes and rocky bluffs, as well as disturbed sites, such as riverflats, mine tailings and along dirt roads. It appears that *Phacelia mollis* is able to colonize recently disturbed areas.

In 2010 it was observed in the LSA at eight sites over five different areas, including steep, dry, grass-forb slopes on tailings along Canadian Creek, old dirt roads and in one high elevation site. In 2012, it was seen at six sites along Hayes Creek valley on gravel bars and an adjacent cutbank, on a dry slope above a tributary creek, as well as on a ledge in rock outcrops (tors) in the subalpine.

This species had been previously reported from the Casino area in 2010 by consultants from AECOM and Summit. The site was re-visited by the Rhonda Rosie and Kaeli Stark (AECOM) to document site conditions and populations. During the re-visit field crews observed *Phacelia mollis* scattered in placer tailings along Canadian Creek near its junction with Britannia Creek, as well as on the adjacent steep dry open slopes. In total, hundreds of individual plants were seen, many in fruit.

The species was also found as scattered individuals in several places on the east side of Britannia Creek, along an old dirt road and scattered in open white spruce at the base of a steep dry grass-forb slope with a total observed population of several dozens. It was also recorded from steep dry grass-forb slopes northeast of Patton Hill near Britannia Creek and on the east side of Casino Creek.

In 2010, a few plants were also recorded by the AECOM TEM crew, on a subalpine ridge at 1290 m, associated with dwarf shrubs, forbs, lichen, and frost boils. Total population size on the ridge is unknown. In 2012, the species was encountered at a number of sites, including several gravel bars and an adjacent cutbank, on a dry slope above a small creek, and on a ledge in rock outcrops (tors) in the subalpine. Populations varied in number from 2 on the dry slope and on rock outcrops, up to two dozen on gravel bars and over 160 plants on the cutbank.

4.2.9 *Silene williamsii* Britton (William's catchfly)

Synonym: *Silene menziesii* ssp. williamsii (Britt.) Hultén

Family: Caryophyllaceae - Pink Family

This species is ranked S2S3 in YK and is on the YCDC Track list. It is endemic to YK and AK and has been observed from several sites in west central YK, including on a bluff on the north side of the Yukon River opposite Brittania Creek, near the LSA. In AK it is only known from the central part of the state.

Silene williamsii is a perennial with viscid-pubescent stems 10 to 35 cm high. Leaves are mainly cauline, lanceolate to lanceolate-linear, and are wider near the base of the leaf. Flowers are few, in a terminal cyme, with notched white petals. Capsules are straw-coloured, slighly longer than the narrow calyx.

Typical habitat for this species includes heaths, disturbed ground, river gravel and bluffs and roadsides. In YK, it is previously known from only a few sites in west central YK, in disturbed situations and open to shaded slopes.

It was found in 2012 in the LSA, as a small clump of about a dozen plants on a ledge of a rocky outcrop (tor) in the subalpine. It was not observed elsewhere, including on other similar outcrops that were visited, but likely occurs in at least some of the many extensive tors present in the LSA.

Photo 9. ***Silene menziesii*** **ssp. williamsii (Britt.) Hultén**

4.3 DISCUSSION AND SUMMARY

Based on the September 2012 YCDC lists of rare status rankings for YK species, eight species were found in the LSA that have conservation status rankings from S2 to S3S4, with three species on the Track list (*Artemisia laciniata*, *Botrychium alaskense, Silene williamsii*), and five on the Watch list (*Cypripedium guttatum, Helictotrichon hookeri, Koenigia islandica, Minuartia yukonensis* and *Phacelia mollis*). At the time of survey, *Erigeron purpuratus,* was included as a species of concern and was on the Watch list. It has since been removed.

These species are of conservation concern in YK with the three Tracked species having the highest level of concern due to low numbers of known populations. As well, three of the rare species observed are known in North America to be from YK and AK only *(Artemisia laciniata, Phacelia mollis,* and *Silene williamsii)*, and in YK these species are mainly restricted to the western part of the Territory. *Botrychium alaskense* is known only from YK, AK and B.C. and is currently on the COSEWIC candidate list, making it a species that may be reviewed more closely in the future (B. Bennett pers. comm. 2012).

The five Watch species observed *(Cypripedium guttatum, Helictotrichon hookeri, Koenigia islandica, Minuartia yukonensis,* and *Phacelia mollis)* are currently considered "vulnerable" in YK and the new locations discovered in 2010 and 2012 are important additions to the known distribution of the species.

Habitats where rare species were found in the LSA include very steep, dry slopes supporting grass and forbs and/or open aspen forest, gravel bars subject to flooding, rock outcrops and disturbed sites, including placer tailings and old roads. Some individual populations can be negatively impacted by human activity through fire or by other natural occurrences; however, other species, (e.g. *Artemisia laciniata*, *Koenigia islandica* and *Phacelia mollis*) may increase or maintain their presence by colonizing suitable disturbed sites. Additionally, fire may be an important factor in maintaining open grass-forb and aspen dominated habitats that support many of the rare species observed. Documented locations of *Botrychium alaskense* and *Silene williamsii* are unlikely to be affected by human disturbance, due to their locations (steep slope and subalpine rock outcrop in undisturbed areas) and there is a good chance that other populations exist elsewhere in the Project area.

As a general rule, sites hosting any rare species should be avoided to preserve existing populations. However, at least some of the nine species found may be more common in YK than documented locations indicate, due to the large size of the Territory and the difficulty of access to remote areas. As more populations are discovered through collections and surveys by qualified botanists, rare status rankings will be more realistically assessed. Some of the species on the YCDC lists will ultimately be downgraded and some species may be removed altogether from the YCDC rare plant list, e.g. *Scirpus hudsonianus*. Any further information on additional populations of these species that are discovered in the LSA and surrounding areas during development would be very useful for the YCDC to develop true status rankings for the species, as well as to assist land managers and planners to avoid uncertainties.

4.3.1 Ecosystem Units and Rare Plants

Vegetation units from the TEM with the greatest potential to host rare species include dry, steep slopes dominated by grasses and forbs or open aspen and/or white spruce forests, alpine and subalpine areas, rock outcrops, wetlands, disturbed sites and riparian corridors. Species included on the YCDC Track and Watch species list for 2013 were assessed for likelihood to occur in ecosites in the LSA. Table 4.3 provides descriptions of the ecosites, relative likelihood of rare plants to be in each ecosites and what rare species were observed in the LSA during 2010 and 2012 surveys. *Minuartia yukonensis*, commonly found on dry slopes, is no longer on the YCDC list, so it was not included for that ecosystem.

Table 4.3 Ecosites likelihood of containing rare plants in the Casino Project's LSA

Code	Ecosystem name	Site Description	Relative likelihood of rare plants	Rare species found 2010 and 2012
Alpine Bioclimate Zone				
To	Tors	Protruding bedrock outcrops on mountain crests. Plant growth is mainly restricted to fractures and crevices where soil has accumulated.	Moderate	*Silene williamsii, Phacelia mollis*
Sd	Dryas/Sparse Herb	Occurs on plateaus and gentle slopes at high elevations. Structural development is limited by environmental conditions, and vegetation communities are mainly composed of mountain-avens, bryophytes and lichens.	Low	*Phacelia mollis*
Fe	Felsenmeer	Veneer of angular rock fragments/boulder fields over gently to moderately sloping ground. Vegetative cover is typically <40%, and includes dwarf shrubs, grasses, bryophytes, and lichens.	Low	
Subalpine Bioclimate Zone				
Sx	Mid to High Elevation Dry Shrub	Dry, open south-facing low-middle elevation slopes with vegetation dominated by low shrub species including mountain cranberry, common bearberry, and crowberry.	Low	
Sm	Subalpine Moist Shrub	Low shrub community dominated by dwarf birch, willow, bog blueberry, mountain cranberry, Labrador tea, northern Labrador tea, and crowberry.	Low	
St	Tall Shrub	Tall (1-1.5 m) willow, dwarf birch, water birch communities on moderate to steep slopes at high elevations.	Low	

Code	Ecosystem name	Site Description	Relative likelihood of rare plants	Rare species found 2010 and 2012
Sw	Mid to High Elevation Wet Shrub	Black spruce-shrub communities occurring on steep, north facing slopes at high elevations. Shrub species are similar to those found in the Subalpine Moist Shrub.	Low	
Boreal High Bioclimate Zone				
Lx	Sloping Grassland	Dry, open south-facing low-middle elevation slopes with vegetation dominated by low shrubs, forbs, and graminoid species. Exposed mineral soil and organic matter accounts for >40% of ground cover.	High	*Artemisia laciniata, Phacelia mollis, Helictotrichon hookeri*; other rare species , including some endemics, possibly present on other slopes and associated outcrops
Fbx	Dry Broadleaf Forest	Broadleaf forest ecosystem on upper-middle south or southwest-facing slopes. Trembling aspen dominates the canopy, and low shrub, forb, and grass species occur in the understory.	Moderate	*Cypripedium guttatum, Botrychium alaskense*
Fbw	Moist Broadleaf Forest	Broadleaf forest ecosystem on north-facing middle and lower slopes. Alaska birch dominates the canopy, and green alder, prickly rose, mountain cranberry, and currant/gooseberry species occur in the shrub layer.	Low	
Fc	Coniferous Forest	Black spruce forest on north-facing slopes (and occasionally white spruce forest on south-facing slopes). Shrub species include Labrador tea, mountain cranberry, and prickly rose. Step moss and fruticose lichens are abundant in the bryophyte layer.	Low	
Fm	Mixedwood Forest	Mixedwood forest ecosystem on moderately steep slopes at various aspects. The canopy is co-dominated by white spruce and Alaska birch. Shrub species include Labrador tea, mountain cranberry, and willow species. Step moss is abundant in the bryophyte layer.	Low	
Fcs	Sparse Coniferous Forest	Sparse white spruce (sometimes black spruce) forest in middle and upper slope positions at various aspects. Shrub species include dwarf birch, Labrador tea, mountain cranberry, and willow species. Red-stemmed feathermoss and reindeer lichens are abundant in the bryophyte layer.	Low	
Sr	Riparian Shrub	Occurs within floodplains and side channels of riverine habitats where seasonal flooding is common. Tall shrub community dominated by willow species.	Low	

Code	Ecosystem name	Site Description	Relative likelihood of rare plants	Rare species found 2010 and 2012
Fbr	Riparian Broadleaf	Well-developed balsam poplar canopy on broad, level floodplains and side channels. Shrub species include prickly rose, grey alder, high bush cranberry, and red osier dogwood. Forb species include horsetail species, tall bluebells, and northern bedstraw.	Low	
Fcr	Riparian Coniferous	Tall white spruce forest on broad floodplains and side channels. Shrub species include willow, prickly rose, grey alder, and twinflower. Horsetail species, bluejoint reedgrass, and step moss are common in the understory.	Low	
Fmr	Riparian Mixedwood	No description provided in draft Summit report.	Low	
Wbc	Coniferous Treed Bog	Discontinuous black spruce canopy over shallow organic soils on level and gently sloping terrain. Labrador tea, mountain cranberry, cloudberry, sweet coltsfoot, step moss, and peat moss are common in the understory.	Low	
Bo	Open Bog	Treeless, or near treeless bog	Low	
Wf	Shrubby Fen	Shrubby fen on level and gently sloping terrain. The tree canopy layer is absent, but the shrub layer is well-developed and includes dwarf birch, mountain cranberry, northern Labrador tea, leatherleaf and some black spruce. Cloudberry, sheathed cottongrass, and peat moss are common in the understory.	Low	
Sparsely Vegetated, Point Features and Anthropogenic Sites				
Gb	Gravel Bar	Coarse-textured gravels and sands deposited by fast-moving waters during flood events. Vegetation cover is sparse.	Moderate	*Erigeron purpuratus, Phacelia mollis*
Ow	Open Water	Waterbodies (rivers, creeks, ponds, etc.).	Low	
TL	Thaw Lake	Ground surface depressions, commonly filled with water, created by the thawing of ice-rich permafrost and associated soil subsidence.	Low	

Code	Ecosystem name	Site Description	Relative likelihood of rare plants	Rare species found 2010 and 2012
Pc	Pingo	A mound of earth-covered ice, in this area formed in an 'open system' where groundwater discharge (seepage) through permafrost freezes and accumulates at or close to the ground surface; all pingos within the mapping area have at least partly collapsed.	Low	
An	Anthropogenic	Early successional weedy vegetation often with bare ground. Disturbances include placer mining, road construction, seismic activity etc.	Moderate	Some species occur on old roadbeds and placer tailings, e.g. *Botrychium* spp., *Artemisia laciniata, Phacelia mollis*

5 VEGETATION HEALTH

Assessing vegetation health is a component of the Project's baseline studies, as it provides a basis for assessing potential impacts to vegetation in relation to abundance, distribution and health, as a result of project activities. The assessment of baseline metal concentrations in vegetation provides a basis for monitoring factors such as fugitive dust deposition associated with the Project, including dust generated from the mining and milling process and transportation on the Freegold Road extension. Numerous studies have been conducted world-wide looking at effects of metals uptake in vegetation and dust deposition on vegetation at industrial sites. The information presented below represents the baseline data collected within the Project LSA.

5.1 VEGETATION HEALTH SAMPLING METHODS

Three vegetation genera were collected for vegetation metals analysis: willow, horsetail and lichen. The genera were chosen based on value as forage for wildlife, variability in metals uptake mechanisms and comparability to other studies. Willow, commonly found throughout the LSA, is an important food source for several mammals and birds that eat the catkins and young leaves, twigs, branches and are known food sources for moose, caribou, deer and bear (Gamberg 2002). Horsetail is eaten by caribou, moose, sheep and grizzly bear (Faculty of NRM 2011). Caribou rely on lichen as a major food source (Gamberg 2000; Gamberg 2008).

Baseline sampling of vegetation for metals analyses was conducted in June 2013. Field sample locations were pre-selected using a Geographic Information System (GIS) prior to fieldwork. Sampling sites were chosen based on terrain, soil type, potential to support at least two focal species, predominant wind direction and distance from the LSA (Figure 5.5).

Sample sites were located adjacent to, near and far from the LSA of the mine site. Adjacent sample sites were located 0 – 25 m from the maximum disturbance area; near sites were approximately 70 – 250 m from the footprint; far sites, located outside the potential influence of the project, were at least 1,500 m and as far as 2,500 m from the maximum disturbance area. Site locations along the access roads to the airstrip and barge landing, and the Freegold Road extension were located adjacent to and near the centrelines of the proposed access roads. Access road adjacent sites were approximately 0 – 25 m, and near sites 80 – 125 m from the centrelines of the proposed roads. Some variations in site distances occurred due of availability of target vegetation species, accessibility and landscape features.

Vegetation samples were taken at 62 sample sites with duplicates taken at three sites for quality assurance/quality control (QA/QC) purposes. Access to sites was by helicopter, all-terrain vehicle and on foot. Sampling was conducted according to the field sampling procedures listed below:

- Wear nitrile powder-free gloves during collection and wipe sampling utensils with alcohol wipes before collecting subsequent sample.

- Collect vegetation samples of each of the target species present at the site and place in new, clean and unused Ziploc© bags. Verify species identification with field guidebooks, if necessary.
- Duplicates taken at three random sites.
- Collect a minimum of 10 grams wet weight for each vegetation sample.
    - Willow – collect only current year growth (leaves and shoots) from multiple plants.
    - Horsetails – collect only above root portion and multiple plants may be required.
    - Lichen – collect whole specimen and specimens from multiple locations may be required.
- Sample bags will be labelled with site/sample number prior to field trip.
- Record field data on Soil and Vegetation Metals Data sheet, including location, species, time of day, collector, etc.
- Take at least one photo per sample location.
- Put samples in temporary cooler storage at the end of every sampling day.

Samples were frozen and sent to Maxxam Analytics in Vancouver, BC for analysis using the inductively couples plasma technique, with mass spectroscopy (ICP-MS).

5.2 VEGETATION HEALTH RESULTS AND DISCUSSION

The Canadian Council of Ministers of the Environment (CCME) released Canadian Environmental Quality Guidelines (CEQG) to assess *in situ* contaminants in soil (CCME 2006). The guidelines are meant to provide "science based goals for the quality of atmospheric, aquatic, and terrestrial ecosystems." CCME guidelines are not presently available for metals in vegetation (CCME 2006). Without guidelines to provide thresholds, determining toxicity to vegetation and/or receptors is not currently possible; however, metals levels can be compared over time to monitor increases in metals from fugitive dust.

Analysis results indicated elevated metal levels in vegetation samples; however, since the area has undergone exploration and the area is known to be mineral rich, higher base levels were expected. Visual interpretation of the vegetation analysis results suggests that there is little to no relationship between metal concentration in plant tissue and proximity to the mine site.

To illustrate the lack of trend in metal levels in vegetation and proximity to the mine site, levels of cadmium, copper, lead and zinc, in willow, are shown in Figures 5.1 to 5.4, respectively. Cadmium, copper, lead and zinc were included in Contaminants in Arctic Moose and Caribou (Gamberg 2008) and identified as metals of interest and/or concern in the Canadian Arctic Contaminants Assessment Report II (CACAR II 2003) – Contaminant Levels, Trends and Effects in the Biological Environment related to terrestrial biota.

Metals analysis results for vegetation samples are in Attachment D.

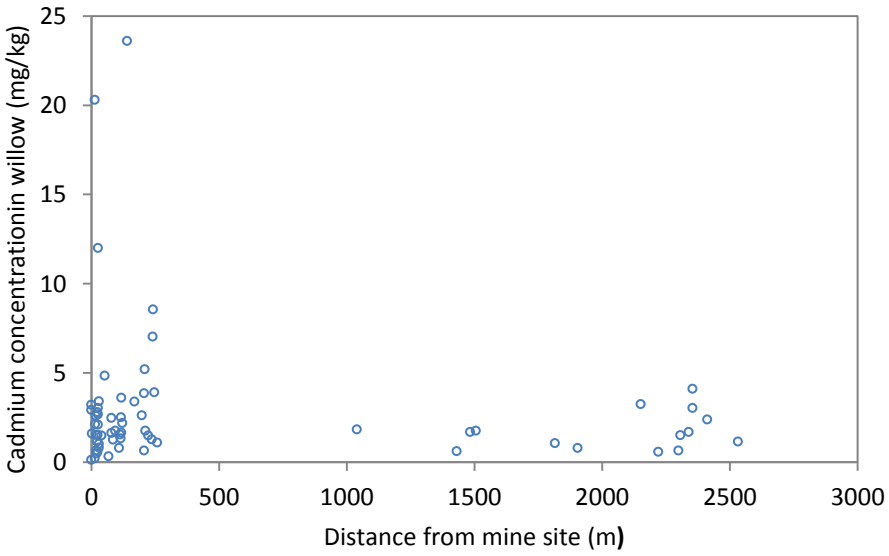


Figure 5.1 Concentration of cadmium in willow (n=64).

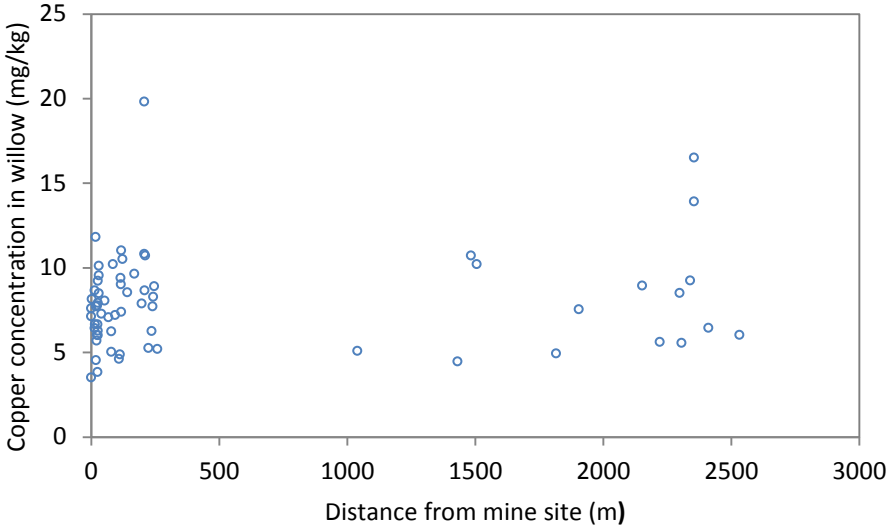


Figure 5.2 Concentration of copper in willow (n=64).

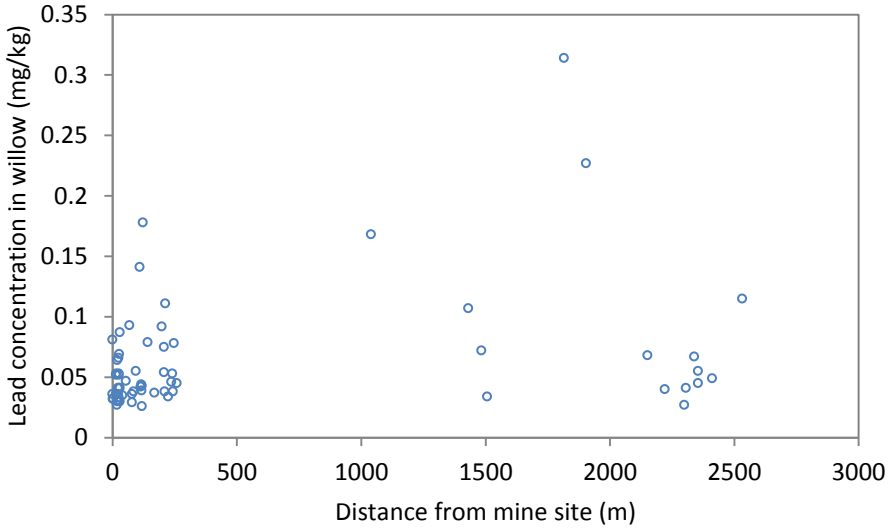


Figure 5.3 Concentration of lead in willow (n=64).

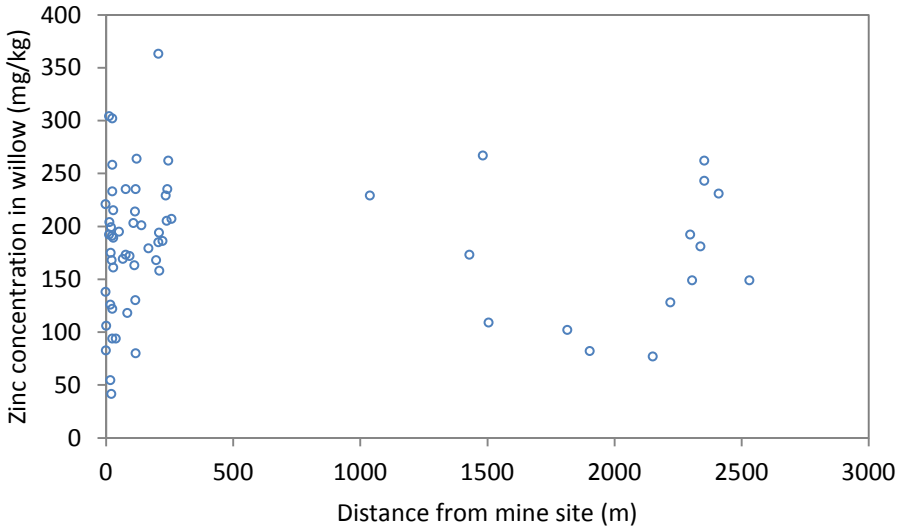
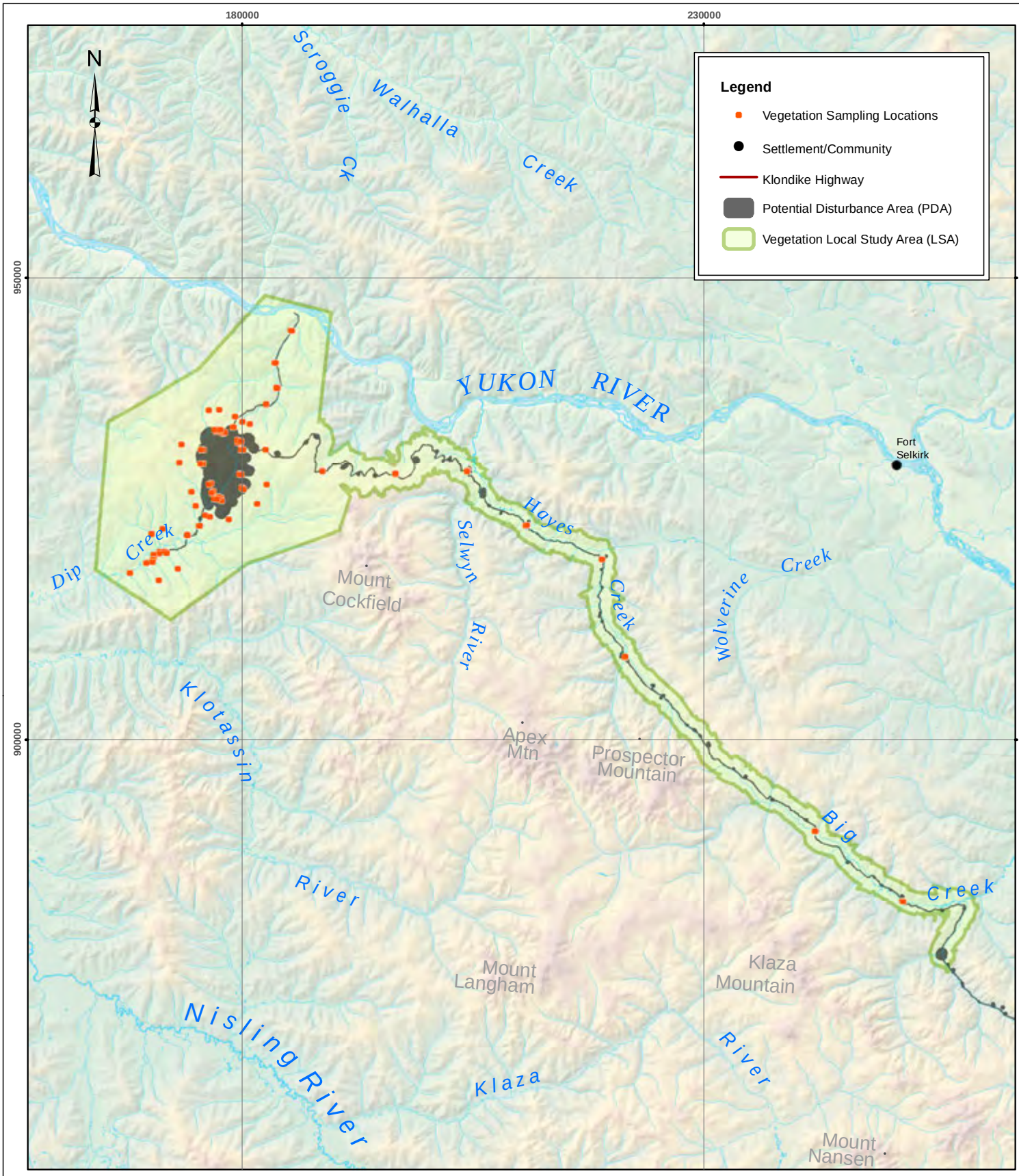


Figure 5.4 Concentration of lead in willow (n=64).



Notes:

1:250,000 Topographic Spatial Data, National Road Network; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

PDA provided by Knight Piesold Ltd. 2013.

LSA developed by EDI and is based on boundary ELC vegetation data collected by AECOM and Summit Environmental Consultants and provided by Knight Piesold Ltd. 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Vegetation sample locations - 2013

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	02/10/2013	5.5

0 5 10 15 20
kilometres

Map scale 1:560,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

EDI

Path: J:\Yukon\Projects\2013\13_Y_0045_CMC_CasinoEA\Mapping\430_Vegetation\BaselineMaps\430_Fig_5_5_VegSamplingLocations.mxd

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6.2 PERSONAL COMMUNICATIONS

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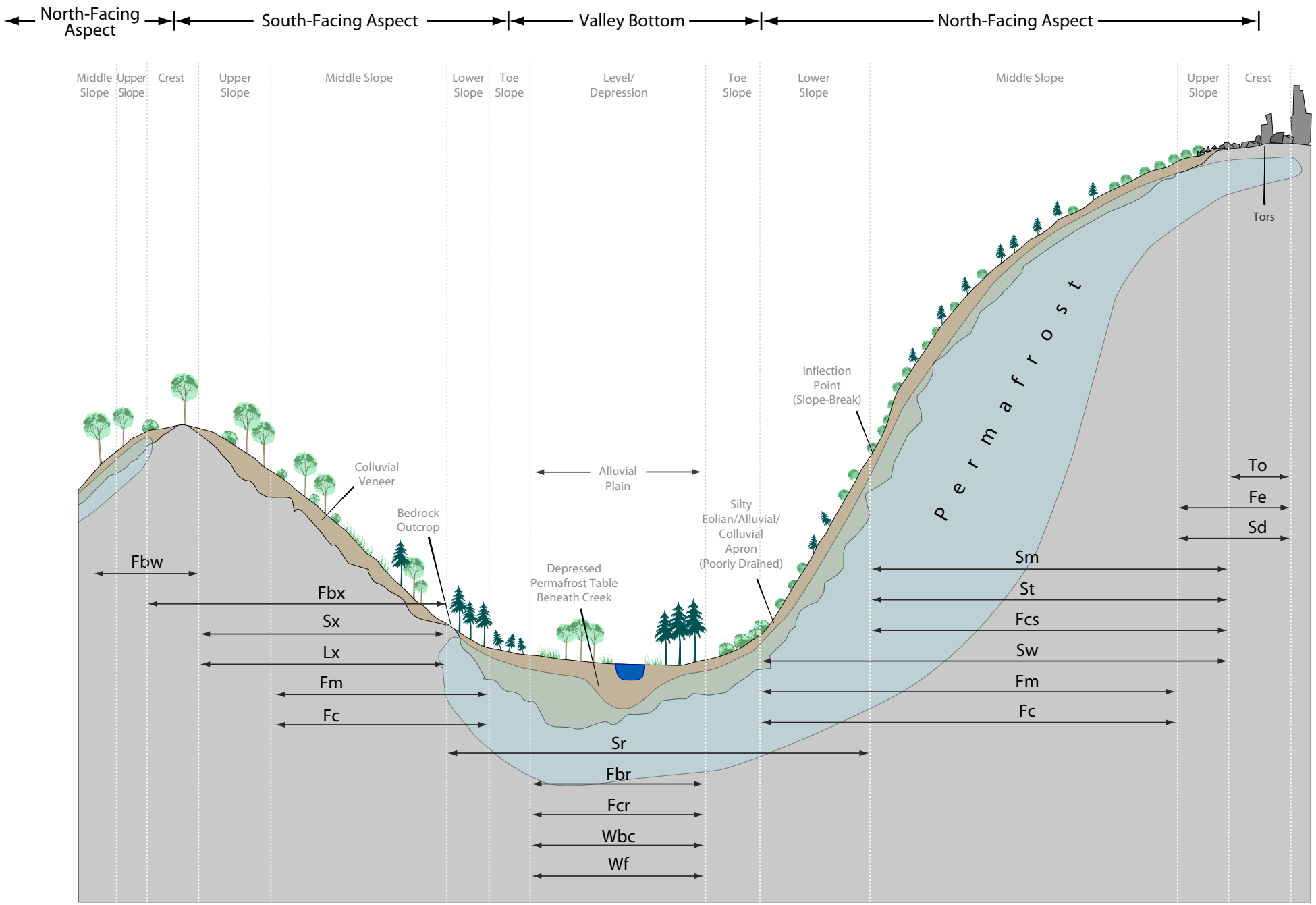
Farrar, D. Professor emeritus, Iowa State University. Personal communication. 28 September 2010.

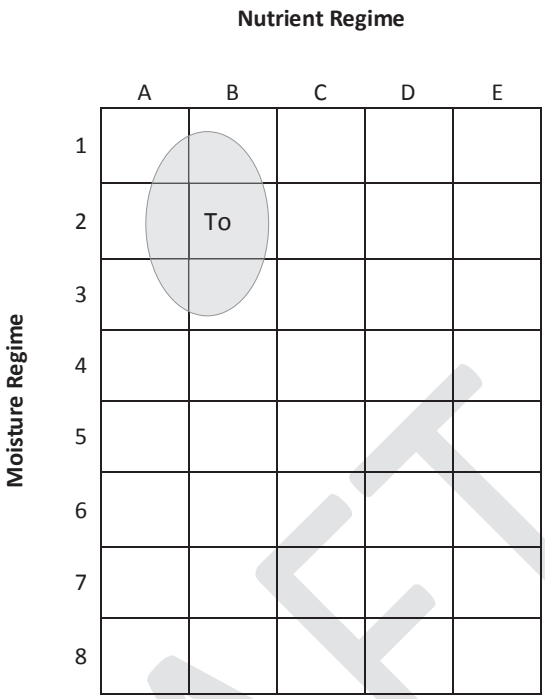
ATTACHMENT A CASINO PROJECT ECOSITE OVERVIEW

DRAFT prepared by AECOM for Western Copper Corporation Casino Mine. February 2011.

Landscape Profile Showing Ecosites



Tors (To)



Soil Characteristics

Soil Classification: O.EB[1]
Surficial Material: bedrock, colluvium
Drainage: very rapid[3]
Organic Thickness: 2 cm
Topsoil Texture: silt loam
Effective Texture: coarse sandy loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: subxeric[2], xeric[1], submesic[1]
Nutrient Regime: poor[3], very poor[1]
Topographic Position: crest[3]
Slope: variable
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[1]
Ground	[1]
Full	[2]

Characteristic Species

Shrub	[6]	willow
Forb	[2]	three-toothed saxifrage
	[+]	alpine anemone
	[+]	arctic cinquefoil
	[+]	black-tipped groundsel
	[+]	fragrant wood fern
Grass	[2]	sedge
	[1]	bluegrass
Moss	[11]	step moss
	[2]	hoary rock-moss
	[1]	red-stemmed feathermoss
Lichen	[5]	reindeer lichen
	[4]	icelandmoss lichen

Tors (To)

Photographs

Ecosite Overview

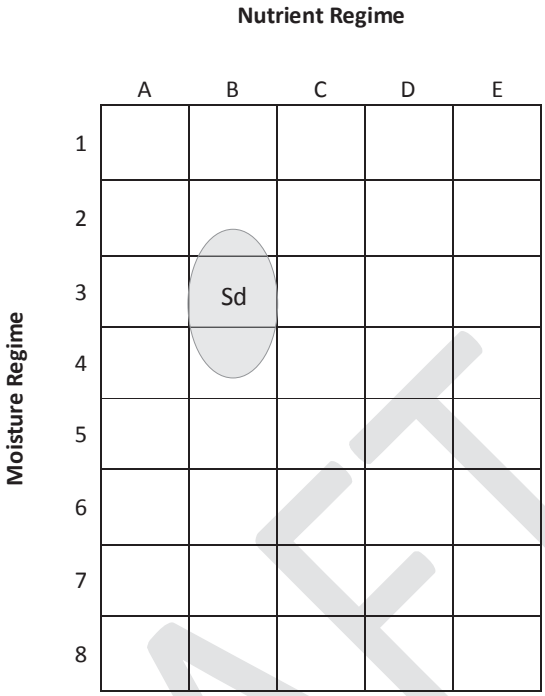
Ground Vegetation

Ecosite Description

The Tors ecosite consists of protruding bedrock outcrops, mainly granodiorite, on summits and ridge crests. Both non-vascular and vascular plant growth occurs within fractures and crevices in the rock, while non-vascular plants also form perched mats on rock ledges. Willow (*Salix*) species occupy some of the deeper crevices where more soil has accumulated. The herb layer is discontinuous and consists of pockets of three-toothed saxifrage (*Saxifraga tricuspidata*), alpine anemone (*Anemone drummondii*), arctic cinquefoil (*Potentilla nana*), black-tipped groundsel (*Senecio lugens*) and fragrant wood fern (*Dryopteris fragrans*). Graminoids dominating this ecosite are sedge (*Carex*) species and bluegrass (*Poa*) species. Mat-forming moss and lichen species including step moss (*Hylocomium splendens*), hoary rock-moss (*Racomitrium lanuginosum*), red-stemmed feathermoss (*Pleurozium schreberi*), icelandmoss lichens (*Cetraria* spp.), and reindeer lichens (*Cladina* spp.) are common. Crustose lichens and cryptic moss species are abundant on rock faces.

The soil moisture regime in the Tors ecosite is xeric to submesic, and the soil nutrient regime is very poor or poor. Soils, where present, are typically very rapidly drained Orthic Eutric Brunisols. Parent materials are commonly weathered bedrock or blocky colluvium. Topsoil is limited within this ecosite; were it does occur, organic LFH is limited to an average depth of 2 cm.

Dryas/Sparse Herb (Sd)



Soil Characteristics

Soil Classification: OD.TC[2], OE.TC[1]
Surficial Material: weathered bedrock, colluvium
Drainage: well
Organic Thickness: 2 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: suspected

Site Characteristics

Moisture Regime: subxeric[3], submesic[3], mesic[2]
Nutrient Regime: poor[8]
Topographic Position: crest[6], upper slope[2]
Slope: 0-12%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[7]
Ground	[5]
Full	[2]

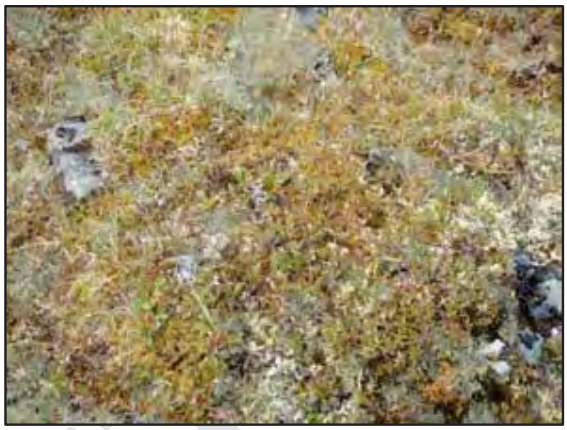
Characteristic Species

Shrub	[23]	mountain-avens
	[5]	mountain cranberry
	[3]	dwarf willow species
Grass	[6]	sedge
	[5]	holy grass
Lichen	[13]	icelandmoss lichens
	[6]	foam lichens
	[6]	reindeer lichens

Dryas/Sparse Herb (Sd)

Photographs

Ecosite Overview



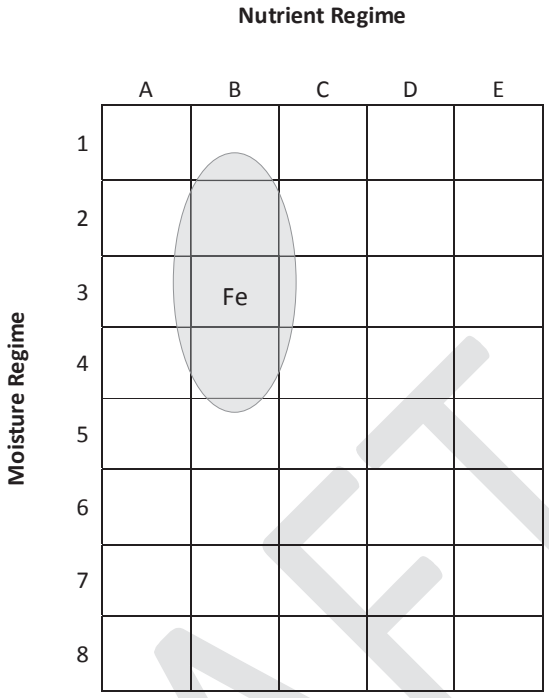
Ground Vegetation

Ecosite Description

The Dryas/Sparse Herb ecosite occurs on plateaus and gentle slopes at high elevations ranging from 1200-1500 m on crest and upper slope positions. Typically the Dryas/Sparse Herb transitions into the Tall Shrub ecosite below. Structural development is limited by environmental conditions, and vegetation communities are mainly composed of bryophytes and lichens. Mountain-avens species (*Dryas* spp.) dominate the shrub stratum of the ecosite, with minor components of mountain cranberry (*Vaccinium vitis-idaea*) and dwarf willow species (*Salix arctica* and *Salix reticulata*). Graminoid species dominating the sites include holy grass (*Hierochloë* spp.) and sedges (*Carex* spp.). Lichen species in the Dryas/Sparse Herb ecosite include icelandmoss lichens (*Cetraria* spp.), foam lichens (*Stereocaulon* spp.), and reindeer lichens (*Cladina* spp.).

The soil moisture regime of the Dryas/Sparse Herb ecosite ranges from subxeric to mesic, and the soil nutrient regime is poor. Dominant topsoil textures are silt loam over weathered bedrock and colluvial parent materials. Limited topsoil is observed at these sites with an average topsoil depth of 2 cm. Soils are well drained Orthic Dystric Turbic Cryosols or Orthic Eutric Turbic Cryosols.

Felsenmeer (Fe)



Soil Characteristics

Soil Classification: O.DYB[1], O.EB[1], O.R[1], TC[1]
Surficial Material: weathered bedrock, colluvium
Drainage: rapid[2], very rapid[1]
Organic Thickness: 8 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually absent near surface, but suspected at depth

Site Characteristics

Moisture Regime: xeric, subxeric, submesic, mesic
Nutrient Regime: poor[5]
Topographic Position: crest[2], upper slope[4], middle slope[1]
Slope: 10-65%
Aspect: northerly, easterly, westerly

Sample Plots

Plot Type	Number of Plots
Visual	[7]
Ground	[6]
Full	[2]

Characteristic Species

Shrub	[6]	willow
	[4]	mountain avens
	[4]	crowberry
	[1]	mountain-heather
Forb	[1]	Prickly saxifrage
Grass	[3]	holy grass
Moss	[6]	rock-moss
Lichen	[21]	icelandmoss lichen
	[5]	reindeer lichen

Felsenmeer (Fe)

Photographs

Ecosite Overview

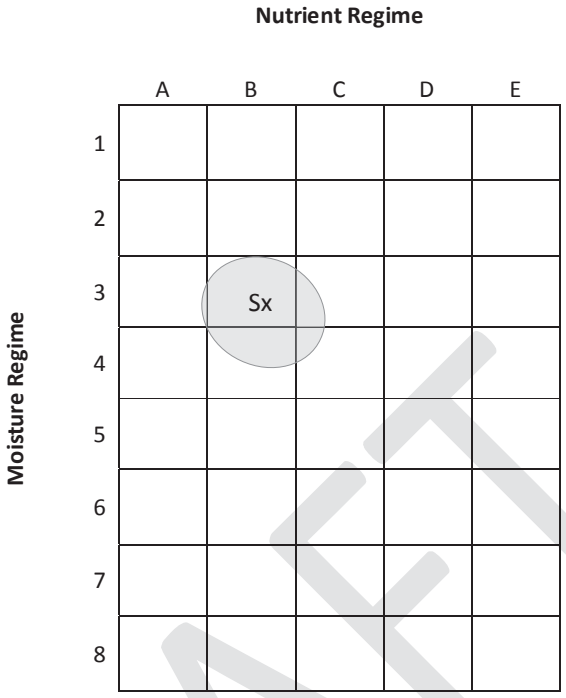
Ground Vegetation

Ecosite Description

The Felsenmeer ecosite occurs on northerly, easterly, and westerly aspects in crest, upper slope, and middle slope positions. Generally, elevations on these sites are 1200-1500m and slope gradients are between 10 and 65%. Fifty to eighty percent of the substrate on these sites consists of boulders and cobbles, and vegetative cover is typically less than 40%. Consequently, vegetation establishment is generally limited to cracks, joints, and depressions between the boulders, where small amounts of organic matter, cobble, and finer sediments have accumulated. Crustose lichens grow on rock faces, with fruticose lichens, foliose lichens, mosses, and some rooted plants occupying pockets and depressions between boulders, or occuring as mats draped across boulders. Where soil accumulation is sufficient, willow species (including *Salix glauca*, *S. planifolia*, and *S. pulchra*) are present. Dwarf shrubs including crowberry (*Empetrum nigrum*) and mountain-heather (*Cassiope* spp.) form mats over boulders, and holy grass (*Hierochloë* spp.) occurs in pockets where soil has accumulated. Dominant bryophyte and lichen species within the ecosite include rock moss (*Racomitrium* spp.), icelandmoss lichens (*Cetraria* spp.), and reindeer lichens (*Cladina* spp.).

The soil moisture regime of the Felsenmeer ecosite ranges from xeric to mesic, and the soil nutrient regime is typically poor. Soil pockets are variable in size and extent, and the soil tends to be rapidly or very rapidly drained. Soil type is variable and includes Orthic Dystric Brunisols, Orthic Eutric Brunisols, Orthic Regosols, and Turbic Cryosols overlying weathered bedrock or colluvial parent materials that have undergone little transport from their source.

Mid to High Elevation Dry Shrub (Sx)



Soil Characteristics

Soil Classification: O.DYB[1], O.EB[1]
Surficial Material: colluvium
Drainage: well[1], rapidly[1]
Organic Thickness: 1 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: submesic[2]
Nutrient Regime: poor[2]
Topographic Position: middle slope[2]
Slope: 40-60%
Aspect: southerly

Sample Plots

Plot Type	Number of Plots
Visual	[1]
Ground	[2]
Full	[1]

Characteristic Species

Shrub	[40]	Alaska birch
	[34]	mountain cranberry
	[19]	common bearberry
	[18]	trembling aspen
	[16]	crowberry
	[8]	dwarf birch
	[8]	white spruce
Forb	[4]	fireweed
Grass	[16]	Altai fescue

Mid to High Elevation Dry Shrub (Sx)

Photographs

Ecosite Overview

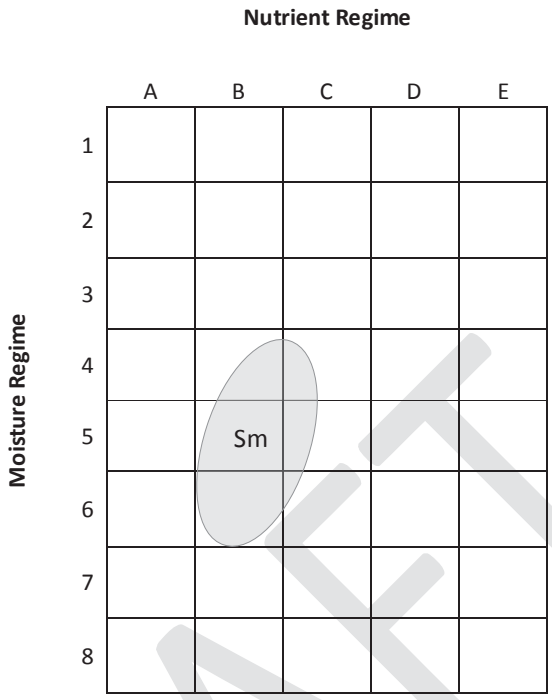
Ground Vegetation

Ecosite Description

The Mid to High Elevation Dry Shrub ecosite occurs on south-facing slopes between 1200 and 1300 m. Regenerating white spruce (*Picea glauca*), Alaska birch (*Betula neoalaskana*) and trembling aspen (*Populus tremuloides*) are present, and are restricted to the tall shrub layer (1-5 m in height). Dwarf shrub species, which dominate the shrub layer, include mountain cranberry (*Vaccinium vitis-idaea*), common bearberry (*Arctostaphylos uva-ursi*), crowberry (*Empetrum nigrum*), and dwarf birch (*Betula glandulosa*). The herb layer is dominated by Altai fescue (*Festuca altaica*) and fireweed (*Epilobium angustifolium*). Bryophytes and lichens are not as abundant in this ecosite as they are in moister shrub ecosites (e.g. Subalpine Moist Shrub, Mid to High Elevation Wet Shrub, Tall Shrub, and Dryas/Sparse Herb). Recorded fire history for the study area shows that this ecosite is prone to fire (likely because of slope position and dry site conditions). Historical fire disturbance has caused these sites to be within different structural and successional stages than adjacent, undisturbed ecosites. Two occurrences of *Botrychium alaskense* (a rare plant ranked S1S3 in Yukon) were observed in the ecosite.

The soil moisture regime of the Mid to High Elevation Dry Shrub ecosite is submesic, and the soil nutrient regime is poor. Topsoil is often limited (average depth 1 cm), and exposed mineral soil and cobbles are common. The topsoil texture is silt loam. Soils are well to rapidly drained Orthic Dystric Brunisols or Orthic Eutric Brunisols, mainly over colluvial parent materials.

Subalpine Moist Shrub (Sm)



Soil Characteristics

Soil Classification: GL.DYB[1], O.DYB[3], GL.SC[3], TC[1], GLTC[3], OE.TC[2], R.TC[1]
Surficial Material: colluvium[15], weathered bedrock[1]
Drainage: poor[8], imperfect[7], moderately-well[1]
Organic Thickness: 12 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually present

Site Characteristics

Moisture Regime: subhygric[8], hygric[6], subhydric[2], mesic[1]
Nutrient Regime: poor[15], medium[3]
Topographic Position: middle slope[9], upper slope[5], crest[3]
Slope: 10-40%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[14]
Ground	[14]
Full	[4]

Characteristic Species

Shrub	[37]	dwarf birch
	[28]	willow species
	[25]	bog blueberry
	[17]	mountain cranberry
	[16]	Labrador tea
	[14]	northern Labrador tea
	[8]	crowberry
Grass	[11]	spruce muskeg sedge
Moss	[38]	step moss
	[30]	red-stemmed feathermoss
Lichen	[15]	reindeer lichens
	[7]	icelandmoss lichens

Subalpine Moist Shrub (Sm)

Photographs

Ecosite Overview

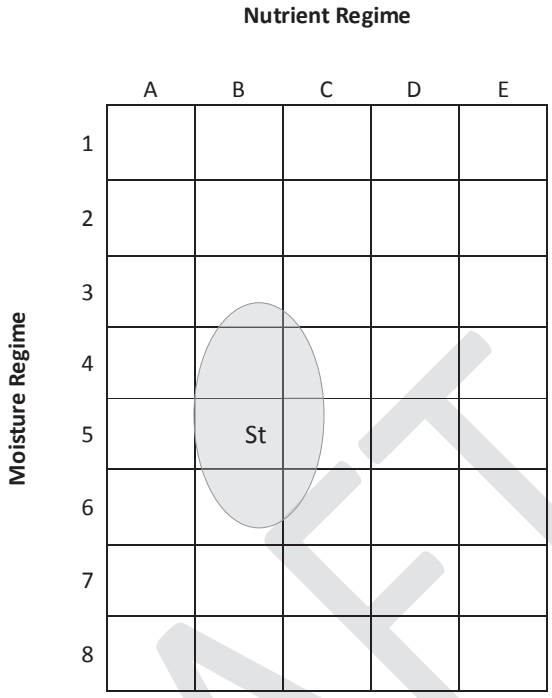
Ground Vegetation

Ecosite Description

The Subalpine Moist Shrub ecosite occurs mainly on north, north-easterly, or north-westerly moderately steep slopes (10-50% gradient) at high elevations (1200-1560 m). The shrub layer is dominated by dwarf birch (*Betula glandulosa*) and various willow species (*Salix glauca*, *S. planifolia*, and *S. pulchra*). Bog blueberry (*Vaccinium uliginosum*), mountain cranberry (*Vaccinium vitis-idaea*), northern Labrador tea (*Ledum palustre* ssp. *decumbens*) and crowberry (*Empetrum nigrum*) are also important and abundant shrub layer species within the ecosite. Forb and graminoid cover is typically low; spruce muskeg sedge (*Carex lugens*) is the only characteristic species in the herb layer. Bryophytes and lichens are important constituents of the Subalpine Moist Shrub ecosite, and most sites contain a combination of step moss (*Hylocomium splendens*), red-stemmed feathermoss (*Pleurozium schreberi*), reindeer lichens (*Cladina mitis*, *C. rangiferina*, and *C. stellaris*), and icelandmoss lichens (*Cetraria cucullata*, *C. ericetorum*, *C. islandica*, and *C. nivalis*).

The soil moisture regime of the Subalpine Moist Shrub ecosite ranges from mesic to subhygric to hygric, and the soil nutrient regime ranges from poor to medium. When permafrost is present within 50 cm of the soil surface, soils tend to be poorly drained Turbic Cryosols. When permafrost is deeper or absent, drainage is imperfect or better, and soils are Orthic or Gleyed Dystric Brunisols.

Tall Shrub (St)



Soil Characteristics

Soil Classification: O.DYB[5], R.SC[1]
Surficial Material: colluvium[5], fluvial[1]
Drainage: well[3], imperfect[2]
Organic Thickness: 5 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: sometimes present

Site Characteristics

Moisture Regime: mesic[3], submesic[1], subhygric[1], hygric[1]
Nutrient Regime: medium[4], poor[2]
Topographic Position: middle slope[3], upper slope[2]
Slope: 15-60%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[7]
Ground	[4]
Full	[1]

Characteristic Species

Shrub	[57]	dwarf birch
	[29]	willow species
	[25]	water birch
	[21]	mountain cranberry
	[16]	Labrador tea
	[10]	crowberry
Lichen	[34]	step moss
	[6]	hair-cap moss
Moss	[13]	reindeer lichens
	[6]	pelt lichens

Tall Shrub (St)

Photographs

Ecosite Overview

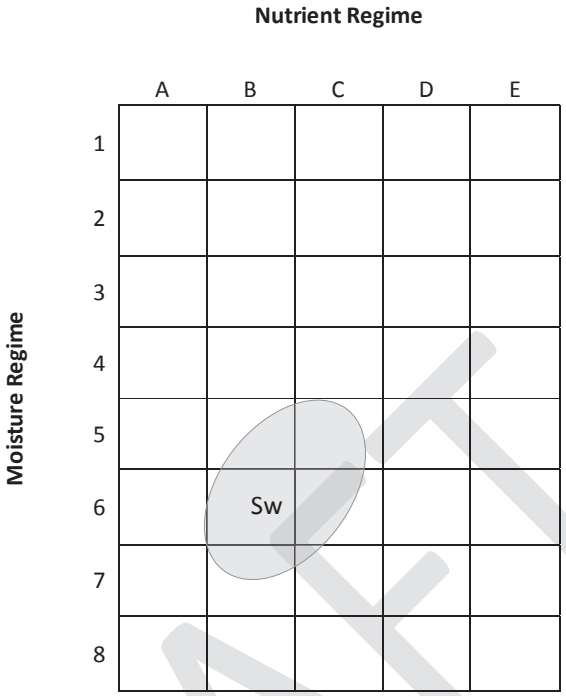
Ground Vegetation

Ecosite Description

The Tall Shrub ecosite occurs at upper and middle slope positions at high elevations (850-1250 m) on moderate to steep slopes (15-55%) with variable aspects, just below the Dryas/Sparse Herb ecosite. Environmental conditions limit structural development to shrubs and trees < 5 m tall, herbs, bryophytes, and lichens. The dominant shrub within the tall shrub layer (1-5 m in height) is dwarf birch (*Betula glandulosa*). Other characteristic shrub species in the ecosite include water birch (*Betula occidentalis*) and willow species (*Salix glauca*, *S. planifolia*, *S. pulchra*, and *S. scouleriana*). The herb layer is composed mainly of dwarf shrub species (e.g. mountain cranberry (*Vaccinium vitis-idaea*) and crowberry (*Empetrum nigrum*)); forb and graminoid species occur sporadically. Bryophyte and lichen cover is usually high, and includes step moss (*Hylocomium splendens*), hair cap moss (*Polytrichum* sp.), reindeer lichens (*Cladina* spp.), and pelt lichens (*Peltigera* spp.). This ecosite occasionally occurs on boulder drainages, which results in taller, more productive shrub layers.

The soil moisture regime of the Tall Shrub ecosite ranges from submesic to hygric, and the soil nutrient regime ranges from poor to medium. Permafrost, which impedes drainage, occurs in some locations with northerly or easterly aspects, particularly in concave, basin-like areas of slopes. Non-permafrost sites are moderately well drained or well drained, and permafrost sites tend to be imperfectly drained. Orthic Dystric Brunisols over colluvial parent materials are the most common soils.

Mid to High Elevation Wet Shrub (Sw)



Soil Characteristics

Soil Classification: CY[1], O.DYB[1], O.EB[1], OC[1], TC[1], R.TC[1]
Surficial Material: colluvium[8]
Drainage: imperfect[3], poor[3]
Organic Thickness: 21 cm
Topsoil Texture: silt loam
Effective Texture: loam
Permafrost: usually present

Site Characteristics

Moisture Regime: subhygric[4], hygric[2], subhydric[2]
Nutrient Regime: poor[5], medium[3]
Topographic Position: upper slope[3], lower slope[3], middle slope[2]
Slope: 20-60%
Aspect: northerly, north-westerly

Sample Plots

Plot Type	Number of Plots
Visual	[4]
Ground	[8]
Full	[0]

Characteristic Species

Shrub	[42]	northern Labrador tea
	[39]	dwarf birch
	[27]	Labrador tea
	[18]	black spruce
	[18]	mountain cranberry
	[11]	willow species
Herb	[4]	alpine knotweed
Moss	[38]	red-stemmed feathermoss
	[34]	step moss
	[34]	peat moss
Lichen	[20]	green reindeer lichen
	[18]	grey reindeer lichen
	[11]	icelandmoss lichens

Mid to High Elevation Wet Shrub (Sw)

Photographs

Ecosite Overview

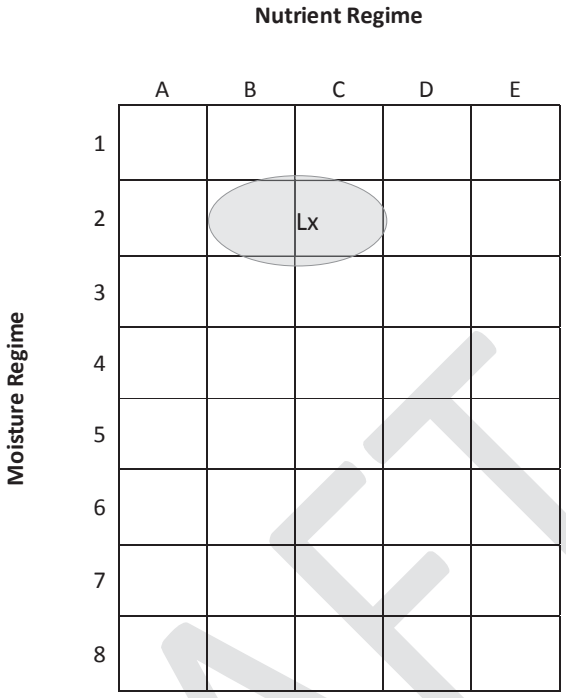
Ground Vegetation

Ecosite Description

The Mid to High Elevation Wet Shrub ecosite occurs mainly on moderate to steep (20-60% gradient) north or north-westerly slopes at mid to high elevations (750-1200 m). Black spruce (*Picea mariana*) is the dominant tree species, but it tends to be stunted with a sparse canopy, and is restricted to the shrub layer (i.e. < 5 m tall). The shrub layer is dominated by Northern Labrador tea (*Ledum palustre* ssp. *decumbens*). Dwarf birch (*Betula glandulosa)*, Labrador tea (*Ledum groenlandicum*), mountain cranberry (*Vaccinium vitis-idaea*), and various willow species (*Salix glauca*, *S. planifolia*, and *S. pulchra*) are both important and common shrub layer species within the Wet Shrub ecosite. Cover of forb and graminoid species is limited due to the cool aspect, high moisture and low nutrients (due to permafrost) within the ecosite. Typically, alpine knotweed (*Polygonum alaskanum*) is the only characteristic species in the herb layer. Bryophytes and lichens are important constituents of the Mid to High Elevation Wet Shrub ecosite, and combined cover is usually greater than eighty percent. Most sites contain a combination of red-stemmed feathermoss (*Pleurozium schreberi*), step moss (*Hylocomium splendens*), peat moss (*Sphagnum* spp.), icelandmoss lichen species (*Cetraria cucullata*, *C. ericetorum*, and *C. nigricans*), and reindeer lichen species (*Cladina mitis*, and *C. rangiferina*).

The soil moisture regime of the Mid to High Elevation Wet Shrub ecosite ranges from subhygric to subhydric, and the soil nutrient regime ranges from poor to medium. Permafrost is almost always present, and soils are correspondingly imperfectly or poorly drained Cryosols overlying colluvial parent materials.

Sloping Grassland (Lx)



Soil Characteristics

Soil Classification: O.EB[2]
Surficial Material: colluvium
Drainage: rapid
Organic Thickness: 2 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: subxeric[5]
Nutrient Regime: poor[3], medium[2]
Topographic Position: middle slope[3], upper slope[2]
Slope: 60-70%
Aspect: southerly

Sample Plots

Plot Type	Number of Plots
Visual	[4]
Ground	[3]
Full	[2]

Characteristic Species

Shrub	[8]	prickly rose
	[4]	aspen
	[2]	buffalo berry
Forb	[13]	prairie sagewort
	[1]	northern bedstraw
	[1]	spikelike goldenrod
	[1]	yarrow
Grass	[23]	purple reedgrass
	[2]	sedge species

Sloping Grassland (Lx)

Photographs

Ecosite Overview

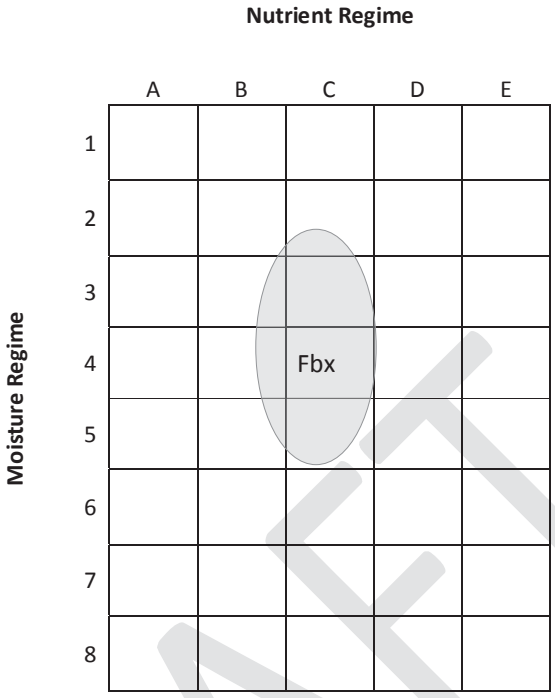
Ground Vegetation

Ecosite Description

The Sloping Grassland ecosite occurs on steep (60-70%), south-facing slopes at low to middle elevations (600-800 m). Trembling aspen (*Populus tremuloides*) is often present as a regenerating tree in the shrub layer, but cover is sporadic (average percent cover 4%). Prickly rose (*Rosa acicularis*) dominates the shrub layer, and buffaloberry (*Shepherdia canadensis*) and low bush cranberry (*Viburnum edule*) are usually also present in the shrub layer with relatively low percent covers. Graminoid communities are dominated by purple reedgrass (*Calamagrostis purpurascens*). Prairie sagewort (*Artemisia frigida*) is an important species in the herb layer, and small amounts of yarrow (*Achillea millefolium*), northern bedstraw (*Galium boreale*), spikelike goldenrod (*Solidago simplex*), and sedge (*Carex concinna* and other *Carex* spp.) species are usually also present in the herb layer. Bryophytes and lichens are not overly abundant on these sites, and exposed mineral soil and organic matter comprise much of the ground layer (average >40% cover). Due to the physically unstable nature of this ecosite, dominant vegetation species are resilient to dry conditions and eroding soils. Two rare species were found in the ecosite within the study area: *Artemisia laciniata* and *Phacelia mollis*.

The soil moisture regime is consistently subxeric, and the soil nutrient regime ranges from poor to medium. Soils are rapidly drained and moderately fine textured Orthic Eutric Brunisols with colluvial parent material. Due to the unstable conditions of these sites (open canopy, dry south facing and steep slopes), topsoil is susceptible to seasonal frost heave and wind and water erosion.

Dry Broadleaf Forest (Fbx)



Soil Characteristics

Soil Classification: O.EB[6], O.DYB[2]
Surficial Material: colluvium
Drainage: well[9], rapidly[4]
Organic Thickness: 3 cm
Topsoil Texture: silt loam
Effective Texture: loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: submesic[6], mesic[5], subxeric[3]
Nutrient Regime: medium[12], poor[2]
Topographic Position: upper slope[7], middle slope[5]
Slope: 20-80%
Aspect: southerly, south-westerly

Sample Plots

Plot Type	Number of Plots
Visual	[7]
Ground	[14]
Full	[2]

Characteristic Species

Tree	[30]	trembling aspen
Shrub	[33]	common bearberry
	[31]	trembling aspen
	[16]	buffaloberry
	[15]	mountain cranberry
Forb	[4]	fireweed
Grass	[25]	bluejoint reedgrass

Dry Broadleaf Forest (Fbx)

Photographs

Ecosite Overview

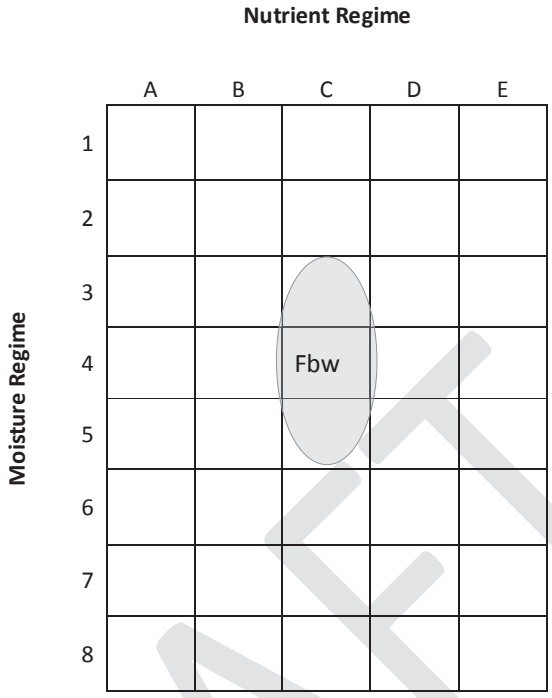
Ground Vegetation

Ecosite Description

The Dry Broadleaf Forest ecosite occurs on south or southwest-facing slopes with slope positions ranging from upper to middle slopes. Elevation ranges from 450 to 1180 m on moderate to steep slopes (30%-80% slope). The canopy is generally dominated by trembling aspen (*Populus tremuloides*), although a number of stands within the northeast corner of the study area that were disturbed by fire within the last 60 years have a main canopy dominated by Alaska birch (*Betula neoalaskana*). Regenerating aspen dominates the tall shrub layer, and buffaloberry (*Shepherdia canadensis*) is common within the low shrub layer (20-100 cm tall). Ground cover within the ecositeis dominated by common bearberry (*Arctostaphylos uva-ursi*), with a minor mountain cranberry (*Vaccinium vitis-idaea*) component. The herb layer is dominated by bluejoint reedgrass (*Calamagrostis canadensis*) and fireweed (*Epilobium angustifolium*); bryophytes and lichens are sporadically distributed or absent. Due to the aspect and slope position, this ecosite is prone to dry conditions, which increase the potential for fire. Many slopes within the study area were observed within a shrub phase dominated by common bearberry and some regenerating trembling aspen because of historical fire disturbance. *Cypripedium guttatum* (a rare species ranked S2 in Yukon) was on found in four locations within this ecosite.

The soil moisture regime of the Dry Broadleaf Forest ecosite is submesic to subhygric, and the soil nutrient regime is poor to medium. The dominant topsoil texture is silt loam over an effective texture of loam overlying colluvial parent materials. Topsoil is limited on these dry, steep slopes and has an average depth of 3 cm. Soils are well drained or rapidly drained Orthic Dystric Brunisols or Orthic Eutric Brunisols. Permafrost is typically absent.

Moist Broadleaf Forest (Fbw)



Soil Characteristics

Soil Classification: O.DYB[1], O.EB[2], TC[1], GL.TC[1]
Surficial Material: colluvium[5]
Drainage: well[2], moderately well[2], imperfect[2]
Organic Thickness: 6 cm
Topsoil Texture: silt loam
Effective Texture: loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: submesic[2], mesic[2], subhygric[2]
Nutrient Regime: medium[5]
Topographic Position: middle slope[3], lower slope[2], upper slope[1]
Slope: 20-50%
Aspect: northerly

Sample Plots

Plot Type	Number of Plots
Visual	[2]
Ground	[4]
Full	[1]

Characteristic Species

Tree	[67]	Alaska birch
Shrub	[33]	green alder
	[20]	prickly rose
	[9]	mountain cranberry
	[6]	currant/gooseberry species
Forb	[16]	horsetail species
	[4]	tall bluebells
Grass	[6]	bluejoint reedgrass
Moss	[36]	step moss

Moist Broadleaf Forest (Fbw)

Photographs

Ecosite Overview

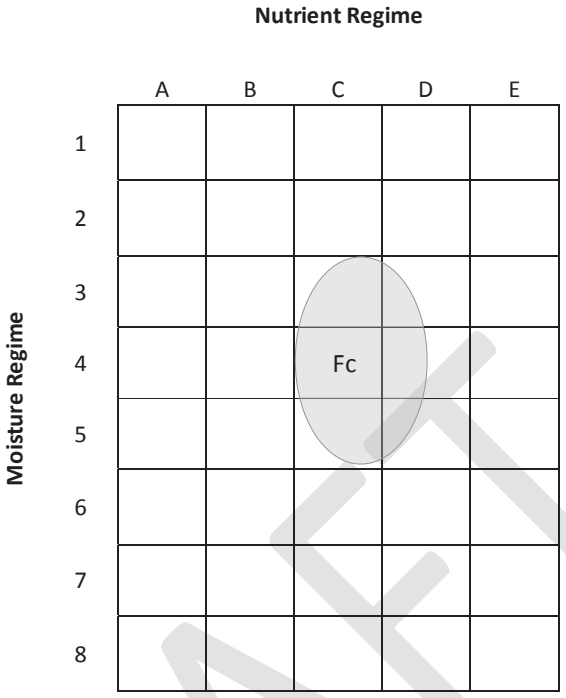
Ground Vegetation

Ecosite Description

The Moist Broadleaf Forest ecosite occurs mainly on north-facing middle and lower slopes, with a 20-60% slope gradient. Elevations within the ecosite range from 400 to 800 m. The main canopy is frequently dense and is composed of Alaska birch (*Betula neoalaskana*). The shrub layer is dominated by green alder (*Alnus viridus*), and also includes prickly rose (*Rosa acicularis*), mountain cranberry (*Vaccinium vitis-idaea*), and currant/gooseberry species (*Ribes lacustre* and *Ribes triste*). As a result of crown density, and ultimately lack of light penetration to the forest floor, in addition to the large amounts of leaf litter observed within the ecosite, the diversity of herbaceous species is limited. Herb and grass species within the ecosite include horsetail species (*Equisetum arvense* and *E. scirpoides*), tall bluebells (*Mertensia paniculata*), and bluejoint reedgrass (*Calamagrostis canadensis*). Step moss (*Hylocomium splendens*) dominates the bryophyte layer.

The soil moisture regime of the ecosite is submesic to subhygric, and the soil nutrient regime is medium. Soils are imperfectly drained Turbic Cryosols when permafrost is present, and moderately well drained or well drained Orthic Dystric Brunisols or Eutric Brunisols when permafrost is absent. Parent materials consist of moderately fine textured colluviums, and often a veneer of soil occurs over a colluvial boulder field.

Coniferous Forest (Fc)



Soil Characteristics

Soil Classification: O.DYB[4], O.EB[2], OE.TC[1] , E.DYB[1]
Surficial Material: colluvium[12], fluvial[2]
Drainage: moderately well[5], well[5], Imperfect[3], poorly[1]
Organic Thickness: 6 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: sometimes present

Site Characteristics

Moisture Regime: mesic[6], submesic[4], subhygric[4]
Nutrient Regime: poor[9], medium[5]
Topographic Position: middle slope[5], lower slope[4], upper slope[2]
Slope: 15-55%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[13]
Ground	[8]
Full	[2]

Characteristic Species

Tree	[44]	black spruce
Shrub	[27]	Labrador tea
	[17]	mountain cranberry
	[4]	prickly rose
Moss	[66]	step moss
Lichen	[24]	reindeer lichens
	[12]	pelt lichens
	[4]	pixie lichens

Coniferous Forest (Fc)

Photographs

Ecosite Overview

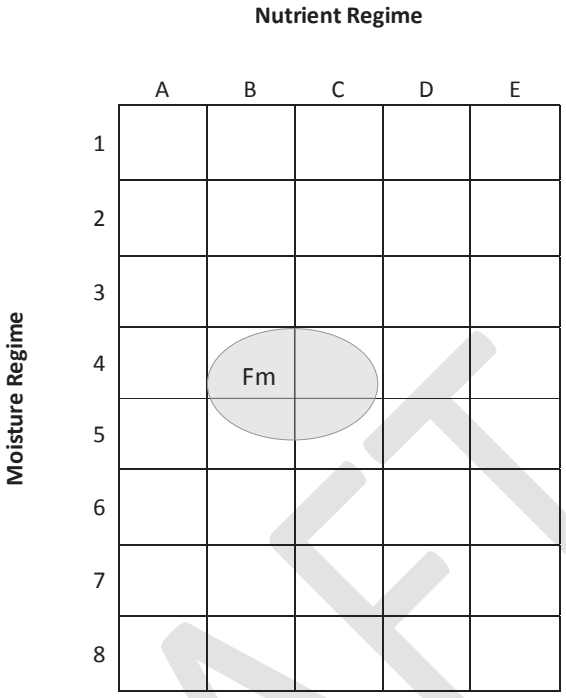
Ground Vegetation

Ecosite Description

The Coniferous Forest ecosite has a 15-55% slope gradient and is found on a variety of aspects. The elevation of these sites ranges from 610-1000 m, and they occur mainly in middle slope positions (although they are sometimes also found occupying upper and lower slopes throughout the study area). The canopy on north facing slopes is composed of black spruce (*Picea mariana*), while pure white spruce (*Picea glauca*) stands occur on south-facing slopes. The shrub layer is composed of Labrador tea (*Ledum groenlandicum*), mountain cranberry (*Vaccinium vitis-idaea*), and prickly rose (*Rosa acicularis*). Forb and graminoid species occur sporadically, and much of the ground is covered by bryophytes and lichens. Step moss (*Hylocomium splendens*) dominates the bryophyte layer on most sites within the study area, and a variety of lichen species including reindeer lichens (*Cladina mitis*, *C. rangiferina*, and *C. stellaris*), pelt lichens (*Peltigera* spp.), and pixie lichens (*Cladonia* spp.) are also present.

The ecosite has a mesic moisture regime with moderately-well to well drained soils and a poor to medium nutrient regime. Generally these sites have moderately fine textured colluvial parent materials. The dominant soil subgroups within the ecosite are Eluviated and Orthic Dystric Brunisols as well as Orthic Eutric Brunisols. Crysols occur occasionally within the ecosite as Gleysolic Turbic Crysols.

Mixedwood Forest (Fm)



Soil Characteristics

Soil Classification: O.DYB[5], O.EB[2], GL.SC[1]
Surficial Material: colluvium[9]
Drainage: well[4], moderately well[3], imperfect [2]
Organic Thickness: 7 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: mesic[7], subhygric[1], hygric[1]
Nutrient Regime: medium[6], poor[3]
Topographic Position: lower slope[5], upper slope[2], middle slope[2]
Slope: 10-50%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[8]
Ground	[7]
Full	[2]

Characteristic Species

Tree	[34]	Alaska birch
	[30]	white spruce
Shrub	[26]	Labrador tea
	[19]	mountain cranberry
	[18]	willow species
	[5]	prickly rose
Forb	[9]	false toadflax
	[2]	tall bluebells
Moss	[62]	step moss

Mixedwood Forest (Fm)

Photographs

Ecosite Overview

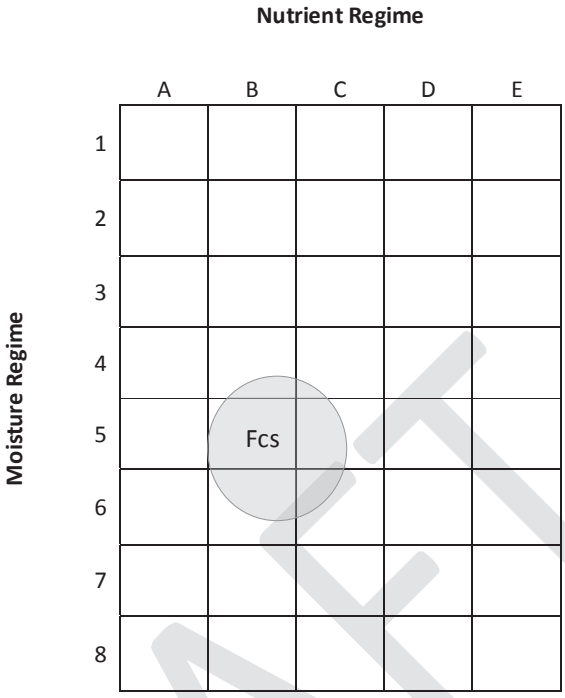
Ground Vegetation

Ecosite Description

The Mixedwood Forest ecosite occurs mainly on middle and lower slopes at variable aspects. This ecosite is generally a mixedwood forest on moderate to steep slopes (10-50%) and mid elevations (range of 600-1150 m). The canopy is co-dominated by white spruce (*Picea glauca*) and Alaska birch (*Betula neoalaskana*). The shrub layer consists of a variety of willow species (including *Salix bebbiana*, *S. glauca*, *S. planifolia*, and *S. scouleriana*), mountain cranberry (*Vaccinium vitis-idaea*), Labrador tea (*Ledum groenlandicum*) and prickly rose (*Rosa acicularis*). The herb layer is sparsely populated with false toadflax (*Geocaulon lividum*) and tall bluebells (*Mertensia paniculata*). The bryophyte layer is dominated by feathermoss species, including step moss (*Hylocomium splendens*).

The soil moisture regime of this ecosite is generally mesic, with a soil nutrient regime of poor to medium. Most soils are moderately well drained or well drained Orthic Dystric Brunisols or Orthic Eutric Brunisols that are free of permafrost. When permafrost is present, soils tend to be imperfectly drained Gleysolic Static Cryosols. Moderately fine textured colluvial parent materials are dominant.

Sparse Coniferous Forest (Fcs)



Soil Characteristics

Soil Classification: GL.DYB[2], O.DYB[1], O.EB[1], O.R[1], BRE.SC[1], TC[2], BRD.TC[1]
Surficial Material: colluvium[6], fluvial[2]
Drainage: imperfect[5], moderately well[2], well[2]
Organic Thickness: 10 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: sometimes present

Site Characteristics

Moisture Regime: subhygric[6], hygric[1]
Nutrient Regime: poor[6], medium[3]
Topographic Position: middle slope[4], upper slope[3], lower slope[1]
Slope: 20-35%
Aspect: variable

Sample Plots

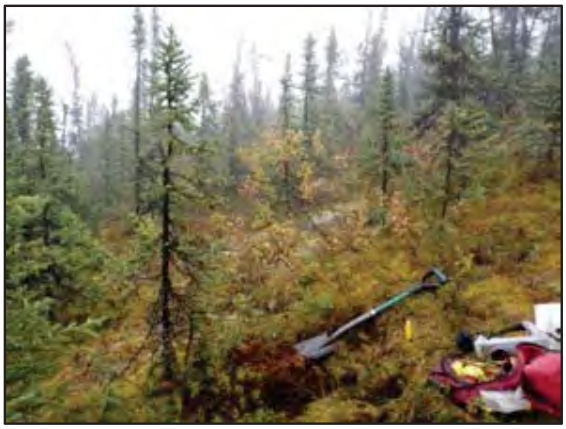
Plot Type	Number of Plots
Visual	[8]
Ground	[8]
Full	[1]

Characteristic Species

Tree	[16]	spruce
Shrub	[47]	dwarf birch
	[32]	Labrador tea
	[11]	mountain cranberry
	[8]	willow species
Moss	[41]	red-stemmed feathermoss
Lichen	[19]	reindeer lichens

Sparse Coniferous Forest (Fcs)

Photographs



Ecosite Overview

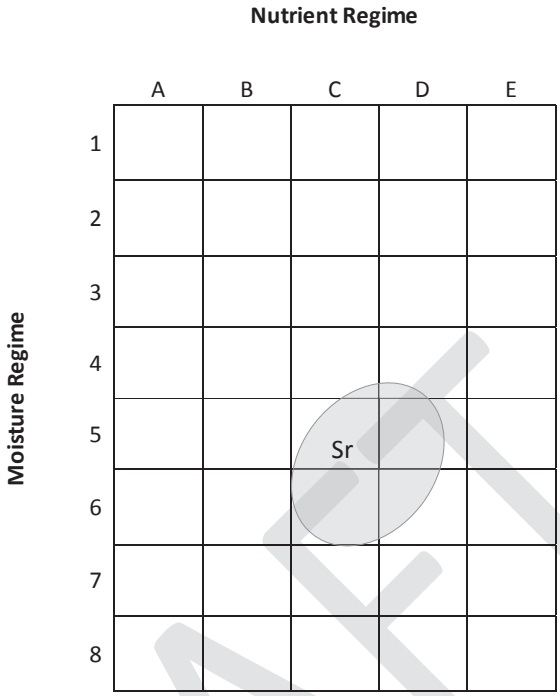
Ground Vegetation

Ecosite Description

The Sparse Coniferous Forest ecosite occurs mainly on middle slope positions with variable exposures. Elevations range from 1000-1250 m on moderately steep slopes (20-35%). The canopy is sparse and is usually composed of white spruce (*Picea glauca*); however, black spruce (*Picea mariana*) stands occasionally occur throughout the study area. The shrub layer is dominated by dwarf birch (*Betula glandulosa*) and Labrador tea (*Ledum groenlandicum*), with minor components of various willow species (including *Salix alaxensis*, *S. glauca*, *S. planifolia*, *S. pulchra*, and *S. scouleriana*) and mountain cranberry (*Vaccinium vitis-idaea*). Forb and graminoid species occur sporadically with limited cover; as a result, the majority of the ground is covered by bryophytes and lichens. Red-stemmed feathermoss (*Pleurozium schreberi*) is common within the ecosite, and the lichen layer is dominated by reindeer lichens (*Cladina mitis* and *C. rangiferina*).

The soil moisture regime of this ecosite is mainly subhygric or hygric, and the nutrient regime is poor to medium. Soils are imperfectly drained Static or Turbic Cryosols when permafrost is present, and moderately well drained or well drained Brunisols or Regosols when permafrost is absent. Moderately fine textured colluvial parent materials are dominant on these sites.

Riparian Shrub (Sr)



Soil Characteristics

Soil Classification: CY[1], CU.R[7], GLCU.R[1]
Surficial Material: fluvial[9]
Drainage: imperfect[4], poor[3]
Organic Thickness: 7 cm
Topsoil Texture: silt loam
Effective Texture: sandy loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: subhygric[5], hygric[3], mesic[1]
Nutrient Regime: medium[7], rich[3]
Topographic Position: level[5], toe slope[4], lower slope[1]
Slope: 1-30%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[7]
Ground	[8]
Full	[2]

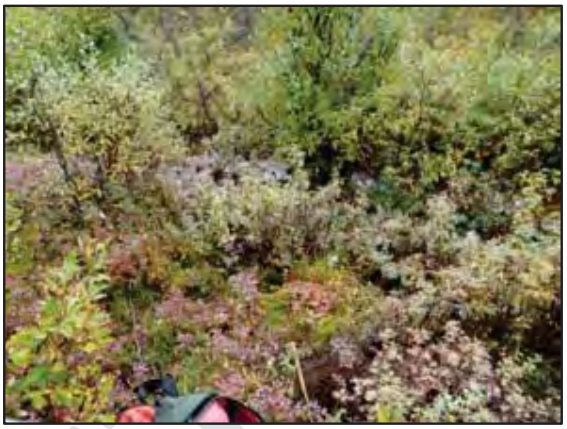
Characteristic Species

Shrub	[80]	willow species
	[42]	bog blueberry
	[18]	shrubby cinquefoil
Forb	[7]	horsetail species
Grass	[15]	sedge species
Moss	[16]	peat moss

Riparian Shrub (Sr)

Photographs

Ecosite Overview



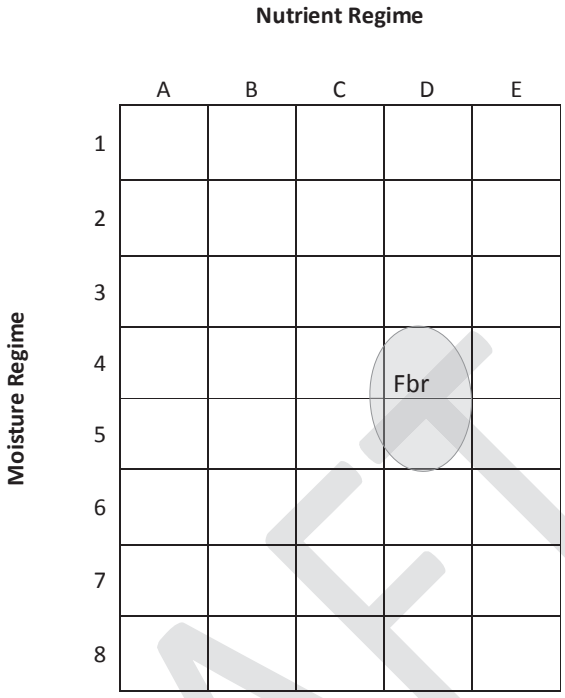
Ground Vegetation

Ecosite Description

The Riparian Shrub ecosite occurs within the historic floodplain and side channels of riverine habitats where seasonal flooding is common. Because of increased moisture and nutrient regimes, most of these sites are open and contain diverse shrub and herb layers. Willow species (including *Salix alaxensis*, *S. glauca*, *S. myrtillifolia*, *S. planifolia*, *S. pulchra*, and *S. scouleriana*) are abundant and typically account for more than 50% cover within Riparian Shrub plots. Other shrub species include bog blueberry (*Vaccinium uliginosum*) and shrubby cinquefoil (*Pentaphylloides floribunda*). The herb layer is composed mainly of sedge species (including *Carex aquatilis*, *C. podocarpa*, *C. saxatilis*, and *C. utriculata*) and horsetail species (including *Equisetum arvense*, *E. fluviatile*, *E. pretense*, *E. scirpoides*, *E. sylvaticum*, and *E. variegatum*). The dominant bryophyte is peat moss (*Sphagnum* spp.).

The soil moisture regime of the Riparian Shrub ecosite is subhygric to hygric, and the soil nutrient regime is medium to rich. Soils are usually imperfectly or poorly drained Cumulic Regosols overlying course textured fluvial parent materials.

Riparian Broadleaf (Fbr)



Soil Characteristics

Soil Classification: O.DYB[1], O.EB[1], CU.HR[1], O.HR[1], O.R[1]
Surficial Material: fluvial[5]
Drainage: moderately well[5]
Organic Thickness: 3 cm
Topsoil Texture: loam
Effective Texture: loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: subhygric[4], mesic[1]
Nutrient Regime: rich[5]
Topographic Position: level[5]
Slope: N/A
Aspect: N/A

Sample Plots

Plot Type	Number of Plots
Visual	[3]
Ground	[3]
Full	[2]

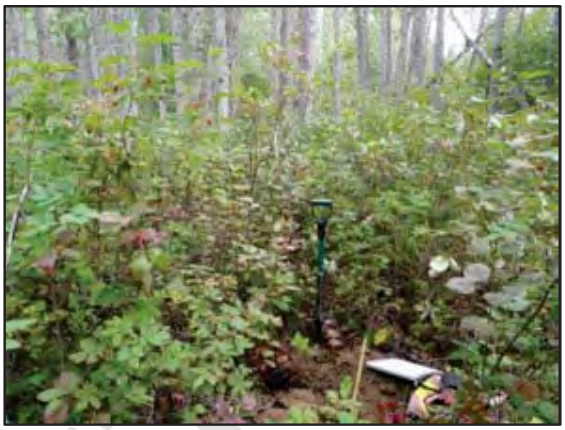
Characteristic Species

Tree	[50]	balsam poplar
Shrub	[44]	prickly rose
	[40]	grey alder
	[16]	high bush cranberry
	[15]	red osier dogwood
Forb	[9]	common horsetail
	[5]	tall bluebells
	[2]	northern bedstraw
Grass	[7]	bluejoint reedgrass

Riparian Broadleaf (Fbr)

Photographs

Ecosite Overview



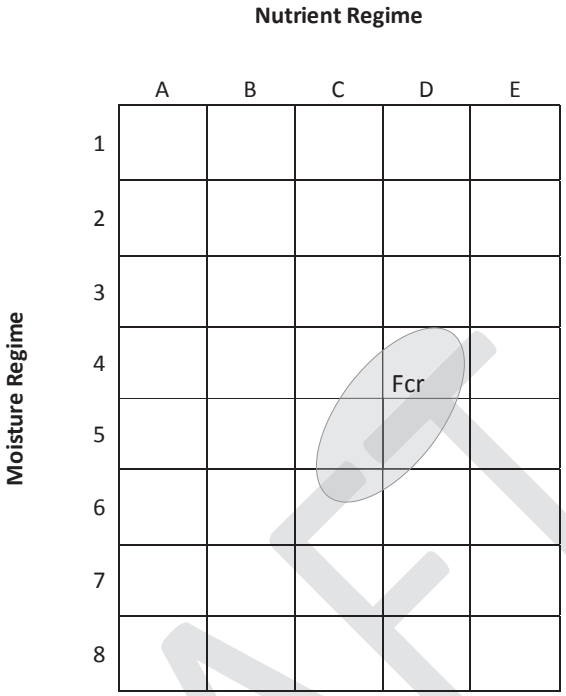
Ground Vegetation

Ecosite Description

The Riparian Broadleaf ecosite occurs on broad, level floodplains where the canopy is well developed and is dominated by balsam poplar (*Populus balsamifera*). The ecosite occurs at lower elevations (350-450 m) along the Yukon River and the smaller watercourses within the study area (Dip Creek, Canadian Creek, Britannia Creek, etc.). The dominant shrub species are prickly rose (*Rosa acicularis*) and grey alder (Alnus incana), and sub-dominant shrub species include high bush cranberry (*Viburnum edule*) and red osier dogwood (*Cornus stolonifera*). The herb layer is sparsely vegetated with common horsetail (*Equisetum arvense*), tall bluebells (*Mertensia paniculata*), northern bedstraw (*Galium boreale*), and bluejoint reedgrass (*Calamagrostis canadensis*). The bryophyte layer is not well developed.

The soil moisture regime of the Riparian Broadleaf ecosite is mesic or subhygric, and the nutrient regime is rich. Soils are moderately well drained Orthic Dystric Brunisols, Orthic Eutric Brunisols, or Cumulic Humic Regosols. Topsoil and effective textures are loam over fluvial parent materials.

Riparian Coniferous (Fcr)



Soil Characteristics

Soil Classification: GL.EB[1], CU.R[2], SC[1]
Surficial Material: fluvial[5]
Drainage: imperfect[4], moderately-well[1]
Organic Thickness: 3 cm
Topsoil Texture: silt loam
Effective Texture: loam
Permafrost: usually absent

Site Characteristics

Moisture Regime: subhygric[3], mesic[2]
Nutrient Regime: rich[4], medium[2]
Topographic Position: level[5]
Slope: N/A
Aspect: N/A

Sample Plots

Plot Type	Number of Plots
Visual	[5]
Ground	[6]
Full	[1]

Characteristic Species

Tree	[50]	white spruce
Shrub	[33]	willow species
	[12]	prickly rose
	[12]	grey alder
	[2]	twin flower
Forb	[20]	horsetail species
Grass	[6]	bluejoint reedgrass
Moss	[34]	step moss

Riparian Coniferous (Fcr)

Photographs

Ecosite Overview

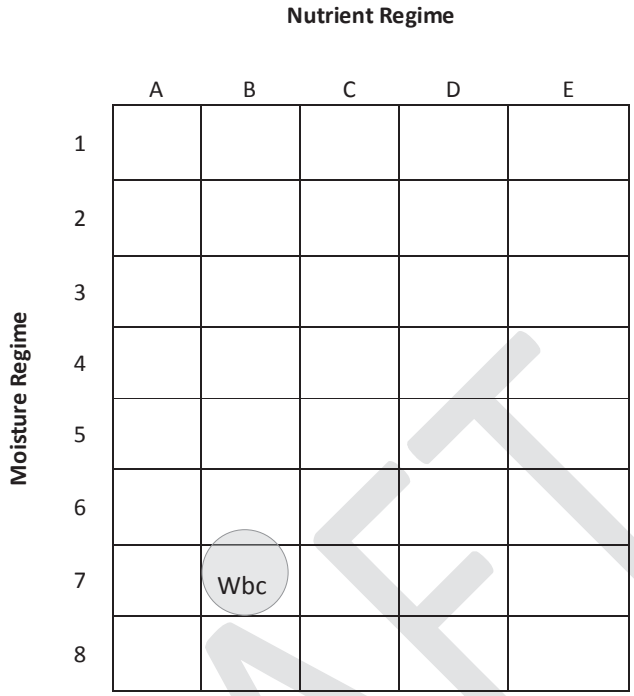
Ground Vegetation

Ecosite Description

The Riparian Coniferous ecosite occurs on broad floodplains where the well-developed canopy is dominated by large white spruce (*Picea glauca*) trees. This ecosite occupies lower elevations (410-610 m) and is found along the Yukon River and other watercourses within the study area. Willow species (including *Salix bebbiana*, *S. planifolia*, and *S. pulchra*) dominate the shrub layer, and prickly rose (*Rosa acicularis*) and grey alder (*Alnus incana*) are usually also present within the shrub layer. The herb layer is sparsely vegetated with horsetail species (including *Equisetum arvense*, *E. pratense*, and *E. scirpoides*), bluejoint reedgrass (*Calamagrostis canadensis*), and twin flower (*Linnaea borealis*). Step moss (*Hylocomium splendens*) is the most common species within the bryophyte layer, and lichens are usually absent. Due to the increased moisture and rich nutrients of this site the main canopy is usually more productive than other ecosites within the study area.

The soil moisture regime of the ecosite is mesic to subhygric, and the nutrient regime is typically rich. The soils of this ecosite tend to occur on a level topographic position most commonly developed in fluvial parent materials and may exhibit buried, humified Ah horizons. Soils are typically imperfectly to moderately well drained Cumulic Regosols.

Coniferous Treed Bog (Wbc)



Soil Characteristics

Soil Classification: SC[2], GL.TC[1]
Surficial Material: colluvium
Drainage: poor[3], imperfect[2]
Organic Thickness: 19 cm
Topsoil Texture: silt loam
Effective Texture: silt loam
Permafrost: usually present

Site Characteristics

Moisture Regime: subhydric[3], hygric[1]
Nutrient Regime: poor
Topographic Position: level[3], lower slope[1]
Slope: 0-10%
Aspect: variable

Sample Plots

Plot Type	Number of Plots
Visual	[6]
Ground	[3]
Full	[2]

Characteristic Species

Tree	[31]	black spruce
Shrub	[26]	Labrador tea
	[14]	mountain cranberry
Forb	[4]	cloudberry
	[3]	sweet coltsfoot
Moss	[48]	step moss
	[25]	peat moss
Lichen	[30]	reindeer lichens

Coniferous Treed Bog (Wbc)

Photographs

Ecosite Overview

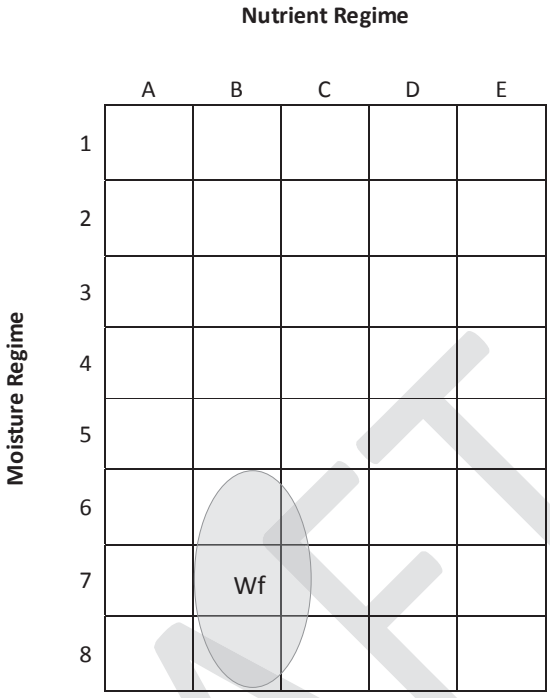
Ground Vegetation

Ecosite Description

The Coniferous Treed Bog ecosite occurs on level and gently sloping terrain. Elevations range from 450-720 m with a slope gradient of 0-10% and variable aspects. Black spruce (*Picea mariana*) forms a discontinuous canopy, with regenerating (< 5 m tall) black spruce often found within the understory. The shrub layer is dominated by Labrador tea (*Ledum groenlandicum*), and mountain cranberry (*Vaccinium vitis-idaea*) occurs sporadically over the ground. The dominant forb species within the ecosite include cloudberry (*Rubus chamaemorus*) and sweet coltsfoot (*Petasites frigidus*). Step moss (*Hylocomium splendens*) tends to be dominant within the bryophyte layer with peat moss (*Sphagnum* spp.) occurring as a secondary species. Reindeer lichens (including *Cladina mitis* and *C. rangiferina*) are also common.

These sites are found on moderately fine textured colluvial parent materials, which have incorporated considerable amounts of wind-blown silt in higher order valleys. The soil moisture regime of the Coniferous Treed Bog ecosite is subhydric to hygric and the soil nutrient regime is poor. Permafrost is usually present on these sites making cryosols the dominant soil group. Soils are poorly or imperfectly drained Static Cryosols or Gleysolic Turbic Cryosols.

Shrubby Fen (Wf)



Soil Characteristics

Soil Classification: TFI.OC[3], GL.SC[2]
Surficial Material: organic[1], fluvial[1]
Drainage: very poor[4], poor[1]
Organic Thickness: 34 cm
Topsoil Texture: n/a
Effective Texture: silt loam
Permafrost: usually present

Site Characteristics

Moisture Regime: subhydric[3], hydric[3], hygric[1]
Nutrient Regime: poor[5], medium[2]
Topographic Position: level[5], toe slope[1], depression[1]
Slope: 0-10%
Aspect: variable

Sample Plots

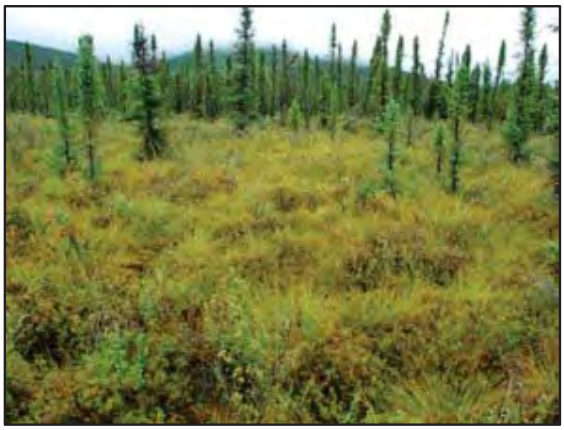
Plot Type	Number of Plots
Visual	[10]
Ground	[5]
Full	[2]

Characteristic Species

Shrub	[16]	dwarf birch
	[14]	mountain cranberry
	14]	northern Labrador tea
	[7]	leatherleaf
	[6]	black spruce
Forb	[5]	cloudberry
Grass	[52]	sheathed cottongrass
Moss	[30]	peat moss

Shrubby Fen (Wf)

Photographs



Ecosite Overview

Ground Vegetation

Ecosite Description

The Shrubby Fen ecosite occurs on level or gently sloping terrain (2-12% slope gradient) with wet to saturated organic cryosol soils. The ecosite occurs at relatively low elevations (350-750 m) and variable aspects. The tree canopy layer is absent from this ecosite and shrubs dominate. Black spruce (*Picea mariana*) is the only tree species found within the ecosite; its cover is sparse and restricted to the shrub layer (i.e. less than 5 m tall). Shrub species in the ecosite include northern Labrador tea (*Ledum palustre* ssp. *decumbens*), mountain cranberry (*Vaccinium vitis-idaea*), dwarf birch (*Betula glandulosa*), and leatherleaf (*Chamaedaphne calyculata*). Tussocks of sheathed cottongrass (*Eriophorum vaginatum*) interspersed with cloudberry (*Rubus chamaemorus*) and peat mosses (*Sphagnum* spp.) cover much of the ground within the ecosite. Proportions of peat moss and cottongrass vary within the ecosite, and in some areas peat moss cover far surpasses cottongrass cover. Other wetland types including small marshes, sedge fens, ponds and oxbow lakes occur near the confluence of Dip and Casino Creeks, but they are too small to be mapped at the current mapping scale.

The soil moisture regime of the Shrubby Fen ecosite ranges from hygric to subhydric to hydric, and the soil nutrient regime is poor or medium. Organic materials were present and mineral topsoil horizons were absent. Soils are poorly or very poorly drained Terric Fibric Organic Cryosols or Gleysolic Static Cryosols over permafrost. Parent material found within the ecosite is predominantly organic, fluvial, and redeposited wind-blown silt.

Gravel Bar (Gb)

Photographs

Ecosite Overview

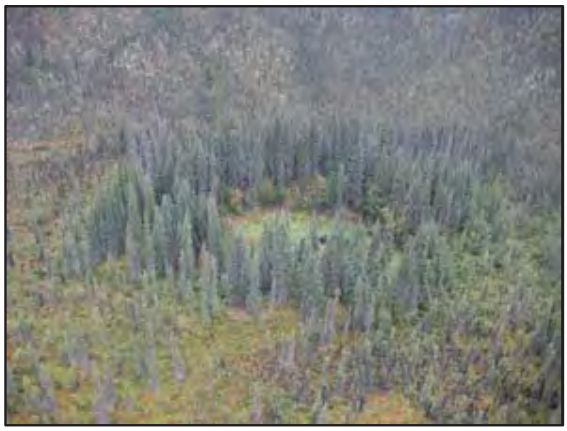
Ground Vegetation

Ecosite Description

Gravel bars are common along the Yukon River as well as occasionally along Dip Creek. They are composed of coarse-textured gravels and sands deposited by fast-moving waters during flood events. Frequent remobilization of bar sediment during moderate to high flows tends to inhibit vegetation establishment, and vegetation cover is correspondingly sparse.

Pingo (Pc)

Photographs



Ecosite Overview

Ground Vegetation

Ecosite Description

A pingo is an earth-covered mound of ice that forms in an "open system", in the LSA, where groundwater discharges through permafrost and freezes close to or at surface. Pingos have a "life cycle" during which they grow (through ice accumulation) and eventually collapse (through ice melt). All pingos within the LSA have at least partly collapsed, generally leaving a small pond enclosed by a rampart. Pingos are relatively common in the LSA and throughout the unglaciated regions of west-central Yukon (in the hundreds).

The pingo mound or rampart supports a typical mature, white spruce forest with associated upland forest species (e.g. prickly rose, tall bluebells, and step moss). Because of contrasting soil conditions, vegetation on the pingo mound is often dramatically different from both vegetation in the collapsed pingo centre and vegetation outside the pingo (both of which are much wetter). Vegetation species composition within the pingo centre is variable, but usually includes wetland grasses, sedges, and bryophytes. Collapsed, open system pingos commonly maintain areas of open water year-round, even through the winter, due to the slow but continuous discharge of groundwater that is several degrees above freezing.

Thaw Lake (TL)

Photographs

Ecosite Overview

Ground Vegetation

Ecosite Description

Thaw lakes, also known as thermokarst lakes, are bodies of water that form through the degradation (melt) of ice-rich permafrost. They form naturally as climate warms, and they also form through anthropogenic land disturbance – most commonly, a disturbance that results in removal or compaction of the insulating vegetation and organic soil. The dimensions of thaw lakes vary over order of magnitude; in the vicinity of the proposed mine site, most thaw lakes have diameters of tens to hundreds of metres. Thaw lakes commonly originate as a small puddle that freezes over in the winter, but they gradually enlarge through retrogressive slumping of their shoreline and eventually do not freeze to their bottoms. Inward, tilted trees and freshly exposed shoreline sediments are a common indication of active shoreline retreat.

Thaw lakes within the LSA most commonly form in level or gentle, valleybottom environments that are underlain by permafrost within fine sediments. Therefore, forests around thaw lakes are usually dominated by black spruce and associated moisture-tolerant shrub species, wetland sedges, and peat mosses. Disturbance-tolerant species such as fireweed often occupy sites where slumping has exposed mineral soil around the edge of the thaw lake.

ATTACHMENT B NATURESERVE CONSERVATION STATUS DEFINITIONS

GLOBAL CONSERVATION STATUS DEFINITIONS

(The following is adapted from the NatureServe Explorer website, accessed November 1, 2010. Available at: http://www.natureserve.org/explorer/ranking.htm - globalstatus)

Listed below are definitions for interpreting NatureServe global (range-wide) conservation status ranks. These ranks are assigned by NatureServe scientists or by a designated lead office in the NatureServe network.

Global (G) Conservation Status Ranks

Rank	Definition
GX	Presumed Extinct (species) — Not located despite intensive searches and virtually no likelihood of rediscovery. Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic taxa and/or elimination of the sites and disturbance factors on which the type depends.
GH	Possibly Extinct (species) Eliminated (ecological communities and systems) — Known from only historical occurrences but still some hope of rediscovery. There is evidence that the species may be extinct or the ecosystem may be eliminated throughout its range, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.[1]
G1	Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	Imperiled—At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.
G3	Vulnerable—At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.
G4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	Secure—Common; widespread and abundant.

[1] Possibly Eliminated ecological communities and systems may include ones presumed eliminated throughout their range, with no or virtually no likelihood of rediscovery, but with the potential for restoration, for example, American chestnut.

Variant Ranks

Rank	Definition
G#G#	Range Rank—A numeric range rank (e.g., G2G3, G1G3) is used to indicate the range of uncertainty about the exact status of a taxon or ecosystem type. Ranges cannot skip more than two ranks (e.g., GU should be used rather than G1G4).
GU	Unrankable—-Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible (when the range of uncertainty is three consecutive ranks or less), a range rank (e.g., G2G3) should be used to delineate the limits (range) of

Rank	Definition
	uncertainty.
GNR	Unranked—Global rank not yet assessed.
GNA	Not Applicable—A conservation status rank is not applicable because the species is not a suitable target for conservation activities.[2]

[2] A global conservation status rank may be not applicable for several reasons, related to its relevance as a conservation target. In such cases, typically the species is a hybrid without conservation value, of domestic origin, or the ecosystem is non-native, for example, ruderal vegetation, a plantation, agricultural field, or developed vegetation (lawns, gardens etc.).

Rank Qualifiers

Rank	Definition
?	Inexact Numeric Rank—Denotes inexact numeric rank; this should not be used with any of the Variant Global Conservation Status Ranks or GX or GH.
Q	Questionable taxonomy that may reduce conservation priority— Distinctiveness of this entity as a taxon or ecosystem type at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon or type in another taxon or type, with the resulting taxon having a lower-priority (numerically higher) conservation status rank. The "Q" modifier is only used at a global level and not at a national or subnational level.
C	Captive or Cultivated Only—Taxon at present is extinct in the wild across their entire native range but is extant in cultivation, in captivity, as a naturalized population (or populations) outside their native range, or as a reintroduced population not yet established. The "C" modifier is only used at a global level and not at a national or subnational level. Possible ranks are GXC or GHC.

INFRASPECIFIC TAXA

Infraspecific taxa refer to subspecies, varieties and other designations below the level of the species. Infraspecific taxon status ranks (T-ranks) apply to plants and animal species only; these T-ranks do not apply to ecological communities.

Infraspecific Taxon Conservation Status Ranks

Rank	Definition
T#	Infraspecific Taxon (trinomial)—The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species . For example, a G1T2 subrank should not occur. A vertebrate animal population, (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.

NATIONAL AND SUBNATIONAL CONSERVATION STATUS DEFINITIONS

Listed below are definitions for interpreting NatureServe conservation status ranks at the national (N-rank) and subnational (S-rank) levels. The term "subnational" refers to state or province-level jurisdictions (e.g., California, Ontario).

Assigning national and subnational conservation status ranks for species and ecosystems follows the same general principles as used in assigning global status ranks. A subnational rank, however, cannot imply that the species or ecosystem is more secure at the state/province level than it is nationally or globally (i.e., a rank of G1S3 is invalid), and similarly, a national rank cannot exceed the global rank. Subnational ranks are assigned and maintained by state or provincial NatureServe network programs.

National (N) and Subnational (S) Conservation Status Ranks

Rank	Definition
NX SX	Presumed Extirpated—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
NH SH	Possibly Extirpated— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
N1 S1	Critically Imperiled—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
N2 S2	Imperiled—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.
N3 S3	Vulnerable—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
N4 S4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
N5 S5	Secure—Common, widespread, and abundant in the jurisdiction.
N#N# S#S#	Range Rank — A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
NU SU	Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
NNR SNR	Unranked—National or subnational conservation status not yet assessed.

NNA SNA	Not Applicable —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[3]
Not provided	Species or ecosystem is known to occur in this nation or state/province. Contact the relevant NatureServe network program for assignment of conservation status.

[3] A conservation status rank may be not applicable for some species, including long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species or ecosystems, for several reasons, described below.

Variant National and Subnational Conservation Status Ranks

Rank	Definition
N#N# S#S#	Range Rank — A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
NU SU	Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
NNR SNR	Unranked—National or subnational conservation status not yet assessed.
NNA SNA	Not Applicable —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[3]
Not provided	Species or ecosystem is known to occur in this nation or state/province. Contact the relevant NatureServe network program for assignment of conservation status.

Rank Qualifier

Rank	Definition
N#? S#?	Inexact Numeric Rank—Denotes inexact numeric rank. This designation should not be used with any of the variant national or subnational conservation status ranks or NX, SX, NH, or SH.

ATTACHMENT C LIST OF PLANT SPECIES OBSERVED DURING RARE PLANT SURVEYS FOR THE CASINO PROJECT 2010 AND 2012

VASCULAR PLANTS

Achillea millefolium L. s.l.
Achillea sibirica Ledeb.
Aconitum delphinifolium DC. ssp. *delphinifolium*
Agrostis scabra Willd. var. scabra
Alnus incana (Linnaeus) Moench
Alnus viridis (Chaix) de Candolle
Alopecurus aequalis Sobol.
Androsace septentrionalis L.
Anemone drummondii S. Wats. var. *lithophila* (Rydb.) C.L. Hitchc.
Anemone multifida Poir. s.l.
Anemone parviflora Michx.
Anemone richardsonii Hook.
Antennaria sp.
Apocynum androsaemifolium L.
Arabis holboellii Hornem.
Arabis kamchatica (Fisch.) Ledeb.
Arctagrostis latifolia (R. Br.) Griseb.
Arctophila fulva (Trin.) Andersson
Arctostaphylos alpina (L.) Spreng.
Arctostaphylos rubra (Rehd. & Wils.) Fern.
Arctostaphylos uva-ursi (L.) Spreng.
Arnica angustifolia Vahl in Hornem. ssp. *angustifolia*
Arnica lessingii (T. & G.) Greene
Artemisia campestris L. s.l.
Artemisia frigida Willd.
Artemisia laciniata Willd.
Artemisia norvegica Fries
Artemisia tilesii Ledeb.
Astragalus eucosmus B.L. Robins.
Astragalus williamsii Rydb.
Barbarea orthoceras Ledeb.
Beckmannia syzigachne (Steud.) Fern.
Betula glandulosa Michx.
Betula neoalaskana Sarg.
Botrychium alaskense Wagner and Grant
Botrychium spp.
Bromus pumpellianus Scribn. s.l.
Bupleurum americanum Coult. & Rose
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis purpurascens R. Br.
Calamagrostis sp.
Campanula aurita Greene
Campanula lasiocarpa Cham.
Cardamine bellidifolia L.
Cardamine purpurea Cham. & Schlecht.
Carex aquatilis Wahlenb.
Carex canescens L.
Carex capitata L.
Carex concinna R. Br.
Carex diandra Schrank
Carex disperma Dewey
Carex leptalea Wahlenb. var. *tayloris* Boivin
Carex loliacea L.
Carex lugens Holm
Carex media R. Br.
Carex microchaeta Holm
Carex obtusata Liljeb.
Carex podocarpa R. Br.
Carex saxatilis L.
Carex sp.
Carex supina Willd. ex Wahlenb.
Carex utriculata Boott
Cassiope tetragona (L.) D. Don
Castilleja hyperborea Pennell
Cerastium beeringianum Cham. & Schlecht.
Chamaedaphne calyculata (L.) Moench
Chamaerhodos erecta (L.) Bge. ssp. *nuttallii* (Pickering ex Rydb.) Hultén
Chenopodium album L.
Chenopodium capitatum (L.) Aschers.
Chrysosplenium tetrandrum (Lund) T. Fries
Claytonia sarmentosa C.A. Mey.
Conioselinum cnidiifolium (Turcz.) A.E. Porsild
Comarum palustre L. (= *Potentilla palustris* (L.) Scop.)
Cornus canadensis L.
Cornus stolonifera Michx.
Crepis elegans Hook.
Crepis tectorum L.
Cypripedium guttatum Sw.
Cypripedium passerinum Richards.
Cystopteris fragilis (L.) Bernh.
Delphinium glaucum S. Wats.
Diapensia lapponica L.
Diphasiastrum complanatum (L.) Holub (= *Lycopodium complanatum* L.)
Draba cana Rydb.
Dryas integrifolia Vahl
Dryas octopetala L.
Dryopteris fragrans (L.) Schott
Elymus spp.
Elymus trachycaulus (Link) Gould ex Shinners
Empetrum nigrum L. ssp. *hermaphroditum* (Lge.) Böcher
Epilobium angustifolium L.
Epilobium ciliatum Raf.
Epilobium latifolium L.
Epilobium palustre L.
Equisetum arvense L.
Equisetum fluviatile L.
Equisetum scirpoides Michx.
Equisetum sylvaticum L.
Equisetum variegatum Schleicher
Erigeron acris L. ssp. politus (Fries) Schinz & Keller
Erigeron caespitosus Nutt.
Erigeron elatus (Hook.) Greene
Erigeron glabellus Nutt. ssp. *pubescens* (Hook.) Cronq.
Erigeron purpuratus Greene
Eriophorum angustifolium Honck.
Eriophorum brachyantherum Trautv. & C.A. Mey.
Eriophorum russeolum Fries var. *albidum* Nyl. (= *E. chamissonis* C.A. Mey. var. *albidum* (Nyl.) Fern.)
Eriophorum vaginatum L.
Erysimum inconspicuum (S. Wats.) MacMill.
Eutrema edwardsii R. Br.
Festuca altaica Trin.
Festuca brachyphylla J.A. Schult. ex J.A. & J.H. Schult.
Festuca sp.
Fragaria virginiana Duchesne
Galium boreale L.
Galium trifidum L.
Gentiana algida Pall.
Gentianella propinqua (Richards.) J.M. Gillett ssp. *propinqua* (= *Gentiana propinqua* Richards. ssp. *arctophila* (Griseb.) Hulten)
Geocaulon lividum (Richards.) Fern.
Geum macrophyllum ssp. *perincisum* (Rydb.) Hult.
Geum rossii (R. Br.) Ser.
Gymnocarpium dryopteris (L.) ssp. *dryopteris*
Hedysarum alpinum L.
Helictotrichon hookeri (Scribn.) Henrard
Hierochlöe alpina (Sw.) R. & S. ssp. *alpina*
Hedysarum boreale Nutt. ssp. *mackenzii* (Richards.) Welsh
Hierochlöe sp.
Hippurus vulgaris L.
Hordeum jubatum L.
Juncus alpinoarticulatus Chaix in Vill ssp. *americanus* (Farwell) Hämet-Ahti
Juncus bufonius L.
Juncus castaneus Smith ssp. *castaneus*
Juniperus communis L.
Koenigia islandica L.
Ledum palustre L. ssp. *groenlandicum* Oeder Hult (= *Ledum groenlandicum* Oeder)
Ledum palustre L. ssp. *decumbens* (Ait.) Hulten (= *Ledum decumbens* (Ait.) Lodd.)
Lemna minor L.

Linnaea borealis L. ssp. *americana* (Forbes) Hulten var. *americana* (Forbes) Rehd.
Loiseluria procumbens (L.) Desv.
Lupinus arcticus S. Wats.
Luzula confusa Lindebl.
Luzula nivalis (Laest.) Beurl. (= *Luzula arctica* Blytt ssp. *arctica*)
Luzula parviflora (Ehrh.) Desv.
Lycopodium annotinum L.
Lycopodium selago L. (= *Huperzia selago* (L.) Bernh.
Menyanthes trifoliata L.
Mertensia paniculata (W. Ait.) G. Don
Minuartia arctica (Stev.) Aschers. & Graebn.
Minuartia dawsonensis (Britt.) House
Minuartia obtusiloba (Rydb.) House
Minuartia yukonensis Hultén
Mitella nuda L.
Moehringia lateriflora (L.) Fenzl
Moneses uniflora (L.) A. Gray
Orthelia secunda (L.) House s.l. (= *Pyrola secunda* L.)
Oxycoccus microcarpus Turcz.
Oxytropis campestris (L.) DC.
Papaver lapponicum (Tolm.) Nordh. (= Papaver cf macounii)
Parnassia kotzebuei Cham.
Parnassia palustris L.
Pedicularis capitata Adams
Pedicularis oederi Vahl ex Hornem.
Pedicularis sp.
Penstemon gormanii Greene
Pentaphylloides floribunda (Pursh) A. Löve (=*Potentilla fruticosa* L. ssp. *floribunda* (Pursh) Elkington
Petasites frigidus (L.) Fries
Petasites saggitatus (Banks ex Pursh) Gray
Phacelia mollis Macbr.
Picea glauca (Moench) Voss
Picea mariana (P. Mill.) B.S.P.
Platanthera hyperborea (L.) Lindl. (= *Platanthera aquilonis* Sheviak)
Poa alpina L.
Poa arctica R. Br.
Poa glauca Vahl
Poa sp.
Polemonium acutiflorum Willd. ex Roem. & Schult.
Polemonium pulcherrimum Hook.
Polemonium sp.
Polygonum alaskanum Wight ex Hulten
Polygonum bistorta L. ssp. *plumosum*
Polygonum viviparum L.
Populus balsamifera L.
Populus tremuloides Michx.
Potamogeton filifolius Pers. var. *borealis* (Raf.) St. John
Potentilla anserina L.
Potentilla nivea L.
Potentilla pensylvanica L.
Potentilla rubricaulis Lehmann
Potentilla uniflora Ledeb.
Pulsatilla patens L.
Pyrola asarifolia Michx.
Pyrola sp.
Ranunculus gmelinii DC.
Ranunculus hyperboreus Rottb.
Ranunculus lapponicus L.
Ranunculus sceleratus L. ssp. *multifidus* (Nutt.) Hulten
Rhododendron lapponicum (L.) Wahl.
Ribes hudsonianum Richards.
Ribes triste Pallas
Rorippa palustris (L.) Bess.
Rosa acicularis Lindl.
Rubus arcticus L.
Rubus chamaemorus L.
Rubus ideaus L. s.l. (= *R. strigosus* Michx.)
Rumex arcticus Trautv.
Salix alaxensis (Anderss.) Cov. ssp. *alaxensis*
Salix arbusculoides Anderss.
Salix arctica Pall.
Salix barclayi Andersson
Salix exigua Nutt.
Salix glauca L.
Salix myrtillifolia Anderss.
Salix planifolia Pursh
Salix pulchra Cham.
Salix reticulata L.
Salix scouleriana Barratt
Saussurea angustifolia (Willd.) DC. ssp. *angustifolia*
Saxifraga hieracifolia Waldst. & Kit.
Saxifraga hirculus L.
Saxifraga nelsoniana D. Don ssp. *pacifica* (Hultén)
Saxifraga reflexa Hook.
Saxifraga tricuspidata Rottb.
Scirpus caespitosus L. ssp. *austriacus* (Pallas) Asch. & Graeb. (=*Trichophorum caespitosum* (L.) Hartm.)
Scirpus hudsonianus (Michx). Fern. (= *Trichophorum alpinum* (L.) Pers.)
Selaginella sibirica (Milde) Hieron.
Senecio cymbalaria Pursh
Senecio lugens Rich.
Shepherdia canadensis (L.) Nutt.
Silene acaulis (L.) Jacq.
Silene involucrata (Cham. & Schlecht.) Bocquet ssp. *involucrata*
Silene repens Patrin ex Pers.
Silene williamsii Britton
Solidago simplex Kunth
Sparganium angustifolium Michx.
Spiranthes romanzoffiana Cham. & Schlecht.
Stellaria borealis Bigelow
Stellaria crassifolia Ehrh.
Taraxacum officinale Webber ex Wiggers
Tephroseris lindstroemii (Ostenfeld) Á Löve & D. Löve
Thalictrum sparsiflorum Turcz. ex Fisch. & Mey.
Tofieldia pusilla (Michx.) Pers.
Trifolium hybridum L.
Triglochin maritimum L.
Trimorpha acris (L.) Gray (= *Erigeron acris* L.)
Trisetum scabra (L.) Richt.
Vaccinium uliginosum L.
Vaccinium vitis-idaea L.
Valeriana capitata Pall.
Viburnum edule (Michx.) Raf.
Viola epipsela Ledeb. ssp. *repens* (Turcz.) Becker
Wilhelmsia physodes (Fisch.) McNeill
Woodsia alpina (Bolton) S.F. Gray
Zygadenus elegans Pursh

BRYOPHYTES

Aulacomnium palustre (Hedw.) Schwaegr.
Brachythecium sp.
Campyllium stellatum (Hedw.) C.E.O. Jensen
Ceratodon purpureus (Hedw.) Brid.
Dicranum sp.
Drepanocladus sp.
Hylocomium splendens (Hedw.) Schimp.
Marchantia polymorpha L.
Paludella squarrosa (Hedw.) Brid.
Pleurozium schreberi (Brid.) Mitt.
Pohlia sp.
Polytrichum commune Hedw.
Polytrichum juniperinum Hedw.
Polytrichum strictum
Ptilium crista-castrensis (Hedw.) De Not.
Racomitrium sp.
Rhizomnium sp.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.

Sphagnum fuscum (Schimp.) Klingrr.
Sphagnum warnstorfii Russ.
Tomenthypnum nitens (Hedw.) Loeske

ALGA
Chara sp.

LICHENS
Alectoria ochroleuca (Hoffm.) A. Massal.
Cetraria cucullata (Bellardi) Ach.
Cetraria delisei (Schaerer) Nyl.
Cetraria ericetorum Opiz
Cetraria islandica (L.) Ach.
Cetraria nivalis (L.) Ach.
Cladina mitis (Sandst.) Hustich
Cladina rangiferina (L.) Nyl.
Cladina stellaris (Opiz) Brodo
Cladonia spp.
Dactylina arctica (Richardson) Nyl.
Masonhalea richardsonii (Hook.) Kärnefelt
Nephroma arcticum (L.) Torss.
Peltigera aphthosa (L.) Willd.
Peltigera canina (L.) Willd.
Peltigera neopolydactyla (Gyelnik) Gyelnik
Peltigera sp.
Sphaerophorus sp.
Stereocaulon sp.
Thamnolia vermicularis (Sw.) Ach.
Vulpicida tilesii (Ach.) J.-E. Mattsson & Lai

ATTACHMENT D VEGETATION METALS ANALYSIS DATA FOR THE CASINO PROJECT IN 2013

Attachment Table 1. Horsetail, LSA Mine Site (units in mg/kg; all analyses done for total metals)

	13-CM-16-HORSETAIL	13-CM-17-HORSETAIL	13-CM-18-HORSETAIL	13-CM-19-HORSETAIL	13-CM-25-HORSETAIL	13-CM-26-HORSETAIL	13-CM-27-HORSETAIL	13-CM-47-HORSETAIL	13-CM-48-HORSETAIL	13-CM-63-HORSETAIL	13-CM-64-HORSETAIL	13-CM-68-HORSETAIL
Distance to footprint (m)	0.4	67.3	1,505.8	0.0	13.4	258.5	1039.6	206.9	2531.9	17.9	84.8	121.8
Aluminum	<10	18.9	10.9	11.7	69.4	7	13.9	74.3	6.9	11.3	158	579
Antimony	<0.0050	<0.0050	<0.0050	<0.0050	0.0089	0.0054	<0.0050	0.0098	<0.0050	0.006	0.0151	0.0666
Arsenic	<0.050	0.176	<0.050	<0.050	<0.050	<0.050	<0.050	0.099	<0.050	0.099	0.612	0.697
Barium	5.77	23.2	50.3	20.1	15.1	34.1	62.3	69.1	39.9	66.5	59.2	133
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	11.9	11.9	9.3	<2.0	9	17.5	12.5	6.9	23.4	28.6	20.3	19.1
Cadmium	0.575	3.57	0.886	16.6	0.636	0.951	1.55	4.32	2.22	8.33	1.11	4.24
Calcium	13300	15000	9930	11700	31600	8790	11500	12900	20100	21700	14100	16300
Chromium	<0.20	<0.20	<0.20	<0.20	0.28	<0.20	<0.20	0.24	<0.20	<0.20	0.58	1.14
Cobalt	0.057	0.687	0.177	0.325	0.167	0.145	0.432	0.42	0.28	0.078	0.263	0.676
Copper	5.75	11.9	9.93	17.9	5.91	12.2	14	28.3	11.3	14.3	13.1	16.9
Iron	68	97	49	92	171	72	81	181	95	101	352	919
Lead	0.029	0.078	0.023	0.092	0.088	0.045	0.486	0.079	0.064	0.048	0.108	2.94
Magnesium	3570	6160	2790	3960	5520	3560	4230	5140	4370	5930	4250	5600
Manganese	63.6	83.6	41.3	84.5	98.8	232	195	204	135	56.1	68.5	130
Mercury	0.015	0.017	0.017	0.015	0.014	0.013	0.016	0.016	0.02	0.017	0.011	0.016
Molybdenum	0.469	1.01	0.888	0.537	0.226	0.976	0.563	0.366	1.24	0.609	0.863	0.918
Nickel	0.168	0.15	1.01	4.12	0.269	0.45	0.428	1.74	0.222	0.65	0.514	0.785
Phosphorus	5250	5420	6070	9330	5320	5780	5070	7390	6710	6690	2760	4600
Potassium	48600	54800	33700	55000	51100	65100	50300	56000	64900	59800	41200	49500
Selenium	<0.050	<0.050	0.117	0.271	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	0.049	<0.020	<0.020	<0.020	0.047	<0.020	<0.020	<0.020	0.029
Sodium	193	69	42	282	184	139	64	160	103	118	37	106
Strontium	38.2	53	43.9	41.6	73.5	31.7	61.3	46.2	67.6	99.1	92.6	140
Thallium	<0.0020	0.0031	0.0046	0.0049	<0.0020	0.0079	<0.0020	0.0029	0.0033	0.0029	0.0047	0.0106
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.17

	13-CM-16-HORSETAIL	13-CM-17-HORSETAIL	13-CM-18-HORSETAIL	13-CM-19-HORSETAIL	13-CM-25-HORSETAIL	13-CM-26-HORSETAIL	13-CM-27-HORSETAIL	13-CM-47-HORSETAIL	13-CM-48-HORSETAIL	13-CM-63-HORSETAIL	13-CM-64-HORSETAIL	13-CM-68-HORSETAIL
Titanium	<1.0	1.2	<1.0	<1.0	4.4	<1.0	<1.0	5.6	<1.0	1	13.9	37.3
Uranium	0.0301	0.0299	0.0202	0.0083	0.0216	0.0064	0.0076	0.0172	0.003	0.0041	0.161	0.632
Vanadium	<0.20	<0.20	<0.20	<0.20	0.24	<0.20	<0.20	0.28	<0.20	<0.20	0.58	1.95
Zinc	52.4	90.9	31.9	100	74.1	97.7	115	129	94.9	92.5	59.4	58.1

Attachment Table 2. Horsetail, LSA Road Extension (units in mg/kg; all analyses done for total metals)

	13-RX-75-HORSETAIL	13-RX-76-HORSETAIL	13-RX-77-HORSETAIL	13-RX-78-HORSETAIL	13-RX-79-HORSETAIL	13-RX-80-HORSETAIL	13-RX-81-HORSETAIL	13-RX-82-HORSETAIL	13-RX-83-HORSETAIL	13-RX-84-HORSETAIL	13-RX-81B-HORSETAIL
Distance to Footprint (m)	24.5	168.5	29.4	93.5	25.7	117.8	29.3	115.0	26.3	116.1	29.3
Aluminum	11.4	20.5	28.9	6920	30	234	51.6	258	38.1	22.3	15
Antimony	0.0138	0.0025	0.011	0.43	0.0059	0.229	0.0067	0.0132	0.0378	0.0025	0.0025
Arsenic	0.059	0.061	0.082	17.1	0.124	0.799	0.092	0.298	0.1	0.025	0.025
Barium	56.1	65.7	44.9	150	38.8	32.8	28.1	27.1	32.7	49.2	26.5
Beryllium	0.05	0.05	0.05	0.45	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Bismuth	0.05	0.05	0.05	0.32	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Boron	15.5	18.2	16.8	6.6	15.3	14.7	12.2	15.6	20.1	14.6	13.1
Cadmium	8.9	1.15	4.99	0.991	2.97	13.2	3.39	7.5	2.07	3.6	4.5
Calcium	11900	9570	9770	7910	12300	11400	13400	8480	9500	10400	14700
Chromium	0.1	0.1	0.25	24	0.1	0.58	0.45	0.98	0.1	0.1	0.1
Cobalt	0.053	0.113	0.066	6.01	0.171	0.222	0.388	0.262	0.066	0.124	0.362
Copper	14.9	6.75	8.87	16.5	11.1	21.3	9.25	13.8	10.7	11	10.7
Iron	84	50	87	14100	109	461	148	493	79	86	81
Lead	0.05	0.052	0.103	16.1	0.137	1	0.083	0.292	0.048	0.058	0.046
Magnesium	4830	4470	3250	5620	2920	2990	6600	3560	3640	4800	6970
Manganese	47.8	29.4	56	432	121	80	82.8	72.3	33.3	39.7	111
Mercury	0.023	0.011	0.013	0.019	0.014	0.025	0.012	0.037	0.016	0.017	0.018
Molybdenum	0.447	0.499	0.421	1.52	0.387	0.474	0.233	0.298	0.581	0.388	0.277
Nickel	0.935	0.541	0.763	16.1	0.508	0.736	1	1.22	0.817	1.31	1.11
Phosphorus	3810	2460	3300	1410	3870	3720	4690	5380	5800	3710	4880
Potassium	47700	35700	36300	17700	41400	42100	38700	47900	34400	37600	40900
Selenium	0.025	0.025	0.025	0.168	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Silver	0.022	0.01	0.038	0.091	0.03	0.038	0.01	0.01	0.029	0.01	0.01
Sodium	74	14	49	114	76	124	160	215	99	70	142
Strontium	80.3	66.9	86.9	83.7	104	94.3	122	89.7	96.4	111	133
Thallium	0.001	0.001	0.0031	0.0826	0.0032	0.0056	0.001	0.004	0.003	0.0024	0.0054

	13-RX-75-HORSETAIL	13-RX-76-HORSETAIL	13-RX-77-HORSETAIL	13-RX-78-HORSETAIL	13-RX-79-HORSETAIL	13-RX-80-HORSETAIL	13-RX-81-HORSETAIL	13-RX-82-HORSETAIL	13-RX-83-HORSETAIL	13-RX-84-HORSETAIL	13-RX-81B-HORSETAIL
Tin	0.05	0.05	0.11	0.27	0.05	0.05	0.05	0.05	0.17	0.05	0.05
Titanium	0.5	0.5	1.3	374	2	14.1	2.5	13.5	0.5	0.5	0.5
Uranium	0.0068	0.0044	0.0175	6.51	0.0369	0.313	0.0217	0.0658	0.0053	0.0075	0.0035
Vanadium	0.1	0.1	0.1	27.2	0.1	0.9	0.1	1.18	0.1	0.1	0.1
Zinc	71.4	37.4	67.2	77.1	56.1	96	86.6	87.1	61.6	62.6	99.4

Attachment Table 3. Lichen, LSA Mine Site (units in mg/kg; all analyses done for total metals), part 1

	13-CM-01-LICHEN	13-CM-02-LICHEN	13-CM-03-LICHEN	13-CM-04-LICHEN	13-CM-06-LICHEN	13-CM-13-LICHEN	13-CM-14-LICHEN	13-CM-15-LICHEN	13-CM-16-LICHEN	13-CM-19-LICHEN	13-CM-20-LICHEN	13-CM-21-LICHEN	13-CM-22-LICHEN	13-CM-24-LICHEN	13-CM-25-LICHEN	13-CM-26-LICHEN	13-CM-27-LICHEN	13-CM-37-LICHEN
Distance to Footprint (m)	25.9	236.4	2306.1	21.2	2298.5	15.0	78.5	2220.4	0.4	0.0	206.9	2354.0	25.8	1904.0	13.4	258.5	1039.6	0.0
Aluminum	229	228	155	362	96	188	207	332	166	319	339	352	158	92.6	2620	187	176	126
Antimony	0.0176	0.0428	0.0146	0.0343	0.0082	0.015	0.0193	0.0307	0.0144	0.0244	0.0263	0.0258	0.0189	0.0075	0.0845	0.0175	0.0189	0.0125
Arsenic	0.192	0.237	0.135	0.349	0.096	0.184	0.21	0.316	0.148	0.28	0.287	0.286	0.166	0.107	0.888	0.21	0.181	0.111
Barium	11.3	7.82	8.32	14.3	7.79	8.04	18.5	18.5	8.39	13.9	36.3	28.4	14.4	7.82	31.2	11.4	11	13
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	18.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cadmium	0.091	0.035	0.031	0.031	0.034	0.031	0.063	0.082	0.029	0.116	0.089	0.184	0.163	0.048	0.08	0.03	0.053	0.131
Calcium	1170	920	887	1140	1350	1390	4150	1800	1640	1590	2600	2610	1250	1170	3070	1680	1390	1480
Chromium	0.53	0.63	0.38	0.87	0.36	0.4	0.51	0.82	0.35	1.36	0.85	0.68	0.48	1.18	34.6	0.47	0.7	0.26
Cobalt	0.178	0.203	0.157	0.305	0.103	0.191	0.148	0.321	0.13	0.368	0.288	0.269	0.166	0.136	2.01	0.181	0.143	0.109
Copper	1.6	1.42	1.08	1.96	0.945	1.3	1.27	2.24	1.09	2.4	2.35	4.08	1.26	1.2	3.53	1.58	1.23	1.2
Iron	391	427	260	679	164	332	353	646	268	741	574	519	257	157	3760	321	254	191
Lead	0.29	0.322	0.205	0.423	0.189	0.291	0.162	0.43	0.252	0.475	0.563	0.377	0.279	0.2	1.16	0.277	0.315	0.198
Magnesium	332	313	296	388	295	362	1880	673	301	497	525	594	552	398	1270	419	457	375
Manganese	185	120	172	193	32.9	234	10.1	206	49	229	122	137	224	174	176	268	158	121
Mercury	<0.010	<0.010	<0.010	<0.010	<0.010	0.028	0.015	0.02	0.019	0.036	0.018	0.028	0.02	0.018	0.032	0.018	<0.010	<0.010
Molybdenum	0.054	0.062	0.053	0.148	<0.050	0.054	<0.050	0.101	0.056	0.173	0.096	0.064	<0.050	<0.050	0.327	0.081	0.074	<0.050
Nickel	0.692	0.77	0.468	0.993	0.371	0.804	1.06	1.46	0.418	1.36	0.999	1.26	0.636	0.775	13.6	0.608	0.669	0.427
Phosphorus	429	384	336	439	373	402	329	370	313	566	566	469	563	495	493	431	399	492
Potassium	963	996	980	839	1330	1430	871	720	900	1370	1530	1450	1720	1650	1650	1410	1120	1260
Selenium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.055	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.021	<0.020	<0.020	0.025	<0.020	<0.020	<0.020
Sodium	16	20	12	17	20	13	38	15	13	18	35	23	12	10	54	24	19	<10
Strontium	3.03	2.89	2.36	3.03	4.56	3.6	32.4	6.6	5.6	2.95	9.88	13.3	3.7	3.1	9.42	3.78	5.62	4.72
Thallium	0.0043	0.0046	0.0057	0.0062	0.002	0.0037	0.0025	0.0047	0.0029	0.0068	0.0062	0.0046	0.0103	<0.0020	0.0265	0.0037	0.0027	<0.0020

	13-CM-01-LICHEN	13-CM-02-LICHEN	13-CM-03-LICHEN	13-CM-04-LICHEN	13-CM-06-LICHEN	13-CM-13-LICHEN	13-CM-14-LICHEN	13-CM-15-LICHEN	13-CM-16-LICHEN	13-CM-19-LICHEN	13-CM-20-LICHEN	13-CM-21-LICHEN	13-CM-22-LICHEN	13-CM-24-LICHEN	13-CM-25-LICHEN	13-CM-26-LICHEN	13-CM-27-LICHEN	13-CM-37-LICHEN
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.24	<0.10	<0.10	<0.10
Titanium	13.3	14.9	8.7	22.6	5.3	11.8	13.7	20.5	10.4	21.8	24.2	18.4	10.9	5	159	12.1	9.5	7.2
Uranium	0.0114	0.0165	0.008	0.0211	0.0062	0.0106	0.0152	0.02	0.0112	0.0651	0.0268	0.0499	0.0079	0.0053	0.396	0.01	0.0119	0.0087
Vanadium	0.73	0.73	0.43	1.17	0.24	0.49	0.69	1.04	0.5	1.33	1.21	0.92	0.47	0.27	8.78	0.61	0.53	0.35
Zinc	13.9	11	10.1	14.8	10.8	16.6	10.7	15.3	11.4	28.6	21.6	32.7	26	14.3	20.2	17.8	17.4	25.6

Attachment Table 4. Lichen, LSA Mine Site (units in mg/kg; all analyses done for total metals), part 2

	13-CM-38-LICHEN	13-CM-39-LICHEN	13-CM-40-LICHEN	13-CM-41-LICHEN	13-CM-42-LICHEN	13-CM-44-LICHEN	13-CM-45-LICHEN	13-CM-47-LICHEN	13-CM-52-LICHEN	13-CM-57-LICHEN	13-CM-58-LICHEN	13-CM-85-LICHEN	13-CM-86-LICHEN	13-CM-87-LICHEN	13-CM-88-LICHEN	13-CM-89-LICHEN	13-CM-90-LICHEN	13-CM-14B-LICHEN
Distance to Footprint (m)	211.1	2151.5	52.8	246.5	2339.2	209.1	1483.2	206.9	13.7	18.3	117.5	39.6	239.8	2411.0	25.3	242.2	1815.5	78.5
Aluminum	239	205	563	274	212	144	134	192	152	307	126	191	435	214	134	146	131	176
Antimony	0.022	0.0162	0.0567	0.0253	0.0169	0.015	0.0142	0.015	0.0128	0.0193	0.0123	0.0187	0.0483	0.0174	0.013	0.0118	0.0092	0.0182
Arsenic	0.19	0.164	0.53	0.333	0.182	0.131	0.143	0.183	0.176	0.223	0.11	0.187	0.505	0.216	0.134	0.16	0.162	0.16
Barium	22.2	17.3	79.3	18.4	18.9	16.3	10.4	12	29.2	66.9	21.8	27.8	30.3	72.7	13.7	37.4	11.5	13.1
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	<2.0	<2.0	5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cadmium	0.261	0.167	0.51	0.128	0.109	0.199	0.056	0.049	1.03	0.076	0.062	0.11	2.43	0.303	0.065	0.424	0.08	0.067
Calcium	2460	1810	6160	2360	2180	2340	1150	1760	2030	3200	1640	1800	3010	13300	1090	1850	1270	3010
Chromium	0.84	0.37	1.13	1.21 (1)	0.42	0.31	0.27	0.49	0.27	0.74	0.28	0.36	0.85	0.56	0.43	0.36	0.26	0.37
Cobalt	0.269	0.159	0.518	0.234	0.157	0.137	0.121	0.178	0.143	0.293	0.119	0.196	0.548	0.189	0.126	0.17	0.146	0.12
Copper	1.87	1.49	6.7	1.96	1.68	1.59	1.31	1.99	1.1	2.21	1.53	1.99	3.38	1.75	1.28	1.59	1.62	1.1
Iron	367	317	1010	478	347	235	210	325	219	487	209	318	840	346	225	254	214	303
Lead	0.385	0.292	1.09	0.534	0.38	0.224	0.196	0.248	0.223	0.285	0.168	0.25	0.684	0.498	0.176	0.193	0.258	0.153
Magnesium	711	507	1310	483	413	777	470	629	470	941	454	518	659	644	505	554	368	1340
Manganese	127	192	929	115	215	184	282	362	38.2	299	69.9	233	141	37.4	194	217	238	12.2
Mercury	<0.010	<0.010	0.044	0.017	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.028	0.022	<0.010	<0.010	<0.010	0.011
Molybdenum	0.07	0.13	0.234	0.124	0.083	<0.050	<0.050	0.056	<0.050	0.11	0.052	0.06	0.135	<0.050	0.071	0.062	0.06	<0.050
Nickel	0.889	0.597	1.88	0.950 (1)	0.626	0.52	0.379	0.602	0.416	0.887	0.409	0.542	1.2	0.706	0.531	0.637	0.517	0.869
Phosphorus	678	712	1020	616	386	783	386	562	494	695	630	608	617	613	467	631	438	290
Potassium	1480	1530	1670	1440	1120	1900	1350	1310	1370	1300	1450	1170	1290	2510	1140	1400	1510	754
Selenium	<0.050	<0.050	0.066	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.027	0.022	<0.020
Sodium	21	16	35	41	22	22	17	33	19	22	20	31	17	49	13	12	30	32
Strontium	10.2	6.99	21.7	6.87	7.15	7.62	2.7	4.61	9.4	9.84	6.63	6.38	11.8	34.1	2.97	5.7	3.06	21

	13-CM-38-LICHEN	13-CM-39-LICHEN	13-CM-40-LICHEN	13-CM-41-LICHEN	13-CM-42-LICHEN	13-CM-44-LICHEN	13-CM-45-LICHEN	13-CM-47-LICHEN	13-CM-52-LICHEN	13-CM-57-LICHEN	13-CM-58-LICHEN	13-CM-85-LICHEN	13-CM-86-LICHEN	13-CM-87-LICHEN	13-CM-88-LICHEN	13-CM-89-LICHEN	13-CM-90-LICHEN	13-CM-14B-LICHEN
Thallium	0.0041	0.0028	0.0082	0.0047	0.0032	0.0028	0.0027	0.0034	0.0026	0.0039	0.0022	0.0033	0.0045	0.003	<0.0020	0.003	0.0039	0.0027
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Titanium	12.5	10.6	31.3	17.5	12.5	8.7	8.5	12	8.2	21.7	8.2	10.4	35.5	11.8	7.8	8.8	7.3	10.1
Uranium	0.0148	0.0118	0.0363	0.0225	0.0117	0.0126	0.0108	0.0123	0.0129	0.0106	0.0061	0.0118	0.0552	0.0109	0.0064	0.0083	0.0134	0.0124
Vanadium	0.68	0.59	1.71	0.93	0.63	0.4	0.37	0.58	0.41	1.08	0.37	0.5	1.42	0.57	0.43	0.52	0.39	0.51
Zinc	32.5	16.2	71.4	27.6	19.1	37.4	14.2	19.8	25.7	13.8	13.4	38.2	96.9	30	15.9	19.1	14.3	8.89

Attachment Table 5. Lichen, LSA Road Extension (units in mg/kg; all analyses done for total metals)

	13-RX-71-LICHEN	13-RX-72-LICHEN	13-RX-83-LICHEN	13-RX-73-LICHEN	13-RX-74-LICHEN	13-RX-21B-LICHEN
Distance to Footprint (m)	19.2	112.7	26.3	24.5	108.6	2354.0
Aluminum	108	156	111	156	217	273
Antimony	0.0127	0.0127	0.008	0.0202	0.0212	0.0196
Arsenic	0.105	0.117	0.115	0.176	0.189	0.282
Barium	7.53	6.58	11.3	44.5	41.9	23
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	<2.0	<2.0	<2.0	6.6	3.4	<2.0
Cadmium	0.046	0.037	0.162	0.048	0.043	0.12
Calcium	712	760	1530	5660	3260	2850
Chromium	0.23	0.31	0.24	1.02	0.47	0.46
Cobalt	0.112	0.104	0.085	0.184	0.185	0.281
Copper	1.18	1.08	1.11	2.54	2.21	2.97
Iron	155	216	149	323	379	417
Lead	0.197	0.192	0.142	0.291	0.417	0.314
Magnesium	316	245	350	566	454	458
Manganese	221	190	30.9	309	99.4	130
Mercury	0.022	0.016	<0.010	0.062	0.047	0.029
Molybdenum	<0.050	0.058	<0.050	0.099	<0.050	0.066
Nickel	0.403	0.436	0.36	0.882	0.677	0.84
Phosphorus	404	292	464	543	370	395
Potassium	1550	782	1290	1550	945	1370
Selenium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Sodium	21	13	19	36	27	77
Strontium	2.2	2.14	14.8	25.5	17	9.67
Thallium	0.006	0.0033	0.0023	0.0041	0.0062	0.0038
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

	13-RX-71-LICHEN	13-RX-72-LICHEN	13-RX-83-LICHEN	13-RX-73-LICHEN	13-RX-74-LICHEN	13-RX-21B-LICHEN
Titanium	5.8	8.9	4.7	9.1	12.5	12.7
Uranium	0.0083	0.0075	0.0073	0.0105	0.0114	0.0476
Vanadium	0.26	0.37	0.24	0.51	0.74	0.66
Zinc	14.8	9.85	15.4	53.8	28.1	20.5

Attachment Table 6. Willow, LSA Mine Site (units in mg/kg; all analyses done for total metals), part 1

	13-CM-01-WILLOW	13-CM-02-WILLOW	13-CM-03-WILLOW	13-CM-04-WILLOW	13-CM-05-WILLOW	13-CM-06-WILLOW	13-CM-13-WILLOW	13-CM-14-WILLOW	13-CM-15-WILLOW	13-CM-16-WILLOW	13-CM-17-WILLOW	13-CM-18-WILLOW	13-CM-19-WILLOW	13-CM-20-WILLOW	13-CM-21-WILLOW	13-CM-22-WILLOW	13-CM-23-WILLOW	13-CM-24-WILLOW
Distance to Footprint (m)	25.9	236.4	2306.1	21.2	223.1	2298.5	15.0	78.5	2220.4	0.4	67.3	1505.8	0.0	206.9	2354.0	25.8	140.6	1904.0
Aluminum	30	14	13	13	<10	<10	10	<10	12	<10	6	7.7	9.5	22.7	39.4	16.5	11.4	22.4
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0105	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0065	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.050	<0.050	0.102	<0.050
Barium	13.3	16	10.2	11.1	10.3	26	24.9	9.09	15.1	7.2	7.38	17.2	44.4	110	27.4	100	729	37.4
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	16.5	11.7	10.6	12.9	13.5	13.8	5.7	14.1	10.6	10.4	22.2	22.5	6	26.6	12.1	6.6	9.7	9.2
Cadmium	2.68	1.29	1.53	0.494	1.51	0.657	2.13	2.49	0.594	0.15	0.335	1.78	3.23	3.87	4.12	12	23.6	0.798
Calcium	6430	7300	4640	7220	8060	12100	5820	7810	4530	16800	9570	10900	7760	14100	8190	5610	11400	6810
Chromium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cobalt	0.626	0.757	1.88	2.14	0.903	0.282	2.03	1.14	0.355	0.049	0.486	0.879	1.23	1.89	2.68	1.67	3.79	1.04
Copper	6.26	6.24	5.54	5.68	5.23	8.5	6.63	6.22	5.6	3.5	7.06	10.2	7.12	19.8	16.5	6	8.53	7.53
Iron	56	65	76	72	59	60	83	61	64	53	55	63	88	123	94	53	60	81
Lead	0.041	0.046	0.041	0.041	0.034	0.027	0.053	0.036	0.04	0.032	0.093	0.034	0.036	0.054	0.055	0.069	0.079	0.227
Magnesium	2770	3160	2330	3460	3340	3190	2600	4460	4750	3510	5240	4310	3870	6880	3280	2150	3690	2890
Manganese	1070	1230	869	1380	1060	110	808	461	311	48.7	129	203	493	340	1850	257	267	244
Mercury	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.037	<0.010
Molybdenum	0.073	0.143	0.245	1.63	0.127	0.184	0.073	0.128	0.133	0.232	0.232	0.528	0.207	0.154	0.06	0.052	0.194	0.127
Nickel	4.54	1.46	2.17	1.11	1.71	1.51	6	1.34	10.3	0.192	1.23	3.86	3.55	4.7	4.03	9.02	3.84	3.24
Phosphorus	3650	4020	3890	3830	2730	3460	3770	3210	4200	2380	3340	6870	4800	7570	8940	4890	6950	4490
Potassium	11700	11900	11100	13100	12300	16800	11800	14700	12000	13600	15200	19600	15800	29800	22600	17300	27600	16400
Selenium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.081	<0.050	<0.050	<0.050	0.055	0.085	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02	0.037	<0.020	<0.020	<0.020

	13-CM-01-WILLOW	13-CM-02-WILLOW	13-CM-03-WILLOW	13-CM-04-WILLOW	13-CM-05-WILLOW	13-CM-06-WILLOW	13-CM-13-WILLOW	13-CM-14-WILLOW	13-CM-15-WILLOW	13-CM-16-WILLOW	13-CM-17-WILLOW	13-CM-18-WILLOW	13-CM-19-WILLOW	13-CM-20-WILLOW	13-CM-21-WILLOW	13-CM-22-WILLOW	13-CM-23-WILLOW	13-CM-24-WILLOW
														0				
Sodium	28	13	16	62	118	55	21	22	20	18	24	<10	18	45	39	18	<10	32
Strontium	33.4	46	22.8	32.7	40.3	45.9	33.2	36.2	23.8	52.1	30.7	39.8	36.9	69	33.1	35.7	67.6	36.2
Thallium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0046	<0.0020	0.0031	<0.0020	0.009	<0.0020	0.0029
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Titanium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	1.4	1.4	<1.0	<1.0	1.8
Uranium	0.0033	0.0081	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0113	0.007	<0.0020	<0.0020	0.003	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	258	229	149	199	186	192	204	235	128	82.6	169	109	138	363	262	233	201	82

Attachment Table 7. Willow, LSA Mine Site (units in mg/kg; all analyses done for total metals), part 2

	13-CM-25-WILLOW	13-CM-26-WILLOW	13-CM-27-WILLOW	13-CM-37-WILLOW	13-CM-38-WILLOW	13-CM-39-WILLOW	13-CM-40-WILLOW	13-CM-41-WILLOW	13-CM-42-WILLOW	13-CM-43-WILLOW	13-CM-44-WILLOW	13-CM-45-WILLOW	13-CM-46-WILLOW	13-CM-47-WILLOW	13-CM-48-WILLOW	13-CM-52-WILLOW	13-CM-53-WILLOW	13-CM-54-WILLOW
Distance to Footprint (m)	13.4	258.5	1039.6	0.0	211.1	2151.5	52.8	246.5	2339.2	24.0	209.1	1483.2	2.1	206.9	2531.9	13.7	197.7	1430.6
Aluminum	6.1	8.2	10.4	12.2	15.9	24.6	12.5	15.9	29.4	65.9	10.1	25.5	9	11.4	8	9	5.7	9.9
Antimony	<0.0050	<0.0050	<0.0050	0.0067	0.0056	0.006	0.0061	0.006	0.0092	0.0071	0.0063	0.0057	0.0064	0.0068	<0.0050	<0.0050	<0.0050	<0.0050
Arsenic	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Barium	3.83	12.1	18.6	63.6	62.1	78.2	23	26	32.1	51.1	49.2	51.4	37.5	11	31.7	124	39.6	12.9
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	5.2	16.3	10.9	11.4	9.5	5.1	5.3	17.2	16.9	9.8	9.6	14	7.4	8.8	13.4	10.9	8.8	5.4
Cadmium	0.227	1.11	1.84	2.93	1.77	3.26	4.85	3.93	1.71	2.82	5.21	1.71	1.62	0.671	1.16	20.3	2.64	0.632
Calcium	12200	9840	8810	10100	10500	11200	6150	9570	7160	9340	11900	7560	9270	6800	7860	13300	8900	4990
Chromium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cobalt	0.141	0.208	0.378	0.494	1.13	1.65	0.167	0.291	0.394	1.36	0.651	0.29	0.382	0.454	0.347	1.02	0.908	1.07
Copper	6.42	5.19	5.07	7.58	10.7	8.93	8.03	8.88	9.22	7.76	8.64	10.7	8.14	10.8	6.02	8.65	7.87	4.45
Iron	67	70	61	66	68	69	60	86	94	134	64	83	60	81	56	57	60	52
Lead	0.036	0.045	0.168	0.081	0.111	0.068	0.047	0.078	0.067	0.066	0.038	0.072	0.032	0.075	0.115	0.052	0.092	0.107
Magnesium	3830	3140	3210	4140	4390	4510	2020	2980	3330	3050	4060	3910	3230	3010	2350	2920	3250	1980
Manganese	131	361	491	292	206	359	348	369	366	473	224	493	314	506	447	328	253	765
Mercury	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Molybdenum	0.136	0.168	0.128	0.08	0.101	0.138	0.096	0.139	0.167	0.087	0.097	<0.050	0.113	0.123	0.325	0.082	0.107	0.072
Nickel	0.739	0.709	0.743	1.26	4.28	7.05	0.927	1.06	2.7	3.32	1.66	2.34	2.52	1.4	0.525	1.27	1.78	0.391
Phosphorus	3860	3520	3030	5710	6330	6480	4700	4940	4290	6840	6320	4250	3860	3790	3480	5470	4010	2950
Potassium	18700	18000	12900	17800	14900	18500	13400	16000	14600	19200	21100	16800	18600	14000	13500	21200	16900	11400
Selenium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

	13-CM-25-WILLOW	13-CM-26-WILLOW	13-CM-27-WILLOW	13-CM-37-WILLOW	13-CM-38-WILLOW	13-CM-39-WILLOW	13-CM-40-WILLOW	13-CM-41-WILLOW	13-CM-42-WILLOW	13-CM-43-WILLOW	13-CM-44-WILLOW	13-CM-45-WILLOW	13-CM-46-WILLOW	13-CM-47-WILLOW	13-CM-48-WILLOW	13-CM-52-WILLOW	13-CM-53-WILLOW	13-CM-54-WILLOW
Silver	<0.020	<0.020	<0.020	0.03	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.022	0.024	0.022	<0.020	<0.020	<0.020	<0.020	<0.020
Sodium	<10	19	17	27	22	32	17	49	21	12	24	23	27	30	29	44	32	13
Strontium	31.8	31.1	43.9	52.9	52.7	84.2	30.5	33.8	45.2	51	51.2	40.8	39.5	23.7	30.1	67.2	33.4	21.9
Thallium	<0.0020	0.0081	<0.0020	<0.0020	0.0059	0.0051	<0.0020	<0.0020	0.0063	0.0021	0.0038	0.0023	0.0035	0.006	<0.0020	<0.0020	0.0028	<0.0020
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Titanium	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	1.7	4.1	<1.0	1.2	<1.0	1	<1.0	<1.0	<1.0	<1.0
Uranium	0.0066	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.002	0.0044	0.0055	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0027	<0.0020	<0.0020
Vanadium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	192	207	229	221	158	76.9	195	262	181	168	194	267	106	185	149	304	168	173

Attachment Table 8. Willow, LSA Mine Site (units in mg/kg; all analyses done for total metals), part 3

	13-CM-57-WILLOW	13-CM-58-WILLOW	13-CM-63-WILLOW	13-CM-64-WILLOW	13-CM-67-WILLOW	13-CM-68-WILLOW	13-CM-85-WILLOW	13-CM-86-WILLOW	13-CM-87-WILLOW	13-CM-88-WILLOW	13-CM-89-WILLOW	13-CM-90-WILLOW	13-CM-14B-WILLOW	13-CM-21B-WILLOW
Distance to Footprint (m)	18.3	117.5	17.9	84.8	22.3	121.8	39.6	239.8	2411.0	25.3	242.2	1815.5	78.5	2354.0
Aluminum	8.5	8.5	8.2	12.5	6.9	48	9.1	12.6	22.9	10.7	17.8	11.6	5.4	22.9
Antimony	<0.0050	<0.0050	<0.0050	0.0072	<0.0050	0.0101	<0.0050	<0.0050	<0.0050	<0.0050	0.0063	<0.0050	<0.0050	<0.0050
Arsenic	<0.050	<0.050	<0.050	0.053	<0.050	0.052	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Barium	115	205	49.4	15.2	11.9	23.2	45.1	37.3	51.1	110	239	15.8	8.84	23.9
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	5.7	28.1	20.9	19.8	6.6	12.3	11.6	14.7	22.6	11.8	20.1	9.4	12.5	8.6
Cadmium	0.67	1.66	2.62	1.27	1.16	2.2	1.51	7.04	2.4	1.54	8.56	1.08	1.65	3.05
Calcium	15400	18800	13500	10200	6990	9240	7930	7060	9940	10800	10700	6560	6020	5760
Chromium	<0.20	0.26	<0.20	<0.20	<0.20	0.21	<0.20	<0.20	<0.20	0.35	<0.20	<0.20	<0.20	<0.20
Cobalt	0.728	0.705	0.425	0.895	0.88	0.439	2.01	0.671	0.196	0.479	0.516	0.554	0.745	1.93
Copper	7.69	11	11.8	10.2	6.02	10.5	7.26	7.69	6.43	6.63	8.27	4.91	5.02	13.9
Iron	53	66	73	85	58	122	66	64	71	50	59	65	51	70
Lead	0.03	0.043	0.027	0.038	0.036	0.178	0.035	0.053	0.049	0.052	0.038	0.314	0.029	0.045
Magnesium	2740	3120	3560	4130	2320	3170	2260	2300	2970	3380	2120	2250	3580	2380
Manganese	73.7	93.5	130	132	526	267	399	356	122	163	283	583	458	1390
Mercury	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Molybdenum	0.071	0.312	0.39	0.398	0.549	0.418	0.06	0.126	<0.050	0.067	0.105	0.091	0.17	0.056
Nickel	3.71	3.3	2.55	2.39	4.46	1.67	1.63	1.16	1.39	5.54	2.03	1.9	1.79	3.6
Phosphorus	3830	5300	5850	4000	4080	3110	6010	4540	3440	4290	5130	3620	2670	6390
Potassium	20000	25800	24800	21900	16900	11400	12900	15100	15600	17400	16100	13200	11200	16900
Selenium	0.056	0.054	<0.050	<0.050	0.078	<0.050	<0.050	<0.050	<0.050	0.064	0.138	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.022	<0.020	0.021	<0.020	<0.020
Sodium	<10	<10	21	24	<10	21	17	30	29	12	26	15	17	26
Strontium	45	75.1	57	57.3	30.3	55.7	40.9	25.1	44.7	34.8	41.4	26.4	27.8	23.6
Thallium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0055	<0.0020	<0.0020	<0.0020	0.0027	0.0022	<0.0020	0.0022	0.0042
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.12	<0.10	<0.10	<0.10	<0.10

	13-CM-57-WILLOW	13-CM-58-WILLOW	13-CM-63-WILLOW	13-CM-64-WILLOW	13-CM-67-WILLOW	13-CM-68-WILLOW	13-CM-85-WILLOW	13-CM-86-WILLOW	13-CM-87-WILLOW	13-CM-88-WILLOW	13-CM-89-WILLOW	13-CM-90-WILLOW	13-CM-14B-WILLOW	13-CM-21B-WILLOW
Titanium	<1.0	<1.0	<1.0	<1.0	<1.0	3.1	<1.0	1.2	1.8	<1.0	<1.0	<1.0	<1.0	<1.0
Uranium	<0.0020	<0.0020	<0.0020	0.0061	<0.0020	0.0588	<0.0020	<0.0020	0.0027	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	54.6	79.9	126	118	41.5	264	93.8	205	231	93.8	235	102	173	243

Attachment Table 9. Willow, LSA Road Extension (units in mg/kg; all analyses done for total metals)

	13-RX-71-WILLOW	13-RX-72-WILLOW	13-RX-76-WILLOW	13-RX-77-WILLOW	13-RX-78-WILLOW	13-RX-79-WILLOW	13-RX-80-WILLOW	13-RX-81-WILLOW	13-RX-82-WILLOW	13-RX-83-WILLOW	13-RX-84-WILLOW	13-RX-73-WILLOW	13-RX-74-WILLOW	13-RX-81B-WILLOW
Distance to Footprint (m)	19.2	112.7	168.5	29.4	93.5	25.7	117.8	29.3	115.0	26.3	116.1	24.5	108.6	29.3
Aluminum	69.3	9.1	25.1	4.6	19.6	10.4	5.3	5.5	8.3	8	9.1	10.6	12.1	9.7
Antimony	0.006	<0.0050	0.0104	<0.0050	0.0058	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0074	<0.0050
Arsenic	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Barium	17.2	28.3	63.4	64.3	845	23.8	22.3	21.6	20.5	34.9	18	39.8	35.8	19.6
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	7	7.7	17.1	24.2	15.5	17	17.5	23.1	21.2	19.4	19.5	17.4	25.4	22.1
Cadmium	1.54	1.55	3.4	3.43	1.77	3.05	3.62	1.04	1.34	2.11	2.53	0.605	0.8	0.819
Calcium	4790	4560	10300	11800	10600	8700	9910	10900	9340	11400	8400	7790	8070	9980
Chromium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.25	<0.20	<0.20
Cobalt	0.6	0.219	0.131	0.07	0.146	0.143	0.077	0.203	0.195	0.31	0.499	0.109	0.131	0.2
Copper	4.52	4.87	9.63	10.1	7.19	9.21	7.37	9.53	9.38	7.91	9.01	3.82	4.6	8.48
Iron	113	52	65	55	80	62	55	70	66	68	92	51	55	80
Lead	0.064	0.042	0.037	0.03	0.055	0.053	0.026	0.041	0.044	0.031	0.039	0.033	0.141	0.087
Magnesium	2190	2270	2990	2750	3240	3150	2520	4740	3960	3190	3900	2350	2970	4060
Manganese	1280	764	17.4	32.3	62.3	151	114	90.4	99.2	56.2	203	167	79.2	81.4
Mercury	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Molybdenum	0.117	0.085	0.147	0.272	0.652	0.479	0.439	0.278	0.423	0.104	0.279	0.056	0.089	0.269
Nickel	1.52	1.75	2.39	1.07	2.25	1.51	0.855	1.76	2.17	1.78	5.75	1.07	1.68	1.49
Phosphorus	4000	3770	3030	4260	3270	3720	5270	4990	4810	5650	5110	2510	2610	4080
Potassium	12300	10500	16800	19000	17100	18800	20400	18600	19400	16300	19500	9340	14300	16000
Selenium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver	<0.020	<0.020	<0.020	<0.020	<0.020	0.021	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Sodium	26	22	20	25	50	21	17	33	36	28	24	29	26	42
Strontium	28.5	32	74.7	102	342	81.7	91.7	122	111	106	75.3	58.3	70.2	106
Thallium	0.0021	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0058	0.0036

	13-RX-71-WILLOW	13-RX-72-WILLOW	13-RX-76-WILLOW	13-RX-77-WILLOW	13-RX-78-WILLOW	13-RX-79-WILLOW	13-RX-80-WILLOW	13-RX-81-WILLOW	13-RX-82-WILLOW	13-RX-83-WILLOW	13-RX-84-WILLOW	13-RX-73-WILLOW	13-RX-74-WILLOW	13-RX-81B-WILLOW
Tin	<0.10	<0.10	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Titanium	2.7	<1.0	<1.0	<1.0	1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Uranium	0.0119	<0.0020	0.0069	<0.0020	0.0122	0.0102	<0.0020	0.002	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	175	163	179	161	172	302	235	215	214	122	130	191	203	189