Appendix 4.7-A Vegetation and Ecosystems Baseline Report

TELKWA COAL
LIMITED

Tenas Project

Ecosystems and Vegetation Baseline Report

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VERSION 2.2

Submitted to:	Telkwa Coal Limited
Submitted by:	Ardea Biological Consulting Ltd.

EXECUTIVE SUMMARY

The ecosystems and vegetation baseline program for the Tenas Project (the Project) covers the Vegetation Local Study Area (V-LSA), which includes the project components and a 250 m to 500 m buffer zone around project components. Project components are the minesite area between Goathorn and Tenas Creeks, the rail infrastructure area near the Bulkley River, and the access corridor connecting the minesite area to the rail infrastructure area. A Vegetation Regional Study Area (V-RSA) was delineated with a 5 km buffer around the project components and includes the V-LSA.

Field assessments, surveys and mapping were completed from 2017 to 2019 to characterize the ecosystems and vegetation that could be affected by the Project, following recognized standards by professional biologists and experienced technical staff.

Terrestrial and Wetland Ecosystems Mapping

Terrestrial Ecosystem Mapping (TEM), along with wetland mapping was completed within the V-LSA using established standards for the mapping (RIC 1998) and field assessments (BC MOF and BC MOE 2010), The mapping in the V-LSA was carried out at a scale of 1:5,000 within the minesite, Goathorn Creek and rail infrastructure areas, and at 1:10,000 scale along the access corridor area. Outside of the TEM area mapped by Ardea, existing 1:20,000 TEM (Oikos 1999) and 1:20,000 Predictive Ecosystem Mapping (PEM; Timberline 2010) was used for the V-RSA.

Field assessments were completed from 2017 to 2019, with a total of 648 plots completed within the V-LSA and available for use in the Survey Intensity Level (SIL) calculation for the TEM. The SIL for the mapping in the access corridor was set at SIL 2 (51-75% polygon inspections) while a SIL 1 (76+% polygon inspections) was set for the minesite and the rail infrastructure areas. The mapping met the SIL values for the access corridor and the rail infrastructure area, but only met SIL 2 (57%) in the minesite area.

A mapping accuracy assessment for the Tenas TEM followed methods outlined in Meiginger (2003) and found an overall overlap between the ecosystems within the mapping and plots completed of 85% ± 2% (80% Confidence Interval). Comparisons of % Dominant Ecosystem Correct, % Dominant Ecosystem Overlap and % Acceptable Ecosystem Overlap were 66% ± 3% (80% CI), 57% ± 3% (90% CI) and 72 ± 3% (90% CI) respectively.

A total of 97 ecosystems were identified and mapped within 35,726.0 ha of the V-RSA across six BGC subzones (BAFAun, ESSFmcw, ESSFmcp, ESSFmc, SBSms2 and SBSdk), and 70 ecosystems were identified and mapped within 3,330.9 ha of the V-LSA in three BGC subzones (ESSFmc, SBSmc2 and SBSdk).

The BAFAun and ESSFmcp and ESSFmcw subzones are only found within the V-RSA and these alpine tundra and subalpine open forest types make up 4% of the V-RSA. The alpine and sub-alpine habitats are primarily a mix of heathlands, herbaceous meadows, unvegetated areas and stunted forest krummholz. At lower elevations, the ESSFmc subzone contributes 13% to the total area of the V-RSA and supports coniferous forests and a mix of herbaceous, unvegetated and wetland habitats. At lower elevations, the SBSmc2 subzone comprises 31% of the V-RSA, with 97% of the SBSmc2 area supporting coniferous forests. The lowest elevation subzone is the SBSdk, which makes up 52% of the V-RSA, with 67% of the subzone supporting coniferous forests, and 22% of the subzone identified as anthropogenic (e.g. urban, agricultural, etc.).

Within the V-LSA, a very small portion (less than 1%) is made up of ESSFmc subzone coniferous forest ecosystems. The SBSmc2 subzone covers 56% of the V-LSA area, while the SBSdk subzone makes up 43%. Within the SBSmc2 subzone, 97% of the area is coniferous ecosystems, with 1.5% mapped as

deciduous ecosystems. There has been significant forest harvesting occurring within the SBSmc2, with 59% of the subzone mapped as early seral stage (less than 35 years old) regenerating forests. The SBSdk subzone area of the V-LSA was mapped as 53% coniferous forest ecosystems and 19% deciduous forest ecosystems. Young forests make up 53% of the subzone, suggesting significant historic disturbance from fire or forest harvesting approximately 40 to 80 years ago, while 14% is in young seral forest from clearing activities in the last 35 years. Approximately 16% of the subzone has been influenced by humans through agriculture, urban/rural development, roads, transmission lines and railways. Wetlands make up 5% of the subzone in the V-LSA, which is the largest percentage of any of the subzones in the V-LSA or V-RSA, likely due to the large (224 ha) Helps Creek wetland complex.

The following descriptions of five general map areas within the V-LSA are provided to further describe the terrestrial and wetland ecosystems found in the V-LSA as well as summarize the results of wetland function assessments conducted for a selection of wetlands in each general map area.

Minesite

The minesite area is 1,911.1 ha and almost all of it is located within the SBSmc2 subzone (1,873.8 ha; 98%) with only 10.5 ha (0.6%) in the ESSFmc and 26.9 ha (1.4%) mapped as the SBSdk subzone. Within the SBSmc2 subzone coniferous forests make up 97% of the mapped ecosystems, with the majority (58%) of the coniferous forests identified as mesic (i.e. 01 - Sxw[1] - Huckleberry) ecosystems. Several moist ecosystems (i.e. 06 Sxw - Oak fern [17.2%]; 09 Sxw - Devil's club [4.1%], and 10 Sxw - Horsetail [10.3%]) made up 31.6% of the forested SBSmc2 area in the minesite. The majority of the SBSmc2 forests (1,094.8 ha, 59%) have been harvested within the last 35 years, with many of the regenerating stands containing a component of trembling aspen which increases the diversity of the forest for wildlife and bird species. Wetland ecosystems were mapped in 156.8 ha of the SBSmc2, with the majority (138.2 ha, 88%) of the wetlands being Ws07 Spruce - Horsetail/10b Sxw - Horsetail - Leafy Mosses (Lacustrine/Morainal) swamp forest. Other wetland types included bog forests, with 9.2% (14.4 ha) of the SBSmc2 area in mapped as Wb05 Black spruce - Water sedge - Peat-moss)/12 SbSxw - Scrub birch - Sedge (11.6 ha, 7.4 %) and Wb01 Black spruce - Creeping snowberry - Peat-moss (2.8 ha, 1.8%).

Goathorn Creek

The Goathorn Creek area is 371.7 ha, with 4.9 ha (1.3%) mapped as SBSmc2 subzone and the remaining 366.8 ha (98.7%) as the SBSdk subzone. The majority (66%) of the SBSdk in the Goathorn Creek area is coniferous (27%) and deciduous (39%) forest ecosystems, with 19% associated with human use (e.g. agriculture [48%]and rural properties [43%]). Approximately 33.1 ha (14%) of the forested ecosystems were identified as floodplain types (Fm02 ActSxw - Red-osier dogwood/08 Act - Dogwood - Prickly rose), while 49.4 ha (20%) were mesic ecosystems (01 Sxw - Spirea - Purple peavine). Wetter ecosystems were mapped within 20% of the forested area of the SBSdk (e.g. 06 Sxw - Twinberry - Coltsfoot [13%], 07 Sxw - Horsetail [4%] and 00 Sxw - Devil’s Club [3%]). Almost 42% of the forested area within the SBSdk subzone in the Goathorn Creek area was identified as deciduous seral associations of trembling aspen (e.g. $At - Canada violet seral Association, $At - Lady fern seral association, $At - Pink wintergreen seral association or $At - Saskatoon - Snowberry seral association), primarily as young forests. A total of 2.3 ha was identified as wetland ecosystems, primarily forested bogs (1.3 ha) and shallow open water (0.7 ha), with small amounts of swamp (0.2 ha) and marsh (0.1 ha) wetland types.

[1] 1) Act = Black Cottonwood, At = Trembling Aspen, Bl = Subalpine Fir, Pa = Whitebark Pine, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce

Access Corridor

The access corridor connects the minesite to the rail infrastructure area and approximately 10 km long with the access corridor map area encompassing 553.6 ha, with all but 0.1 ha within the SBSdk subzone. Coniferous forests make up 61% (340.0 ha) of the SBSdk area, while 21% (116.8 ha) was mapped as deciduous forest ecosystems and 15% was mapped as ecosystems related to human use such as agriculture (cultivated fields [64%] and pasture [11%]) at the western portion of the corridor, a BC Hydro transmission line that is within the corridor for approximately 3.2 km and accounts for (23%) of the human related use area. The access corridor crosses several creeks including Helps Creek with a large amount of moist 06 Sxw - Twinberry - Coltsfoot ecosystem mapped in 52% of the coniferous forest area of the SBSdk. The mesic 01 Sxw - Spirea - Purple peavine ecosystem was mapped in 37% of the coniferous forest ecosystems within the corridor. Deciduous forest types were almost all seral trembling aspen associations including the $At - Canada violet seral association (54% of the deciduous forest area), $At - Pink wintergreen seral association (41%), $At - Hardhack seral association (3%) and the $At - Saskatoon - Snowberry seral association (1%). A total of 12.0 ha of wetland ecosystems were mapped within the corridor, with swamps accounting for 7.0 ha (58% of the wetland area) and marshes the remaining 5.0 ha (42%).

Helps Creek Wetland Complex

North of the access corridor is a large wetland complex that receives water from Helps Creek drainage to the south, as well as from a small lake/wetland complex to the north before draining through Helps Creek to the Bulkley River northwest of the rail infrastructure area. The Helps Creek wetland mapped area is 307.2 ha and is within the SBSdk subzone. The actual wetland complex area covers 224.0 ha (73%) of the general map area, containing primarily forested bog wetlands, with willow sedge fens, swamp forests and small open water areas. This wetland complex is surrounded by and has been influenced by pastures and cultivated lands to the east, as well historic forest harvesting to the south and west.

Rail Infrastructure

The rail infrastructure area is 187.2 ha and will contain the proposed rail loop, rail loadout and associated infrastructure for loading rail cars. It is adjacent to the Bulkley River, approximately 6 km upstream of the confluence with the Telkwa River and the Village of Telkwa. The area is within the SBSdk subzone and is primarily cultivated fields and pastures, with a mixture of early seral and young dry to mesic pine forests. The south-eastern portion of the rail infrastructure area is primarily young deciduous forest types growing on an upland bench above the floodplains. Some cottonwood floodplain ecosystems are found along the Bulkley River, as well as two small man-made wetlands and the rail line.

Wetland Function Assessments

Wetland function assessments were completed using a methodology developed from existing sources (e.g. US EPA 2002, Apelbeck and Farris 2006, Fenessey et al. 2007 and Fletcher et al. 2018) and included both office assessments and field data collection at wetlands in the V-LSA. Ratings based on hydrological, biochemical, habitat and climate wetland function data were developed and used to identify the wetlands assessed.

Four wetland sites had wetland function assessments completed within the minesite area, with another wetland function assessment completed on a wetland south-east of the minesite area. The four wetlands within the minesite area ranged from moderate to moderately-high rated wetlands, with a 4.68 ha forested bog/swamp rated moderately-high and a 4.77 ha forested bog, small (0.3 ha) open water and small (1.0 ha) swamp all rated moderate. The wetland outside of the minesite area was a 2.2 ha marsh/swamp complex that was rated high. In the Goathorn Creek area, two wetland sites were assessed for wetland function, one downstream of the proposed crossing of Goathorn Creek and one upland site near the proposed access corridor. A small (0.4 ha) marsh/swamp wetland along Goathorn Creek was rated high, while the upland wetland was a 0.2 ha marsh that was rated as moderately-high. Six small wetland/wetland

complex sites were reviewed during the wetland function assessments along the access corridor, ranging is size from 0.07 to 1.06 ha and rated from moderate to high value. Two marsh wetlands and one swamp wetland were rated as moderate, one bog/marsh complex and a marsh were rated as moderate and a marsh/swamp complex was rated as high. In the Helps Creek wetland complex, three wetland sites within the wetland complex were assessed for wetland functions and the forested bogs were rated as moderate to while a small wetland that contained a mixture of shallow water, fen and marsh ecosystems was rated high. No wetland function assessments were completed in the rail infrastructure areas as there were only man-made wetlands identified in the area.

Old Growth Forests and Timber Volumes

Old growth forests were identified within the V-RSA and V-LSA using the ecosystem mapping products to classify polygons within each of the biogeoclimatic subzones that were greater than 250 years old in the ESSFmc BGC subzone and greater than 140 years old in the SBSmc2 and SBSdk BGC subzones. A total of 491.4 ha of old growth forest was identified within the V-LSA and 5,352.6 ha was identified within the V-RSA. Within the V-LSA, the SBSmc2 subzone had 485.7 ha (99%) of the identified old growth forest, with 5.7 ha (1%) in the SBSdk. Almost all (99%) of the old growth forests within the V-LSA were identified within the minesite area in the SBSmc2 subzone. In the V-RSA, 274.4 ha (5% of V-RSA area) of old growth forest was mapped within the ESSFmcw and 962.1 ha (18% of the V-RSA area) was identified in ESSFmc subzone. The majority of the old growth forest (57%; 3,062.5 ha) was mapped in the SBSmc2 subzone and 1,053.5 ha (20%) in the SBSdk subzone. The old growth polygons were distributed mostly in the south-west portions of the ESSFmc and ESSFmcw subzones in the V-RSA and distributed in relatively large groups of polygons within the SBSmc2 and smaller scattered areas within the SBSdk along the Bulkley River and southwest of the rail infrastructure area. Very little old growth was identified on the east side of the Bulkley River.

Timber volumes for deciduous and coniferous species within the V-RSA and V-LSA were calculated using the VRI data and an estimated volume of 212,581 m^3 was calculated in the V-LSA and a volume of 2,630,585 m^3 was identified in the V-RSA. In the V-LSA, the ESSFmc contributed less than 2% to the total volume, while the SBSmc2 contributed 52% and the SBSdk was 46% of the total volume calculated. In the V-RSA, the ESSFmc timber volume was 20% of the total, while the SBSmc2 and SBSdk were 31% and 49% respectively. There are large differences between the amount of conifer and deciduous volumes in the V-LSA for the SBSmc2 and SBSdk subzones, with the SBSmc2 having 99% of the timber volume made up of conifer species, while in the SBSdk conifers contributed 45% and deciduous contributed 55% of the total volume.

Listed Plants, Lichens and Ecological Communities

Two listed plant species were identified as being within the V-RSA using existing BC CDC sources and the VRI mapping; American sweet-flag, a wetland species and whitebark pine, a sub-alpine tree species. American sweet-flag was identified at a location on Tyhee Lake and a second observations was made on Glacis Creek approximately 4 km south of the V-RSA. Whitebark pine was recorded by the BC CDC along Cabinet Creek within the southern portion of the V-RSA, while VRI mapping identified 24 polygons with whitebark pine percentages ranging from 5 to 60% within ESSFmc subzone in the southern portions of the V-RSA and on an ESSFmc ridge overlooking the upper Goathorn Creek. No listed plants or lichen species were observed during the vegetation or ecological baseline studies within the V-LSA.

The BC CDC lists nine ecological communities that could potentially be found within the BGC subzones in the V-RSA and V-LSA. Most are wetland ecosystems that are listed as blue, while a middle bench floodplain and two grassland ecological communities are red listed by the BC CDC. Of the listed communities that could potentially occur, all were identified within the ecosystem mapping and field assessments to be within the V-RSA and the V-LSA.

A total of 1,817.3 ha of listed ecological communities were mapped within the V-RSA, with 75% (1,367.9 ha) of the V-RSA listed ecological community being blue listed, while 25% (449.4 ha) were red listed. The Spruce - Common horsetail - Leafy mosses / Sxw - Horsetail (Lacustrine/morainal) / Sxw - Horsetail (Poorly drained) forested swamp wetland types made up 69% (1,250.3 ha) of the listed ecological community area in the V-RSA. This large area is a conservative estimate, as there was not way to distinguish the listed lacustrine/morainal and poorly drained sub-types from the more common Sxw - Horsetail ecosystem within Oikos TEM or Bulkley PEM portions of the V-RSA mapping. Other listed communities made up smaller proportions of the V-RSA, including the Act - Dogwood - Prickly rose/Black cottonwood - Hybrid white spruce - Red-osier dogwood floodplain community which was mapped in 403.2 ha (22% of the listed ecological community area). The other red listed communities were the Saskatoon - Slender wheatgrass and Bluegrass - Slender wheatgrass grassland communities that were mapped in 35.5 ha and 10.7 ha respectively within the ESSFmc, SBSmc2 and SBSdk subzones in the V-RSA.

In the V-LSA, a total of 248.1 ha of blue and red listed communities were mapped, with the Spruce - Horsetail forested swamp communities combining for a total of 192.8 ha (78% of the listed ecological community area). This blue listed ecological community was quite common in the minesite area, with 138.2 ha (56% of total listed community area) mapped. The next most extensive listed ecological community was the red-listed Act - Dogwood - Prickly rose / Black cottonwood - Hybrid white spruce - Red-osier dogwood floodplain ecosystems, which were mapped in 37.6 ha and accounted for over 99% of the red listed communities and 15% of all listed ecological communities in the V-LSA. This community was found mostly along Goathorn Creek (33.1 ha), with 4.5 ha mapped along the Bulkley River in the rail infrastructure area.

Invasive Plants

Invasive plant species were identified within the V-LSA and V-RSA using existing information sources as well as field surveys. Twenty-one species were identified in the V-LSA and within one kilometer of the V-LSA in the V-RSA using the invasive alien plant database, while field surveys found ten of those same species and an additional four species, for a total of twenty-five invasive species occurring within one kilometer of the V-LSA. Invasive plants were observed throughout the V-LSA, with species such as Canada thistle and Oxeye daisy identified within all of the general map areas. Two invasive plant species were of interest, St. John's-wort and Tartarian honeysuckle were both observed in the Goathorn Creek area. St. John's-wort is listed as an Early Detection Rapid Response species for the Bulkley Invasive Plant Management area, while Tartarian honeysuckle has not been detected within this region previously.

Plants Important for Cultural Use

Twelve plant species were identified as plants important for cultural use so that ecosystem polygons that potentially contain the species could be mapped within the V-RSA and V-LSA using the ecosystem mapping and assumptions on the ecosystems and structural stages where they might be found. Plant species were selected based on their use for food, medicinal or other cultural uses and included: black huckleberry, buckbean, cow parsnip, devil's club, fireweed, highbush cranberry, Indian hellebore, kinnickinnick, oval-leaved blueberry, red raspberry, soopolallie and willow species. Determining the area of ecosystems with the potential to support plants important for cultural use was based on the proportion of a polygon that may contain an ecosystem / structural stage combination that had a high likelihood of containing the plant species.

Within the V-RSA a total of 64,025 ha was identified as potentially containing plants that were culturally important, with the areas of individual plant species ranging from 354 ha for Indian hellebore to 11,474 ha for soopolallie. Other species that had large areas where they might be found included black huckleberry (10,535 ha), highbush cranberry (8,763 ha), red raspberry (8,284 ha) and fireweed (8,180 ha). Species such as Indian hellebore and buckbean had very limited ranges due to the limited number of ecosystems that were rated as having a high likelihood of containing the plant.

The V-LSA had at total of 5,329 ha of ecosystems with the potential to support plants of cultural importance. All of the species identified as culturally important were identified as potentially being found within the V-LSA, except Indian hellebore, which was expected to be more common at higher elevations. Ecosystems potentially supporting the individual plant species varied from a low of 5.1 ha for oval-leaved blueberry to a high of 984 ha for highbush cranberry in the V-LSA. The proportion of ecosystems supporting the culturally important species followed similar patterns to what was observed within the V-RSA, except for species found primarily in higher elevation BGC subzones (e.g. ESSFmc) such as hellebore, kinnickinnick and oval-leaved huckleberry.

Vegetation Trace Metals

Twenty-three plant species were identified as important food for humans or wildlife were sampled within the V-LSA, with both leaves/stems and berries sampled and analyzed for a range of trace metals. Plants sampled included: Alaska willow, beaked sedge, black cottonwood, black gooseberry, black huckleberry, black twinberry, bluejoint reedgrass, common horsetail, cow parsnip, devil’s club, fireweed. grey-leaved willow, highbush cranberry, prickly rose, red elderberry, red osier dogwood, red raspberry, Scouler's willow, Sitka alder, soopolallie, subalpine fir, tea-leaved willow and western mountain-ash.

A total of 150 samples were analyzed, with replicate samples obtained for as many plants and tissues as possible, as well as replicates within the general project areas (minesite, Goathorn Creek, access corridor and rail loadout. At several sample sites multiple plants along with soils were collected to allow for comparison across species. Data were summarized and presented for eight trace metals of environmental interest; arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.

In general, trace metals such as arsenic, lead and mercury were relatively low with many sample concentrations for most plant species below the method detection limit. Cadmium levels were usually also low, except for species such as Scouler’s willow, while chromium, copper, nickel, and zinc showed differences in concentrations across many plant species and sample sites within the V-LSA.

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- Jennifer Muir (EDI) - Technical Review
- Cathy MacKay (EDI) - Advisor and Senior Review

PROFESSIONAL CERTIFICATIONS

The undersigned certify that they are responsible for the work completed and reported on in this document, and that they were working within their area of expertise and within the Regulations and Policies of the College of Applied Biology.

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Tenas Project

Ecosystems and Vegetation Baseline Report

TABLE OF CONTENTS

Executive Summary i

Acknowledgements vii

Professional Certifications viii

Table of Contents ix

List of Tables xi

List of Figures xiii

List of Appendices xiv

Glossary and Abbreviations xv

1. Introduction 1

1.1 Project Components and Study Areas 1

1.2 Ecological Overview 2

2. Methodologies 5

2.1 Existing Information Review 5

2.1.1 Conservation Context 5

2.2 Baseline Program 6

2.3 Terrestrial Ecosystem Mapping 7

2.4 Mapping Data Acquisition and Preparation 9

2.5 Wetland Function Assessment 13

2.6 Old Growth Forest Assessment 19

2.7 Timber Volume Assessment 19

2.8 Listed Plants and Lichens Surveys and Listed Ecological Communities Assessments 19

2.9 Invasive Plants Surveys 20

2.10 Plant Species Important for Cultural Use 21

2.11 Vegetation Trace Metals Sampling and Analysis 23

3. Data Summary 28

3.1 Existing Information Review 28

3.1.1 Regulatory and Policy Context 28

3.1.2 Indigenous Knowledge 32

3.2 Terrestrial Ecosystem Mapping 33

3.2.1 Existing Information 33

3.2.2 Terrestrial Ecosystem Mapping Extents 34
3.2.3 Mapping Survey Intensity Levels and Accuracy Assessment 35
3.2.4 Terrestrial Ecosystems and Wetlands 38
3.3 Wetland Function 50
3.3.1 Comparison of Wetlands Classified under TEM and Wetland Function Assessment 50
3.3.2 Wetland Function Field Assessments 50
3.4 Old Growth Forest Assessment 54
3.5 Timber Volume Assessment 57
3.6 Listed Plants, Lichens and Ecological Communities 60
3.7 Invasive Plants 64
3.8 Plant Species Important for Cultural Use 68
3.9 Vegetation Trace Metals 72
4. References 82

LIST OF TABLES

Table 2.1-1: Data sources used to identify available information for Project. 5

Table 2.1-2: Conservation status definitions for provincial and federal species at risk. 6

Table 2.4-1: Datasets used in the development of updated forestry and anthropogenic features mapping. 10

Table 2.4-2: Structural stage age class breaks in years for zonal ecosystems in each forested BEC subzone. 11

Table 2.5-1: Summary of wetland categories and functions to be considered during environmental assessments (from Hanson et al. 2008) and types of data collected for wetland function assessment. 14

Table 2.5-2: Field data forms applied to wetland function assessments. 15

Table 2.5-3: Summary of wetland class functions and ratings. 16

Table 2.5-4: Wetland function ratings and scores 19

Table 2.10-1: Plant species selected as important cultural and wildlife use to be used for trace metals sampling and culturally important plants mapping. 21

Table 2.10-2: Structural stages identified for mapping culturally important plants. 22

Table 2.11-1: Plant species selected for trace metals sampling. 23

Table 2.11-2: Summary of plant species and tissues analyzed from the 2017 to 2019 vegetation trace metals sampling program. 25

Table 2.11-3: Trace metals and their method detection limits (MDL). 26

Table 3.1-1: Applicable legislation and regulations related to ecosystems and vegetation. 28

Table 3.1-2: Summary of strategies, guidelines, plans and best management practices applicable to ecoystems and vegetation. 30

Table 3.1-3: Summary of previous environmental assessment reports for the Tenas Coal Project area. 32

Table 3.2-1: Summary of the biogeoclimatic subzone areas from the ecosystem mapping products used in the V-LSA and V-RSA. 34

Table 3.2-2: Ecosystem plot distribution within the Project area by year. 35

Table 3.2-3: Summary of survey intensity for the Tenas TEM within the V-LSA. 35

Table 3.2-4: Summary of results of quality assurance assessments using methods outlined in Meidinger (2003) for the Tenas TEM within the V-LSA. 38

Table 3.2-5: Summary of mapped vegetated ecosystems by BGC subzone within the V-LSA and the V-RSA. 39

Table 3.2-6: Summary of wetland ecosystems mapped in the Tenas TEM and V-LSA. 46

Table 3.3-1: Wetland function assessment scores by wetland ID. 51

Table 3.3-2: Wetland function site class summary 53

Table 3.4-1: Summary ecosystems from TEM and PEM data classified as old growth within BGC subzones in the V-LSA and V-RSA. 54

Table 3.5-1: Summary of potential timber volume available wtihn the V-LSA and V-RSA. 57

Table 3.6-1: Conservation status of plant and lichen species that potentially occur in the V-RSA. 60

Table 3.6-2: Conservation status of listed ecologicaly communities that potentially occur in the V-RSA. 62

Table 3.6-3: Summary of listed ecological communities identified within the V-LSA and V-RSA. 63

Table 3.7-1: List of invasive plant species identified in the Invasive Alien Plant Species Database (BC FLNRORD 2018) within the V-LSA and V-RSA. 64

Table 3.7-2: List of invasive plant species found in the V-LSA. 66

Table 3.9-1: Summary of leaf/stem tissues sampled. 72

Table 3.9-2: Summary of berry tissues sampled. 75

LIST OF FIGURES

Figure 1.2-1: Project components and study area boundaries. 3

Figure 2.4-1: Distribution of ecosystem mapping products used within the V-LSA and V-RSA. 12

Figure 2.11-1: Location of vegetation trace metal sampling sites. 27

Figure 3.2-1: Distribution of ecosystem plots within the V-LSA and V-RSA. 36

Figure 3.2-2: Distribution of general ecosystem types within the V-LSA and V-RSA. 44

Figure 3.2-3: Structural stage distributions mapped within the V-LSA. 45

Figure 3.2-4: Structural stage distributions mapped within the V-RSA. 45

Figure 3.2-5: Proportions of wetland ecosystems mapped within the V-LSA and V-RSA. 48

Figure 3.2-6: Location and proportions of polygons containing wetland ecosystems within the V-LSA and V-RSA. 49

Figure 3.2-7: Wetland ecosystems mapped within the general areas of the V-LSA. 50

Figure 3.3-1: Locations and wetland function ratings for wetlands assessed within the V-LSA. 52

Figure 3.4-1: Distribution of old growth forests within the V-LSA and V-RSA from TEM and PEM. 56

Figure 3.5-1: Distribution of potential deciduous timber volume within the V-LSA and V-RSA. 58

Figure 3.5-2: Distribution of potential conifer timber volume for the V-LSA and V-RSA. 59

Figure 3.6-1: Locations of listed plants identified from existing information within and adjacent to the V-RSA. 61

Figure 3.6-2: Location of listed ecological communities within the V-LSA and V-RSA. 65

Figure 3.7-1: Survey effort and locations of invasive plant species observed within the V-LSA. 67

Figure 3.8-1: Potential available area of plants important for cultural use within the V-LSA. 68

Figure 3.8-2: Potential available area of plants important for cultural use within the V-RSA. 68

Figure 3.8-3: Potential distribution of fireweed, cow parsnip, kinnickinnick and buckbean in the V-LSA and V-RSA. 69

Figure 3.8-4: Potential distribution of Devil's club, raspberry, black huckleberry and oval-leaved blueberry in the V-LSA and V-RSA. 70

Figure 3.8-5: Potential distribution of high bush cranberry, Indian hellebore, willows and soopolallie in the V-LSA and V-RSA. 71

Figure 3.9-1: Box-plot of trace metals of environmental interest for black twinberry samples (n=15) within the V-LSA. 73

Figure 3.9-2: Box-plot of trace metals of environmental interest for common horsetail samples (n=15) within the V-LSA. 73

Figure 3.9-3: Box-plot of trace metals of environmental interest for fireweed samples (n=19) within the V-LSA. 74

Figure 3.9-4: Box-plot of trace metals of environmental interest for Scouler's willow samples (n=12) within the V-LSA. 74

Figure 3.9-5: Box-plot of trace metals of environmental interest for subalpline fir samples (n=10) within the V-LSA. 75

Figure 3.9-6: Comparison of trace metals of environmental interest for black gooseberry, black huckleberry, black twinberry, devil's club and red raspberry berry samples from listed sample plots. 76

Figure 3.9-7: Comparison of trace metals of environmental interest for red elderberry and soopolallie berry samples from listed sample plots. 76

Figure 3.9-8: Box-plot of trace metals of environmental interest for highbush cranberry berry samples (n=11) within the V-LSA. 77

Figure 3.9-9: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg05 in the Goathorn Creek area. 78

Figure 3.9-10: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg06 in the Goathorn Creek area. 78

Figure 3.9-11: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg09 in the minesite area. 79

Figure 3.9-12: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg19 in the minesite area. 79

Figure 3.9-13: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg21 in the access corridor area. 80

Figure 3.9-14: Box-plots comparing trace metals of environmental interest for selected plant species within project sub-areas. 81

LIST OF APPENDICES

Appendix A Ecosystem Mapping Accuracy Assessment

Appendix B Ecosystem Descriptions

Appendix C 1:10,000 Terrestrial Ecosystem Map

Appendix D Wetland Function Assessment Data

Appendix E Invasive Plant Plot Data and Plant Descriptions

Appendix F Plants Important for Cultural Use

Appendix G Vegetation Trace Metals Results

GLOSSARY AND ABBREVIATIONS

ABBREVIATION	LONG FORM OF ABBREVIATION
BAFAun	Boreal Altai Fescue Alpine Undifferntiated
BC	British Columbia
BC CDC	British Columbia Conservation Data Centre
BEC	Biogeoclimatic Ecosystem Classification
BGC	Biogeoclimatic
BUB	Bulkley Basin
BUR	Bulkley Ranges
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
ESSFmc	Engelmann Spruce - Subalpine Fir Moist Cold
ESSFmcp	Engelmann Spruce - Subalpine Fir Moist Cold Parkland
ESSFmcw	Engelmann Spruce - Subalpine Fir Moist Cold Woodland
FRPA	*Forest and Range Practices Act*
LSA	Local Study Area
MDL	Method Detection Limit
MAP	Mean Annual Precipitation
MAT	Mean Annual Temperature
PEM	Predictive Ecosystem Mapping
RSA	Regional Study Area
SARA	*Species at Risk Act*
SBS	Sub-Boreal Spruce
SBSdk	Sub-Boreal Spruce Dry Cool
SBSmc2	Sub-Boreal Spruce Babine Moist Cold
TEM	Terrestrial Ecosystem Mapping
VRI	Vegetation Resources Inventory

1. INTRODUCTION

Telkwa Coal Limited (TCL) is proposing to develop the Tenas Project (the Project), a surface coal mine designed to produce approximately 15 million tonnes of washed metallurgical coal product, at about 0.750 million saleable tonnes per year, to be used in the manufacture of steel. The Project requires a Certificate under the *BC Environmental Assessment Act* and major mines permitting under the *Mines Act* and *Environmental Management Act*, and subsequent permitting. These requirements trigger the need for baseline studies followed by assessment of potential effects of the Project on various Valued Components.

The proposed Project is located in northwestern BC, approximately 25 kilometres (km) south of Smithers and 7 km southwest of the village of Telkwa. The Project is on provincial Crown Land, on three freehold land parcels owned by TCL and nine coal licences held by TCL. The Project falls within Wet'suwet'en traditional territories: the mine site is located in Cas'Yex House territory, while the rail loop and loadout are located in Kwen Bea Yex House territory (Budhwa et al. 2020).

The Project will be a conventional shovel and truck operation like other rock quarry and surface mine operations in the region. Coal will be extracted using heavy machinery and sent to an on-site coal processing plant. Following processing, the coal will be trucked to a rail loadout facility and associated rail loop connecting to the existing main Canadian National Railway line. In addition to the mine pit, coal processing plant and rail infrastructure, the Project will include the following major components: a materials handling system, various rock and soil storage piles, water management features, mine access and haul roads, a powerline, propane storage, explosives storage, administrative and warehouse buildings, and various other supporting infrastructure. An originally proposed water discharge pipeline to the Telkwa River is no longer part of the Project. The Project life will be approximately 25 years including the construction, operation, decommissioning and reclamation phases.

The objective of the ecosystems and vegetation baseline program was to characterize the plants and ecological communities in the vicinity of the Project to support a subsequent assessment of potential Project effects on ecosystems and vegetation and to identify any potential constraints on the Project related to ecosystems and vegetation.

This *Ecosystems and Vegetation Baseline Report* summarizes the current knowledge and baseline conditions for ecosystems and vegetation species associated with the proposed Project based on a review of existing information and the results of Project-specific surveys, mapping and analysis. The various components and methods used in the baseline program are outlined in Section 2, the results are provided in Section 3 and summarized in Section 4.

1.1 Project Components and Study Areas

The **Project Area** is 1,095 ha and encompasses the area that would potentially be directly disturbed by Project activities. To facilitate data analyses and discussions in this baseline report, Project components within the Project area were divided into three general map areas: the minesite area, where coal mining and processing will occur; the rail infrastructure area, where the coal will be loaded onto rail cars; and the access corridor, which connects the minesite and rail infrastructure areas (Figure 1.2-1).

The **Vegetation Local Study Area** (V-LSA) is 3,462 ha and encompasses a 500 m buffer on the mine infrastructure, Goathorn Creek and rail infrastructure areas, and a 250 m buffer on the access corridor (Figure 1.2-1). It also includes the large Helps Creek wetland complex that is north and downgradient of the access corridor near the rail infrastructure area. The V-LSA represents the area within which potential Project effects are expected to occur on ecosystems and vegetation species and is the area within which

most fine-scale baseline data were collected for analyses. Much of the V-LSA has been disturbed by historic forest harvesting activity, with agricultural activity and rural residences in lower elevation areas.

The **Vegetation Regional Study Area** (V-RSA) is 35,726 ha and encompasses a minimum 5 km buffer around the Project Area (Figure 1.2-1). The V-RSA includes the Village of Telkwa and part of Tyhee Lake to the north; Round Lake to the east; the lower slopes of Hunter Basin to the south, and the lowest reaches of Pine Creek to the west. It overlaps portions of both the Telkwa and Bulkley rivers, as well as Tenas and Goathorn creeks. The V-RSA has a notable existing anthropogenic footprint including the Village of Telkwa and overlap with the Highway 16 corridor. Agricultural development and rural residences are common in the lower elevations of the V-RSA, while higher elevation areas show a history of forest harvest activities.

1.2 Ecological Overview

The Project is located within the Bulkley Basin (BUB) and Bulkley Ranges (BUR) ecosections of northwestern BC. The BUB ecosection occurs at lower elevations and spans a broad lowland area in the rainshadow of the Kitimat and Nass ranges of the Coast Mountains (Demarchi 2011). This ecosection contains many lakes (Demarchi 2011), including Tyhee Lake, Round Lake, Seymour Lake, and Coffin Lake within the Project V-RSA. Major drainages in the BUB ecosection that intersect the Project Area include the Bulkley and Telkwa rivers and Goathorn and Tenas creeks. The BUR ecosection occurs at higher elevations and spans a narrow, rounded range of mountains on the leeward side of the Kitimat Ranges (Demarchi 2011); mountains/mountain ranges that overlap the V-RSA include parts of the Telkwa Mountain Range and Hudson's Bay Mountain. Many small lakes occur across this upland area and the ecosection is drained by numerous small streams that flow into larger streams and rivers such as the Telkwa and Morice rivers (Demarchi 2011).

The Biogeoclimatic Ecosystem Classification (BEC) system is used in British Columbia to classify ecosystems (Pojar et al. 1987, MacKenzie and Meidinger 2017). The BEC system uses a hierarchical system to classify the land into ecosystems using the dominant vegetation, climate and site conditions (MacKenzie and Meidinger 2017). The BEC system allows the classification of vegetation at different levels from the regional to the site specific.

Most of the Project overlaps the Sub-Boreal Spruce (SBS) biogeoclimatic (BGC) zone, made up of the SBS Dry Cool (SBSdk) and the SBS Moist Cold (SBSmc2) BGC subzones. A small portion of the Project overlaps the Engelmann Spruce - Subalpine Fir Moist Cold (ESSFmc) BGC subzone. These same BGC subzones are found throughout the V-LSA and V-RSA, along with several additional BGC subzones including the Engelmann Spruce - Subalpine Fir Moist Cold Parkland (ESSFmcp) and the Boreal Altai Fescue Alpine Undifferentiated (BAFAun). The SBSdk occurs at lower elevations and transitions into the SBSmc2, which transitions into the ESSFmc as elevation increases (Banner et al. 1993). Elevation ranges from 700 to 1,050 m in the SBSdk, from 850 to 1,350 m in the SBSmc2, and from 950 to 1,500 m in the ESSFmc (Banner et al. 1993).

Fires have historically been the main stand replacing event within the lower elevations of the V-RSA, with historic fires in the SBSdk and SBSmc2 subzones commonly burning most stands every 100 years and few stands older than 300 years (Banner et al. 1993, Steventon 2001 *In* Wong et al. 2003). In the ESSFmc, fires are less frequent with stand replacing events estimated at 200 years (Steventon 2001 *In* Wong et al. 2003).

In the SBSdk, the main conifer tree species are hybrid white spruce and lodgepole pine, with lesser amounts of subalpine fir, but there is a significant presence of deciduous tree species with deciduous and seral ecosystems containing trembling aspen, black cottonwood, and paper birch. Douglas maple and Rocky Mountain juniper occur in moist and dry habitats respectively. The SBSdk is known for the diversity of its shrub and herb layers that are typically well developed (Banner et al. 1993). This diversity of plant species

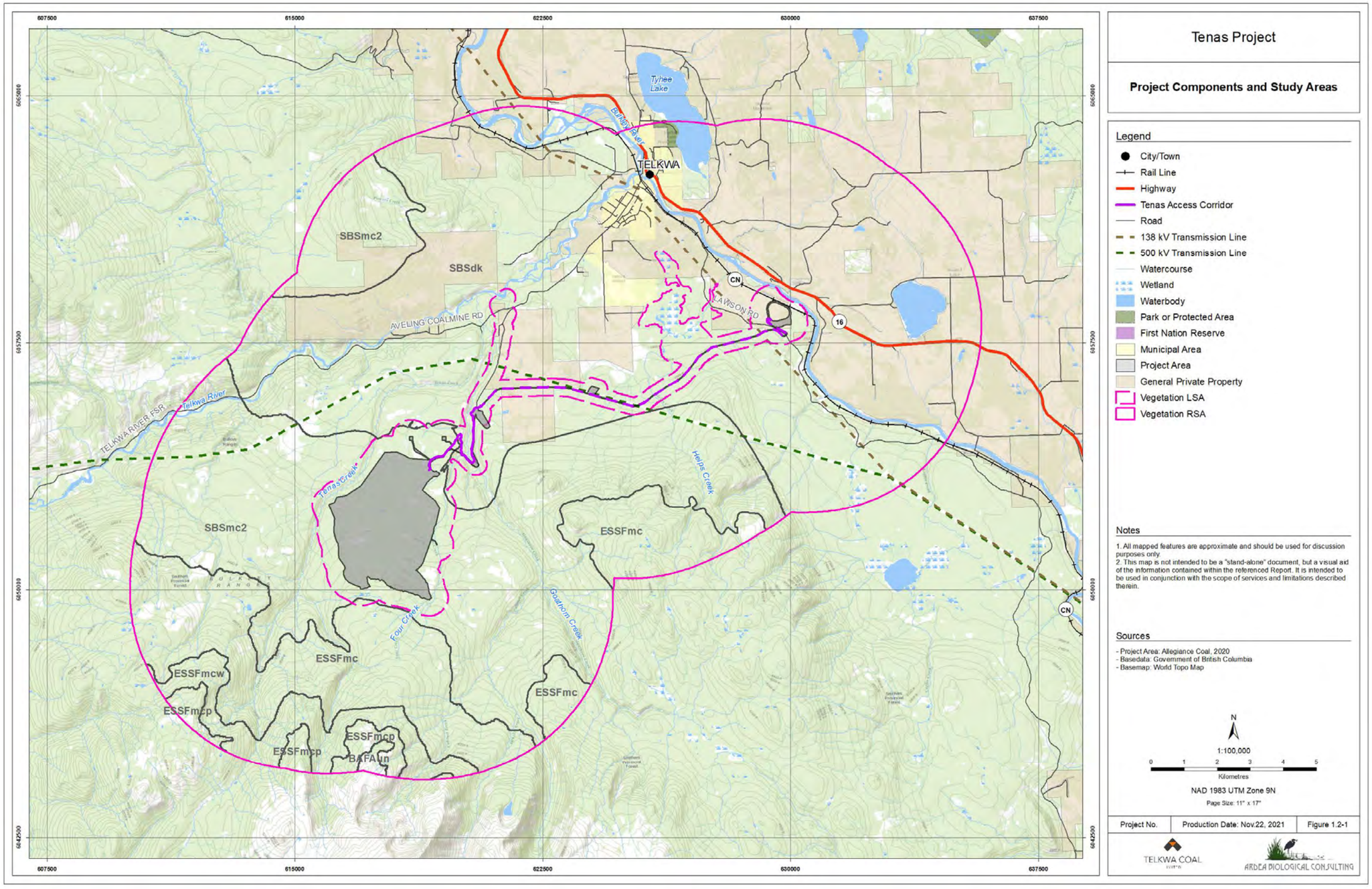

Figure 1.2-1: Project components and study area boundaries.

has led to a high diversity of ecosystems in its coniferous and deciduous forests, floodplains, wetlands and non-forested shrublands. As outlined above, fires have been the greatest historic influence on the distribution of vegetation within the SBSdk, with agricultural development, forest harvesting and cattle grazing more recently affecting the distribution of forested ecosystem within this subzone.

Deciduous forests are relatively uncommon in the SBSmc2, with hybrid white spruce, lodgepole pine and subalpine fir being the dominant tree species. These coniferous stands may have a component of trembling aspen, black cottonwood or paper birch. The shrub and herb layers are not as well-developed or diverse as the SBSdk, and moss layer is better developed and may be dominant (Banner et al. 1993). Old forests are relatively common in areas that have escaped historic fires, although recent forest harvesting has been extensive in this subzone in the project area.

The higher elevation ESSFmc contains subalpine fir, hybrid white spruce and lodgepole pine as the dominant tree species, with western hemlock, whitebark pine, and deciduous tree species being uncommon (Banner et al. 1993). The ESSFmc is split into forested (ESSFmc), woodland (ESSFmcw) and parkland (ESSFmcp) subzones as forests get progressively more open at higher elevations before the BAFA zone begins and forests are unable to grow. In the ESSFmcw subzone, forests have low productivity and are relatively open. The lower boundary of the ESSFmcw subzone usually represents the upper limit of forest harvesting operability (Trowbridge and Banner 2002). The ESSFmcp subzone is characterized by clumps of trees that are separated by areas of heath, meadow, and grassland (Banner et al. 1993).

The BAFA has long cold winters and short cool summers. The snowpack is usually thin and windblown, but may be deeper in some areas. The vegetation can be diverse, with a mosaic of krummholz tree patches, heather, meadows, and tundra. Dwarf willows, grasses, sedges, and lichens can be common (Mackenzie 2006).

The regional climate of the area is reflected in the BEC classification, with the SBS zone having a mostly continental climate, with some coastal influences in the Bulkley Valley (Banner *et al*. 1993). Winters in the SBS are snowy and severe, with short summers that warm and moist. The closest weather station is at the Smithers Airport, 25 km to the north, in the SBSdk subzone (Environment and Climate Change Canada 2019); the figures presented are from 1981 to 2010. The mean annual precipitation (MAP) at this weather station is 508 mm, with 367 mm as rainfall and 182 mm as snow. The wettest month is October with 65 mm and the driest month is March with 21 mm. The mean annual temperature (MAT) is 4.2^{o}C, with July being the warmest month with an average temperature of 15.2^{o}C, and January being the coldest month at -7.2^{o}C (Environment and Climate Change Canada 2019). The ClimateBC program (Wang *et al*. 2016), was used to determine the climate of the SBSmc2 in the study area. The MAP is 631 mm with November being the wettest month is with 75 mm and the driest month being April with 32 mm. The MAT is 2.2^{o}C, with July being the warmest month with an average temperature of 12.4^{o}C, and January being the coldest month at -7.6^{o}C.

The valley bottom, which contains the SBSdk, has a longer growing season than higher elevation areas containing the SBSmc2 due to being drier and warmer in summer, and has a much thinner snowpack that is present for a shorter duration. Winter temperatures in the SBSdk may not be colder than those in the SBSmc2. Wildfire, which is climate driven and is more frequent in the SBSdk than the SBSmc2, has contributed to the development of deciduous stands in the valley bottoms (Banner e*t al*. 1993, Williams *et al.* 2001, Pojar 1995).

2. METHODOLOGIES

2.1 Existing Information Review

The desktop review included an examination of available published and unpublished scientific data, citizen science data, Indigenous Knowledge and local knowledge, as well as a review of federal and provincial legislation, regulations, strategies, guidelines, plans, best management practices (BMPs), and land use plans applicable to ecosystems and vegetation within the Project region. Baseline information from previous environmental assessments conducted near the Project were also reviewed and assessed for use for this Project.

The online resources outlined in Table 2.1-1 were used to help identify information on at-risk plants and lichens, and ecological communities within the Project region as well as any additional baseline information from projects involved in environmental assessments or other ecological studies related to vegetation.

Table 2.1-1: Data sources used to identify available information for Project.

Title	Content	Reference
BC Conservation Data Centre (BC CDC)	Provides status reports and designations for at risk plant species and ecological communities in BC.	(BC CDC 2018b, 2020)
Canadian Impact Assessment Registry Canadian Environmental Assessment Archive	Provides status and available documents for projects undergoing an environmental assessment with the Impact Assessment Agency of Canada. Projects initiated but suspended or completed prior to 2016 are in the CEA Archive.	(IAAC 2020, CEAA 2018)
EcoCat: The Ecological Reports Catalogue	Map application and catalogue to identify available ecological reports completed in BC.	(BC MOE 2018)
Electronic Atlas of the Flora of BC (eFlora)a	Provides descriptions and distribution maps of plants, bryophytes, lichens, algae, fungi and slime molds of BC	(Klinkenberg 2018)
Environmental Assessment Project Information Centre (EPIC)	Provides status and available documents for projects undergoing an environmental assessment with the BC Environmental Assessment Office	(BC EAO 2019)
iMap Incident Mapping Application	Provides locations for listed plants and lichens in BC	(BC CDC 2018a)
Species at Risk Act (SARA) Registry	Provides status reports and designations for at risk plants species in BC.	(ECCC 2018)

Additional sources of information related to specific assessments and studies completed during the baseline program are outlined within the appropriate sections below.

2.1.1 Conservation Context

Plant and lichen species as well as ecological communities are listed by provincial and federal agencies based on their population size, distribution and potential threats from a variety of human activities or natural events. The conservation status information provided for plant and lichen species and ecological communities was obtained by using the *BC Species and Ecosystems Explorer* online search function of the BC Conservation Data Centre (BC CDC) (BC CDC 2018a, 2020) and the Species at Risk Act (SARA) Public Registry online search function (ECCC 2018). The primary source of information was the BC CDC, which outlines the status for the Province as well as provides the results of reviews from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which evaluates species for potential SARA listing as well as the status for SARA.

To identify potential lists of species at risk within the Project area, a query of the BC CDC online search engine was conducted for any provincially or federally listed plant or lichen species within the Skeena Stikine - Bulkley and Nadina Forest Districts as well as the BC Ministry of Environment and Climate Change Strategy (BC MOECCS) Skeena and Omineca Management Regions. Refinements to the searches to only include BGC subzones within the V-RSA was done to reduce the species list to only those species likely to be found within the various V-RSA. A summary of the provincial and federal species conservation status definitions used for conservation status descriptions within this report is provided in Table 2.1-2.

Table 2.1-2: Conservation status definitions for provincial and federal species at risk.

Designating Agency	Status	Definition
BC Conservation Data Centre (BC CDC)	Red	Indigenous species or subspecies that have been designated, or are candidates for designation as Extirpated, Endangered, or Threatened status in BC.
	Blue	Indigenous species or subspecies considered to be of Special Concern in BC.
	Yellow	Indigenous species that are apparently secure and not at risk of extinction in BC. Yellow-listed species may have red- or blue-listed subspecies.
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Endangered	A species facing imminent extirpation or extinction.
	Threatened	A species that is likely to become endangered if limiting factors are not reversed.
Species at Risk Act (SARA)	Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

2.2 Baseline Program

Field assessments and surveys were conducted within the V-LSA and V-RSA between 2017 and 2019 to characterize the ecosystems and vegetation within the vicinity of the Project. In developing our Baseline program, we were interested in characterizing the ecosystems and plant species that have the potential to interact with the Project and are ecosystems or plants either of conservation concern or have distinct social, cultural (e.g. food or medicinal plants), or economic values (e.g. invasive plants or timber resources).

The tasks that were identified within the baseline program for the ecosystems and vegetation baseline studies are:

1. To map and characterize the terrestrial and wetland ecosystems surrounding the Project, identify and map old growth forests, and identify and map any listed ecosystems being tracked by the BC CDC;
2. To identify listed plant and lichen species that have been identified by the BC CDC or COSEWIC or protected under SARA;
3. To identify and map invasive plant species;
4. To map areas where plant species important for cultural use are found within the project study areas;
5. To complete an assessment of potential timber volume within the project study areas; and
6. To sample plant species used by First Nations and/or consumed by wildlife to determine baseline levels of trace metals.

Where possible, historic data from available sources was included in the review of baseline and current conditions, along with any research, studies or assessments completed to support the Project or other nearby projects.

A key part of the Baseline program was to complete Terrestrial Ecosystem Mapping (TEM), which classifies and maps terrestrial and wetland ecosystems to a provincial standard. TEM can be used to identify old-growth habitat and identify listed ecological communities. As well, during the TEM field sampling, the presence and abundance of dominant plant species is gathered, which can be used in assessments for culturally important and rare plant and lichen species. Additional surveys and assessments were completed to assess wetland function, identify listed plants and lichens. assess the extent of invasive plants, and collect vegetation trace metals data to provide baseline information for ecosystems and vegetation. In addition to collecting data during the above surveys, plant and ecosystem information was recorded during most avian, wildlife and terrain and soils related baseline surveys.

Assessments, surveys and mapping completed under the Baseline programs were all conducted in accordance with accepted standards and guidebooks including:

- *A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region* (Banner et al. 1993)
- *Field Guide Supplement to the Identification of High Elevation ESSF Woodland Subzones and Site Units of the Bulkley Timber Supply Area: Supplement No. 2 to Land Management Handbook No. 26* (Trowbridge and Banner 2002)
- *Field Guide to Identification and Interpretation of Hardwood-Dominated Ecosystems in the SBSdk and ICHmc2 of the Prince Rupert Forest Region: Supplement No. 1 to Land Management Handbook No. 26* (Williams et al. 2001)
- *Field Manual for Describing Terrestrial Ecosystems* (BC MOF and BC MOE 2010)
- *Protocol for Accuracy Assessment of Ecosystem Maps* (Meidinger 2003).
- *Protocols for Rare Plant Surveys* (Penny and Klinkenberg 2018)
- *Standard for Terrestrial Ecosystem Mapping (TEM) - Digital Data Capture in British Columbia, Version 3.0* (RIC 2000)
- *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998)
- *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004)

Georeferenced field maps were created for all aspects of the Vegetation baseline program assessments and surveys using ArcMap, consisting of ortho-images overlayed with available road atlas, proposed Project infrastructure, and appropriate additional information, depending on the assessment or survey being completed (e.g. preliminary TEM polygons, or known wetlands). The field maps were loaded on to GPS activated tablets that were used for navigation and data collection in the field. During the baseline surveys, all survey points and tracks were recorded on the tablets and a handheld Garmin GPS unit was used to provide additional locations for post-field mapping as well as in-field back-up. Photos were taken of survey locations and any observed animals or sign, and habitat features recorded as field notes outlining habitat characteristics.

2.3 Terrestrial Ecosystem Mapping

Polygon Delineation and Ecosystem Classification

Terrestrial and wetland ecosystems were classified and mapped using standard TEM methods (RIC 1998). The TEM methodology uses a bioterrain approach, where terrain map polygons are digitally delineated using aerial photographs or digital imagery based on terrain features such as slope, aspect, drainage, and slope position. Ecosystem delineation and classification is then completed using the terrain polygons and vegetation features identified on the photographs or imagery. Field plots including full ecosystem plots (form

FS882) and less detailed ground, visual or note plots types (form FS1333) (BC MOF and BC MOE 2010) are then used to provide information to verify or adjust the mapping classification.

Initial bioterrain polygon delineation was completed by I. Weiland as part of the terrain mapping program outlined in the *Tenas Project Terrain and Soils Baseline Report* (Ardea 2021). Bioterrain interpretation used scanned 1:18,000 scale, colour air photographs from 2006. ArcGIS ver. 10.4 and DAT/EM's digital stereo plotter *Summit Lite* to create the digital polygons. Bioterrain polygons were updated in 2018 using digital orthophoto imagery collected in 2017 during LiDAR data collection and provided higher resolution and more current orthophoto imagery (1:2,000 scale) and more detailed topographic representation of the landscape (LiDAR hillshade and contours at 0.5 m resolution). Where ecosystem or structural stage changes were observed on the 2017 orthophoto imagery, the bioterrain polygons were adjusted to accommodate the ecosystems observed. Mapping was completed at 1:5,000 scale within the minesite, Goathorn Creek and rail infrastructure areas and at 1:10,000 scale within the access corridor area.

Polygon ecosystem classifications were initially based on interpretation of the imagery for identifiable plant species, vegetation pattern, landscape position, slope and aspect to match the ecosystem classifications outlined in Banner et al. (1993) and Williams et al. (2001) for forested ecosystems and MacKenzie and Moran (2003) for wetland ecosystems. There is some overlap among these field guides for forested wetlands and floodplains; where this overlap occurred, the more recent classification was used. While the guide for deciduous forest ecosystems (Williams et al. 2001) is for the SBSdk, some of these ecosystems also occur in the SBSmc2 and were therefore classified as the same ecosystem. Each polygon was classified with up to three ecosystems and the classification, structural stage and any ecosystem or structural stage modifier were entered into a standardized database (RIC 2000).

Field Assessments

Field assessments to confirm or modify the initial ecosystem classifications were conducted in July and August 2017, June to September 2018, and June and July 2019. Plot data collection was completed using a number of different forms with decreasing details for each form. The most detailed form is the *Ecosystem Field Form* (FS882) which collects comprehensive plot data (i.e. full plot), with detailed site, vegetation, terrain and soils information (BC MOF and BC MOE 2010). Less detailed plot information was obtained using the *Site Visit Form* (FS 1333), which can be used to collect *ground plot* data; which includes site series, vegetation, terrain and soils information; or it can be used for a *visual plot* that collects limited site and ecosystem data. The least amount of plot detail is collected as field notes, which primarily record ecosystem and structural stage information.

In general, more detailed plots (i.e. full plots) were completed early in the field program to document the range of ecosystem types as they were encountered within the mapping area, with less detailed plots (i.e. SIVI ground and visual plots) were completed as ecosystems that had been described by full plots were encountered. The recommended ratio for the plot types is outlined by the SIL; which for a SIL 2 would be 3 full plots to 17 ground plots to 80 visual plots (RIC 1998).

Ecosystem information was also recorded during most avian, wildlife and terrain and soils related baseline surveys following the same standards for gathering ecosystem and vegetation information (BC MOF and BC MOE 2010). Completed full or ground plots that contained were completed that contained This data supplemented the dedicated TEM field assessments completed during 2017 to 2019.

All field data was entered into a VPro database (MacKenzie and Klassen 2009) that allows for data analysis, classification of ecosystems and summaries of ecosystem, vegetation, terrain or soils information. Ecosystem information obtained from the field data was used to modify and update the polygon database information based on the ecosystem, structural stage or modifiers data collected in the field.

Mapping Survey Intensity Levels and Accuracy Assessments

For the project footprint (minesite, access corridor and rail infrastructure areas), a survey intensity level two (SIL 1) was set for the 1;5,000 mapping of the minesite and rail infrastructure areas, while SIL for the 1:10,000 mapping of the access corridor area was set at level one. A SIL 2 requires that a polygon inspection rate of 51% to 75% be met (RIC 1998), while a SIL 1 requires 76% to 100% polygon inspection rate be achieved. To calculate the SIL, plots were selected that had site plot quality identified as *Fair* to *Excellent* indicating that sufficient ecosystem data (i.e. biogeoclimatic subzone, soil moisture / soil nutrient, site series and dominant vegetation information) was recorded for the plot to allow for accurate identification of the plot ecosystem. Percent of polygon inspections were calculated by dividing the number of polygons that contained a plot by the total number of TEM polygons within the project footprint areas.

Two accuracy assessments were completed for the TEM to assess the mapping accuracy during the development of the final TEM product. An initial accuracy assessment was carried out by an independent experienced ecosystem mapper, Claudia Houwers, R.P.Bio. of Houwers Ecological Consulting, using the preliminary ecosystems mapped to that point. In September 2018, a total of 55 plots were completed on a representative sample of polygons and ecosystems within the minesite, access corridor and rail infrastructure areas. The collected plot data was compared to the ecosystems within the polygons to determine if the ecosystems matched the plot data. If the plot data differed from the mapped ecosystem data, the mapping team and the QA team identified if it was an error in imagery interpretation or plot interpretation if there was a plot nearby for comparison. Based on the result of that review, some polygon ecosystem interpretations were adjusted for the final mapping.

A second mapping accuracy assessment was carried out based on the methods outlined in Meidinger (2003) with plots collected from 2017 to 2019 used in the assessment. Similar to the SIL calculation outlined above, all of the selected plots were those where the site plot quality was identified as *fair* to *excellent*, to allow for accurate identification of the plot ecosystem.

As outlined in Meidinger (2003), several accuracy assessments were carried out:

- Comparison of mapped ecosystem percentages to plot ecosystem percentages, and their overlap proportions in tabular and graphic format.
- Comparison of the percent dominant ecosystems correct; weighted and not weighted by polygon area for each plot and mapped ecosystem with 80% confidence intervals.
- Comparison of the percent of dominant ecosystem overlap; weighted and not weighed by polygon area for each plot and mapped ecosystem with 90% confidence intervals.
- Comparison of the percent acceptable ecosystem overlap; weighted and not weighted by polygon area for each plot and mapped ecosystem with 90% confidence intervals.

As plots were normally not completed within anthropogenic sites (e.g. roads, rural, railways) or large water bodies (e.g. rivers, lakes and ponds), these ecosystems were not used in the comparison. Scoring to determine similarity was completed by comparing the plot data to the dominant TEM map components. The proportions were compared graphically and by evaluating the percent overlap of the polygon proportions with the plot proportions (Meidinger 2003).

2.4 Mapping Data Acquisition and Preparation

Updated Forestry Mapping

The spatial datasets used to complete assessments for old growth forests and timber volumes, as well as update previous ecosystem mapping within the V-LSA and V-RSA are provided in Table 2.4-1. The provincial Vegetation Resource Inventory (VRI) dataset was merged and updated with fire, cutblock, and forest reserve layers to better represent current conditions.

All analyses were completed using NAD83 BC Albers projected coordinate reference system (EPSG: 3005). Analyses and management of spatial data was completed using ArcGIS Desktop 9.31 or 10.3 with the Spatial Analyst extension (ESRI 2013).

Table 2.4-1: Datasets used in the development of updated forestry and anthropogenic features mapping.

Dataset Name	Description	Source
Vegetation Resource Inventory	Polygons representing vegetated and non-vegetated land classifications combined with VRI, wildfire, harvested area, and forest reserve layers	https://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer https://catalogue.data.gov.bc.ca/dataset/fire-perimeters-historical https://catalogue.data.gov.bc.ca/dataset/harvested-areas-of-bc-consolidated-cutblocks- https://catalogue.data.gov.bc.ca/dataset/recreation-sites-reserves-and-interpretive-forests-details-and-closures-fully-attributed
Digital Road Atlas	Road dataset for BC	https://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-master-partially-attributed-roads
GeoBase 250K Land Cover, Circa 2000	Polygons identifying land classifications (e.g., annual cropland, snow/ice, developed)	https://catalogue.data.gov.bc.ca/dataset/other-land-cover-1-250-000-geobase-land-cover#edc-pow
Recreation Tenure Alpine Ski Areas	Polygon and point features for ski areas	https://catalogue.data.gov.bc.ca/dataset/recreation-tenure-alpine-ski-areas
Municipalities - Legally Defined Administrative Areas of BC	Polygons outlining legally defined municipalities in BC	https://catalogue.data.gov.bc.ca/dataset/municipalities-legally-defined-administrative-areas-of-bc#edc-pow
CanVec	Point sources for anthropogenic features (e.g., dam, dike/levee, sewage pipeline)	https://open.canada.ca/data/en/dataset/fd4369a4-21fe-4070-914a-067474da0fd6
OpenStreetMap	Point sources for buildings to represent building corners.	https://osmbuildings.org/data/
TRIM Enhanced Base Map	Polygons representing building footprints	https://catalogue.data.gov.bc.ca/dataset/buildings-trim-enhanced-base-map-ebm
Mineral Titles Online Tenure	Data for minder, placer claims and leases, and coal licence applications/licences/leases	https://catalogue.data.gov.bc.ca/dataset/mta-mineral-placer-and-coal-tenure-spatial-view
Forest Tenure Road Section Lines	Roads under the BC Forest and Range Act Tenures	https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-section-lines
GeoBase National Railway Network	Contains railway track classification, use type, and operator data.	https://catalogue.data.gov.bc.ca/dataset/railway-track-line#edc-pow
Oil and Gas Commission Pipeline Right-of-Way Permits	Polygon data for approved and post-construction pipeline right-of-ways	https://catalogue.data.gov.bc.ca/dataset/oil-and-gas-commission-pipeline-right-of-way-permits
Oil and Gas Associated Ancillary Permit	Polygons of associated oil and gas activities (e.g., campsites, staging areas, workspaces)	https://catalogue.data.gov.bc.ca/dataset/oil-and-gas-commission-associated-and-ancillary-permits

Dataset Name	Description	Source
Oil and Gas Pipeline Segment Permit	Polygons representing segments of non-continuous pipeline	https://catalogue.data.gov.bc.ca/dataset/oil-and-gas-commission-pipeline-segment-permits
GBA Transmission Lines	High voltage electrical transmission lines for power distribution	https://catalogue.data.gov.bc.ca/dataset/bc-transmission-lines
Telkwa Caribou Motor Vehicle Closure	Road closures due to caribou habitat protections	ftp://ftp.geobc.gov.bc.ca/publish/Regional/Smithers/Telkwa%20motor%20vehicle%20closure/
Recreation Polygons	Polygons of a recreation feature (e.g., recreation reserve, recreation site, interpretive forest)	https://catalogue.data.gov.bc.ca/dataset/recreation-polygons
Recreation Line	Linear spatial representation for recreation features (e.g., recreation trails)	https://catalogue.data.gov.bc.ca/dataset/recreation-line

Updating Existing Ecosystem Mapping

Two existing ecosystem mapping projects have been completed historically within V-RSA. In 1999, Oikos Consulting Ltd., produced a 1:20,000 scale TEM (Oikos TEM) for the Manalta Coal Ltd. Telkwa Coal Project (Oikos 1999). In 2010, Predictive Ecosystem Mapping (PEM) was completed by Timberline Natural Resources Group Ltd. for the Bulkley Timber Supply Area (Bulkley PEM) (Timberline 2010).

The updated forestry mapping for ages and new harvesting was used to update both the Oikos TEM and the Bulkley PEM to reflect changes in structural stages and polygon outlines due to harvesting. Ecosystem names and codes were also updated for consistency across the data sets. The age cut-offs for structural stages were set for each forested ecosystem using Site Index productivity information obtained from *Site Index for BEC* (SIBEC) (Mah 2003). Mah (2003) identified that lower productivity ecosystems take longer to reach the next structural stage, and higher productivity ecosystem enter the next structural stage more quickly (Table 2.4-2). This does not apply to the old forest structural stage, which follows ages outlined in RIC (1983) and BC MOFR and BC MOE (2010).

Table 2.4-2: Structural stage age class breaks in years for zonal ecosystems in each forested BEC subzone.

Subzone	Shrub	Pole\Sapling	Young Forest	Mature Forest	Old Forest
SBSdk	≤24	25 to 49	50 to 79	80 to 139	≥140
SBSmc2	≤29	30 to 59	60 to 89	90 to 139	≥140
ESSFmc	≤34	35 to 69	70 to 149	150 to 249	≥250
ESSFmcw	≤59	60 to 119	120 to 199	200 to 249	≥250

The updated historic mapping products were used outside of the new Tenas TEM, to provide ecosystem mapping information for the portions of the V-LSA and V-RSA as outlined in Figure 2.4-1.

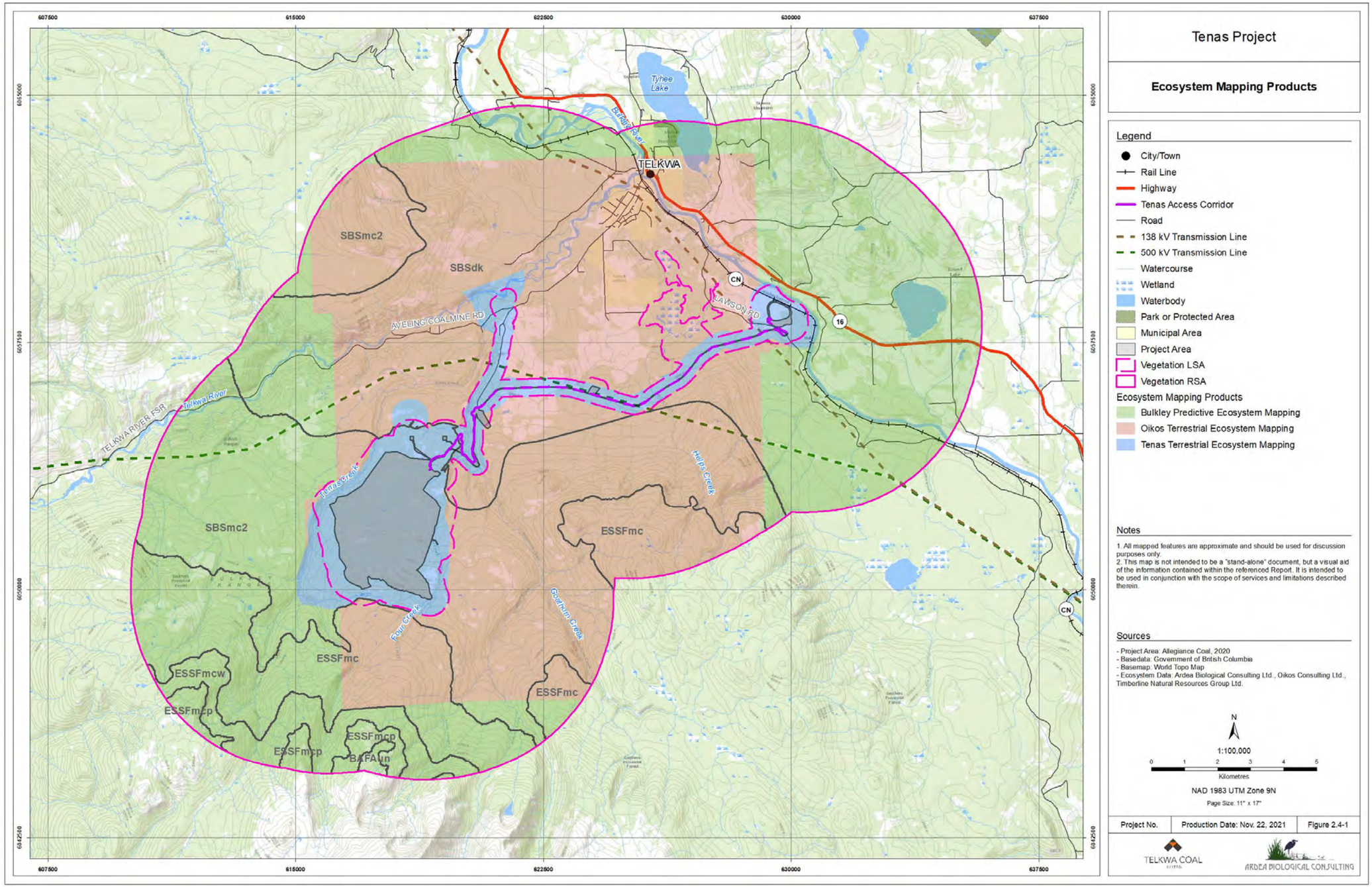

Figure 2.4-1: Distribution of ecosystem mapping products used within the V-LSA and V-RSA.

2.5 Wetland Function Assessment

Development of Wetland Function Assessment

Assessments of wetland functions can be conducted using a three-tiered approach using desktop landscape-scale assessments (Level 1), to rapid field assessments (Level 2) and detailed assessments (Level 3) that can include intensive field data collection and/or modelling, or long-term monitoring programs (Apfelbeck and Farris 2005, Fennessy et al. 2007, Hanson et al. 2008). Based on the guidance of Hanson et al. (2008) the following documents were reviewed to develop the wetland assessment methods for the Tenas Project:

- *An Evaluation of Rapid Methods for Assessing the Ecological Condition of Wetlands* (Fennessy et al. 2007)
- *Field Supplement to Evaluating the Condition of Wetlands* (Fletcher et al. 2018)
- *Montana Wetland Rapid Assessment Method Guidebook (Version 2.0)* (Apelbeck and Farris 2005)
- *Methods for Evaluating Wetland Condition: Study Design for Monitoring Wetlands* (US EPA 2002)
- *Wetland Evaluation Guide. Final Report of the Wetlands are not Wastelands Project (Bond et al. 1992)*

Based on this review, the following data was determined to be important for collection:

- identify wetland boundaries and calculate size;
- determine hydrodynamic index - a measure of flow through a wetland;
- identify water pathways;
- identify hydric soil indicators, rooting depth and depth to water;
- record water pH;
- identify plant species and relevant percent cover;
- classify wetland;
- assess wildlife habitat use and value;
- identify up-slope impacts such as roads, farming or forestry; and.
- identify/describe current and historical condition and function.

A combination of Level 1 (office) and Level 2 (field) assessment data was collected to assess wetland function as outlined in Table 2.5-1.

Wetland Function Ratings

Using the general wetland function categories outlined in Table 2.5-1, detailed descriptions of potential wetland types that could be found within the V-LSA were developed, along with rating scales (Table 2.5-3). These ratings were based on descriptions and ratings described in Hansen et al. (2008) with adjustments based on the likely services provided by the wetlands types and sizes found within the V-LSA.

Table 2.5-1: Summary of wetland categories and functions to be considered during environmental assessments (from Hanson et al. 2008) and types of data collected for wetland function assessment.

		Office Assessment (Level 1)					Field Assessment (Level 2)									
Function Category	Functions	Wetland Delineation	Hydrogeomorphic Setting	Watershed Area	Land Use	Land Cover Types	Wetland Classification	Hydrodynamic Index	Surface Flow	Decomposition Rates	pH	Soil Moisture	Vegetation Composition	Wildlife Use	Coarse Woody Debris	Wildlife Tree Attributes
Hydrological	Aquifer recharge and discharge Surface water storage and release Flow moderation	X	X	X	X	X	X	X	X			X	X			
Biogeochemical	Nutrient transformations Biomass production Soil production		X		X	X	X			X	X	X	X			
Habitat	Biological productivity and diversity	X		X	X	X	X						X	X	X	X
Climate	Carbon fixation and CO_2 balance Rainfall and humidity increase Micro-climate influences					X				X	X		X		X	

Wetland Function Site Selection

Available digital data for existing wetland mapping in the Project area was obtained from several sources including the current and previous TEM (Tenas TEM, Oikos TEM), BC Freshwater Atlas Data; BC Conservation Data Centre information and a rare ecosystem mapping project within the Bulkley Valley (Haeussler 1998). Other digital data layers were also reviewed such as VRI, fire history mapping and satellite imagery to help identify current land uses including private land, agricultural, forest fire and forest harvesting activities. Data collected during other Project baseline surveys (e.g. amphibian, breeding bird, waterfowl and wildlife habitat assessments) were also reviewed and the data obtained that were relevant for the wetland function assessment.

The digital data outlined above was organized in ArcMap 10.1 GIS to identify potential sampling sites within the Project area for wetland function field surveys. A range of sample sites were selected for field surveys based on proximity to proposed Project infrastructure, BGC subzone (SBSmc2, SBSdk), available wetland

types (e.g. marsh, open water ponds, forested wetland, floodplain wetland), topographic position, adjacent current and historic land uses and existing ecological and wildlife information.

Wetland Function Field Surveys

The field surveys for the wetland function assessments were conducted within the V-LSA and included collection of wetland ecosystem data, wildlife habitat value and habitat use, which were recorded on standard Ecosystem Field Forms (FS882 and FS1333) (Table 2.5-2) to maintain consistency between the wetland function and other baseline studies for ecosystem mapping and wildlife habitat assessments. The wetland function data was recorded at each assessment location on a customised wetland function form (Tenas Wetland Function) using criteria outlined in Appendix D (Table D-1).

Table 2.5-2: Field data forms applied to wetland function assessments.

Survey Name	Form ID	Type
Tenas Wetland Function	Tenas Wetland Function	Wetland assessment transects and plots crossing the wetland feature, and wetland feature perimeter transects.
Ecosystem/Site Visit	FS882(1,2,3)/FS1333	Wetland ecosystem description as well as adjacent riparian/upland ecosystem plot(s).
Wildlife Habitat Assessment (WHA)	FS882(5)	Wildlife habitat value and use information recorded in within plot and plot-in-context area for wetland and adjacent riparian/upland area.
Tree Attributes for Wildlife (TAW)	FS882(6)	Fixed area plot located adjacent to the wetland plot.
Coarse Woody Debris (CWD)	FS882(7)	Two 24 m sampling transects with the start location associated with the wetland plot.

The perimeter of each wetland was traversed and the margins were surveyed for in and out flow locations. Areas of open water and water control structures (i.e., beaver dams, culverts) were also recorded. Wetland hydrodynamics and hydrogeomorphic position were recorded at each site.

Survey methods were adapted from those identified in the Forest and Range Evaluation Program (FREP) wetland protocol (Fletcher *et al.* 2018). At each wetland, a transect, starting 10 m upslope of the wetland edge, were walked at a right angle from the wetland edge toward the center of the wetland. Transect length varied for wetland size and any barriers encountered (deep water, channel, soft bottom etc.). Plots were completed in zone changes that indicated a change in wetland class or plant association. Structural stage, soil description, depth to water, water pH and temperature, and dominant plant species, form, vigor and recruitment were recorded. In complex wetlands, additional ten meter transects were conducted at right angles to the end of the first transect on either side, and if the wetland was large enough extended along the original transect for 10 m.

Soil nutrients were characterised through observational data such as colour, level of decomposition, texture and water availability, and wetland class was identified according to MacKenzie and Moran (2004). Plants were identified using *Plants of Northern British Columbia, 2nd edition* (MacKinnon *et al.* 1999) and *E-Flora BC: Electronic Atlas of the Flora of British Columbia* (Klinkenberg 2018).

Wildlife habitat value and use was recorded to assess the wetland's ability to support local and regional biodiversity through a range of aquatic and terrestrial habitat types and followed the methods outlined in BC MOFR and BC MOE (2010).

A detailed ratings scheme for the wetland functions within the wetland types was created based on descriptions and ratings described in Hansen et al. (2008) (Table 2.5-3). These ratings were recorded during the field assessments to be used in post-field scoring of the functions and wetlands.

Table 2.5-3: Summary of wetland class functions and ratings.

Wetland Function	Description	Wetland				
		Bog	Fen	Marsh	Swamp	Shallow Open Water
Hydrological	Water flow moderation (flood protection): The ability of a wetland, or group of wetlands, within a watershed to mediate downstream risks. Based on volume capability compared to flow within a watershed.	Low as generally isolated from surface water inputs; Low for small isolated bogs < 0.5 ha; Low-Moderate for larger bogs or a cluster of small bogs (total area > 0.5 ha); Moderate for bogs > 5 ha and those associated with wetland complexes that cover >5% of a watershed.	Variable due to water table fluctuation. Low-Moderate for smaller (<0.5ha) isolated fens (less water storage); Moderate-High for larger fens or a cluster of small fens (> 0.5 ha); Mod-High for fens associated with wetland complexes that cover more than 5% of a watershed.	Low to High Low for small marshes < 0.5 ha Moderate for riparian or floodplain marshes > 0.5 ha Moderate-high for larger marshes or marsh complexes situated in up gradient locations	Low as soils are usually saturated. Low-Moderate for larger swamps (> 0.5 ha) Moderate for wetland complexes	Low to High Higher value for flow moderation when situated at the top of a watershed.
	Groundwater recharge: Variable based on basin shape, location in the watershed, substrate and groundwater gradients. Groundwater recharge is possible from basins situated in topographic highs where water can migrate out horizontally or vertically through permeable substrates.	Low for bogs in colder (short frost-free time) high elevation areas (ESSF, BAFA) Low for bogs located in low lying areas Moderate for topographic heights	Low May be higher if associated with a complex	Low to Moderate Low for low lying locations Moderate for topographic heights	Low May be higher if associated with a complex	Low to Moderate based on-site conditions Low for low lying locations Moderate for topographic heights

Wetland Function	Description	Wetland				
		Bog	Fen	Marsh	Swamp	Shallow Open Water
Hydrological	Erosion protection: Erodibility of terrestrial region of wetland - related to composition of substrate and energy of the water body. The value is related to the use of the terrestrial lands adjacent to the wetland.	Low	Low	Moderate to High	Moderate	Low
Biogeochemical	Water quality treatment: Physical, chemical and biological water quality treatment for constituents of concern, loading rates, water balance and hydro period, substrate and vegetation assemblages. The value is related to the sensitivity or use of receiving waters. Amphibians and fish are generally sensitive to water quality changes. Drinking water wells. All wetlands and receiving waters are considered sensitive.	Low Low to Moderate for complexes	Moderate High for Wetland complexes	Moderate High for Wetland complexes	Moderate High for Wetland complexes	Moderate High for Wetland complexes
	Carbon storage: attributes include humification of peat and volume of woody and ericaceous biomass. Generalised by wetland type and adjusted based on size.	Moderate for smaller bogs Moderate to High for > 0.05 ha and complexes	Moderate to High for > 0.05 ha and complexes	Moderate	Moderate to High for > 0.05 ha and complexes	Low unless associated with a complex
	Nutrient and organic export: Export of nutrients and organic carbon to streams that contribute to the aquatic food chain. Larger wetlands tend to contribute over a longer period of time.	Moderate to High based on size	Moderate to High based on size	Moderate to High based on size	Low to Moderate based on size	Low unless associated with a complex

Wetland Function	Description	Wetland				
		Bog	Fen	Marsh	Swamp	Shallow Open Water
Habitat (Ecological)	Biological productivity and support for biodiversity: Maintains regional biodiversity and food chains; Supports recreational and ecological values; Supports fish and other aquatic life. Presence or absence, and abundance of valued wildlife and vegetation species from literature and field data. Size/Volume (area) provides more area for waterfowl Edges (Perimeter) provide food for amphibians, moose, waterfowl, etc.	Moderate to High Provides tall tree, shrub, and open area cover types for a variety of species	Moderate to High Provides open areas and cover for a variety of species (birds, amphibians); provides early season palatable vegetation for bears	Moderate to High Considered critically important; most important wetland class for providing habitat; Provides habitat for migratory birds, amphibians and semi-aquatic mammals	Low to High Higher vertical structure; supports diverse avifauna; provides cover habitat and forage for ungulates (moose), bears; provides connectivity with fresh water aquatic systems such as rivers	Low to High Provides open water habitat for migratory birds, moose, and amphibians
Climate	Maintenance of current climate: Carbon fixation and CO_2 balance, methane equilibrium, rainfall and humidity control and micro-climate influences. Climate regulation: Related to evapotranspiration rates based on the size and type of wetland (vegetation cover).	Low to Moderate Low for < 0.5 ha and Moderate for > 0.5 ha or complexes	Moderate to Moderate-High Moderate for < 0.5 ha and Moderate High for > 0.5 ha or complexes	Moderate to High Moderate for < 0.5 ha and Moderate-High for > 0.5 ha or complexes	Low to Moderate Depends on vegetation cover and size Low for < 0.5 ha and Moderate for > 0.5 ha	Low to Moderate Depends on vegetation cover and size Low for < 0.5 ha and Moderate for > 0.5 ha

Post-Field Wetland Analyses and Ratings

After the field surveys were completed, GIS analyses and mapping reviews were completed to map the wetlands and provide watershed and hydrogeomorphic setting data for the wetlands surveyed. The first task was to use digital imagery and hillshade information to map and adjust, if required, the in-field mapping of the wetland. Stream and watershed boundary information from the BC Freshwater Atlas digital data (GeoBC 2010) were queried to determine a number of parameters for rating including:

- the watershed and area of watershed that the wetland was in,
- the position within the watershed (upper, mid, lower),
- the position within the watershed in relation to streams and the watershed side edges to measure potential flow volumes (near flow path, away from flow path, at edge), and
- if the wetland was part of a complex that wasn't apparent from the field survey.

Using the field survey and post-field analyses ratings, each wetland surveyed was scored based on the criteria outlined in Table 2.5-3. The scores were added together to provide an overall score for a wetland. Final wetland scores were translated back to a rating using the ranges for final scores outlined in Table 2.5-4.

Table 2.5-4: Wetland function ratings and scores

Rating	Function Score	Overall Score
Low	1	1 - 9
Low-Moderate	2	10 - 18
Moderate	3	19 - 27
Moderate-High	4	28 - 36
High	5	37 - 45

2.6 Old Growth Forest Assessment

The TEM/PEM data for the V-RSA (see Section 2.4) was used to complete an analysis of the amount of old growth forest available within the V-LSA and V-RSA. Forested ecosystem polygons were selected that had ages greater than 140 years in SBS forests and greater than 250 years in ESSF forests (BCE 1995). The resulting data was then summarized for each BGC subzone within the V-LSA and V-RSA.

2.7 Timber Volume Assessment

An assessment of the timber volume available within the V-LSA and V-RSA was completed using the updated digital VRI mapping developed for the project (see Section 2.4). Anthropogenic features such as urban and agricultural areas, as well as protected and alpine areas were removed from the data set. A simple volume calculation was completed based on the formula:

Polygon live volume (m^3/ha) = (% tree species/polygon x live volume m^3/ha) x polygon area

Up to six tree species per polygon are available within the data and volumes per species were maintained by polygon in an Access database. For pine species, the live volume greater than 12.5 cm (VRI field name: LIVE_VOL_PER_HA_SPP1_125) was used, while for all other species the live volume greater than 17.5 cm (field name: LIVE_VOL_PER_HA_SPP1_175) was used. The resulting data was imported into Excel to allow summarization of the data within pivot tables for each polygon, BGC subzone within the V-LSA and V-RSA.

2.8 Listed Plants and Lichens Surveys and Listed Ecological Communities Assessments

Plants and lichen species, along with ecosystems of conservation concern that have been listed provincially or federally were identified using the Conservation Data Centre's Ecosystem Explorer as outlined in Section 2.1.1. The iMap application (BC CDC 2018a) and the E-Flora database (Klinkenberg 2018) were

also used to search for known occurrences of listed plants and lichen species of conservation concern within the V-RSA. Existing mapping projects were reviewed (Haeussler 1998, Oikos 1999) to determine if they had mapped any listed ecological communities in the V-LSA or the V-RSA.

Searches for the identified plants and lichen species were conducted in the V-LSA simultaneously with the TEM fieldwork using methods outlined in Penny and Klinkenberg (2018). As part of the field sampling plan, uncommon terrain such as wetlands, south-facing slopes, floodplains and rock outcrops were targeted, as these areas often contain listed plant and lichen species. Searches for listed plants and lichens were not done outside of the V-LSA, although any occurrences that were identified in previous studies were noted and locations obtained where possible.

A GIS analysis to determine the types and areal extent of listed ecosystems was completed within the V-LSA and the V-RSA using the available TEM and PEM mapping sources. A summary table and mapping were produced for any listed plant, lichen or ecosystem identified within the V-LSA and V-RSA.

2.9 Invasive Plants Surveys

Invasive Species List Development

Invasive plants are managed under various regulations and organizations in BC and include provincial, regional and sub-regional listings of invasive species. From a regulatory standpoint, the *Weed Control Regulation* (Government of BC 2011) outlines a list of provincial and regional noxious weeds that require control. At the provincial level, the BC Ministry of Environment and Climate Change Strategy (BC MOECCS) and the Inter-Ministry Invasive Species Working Group (IMISWG) identifies invasive species at the provincial level with a range of management categories and objectives (BC MOECCS 2020b). The IUWISWG is also responsible for the *Invasive Species Early Detection and Rapid Response Plan for British Columbia* (BC EDRR Plan; IMSWG 2014) and identifying new invasive species to BC on a regular basis.

A target list of invasive plant species to search for within the V-RSA was initially developed from the above provincial sources, refinements and additional species selected from regional level listings. Specific regional sources included the Invasive Species Council of BC (ISCBC) *List of Regulated Invasive Plants in BC* (ISCBC 2018), the BC Northwest Invasive Plant Council (NWICP) *Target Invasive Plant List* (NWIPC 2017) and a localized list from the NWIPC for the Bulkley Valley (NWIPC 2018).

Invasive Plant Survey Methods

Invasive plant species are most common in disturbed areas; thus, the invasive plant surveys were focussed on disturbed areas. This included roads, transmission lines, railways, cultivated areas and grazed areas. In addition, invasive plants were also recorded when they occurred within TEM plots or other ecological or wildlife surveys. All the main roads, and most of the spur roads in the project areas were surveyed, as was the transmission line right-of-way, some fields and pastures, and some areas beside the railway.

Surveys were conducted within the V-LSA by walking, driving, and riding bike along the disturbed areas, and recording the species and abundance of invasive plants as they were encountered on the Invasive Alien Plant Program (IAPP) (BC MOECCS 2020a) application on an iPad. Collections of plants were made for identification as required.

Plants were identified using the *Illustrated Flora of British Columbia* (Douglas et al. 1998), *Field guide to Noxious Weeds and other Invasive Plant of British Columbia, 10th edition* (ISCBC and IMISWG 2019), *Plants of Northern British Columbia, 2nd edition* (MacKinnon *et al.* 1999), *Key to Identification of Invasive and Native Hawkweeds (Hieracium spp.) in the Pacific Northwest* (Wilson 2006) and *E-Flora BC: Electronic Atlas of the Flora of British Columbia* (Klinkenberg 2018).

2.10 Plant Species Important for Cultural Use

Plant Species Selection

The authors have conducted several projects where plants important for cultural use have been identified for inclusion in baseline studies and assessments (Turney et al. 2006, Coosemans and Turney 2007, Ardea 2014, Ardea 2015). Numerous plant species that occur in the Project area are sources of food and medicine for humans (Budhwa et al. 2020) and several documents were reviewed in the development of a list of species important for cultural use including:

- *Gitksan Traditional Medicine: Herbs and Healing* (Johnson Gottesfield and Anderson 1988),
- *Plants, Land and People, A Study of Wet'suwet'en Ethnobotany* (Johnson Gottesfeld 1993),
- *Wet'suwet'en Ethnobotany: Traditional Plant Uses* (Johnson Gottesfeld 1994),
- *The Role of Plant Foods in Traditional Wet'suwet'en Nutrition* (Johnson Gottesfeld 1995),
- *Health, Wholeness, and the Land: Gitksan Traditional Plant Use and Healing* (Johnson Gottesfeld 1997),
- *Gitksan Medicinal Plants - Cultural Choice and Efficacy* (Johnson 2006),

Table 2.10-1 outlines the plant species selected for mapping of culturally important species based on the above documents as well as a review of relative availability on the landscape to identify ecosystems with those plants in them.

Table 2.10-1: Plant species selected as important cultural and wildlife use to be used for trace metals sampling and culturally important plants mapping.

Common Name	Scientific Name	Primary Uses
Black Huckleberry	*Vaccinium membranaceum*	Food
Buckbean	*Menyanthes trifoliata*	Food / Medicinal
Cow Parsnip	*Heracleum maximum*	Medicinal
Devils Club	*Oplopanax horridus*	Food / Medicinal
Fireweed	*Epilobium angustifolium*	Food / Medicinal
Highbush Cranberry	*Viburnum edule*	Food
Indian Hellebore	*Veratrum viride*	Medicinal
Kinnickinnick	*Arctostaphylos uva-ursi*	Food / Medicinal
Oval-leaved Blueberry	*Vaccinium ovalifolium*	Food
Red Raspberry	*Rubus idaeus*	Food
Soopolallie	*Shepherdia canadensis*	Food / Medicinal
Willow species	*Salix* spp.	Medicinal / Baskets

Mapping Culturally Important Plants

Mapping the distribution of plants important for cultural use (Table 2.10-1) was undertaken using the available ecosystem mapping within the V-RSA (i.e., Tenas TEM, Oikos TEM and PEM). Ecosystems were identified using the following steps:

- An initial look-up table containing all of the unique BGC subzones, site series and structural stages was created from the ecosystem mapping data within the V-RSA.

- Each identified plant species was reviewed within Land Management Handbook (LMH) 26 (Banner et al. 1993) and supplements (Williams et al. 2001, Trowbridge and Banner 2002) or within the wetland classification guidebook (MacKenzie and Moran 2004). Additional information on the distribution of some of the important cultural plants within the subzones was obtained from Beaudry et al. (1999).
- Ecosystems (e.g., site series, site associations, or map units) were identified to have the potential to support a selected culturally important plant species if they fulfilled one or more of the following conditions:
  - The culturally important plant species had a documented prominence class of 3, 4 or 5 within the ecosystem;
  - The culturally important plant species forms part of the ecosystem name;
  - The culturally important plant species was observed at an average percent cover of 5% or greater within field plots.
  - For culturally important plant species with generally low abundance in the study area (i.e., buckbean, oval-leaved blueberry), all ecosystems identifying any prominence value were determined to have the potential to support the species.
  - For BGC subzones and variants without detailed ecosystems descriptions (i.e., BAFAun, ESSFmcp) available in published sources, professional judgement was used to determine whether ecosystems had the potential to support the culturally important species.
- Once the list of ecosystems with the potential to support culturally important plant species was identified, a review of the structural stages for each ecosystem was completed with the use of available literature and professional judgement to further refine the list (Table 2.10-2).
- A final lookup table was created from the list of ecosystems and structural stages identified to provide a high potential for culturally important plant species (Appendix F).

Table 2.10-2: Structural stages identified for mapping culturally important plants.

Species	Structural Stages[1]	Rationale
Black huckleberry	3 to 7	Variable habitat requirements - shade tolerant to shade-intolerant, may decrease, persist or increase in abundance in pioneer seral stage (Beaudry et al. 1999)
Devil's club	3 to 7	late seral, climax and old-growth forest understory species (Vance et al. *in press*) http://a100.gov.bc.ca/pub/eswp/speciesSummary.do?id=16924
Soapberry	3 to 7	occurs in seral and climax communities https://www.fs.fed.us/database/feis/plants/shrub/shecan/all.html
Willow	3 to 7	Many species with various habitat requirements and successional relationships.
Cow parsnip	2 to 7	Occurs in seral and climax communities https://www.fs.fed.us/database/feis/plants/forb/hermax/all.html
Fireweed	2, 3, 4, 5, 6, 7	early seral species; the length of time fireweed populations are present varies among ecosystems https://www.fs.fed.us/database/feis/plants/forb/chaang/all.html
Buckbean	Open water	Wetland species found in shallow water associated with wetland bog types
Oval-leaved blueberry	3 to 7	commonly appears soon after disturbance; a common constituent of climax old growth https://www.fs.fed.us/database/feis/plants/shrub/vacovl/all.html

Species	Structural Stages[1]	Rationale
Highbush cranberry	3 to 7	moderately shade tolerant and is important throughout all stages of forest succession; sprouts following fire https://www.fs.fed.us/database/feis/plants/shrub/vibedu/all.html
Indian hellebore	2 to 7	Moist meadows, openings in coniferous forests. Shade-tolerant to shade-intolerant; persists in pioneer seral stands (Beaudry et al. 1999)
Kinnikinnick	2 to 7	seral, shade-intolerant species often found in seral, open pine forests; grows best in high light situations and becomes rare when shade becomes intense https://www.fs.fed.us/database/feis/plants/shrub/arcuva/all.html
Red raspberry	3 to 7	pioneer or early seral species; shade-intolerant https://www.fs.fed.us/database/feis/plants/shrub/rubida/all.html

Note: 1) 0 = no structure (water, anthropogenic); 1 = Sparse/bryoid; 2 = Herb (< 20 to 100+ years old); 3 = Shrub/Herb (< 20 to 40 years old); 4 = Pole/Sapling (< 40 to 100+ years old); 5 = Young Forest (< 40 to 100+ years old); 6 = Mature Forest (80 to 140 years in SBS, 80 to 250 years in ESSF); 7 = Old Forest > 140 years in SBS, > 250 years in ESSF (RIC 1998).

Using the final lookup table and the updated ecosystem mapping prepared in Section 2.4, distribution maps and summary graphs for the identified culturally important plant species were created.

2.11 Vegetation Trace Metals Sampling and Analysis

Plant Species Selection

Numerous plant species that occur in the study area are sources of food for wildlife and humans. Plant tissues can be bio-accumulators of heavy metals (Gamberg et al. 2005, Tchounwou et al. 2012, Tovar-Sanchez et al. 2018) taking up heavy metals from the soil, water or through direct deposition by airborne contaminants. This bio-accumulation can be passed along directly to humans and wildlife, as well humans may obtain them indirectly by eating wildlife that have eaten the plants. As part of the human effects' assessment and overall monitoring of baseline ecosystem conditions, sampling of selected plants for trace metals concentrations was undertaken. Sample species were selected based on potential consumption by humans and/or wildlife, as well as frequency of occurrence in sufficient quantity to produce at least a single sample. In total, sampling included 23 plant species in 20 genera as outlined in Table 2.11-1.

Table 2.11-1: Plant species selected for trace metals sampling.

Common Name	Scientific Name	Primary Consumption	Tissue(s) Sampled
Alaska Willow	*Salix alaxensis*	Humans (medicinal), ungulates, hares	Leaves/stems
Beaked Sedge	*Carex utriculata*	Bears, ungulates, hares, rodents	Leaves/stems
Black Cottonwood	*Populus trichocarpa*	Humans (medicinal), hares, ungulates	Leaves/stems
Black Gooseberry	*Ribes lacustre*	Humans, bears, birds, rodents	Berries
Black Huckleberry	*Vaccinium membranaceum*	Humans, bears, birds, rodents	Berries
Black Twinberry	*Lonicera involucrata*	Bears, ungulates	Berries, leaves/stems
Bluejoint Reedgrass	*Calamagrostis canadensis*	Bears, ungulates, rodents, hares	Leaves/stems
Buckbean	*Menyanthes trifoliata*	Humans, moose	Not sampled
Common Horsetail	*Equisetum arvense*	Humans, bears, hares, ungulates	Leaves/stems
Cow Parsnip	*Heracleum maximum*	Humans, bears	Leaves/stems
Devils Club	*Oplopanax horridus*	Humans (medicinal), bears, birds	Berries, leaves/stems

Common Name	Scientific Name	Primary Consumption	Tissue(s) Sampled
Fireweed	*Epilobium angustifolium*	Humans, bears, rodents, hares, ungulates	Leaves/stems
Grey-leaved Willow	*Salix glauca*	Humans (medicinal), ungulates, hares	Leaves/stems
Highbush Cranberry	*Viburnum edule*	Humans, bears, birds, rodents	Berries
Indian Hellebore	*Veratrum viride*	Humans (medicinal), bears	Not sampled
Kinnickinnick	*Arctostaphylos uva-ursi*	Humans, bears, rodents	Not sampled
Prickly Rose	*Rosa acicularis*	Humans (medicinal), hares	Leaves/stems
Red Elderberry	*Sambucus racemosa*	Humans (medicinal), bears, birds, rodents	Berries
Red Osier Dogwood	*Cornus stolonifera*	Ungulates, bears, hares	Leaves/stems
Red Raspberry	*Rubus idaeus*	Humans, bears, birds, rodents	Berries
Scouler's Willow	*Salix scoulerina*	Humans (medicinal), ungulates, hares	Leaves/stems
Sitka Alder	*Alnus viridis ssp. sinuata*	Ungulates, hares	Leaves/stems
Soopolallie	*Shepherdia canadensis*	Humans, bears, birds, rodents	Berries
Subalpine Fir	*Abies lasiocarpa*	Humans (medicinal), ungulates, hares	Leaves/stems
Tea-leaved Willow	*Salix planifolia*	Humans (medicinal), ungulates, hares	Leaves/stems
Western Mountain-ash	*Sorbus scopulina*	Humans (medicinal), rodents, ungulates	Leaves/stems

Sample Site Selection

Sample sites were selected based on their location with respect to current or planned infrastructure, as well as the presence of sufficient quantities of plant species of interest for vegetation sampling. Crews conducted vegetation sampling during three consecutive growing seasons (2017 to 2019) within the V-LSA, with a focus on potential infrastructure development areas such as the minesite, access corridor and rail infrastructure areas.

At each sampling location, a Site Visit (SIVI) form was used to record the plot number, GPS location, species collected and individual sample IDs, along with recording ecosystem characteristics at a visual-level. (BC MOFR and BC MOE 2010).

Tissue Sampling Protocol

For each vegetation sample collected for analysis, the crew obtained sufficient samples to provide a minimum dry weight of three grams. Each sample was a composite of a minimum of five individual plants, and only the current year's growth in the above-ground portions of tissue were sampled. Nitryl gloves and sterilized implements (clippers and knives) were used to assist in collecting the samples and keeping them free of contaminants. All non-target plant materials and other debris were removed prior to the sample being placed into a plastic sampling bag. Sample bags were labeled with species name, tissue collected, sample site ID and date. Samples were placed in a freezer or cooler within four hours of collection and sent frozen to CARO Analytical Services for analyses of the samples.

Plant Tissue Samples Collected

During the 2017, 2018 and 2019 field programs, 175 samples of plant tissue were collected from 79 sample sites (Figure 2.11-1) during the vegetation trace metals sampling program. A total of 150 samples were sent to the lab for trace metals analysis from 74 of those sites (Table 2.11-2).

Although berries are an important cultural and wildlife food, they were found to be limited within the V-LSA during the 2017-2019 seasons, and so we were unable to collect a large number of samples. Crews

collected berry samples from eight species, but only a single sample was collected from three of these species; the majority of berry samples were collected from highbush cranberry (Table 2.11-2).

Vegetation samples that included leaves/stems were collected from 17 species, with fireweed being the most commonly sampled vegetative tissue (collected at 19 sites). Black twinberry and common horsetail tissues were collected at 15 sites each, Scouler's willow at 12 sites, and subalpine fir at 10 sites. Sample sizes for other species where leaves/stem samples were collected ranged from 1 to 9 (Table 2.11-2).

Table 2.11-2: Summary of plant species and tissues analyzed from the 2017 to 2019 vegetation trace metals sampling program.

Common Name	Latin Name	Berries	Leaves/ Stems	Total
Alaska Willow	*Salix alaxensis*		1	1
Beaked Sedge	*Carex utriculata*		3	3
Black Cottonwood	*Populus trichocarpa*		8	8
Black Gooseberry	*Ribes lacustre*	1		1
Black Huckleberry	*Vaccinium membranaceum*	2		2
Black Twinberry	*Lonicera involucrata*	1	15	16
Bluejoint Reedgrass	*Calamagrostis canadensis*		1	1
Common Horsetail	*Equisetum arvense*		15	15
Cow Parsnip	*Heracleum maximum*		5	5
Devils Club	*Oplopanax horridus*	1	2	3
Fireweed	*Epilobium angustifolium*		19	19
Grey-leaved Willow	*Salix glauca*		1	1
Highbush Cranberry	*Viburnum edule*	11		11
Prickly Rose	*Rosa acicularis*		7	7
Red Elderberry	*Sambucus racemosa*	4		4
Red Osier Dogwood	*Cornus stolonifera*		9	9
Red Raspberry	*Rubus idaeus*	2		2
Scouler's Willow	*Salix scoulerina*		12	12
Sitka Alder	*Alnus viridis ssp. sinuata*		3	3
Soopolallie	*Shepherdia canadensis*	3		3
Subalpine Fir	*Abies lasiocarpa*		10	10
Tea-leaved Willow	*Salix planifolia*		7	7
Western Mountain-ash	*Sorbus scopulina*		7	7
Total # Samples		***25***	***125***	***150***

Plant Tissue Analysis

Plant tissue samples were analyzed for moisture content and the concentration of 31 trace metals. Metal concentrations in vegetation tissue were analyzed using wet tissue samples, and resulting wet weight concentrations have been converted *post hoc* to dry weight concentrations using the formula:

*Dry Weight Concentration = Wet Weight Concentration * (100/(100-%moisture)).*

Because tissue moisture content can vary substantially depending on season and water availability, dry weight concentrations present a more objective measure of metal concentration. Method Detection Limits (MDL) for sample moisture content (% wet) and each of the trace metals (mg/kg wet) analyzed are provided in Table 2.11-3.

Table 2.11-3: Trace metals and their method detection limits (MDL).

Analyte	Code	Units	MDL	Analyte	Code	Units	MDL
Moisture		% wet	1	Manganese	Mn	mg/kg wet	0.02
Aluminum	Al	mg/kg wet	0.4	Mercury	Hg	mg/kg wet	0.002
Antimony	An	mg/kg wet	0.002	Molybdenum	Mo	mg/kg wet	0.01
Arsenic	As	mg/kg wet	0.005	Nickel	Ni	mg/kg wet	0.01
Barium	Ba	mg/kg wet	0.01	Phosphorus	P	mg/kg wet	5
Beryllium	Be	mg/kg wet	0.002	Potassium	K	mg/kg wet	10
Bismuth	Bi	mg/kg wet	0.02	Selenium	Se	mg/kg wet	0.02
Boron	Bo	mg/kg wet	0.2	Silver	Ag	mg/kg wet	0.01
Cadmium	Cd	mg/kg wet	0.002	Sodium	Na	mg/kg wet	2
Calcium	Ca	mg/kg wet	2	Strontium	Sr	mg/kg wet	0.01
Chromium	Cr	mg/kg wet	0.01	Thallium	Th	mg/kg wet	0.001
Cobalt	Co	mg/kg wet	0.004	Tin	Sn	mg/kg wet	0.02
Copper	Cu	mg/kg wet	0.01	Titanium	Ti	mg/kg wet	0.05
Iron	Fe	mg/kg wet	1	Uranium	U	mg/kg wet	0.001
Lead	Pb	mg/kg wet	0.004	Vanadium	V	mg/kg wet	0.02
Magnesium	Mg	mg/kg wet	2	Zinc	Zn	mg/kg wet	0.1

Note: Shading indicates trace metals of environmental interest.

Summary statistics (maximum, minimum, median, mean and standard deviation values) were calculated for dry weight metal concentrations for plants species and tissues where there were at least ten samples. Because uptake, allocation, and concentration of metals may differ between species and tissue type, metal concentrations are summarized separately for each species/tissue type. Metal concentrations with values below MDL were replaced with half the value of the detection limit for summary calculations. As there are currently no provincial or federal regulatory guidelines for plant tissue metal concentrations, we were unable to compare the resultant values to any guidelines.

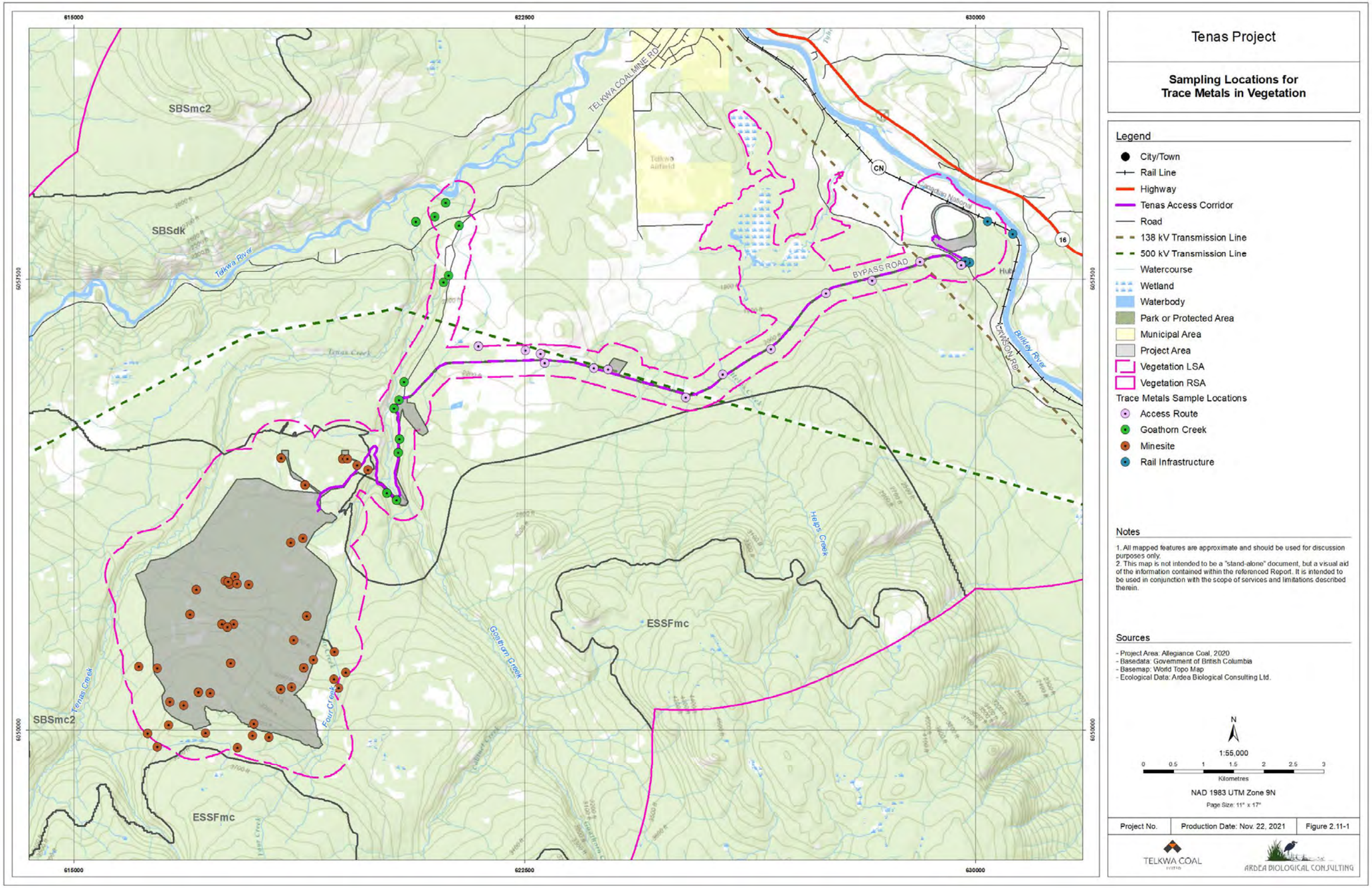

Figure 2.11-1: Location of vegetation trace metal sampling sites.

3. DATA SUMMARY

3.1 Existing Information Review

3.1.1 Regulatory and Policy Context

When developing the baseline ecosystems and vegetation program we considered applicable federal and provincial legislation, regulations, strategies, guidelines, plans, and best management practices (BMPs) relevant to the Vegetation VC, we also included available information provided by Indigenous groups. Applicable information from provincial land use plans and designations were also considered.

Federal and provincial legislation and regulations applicable to the Project and relevant to the ecosystems and vegetation are described in Table 3.1-1.

Table 3.1-1: Applicable legislation and regulations related to ecosystems and vegetation.

Name	Year	Description
Canadian Environmental Protection Act	1999	The *Canadian Environmental Protection Act* focuses on protecting environmental and human health by preventing, controlling, and managing pollutants, wastes, and other toxic substances and contributing to sustainable development (Environment and Climate Change Canada 2019).
Species at Risk Act (SARA)	2019	SARA protects species listed on Schedule 1 as Extirpated, Endangered and Threatened, and affords species listed as Special Concern the benefits of management planning. Species included in Schedule 1 are established by the federal Cabinet and are based on recommendations by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and consultation with government, Indigenous groups, and the public. SARA focuses on establishing and implementing plans to protect listed species and their critical habitat, reduce threats, and foster recovery.
BC Agricultural Land Commission Act	2002	The *Agricultural Land Commission Act* sets the legislative framework for the establishment and administration of the agricultural land preservation program. The associated Agricultural Land Reserve Use Regulation identifies permitted land uses within the Agricultural Land Reserve (ALR), and the Agricultural Land Reserve General Regulation sets out the required application procedures for alternative land uses.
BC Ecological Reserve Act	1996	The *Ecological Reserve Act* provides for the establishment and administration of ecological reserves, which may be created to protect and preserve species at risk and their habitats (BC Parks 2019). No ecological reserves as delineated by the Government of BC (2019a) exist within the Study Areas for the Vegetation VC.
BC Environmental Assessment Act	2002	The *Environmental Assessment Act* provides a mechanism for the Province of BC to review all major projects proposed in the province to assess for any potentially adverse environmental, economic, social, heritage, or health effects (Government of British Columbia 2002). This Project requires an assessment of potential adverse environmental effects under the Reviewable Projects Regulations of the Act as the Project exceeds the production capacity of 75 thousand tonnes per year.

Name	Year	Description
BC Environmental Management Act	2003	The *Environmental Management Act* regulates pollution, hazardous waste, contaminated site remediation, and the discharge of municipal and industrial waste to the environment while ensuring the protection of human health and the environment (Government of British Columbia 2019b). The Contaminated Sites Regulations of the Act provide quantitative standards to define site contamination and to evaluate reclamation success.
BC Forest and Range Practices Act	2002	The *Forest and Range Practices Act* outlines standards and requirements for how forest and range practices and natural resource activities should be conducted on Crown land in BC in a manner that safeguards protection of natural resources, including vegetation (Government of British Columbia 2020). The Invasive Plants Regulation is a provision to section 47 the *Forest and Range Practices Act,* preventing the introduction or spread of invasive plants. This regulation specifies vegetation species recognized as invasive plants in BC. The *Forest and Range Practices Act* regulates forest clearing and applies protection to old growth forests and riparian areas. It also manages ecosystems as wildlife habitat through the Identified Wildlife Management Strategy.
BC Integrated Pest Management Act	2003	The *Integrated Pest Management Act* and associated regulations legislate the sale and use of pesticides in BC to reduce reliance on and use of pesticides. From a vegetation perspective, the Act regulates the use of herbicides to control weeds and invasive plants.
BC Land Act	1996	Crown land is partly managed under the authority of the *Land Act*, which is the primary legislation the Province of BC uses to convey land to the public for community, business, or industrial use (Government of British Columbia 2019b). Sustainable management of Crown land and natural resources is guided in part by the *Land Act* and associated Land Use Objectives Regulation in addition to land use plans, which work to protect species at risk and their habitats within certain geographical regions (Government of British Columbia 2019c).
Mines Act	1996	The *Mines Act* describes how mines in BC are to be operated, including administration, permitting, acquisition, delegation of power, inspection, health and safety, penalties, abandonment, and enforcement. The BC Ministry of Energy and Mines requires completion of a vegetation assessment and development of an environmental management and reclamation plan to support the mitigation, decommissioning and closure of a Project.
Riparian Areas Protection Act	2016	The *Riparian Areas Protection Act* regulates approval of work in and around watercourses including provision of directives relating to the protection and enhancement of riparian areas.
Water Sustainability Act	2014	The *Water Sustainability Act* manages the licensing, diversion, and use of water resources in BC. This includes regulation of changes made in and around watercourses, and provision of directives to protect water quantity, water quality and aquatic ecosystems.
Weed Control Act	1996	The *Weed Control Act* establishes the duty to control designated noxious weeds growing on any occupied land in BC. The Weed Control Regulation specifies provincial and regional noxious weeds and provides instruction on controlling their introduction and spread
Wildlife Act	2019	The BC *Wildlife Act* provides for conservation of specific ecosystems and ecosystem components that provide habitat for wildlife species managed by the Ministry of Environment.

Strategies, Guidelines, Plans, and Best Management Practices

Other strategies, guidelines, plans, and best management practices are also applicable to the ecosystems and vegetation (Table 3.1-2). These documents were reviewed when identifying the potential effects of the Project on vegetation and ecosystem resources, guiding the scope and development of the baseline program.

Table 3.1-2: Summary of strategies, guidelines, plans and best management practices applicable to ecoystems and vegetation.

Name	Year	Description
A Compendium of Wildlife Guidelines for Industrial Development Projects in the North Area, BC - Interim Guidance	2014	These guidelines provide direction for considering and mitigating threats to wildlife and wildlife habitat in the North Area (i.e., Peace, Omineca, and Skeena regions) during industrial activities (BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) 2014).
BC Conservation Framework: Conservation Priorities for Species and Ecosystems	2009	A science-based framework designed to prioritize species and ecosystems for conservation, select effective conservation actions, and co-ordinate management actions. Results can be used to advise conservation programs for a variety of stakeholders and organizations (Government of British Columbia 2009).
Canadian Biodiversity Strategy	1995	The three objectives of the Canadian Biodiversity Strategy are the conservation of biodiversity, the sustainable use of biological resources, and the fair and equitable sharing of the benefits that result from the use of genetic resources (Government of Canada 1995).
Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia: Section 4	2014	The purpose of these guidelines is to provide province-wide direction for maintaining environmentally valuable resource during urban and rural land development in BC. Environmentally valuable resources include species, features, or Environmentally Valuable Resources locations that enhance the biodiversity of an area; these may include common or rare species or habitats (Government of British Columbia 2014a).
Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada	2004	This best practice guide for considering plant and wildlife species at risk in environmental assessment provides best practice guidelines, key sources of information, policy commitments and laws and a discussion of the implications of the federal *Species at Risk Act* (Environment Canada 2004).
Federal Policy on Wetland Conservation	1991	The Federal Policy on Wetland Conservation provides goals, guiding principles, and strategies to protect, promote, conserve, and enhance wetlands located on federal lands and waters in Canada, based on scientific evidence and co-operation.
Handbook for Mineral and Coal Exploration in BC	2008	This handbook compiles existing knowledge and recommended management practices for coal exploration and mining, including practices for water management and reclamation (Association for Mineral Exploration British Columbia et al. 2008)
Health, Safety and Reclamation Code for Mines in BC	2017	This Code guides mining operations to minimize associated risks to human and environmental health and safety and provide standards for reclamation. The Code focuses on mine operation and personnel. Reclamation standards include land use, revegetation, watercourse, and monitoring specifications (Province of British Columbia 2017).

Name	Year	Description
Identified Wildlife Management Strategy - Accounts and Measures for Managing Identified Wildlife: Northern Interior Forest Region	2006	The Accounts and Measures for Managing Identified Wildlife summarize the status, life history, distribution, and habitat requirements of identified species and plant communities; they also outline specific guidelines for habitat conservation and management (Government of British Columbia 2004a).
Identified Wildlife Management Strategy - Procedures for Managing Identified Wildlife	2004	The Procedures for Managing Identified Wildlife describe the procedures for establishing, modifying, and rescinding a Wildlife Habitat Area (WHA), and for implementing strategic and landscape level planning recommendations (Government of British Columbia 2004b)
Interim Assessment Protocol for Old Growth Forest in BC	2017	This report outlines the protocol for two types of assessments of old growth forest objectives in BC: old and old and mature forest retention, and incursions into Old Growth Management Areas (OGMAs) (Provincial Old Growth Forest Technical Working Group - Ministry of Forests, Lands, Natural Resource Operations and Rural Development - for the Value Foundation Steering Committee 2017).
North West Invasive Plant Council (NWIPC)	N/A	The Project is located within the Bulkley Invasive Plant Management Area of the NWIPC. The NWIPC provides support and co-ordination for invasive plant management, including providing a shared invasive plant inventory and a list of target invasive plants, spreading awareness about invasive plants, and assessing and treating new and existing invasive plant infestations.
Order Establishing Provincial Non-Spatial Old Growth Objectives	2004	This Order identifies the age and amount of old growth forest (in percent) to be maintained in various natural disturbance types, biogeoclimatic zones, and landscape units to maintain target biodiversity values, and subsequently the amount available for timber harvesting (Government of British Columbia 2004c).
Policy for Mitigating Impacts on Environmental Values	2014	The purpose of this policy is to improve the quality, transparency, and consistency of information to support provincial staff, decision makers, and proponents when there is an identified need for environmental mitigation under existing legislation. The policy applies to the identification of VCs, the assessment of potential effects, the development of mitigation measures, and the preparation of mitigation plans (BC Ministry of Environment 2014).
Policy for Mitigating Impacts on Environmental Values	2014	This Policy provides guidance to decisions concerning environmental mitigation measures. It incorporates environmental, social, and economic values, encourages use of the best available data and data sharing, and provides a recommended mitigation hierarchy and mitigation process and plan (BC Ministry of Environment 2014).
Protecting Vulnerable Species: A Five-Year Plan for Species at Risk in BC	2014	A five-year plan to manage and protect species at risk in BC while balancing economic, environmental, and community values. This plan outlines five main goals of the plan and recommends strategic action items to achieve these goals (Government of British Columbia 2014b).
Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in BC. Wetland Stewardship Partnership	2009	A document providing recommended practices on wetland protection and conservation to land managers and land users, with the goal of maintained or increased wetland quality and quantity. The document includes specific guidelines for various sectors, including mining (Province of British Columbia 2009).

Land Use Plans

The V-LSA and the V-RSA are located within the *Bulkley Land and Resource Management Plan* (LRMP) (BVCRB and IRT 1998). The LRMPs were developed to direct management of public land and resources within the planning regions by providing specific directions developed through local input. More detailed landscape unit plans have also been developed for landscape units that overlap the V-RSA; with land use

planning objectives within the Telkwa Landscape Unit and the Bulkley Valley Landscape Unit governed by the *Telkwa Land Use Plan* (BCFD 1999) and the *Bulkley Valley Sustainable Resource Management Plan* (BC MAL 2005) respectively. Together, these plans describe resource management objectives for vegetation, including forest structure and old growth forest retention, wetlands, rare plants and lichens, and listed ecological communities.

Previous Environmental Assessment Reports

There have been several projects proposed to mine coal in the proposed Tenas Coal Project area that have prepared environmental assessment documents since 1983. A summary of the reports prepared that contain vegetation and ecosystem information is outlined Table 3.1-3.

Table 3.1-3: Summary of previous environmental assessment reports for the Tenas Coal Project area.

Report	Content	Reference
Telkwa Project Stage I Application	General forest cover and ecosystem information and mapping provided for the proposed project area to describe the area. No other vegetation information was included.	CNRL and REPAL Ltd. 1983
Telkwa Project Vegetation - Forestry - Wildlife	Stage II report prepared to provide ecosystem mapping, forest capability and potential rare plants and plant communities within the project area. A 1:20,000 paper ecosystem map (12,958 ha) that covered the existing Tenas Project area was provided to the standard of the day, with 64 plots completed. Plants identified as potentially rare and a rare plant community were identified within the project area.	TAESCO 1984
Telkwa Coal Project Application for a Project Approval Certificate	Initial project application that summarized the TAESCO (1984) for the area. No new vegetation or ecosystem data was collected or provided in this report.	Manalta Coal Ltd. 1997
Telkwa Coal Terrestrial Ecosystems, Volume 1: Inventory	Report outlining methods and results for Terrestrial Ecosystem Mapping, Agricultural Land Capability mapping, Forest Capability mapping, rare plant surveys, rare and sensitive ecosystems mapping, and sampling of vegetation for trace metals analysis.	Oikos 1999

3.1.2 Indigenous Knowledge

The Cultural Use Study (CUS) compiled a baseline inventory of cultural heritage resources pertaining to Wet'suwet'en communities by examining pre-existing cultural, social, historic, and economic data (Budhwa et al. 2020). That study and other available sources of Indigenous Knowledge were reviewed for information relating to plants and plant communities (see Section 2.11). Through the information outlined in the CUS and other documents, there is a recognition of the value of the natural environment that is intrinsic to how the Wet'suet'en view the land and how it is used:

> "The Wet'suwet'en continue to maintain a substantial connection to their hereditary lands by way of Yintah. For the Wet'suwet'en, Yintah is a central factor in their culture; it is the physical and spiritual connection that everything has to their territories… [Yintah is] a concept in which all environmental components - from plants and animals to waterways and mountains - are all interconnected and linked with the human world" (Budhwa et al. 2020).

Plants historically and currently provide important food, medicinal, spiritual, ceremonial and functional requirements for the Wet'suwet'en. Gathering plants was an important part of the traditional seasonal round related to the use of the land, with gathering places for those plants considered part of a house territory to be managed (Budhwa et al. 2020).

3.2 Terrestrial Ecosystem Mapping

3.2.1 Existing Information

Ecosystem Classification Guides

All field guides that describe ecosystems in the area were assembled (Banner *et al*. 1993; Williams *et al*. 2001; MacKenzie and Moran 2004). As timelines did not allow for pre-typing of the area, field sampling was designed to cover as many different ecosystem and terrain types as possible. Banner *et al.* (1993) and Williams *et al.* (2001) contain classifications at the subzone level with site series described for classification units within subzone. MacKenzie and Moran (2004) contains a wetland classification at the site association level, with these classification units being applicable across all sites capable of supporting similar plant associations.

Terrestrial and wetland ecosystem classifications sometimes overlap in their classifications of the same community, with some of the forested ecosystems in Banner et al. (1993) also classified as wetland ecosystems in Mackenzie and Moran (2004). For example, the Ws07 Spruce - Common Horsetail - Leafy mosses swamp ecosystem (Mackenzie and Moran 2004) was considered equivalent to the poorly drained phase of the SBSdk Spruce - Horsetail ecosystem - the SBSdk 07b; and the lacustrine/morainal phase of the SBSmc2 Spruce - Horsetail ecosystem - the SBSmc2 10b from Banner et al. (1993).

Ecosystems have also been found outside of the original BGC subzone identified in Banner et al. (1993). For example, the Spruce / Devil's club ecosystem (site series 08) is only described in the SBSmc2 subzone, but this ecosystem was sampled and mapped in the SBSdk in the project area in both the Tenas TEM and Oikos TEM (Oikos 1999).

Existing Ecosystem Mapping

An ecosystem map was produced in 1983 for the Stage 1 Application for the Telkwa Project by Crows Nest Resources Limited. This map contained generalized ecosystems with large polygons, classified by broad structural and leading forest conditions (CNRL 1983). A more detailed Stage 2 project completed by TAESCO Consultants Ltd. in 1984 produced a 1:20,000 scale map using ecosystem mapping standards of that period (TAESCO 1984). Although more detailed than the Stage 1 mapping, this Stage 2 product was not found to meet current mapping standards and was not used in the development of the Tenas TEM.

The 1:20,000 scale Oikos TEM (Oikos 1999) was used to assist in some of the classifications of the Tenas TEM ecosystems, especially in areas where few ecosystem plots were available. Due to the new hardwood ecosystem classification (Williams et al. 2001), the Oikos TEM mapping for deciduous forests that are common in the SBSdk portion of the project area required additional interpretation. Oikos completed 428 plots during the ecosystem mapping classification and for quality control purposes. Plots included full ecosystem plots, ground plots and visual / quality assurance type plots (Oikos 1999). The plot data collected by Oikos were used to assist in identification of ecosystems, especially in areas not visited by Ardea mappers and in the calculation of survey intensity.

The 1:20,000 scale Bulkley PEM (Timberline 2010) is a derived ecosystem mapping product, based on interpretations of the VRI data in relation to slope position, slope and aspect. As a derived product, with limited ground-truthing it was not used for development of the Tenas TEM.

Haeussler (1998) mapped rare ecosystems in the Bulkley Timber Supply Area (TSA) with polygons within the V-LSA and V-RSA. Ecosystem information provided in this mapping assisted in the classification of the Tenas TEM ecosystems.

3.2.2 Terrestrial Ecosystem Mapping Extents

The original boundaries of the Tenas TEM were based on a 2017 version of project component locations that were revised during refinements to the Project components and the inclusion of the Helps Creek wetland complex. The final delineation of the V-LSA was then based on a 250 m to 500 m buffer of the current extents of the Project components as outlined in Section 1.1, along with the addition of the Helps Creek wetland complex north of the access corridor. The small gaps created in the V-LSA that were outside of the Tenas TEM, were filled using small areas from the Oikos TEM and Bulkley PEM, while the Helps Creek wetland complex polygons were added from the Oikos TEM.

Within the V-LSA, three BGC subzones were mapped; the Engelmann Spruce Sub-alpine Fir moist cold (ESSFmc), the Sub-Boreal Spruce dry cool (SBSdk) and the Sub-Boreal Spruce moist cold Babine variant (SBSmc2). During the field assessments and mapping, adjustments to the provincial BGC linework were made to reflect the BGC ecosystems found (RIC 1999).

In the V-RSA, three additional BGC subzones were mapped including the Boreal Altai Fescue Alpine undifferentiated (BAFAun), Engelmann Spruce Subalpine Fir moist cold parkland (ESSFmcp) and the Engelmann Spruce Subalpine Fir moist cold woodland (ESSFmcw). A summary of the areas contributed by the various ecosystem mapping products within each BGC subzone for the V-LSA and V-RSA are provided in Table 3.2-1.

Table 3.2-1: Summary of the biogeoclimatic subzone areas from the ecosystem mapping products used in the V-LSA and V-RSA.

Biogeoclimatic (BGC) Subzone	BGC Subzone	Tenas TEM Area (ha)	Oikos TEM Area (ha)	Bulkley PEM Area (ha)	Total Area (ha)
V-LSA					
Engelmann Spruce Subalpine Fir moist cold	ESSFmc		10.5		10.5
Sub-Boreal Spruce dry cool	SBSdk	1,060.2	381.4		1,441.6
Sub-Boreal Spruce moist cold Babine variant	SBSmc2	1,811.8	64.2	2.9	1,878.8
Total V-LSA Area (ha)		***2,872.0***	***456.0***	***2.9***	***3,330.9***
V-RSA					
Boreal Altai Fescue Alpine unclassified	BAFAun			60.7	60.7
Engelmann Spruce Subalpine Fir moist cold parkland	ESSFmcp			448.7	448.7
Engelmann Spruce Subalpine Fir moist cold woodland	ESSFmcw			999.0	999.0
Engelmann Spruce Subalpine Fir moist cold	ESSFmc		2,148.9	2,460.6	4,609.5
Sub-Boreal Spruce dry cool	SBSdk	1,361.7	8,875.2	8,444.4	18,681.3
Sub-Boreal Spruce moist cold Babine variant	SBSmc2	2,051.4	5,610.0	3,265.4	10,926.8
Total V-RSA Area (ha)		***3,413.2***	***16,634.1***	***15,678.8***	***35,726.0***

3.2.3 Mapping Survey Intensity Levels and Accuracy Assessment

Survey Intensity Levels

Ecosystem plots were placed throughout the V-LSA to complete the Tenas TEM, with efforts made to place plots in all identifiable ecosystem types. Sampling occurred from 2017 to 2019 with the majority of the plots being completed during 2018 (Table 3.2-2 and Figure 3.2-1). Seven plots from 2007 obtained from the provincial ecosystem database and 127 plots from Oikos collected in 1997/1998 for the Manalta TEM (Oikos 1999) were available within the V-LSA for a total of 780 available for use in the survey intensity calculations.

Table 3.2-2: Ecosystem plot distribution within the Project areas in the V-LSA by year.

General Map Arear	Year					Grand Total
	2007	1997/98	2017	2018	2019	
Access Corridor		27		106	11	144
Goathorn Creek		11	16	75	3	105
Helps Crk. Wetland		21		5		26
Minesite	6	68	156	214	1	445
Rail Infrastructure	1		25	14	20	60
Total Plots	***7***	***127***	***197***	***414***	***55***	***780***

As outlined in Section 2.2, the Tenas TEM will be used in the assessment of effects of the project on plants and vegetation communities, as the basis for wildlife habitat suitability mapping, and to help in mitigation and restoration planning within the project footprint. Survey intensity levels (SILs) were set for the different mapping scales completed in the Tenas TEM (Section 2.3) and can be calculated by assessing the percentage of polygon inspections completed and is based on the scale of mapping and potential uses of the mapping (RIC 1998).

A summary of the SIL calculation results for the V-LSA TEM polygons within the project footprint areas is provided in Table 3.2-3. The TEM within the footprint of the rail infrastructure area met the planned SIL 1 inspection rate (76+%), while TEM in the access corridor footprint area met the planned SIL 2 inspection rate (51% to 75%). For the TEM in the minesite footprint area, a SIL 2 was met, which is below the planned SIL 1. Although SIL1 was not achieved on the minesite footprint area, the TEM was completed by highly experienced mappers with extensive local expertise and achieved a high accuracy for the majority of the ecosystems mapped in the area (see Mapping Accuracy Assessment below).

Table 3.2-3: Summary of survey intensity for the Tenas TEM within the V-LSA.

Mapping Scale	Project Footprint Area	Number of Polygons in Project Footprint Areas	Number of Polygons with Plots Completed Within Project Footprint Area			Polygon Inspection Percent	Survey Intensity Level Obtained
			Tenas TEM Plots	Oikos TEM Plots[1]	Total		
1:5,000	Minesite	309	168	7	175	57%	2
	Rail Infrastructure	21	19	-	19	90%	1
1:10,000	Access Corridor	65	39	4	140	66%	2

Notes: 1) Additional polygons that contained Oikos TEM plots
Shading indicates Survey Intensity Level met

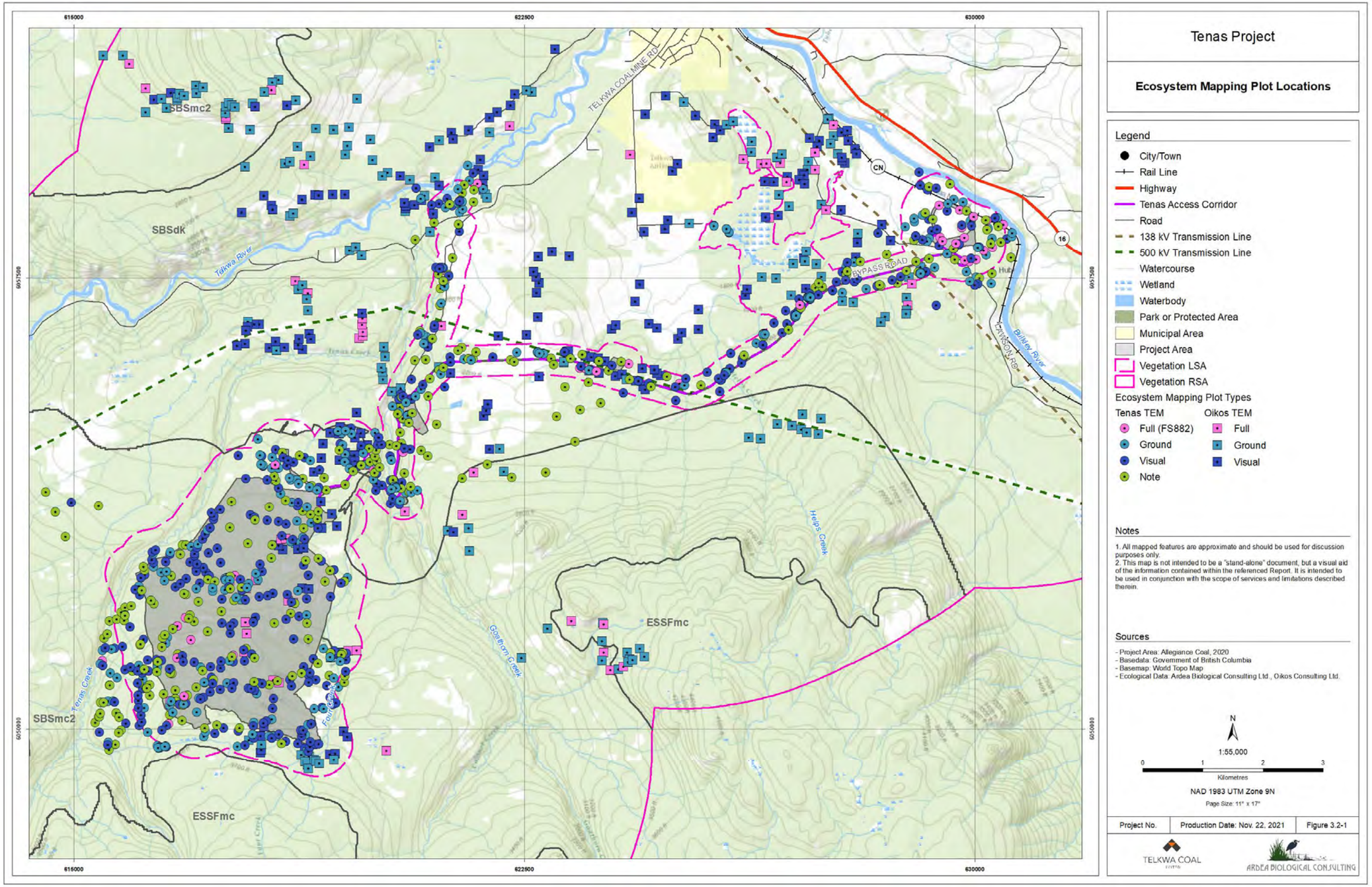

Figure 3.2-1: Distribution of ecosystem plots within the V-LSA and V-RSA.

Mapping Accuracy Assessment

The detailed results of the ecosystem mapping accuracy assessment based on the methods outlined in Meidinger (2003) are provided in Appendix A and summarized below.

At total of 338 TEM polygons were identified that contained ecosystem plots with a *Fair* to *Excellent* site plot quality (total 644 plots, with 1 to 13 plots/polygon). This sample size was greater than the recommended sample size of 272 (confidence level = 0.90, max error of ± 5%) provided in Meidinger (2003) for ecosystem mapping projects of this size and complexity.

A simple comparison of the percent overlap area for each ecosystem mapped in the TEM within the V-LSA to the percent of ecosystems identified in the plots was completed, along with the percent overlap between the ecosystems (Appendix A; Table A-1). The total percent overlap for the mapped area based on this assessment would be 85% ± 2% (80% Confidence Interval) for the SBSmc2 BGC subzone, for the 23 ecosystems identified in the mapping and the plots, with the highest overlaps occurring within the Sxw - Huckleberry (46.7%) and Sxw - Oak fern (17.2%) ecosystems. In the SBSdk BGC subzone, the overlap was 70% ± 4% for 38 ecosystems, with the highest overlaps occurring in the Sxw - Spirea - Purple peavine (17.5%) and Sxw - Twinberry - Coltsfoot (14.5%) ecosystems. A graphic comparison of the TEM map area and plot percentages for the SBSmc2 and SBSdk BGC subzones is provided in Appendix A, Figure A-1 and Figure A-2.

This type of comparison is non-spatial as it is comparing the overall percentages of mapped ecosystems to the percentage of plot ecosystems without identifying where each of the mapped and plotted ecosystems are located in comparison to each other. Both the table and graphs for this comparison identifies ecosystems that are mapped but were not captured in the plots (e.g. SBSmc2 DM - Drummond's willow - Mountain alder, SS - SbSxw - Scrub birch - Sedge; several wetland ecosystems), due to their small mapped causing them to be missed. In other instances, several ecosystems were captured in the plots but were not mapped in the TEM (e.g. SBSdk Wf01 - Water sedge - Beaked sedge, Wb01 - Black spruce - Creeping snowberry - Peat-moss), this is due to the ecosystem not being at least 10% of a polygon and therefore not mapped.

Three other quality assessments were completed based on the methods outlined in Meidinger (2003), all related to the dominant ecosystem found in the TEM polygons within the V-LSA and are summarized in Table 3.2-4. The first assessment scored matches between the dominant ecosystem and the plot ecosystem as 100% correct. The second assessment scored matches between the dominant ecosystem and the plot ecosystem based on the overlap percentage assigned for the mapped and plot ecosystems[2]. The third assessment also looked at the overlap percentages between the mapped and plot ecosystems, but also allowed for *acceptable*[3] ecosystems to be scored at 50% of their overlap value. The ecosystems identified as an *acceptable* identification for target ecosystems in this assessment are provided in Appendix A (Table A-2 and Table A-3).

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[2] E.g. if the mapped ecosystem in polygon was 80% of the polygon and the total of the plot ecosystems was 50% for that ecosystem the score would be 50% for the overlap of the percentage for that ecosystem.

[3] *Acceptable* ecosystems were those that were similar, having an overlap in soil nutrient or soil moisture values and usually similar vegetation complexes making them sometimes difficult to distinguish apart from each other.

Table 3.2-4: Summary of results of quality assurance assessments using methods outlined in Meidinger (2003) for the Tenas TEM within the V-LSA.

BGC Subzone	% Dominant Correct (80% Confidence Interval)		% Dominant Overlap (90% Confidence Interval)		% Acceptable Overlap (90% Confidence Interval)	
	Average Score Contribution	Weighted Average Contribution	Average Score Contribution	Weighted Average Contribution	Average Score Contribution	Weighted Average Contribution
SBSmc2	50% ± 4%	57% ± 2%	46% ± 5%	48% ± 2%	72% ± 5%	75% ± 2%
SBSdk	71% ± 5%	71% ± 2%	59% ± 7%	57% ± 3%	73% ± 6%	72% ± 3%
Overall	66% ± 3%	68% ± 1%	57% ± 3%	56% ± 2%	72% ± 3%	72% ± 1%

For the assessment methods, the % Dominant Overlap scores were lower than the % Dominant Correct or % Acceptable Overlap scores for both the SBSmc2 and SBSdk BGC subzones, and the % Acceptable Overlap had the highest overall scores for both subzones (Table 3.2-4). The scores for the individual ecosystems for the three assessment methods can be found in Appendix A (Table A-4) and are quite varied depending on the number of TEM polygons having those ecosystems as dominant and the number of plots containing those same or acceptable ecosystems. In general, ecosystems with small areas within the Tenas TEM had low scores due to the limited number of plots collected for those ecosystems and that those ecosystems would not be dominant within a polygon. Another potential reason for low scores for some ecosystems was the challenge in consistently identifying hardwood and seral ecosystems as map polygons could be identified as either a mixed or deciduous version of a coniferous ecosystem (e.g. Sxw - Twinberry - Coltsfoot) with a Stand modifier (M = Mixed or B = Broadleaf) in the mapping, while an ecologist on the ground may identify it as a hardwood dominated ecosystem (Williams et al. 2001). As many of the hardwood ecosystems overlap the climax coniferous ecosystems, the % Acceptable Overlap assessment is likely the only assessment that will provide a reasonable assessment of the quality of the mapping.

Meidinger (2003) outlines minimum scores for timber supply analysis of: 65% percent overlap for the entire map; 65% for % Dominant Correct and 65% for the % Overlap scores for sampled polygons. Based on the assessments completed, the overall map percent met the minimum (85% for SBSmc2 and 70% for SBSdk; Appendix A; Table A-1) as well as for the overall score for the % Dominant Correct (66% for Average Score and 68% for Weighted Average; Table 3.2-4). Although the % Dominant Overlap scores were below the recommended 65%, it is likely that additional sampling within the ecosystems with small areas and deciduous seral ecosystems will increase the scores to meet the recommend

3.2.4 Terrestrial Ecosystems and Wetlands

A summary of the ecosystems mapped and their total area within the V-LSA and V-RSA by BGC subzone is outlined in Table 3.2-5. Appendix B provides detailed descriptions of the ecosystems within the Tenas TEM, while Appendix C contains the 1:10,000 scale map of the Tenas TEM that was produced and used in portions of the V-LSA and V-RSA.

Coniferous forests are the major ecosystem type found within the BGC subzones within both the V-LSA and the V-RSA, making up over 78.0% of the V-LSA and 80.2% of the V-RSA mapped areas (Figure 3.2-2). Zonal forest ecosystems (e.g. site series = 01, 01a, 01b, 01c) make up 40.4% of the total area mapped in the V-LSA and 39.9% of the total area mapped in the V-RSA. The second most common site series in the ecosystem mapping was the 06 (e.g. ESSFmc: Bl - Oak fern - Heron's-bill, SBSmc2: Sxw-Oak fern, SBSdk: Sxw - Twinberry - Coltsfoot) which are generally moist, medium to rich sites and make up 17.3% in the V-LSA and 18.1% in the V-RSA. Dry or wet vegetated ecosystems made up the remainder of the mapped ecosystems: 31.9% in the V-LSA and 23.0% in the V-RSA.

Table 3.2-5: Summary of mapped vegetated ecosystems by BGC subzone within the V-LSA and the V-RSA.

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
BAFAun	00	HG	Heath - Grassland		30.6
	00	HM	Herbaceous meadow		28.6
	00	PF	Krummholz		0.9
	00	RO	Rock Outcrop		0.6
	Total BAFAun Area (ha)				**60.7**
ESSFmcp	00	HG	Heath - Grassland		139.3
	00	HM	Herbaceous Meadow		41.5
	00	LA	Lake		0.5
	00	PF	Krummholz		230.6
	00	RO	Rock Outcrop		26.9
	00	WL	Wetland		0.1
	00	WM	Wet meadow		9.7
	Total ESSFmcp Area (ha)				**448.7**
ESSFmcw	00	CB	Cutbank		1.4
	00	HM	Herbaceous Meadow		1.6
	00	PD	Pond		1.4
	00	RO	Rock Outcrop		4.7
	00	TA	Talus		2.5
	01	FL	Bl - Huckleberry - Leafy liverwort - Heron's bill		679.0
	02	FC	Bl(PaPl) - Huckleberry - Crowberry - Lichen		55.6
	03	FJ	Bl(PaPl) - Huckleberry - Juniper - Lichen		29.8
	04	FV	Bl - Valerian - Leafy moss		184.8
	05	FG	Bl - Mixed shrub - Glow moss		29.3
	31	WE	Non-forested wetland		8.8
	Total ESSFmcw Area (ha)				**999.0**
ESSFmc	00	CB	Cutbank		1.7
	00	ES	Exposed Soil		3.7
	00	OW	Open Water		0.3
	00	PD	Pond		3.1
	00	RO	Rock Outcrop		3.1
	00	RZ	Road Surface		4.4
	00	SS	SbSxw - Scrub birch - Sedge		28.4
	00	TA	Talus		1.6
	00	WF	Willow - Sedge fen		20.4

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
ESSFmc	01	FB	Bl - Huckleberry - Leafy liverwort	4.8	2,606.5
	02	LC	BlPl - Juniper - Cladonia		71.0
	03	FC	Bl - Huckleberry - Crowberry	5.4	59.6
	04	HH	Bl - Huckleberry - Heron's-bill		338.5
	05	FT	Bl - Huckleberry - Thimbleberry		21.6
	06	FO	Bl - Oak fern - Heron's-bill	0.2	898.8
	07	FD	Bl - Devil's club - Lady fern		187.9
	08	FV	Bl - Valerian - Sickle moss		87.9
	09	HG	Bl - Horsetail - Glow moss		25.0
	10	FH	Bl - Horsetail - Leafy moss		182.3
	31	WE	Non-forested wetland		31.7
	32	LS	Non-forested bog		9.8
	52	SL	Sitka alder - Lady Fern		18.8
	81	SW	Saskatoon - Slender wheatgrass		1.2
	82	BW	Bluegrass - Slender wheatgrass		2.0
	Total ESSFmc Area (ha)			**10.5**	**4,609.5**
SBSmc2	00	CB	Cutbank	0.2	9.0
	00	DM	Drummond's willow - Mountain alder	0.8	5.6
	00	ES	Exposed Soil	0.2	0.9
	00	GB	Gravel Bar		11.7
	00	OW	Shallow Open Water	0.2	0.5
	00	PA	Pasture		34.4
	00	PD	Pond		0.5
	00	RI	River		12.8
	00	RO	Rock Outcrop		10.5
	00	RS	Riparian Shrub		7.8
	00	RW	Rural		0.4
	00	RZ	Road Surface	0.6	17.2
	00	SD	Sxw - Devil's club	0.6	16.4
	00	TL	Transmission Line		24.8
	00	UR	Urban/Suburban		40.6
	00	WF	Willow - Sedge fen	0.9	1.4
	01	SB	Sxw - Huckleberry	33.8	4,419.1
	01a	SB	Sxw - Huckleberry (Mesic, fine-textured)	879.0	1,006.2
	01c	SB	Sxw - Huckleberry (Submesic)	147.7	151.0
	02	PH	Pl - Huckleberry - Cladonia	1.3	106.7

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
SBSmc2	03	BM	SbPl - Feathermoss	58.0	66.7
	05	TC	Sxw - Twinberry - Coltsfoot	64.0	1,361.7
	06	SO	Sxw - Oak fern	323.9	1,439.0
	07	BF	Sxw - Scrub birch - Feathermoss	41.3	45.3
	09	SD	Sxw - Devil's club	0.9	966.6
	09a	SD	Sxw - Devil's club (Fluvial)	16.7	24.3
	09b	SD	Sxw - Devil's club (Morainal)	59.5	82.3
	10	SH	Sxw - Horsetail	7.3	680.2
	10a	SH	Sxw - Horsetail (Fluvial)	55.0	68.0
	10b	SH	Sxw - Horsetail (Lacustrine/morainal)	130.9	136.3
	12	SS	SbSxw - Scrub birch - Sedge	2.4	20.1
	31	WE	Non-forested bog		12.4
	32	LS	Non-forested bog		0.6
	51	WT	Scouler’s willow - Thimbleberry	7.2	11.0
	52	AN	Mountain alder - Stinging nettle	0.8	0.8
	52	SL	Sitka alder - Lady Fern		73.9
	81	SW	Saskatoon - Slender wheatgrass		8.4
	82	BW	Bluegrass - Slender wheatgrass		3.8
	Atcv	Atcv	$At - Canada violet seral Association	1.1	1.1
	Atha	Atha	$At - Hardhack seral association	27.1	27.1
	Fl01	Fl01	Mountain alder - Common horsetail	2.6	4.4
	Wb01	Wb01	Black spruce - Creeping snowberry - Peat-moss	2.8	2.8
	Wb05	Wb05	Black spruce - Water sedge - Peat-moss	9.2	9.2
	Wf01	Wf01	Water sedge - Beaked sedge	1.4	1.6
	Wm02	Wm02	Swamp horsetail - Beaked sedge	0.3	0.4
	Ws02	Ws02	Mountain alder - Pink spirea - Sitka sedge	0.9	0.9
	Ws03	Ws03	Bebb’s willow - Bluejoint reedgrass	0.3	0.3
	Total SBSmc2 Area (ha)			**1,877.7**	**10,763.6**
SBSdk	00	AP	Airport/Airstrip		7.7
	00	CA	Cow parsnip - Large-leaved avens	0.2	3.8
	00	CB	Cutbank	0.2	43.8
	00	CF	Cultivated Field	120.0	2,713.0
	00	DM	Drummond's willow - Mountain alder		17.8
	00	ES	Exposed Soil	2.0	11.6
	00	GB	Gravel Bar	12.7	29.8
	00	GP	Gravel Pit	3.7	53.2

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
SBSdk	00	LA	Lake		330.8
	00	OW	Shallow Open Water	1.4	4.9
	00	PA	Pasture	49.2	768.5
	00	PD	Pond	3.2	18.9
	00	RI	River	6.3	346.5
	00	RN	Railway Surface	2.6	20.0
	00	RW	Rural	33.0	249.4
	00	RZ	Road Surface	7.6	54.0
	00	SD	Sxw - Devil's club (Morainal)	12.7	183.3
	00	TA	Talus		0.9
	00	TL	Transmission Line	20.5	71.8
	00	UR	Urban/Suburban		295.1
	00	WF	Willow - Sedge fen	66.3	107.0
	01	SP	Sxw - Spirea - Purple peavine	59.6	5,748.0
	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)	155.6	219.1
	01b	SP	Sxw - Spirea - Purple peavine (Coarse-textured)	66.5	102.7
	02	LJ	Pl - Juniper - Ricegrass	0.5	99.9
	03	LC	Pl - Feathermoss - Cladina	19.4	1,202.3
	05	SF	Sxw - Spirea - Feathermoss	4.1	288.2
	06	ST	Sxw - Twinberry - Coltsfoot	252.9	4,132.0
	07	SH	Sxw - Horsetail	48.7	427.8
	07a	SH	Sxw - Horsetail (Freely drained/Fluvial)	32.5	40.0
	07b	SH	Sxw - Horsetail (Poorly drained)	5.9	5.9
	08	CD	Act - Dogwood - Prickly rose	0.2	316.0
	09	BS	Sb - Creeping-snowberry - Sphagnum	8.5	8.5
	10	SS	Sb - Soft-leaved sedge - Sphagnum	98.8	136.0
	31	WE	Non-forested wetland		114.0
	32	LS	Non-forested bog		1.2
	51	WT	Scouler's willow - Thimbleberry	33.7	42.2
	52	AN	Mountain alder - Stinging nettle	2.0	2.3
	52	SL	Sitka alder - Lady Fern	6.4	25.7
	53	AM	Mountain alder - Mitrewort	11.7	11.8
	81	SW	Saskatoon - Slender wheatgrass	0.0	25.8
	82	BW	Bluegrass - Slender wheatgrass	0.1	4.9
	Atcv	Atcv	$At - Canada violet seral Association	115.2	133.0
	Atha	Atha	$At - Hardhack seral association	7.0	9.4

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
SBSdk	Atki	Atki	$At - Kinnikinnick seral association		0.9
	Atlf	Atlf	$At - Lady fern seral association	1.7	2.5
	Atpw	Atpw	$At - Pink wintergreen seral association	96.9	107.5
	Atss	Atss	$At - Saskatoon - Snowberry seral association	9.2	17.4
	Epdm	Epdm	Paper birch - Douglas maple	9.6	11.3
	Fl01	Fl01	Mountain alder - Common horsetail	8.2	17.7
	Fm02	Fm02	ActSxw - Red-osier dogwood	37.4	87.1
	Wm01	Wm01	Beaked sedge - Water sedge	2.1	2.1
	Wm02	Wm02	Swamp horsetail - Beaked sedge	3.8	3.9
	Wm05	Wm05	Cattail	0.6	0.6
	Ws02	Ws02	Mountain alder - Pink spirea - Sitka sedge	0.2	0.2
	Ws03	Ws03	Bebb's willow - Bluejoint reedgrass	0.7	1.0
	Ws04	Ws04	Drummond's willow - Beaked sedge	0.2	0.2
	Xs	Xs	Disclimax shrub	0.3	0.3
	Total SBSdk Area (ha)			**1,441.6**	**18,681.3**
Total Mapped Area (ha)				***3,330.9***	***35,726.0***

Note: 1) Act = Black Cottonwood, At = Trembling Aspen, Bl = Subalpine Fir, Pa = Whitebark Pine, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce

Anthropogenic ecosystems (including sparsely vegetated or water types) made up 7.9% of the mapped areas within the SBSdk subzone, but only 0.03% within the SBSmc2 subzone in the V-LSA. The percent for anthropogenic ecosystems within the V-RSA was significantly larger (SBSdk: 14.0%; SBSmc2: 0.5%) due to extensive cultivated fields/pastures as well the inclusion of the Village of Telkwa and portions of the Town of Smithers.

The structural stage distributions within the V-LSA and V-RSA reflect the distribution and area of forested ecosystems in the study areas, the forest harvesting history, the extent of clearing for farming/range use and the extent of municipal lands and other infrastructure such as roads and transmission corridors (hydro and pipelines). In the V-LSA, young forests (structural stage 5[4]) dominate forested areas mapped within SBSdk, with mature forests (structural stage 6) being the second most common (Figure 3.2-3). Grass-dominated ecosystems (structural stage 2b) are the third most common due to the agricultural activities in the area.

[4] Structural stages reflect the growth of vegetation within an ecosystem and are based on both the structural appearance and age of the plant species that dominate the ecosystem. 0 = no structure (water, anthropogenic); 1 = Sparse/bryoid; 2 = Herb (< 20 to 100+ years old); 3 = Shrub/Herb (< 20 to 40 years old); 4 = Pole/Sapling (< 40 to 100+ years old); 5 = Young Forest (< 40 to 100+ years old); 6 = Mature Forest (80 to 140 years in SBS, 80 to 250 years in ESSF); 7 = Old Forest > 140 years in SBS, > 250 years in ESSF (RIC 1998).

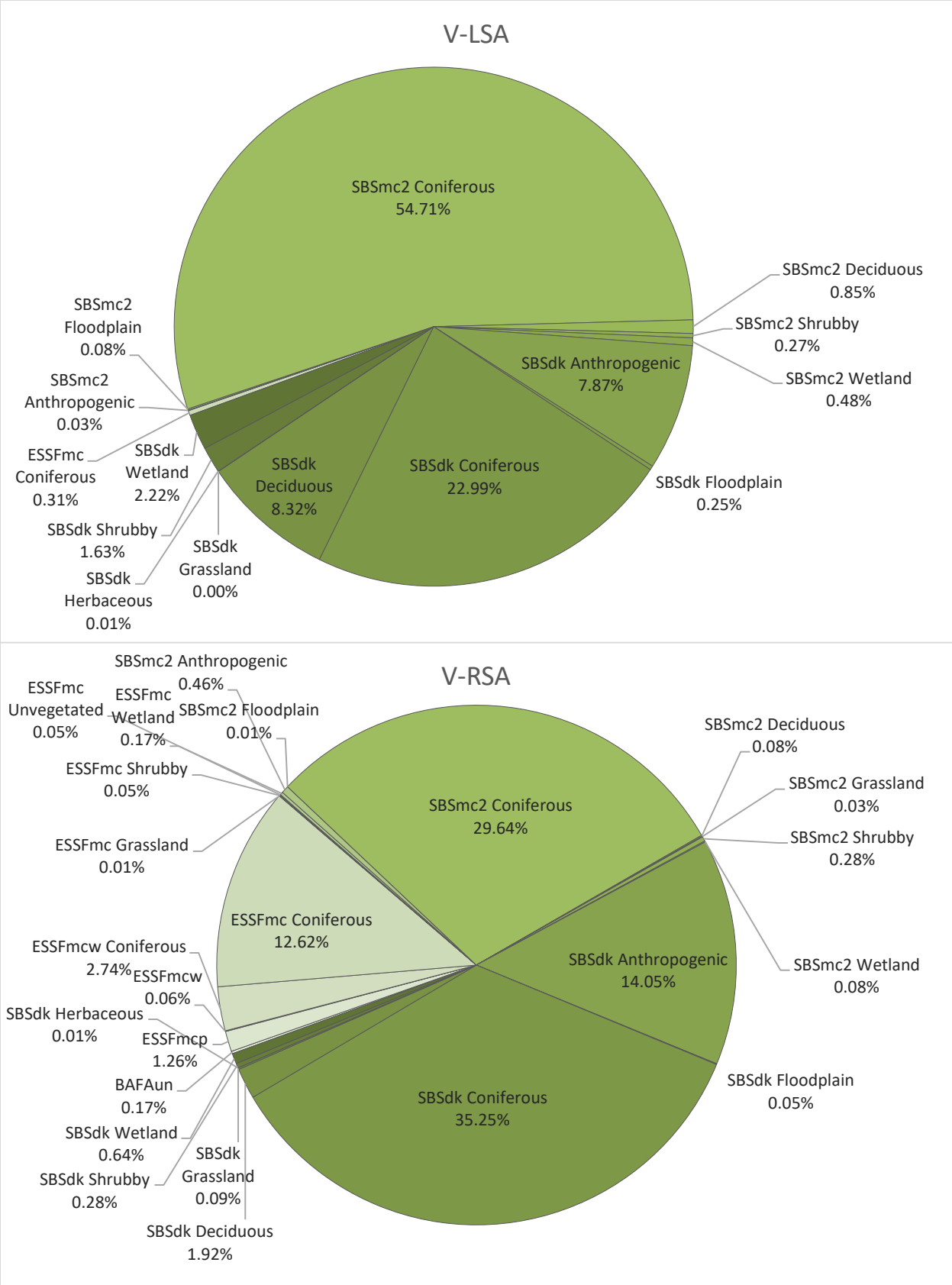


Figure 3.2-2: Distribution of general ecosystem types within the V-LSA and V-RSA.

Forest harvesting has contributed to the younger structural stages (structural stage 3, 4 and 5) within that zone. In the SBSmc2, pole/sapling and young forests are the most common due to forest harvesting, with unharvested old (structural stage 7) and mature forests being the next most abundant. Most of the shrub structural stages have also resulted from forest harvesting, with some of these areas being wetlands or other shrub type habitats (Figure 3.2-3).

The structural stage distribution within the V-RSA has a much higher proportion of mature forest and lower pole/sapling forest overall than what is found within the V-LSA (Figure 3.2-4). Differences in these distributions, along with other structural stages are due to the different proportions of the SBSmc2 and SBSdk subzones with almost twice as much SBSdk than SBSmc2 in the V-RSA as there is in the V-LSA, as well as inclusion of significantly more ESSFmc area within the V-RSA (see Table 3.2-5). The increase in structural stage 0 in the V-RSA reflects the increase in anthropogenic types infrastructure related to municipal lands and roads, as well as more rivers, ponds and lakes.

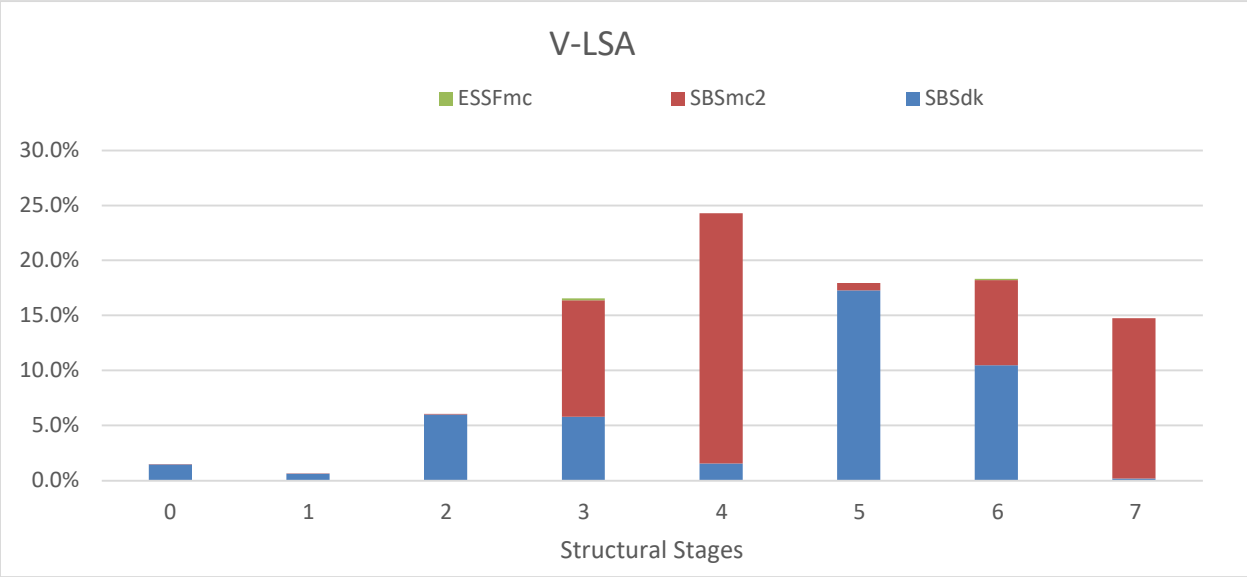


Figure 3.2-3: Structural stage distributions mapped within the V-LSA.

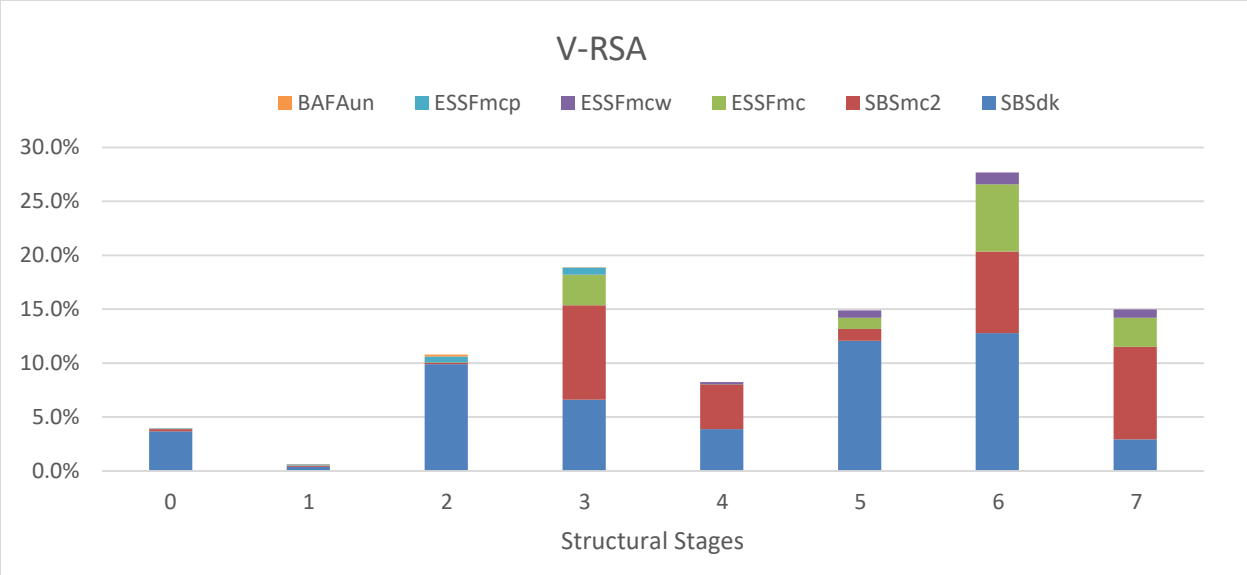


Figure 3.2-4: Structural stage distributions mapped within the V-RSA.

Wetland Ecosystems

Wetland ecosystems were mapped as 11.9% of the V-LSA (397.1 ha) and 5.6% of the V-RSA (2,011.0 ha) (Table 3.2-6). Within both the V-LSA and the V-RSA the majority of wetland ecosystems were swamp types, followed by bog and fen wetland types; marsh wetlands were primarily identified within the V-LSA.

Table 3.2-6: Summary of wetland ecosystems mapped in the Tenas TEM and V-LSA.

Wetland Class	Site Series	Code	Wetland Type	Area (ha)	
				V-LSA	V-RSA
Bog	00	SS	SbSxw - Scrub birch - Sedge		28.4
	09	BS	Sb - Creeping-snowberry - Sphagnum	8.5	8.5
	10	SS	Sb - Soft-leaved sedge - Sphagnum	98.8	136.0
	12	SS	SbSxw - Scrub birch - Sedge	2.4	20.1
	31	WE	Non-forested bog		12.4
	32	LS	Non-forested bog		11.5
	Wb01	Wb01	Black spruce - Creeping snowberry - Peat-moss	2.8	2.8
	Wb05	Wb05	Black spruce - Water sedge - Peat-moss	9.2	9.2
Total Bog Area (ha)				**121.8**	**228.9**
Fen	00	WF	Willow - Sedge fen	67.2	128.9
	Wf01	Wf01	Water sedge - Beaked sedge	1.4	1.6
Total Fen Area (ha)				**68.6**	**130.5**
Marsh	Wm01	Wm01	Beaked sedge - Water sedge	2.1	2.1
	Wm02	Wm02	Swamp horsetail - Beaked sedge	4.1	4.3
	Wm05	Wm05	Cattail	0.6	0.6
Total Marsh Area (ha)				**6.8**	**7.1**
Swamp	07/Ws07	SH/Ws07	Sxw - Horsetail	48.7	427.8
	07b/Ws07	SH/Ws07	Sxw - Horsetail (Poorly drained)	5.9	5.9
	09	HG	Bl - Horsetail - Glow moss		25.0
	10	FH	Bl - Horsetail - Leafy moss		182.3
	10/Ws07	SH/Ws07	Sxw - Horsetail	7.3	680.2
	10b/Ws07	SH/Ws07	Sxw - Horsetail (Lacustrine/morainal)	130.9	136.3
	Ws02	Ws02	Mountain alder - Pink spirea - Sitka sedge	1.1	1.1
	Ws03	Ws03	Bebb's willow - Bluejoint reedgrass	1.0	1.3
	Ws04	Ws04	Drummond's willow - Beaked sedge	0.2	0.2
Total Swamp Area (ha)				**195.1**	**1,460.3**
Undifferentiated Wetland	00	WL	Wetland		0.1
	31	WE	Non-forested wetland		154.5
Total Undifferentiated Wetland Area (ha)					**154.6**

Wetland Class	Site Series	Code	Wetland Type	Area (ha)	
				V-LSA	V-RSA
Open Water	00	OW	Shallow Open Water	1.6	5.7
	00	PD	Pond	3.2	24.0
Total Open Water Area (ha)				**4.8**	**29.7**
Total Wetland Area (ha)				***397.1***	***2,011.0***

Note: 1) Act = Black Cottonwood, At = Trembling Aspen, Bl = Subalpine Fir, Pa = Whitebark Pine, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce

The percent area mapped of the wetland ecosystems within the V-LSA and the V-RSA is provided in Figure 3.2-5 and shows that the main wetland type found within the V-LSA was the Sxw - Horsetail swamp ecosystem, which comprised 55.1% of the wetland types mapped. This forested swamp wetland is classified in Mackenzie and Moran (2004) as the Ws07 (Spruce - Common horsetail - Leafy moss) wetland and is equivalent to the SBS 07b Sxw - Horsetail (Poorly drained) and the SBSmc2 10b Sxw - Horsetail (Lacustrine/morainal) ecosystems in Banner et al. (1993). Within the V-LSA, the Tenas TEM differentiated between the SBSdk 07a (Freely drained/Fluvial) and SBSmc2 10a (Fluvial) forms of these site series, which are not considered wetlands, but neither the Oikos TEM nor the Bulkley PEM did; all SBSdk 07 and SBSmc2 10 site series from those map products were therefore conservatively classified as wetland types.

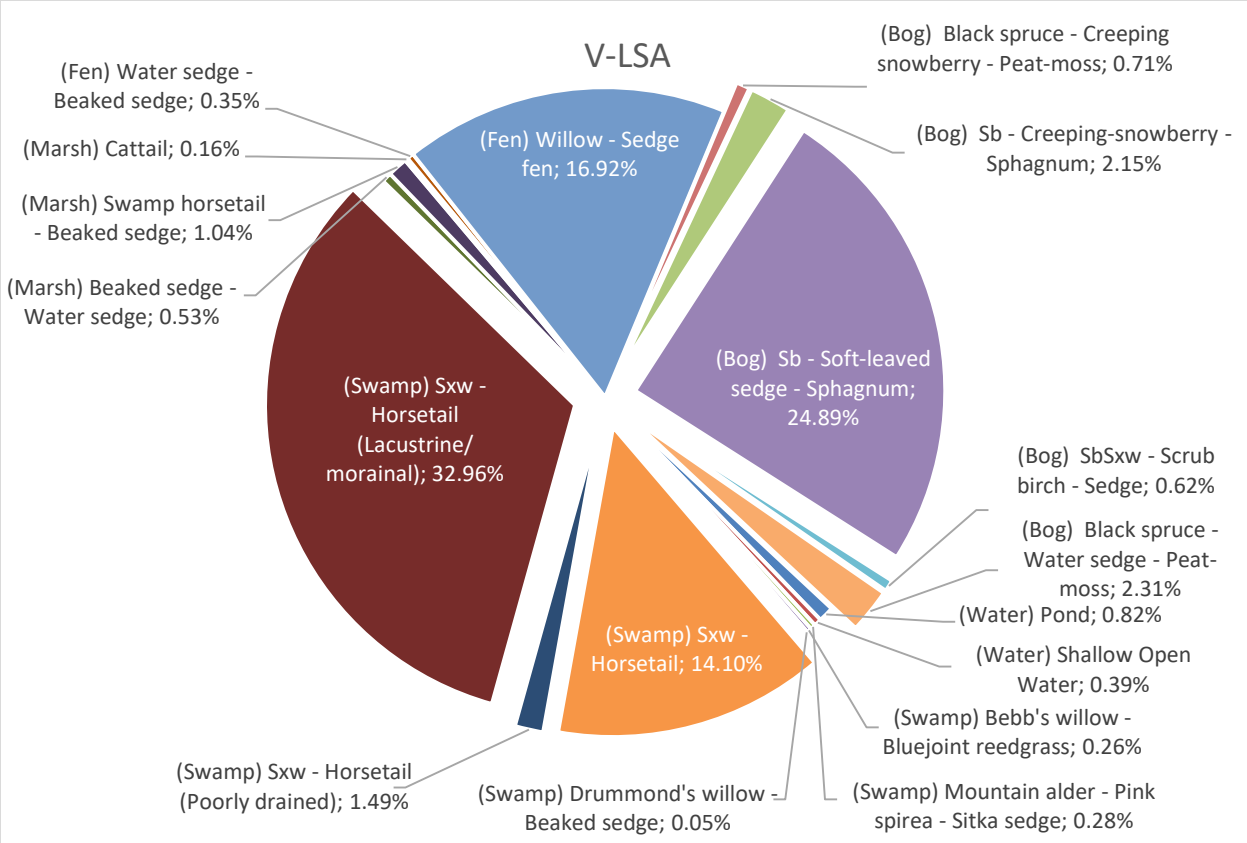
The forested wetland types in the V-LSA (Figure 3.2-5) include the forested swamp ecosystems described above, as well as three forested bog wetland ecosystems: the Sb - Creeping snowberry - Sphagnum (SBSdk 09) / Black spruce - Creeping-snowberry - Peat-moss (SBSmc2 Wb01), the Sb - Soft-leaved sedge - Sphagnum (SBSdk 10) / Black spruce - Water sedge - Peat-moss (SBSmc2 Wb05) and the SbSxw - Scrub birch - Sedge (SBSmc2 12). Together these forested wetlands account for 79.5% of all wetlands within the V-LSA.

Figure 3.2-6 outlines the location and distribution of the wetlands within the V-LSA and V-RSA. As Tenas TEM polygons can contain up to three ecosystem components, shading has been used to portray the percent of the polygon containing wetland components.

Within the V-LSA, the majority (56.4%) of the total wetland area was contained within the Helps Creek wetland complex north of the access corridor (Figure 3.2-7)., which contained bog, fen and swamp wetland types primarily. Outside of the Helps Creek wetland complex, the minesite contained a variety of wetland types, with forested swamp and bogs making up the majority (97.6%) of the wetland types within this area.

Outside of the Helps Creek wetland complex, wetlands in the V-LSA are generally small and isolated, with the wetland sizes ranging from 0.2 to 7.7 ha for all wetland types, and from 0.2 to 1.4 ha for non-forested wetland types.

Four wetland types, all of which were found within both mapped areas are believed to form part of a long-term peatland successional sequence following the order: Wm01→Wf01→Wb05→Wb01. Succession from one ecosystem to another would be gradual as peat accumulates in the basin (MacKenzie and Moran 2004).



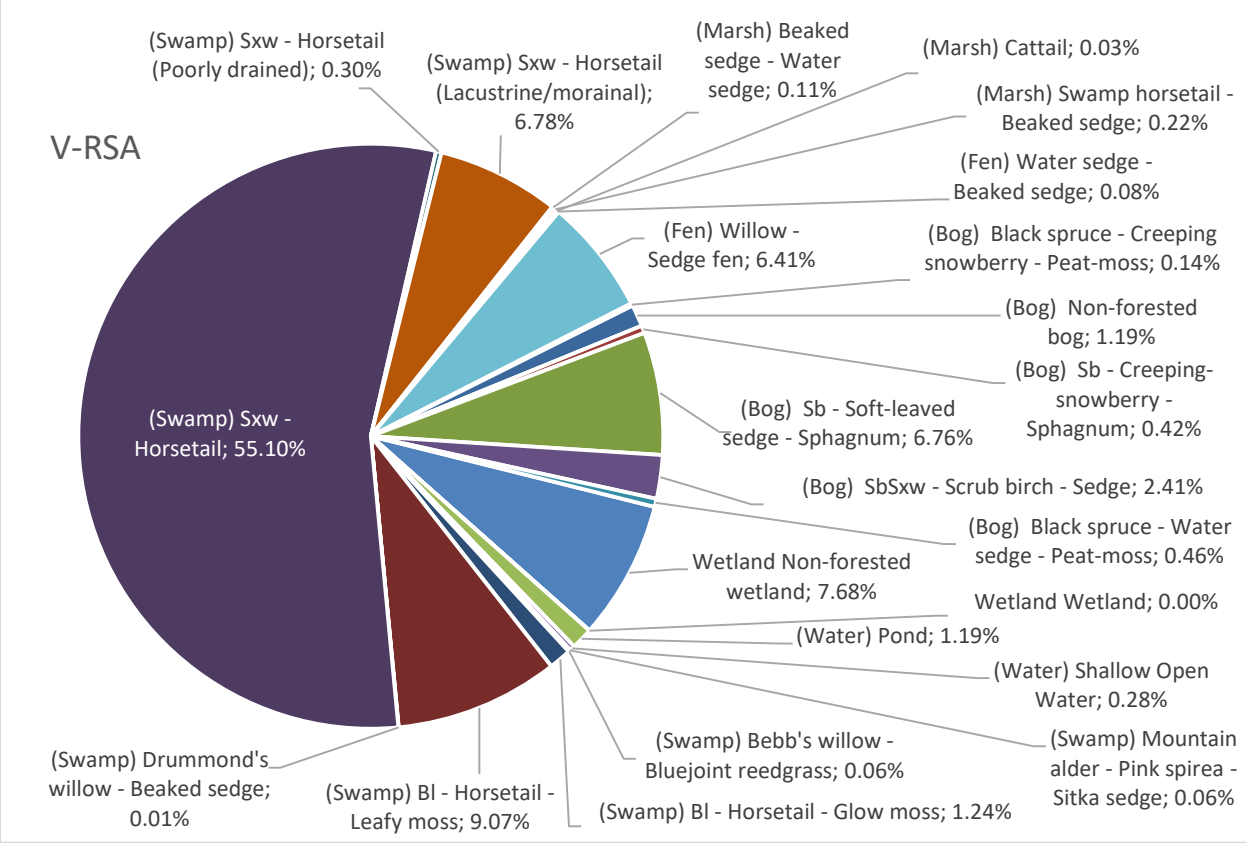


Figure 3.2-5: Proportions of wetland ecosystems mapped within the V-LSA and V-RSA.

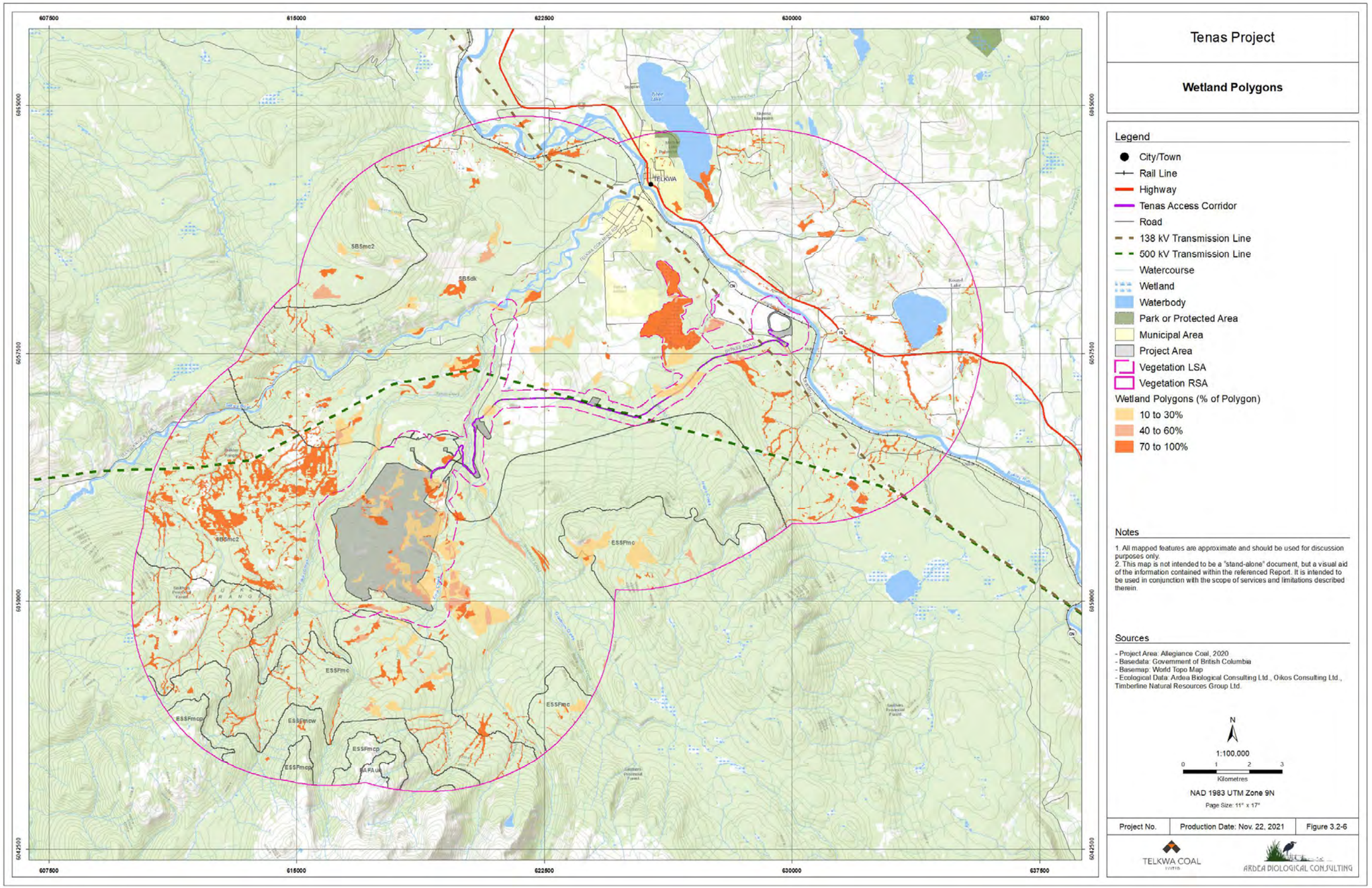


Figure 3.2-6: Location and proportions of polygons containing wetland ecosystems within the V-LSA and V-RSA.

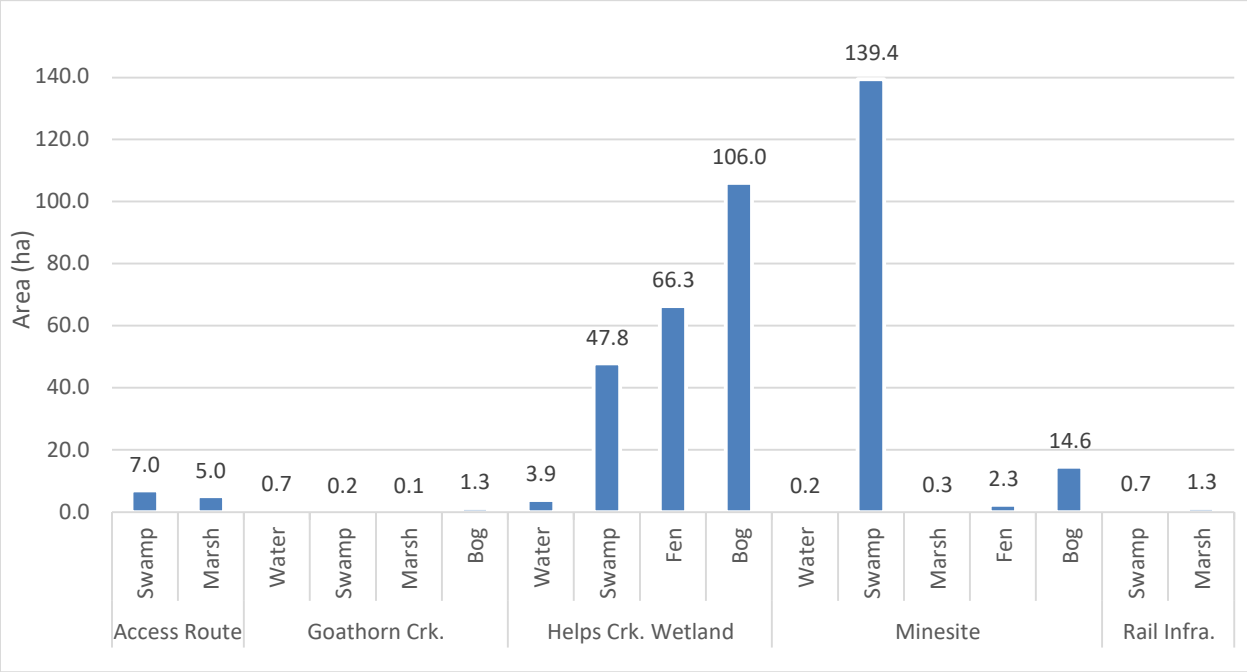


Figure 3.2-7: Wetland ecosystems mapped within the general areas of the V-LSA.

3.3 Wetland Function

3.3.1 Comparison of Wetlands Classified under TEM and Wetland Function Assessment

The wetlands assessed for the wetland function program included some of the wetlands mapped within the Tenas and Oikos TEM products. There are differences however, between the TEM and the wetland function assessments and wetland descriptions due to the RIC (1998) TEM and RIC (2000) digital data capture standards. For the Tenas TEM, RIC (1998) requires that mapped ecosystems be a minimum of 10% of a polygon area as well as only describing three ecosystem components within a polygon. The digital mapping standard (RIC 2000) requires minimum polygon sizes for 1:5,000 scale mapping as 0.125 ha and 0.5 ha for 1:10,000 scale mapping.

In many cases, the Tenas TEM was only able to describe the major component of a wetland, while the wetland function assessment, was able to delineate and describe smaller portions of the wetland as distinct wetland types. In other cases, the wetland assessment was able to describe several smaller wetlands as distinct wetland types, while the TEM had to aggregate those wetlands into one component / percentage of a polygon. The results of the wetlands classified under the Tenas TEM and the wetland function assessment are different and the two assessments and summaries need to be treated as separate products as they were developed for different uses.

3.3.2 Wetland Function Field Assessments

Wetland function field assessments were completed over seven days from August 1st to 10th, 2018. Within the V-LSA, 19 locations were assessed, with a total of 17 sites identified as wetlands, one identified as a floodplain site and another as a muddy depression. These last two sites were removed from the analysis as they did not meet the wetland classification criteria. The assessed wetland sites (WF01 to WF09 and WF11 to WF18) are shown in Figure 3.3-1. The field assessment results are shown by Wetland ID in Table 3.3-1, and summarized by wetland class in Table 3.3-2. Additional summary data is provided in Appendix D for the wetland assessments (Table D-2 to Table D-4).

Table 3.3-1: Wetland function assessment scores by wetland ID.

Wetland ID	Ecological Function					Function Value Score									Wetland Total Score	Wetland Function Rating
						Hydrologic			Biogeochemical			Other				
	BGC Subzone	Area (ha)	Site Class	Site Association	Adjacent / Upland Map Code	Flow	Recharge	Erosion	Water Quality	Nutrients	Carbon Storage	Habitat	Wildlife Use	Climate		
WF01	SBSdk	0.40	Marsh	Wm05	06	1	2	3	3	4	4	4	5	4	30	MH
WF02	SBSdk	0.22	Marsh	Wm01	06	1	2	3	3	4	4	4	1	4	26	M
WF03	SBSdk	0.27	Marsh/Swamp	Wm01/Ws04	06(01)	1	2	2	5	3	3	4	3	3	26	M
WF04	SBSdk	0.09	Swamp	Ws07	6/Wm02	4	1	3	3	3	4	4	3	3	28	MH
WF05	SBSdk	0.07	Swamp	Ws07	6/Wm02	4	1	3	3	3	4	4	1	3	26	M
WF06	SBSdk	0.41	Marsh	Wm01	06	3	2	5	4	4	4	3	5	4	34	MH
WF07	SBSdk	1.06	Bog/Marsh	Wb01/Wm05	09	3	2	2	4	5	5	3	3	3	30	MH
WF08	ESSFmc	2.20	Marsh/Swamp	Wm02/Ws02	01	5	2	5	5	5	5	3	5	4	39	H
WF09	SBSmc2	4.77	Bog	Wb01/Wb05	10	2	1	2	2	5	5	4	1	2	24	M
WF11	SBSdk	0.42	Marsh/Swamp	Wm02/Ws02	10/06	5	3	5	5	5	5	3	3	4	38	H
WF12	SBSdk	1.90	Shallow Water/ Fen/(Marsh)	OW/Wf01 (Wm01)	Wb05/10	5	3	5	5	5	5	3	5	4	40	H
WF13	SBSdk	29.31	Bog	Wb05	10	3	1	2	1	4	4	3	5	3	26	M
WF14	SBSdk	40.20	Bog	Wb05	10	3	1	2	1	4	4	3	1	3	22	M
WF15	SBSdk	0.16	Marsh	Wm01	7	4	3	5	4	4	4	3	3	4	34	MH
WF16	SBSmc2	1.00	Swamp	Ws03	3	3	1	3	3	2	4	3	3	2	24	M
WF17	SBSmc2	4.68	Bog/Swamp	Wb05/Ws02	06/Atha, 01c	3	2	2	2	5	5	3	5	2	29	MH
WF18	SBSmc2	0.31	Open Water	OW	10b(06)	3	3	1	3	1	1	3	5	1	21	M

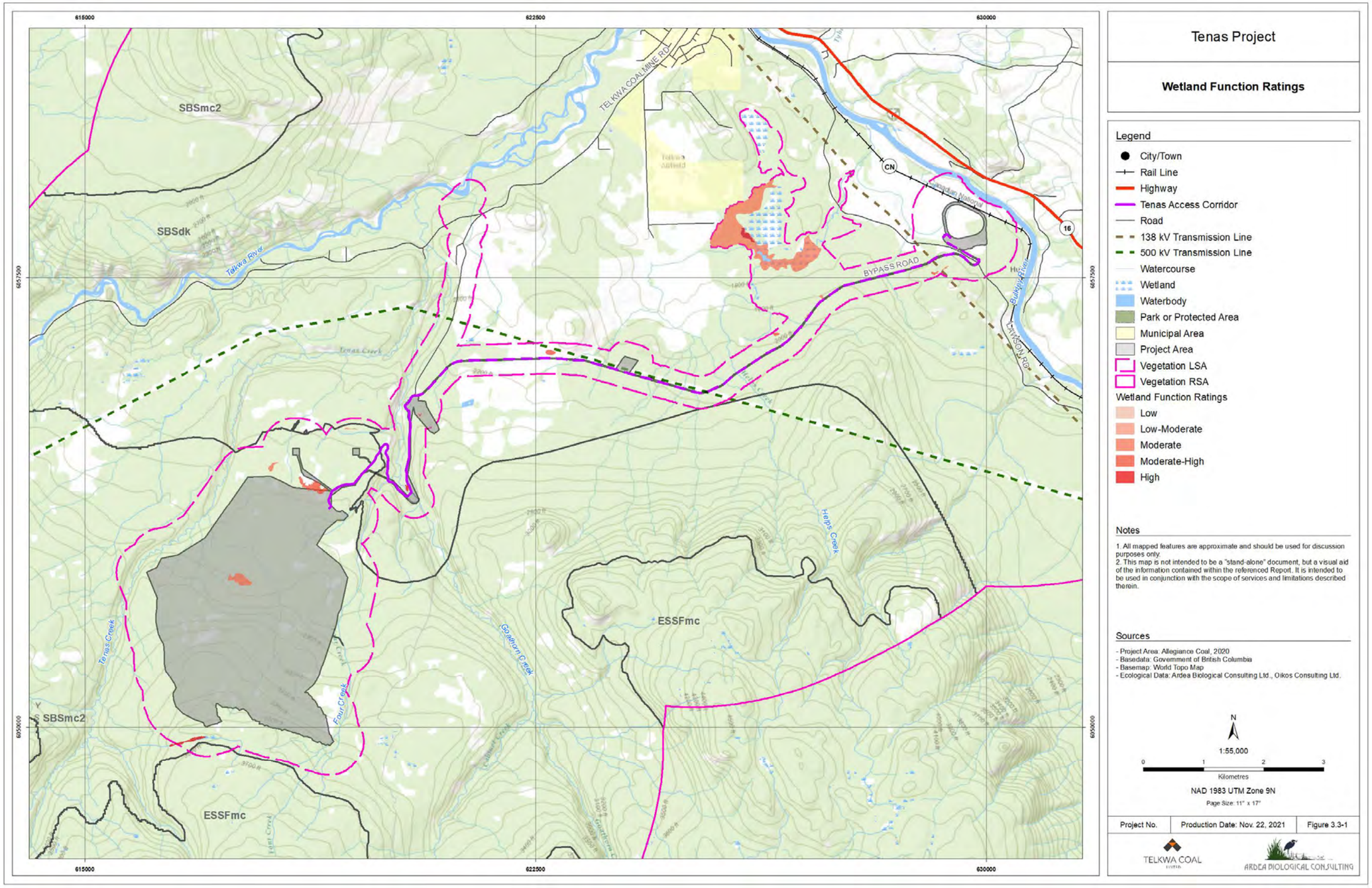


Figure 3.3-1: Locations and wetland function ratings for wetlands assessed within the V-LSA.

Table 3.3-2: Wetland function site class summary.

Site Class	Site Association	General Area					Wetland Function Scores					Final Rating
		Access Corridor	Goathorn Creek	Helps Creek Wetland	MInesite	Total Area (ha)	Hydrological	Biogeochemical	Wildlife / Habitat	Climate	Overall Score	
Bog	Wb05			69.52		69.52	6	9	6	3	24	M
	Wb05/ Wb01				4.77	4.77	5	12	5	2	24	M
Bog/Marsh	Wb01/ Wm05	1.06				1.06	7	14	6	3	30	MH
Bog/Swamp	Wb05/ Ws02				4.68	4.68	7	12	8	2	29	MH
Marsh	Wm01	0.22				0.79	8	12	7	4	30	MH
			0.16				6	11	9	4	30	MH
		0.41					12	12	6	4	34	M
	Wm05	0.40				0.40	5	11	7	3	26	M
Marsh/ Swamp	Wm01/ Ws04	0.27				0.27	13	15	7	4	39	H
	Wm02/ Ws02				2.20	2.20	7	5	8	1	21	M
	Wm02/ Ws02		0.42			0.42	13	15	8	4	40	H
Open Water	OW				0.31	0.31	7	9	6	2	24	M
Open Water /Fen/(Marsh)	OW/Wf01 (Wm01)			1.90		1.90	8	10	6	3	27	M
Swamp	Ws03				1.00	1.00	6	9	6	3	24	M
	Ws07	0.15				0.15	5	12	5	2	24	M
Total Wetland Area (ha)		***2.53***	***0.58***	***71.41***	***12.22***	***87.48***						

Wetlands assessed for wetland function were distributed within the minesite area (n=4), Goathorn Creek (n=2), access corridor (n=6) and Helps Creek wetland complex areas (n=3), but due to the lack of natural wetlands within the rail infrastructure area, no wetland function assessments were conducted in that area. The majority of wetlands assessed outside of the Helps Creek wetland complex were very small (< 1 ha), with an average size of 1.1 ha (range 0.1 to 4.8 ha). Portions of two large wetland polygons (WF13 - 29.3 ha and WF15 - 40.2 ha) mapped by Oikos (1999) within the Helps Creek wetland complex were assessed and found to be primarily Wb05 bogs (Sb - Water sedge - Peat-moss) (Table 3.3 1).

Wetlands rated as high were primarily marsh or marsh/swamp complexes and made up only 5.2% of the total area assessed (Table 3.3 2). These wetlands showed evidence of use by a variety of wildlife species (e.g. amphibians, waterfowl, mammals), having habitat suitability ratings for a variety of wildlife species of interest and high ratings for hydrologic and biogeochemical functions (Table 3.3 1 and Figure 3.3 1). Other complex wetlands such as bog/marsh, bog/swamp and marsh wetland types were rated as moderately-

high (Table 3.3 2) and made up 7.8% of the total area, while bogs, swamps and open water wetland types were rated as moderate, making up the remaining 87.1% of the wetland function area assessed.

3.4 Old Growth Forest Assessment

A total of 491.4 ha of old growth forest was identified using the ecosystem (TEM and PEM) data within the V-LSA, while 5,352.6 ha of old growth forest was identified in the V-RSA (Table 3.4-1). Very little old growth forests were identified within the SBSdk subzone (5.7 ha), the majority (99%; 485.7 ha) occurring in the SBSmc2 within the V-LSA. The majority of the old growth forest in the V-RSA are located within the SBSmc2 (57%; 3,062.5 ha), the SBSdk (20%; 1,053.5 ha) and ESSFmc (18%; 962.1 ha) BGC subzones are similar, with a small amount of old growth mapped within the ESSFmcw (5%; 274.4 ha).

Table 3.4-1: Summary ecosystems from TEM and PEM data classified as old growth within BGC subzones in the V-LSA and V-RSA.

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
ESSFmcw	01	FL	Bl - Huckleberry - Leafy liverwort - Heron's bill		194.8
	02	FC	Bl(PaPl) - Huckleberry - Crowberry - Lichen		11.6
	03	FJ	Bl(PaPl) - Huckleberry - Juniper - Lichen		9.0
	04	FV	Bl - Valerian - Leafy moss		47.6
	05	FG	Bl - Mixed shrub - Glow moss		11.4
	Total ESSFmcw Area				**274.4**
ESSFmc	01	FB	Bl - Huckleberry - Leafy liverwort		606.4
	02	LC	BlPl - Juniper - Cladonia		17.2
	03	FC	Bl - Huckleberry - Crowberry		6.0
	04	HH	Bl - Huckleberry - Heron's-bill		48.1
	05	FT	Bl - Huckleberry - Thimbleberry		2.5
	06	FO	Bl - Oak fern - Heron's-bill		182.2
	07	FD	Bl - Devil's club - Lady fern		43.6
	08	FV	Bl - Valerian - Sickle moss		9.7
	09	HG	Bl - Horsetail - Glow moss		0.2
	10	FH	Bl - Horsetail - Leafy moss		46.2
	Total ESSFmc Area				**962.1**
SBSmc2	01	SB	Sxw - Huckleberry	0.1	1161.3
	01a	SB	Sxw - Huckleberry (Mesic, fine-textured)	217.3	291.6
	01c	SB	Sxw - Huckleberry (Submesic)	15.2	17.5
	02	PH	Pl - Huckleberry - Cladonia		20.7
	03	BM	SbPl - Feathermoss	0.5	0.7
	05	TC	Sxw - Twinberry - Coltsfoot	14.5	317.4
	06	SO	Sxw - Oak fern	124.1	460.8
	07	BF	Sxw - Scrub birch - Feathermoss	9.7	10.8

BGC Sub zone	Site Series	Map Code	Site Series Name	Area (ha)	
				V-LSA	V-RSA
SBSmc2	09	SD	Sxw - Devil's club	0.1	412.8
	09a	SD	Sxw - Devil's club (Fluvial)	9.2	11.0
	09b	SD	Sxw - Devil's club (Morainal)	28.9	47.5
	10	SH	Sxw - Horsetail	1.1	234.8
	10a	SH	Sxw - Horsetail (Fluvial)	17.2	18.1
	10b	SH	Sxw - Horsetail - Leafy Mosses (Lacustrine/morainal)	46.3	46.6
	12	SS	SbSxw - Scrub birch - Sedge		9.5
	Wb05	Wb05	Black spruce - Water sedge - Peat-moss	1.6	1.6
	Total SBSmc2 Area			**485.7**	**3,062.5**
SBSdk	00	SD	Sxw - Devil's club (Lacustrine/morainal)	< 0.1	22.2
	01	SP	Sxw - Spirea - Purple peavine	< 0.1	556.2
	02	LJ	Pl - Juniper - Ricegrass		11.4
	03	LC	Pl - Feathermoss - Cladina		30.4
	05	SF	Sxw - Spirea - Feathermoss		12.8
	06	ST	Sxw - Twinberry - Coltsfoot		266.0
	07	SH	Sxw - Horsetail		59.2
	07a	SH	Sxw - Horsetail (Freely drained)	0.4	0.4
	08	CD	Act - Dogwood - Prickly rose		77.3
	10	SS	Sb - Soft-leaved sedge - Sphagnum	5.3	17.7
	Total SBSdk Area			**5.7**	**1,053.5**
Total Old Growth Area				***491.4***	***5,352.6***

Note: 1) Act = Black Cottonwood, At = Trembling Aspen, Bl = Subalpine Fir, Pa = Whitebark Pine, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce

The spatial distribution of the old growth forest polygons outlined in Figure 3.4-1 shows the distribution of old growth within the V-LSA is almost all located within the minesite area (99%; 485.7 ha), with a small area (5.1 ha) within the Helps Creek wetland and 0.4 ha in the Goathorn Creek within the SBSdk BGC subzone. There was no old growth forest identified within the access corridor or rail infrastructure areas within the V-LSA and only limited amounts on the east side of the Bulkley River. In the SBSdk portions of the V-RSA, most of the old growth is distributed adjacent to the Bulkley River and on islands within the river northwest of Telkwa and southwest of the rail loadout. In the SBSmc2 BGC subzone, old growth is found along the Telkwa River, as well as at higher elevation areas adjacent to the ESSFmc subzone southwest of the minesite and south of the access corridor. Old growth forests within the ESSFmc and ESSFmcw BGC subzones are also located southwest of the minesite and south of the access corridor (Figure 3.4-1).

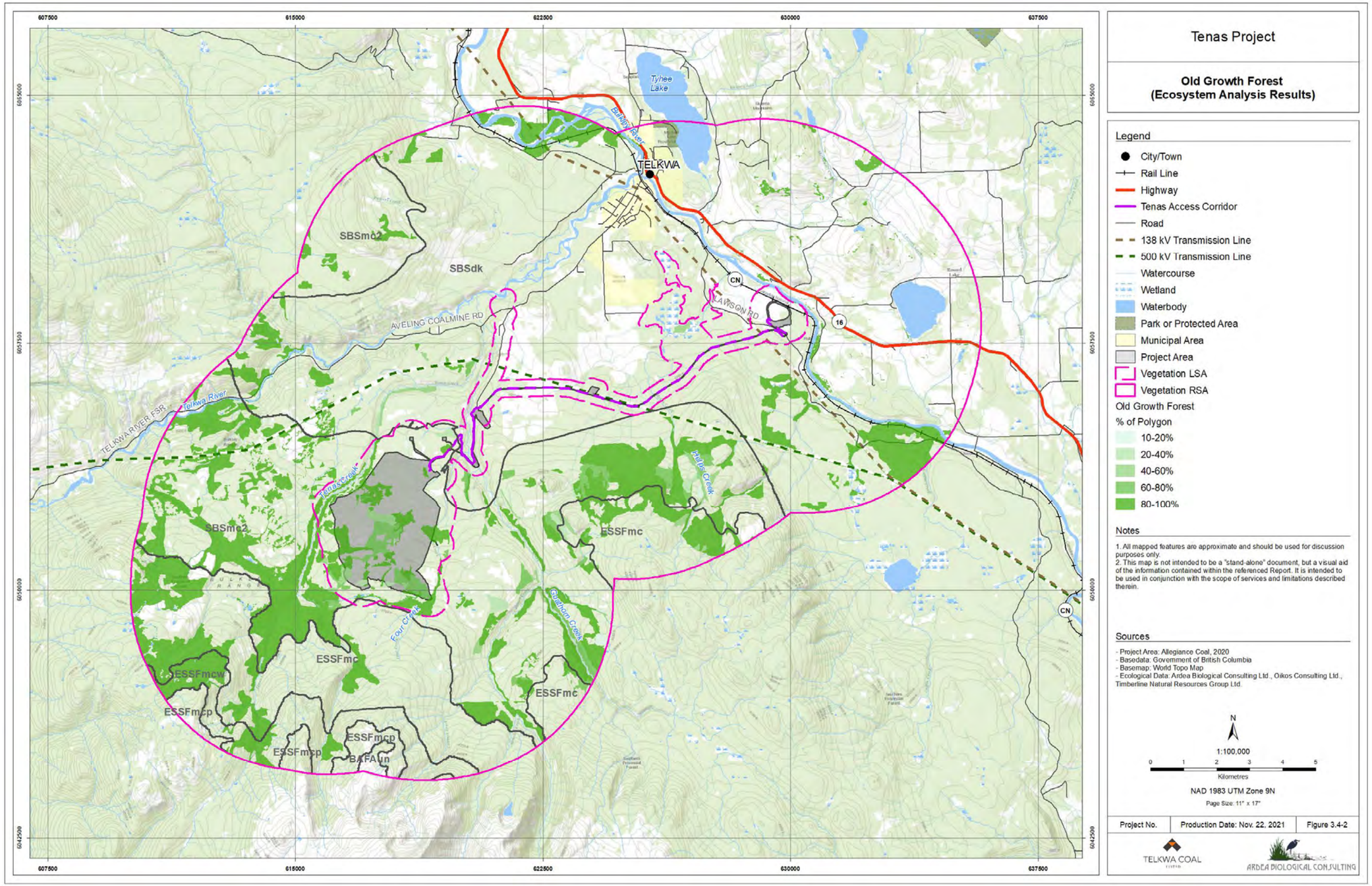


Figure 3.4-1: Distribution of old growth forests within the V-LSA and V-RSA from TEM and PEM.

3.5 Timber Volume Assessment

The timber volume assessment, using a simple map-based exercise based on the VRI data, identified a potential of volume of 212,581 m^3 of merchantable timber within the V-LSA and 2,630,585 m^3 in the V-RSA (Table 3.5-1). The overall volumes in the SBSdk and SBSmc2 BGC subzones within the V-LSA are relatively similar (46% and 52% respectively), but the majority of volume in the SBSdk is from deciduous trees (55%), while coniferous trees make up the majority (99%) in the SBSmc2. Within the V-RSA, the majority of the timber volume was identified within the SBSdk subzone (49%), with the SBSmc2 containing 31% of the total timber volume and the ESSFmc subzone having 20%. In the V-RSA, deciduous trees make of the majority of the volume in the SBSdk (62%), with coniferous trees the majority in the SBSmc2 (94%). Both the ESSFmc and ESSFmcp timber volumes are 100% conifers in the V-RSA. The distribution of the timber volumes within the V-LSA and V-RSA for deciduous and conifer species are outlined in Figure 3.5-1 and Figure 3.5-2.

Table 3.5-1: Summary of potential timber volume available wtihn the V-LSA and V-RSA.

BGC Sub zone	Tree Species	V-LSA Volume (m^3)	V-RSA Volume (m^3)	Tree Species	V-LSA Volume (m^3)	V-RSA Volume (m^3)
ESSFmcp	Spruce		6	Whitebark Pine		25
	Subalpine Fir		7,901			
	ESSFmcp Total (ha)					**7,932**
ESSFmc	Black Spruce		2	Subalpine Fir	880	403,611
	Cottonwood		113	Trembling Aspen	3	1,356
	Pine	410	16,676	Whitebark Pine		439
	Spruce	2,478	94,406	Black Spruce		2
	ESSFmc Total (ha)				**3,771**	**516,603**
SBSmc2	Amabalis Fir	5	34	Pine	13,929	50,402
	Black Spruce	63	67	Spruce	62,319	473,177
	Cottonwood	359	22,075	Subalpine Fir	33,824	238,116
	Hemlock		684	Trembling Aspen	655	25,217
	Paper Birch	< 1	2,056			
	SBSmc2 Total Area (ha)				**111,155**	**811,828**
SBSdk	Amabalis Fir		1	Pine	10,232	172,041
	Black Spruce	4,625	5,405	Spruce	28,183	299,278
	Cottonwood	16,984	210,407	Subalpine Fir	573	18,463
	Hemlock		38	Trembling Aspen	36,321	561,989
	Paper Birch	733	26,595	Western Larch	6	6
	SBSdk Total Area (ha)				**97,655**	**1,294,222**
Total Area (ha)					***212,581***	***2,630,585***

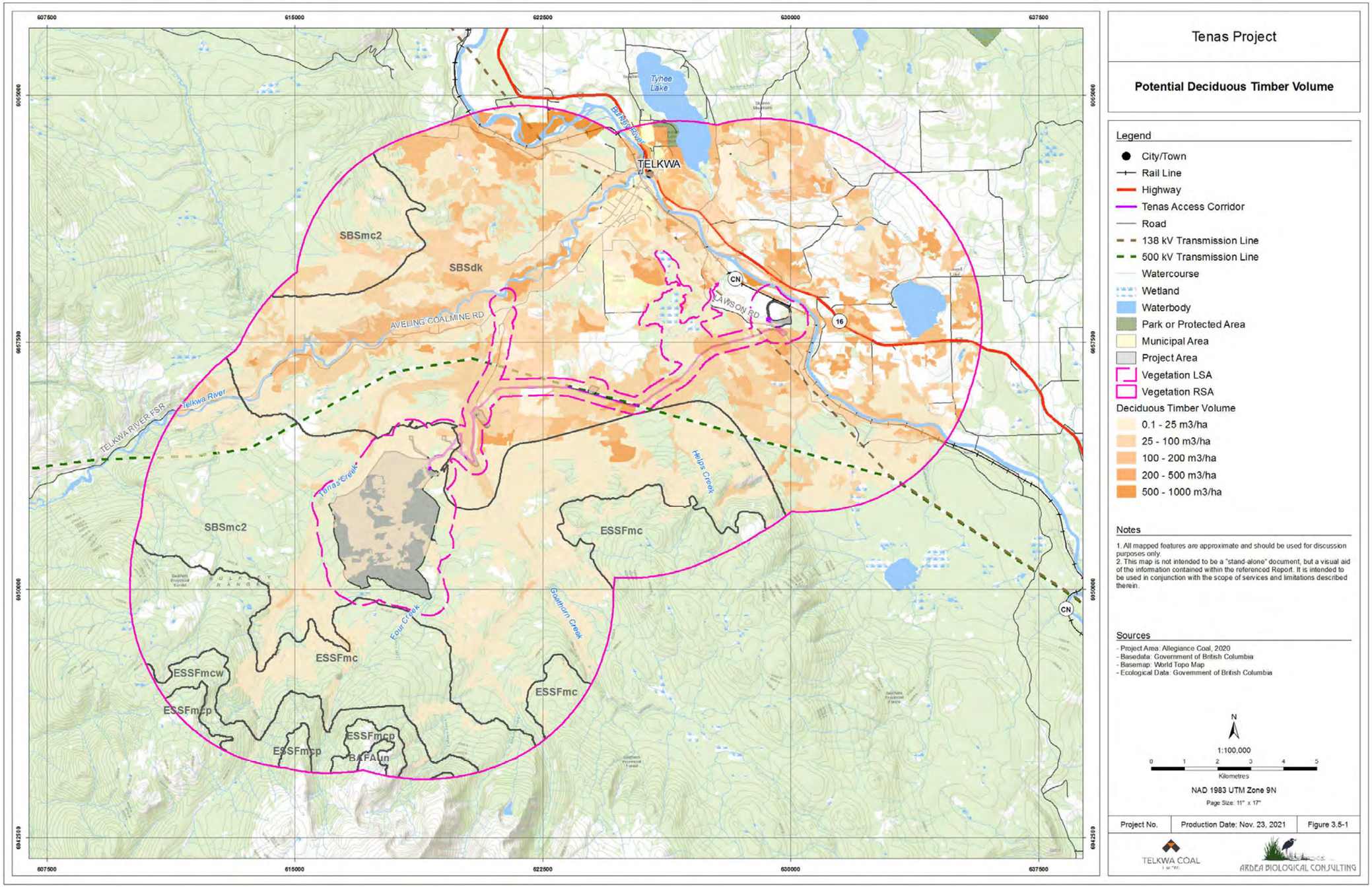


Figure 3.5-1: Distribution of potential deciduous timber volume within the V-LSA and V-RSA.

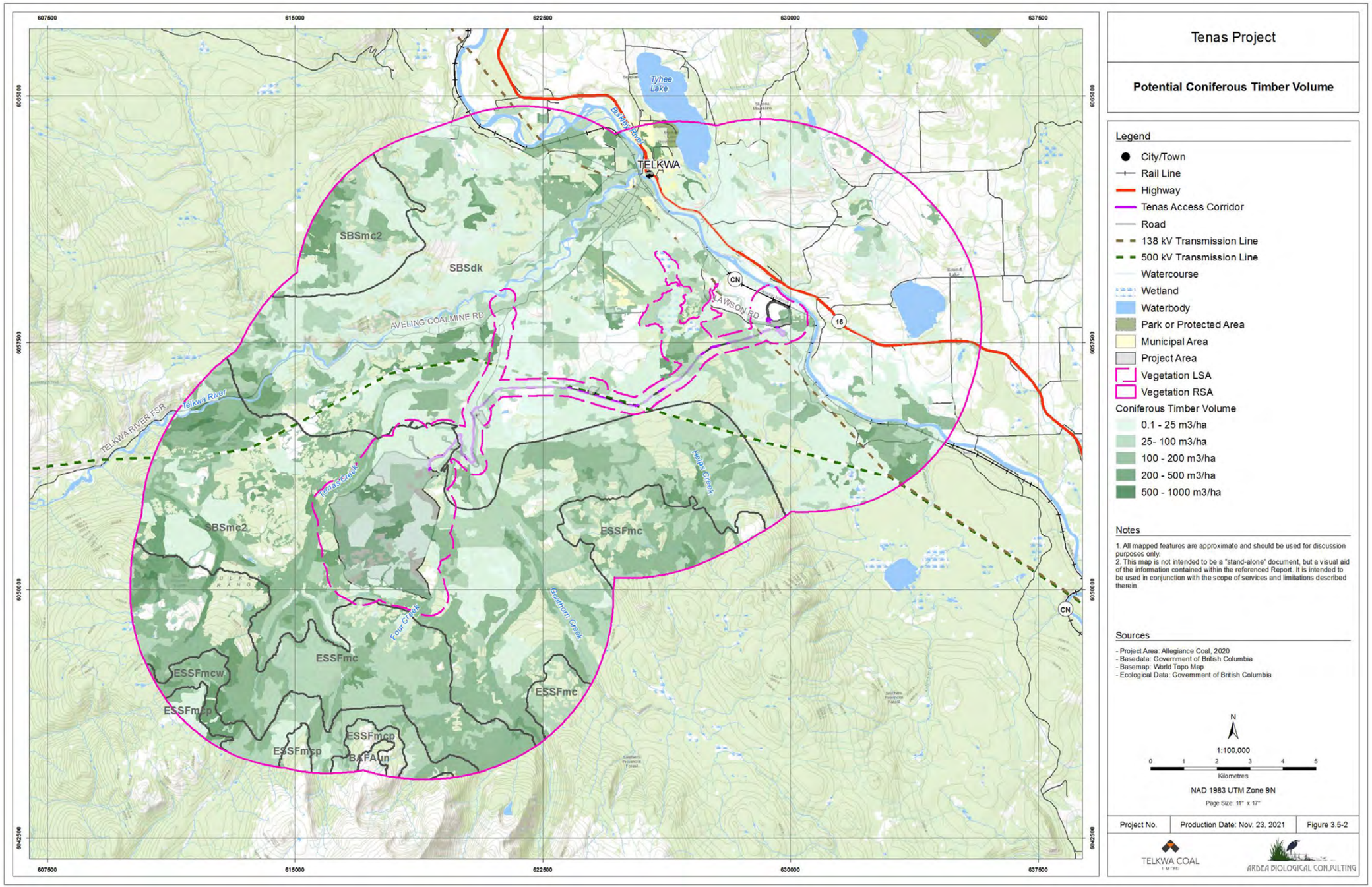


Figure 3.5-2: Distribution of potential conifer timber volume for the V-LSA and V-RSA.

3.6 Listed Plants, Lichens and Ecological Communities

Existing Information

The listed plant and moss species with the potential to be found within the V-RSA is provided in Table 3.6-1 based on searches of provincial and federal sources as outlined in Table 2.1-2. No listed lichen species were identified with the potential to be found within the BGC zones or subzones within the V-RSA. No occurrences of listed plant species have been historically recorded within the V-LSA, although two blue-listed species have been recorded within the V-RSA by the BC CDC (2020); whitebark pine and American sweet-flag. Whitebark pine is found on mesic to dry slopes primarily in the ESSF BGC zone in BC (Klinkenberg 2020), and the BC CDC has an occurrence mapped on a subalpine slope in the southern portion of the V-RSA in the Telkwa Mountains near Cabinet Creek. Whitebark pine is additionally federally listed as Endangered under SARA and COSEWIC (Table 3.6-1). Additional polygons (24 polygons, 39.4 ha) with the potential to contain whitebark pine were also identified within the VRI data at the southern extent of the V-RSA.

American sweet-flag is a wetland plant found in open water areas, such as marshes, lakes, and ponds in montane areas of BC (Klinkenberg 2020), and was recorded in the V-RSA at the outlet of Tyhee Lake and along Glacis Creek 4.2 km south of the V-RSA. Figure 3.6-1 shows the locations of these listed species within the V-LSA and V-RSA.

Table 3.6-1: Conservation status of plant and lichen species that potentially occur in the V-RSA.

Species Name		Conservation Status[1]		
		Provincial	Federal	
Common	Scientific	BC CDC	COSEWIC	SARA Schedule 1
American sweet-flag	*Acorus americanus*	Blue	-[2]	-
Holzinger's brachythecium	*Brachythecium hozingeri*	Blue	-	-
Britton's moss	*Brybrittonia longipes*	Blue	-	-
Candle snuffer moss	*Encalypta brevipes*	Blue	-	-
Water Grimmia moss	*Grimmia mollis*	Blue	-	-
Polar brook-moss	*Hygrohypnum polare*	Blue	-	-
Long-stalked thread moss	*Meessia longiseta*	Blue	-	-
Whitebark pine	*Pinus albicaulis*	Blue	Endangered	Endangered
Wedge-leaf primrose	*Primula cuneifolia ssp. saxifragifolia*	Blue	-	-
Northern gooseberry	*Ribes cognatum*	Red	-	-
Norwegian timmia moss	*Timmia norvegica*	Blue	-	-
Rugged dung moss	*Spalchnum vasculosum*	Blue	-	-
Baltic sphagnum	*Sphagnum balticum*	Blue	-	-
Twisted peatmoss	*Sphagnum contortum*	Blue	-	-
Wulf's peatmoss	*Sphagnum wulfianum*	Blue	-	-
Long-leaved aster	*Symphyotrichum ascendens*	Blue	-	-

Notes: 1) See Table 2.1-2 for status definitions
2) " - " = Not assessed

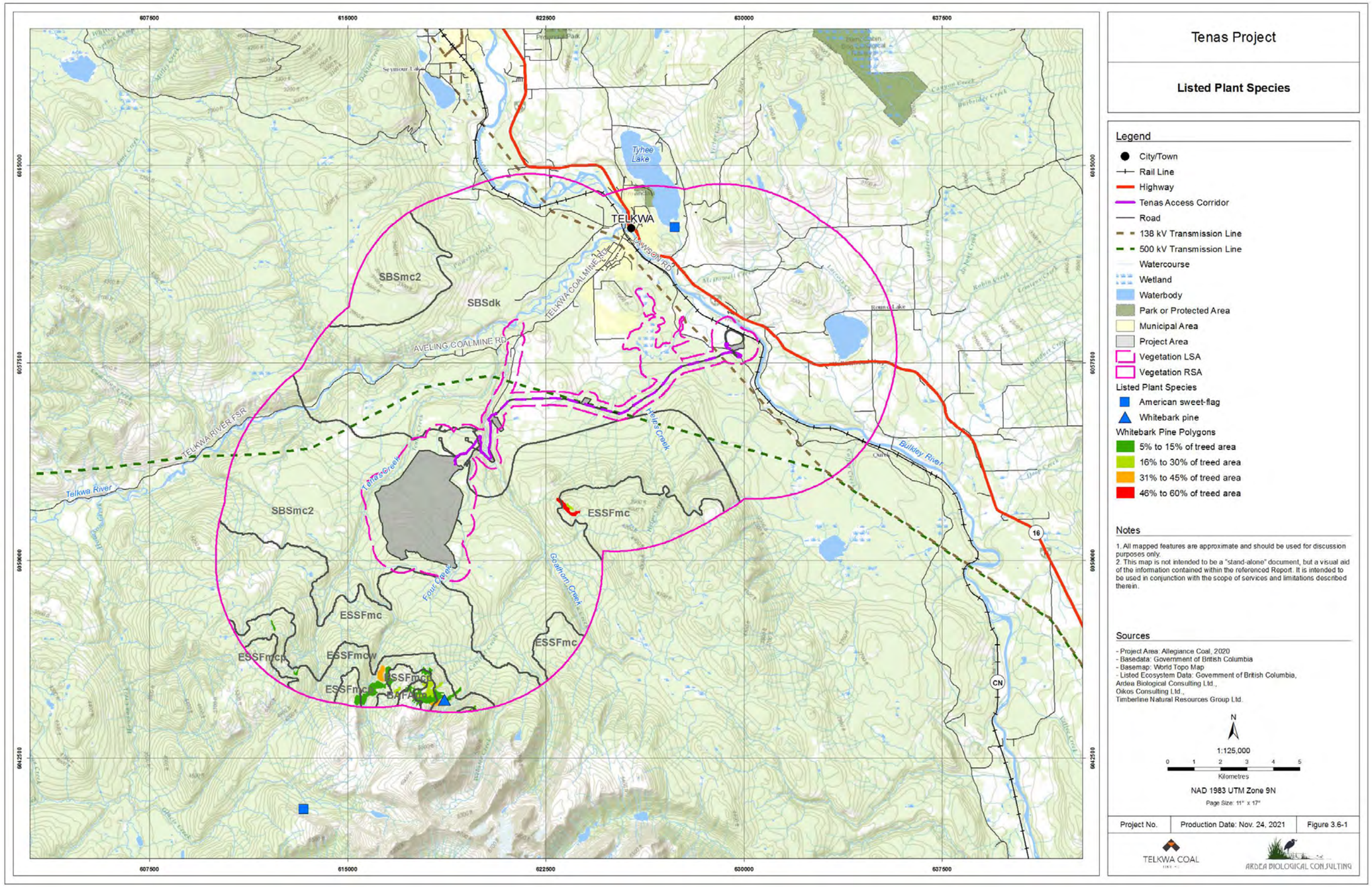


Figure 3.6-1: Locations of listed plants identified from existing information within and adjacent to the V-RSA.

Table 3.6-2: Conservation status of listed ecologicaly communities that potentially occur in the V-RSA.

Ecological Community[1]	Site Series	Map Code	Conservation Status[2]		
			Provincial	Federal	
			BC CDC	COSEWIC	SARA Schedule 1
Black cottonwood - Hybrid white spruce - Red-osier dogwood floodplain[4]	SBSdk Fm02	Fm02	Red	-[3]	-
Act - Dogwood - Prickly rose floodplain	SBSdk/08	CD			
Pl - Juniper - Ricegrass	SBSdk/02	LJ	Blue	-	-
Saskatoon - Slender wheatgrass	SBSdk/81	SW	Red	-	-
Bluegrass - Slender wheatgrass	SBSdk/82	BW	Red	-	-
Black spruce - Creeping-snowberry - Peat-moss bog	SBSmc2/ Wb01	Wb01	Blue	-	-
Sb - Creeping-snowberry - Sphagnum	SBSdk/09	BS			
Swamp horsetail - Beaked sedge marsh	SBSmc2 or SBSdk/ /Wm02	Wm02	Blue	-	-
Cattail marsh	SBSdk/ Wm05	Wm05	Blue	-	-
Bebb's willow / Bluejoint reedgrass swamp	SBSmc2 or SBSdk/ /Ws03	Ws03	Blue	-	-
Spruce - Common horsetail - Leafy mosses swamp	SBSmc2 or SBSdk/ /Ws07	Ws07	Blue	-	-
Sxw - Horsetail (Lacustrine/morainal)	SBSmc2/10b	SH			
Sxw - Horsetail (Poorly drained)	SBSdk/07b	SH			

Notes: 1) Act = Black Cottonwood, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce
2) See Table 2.1-2 for status definitions
3) " - " = Not assessed
4) This community is currently under review, but last ranking by CDC (2018) identified it as red-listed.

A review of existing mapping and reports found occurrences of red listed ecological communities within the V-LSA and the V-RSA. Haeussler (1998) identified three red-listed (BC CDC 2020) ecosystems occurring within the V-LSA: the Black cottonwood - Hybrid white spruce - Red-osier dogwood floodplain ecosystem which is considered the same as the Act - Dogwood - Prickly rose floodplain ecosystem outlined in Banner et al. (1993); the Saskatoon - Slender wheatgrass ecosystem and the Bluegrass - Slender wheatgrass ecosystem. Haeussler (1998) mapped the floodplain ecosystem along Tenas Creek, the Telkwa and Bulkley rivers, while the Saskatoon - Slender wheatgrass and the Bluegrass - Slender wheatgrass grassland ecosystems were mapped near the Telkwa River. Both the Oikos TEM (Oikos 1999) and Bulkley PEM (Timberline 2010) mapped the Saskatoon / Slender wheatgrass and Act - Dogwood - Prickly rose floodplain ecosystems within the V-RSA, and they correspond to the mapping outlined by Haeussler (1998).

Field Surveys for Listed Plants and Lichen Species

No listed plant or lichen species were identified during the listed plant and lichen surveys completed within the V-LSA. This is likely due to the limited area of uncommon habitats such as wetlands or rocky/dry areas in the V-LSA where listed plants are typically found.

Listed Ecological Communities Identified in Ecosystem Mapping

Three red-listed and six blue-listed ecological communities were identified from the Tenas TEM in the V-LSA and the V-RSA (Table 3.6-3) totalling an estimated 248.1 ha in the V-LSA (7% of V-LSA) and 1,817.3 ha in the V-RSA (5% of V-RSA).

The most common listed ecosystem community that was identified in both the V-LSA and the V-RSA was a group of ecosystems that include the Spruce - Horsetail - Leafy mosses (SBSmc2/SBSdk Ws07; Mackenzie and Moran 2004), the Sxw - Scrub birch - Horsetail (lacustrine/morainal) (SBSmc2 10b; Banner et al 1993) and the Sxw - Horsetail (poorly drained) (SBSdk 07b; Banner et al 1993). These three ecosystem classifications describe the same ecological community which for ease of discussion will be called the Spruce - Horsetail forested swamp. The Spruce - Horsetail forested swamp, was identified in 192.8 ha (78% of listed communities) in the V-LSA and 1,250.3 ha, (69% of listed communities) in the V-RSA. This ecological community occurs on moist receiving sites and riparian areas throughout the V-LSA and V-RSA. The floodplain Act - Dogwood - Prickly rose (SBSdk 08; Banner et al. 1993) and the Black cottonwood - Hybrid white spruce / Red-osier dogwood (SBSmc2/SBSdk Fm02; Mackenzie and Moran 2004) ecological communities are descriptions of the same ecological community that is also extensive within the V-RSA, with 403.2 ha (22% of listed communities) located along the Telkwa and Bulkley Rivers in the area. Within the V-LSA, 37.6 ha of this ecological community was mapped, primarily within the Goathorn Creek area.

Table 3.6-3: Summary of listed ecological communities identified within the V-LSA and V-RSA.

Ecological Community[1]	Site Series	Location in V-LSA	Area (ha)	
			V-LSA	V-RSA
Black cottonwood - Hybrid white spruce - Red-osier dogwood	SBSdk/Fm02	Goathorn Creek, Telkwa River and Bulkley River	37.6	403.2
Act - Dogwood - Prickly rose floodplain	SBSdk/08			
Pl - Juniper - Ricegrass	SBSdk/02	East end of access corridor	0.5	99.9
Saskatoon - Slender wheatgrass	ESSFmc/81 SBSdk/81	North of access route	0.02	35.5
Bluegrass - Slender wheatgrass	ESSFmc/82 SBSdk/82	Telkwa River near Goathorn Creek	0.05	10.7
Black spruce - Creeping-snowberry - Peat-moss	SBSmc2/Wb01	Two locations in Helps Creek wetland	11.4	11.4
Sb- Creeping-snowberry - Sphagnum	SBSdk/09			
Swamp horsetail - Beaked sedge marsh	SBS Wm02	Three locations: east end of access corridor, Goathorn Creek, and south edge of minesite	4.1	4.3
Cattail marsh	SBSdk/Wm05	Two locations along access corridor	0.6	0.6
Bebb's willow / Bluejoint reedgrass	SBSdk/Ws03	West side of Lawson Road	1.0	1.3
Spruce - Common horsetail - Leafy mosses	SBSmc2Ws07	Moist, receiving sites and riparian areas within the minesite area	138.2	816.6
Sxw - Horsetail (Lacustrine/morainal)	SBSmc2/10b			
Spruce - Common horsetail - Leafy mosses	SBSdk/Ws07	Moist, receiving sites and riparian areas within the access corridor and Helps Creek wetland	54.6	433.8
Sxw - Horsetail (Poorly drained)	SBSdk/07b			
Total Listed Communities Area (ha)			***248.1***	***1,817.3***

Note: 1) Act = Black Cottonwood, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce

The distribution of the red-listed and blue-listed ecological communities identified and mapped in the Tenas TEM is outlined in Figure 3.7-1.

The most common listed ecological community within the minesite area was the blue listed Spruce - Common horsetail - Leafy mooses (Ws07) forested swamp, with 138.2 ha (56% of listed communities) mapped. This listed ecological community was also found within the access corridor (6.8 ha, 3% of listed community area) and in the Helps Creek wetland complex (47.8 ha, 19% of listed community area). Within the V-LSA, 37.6 ha of the red-listed Act - Dogwood - Prickly rose/ActSxw - Red-osier dogwood floodplain ecosystems were mapped, accounting for over 99% of the red-listed communities and 15% of all listed ecological communities. This community was found within the Goathorn Creek area (33.1 ha), with a small amount (4.5 ha) mapped along the Bulkley River in the rail infrastructure area.

3.7 Invasive Plants

Existing Information

The invasive alien plant database was queried for known occurrences of invasive alien plant species. This database showed six species in the V-LSA, mostly in the rail infrastructure area but also by the Goathorn Creek crossing, and an additional 15 species within one kilometer of the V-LSA in the V-RSA (Table 3.7-1) (BC FLNRORD 2018). The occurrences of invasive species were mostly along Lawson Road and Highway 16, and in areas close to these roads.

Table 3.7-1: List of invasive plant species identified in the Invasive Alien Plant Species Database (BC FLNRORD 2018) within the V-LSA and V-RSA.

	Code	Common name	Latin name	Location
Species within the V-LSA	BT	Bull thistle	*Cirsium vulgare*	Near PNG pipeline; Near Lawson Road
	CT	Canada thistle	*Cirsium arvense*	Fields near rail infrastructure; Near CN tracks and residence; Near PNG pipeline
	HB	Annual Hawksbeard	*Crepis tectorum*	Field near Lawson Road
	OD	Oxeye daisy	*Leucanthemum vulgare*	Field near Lawson Road; Goathorn Creek crossing
	TC	Common tansy	*Tanacetum vulgare*	Goathorn Creek crossing
	YH	Yellow Hawkweed	*Hieracium pratense*	Under transmission line; Field near Lawson Road

	Code	Common Name	*Latin Name*	Code	Common Name	*Latin Name*
Additional Species within 1 km of the V-LSA in the V-RSA	CD	Curled dock	*Rumex crispus*	SO	Sow thistle spp.	*Sonchus spp.*
	DT	Dalmatian toadflax	*Linaria dalmatica*	SK	Spotted knapweed	*Centaurea biebersteinii*
	FS	Field Scabious	*Knautia arvensis*			
	HS	Hawkweed spp.	*Hieracium spp*	TH	Tall hawkweed	*Hieracium piloselloides*
	MB	Meadow buttercup	*Ranunculus acris*	WG	Western goat's beard	*Tragopogon dubius*
	OH	Orange hawkweed	*Hieracium aurantiacum*	WW	Wormwood	*Artemisia absinthium*
	PS	Perennial sow thistle	*Sonchus arvensis*	YD	Yellow devil hawkweed	*Hieracium glomeratum*
	SH	Scentless chamomile	*Matricaria perforata*	YT	Yellow toadflax	*Linaria vulgaris*

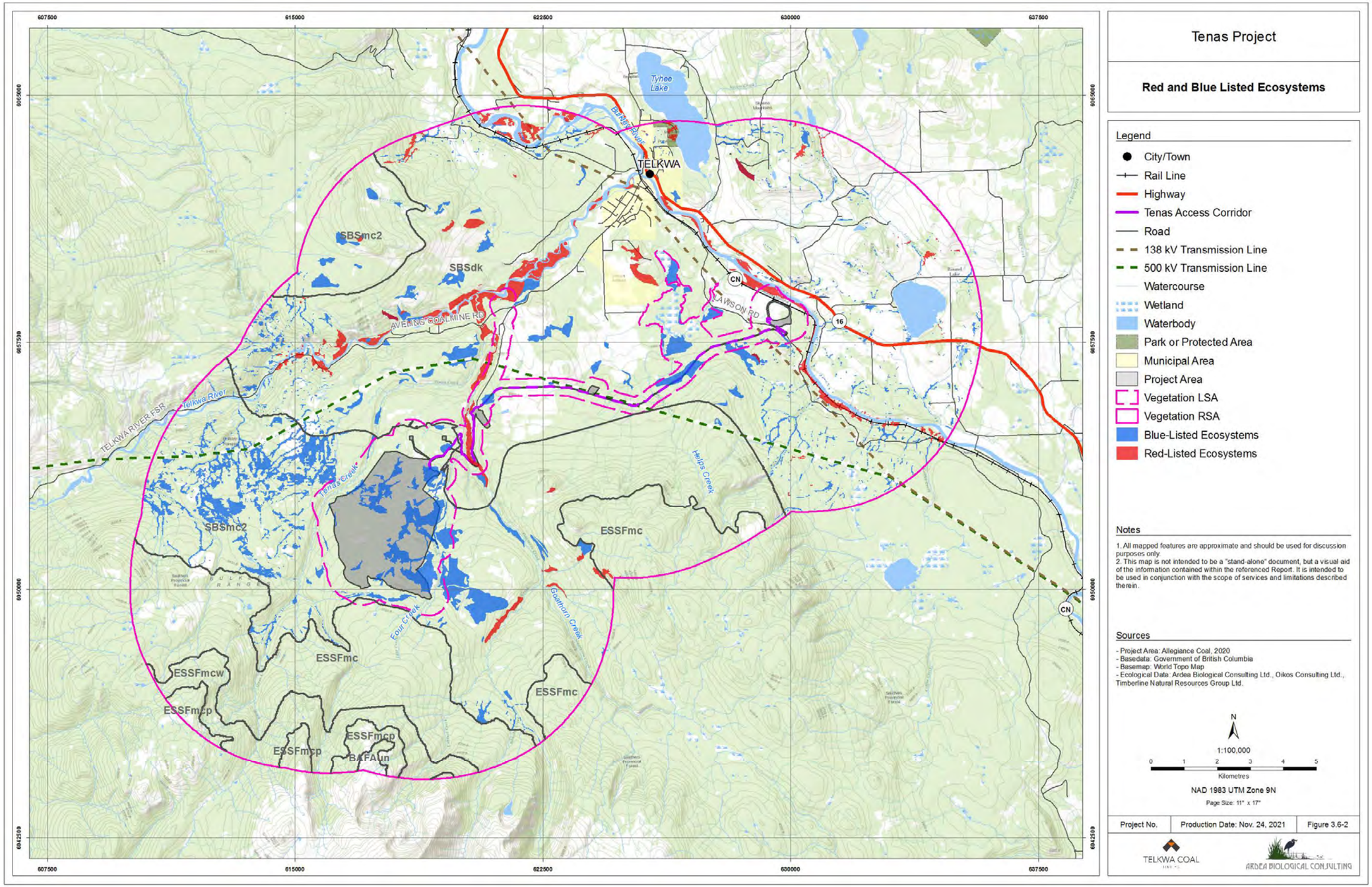


Figure 3.7-1: Location of listed ecological communities within the V-LSA and V-RSA.

Field Surveys

Fourteen invasive plant species were found in the V-LSA (Table 3.7-2) during the field surveys conducted in 2017 and 2018. Five species were observed in the minesite area, five in the Goathorn Creek area, eight along the access corridor and eight in the rail infrastructure area. The size of the infestations ranged from a single individual of Tatarian honeysuckle to many patches and individuals of Canada thistle. St. John's-wort is listed as Early Detection Rapid Response (EDRR) for the Bulkley Invasive Plant Management Area, and Tatarian honeysuckle was not previously recorded in the region. The survey transects and locations of invasive species plots are outlined in Figure 3.7-2, while a summary of the plants observed at each plot location, brief descriptions and mechanical site treatment options for control of species are outlined in Appendix E.

Table 3.7-2: List of invasive plant species found in the V-LSA.

Code	Common Name	Species Name	Regulated List[1]	Target list[2]	Priority List[3]	Minesite	Goathorn Crk.	Access Corr.	Rail Infra.
BT	Bull thistle	*Cirsium vulgare*	C		Lower	x		x	
CL	Cluster tarweed	*Madia glomerata*			Plant of concern			x	
CT	Canada thistle	*Cirsium arvense*	P		Lower	x	x	x	x
CD	Curled dock	*Rumex crispus*	C		Plant of concern				x
MB	Meadow hawkweed	*Hieracium caespitosum*		Extremely invasive		x		x	x
OH	Orange hawkweed	*Hieracium aurantiacum*	R		Lower	x			
OD	Oxeye daisy	*Leucanthemum vulgare*		Very invasive	Lower	x	x	x	x
SH	Scentless chamomile	*Matricaria perforata*	P	Very invasive	Lower			x	
SO	Annual sow thistle	*Sonchus oleraceus*	P				x	x	x
SJ	St. John's-wort	*Hypericum perforatum*	C		EDRR		x		
TC	Common tansy	*Tanacetum vulgare*	R	Extremely invasive	High				x
TH	Tatarian honeysuckle	*Lonicera tatarica*			Not listed		x		
WT	Western goat's-beard	*Tragopogon dubius*			Plant of concern				x
YT	Yellow toadflax	*Linaria vulgaris*	P	Bio-control available	Lower			X	X

Notes:

1) C = unregulated invasive plants of concern;
P = provincially regulated noxious species;
R = regionally regulated noxious species; (from ISCBC 2018)

2) (from NWIPC 2017)

3) EDRR = early detection rapid responses (from NWIPC 2018)

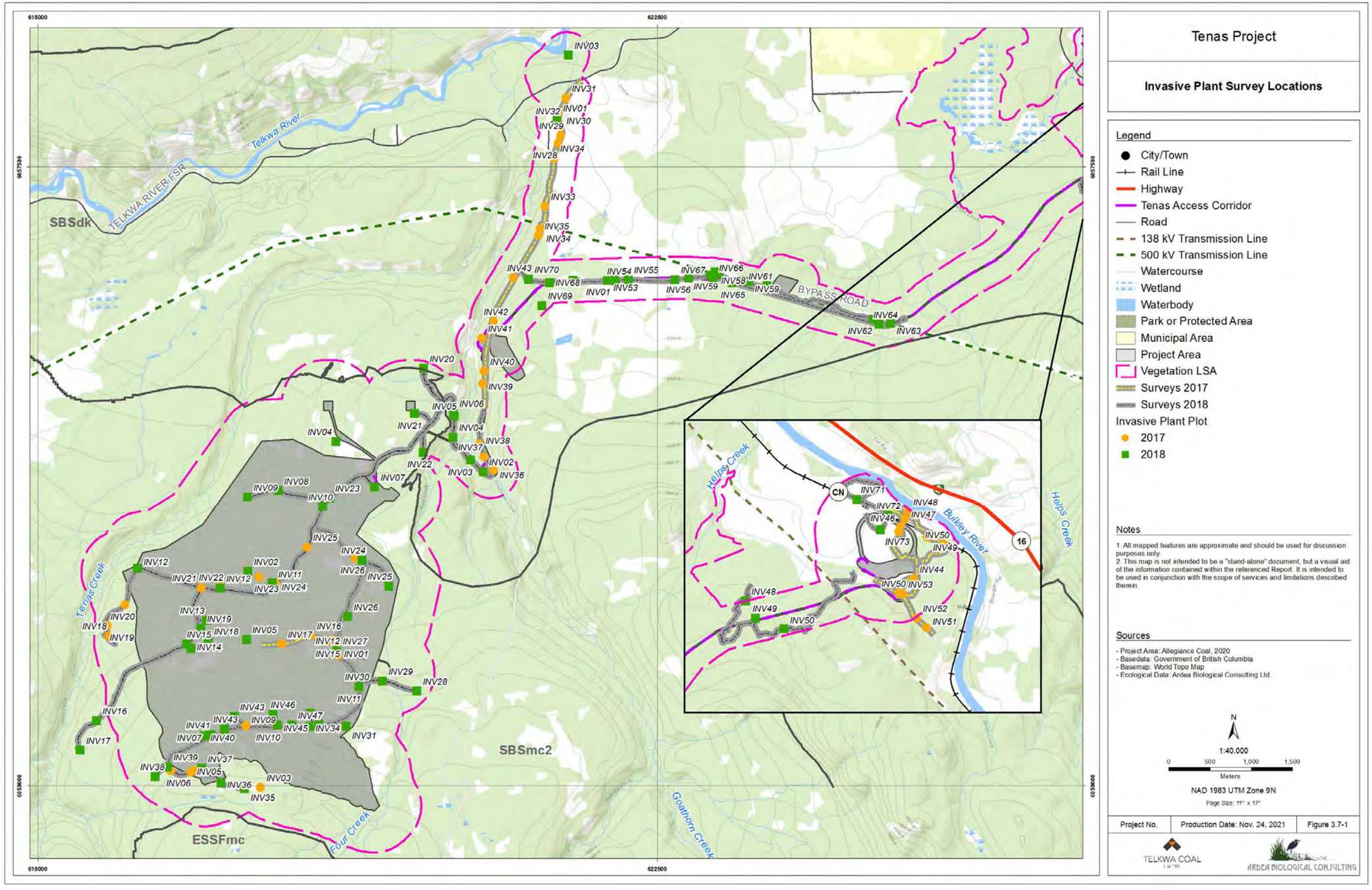


Figure 3.7-2: Survey effort and locations of invasive plant species observed within the V-LSA.

3.8 Plant Species Important for Cultural Use

The GIS analysis for plant species important for cultural use was based on assumptions of the plant being relatively easy to find within specific ecosystems and structural stages. These assumptions are based on existing data from various sources, field data collected in this baseline and the professional judgement of the authors' based on their work in the region (Appendix F; Table F-1). A summary of the area of ecosystems with the potential to support plant species important for cultural use within each of the BGC subzones is provided in Appendix F; Table F-2; and in Figure 3.8-1 for the V-LSA and Figure 3.8-2 for the V-RSA. Maps of those distributions are provided in Figure 3.8-3 to Figure 3.8-5.

Within the V-LSA and the V-RSA, berry species such as black huckleberry, highbush cranberry, red-raspberry and soopolalie were relatively common, with oval-leaved blueberry only common in the V-RSA, but not the V-LSA. Other cultural plants such as buckbean, devil's club, Indian hellebore and kinnickinnick were less common within both the V-LSA and V-RSA.

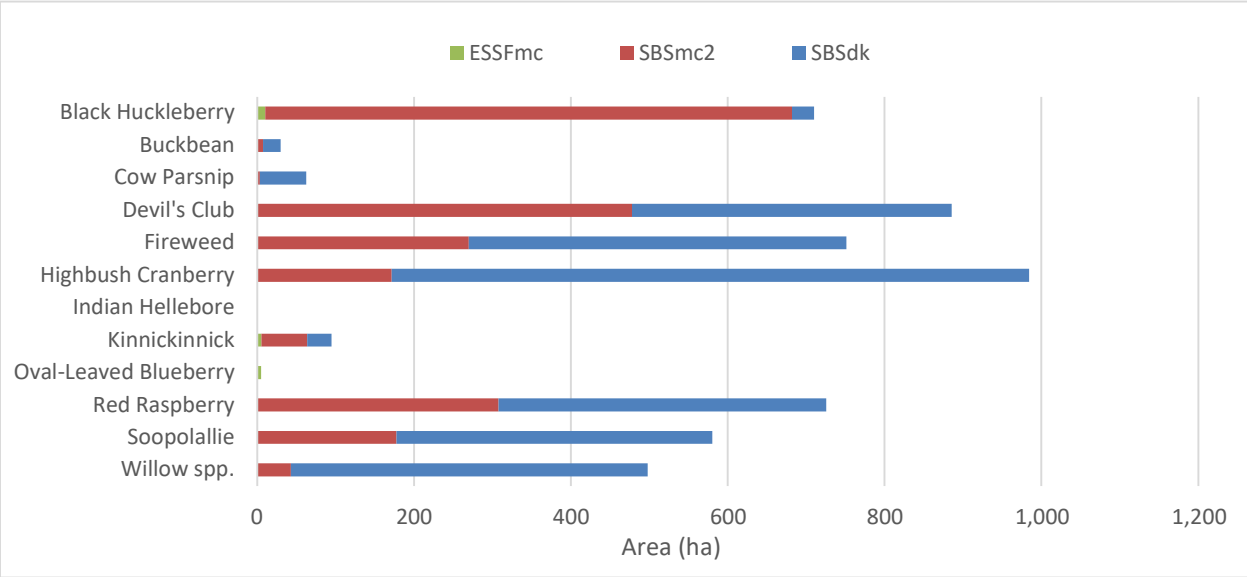


Figure 3.8-1: Potential available area of plants important for cultural use within the V-LSA.

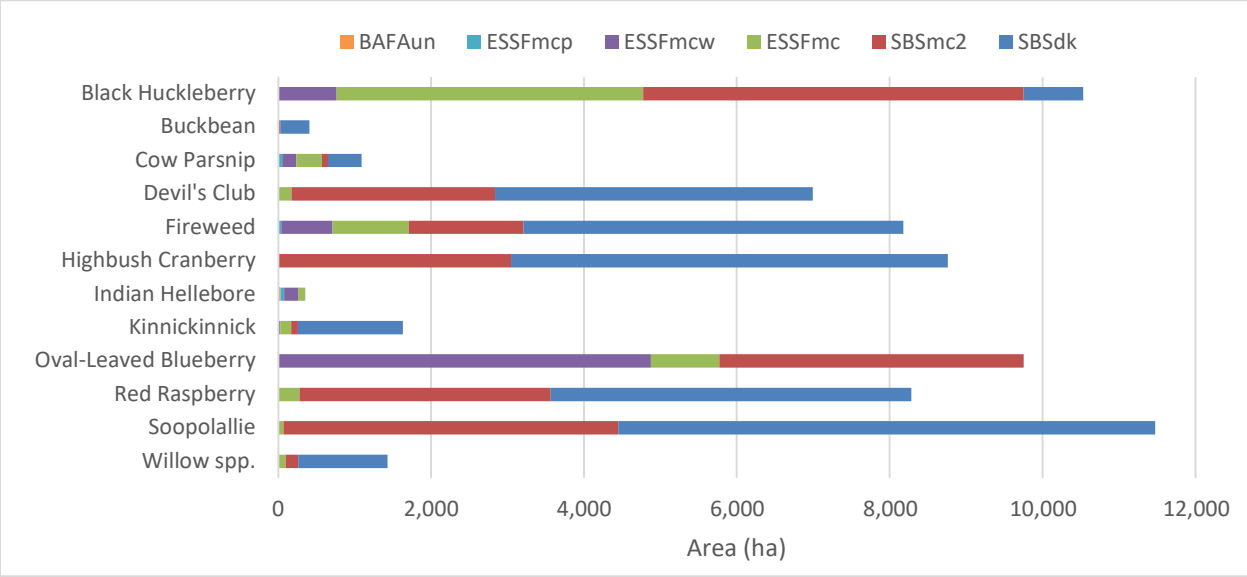


Figure 3.8-2: Potential available area of plants important for cultural use within the V-RSA.

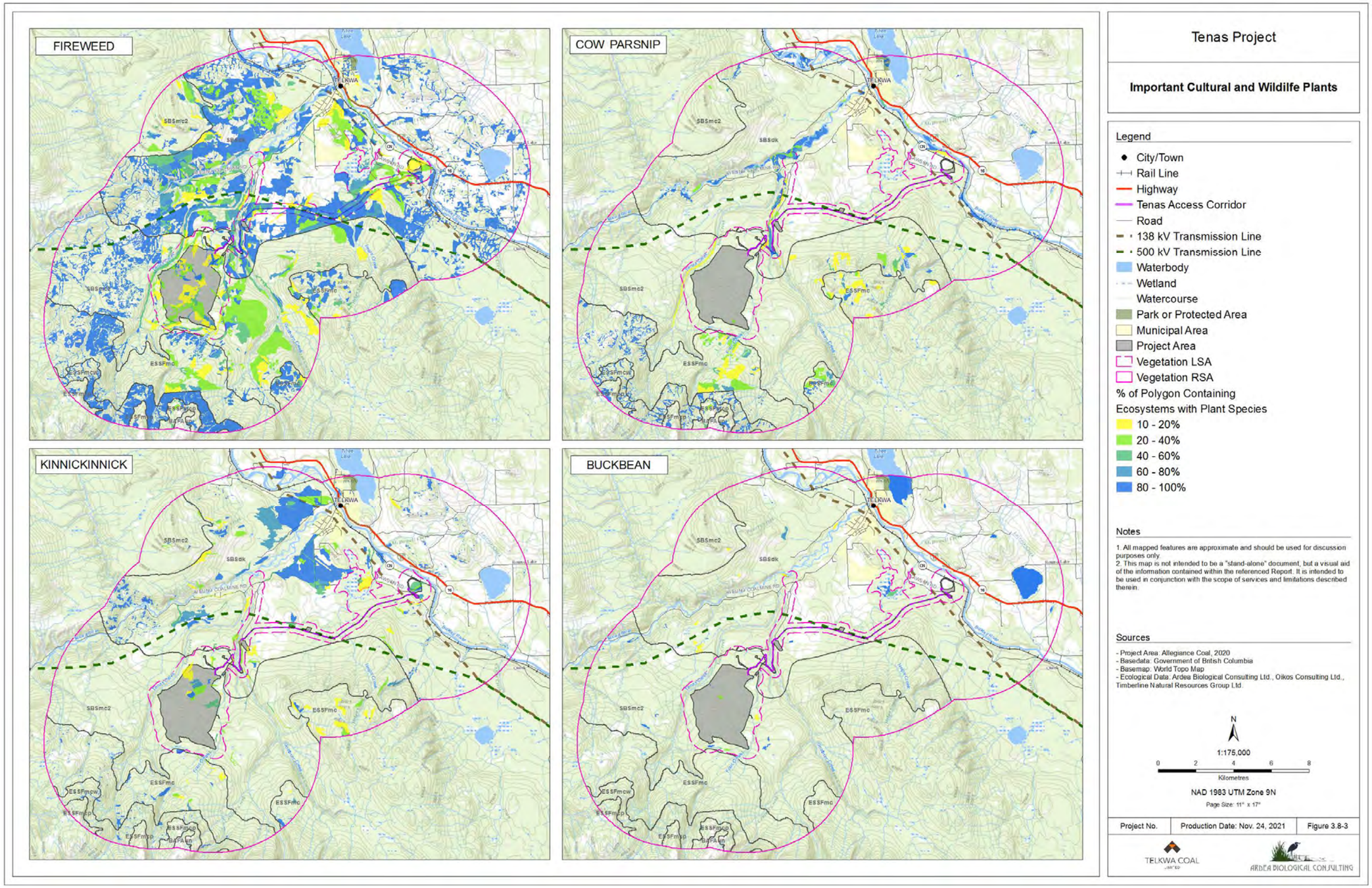


Figure 3.8-3: Potential distribution of fireweed, cow parsnip, kinnickinnick and buckbean in the V-LSA and V-RSA.

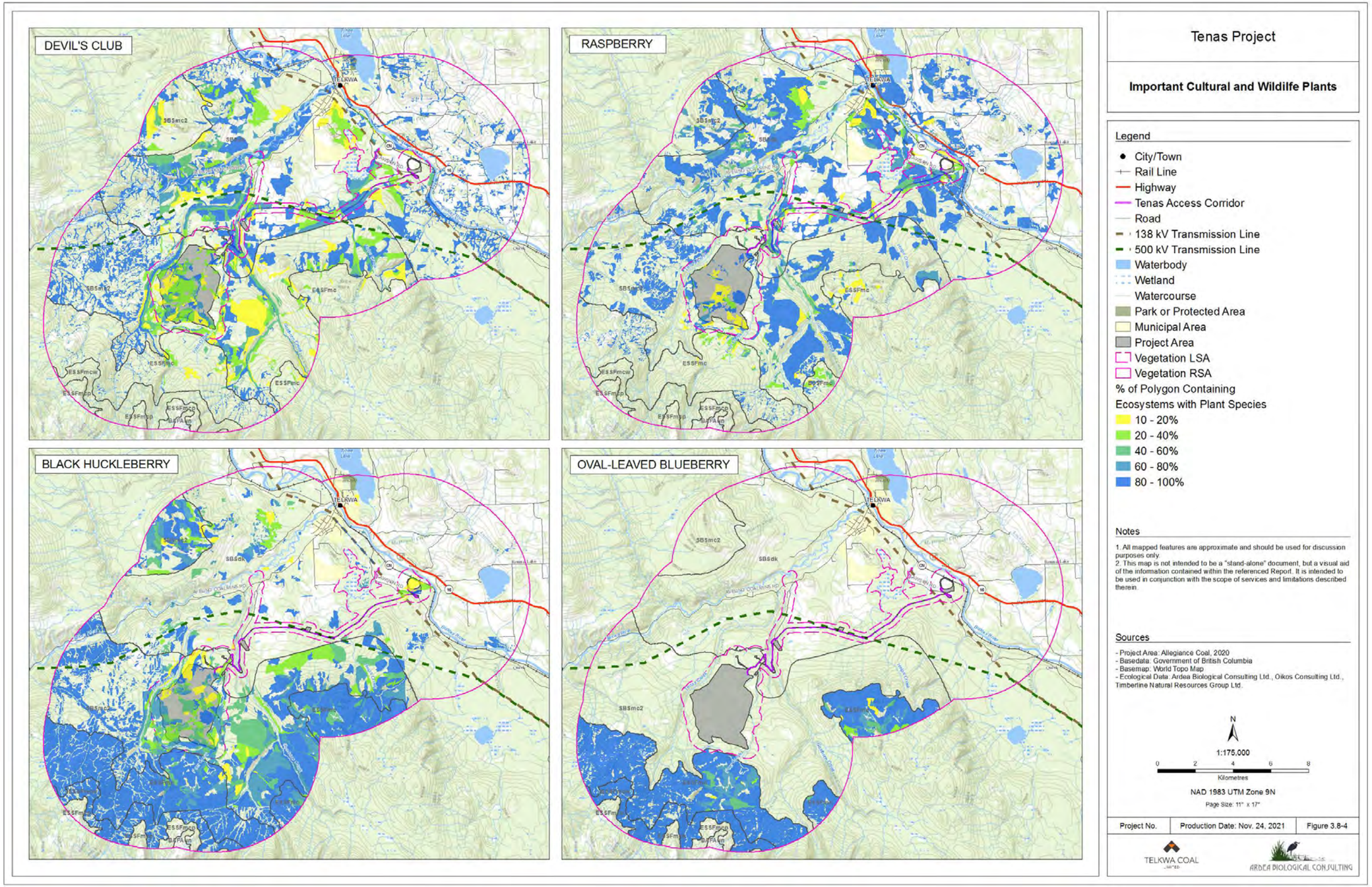


Figure 3.8-4: Potential distribution of Devil's club, raspberry, black huckleberry and oval-leaved blueberry in the V-LSA and V-RSA.

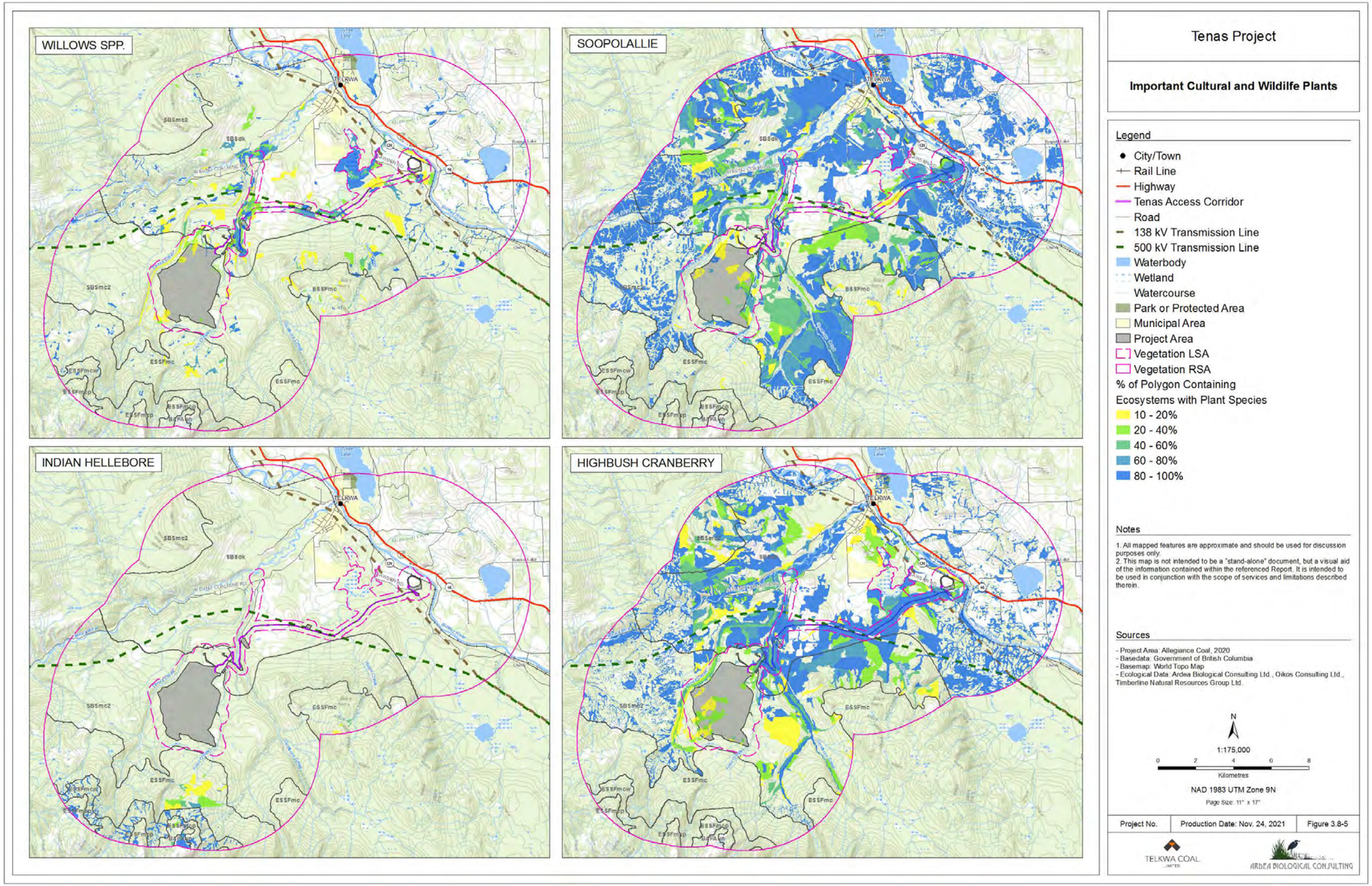


Figure 3.8-5: Potential distribution of high bush cranberry, Indian hellebore, willows and soopolallie in the V-LSA and V-RSA.

3.9 Vegetation Trace Metals

Several metals such as arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), nickel (Ni), copper (Cu) and zinc (Zn) are considered toxic to a variety of organisms due to their potential to damage organs when ingested, even at low levels (Tchounwou et al. 2012, Ali et al. 2019). These eight trace metals were chosen for providing summaries for the vegetation sampling outlined below, with a complete listing of the results for all samples provided in Appendix G.

Analysis of Leaf/Stem Tissue Trace Metals by Species

Leaf and/or young stem tissues were sampled in a total of 17 species (Table 3.9-1), including two species for which berry samples were also analyzed (devil's club and black twinberry). Red elderberry samples of mixed leaf and berry tissues are included in the berry section, below.

Table 3.9-1: Summary of leaf/stem tissues sampled.

English Name	Latin Name	# of Samples
Alaska Willow	Salix alaxensis	1
Beaked Sedge	Carex utriculata	3
Black Cottonwood	Populus trichocarpa	8
Black Twinberry	Lonicera involucrata	15
Bluejoint Reedgrass	Calamagrostis canadensis	1
Common Horsetail	Equisetum arvense	15
Cow Parsnip	Heracleum maximum	5
Devils Club	Oplopanax horridus	2
Fireweed	Epilobium angustifolium	19
Grey-leaved Willow	Salix glauca	1
Prickly Rose	Rosa acicularis	7
Red-osier Dogwood	Cornus stolonifera	9
Scouler's Willow	Salix scoulerina	12
Sitka Alder	Alnus viridis ssp. sinuata	3
Subalpine Fir	Abies lasiocarpa	10
Tea-leaved Willow	Salix planifolia	7
Western Mountain-ash	Sorbus scopulina	7
Total # Samples		***125***

Summaries of the trace metal concentrations for selected metals for the species with ten or more samples (black twinberry, common horsetail, fireweed, Scouler's willow and subalpine fir) are shown as box-plots in Figure 3.9-1 to . The box-plots show the range of the upper and lower 25% of the values, with the large boxes outlining the range of 50% of the data. Median values are shown with a horizontal line, while an "X" is the mean value. Tabular date for these species is provided in in Appendix B.

The concentrations of trace metals of environmental interest within the leaf/stem samples showed some variation across the plant species and by trace metal, but most were relatively consistent. Trace elements such as lead, mercury and nickel did not vary much across the plant species, and had narrow ranges of concentrations, with lead and mercury all showing mean and median concentrations below 0.002 mg/kg (dry) and nickel below 3.000 mg/kg (dry). Arsenic showed very little variation for most species with mean and median concentrations all below 0.200 mg/kg (dry), although common horsetail had more variation, with some samples having concentrations up to 0.697 mg/kg (dry). Cadmium was also relatively consistent with low concentrations (< 0.100 mg/kg (dry)), except for Scouler's willow, which had a wide range of values (0.057 to 5.755 mg/kg (dry)), a mean of 0.94 mg/kg (dry) and a median of 0.0.48 mg/kg (dry). Chromium concentrations were variable across the plant species, with Scouler's willow and subalpine fir showing relatively narrow ranges, while black twinberry and common horsetail having wide ranges and fireweed intermediate between those groups of species. Copper concentrations were consistent across all species, while zinc showed wide ranges across species, and associated differences in means and medians.

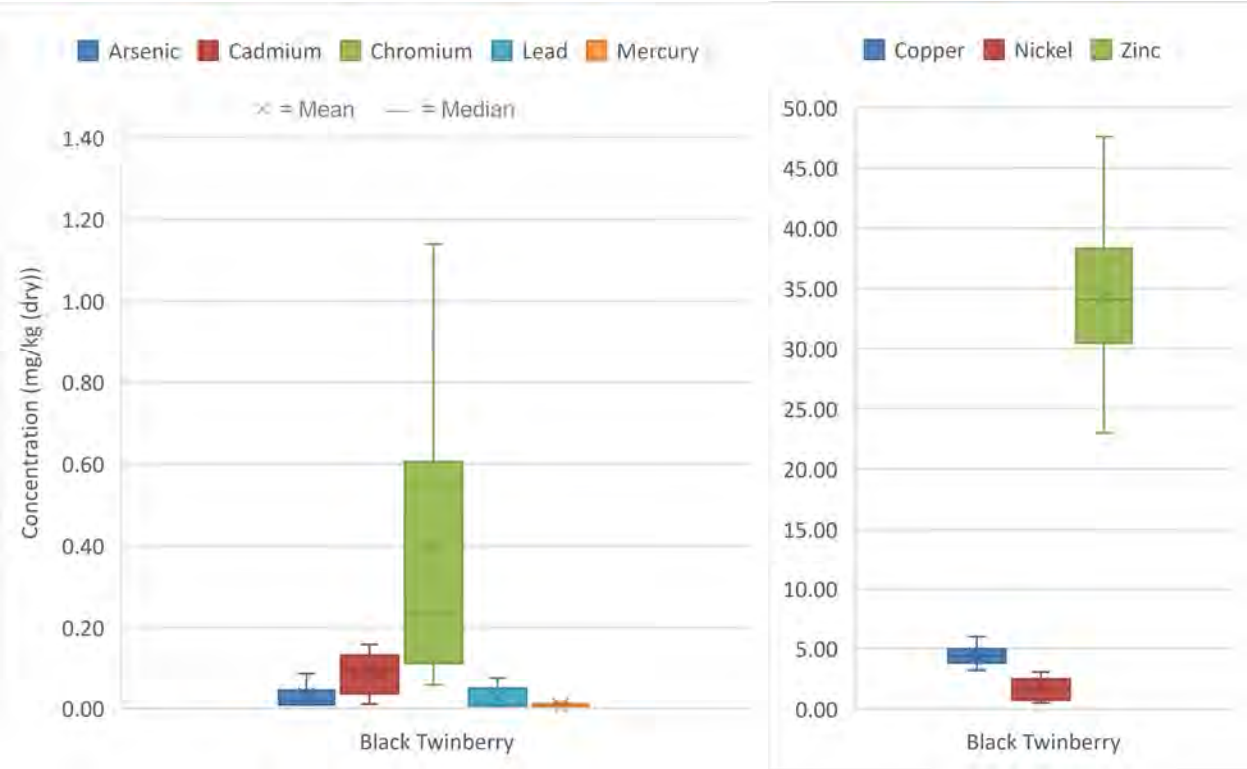


Figure 3.9-1: Box-plot of trace metals of environmental interest for black twinberry samples (n=15) within the V-LSA.

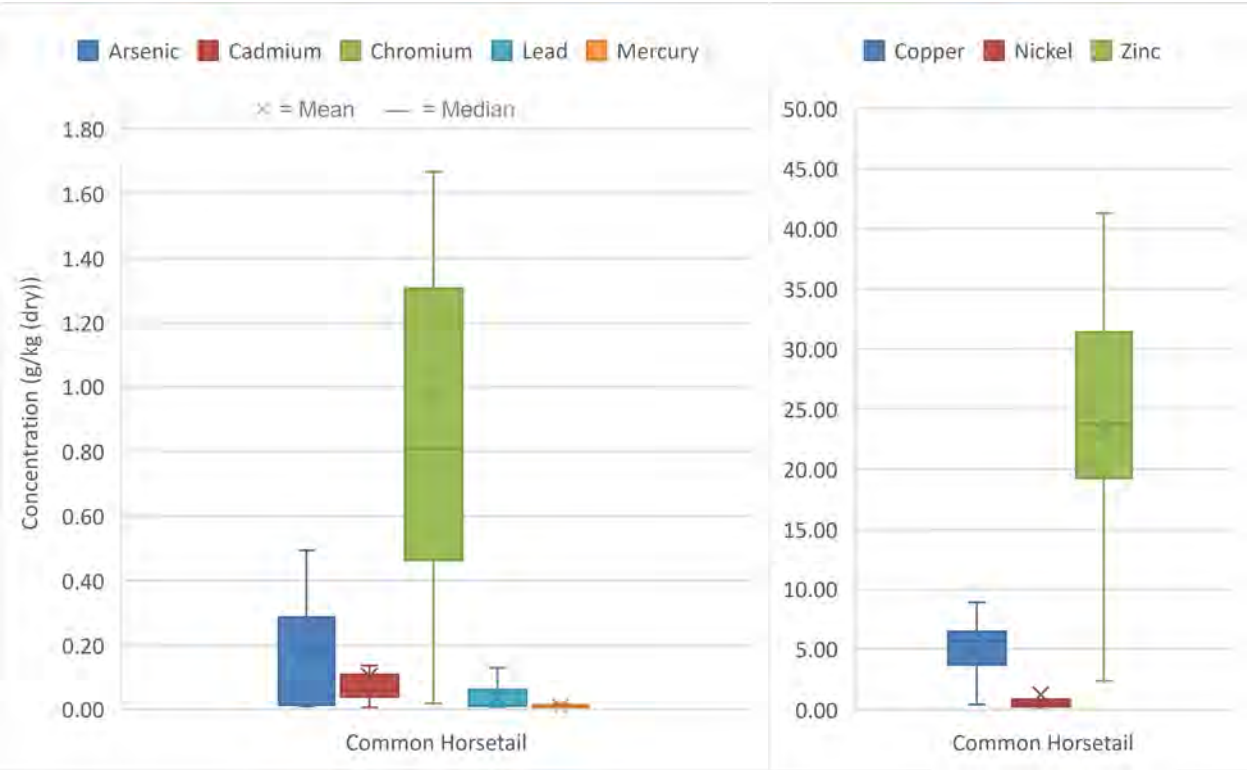


Figure 3.9-2: Box-plot of trace metals of environmental interest for common horsetail samples (n=15) within the V-LSA.

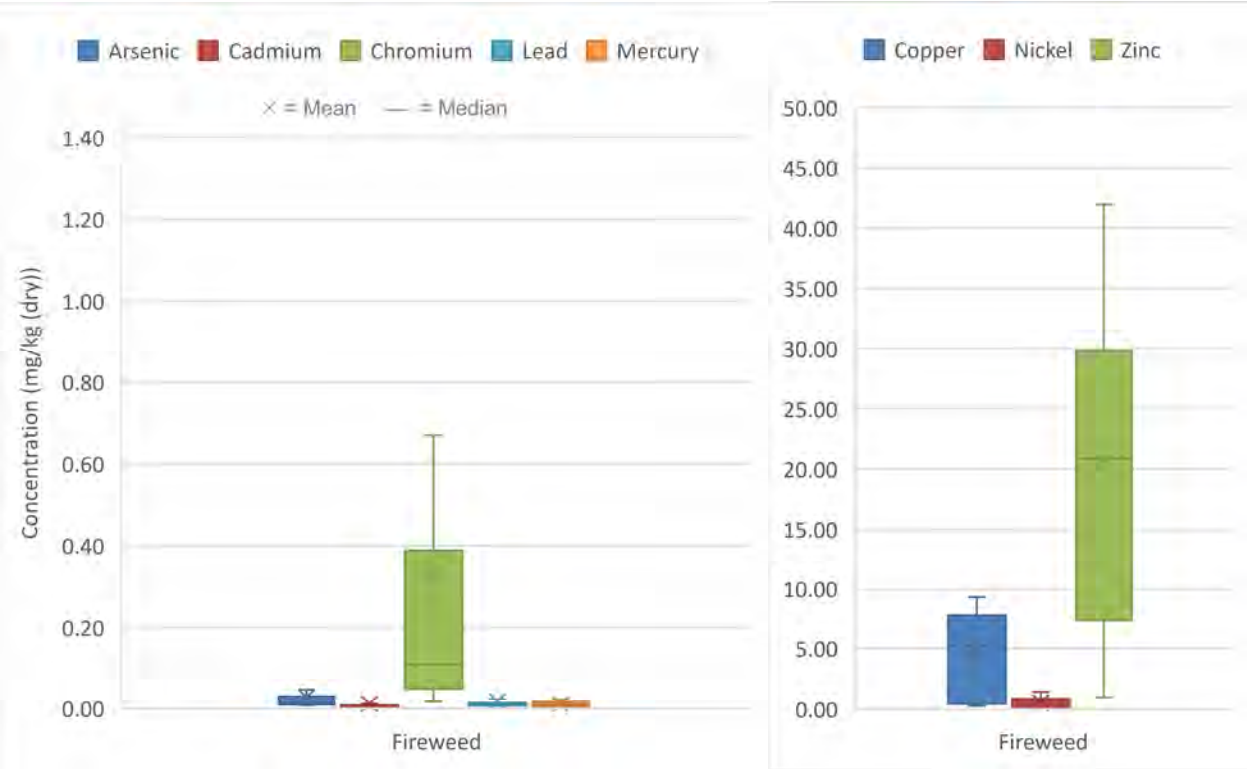


Figure 3.9-3: Box-plot of trace metals of environmental interest for fireweed samples (n=19) within the V-LSA.

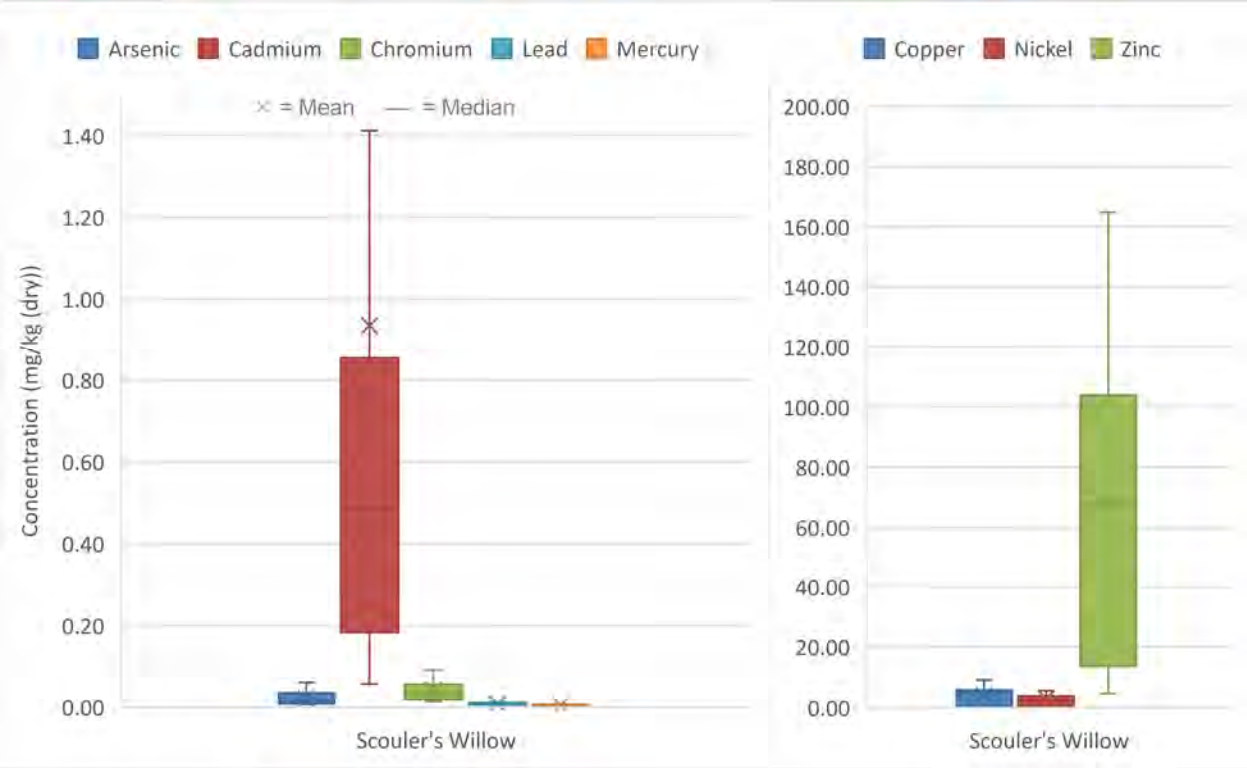


Figure 3.9-4: Box-plot of trace metals of environmental interest for Scouler's willow samples (n=12) within the V-LSA.

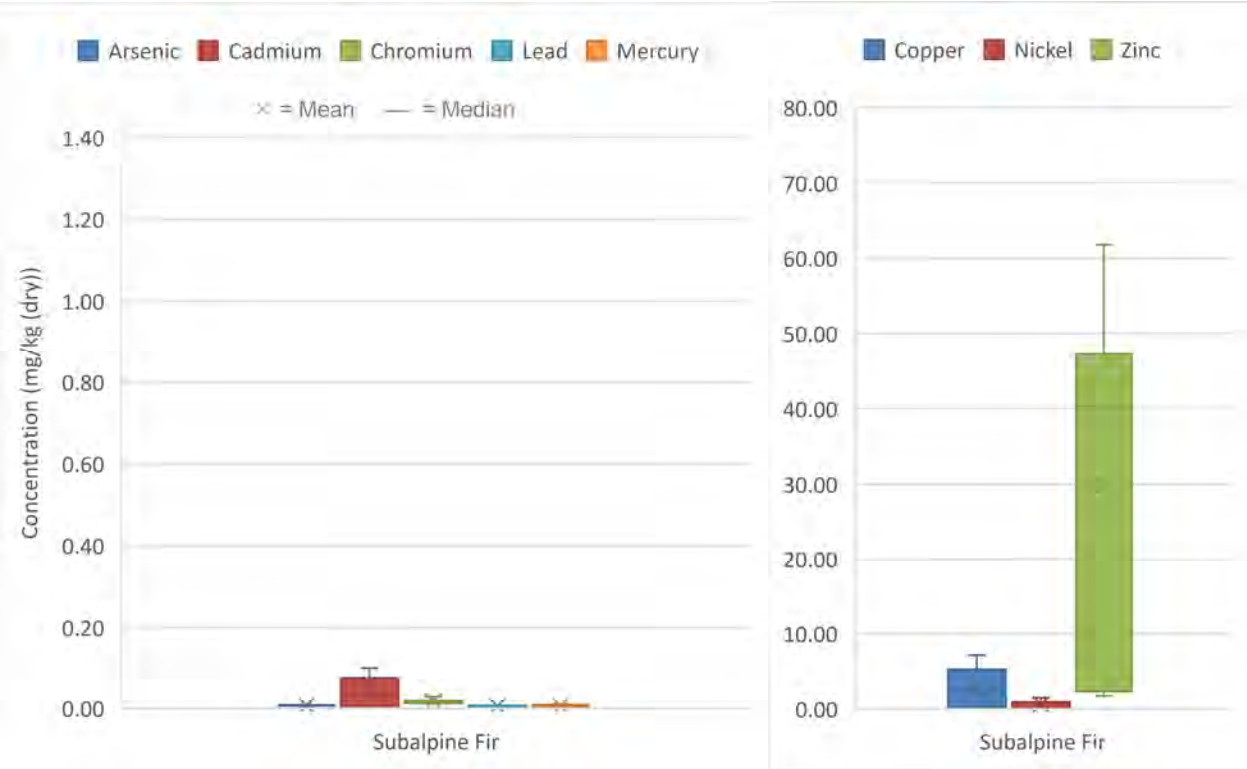


Figure 3.9-5: Box-plot of trace metals of environmental interest for subalpline fir samples (n=10) within the V-LSA.

Analysis of Berry Tissues Trace Metals by Species

We were unable to collect replicate samples for some of the berry species and in most cases only limited replicates were obtained, except for highbush cranberry where 11 samples were collected (Table 3.9-2).

Summary trace metal data for all species except for highbush cranberry are shown individually in Figure 3.9-6 and Figure 3.9-7. Each trace metal of environmental interest is shown on a log scale to show both very small and very large numbers effectively for comparison. Tabular date for these species is provided in in Appendix B.

Table 3.9-2: Summary of berry tissues sampled.

English Name	Latin Name	# of Samples
Black Gooseberry	*Ribes lacustre*	1
Black Huckleberry	*Vaccinium membranaceum*	2
Black Twinberry	*Lonicera involucrata*	1
Devils Club	*Oplopanax horridus*	1
Highbush Cranberry	*Viburnum edule*	11
Red Elderberry	*Sambucus racemosa*	4
Red Raspberry	*Rubus idaeus*	2
Soopolallie	*Shepherdia canadensis*	3
Total # Samples		***25***

Nickel, arsenic, mercury and chromium values were all low, with arsenic and nickel concentrations below 0.010 mg/kg (dry), and chromium between 0.010 and 0.100 mg/kg (dry). Cadmium concentrations were below 0.010 mg/kg (dry), except for red raspberry where it was just above 0.010 mg/kg (dry). Lead concentrations were quite variable, ranging from 0.100 and 10.000 mg/kg (dry), with red elderberry, black twinberry and red raspberry at the higher end of the range. Black twinberry, red raspberry and red elderberry

also had higher copper and zinc concentrations than the other berry species, with zinc having the highest values of all the trace metals with concentrations between 10.000 and 100.000 mg/kg (dry).

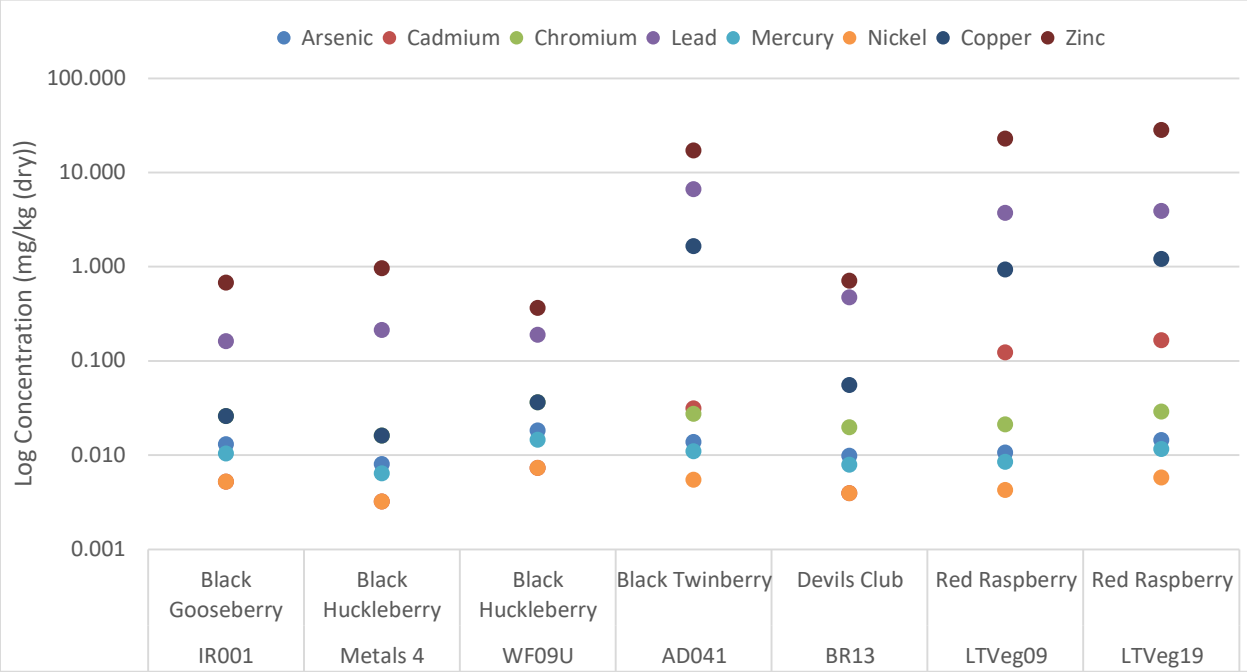


Figure 3.9-6: Comparison of trace metals of environmental interest for black gooseberry, black huckleberry, black twinberry, devil's club and red raspberry berry samples from listed sample plots.

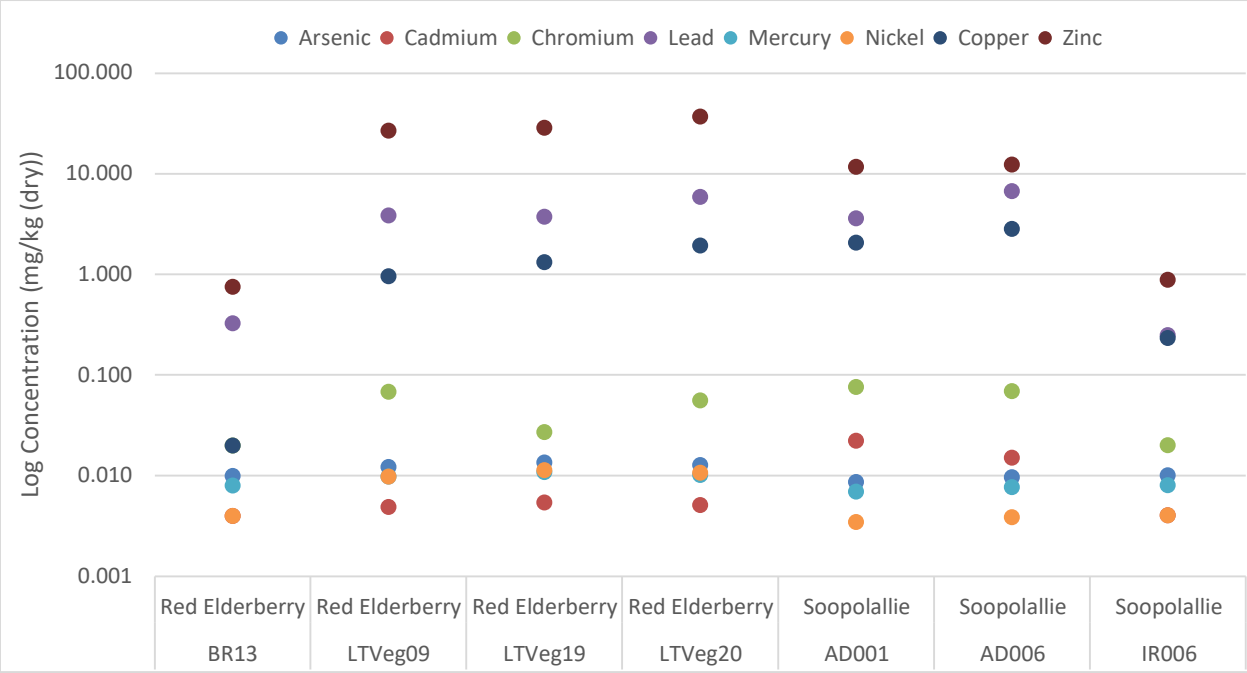


Figure 3.9-7: Comparison of trace metals of environmental interest for red elderberry and soopolallie berry samples from listed sample plots.

Eleven samples of highbush cranberry were obtained within the V-LSA and the results of the trace metals analysis is provided as a box-plot in Figure 3.9-9. Arsenic, cadmium, chromium, lead and mercury were all very low concentrations for highbush cranberry, with nickel concentrations ranging from 0.02 to 0.92 mg/kg (dry). Both copper and zinc concentrations were higher than the other trace metals, with copper rating from 0.13 to 4.24 mg/kg (dry) and zinc concentrations ranging from 0.25 to 11.69 mg/kg (dry).

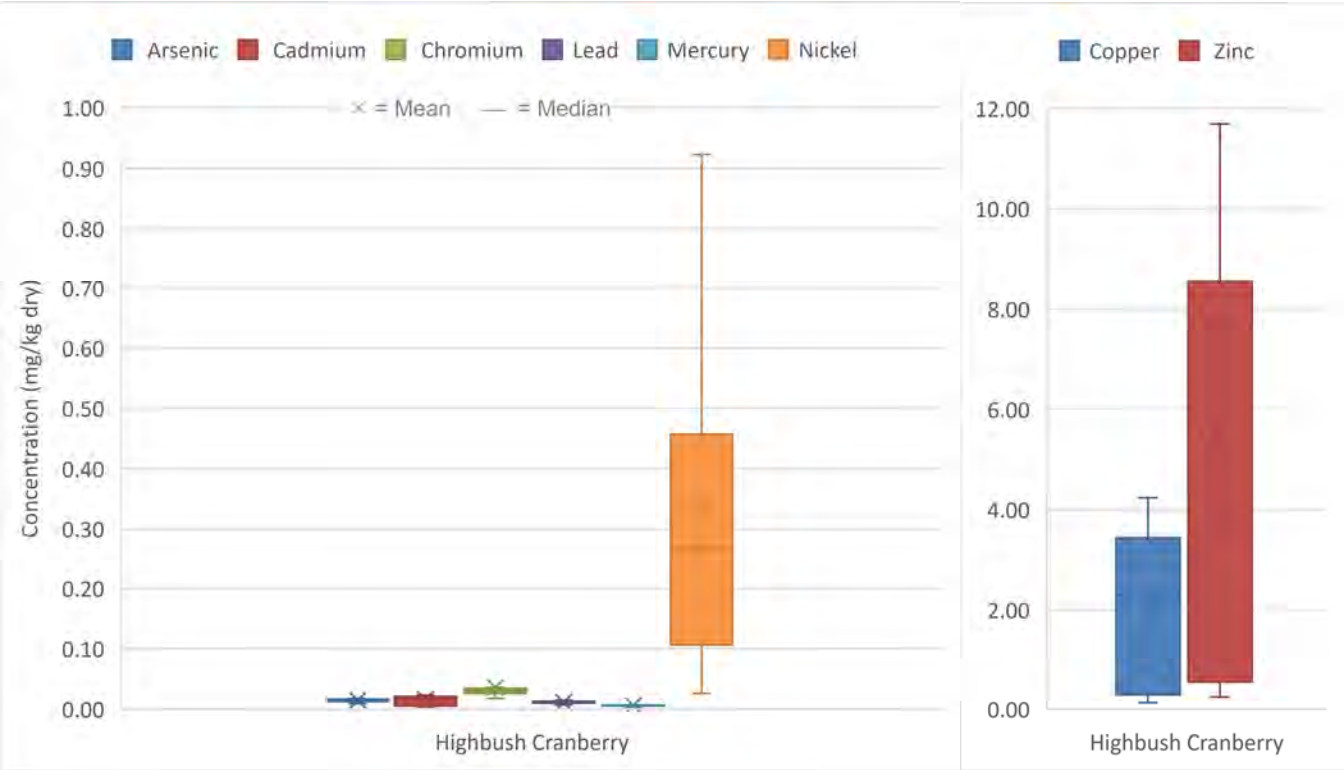


Figure 3.9-8: Box-plot of trace metals of environmental interest for highbush cranberry berry samples (n=11) within the V-LSA.

Analysis of Trace Metals by Sample Site

In some cases, vegetation samples of multiple species and/or tissues were collected from a single site, providing an opportunity to compare trace metal concentrations among species and tissues. Of the 35 sites where multiple samples were collected, 14 sites had 2 samples, 9 sites had 3 samples, 7 sites had 4 samples, 3 sites had 5 samples, and 2 sites had 6 samples. A comparison of species/tissues of trace metals of environmental interest at sample sites where sampling included 5 or more species is outlined in Figure 3.9-9 to Figure 3.9-13. Each trace metal of environmental interest is shown on a log scale to show both very small and very large numbers effectively for comparison.

Overall, the concentrations of trace metals between the species and tissues within a sample site were relatively similar for almost all metals. Copper and zinc were all consistently high within all plots for all species/tissues, while nickel was almost always near 1.0 mg/kg (dry). Cadmium and chromium concentrations varied across species within a site as well as across sites, where there were the same species (e.g. red elderberry, red raspberry, western mountain ash). Arsenic, mercury and lead were all consistently low across all sites and plant species.

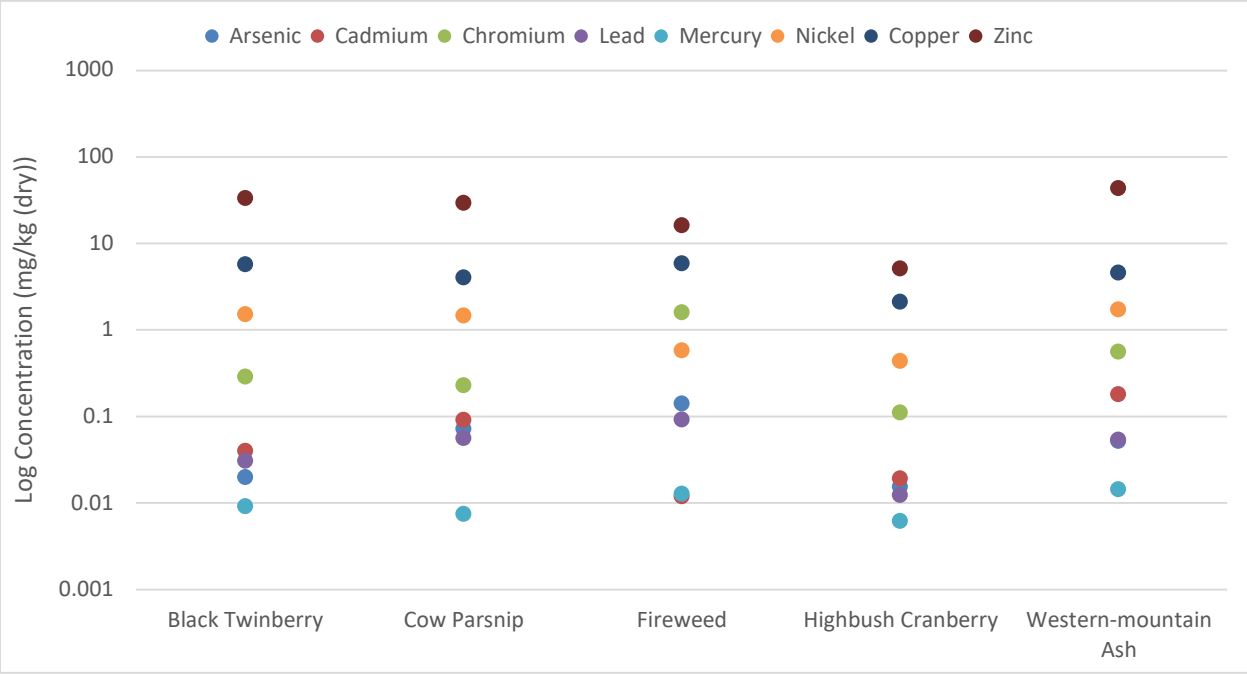


Figure 3.9-9: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg05 in the Goathorn Creek area.

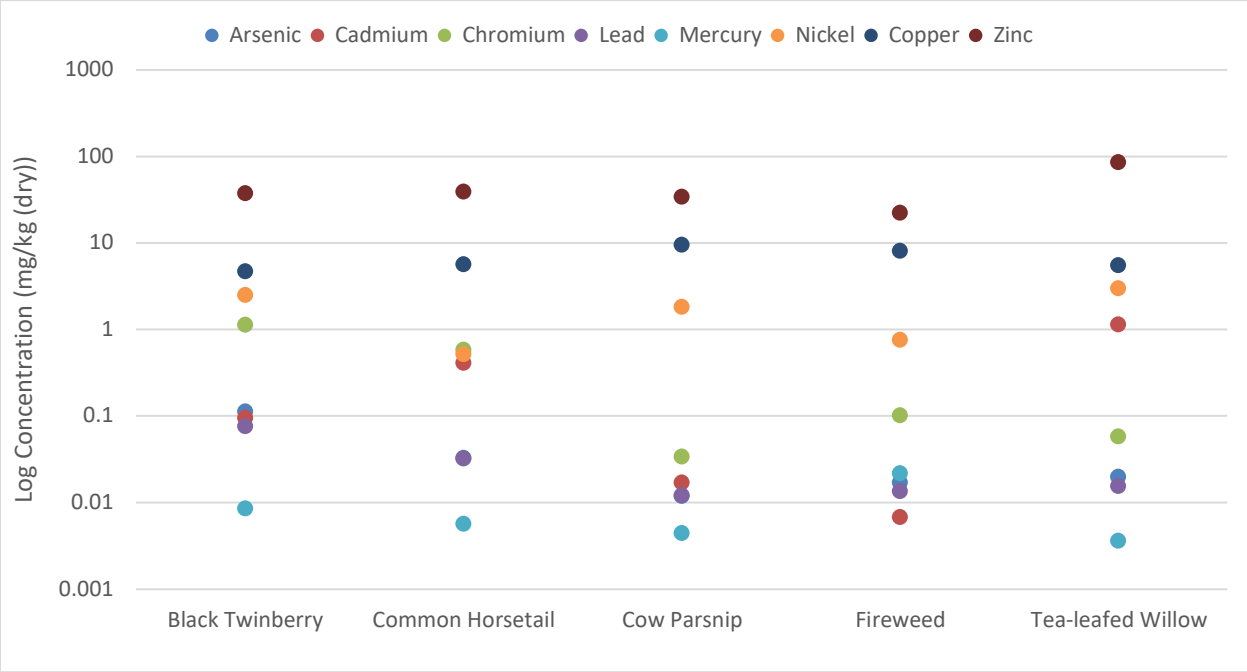


Figure 3.9-10: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg06 in the Goathorn Creek area.

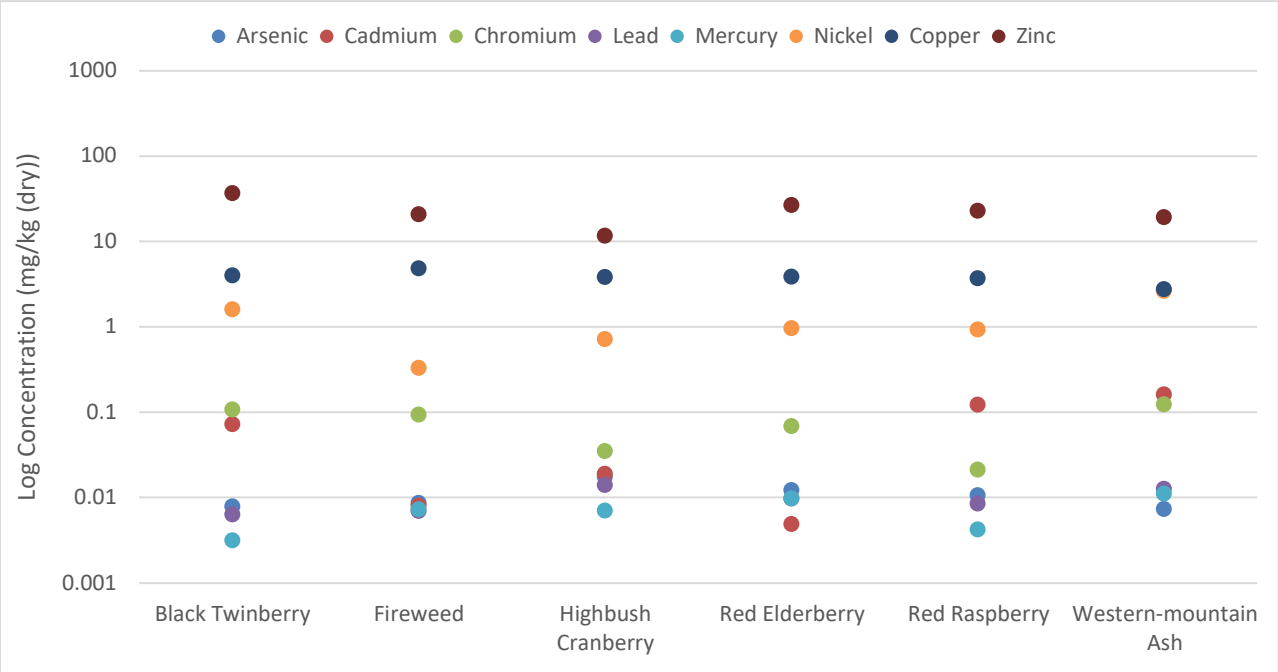


Figure 3.9-11: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg09 in the minesite area.

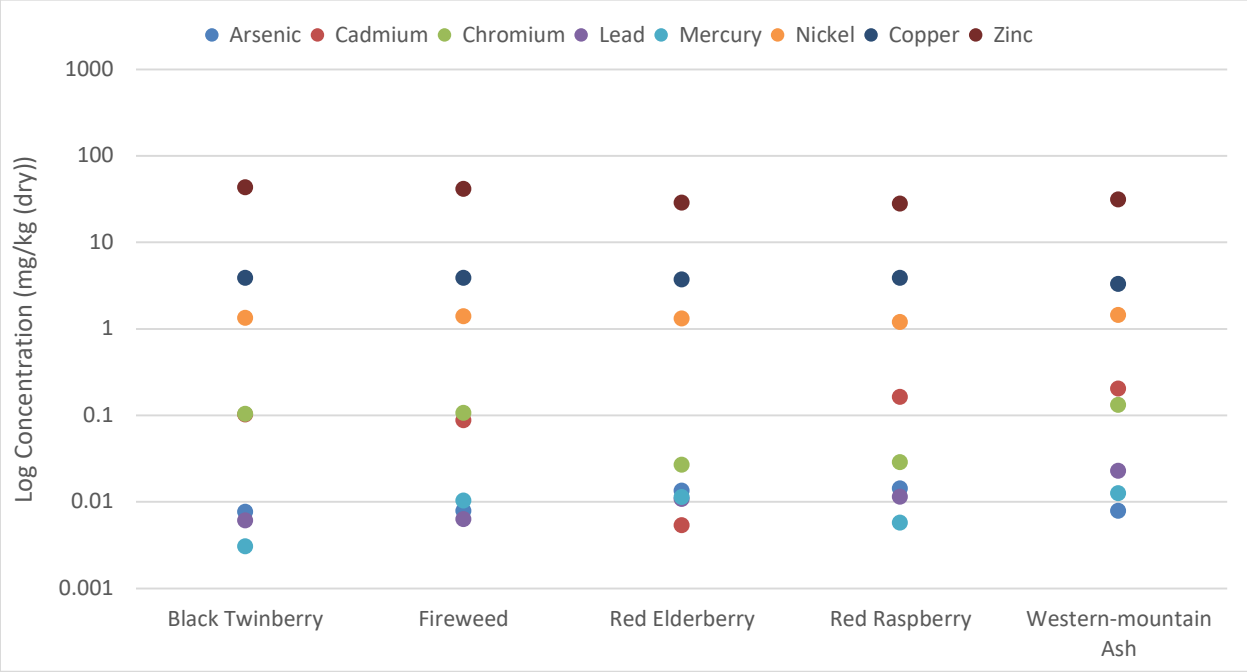


Figure 3.9-12: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg19 in the minesite area.

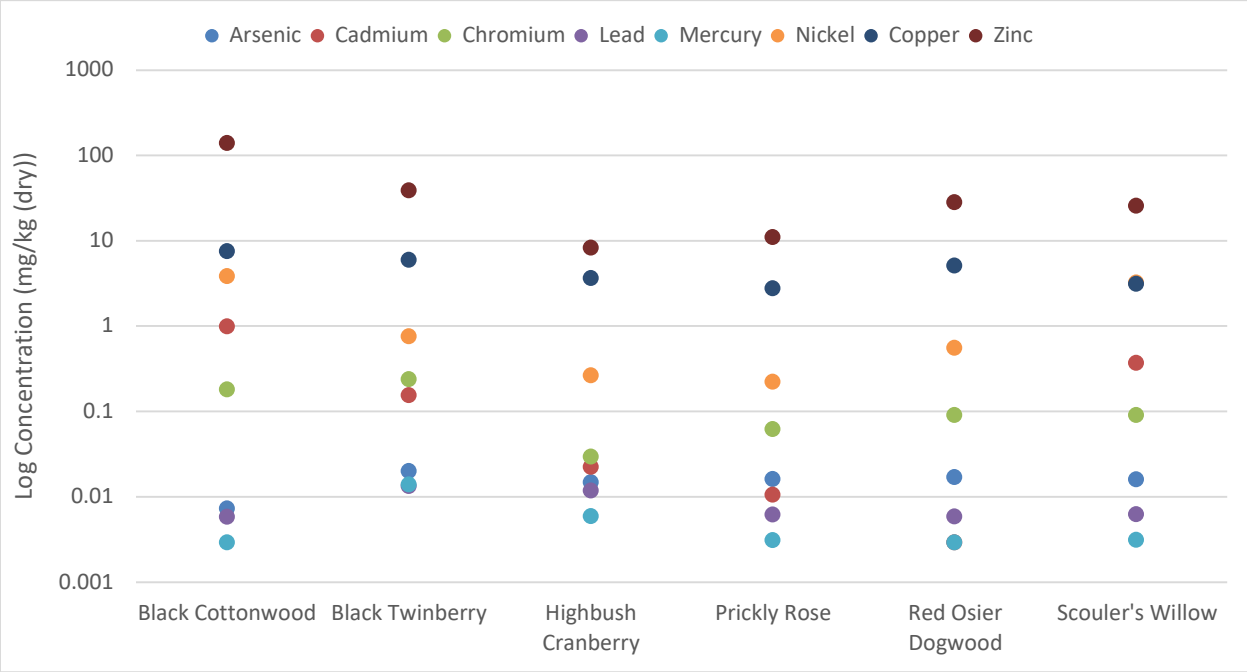


Figure 3.9-13: Comparison of trace metals of environmental interest for plant species sampled at site LTVeg21 in the access corridor area.

Comparison of Samples within General Project Areas

Across all sites and samples, five species (black twinberry, common horsetail, fireweed, highbush cranberry and red osier dogwood) had a minimum of 3 samples (range 3 to 12 samples) in each of the access corridor, Goathorn Creek and minesite areas. A comparison of the concentrations of trace metals of environmental interest is provided in Figure 3.9-14 as box-plots.

Comparison of the different plant species within the general project areas shows the variability of trace metals concentrations by the same plant species at different sites. The low sample sizes, however limits the ability to complete a robust statistical analysis comparing the values. In almost all cases the ranges of values obtained for the trace metals in the plant species overlap across the sites suggesting that the differences may not be significant. An exception may be black twinberry chromium values, where they appear to be higher in the Goathorn Creek sites than within the access corridor or the minesite areas.

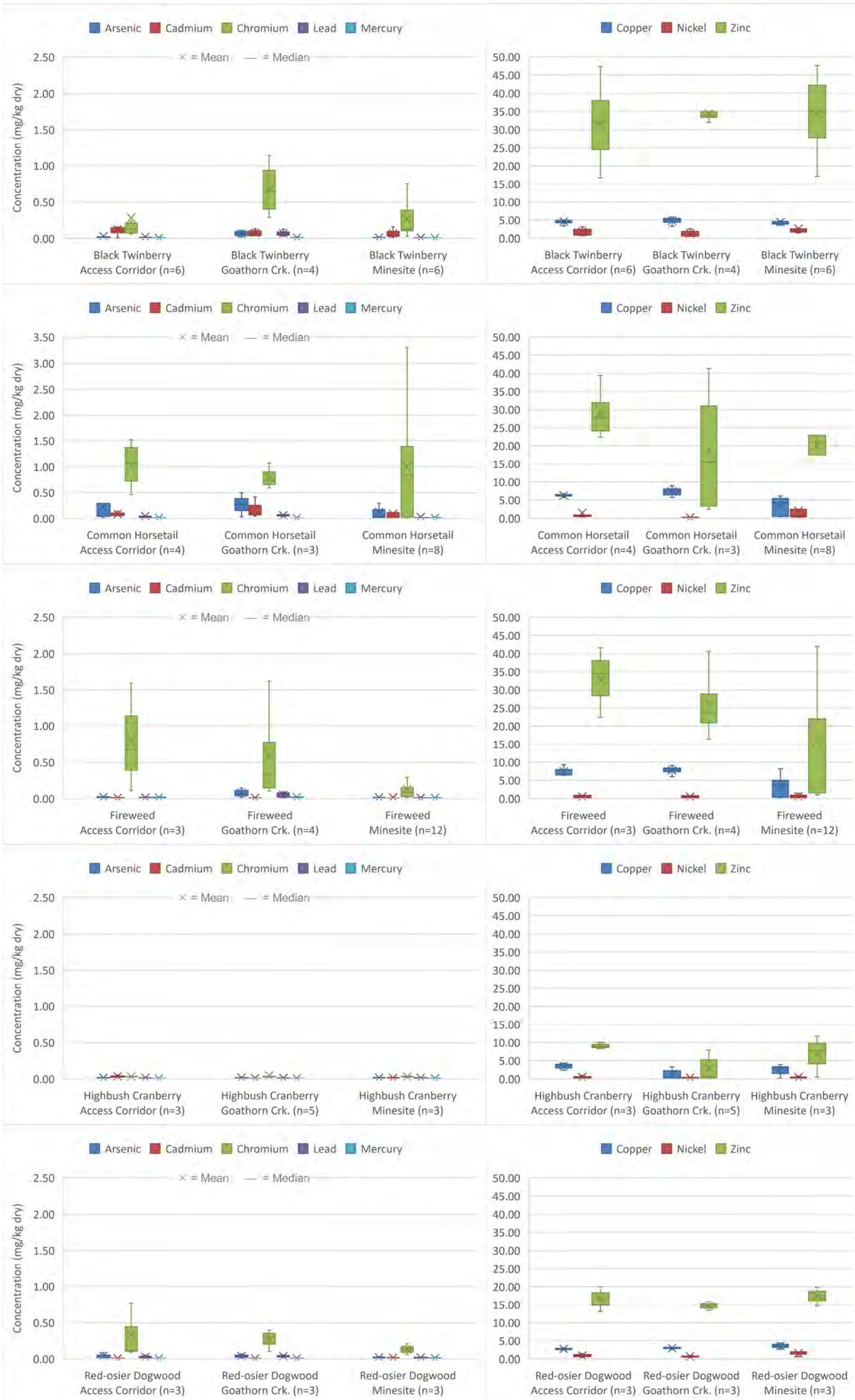


Figure 3.9-14: Box-plots comparing trace metals of environmental interest for selected plant species within project sub-areas.

4. REFERENCES

Ali, H., E. Khan and I. Ilahi. 2019. Environmental Chemistry and Ecotoxicity of Hazardous Heavy Metals: Environmental Persistence, Toxicity and Bioaccumulation. Journal of Chemistry. 2019

Apfelbeck, R. and E. Farris. 2005. Montana Wetland Rapid Assessment Method Guidebook (Version 2.0) Montana Department of Environmental Quality. Helena, MT.

Ardea Biological Consulting Ltd. (Ardea). 2014. Overview of Phase 1 Sample Section: Technical and Cultural Process. Baseline Monitoring of Soils, Vegetation and Wildlife along the Apache Pipeline within Wet'suwet'en Territory. Technical Memo prepared for Office of the Wet'suet'en and Chevron Canada. Smithers, BC.

Ardea Biological Consulting Ltd. (Ardea). 2015. Kemess Underground Project: Ecosystems and Vegetation Baseline Report. Prepared for AuRico Metals Inc. by Ardea Biological Consulting Ltd. Smithers, BC.

Ardea Biological Consulting Ltd. (Ardea). 2021. Tenas Project Terrain and Soils Baseline Report. Prepared for Telkwa Coal Limited for the BC Environmental Assessment Office. Smithers, BC.

Banner, A. W.H. Mackenzie, S. Haeussler, S. Thomson, J. Pojar and R. Trowbridge. 1993. A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region. B.C. Min. For., Victoria, B.C. Land Management Handbook 26.

BC Conservation Data Centre (BC CDC). 2018a. iMap Incident Mapping Application. Victoria, British Columbia, Canada. Available: http://maps.gov.bc.ca/ess/sv/cdc/. Accessed: October, 2018.

BC Conservation Data Centre (BC CDC). 2018b. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria B.C. Available: http://a100.gov.bc.ca/pub/eswp/. Accessed: March, 2018.

BC Conservation Data Centre (BC CDC). 2020. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria B.C. Available: http://a100.gov.bc.ca/pub/eswp/. Accessed: February, 2020

BC Environmental Assessment Office (BC EAO). 2019. Environmental Assessment Project Information Centre. Available: https://www.projects.eao.gov.bc.ca/

BC Ministry of Agriculture, Food and Fisheries (BC MAFF). 2002. Guide to Weeds in British Columbia. Ministry of Agriculture, Food and Fisheries, Victoria, BC.

BC Ministry of Environment (BC MOE). 2018. EcoCat: The Ecological Reports Catalogue. Available: https://a100. gov.bc.ca/pub/acat/public/welcome.do.

BC Ministry of Environment and Climate Change Strategy (BC MOECCS). 2020a. Invasive Alien Plant Program (IAPP) database and map display. Available: http://nwipc.org/documents/NWIPC_2017 _Target_Invasive_Plant_List.pdf.

BC Ministry of Environment and Climate Change Strategy (BC MOECCS). 2020b. Priority Invasive Species. Available: https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/priority-species

BC Ministry of Forests and BC Ministry of Environment (BC MOF and BC MOE). 1995. Biodiversity Guidebook, September 1995. BC Ministry of Forests and BC Ministry of Environment, Victoria, BC.

BC Ministry of Forests and Range and BC Ministry of Environment (BC MOFR and BC MOE). 2010. Field Manual for Describing Terrestrial Ecosystems, 2nd edition. BC Ministry of Forests and Range and BC Ministry of Environment, Victoria, BC. Land Management Handbook 25.

BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC FLNRORD). 2018. Invasive Alien Plant Site. Available: https://catalogue.data.gov.bc.ca/dataset/invasive-alien-plant-site. Accessed Nov. 06, 2018

Blackwell M.S.A. and E.S. Pilgrim. 2011. Ecosystem services delivered by small-scale wetlands, Hydrological Sciences Journal, 56:8, 1467-1484.

Bond, W.K. M.J. Bardecki, K.W. Cox and E.W. Manning. (1988). Wetlands are Not Wastelands: Interim Report. Report No. 2, Wetlands are Not Wastelands Project, Wildlife Habitat Canada and Environment Canada, Ottawa.

Bond, W.K.K. W. Cox, T. Heberlein, E. W. Manning, D. R. Witty and D. A Young. 1992. Wetland Evaluation Guide. Final Report of the Wetlands are not Wastelands Project. Issues Paper No. 1992-1. North American Wetlands Conservation Council (Cnanda), Ottawa, ON.

Braun, D., and V. Clark. 2017. The Benefits of Small Wetlands. April 2017.

Budhwa, R., J. Franks, M. Henderson, C, Lewis and S. O'Rourke. 2020. Telkwa Coal Project - Cultural Use Study (Draft). Report prepared for Telkwa Coal Ltd., Smithers, BC.

Coosemans, A. and L. Turney. 2007. Food and Medicinal Use of Plants in the Kemess North Area. Letter Report to Northgate Minerals Corporation by Gartner Lee Limited. Smithers, BC.

Crows Nest Resources Limited and Read Environmental and Planning Associates Ltd. (CNRL and REPAL). 1983. Telkwa Project Stage I Application. Crows Nest Resources Limited, Calgary, AB.

Demarchi, D.A. 2011. **The British Columbia Ecoregion Classification**, Third Edition. Ecosystem Information Section, Ministry of Environment, Victoria, BC.

Douglas, G.W., G.B. Straley, D. Meidinger and J. Pojar. 1998. Illustrated Flora of British Columbia: volumes 1 to 8. Ministry of Environment, Lands and Parks, and Ministry of Forests, Victoria, BC.

Environment and Climate Change Canada (ECCC). 2018. Species at Risk Public Registry. Available: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Environment and Climate Change Canada (ECCC). 2019. 1981-2010 Climate Normals and Averages. Environment and Climate Change Canada, Ottawa, Ont. https://climate.weather.gc.ca climate_normals /index_e.html.

Environmental Protection Agency (EPA). 2002. Methods for Evaluating Wetland Condition: Using Vegetation to Assess Environmental Conditions in Wetlands. Office of Water, U.S. Environmental Protection Agency. Washington, DC. EPA-822-R-02-020.

Fennessy, M.S., A.D. Jacobs and M.E. Kentula. 2004. Review of Rapid Methods for Assessing Wetland Condition. US Environmental Protection Agency. Washington DC. EPA-630-3-04-009.

Fennessy, M.S., A.D. Jacobs and M.E. Kentula. 2007. An Evaluation of Rapid Methods for Assessing the Ecological Condition of Wetlands. Wetlands 27:543-560.

Ferguson, A., G. Holman and R. Kistritz. (1989). Application of Wetland Evaluation Methods to the Cowichan Estuary, British Columbia. Report No. 4, Wetlands are Not Wastelands Project, Wildlife Habitat Canada and Environment Canada, Ottawa.

Fletcher, N.F., D.B. Tripp, P.L. Hansen, L. Nordin, M. Porter, and D. Morgan. 2018. Field Supplement to Evaluating the Condition of Wetlands (Wetland Health Management Routine Effectiveness

Evaluation). Version 2.0. Forest and Range Evaluation Program, B.C. Ministry of Forests, Lands, Natural Resources Operations and Rural Development, Victoria, B.C.

Gamberg, M., B. Braune, E. Davey, B. Elkin, P.F. Hoekstra, D. Kennedy, C. Macdonald, D. Muir, A. Nirwal, M. Wayland and B. Zeeb. 2005. Spatial and temporal trends of contaminants in terrestrial biota from the Canadian Arctic. Science of the Total Environment 351/352: 148-164.

GeoBC, 2010. British Columbia Fresh Water Atlas. Integrated Land Management Bureau. Ministry of Agriculture and Lands. Available at: https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater

Government of BC. 2011. *Weed Control Act 1996 - Weed Control Regulation 66/85; 143/2011.* Available: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/10_66_85.

Government of Canada. 2018. Canadian Environmental Assessment Archives. Available: https://iaac-aeic.gc.ca/052/index-eng.cfm.

Haeussler, S. 1998. Rare and endangered plant communities of the southeastern Skeena Region. Unpublished contract report by Skeena Forestry Consultants, Smithers B.C. for BC Environment and Habitat Conservation Trust Fund. Smithers, BC.

Hanson, A., L. Swanson, D. Ewing, G. Grabas, S. Meyer, L. Ross, M. Watmough, and J. Kirkby. 2008. Wetland Ecological Functions Assessment: An Overview of Approaches. Canadian Wildlife Service Technical Report Series No. 497. Atlantic Region. 59 pp.

Howes, D.E. and E. Kenk. 1997. Terrain classification system for British Columbia. Version 2. Update by Resource Inventory Branch, Ministry of Environment, Victoria, B.C.

Impact Assessment Agency of Canada (IAAC). 2019. Canadian Impact Assessment Registry. Available: https://iaac-aeic.gc.ca/050/evaluations/exploration?active=true&showMap=false&document_type=project.

Invasive Species Council of BC and Inter-Ministry Invasive Species Working Group (ISCBC and IMISWG). 2019. Field guide to Noxious Weeds and other Invasive Plant of British Columbia, 10th edition. Available: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/publications/field_guide_to_noxious_weeds_10th_edition_32619.pdf

Invasive Species Council of BC (ISCBC). 2018. List of Regulated Invasive Plants in BC. Available: https://bcinvasives.ca/invasive-species/about/regulated-invasive-species-in-bc/list-of-regulated-invasive-plants-in-bc/

Johnson Gottesfeld, L.M. 1993. Plants, Land and People, A Study of Wet’suwet’en Ethnobotany. M.Sc. Thesis. Department of Anthropology, University of Alberta. Edmonton Alberta.

Johnson Gottesfeld, L.M. 1994. Wet’suwet’en Ethnobotany: Traditional Plant Uses. J. Ethnobiol. 14(2):185-210.

Johnson Gottesfeld, L.M. 1995. The Role of Plant Foods in Traditional Wet'suwet'en Nutrition. Ecology of Food and Nutrition. 34(2): 149-169.

Johnson Gottesfeld, L.M. and B. Anderson. 1988. Gitksan Traditional Medicine: Herbs and Healing. J. Ethnobiol. 8(1):13-33.

Johnson, L.M. 1997. Health, Wholeness, and the Land: Gitksan Traditional Plant Use and Healing. Ph.D. Dissertation. Department of Anthropology, University of Alberta. Edmonton Alberta.

Klinkenberg, B. (Editor). 2018. E-Flora BC: Electronic Atlas of the Flora of British Columbia [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Available: https://ibis.geog.ubc.ca/biodiversity/eflora/

Klinkenberg, B. (Editor). 2020. Whitebark Pine *In:* E-Flora BC: Electronic Atlas of the Flora of British Columbia [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Available: https://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Pinus%20albicaulis

Kuhnlein, H.V. and N.J. Turner. 1991. Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany and Use. Gordon and Breach Publishers.

MacKenzie, W.H. and D. Meidinger. 2017. The Biogeoclimatic Ecosystem Classification Approach: An Ecological Framework for Vegetation Classification. Phytocoenologia.

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: A Guide to Identification. Land Management Handbook 52. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Victoria, BC.

MacKenzie, W.H. and R. Klassen. 2009. VPro 13: Software for Management of Ecosystem Data and Classification. Version 6.0. BC. Ministry of Forests and Range, Research Branch, Victoria BC. Available: https://www.for.gov.bc.ca/hre/becweb/resources/software/vpro/index.html

MacKenzie, W.H. 2006. The Ecology of the Alpine Zone. Ministry of Forests and Range, Research Branch, Victoria, B.C.

MacKinnon, A., J. Pojar and R. Coupé. 1999. Plants of northern British Columbia, 2nd edition. BC Ministry of Forests. Lone Pine, Vancouver.

Mah, S. 2013. Site Index Estimates by Site Series: Report by Biogeoclimatic Unit *(*2013 Approximation*).* Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.

Manalta Coal Ltd. 1997. Telkwa Coal Project Application for a Project Approval Certificate. Prepared by Manalta Coal Ltd. Calgary, AB.

Meidinger, D.V. 2003. Protocol for Accuracy Assessment of Ecosystem Maps. Technical Report 11. Research Branch, BC Ministry of Forests. Victoria, BC

Northwest Invasive Plant Council (NWIPC). 2017. Target invasive plant list. Available: http://nwipc.org/documents/NWIPC_2017_Target_Invasive_Plant_List.pdf

Northwest Invasive Plant Council (NWIPC). 2018. Bulkley Invasive Plant Management Area of the Northwest Invasive Plant Council. Available: http://nwipc.org/documents/private/Bulkley_IPMA_Target_Plant_List_2018.pdf

Oikos Ecological Services (Oikos). 1999. Appendix 4: Terrestrial Ecosystem Mapping, Telkwa Coal Terrestrial Ecosystems, Volume 1: Inventory. Prepared for Manalta Coal Ltd. Smithers, BC

Penny, J. and R. Klinkenberg. 2018. Protocols for Rare Plant Surveys. *In:* Klinkenberg, B. (Editor) 2018. E-Flora BC: Electronic Atlas of the Flora of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Available: https://ibis.geog.ubc.ca/biodiversity/eflora/ProtocolsforRarePlantSurveys.html

Pojar, J., K. Klinka, and D.V. Meidinger, 1987. Biogeoclimatic Ecosystem Classification in British Columbia. Forest Ecology and Management 22: 119-154.

Pojar, R.A. 1995. Breeding bird communities in aspen forests of the Sub-boreal Spruce (dk Subzone) in the Prince George Forest Region. Research Branch, B.C. Ministry of Forests, Victoria, BC. Land Management Handbook 33.

Province of BC. 2008. Forest Range and Practices Act Invasive Plants Identification Field Guide for use with Invasive Plants Resource Stewardship Monitoring Cards. FRPA Resource Evaluation Program. BC Ministry of Forests, Victoria, BC.

Resources Inventory Committee (RIC). 1998. Standard for terrestrial ecosystem mapping in British Columbia. Terrestrial Ecosystems Task Force, Ecosystems Working Group. Victoria, BC.

Resources Inventory Committee (RIC). 2000. Standard for terrestrial ecosystem mapping (TEM) - digital data capture in British Columbia, Version 3.0. Ecological Data Committee, Ecosystems Working Group/Terrestrial Ecosystems Task Force. Victoria, BC.

Resources Information Standards Committee (RISC). 2006. Standard for mapping ecosystems at risk in British Columbia, Version 1.0. Ministry of Environment, Ecosystems Branch. Victoria, BC.

Steventon, J.D. 2001. Historic disturbance regimes of the Morice and Lakes Timber Supply Areas. BC Min. For., For. Sci., Prince Rupert For. Reg., Smithers, B.C. Unpublished draft report.

TAESCO Consultants Ltd. (TAESCO). 1984. Telkwa Project: Vegetation - Forestry - Wildlife. Report prepared for Crows Nest Resources Ltd., Vancouver, BC.

Tchounwou P.B., C.G. Yedjou, A.K. Patlolla, D.J. Sutton. 2012. Heavy metal toxicity and the environment. Experientiea Supplimentum 101:133-164. doi:10.1007/978-3-7643-8340-4_6

Telkwa Coal Limited. 2019. Tenas Project Valued Component Scoping Document. Prepared by Telkwa Coal for the BC Environmental Assessment Office. Vancouver, BC.

Telkwa Coal Limited. 2020a. Application Information Requirements, Tenas Project. Prepared by Telkwa Coal Limited for the BC Environmental Assessment Office. Vancouver, BC.

Timberline Natural Resources Group Ltd. (Timberline). 2010. Predictive Ecosystem Mapping in The Bulkley Timber Supply Area. Prepared for Pacific Inland Resources Ltd., Smithers, BC

Tovar-Sanchez, E., I, Hernandez-Plata, M.S. Martinez, L. Valecia-Cuevas and P. M. Glante. 2018. Heavy Metal Pollution as a Biodiversity Threat. IntechOpen. Available: http://dx.doi.org/10.5772/ intechopen.74052

Trowbridge, R. and A. Banner. 2002. Field Guide Supplement to the Identification of High Elevation ESSF Woodland Subzones and Site Units of the Bulkley Timber Supply Area: Supplement No. 2 to Land Management Handbook No. 26: A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region - Interim Edition. Boreal Research and Development Ltd., Smithers, B.C.

Turney, L., A. MacLeod and L. Rach. 2006. Wildlife Habitat Suitability Assessment and Vegetation Trace Metals Analysis for the Proposed Davidson Project - Blue Pearl Mining. Report prepared for Rescan Environmental Services Ltd. by Ardea Biological Consulting. Smithers, BC

Wang, T., A. Hamann, D.L. Spittlehouse and C. Carroll. 2016. Locally downscaled and spatially customizable climate data for historical and future periods for North America. PLoS ONE 11(6): e0156720.

Wetlands in Canada: Canada's Ramsar Sites. 1991. Canadian Wildlife Service, Environment Canada. Ottawa.

Wetlands of Canada. 1988. Ecological land Classification Series, No. 24. Canadian Wildlife Service, Environment Canada and Polyscience Publications Inc.

Williams, H., K. Klinka, D. McLennan and A. Banner. 2001. Field guide to Identification and Interpretation of Hardwood-Dominated Ecosystems in the SBSdk and ICHmc2 of the Prince Rupert Forest Region. Supplement No. 1 to Land Management Handbook 26: A Field Guide to Site

Identification and Interpretation for the Prince Rupert Forest Region. Ministry of Forests, Victoria, BC.

Wilson, L.M. 2006. Key to Identification of Invasive and Native Hawkweeds (*Hieracium* spp.) in the Pacific Northwest. B.C. Ministry of Forests and Range, Forest Practices Branch, Kamloops, BC.

Wisconsin Wetlands Association. 2017. Small wetlands make big impact: Isolated and non-federal wetlands. Available: https://wisconsinwetlands.org/updates/small-wetlands-make-big-impact/. Accessed: October 5, 2017.

Wong, C., B. Dorner, and H. Sandmann. 2003. Estimating historical variability of natural disturbances in British Columbia. BC. Min. For., Res. Br., B.. Min. Sustain. Resource. Manage., Resource Plan. Br., Victoria, B.C. Land Manage. Handb. No. 53.

Appendix A Ecosystem Mapping Accuracy Assessment

Appendix B Tenas TEM Ecosystem Descriptions

Appendix C 1:10,000 Terrestrial Ecosystem Map

Appendix D Wetland Function Assessment Data

Appendix E Invasive Plant Plot Data and Plant Descriptions

Appendix F Plants Important for Cultural Use

Appendix G Vegetation Trace Metals Results

Appendix A Ecosystem Mapping Accuracy Assessment

Table A-1: Comparison of percent overlap for Tenas TEM ecosystem map area and plots in the SBSmc2 and SBSdk subzones.

Map Code	Ecosystem Name	Area (ha)	TEM %	Plots (n)	Plot %	Overlap
SBSmc2						
AN	Mountain alder - Stinging nettle	0.8	<0.1%	1	0.3%	<0.1%
Atcv	$At - Canada violet seral association	1.1	0.1%	1	0.3%	0.1%
Atha	$At - Hardhack seral association	27.1	1.4%	14	3.7%	1.4%
BF	Sxw - Scrub birch - Feathermoss	41.3	2.2%	5	1.3%	1.3%
BM	SbPl - Feathermoss	58.0	3.1%	10	2.7%	2.7%
DM	Drummond's willow - Mountain alder	0.8	<0.1%	0	0.0%	0.0%
Fl01	Mountain alder - Common horsetail	2.6	0.1%	1	0.3%	0.1%
PH	Pl - Huckleberry - Cladonia	1.3	0.1%	4	1.1%	0.1%
SB	Sxw - Huckleberry	1,060.5	56.5%	175	46.7%	46.7%
SD	Sxw - Huckleberry	77.6	4.1%	20	5.3%	4.1%
SH	Sxw - Horsetail	193.2	10.3%	29	7.7%	7.7%
SO	Sxw - Oak fern	323.9	17.2%	77	20.5%	17.2%
SS	SbSxw - Scrub birch - Sedge	2.4	0.1%	0	0.0%	0.0%
TC	Sxw - Twinberry - Coltsfoot	64.0	3.4%	9	2.4%	2.4%
Wb01	Black spruce - Creeping snowberry - Peat-moss	2.8	0.2%	5	1.3%	0.2%
Wb05	Black spruce - Water sedge - Peat-moss	9.2	0.5%	5	1.3%	0.5%
WF	Willow - Sedge fen	0.9	<0.1%	0	0.0%	0.0%
Wf01	Water sedge - Beaked sedge	1.4	0.1%	0	0.0%	0.0%
Wm02	Swamp horsetail - Beaked sedge	0.3	<0.1%	0	0.0%	0.0%
Ws02	Mountain alder - Pink spirea - Sitka sedge	0.9	<0.1%	4	1.1%	<0.1%
Ws03	Bebb's willow - Bluejoint reedgrass	0.3	<0.1%	2	0.5%	<0.1%
Ws07	Hybrid white spruce - Horsetails - Leafy mosses	0.0	0.0%	10	2.7%	0.0%
WT	Scouler's willow - Thimbleberry	7.2	0.4%	3	0.8%	0.4%
Totals		***1,877.7***	***100.0%***	***375***	***100.0%***	***85.0%***
SBSdk						
AM	Mountain alder - Mitrewort	11.7	0.9%	7	2.6%	0.9%
AN	Mountain alder - Stinging nettle	2.0	0.2%	4	1.5%	0.2%
Atcv	$At - Canada violet seral association	115.2	9.0%	18	6.7%	6.7%
Atha	$At - Hardhack seral association	7.0	0.6%	1	0.4%	0.4%
Atki	$At - Kinnikinnick seral association	0.0	0.0%	1	0.4%	0.0%
Atlf	$At - Lady fern seral association	1.7	0.1%	0	0.0%	0.0%
Atpw	$At - Pink wintergreen seral association	96.9	7.6%	21	7.8%	7.6%
Atss	$At - Saskatoon - Snowberry seral association	9.2	0.7%	4	1.5%	0.7%
BW	Bluegrass - Slender wheatgrass	0.1	<0.1%	0	0.0%	0.0%

Map Code	Ecosystem Name	Area (ha)	TEM %	Plots (n)	Plot %	Overlap
CA	Cow parsnip - Large-leaved avens	0.2	<0.1%	0	0.0%	0.0%
CF	Cultivated Field	120.0	9.4%	8	3.0%	3.0%
Epdm	Paper birch - Douglas maple	9.6	0.8%	7	2.6%	0.8%
Fl01	Mountain alder - Common horsetail	8.2	0.6%	1	0.4%	0.4%
Fm02	ActSxw - Red-osier dogwood	37.6	3.0%	19	7.1%	3.0%
LC	BlPl - Juniper - Cladonia	19.4	1.5%	5	1.9%	1.5%
LJ	Pl - Juniper - Ricegrass	0.5	<0.1%	1	0.4%	0.0%
PA	Pasture	49.2	3.9%	16	5.9%	3.9%
SD	Sxw - Devil’s club (Lacustrine/Morainal)	12.7	1.0%	5	1.9%	1.0%
SF	Sxw - Spirea - Feathermoss	4.1	0.3%	2	0.7%	0.3%
SH	Sxw - Horsetail	87.1	6.8%	14	5.2%	5.2%
SL	Sitka alder - Lady Fern	6.4	0.51%	0	0.0%	0.00%
SP	Sxw - Spirea - Purple peavine	281.6	22.1%	47	17.5%	17.5%
SS	SbSxw - Scrub birch - Sedge	252.9	19.9%	39	14.5%	0.00%
ST	Sxw - Twinberry - Coltsfoot	98.8	7.76%	0	0.0%	14.5%
SW	Saskatoon - Slender wheatgrass	<0.1	0.0%	0	0.0%	0.0%
Wb01	Black spruce - Creeping snowberry - Peat-moss	0.0	0.0%	3	1.1%	0.0%
Wb05	Black spruce - Water sedge - Peat-moss	0.0	0.0%	1	0.4%	0.0%
WF	Willow - Sedge fen	0.0	0.0%	1	0.4%	0.0%
Wf01	Water sedge - Beaked sedge	0.0	0.0%	1	0.4%	0.0%
Wm01	Beaked sedge - Water sedge	2.1	0.2%	12	4.5%	0.2%
Wm02	Swamp horsetail - Beaked sedge	3.8	0.3%	2	0.7%	0.3%
Wm05	Cattail	0.6	<0.1%	12	4.5%	<0.1%
Ws02	Mountain alder - Pink spirea - Sitka sedge	0.2	<0.1%	2	0.7%	<0.1%
Ws03	Bebb's willow - Bluejoint reedgrass	0.7	0.1%	1	0.4%	0.1%
Ws04	Drummond's willow - Beaked sedge	0.2	<0.1%	3	1.1%	<0.1%
Ws07	Hybrid white spruce - Horsetails - Leafy mosses	0.0	0.0%	4	1.5%	0.0%
WT	Scouler’s willow - Thimbleberry	33.7	2.6%	6	2.2%	2.2%
Xs	Disclimax shrub	0.3	<0.1%	1	0.4%	<0.1%
Totals		***1,273.7***	***100.0%***	***269***	***100.0%***	***70.3%***

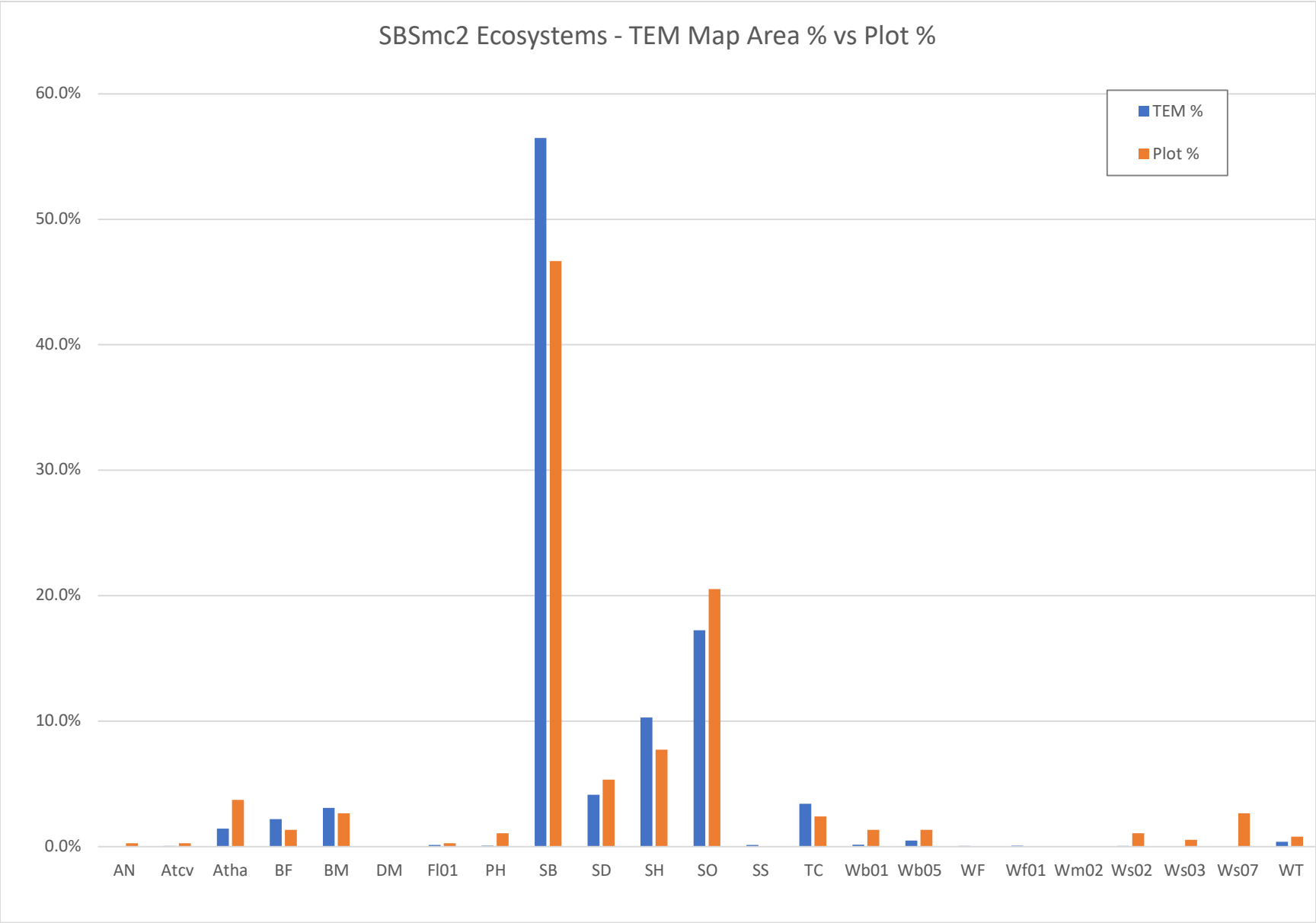


Figure A-1: Comparison of ecosystem proportions between Tenas TEM mapped area and plots for the SBSmc2 subzone.

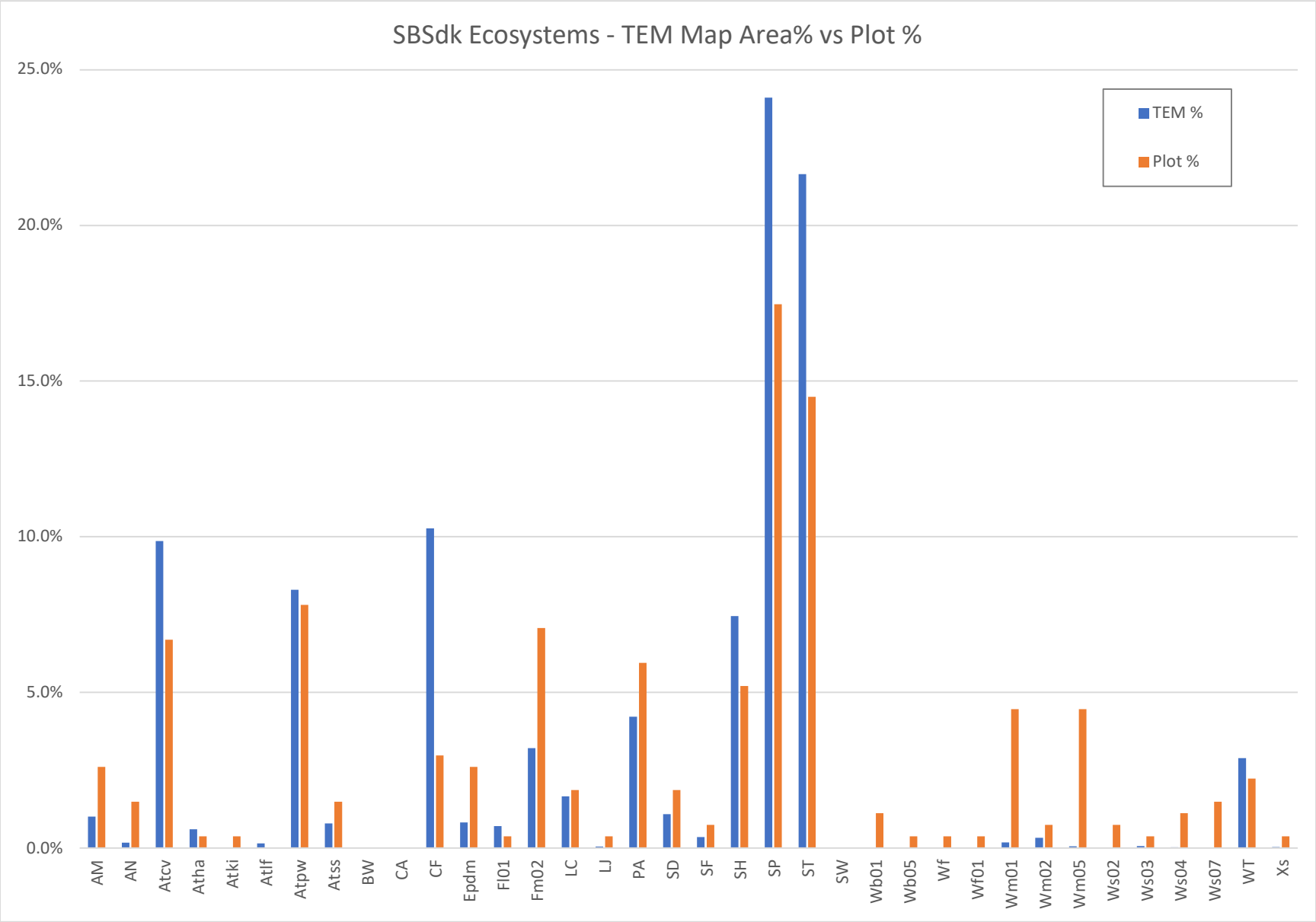


Figure A-2: Comparison of ecosystem proportions between Tenas TEM mapped area and plots for the SBSdk subzone.

Table A-2: Matrix of acceptable vegetated ecosystems within the SBSmc2 BGC subzone used in the assessment of the acceptable overlap quality assurance assessment.

Map Code	Ecosystem Name	AN	DM	RS	WF	SB	PH	BM	TC	SO	ST	BF	SD	SH	SS	WE	LS	WT	AN	SL	SW	BW	SB	SBc	SD	SD	SH	SH	Atcv	Atha	Atpw	Fl01	Wb01	Wb05	Wf01	Wf02	Wf05	Wf08	Wm02	Ws02	Ws03	Ws07
DM	Drummond's willow - Mountain alder													x													x	x								x				x	x	x
RS	Riparian Shrub												x	x					x	x					x	x	x	x												x	x	x
WF	Willow - Sedge fen		x																																x	x	x	x	x	x	x	
SB	Sxw - Huckleberry							x	x	x	x							x					x	x					x	x	x												
PH	Pl - Huckleberry - Cladonia																							x																			
BM	SbPl - Feathermoss					x						x											x	x						x	x												
TC	Sxw - Twinberry - Coltsfoot					x			x				x	x				x					x				x		x	x	x												
SO	Sxw - Oak fern					x			x		x		x					x					x						x	x	x												
BF	Sxw - Scrub birch - Feathermoss							x						x													x			x	x												
SD	Sxw - Devil's club	x		x					x	x	x			x				x	x	x					x	x	x	x	x														x
SH	Sxw - Horsetail			x					x	x	x		x					x	x	x					x	x	x	x	x	x	x												x
SS	SbSxw - Scrub birch - Sedge													x														x														x	x
WE	Non-forested wetland/fen		x																														x	x	x	x	x	x	x	x	x		
LS	Non-forested bog		x																														x	x	x	x			x				
WT	Scouler's willow - Thimbleberry					x			x	x	x		x	x					x	x			x		x	x	x		x	x	x												
AN	Mountain alder - Stinging nettle			x									x	x											x	x	x	x												x	x	x
SL	Sitka alder - Lady Fern			x									x	x					x						x	x	x	x												x	x	x
SW	Saskatoon - Slender wheatgrass						x															x																					
BW	Bluegrass - Slender wheatgrass						x														x																						
SB	Sxw - Huckleberry (Mesic, Fine-textured)					x		x										x					x	x					x	x	x												
SBc	Sxw - Huckleberry (Submesic)					x	x	x										x					x	x					x	x	x												
SD	Sxw - Devil's club (Fluvial)	x	x	x					x	x	x		x	x				x	x						x		x	x	x														x
SD	Sxw - Devil's club (Morainal)	x		x					x	x	x		x	x				x	x							x	x	x	x														x
SHa	Sxw - Horsetail (Fluvial)			x					x	x	x		x	x	x				x						x	x	x	x	x	x	x												x
SHb	Sxw - Horsetail (Lacustrine/morainal)		x	x									x	x	x				x						x	x	x	x		x													x
Atcv	$At - Canada violet seral association			x		x			x	x	x		x	x				x	x	x			x		x	x		x															
Atha	$At - Hardhack seral association					x		x	x	x	x	x		x				x					x				x	x			x												
Atpw	$At - Pink wintergreen seral association					x		x	x	x	x	x		x				x					x		x	x	x			x													
Fl01	Mountain alder - Common horsetail																																										
Wb01	Black spruce - Creeping snowberry - Peat-moss																																	x									
Wb05	Black spruce - Water sedge - Peat-moss																																x										
Wf01	Water sedge - Beaked sedge																																		x	x	x	x	x				
Wf02	Scrub birch - Water sedge		x																																x		x	x	x	x	x		
Wf05	Slender sedge - Common hook-moss																																		x	x		x	x				
Wf08	Shore sedge - Buckbean - Hook-mosses																																		x	x	x		x				
Wm02	Swamp horsetail - Beaked sedge																																		x	x	x	x					
Ws02	Mountain alder - Pink spirea - Sitka sedge		x	x	x											x	x		x	x										x						x					x	x

Map Code	Ecosystem Name	AN	DM	RS	WF	SB	PH	BM	TC	SO	ST	BF	SD	SH	SS	WE	LS	WT	AN	SL	SW	BW	SB	SBc	SD	SD	SH	SH	Atcv	Atha	Atpw	Fl01	Wb01	Wb05	Wf01	Wf02	Wf05	Wf08	Wm02	Ws02	Ws03	Ws07
Ws03	Bebb's willow - Bluejoint reedgrass		x	x	x											x	x		x	x																	x				x		x
Ws07	Hybrid white spruce - Horsetails - Leafy mosses			x	x								x	x	x	x			x	x					x	x	x	x		x			x	x		x				x	x	

Table A-3: Matrix of acceptable vegetated ecosystems within the SBSdk BGC subzone used in the assessment of the acceptable overlap quality assurance assessment.

Map Code	Ecosystem Name	CA	CF	DM	PA	SD	WF	SP	LJ	LC	DS	SF	ST	SH	CD	BS	SS	WE	LS	WT	AN	SL	AM	SW	BW	SP	SP	SH	SH	Atcv	Atha	Atki	Atlf	Atpw	Atss	Epdm	Fl01	Fl02	Fl05	Fm02	Wb01	Wb05	Wf01	Wf02	Wf05	Wf08	Wm01	Wm02	Wm05	Ws02	Ws03	Ws04	Ws07	Xs
CA	Cow parsnip - Large-leaved avens					x							x	x							x	x	x					x	x	x			x																						
CF	Cultivated Field				x																																																		
DM	Drummond's willow - Mountain alder																																																			x	x		
PA	Pasture		x																																																				
SD	Sxw - Devil's club (Morainal)	x						x					x	x			x			x	x	x	x			x	x	x	x	x	x		x																					x	
WF	Willow - Sedge fen																	x																									x	x	x	x	x	x	x	x	x				
SP	Sxw - Spirea - Purple peavine											x	x	x												x	x		x	x	x			x	x	x																				
LJ	Pl - Juniper - Ricegrass											x																																											
LC	Pl - Feathermoss - Cladina											x																					x																							
DS	Fd - Soopolallie - Feathermoss									x		x																					x			x																				
SF	Sxw - Spirea - Feathermoss							x			x									x			x			x	x								x	x	x																				
ST	Sxw - Twinberry - Coltsfoot					x		x						x						x	x	x	x			x	x	x	x	x	x		x	x																					x
SH	Sxw - Horsetail	x				x		x					x				x		x		x	x	x					x	x	x	x		x	x																						
CD	Act - Dogwood - Prickly rose																																				x	x	x	x															
BS	Sb - Creeping-snowberry - Sphagnum																														x																								
SS	Sb - Soft-leaved sedge - Sphagnum					x								x							x	x						x	x				x									x													x	
WE	Non-forested wetland																		x																						x	x	x	x	x	x	x	x	x	x	x	x			
LS	Non-forested bog															x																									x	x	x	x			x	x				x			
WT	Scouler's willow - Thimbleberry					x		x					x								x	x	x			x	x	x	x	x	x		x	x																					x
AN	Mountain alder - Stinging nettle	x				x							x	x			x			x		x	x					x	x	x	x		x	x																	x	x		x	
SL	Sitka alder - Lady Fern	x				x							x	x			x			x	x		x					x	x	x	x		x	x	x																x	x		x	
AM	Mountain alder - Mitrewort	x				x		x					x	x			x			x	x	x				x	x	x	x	x	x		x	x																					x

Map Code	Ecosystem Name	CA	CF	DM	PA	SD	WF	SP	LJ	LC	DS	SF	ST	SH	CD	BS	SS	WE	LS	WT	AN	SL	AM	SW	BW	SP	SP	SH	SH	Atcv	Atha	Atki	Atlf	Atpw	Atss	Epdm	Fl01	Fl02	Fl05	Fm02	Wb01	Wb05	Wf01	Wf02	Wf05	Wf08	Wm01	Wm02	Wm05	Ws02	Ws03	Ws04	Ws07	Xs
SW	Saskatoon - Slender wheatgrass									x		x													x																														
BW	Bluegrass - Slender wheatgrass																							x																														
SP	Sxw - Spirea - Purple peavine (Fine-textured)							x				x	x	x													x		x	x	x			x	x	x																		
SP	Sxw - Spirea - Purple peavine (Coarse-textured)							x				x	x													x			x	x	x			x	x	x																		
SHa	Sxw - Horsetail (Freely drained)	x				x		x					x	x			x		x		x	x	x					x	x	x	x		x	x																				
SHb	Sxw - Horsetail (Poorly drained)	x				x		x					x	x			x		x		x	x	x					x	x	x	x		x	x																				
Atcv	$At - Canada violet seral association					x		x					x	x						x	x	x	x										x																					x
Atha	$At - Hardhack seral association							x					x	x			x			x			x			x	x	x	x					x																				
Atki	$At - Kinnikinnick seral association									x		x																								x																		
Atlf	$At - Lady fern seral association	x				x							x	x			x			x	x	x	x					x	x	x																								
Atpw	$At - Pink wintergreen seral association							x				x	x							x			x								x																							
Atss	$At - Saskatoon - Snowberry seral association							x			x	x														x	x								x																			
Epdm	Paper birch - Douglas maple							x		x	x	x														x	x					x			x																			
Fl01	Mountain alder - Common horsetail																																					x	x	x													
Fl02	Mountain alder - Red-osier dogwood - Lady fern																																				x		x	x													
Fl05	Drummond's willow - Bluejoint reedgrass																																				x	x		x													
Fm02	ActSxw - Red-osier dogwood														x																						x	x	x														
Wb01	Black spruce - Creeping snowberry - Peat-moss															x	x	x	x																						x													
Wb05	Black spruce - Water sedge - Peat-moss															x	x																								x													
Wf01	Water sedge - Beaked sedge						x																																				x	x	x	x							
Wf02	Scrub birch - Water sedge						x												x																									x	x	x	x	x	x	x	x		
Wf05	Slender sedge - Common hook-moss																																									x	x		x	x	x	x					

Map Code	Ecosystem Name	CA	CF	DM	PA	SD	WF	SP	LJ	LC	DS	SF	ST	SH	CD	BS	SS	WE	LS	WT	AN	SL	AM	SW	BW	SP	SP	SH	SH	Atcv	Atha	Atki	Atlf	Atpw	Atss	Epdm	Fl01	Fl02	Fl05	Fm02	Wb01	Wb05	Wf01	Wf02	Wf05	Wf08	Wm01	Wm02	Wm05	Ws02	Ws03	Ws04	Ws07	Xs
Wf08	Shore sedge - Buckbean - Hook-mosses																																												x	x		x	x	x					
Wm01	Beaked sedge - Water sedge						x																																				x	x	x	x		x	x					
Wm02	Swamp horsetail - Beaked sedge																		x																								x	x	x	x	x		x					
Wm05	Cattail																																											x	x	x	x	x						
Ws02	Mountain alder - Pink spirea - Sitka sedge																				x	x									x													x							x		x	
Ws03	Bebb's willow - Bluejoint reedgrass																				x	x																						x							x		x	x	
Ws04	Drummond's willow - Beaked sedge			x															x																									x								x		x	
Ws07	Hybrid white spruce - Horsetails - Leafy mosses			x		x								x		x	x				x	x						x	x												x	x									x	x	x		
Xs	Disclimax shrub												x							x										x	x			x																						

Table A-4: Summary of results of quality assurance assessments for individual ecosystems

BGC Sub zone	Map Code	Ecosystem Name	% Dominant Correct (80% Conf. Interval)		% Dominant Overlap (90% Conf. Interval)		% Acceptable (90% Conf. Interval)	
			Average Score	Weighted Average	Average Score	Weighted Average	Average Score	Weighted Average
SBSmc2	Atcv	$At - Canada violet seral association	0%	0%	0%	0%	100%	100%
	Atha	$At - Hardhack seral association	60% (40-80%)	40% (18-62%)	54% (20-80%)	38% (18-62%)	54% (20-80%)	38% (18-62%)
	BF	Sxw - Scrub birch - Feathermoss	25% (0-50%)	22% (14-31%)	24% (0-50%)	19% (9-28%)	36% (13-63%)	33% (21-45%)
	BM	SbPl - Feathermoss	50% (25-50%)	69% (60-79%)	38% (0-75%)	45% (32-58%)	61% (25-100%)	68% (55-79%)
	SB	Sxw - Huckleberry	76% (71-81%)	81% (79-82%)	58% (50-67%)	59% (56-62%)	77% (71-83%)	75% (73-78%)
	SD	Sxw - Devil's club	50% (36-64%)	82% (76-86%)	40% (23-55%)	56% (47-64%)	60% (41-77%)	83% (76-89%)
	SH	Sxw - Horsetail	79% (50-100%)	82% (70-92%)	72% (33-100%)	74% (54-87%)	84% (50-100%)	83% (65-92%)
	SO	Sxw - Oak fern	65% (53-79%)	66% (57-72%)	44% (26-63%)	40% (29-49%)	75% (58-89%)	74% (65-82%)
	TC	Sxw - Twinberry - Coltsfoot	0%	0%	28% (16-41%)	37% (30-44%)	76% (65-86%)	84% (79-90%)
	Wb01	Black spruce - Creeping snowberry - Peat-moss	50% (53-79%)	82% (66-90%)	54% (0-100%)	56% (36-72%)	74% (33-100%)	89% (72-96%)
	Wb05	Black spruce - Water sedge - Peat-moss	100%	100%	100%	100%	100%	100%
	Total		***50% ± 4%***	***57% ± 2%***	***46% ± 5%***	***48% ± 2%***	***72% ± 5%***	***75% ± 2%***
SBSdk	AM	Mountain alder - Mitrewort	100%	100%	100%	100%	100%	100%
	Atcv	$At - Canada violet seral association	57% (43-71%)	71% (64-77%)	44% (29-62%)	47% (39-55%)	78% (62-90%)	78% (70-84%)
	Atlf	$At - Lady fern seral association	0%	0%	0%	0%	40%	40%
	Atpw	$At - Pink wintergreen seral association	59% (41-76%)	58% (48-66%)	50% (29-71%)	45% (34-56%)	73% (53-88%)	72% (60-80%)
	Atss	$At - Saskatoon - Snowberry seral association	100%	100%	33%	33%	80%	80%
	CF	Cultivated Field	83% (67-100%)	91% (86-94%)	75% (50-100%)	69% (59-77%)	78% (50-100%)	70% (61-78%)
	Epdm	Paper birch - Douglas maple	100%	100%	73% (33-100%)	72% (24-98%)	73% (33-100%)	72% (24-98%)
	Fl01	Mountain alder - Common horsetail	100%	100%	40%	40%	40%	40%
	Fm02	ActSxw - Red-osier dogwood	100%	100%	69% (33-100%)	63% (51-75%)	71% (33-100%)	69% (56-80%)
	LC	BlPl - Juniper - Cladonia	67% (33-100%)	18% (11-56%)	73% (33-100%)	48% (30-64%)	84% (33-100%)	75% (59-89%)
	LJ	Pl - Juniper - Ricegrass	100%	100%	70%	70%	70%	70%
	PA	Pasture	83% (67-100%)	70% (60-80%)	80% (50-100%)	70% (57-83%)	80% (50-100%)	70% (57-83%)
	SD	Sxw - Devil's club (Lacustrine/Morainal)	50% (25-75%)	40% (11-56%)	30% (0-75%)	23% (0-45%)	69% (25-100%)	64% (34-79%)

BGC Sub zone	Map Code	Ecosystem Name	% Dominant Correct (80% Conf. Interval)		% Dominant Overlap (90% Conf. Interval)		% Acceptable (90% Conf. Interval)	
			Average Score	Weighted Average	Average Score	Weighted Average	Average Score	Weighted Average
SBSdk	SH	Sxw - Horsetail	67% (33-83%)	87% (76-94%)	64% (33-100%)	75% (58-89%)	72% (33-100%)	88% (76-98%)
	SP	Sxw - Spirea - Purple peavine	82% (71-93%)	90% (87-93%)	69% (54-82%)	65% (59-70%)	80% (68-93%)	79% (74-84%)
	SS	SbSxw - Scrub birch - Sedge	0%	0%	0%	0%	50%	50%
	ST	Sxw - Twinberry - Coltsfoot	75% (58-92%0	97% (94-98%)	61% (42-83%)	75% (69-81%)	81% (58-100%)	86% (81-90%)
	WF	Willow - Sedge fen	100%	100%	50%	50%	50%	50%
	Wm01	Beaked sedge - Water sedge	100%	100%	84% (50-100%)	78% (0-0%)	84% (50-100%)	78% (50-100%)
	Wm02	Swamp horsetail - Beaked sedge	100%	100%	100%	100%	100%	100%
	Wm05	Cattail	0%	0%	50%	50%	50%	50%
	Ws02	Mountain alder - Pink spirea - Sitka sedge	0%	0%	43%	43%	73%	73%
	Ws04	Drummond's willow - Beaked sedge	100%	100%	100%	100%	100%	100%
	WT	Scouler's willow - Thimbleberry	100%	100%	100%	100%	100%	100%
	Total		***71% ± 5%***	***71% ± 2%***	***59% ± 7%***	***57% ± 3%***	***73% ± 6%***	***72% ± 3%***
Overall	AM	Mountain alder - Mitrewort	100%	100%	100%	100%	100%	100%
	Atcv	$At - Canada violet seral association	55% (41-68%)	70% (64-76%)	42% (27-59%)	47% (38-55%)	79% (64-91%)	79% (71-84%)
	Atha	$At - Hardhack seral association	60% (40-80%)	40% (18-62%)	54% (20-80%)	38% (18-62%)	54% (20-80%)	38% (18-62%)
	Atlf	$At - Lady fern seral association	0%	0%	0%	0%	40% (0-100%)	40% (0-56%)
	Atpw	$At - Pink wintergreen seral association	59% (41-76%)	58% (48-66%)	50% (29-71%)	45% (34-56%)	73% (53-88%)	72% (60-80%)
	Atss	$At - Saskatoon - Snowberry seral association	100%	100%	33% (0-100%)	33% (0-54%)	80% (0-100%)	80% (36-91%)
	BF	Sxw - Scrub birch - Feathermoss	25% (0-50%)	22% (14-31%)	24% (0-50%)	19% (9-28%)	36% (13-63%)	33% (21-45%)
	BM	SbPl - Feathermoss	50% (25-75%)	69% (60-79%)	38% (0-75%)	45% (32-58%)	61% (25-100%)	68% (55-79%)
	CF	Cultivated Field	83% (67-100%)	91% (86-94%)	75% (50-100%)	69% (59-77%)	78% (50-100%)	70% (61-78%)
	Epdm	Paper birch - Douglas maple	100%	100%	73% (33-100%)	72% (24-98%)	73% (33-100%)	72% (24-98%)
	Fl01	Mountain alder - Common horsetail	100%	100%	40% (0-100%)	40% (16-65%)	40% (0-100%)	40% (16-65%)
	Fm02	ActSxw - Red-osier dogwood	100% (100-100%)	100%	69% (33-100%)	63% (51-75%)	71% (33-100%)	69% (56-80%)
	LC	BlPl - Juniper - Cladonia	67% (33-100%)	18% (8-25%)	73% (33-100%)	48% (30-64%)	84% (33-100%)	75% (59-89%)
	LJ	Pl - Juniper - Ricegrass	100%	100%	70% (0-100%)	70% (0-0%)	70% (50-100%)	70% (50-100%)

BGC Sub zone	Map Code	Ecosystem Name	% Dominant Correct (80% Conf. Interval)		% Dominant Overlap (90% Conf. Interval)		% Acceptable (90% Conf. Interval)	
			Average Score	Weighted Average	Average Score	Weighted Average	Average Score	Weighted Average
Overall	PA	Pasture	83% (67-100%)	70% (60-80%)	80% (50-100%)	70% (57-83%)	80% (50-100%)	70% (57-83%)
	SB	Sxw - Huckleberry	76% (71-81%)	81% (79-82%)	58% (51-65%)	59% (57-62%)	77% (71-83%)	75% (73-78%)
	SD	Sxw - Devil's club	50% (30-70%)	68% (55-77%)	36% (10-60%)	45% (29-62%)	64% (40-90%)	77% (62-88%)
	SH	Sxw - Horsetail	76% (64-88%)	83% (78-88%)	70% (56-84%)	74% (65-81%)	81% (68-92%)	84% (78-90%)
	SO	Sxw - Oak fern	65% (54-76%)	66% (60-72%)	44% (30-57%)	40% (32-47%)	75% (62-86%)	74% (67-81%)
	SP	Sxw - Spirea - Purple peavine	82% (71-93%)	90% (87-93%)	69% (54-82%)	65% (59-70%)	80% (68-93%)	79% (74-84%)
	SS	SbSxw - Scrub birch - Sedge	0%	0%	0%	0%	50% (0-100%)	50% (35-63%)
	ST	Sxw - Twinberry - Coltsfoot	75% (58-92%)	97% (94-98%)	61% (42-83%)	75% (69-81%)	81% (58-100%)	86% (81-90%)
	TC	Sxw - Twinberry - Coltsfoot	0%	0%	28% (0-67%)	37% (18-54%)	76% (33-100%)	84% (66-96%)
	Wb01	Black spruce - Creeping snowberry - Peat-moss	50% (0-100%)	82% (46-93%)	54% (0-100%)	56% (23-93%)	74% (0-100%)	89% (46-93%)
	Wb05	Black spruce - Water sedge - Peat-moss	100%	100%	100%	100%	100%	100%
	WF	Willow - Sedge fen	100%	100%	50% (0-100%)	50% (30-67%)	50% (0-100%)	50% (30-67%)
	Wm01	Beaked sedge - Water sedge	100%	100%	84% (50-100%)	78% (50-100%)	84% (50-100%)	78% (50-100%)
	Wm05	Cattail	100%	100%	100%	100%	100%	100%
	Ws02	Mountain alder - Pink spirea - Sitka sedge	0%	0%	50% (0-100%)	50% (0-100%)	50% (0-100%)	50% (0-100%)
	Ws04	Drummond's willow - Beaked sedge	0%	0%	43% (0-100%)	43% (0-100%)	73% (0-100%)	73% (0-100%)
	WT	Scouler's willow - Thimbleberry	100%	100%	100%	100%	100%	100%
	Total		***66% ± 3%***	***68% ± 1%***	***57% ± 3%***	***56% ± 2%***	***72% ± 3%***	***72% ± 1%***

Appendix B Tenas TEM Ecosystem Descriptions

The ecosystem descriptions provided in Table B-1 and Table B-2 are based on the polygons mapped within the Tenas TEM, which is located primarily within the V-LSA, but some portions of the mapping is within the V-RSA due to changes in the boundaries of the V-LSA after the Tenas TEM was completed.

Table B-1: Summary of anthropogenic, non-vegetated and sparsely vegetated communities mapped for the Tenas TEM.

Map Code	Name	Description[1]	Area mapped (ha)
CF	Cultivated Field	A flat or gently rolling, non-forested, open area that is subject to human agricultural practices (including plowing, fertilization and non-native crop production) which often result in long-term soil and vegetation changes.	133.9
ES	Exposed Soil	An area of exposed soil that is not included in any of the other definitions. It includes areas of recent disturbance, such as mud slides, debris torrents, avalanches, and human-made disturbances where vegetation cover is limited (< 5%).	2.0
GB	Gravel Bar	An elongated landform generated by waves and currents and usually running parallel to the shore. It is composed of unconsolidated small rounded cobbles, pebbles, stones and sand	20.1
GP	Gravel Pit	An area exposed through the removal of sand and gravel.	3.9
OW	Shallow Open Water	A wetland composed of permanent shallow open water and lacking extensive emergent plant cover. The water is less than 2 m deep.	1.2
PA	Pasture	Flat or gently rolling, non-forested open area that is used for the grazing of livestock.	51.3
RI	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial. An area with an ephemeral flow and no channel with definable banks is not considered a river.	11.9
RN	Railway Surface	A roadbed with fixed rails for possibly single or multiple rail lines.	5.3
RW	Rural Residential	Any area in which residences and other human developments are scattered and intermingled with forest, range, farm land, and native vegetation or cultivated crops.	36.8
RZ	Road Permanent	An area cleared and compacted for the purpose of transporting goods and services by vehicles.	10.5
TL	Transmission Line	A cleared right-of-way for transmission or pipelines that are maintained in a permanent early seral stage.	19.7

Note: 1) from TEIU 2020

Table B-2: Ecosystem descriptions for vegetated communities mapped for the Tenas TEM.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**01a/1b**	**SB**	**Hybrid white spruce - Huckleberry (Sxw - Huckleberry) (mesic, fine-textured phase/coarse-textured phase)**	**1,006.2**

Site Photo

Soil Pit Photo

Hybrid white spruce - Huckleberry forests are widespread and common in the study area. They mostly occur on level to gently sloping morainal surficial materials but also on glaciofluvial and fluvial materials. Soils are usually mesic with a medium nutrient regime with a range of particle sizes. Soil drainage is usually well or moderately well, and the humus form Mor. All polygons are coded 01a in the attribute table but could be either fine (01a) or coarse-textured (01b) phase.

Extensive forest harvesting has occurred in this ecosystem leading to a range of structural stages, plant species and layer cover values. In natural stands hybrid white spruce (*Picea engelmannii x glauca*) usually dominates the canopy, but subalpine fir (*Abies lasiocarpa*) or lodgepole pine (*Pinus contorta*) are leading in some stands. Trembling aspen (*Populus tremuloides*) and black cottonwood (*Populus trichocarpa*) may also be present. Planted stand are usually dominated by hybrid white spruce and lodgepole pine.

The shrub layer can contain a wide range of species. There is usually some subalpine fir regeneration; Sitka alder (*Alnus viridis* ssp. *sinuata*), black twinberry (*Lonicera involucrata*), false azalea (*Menziesia ferruginea*), black huckleberry (*Vaccinium membranaceum*), thimbleberry (*Rubus parviflorus*), highbush-cranberry (*Viburnum edule*) and black gooseberry (*Ribes lacustre*) are present on many sites.

The herb layer nearly always contains bunchberry (*Cornus canadensis*), with five-leaved bramble (*Rubus pedatus*), heart-leaved arnica (*Arnica cordifolia*), twinflower (*Linnaea borealis*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*) and three-leaved foamflower (*Tiarella trifoliata*) occurring frequently. The moss layer is dominated by feathermosses including red-stemmed feathermoss (*Pleurozium schreberi*), knight's plume (*Ptilium crista-castrensis*) and step moss (*Hylocomium splendens*) though a number of other moss and lichen species may be present.

Plot Numbers (Cont'd):

AD135, AD148, AD155, IR014, IR015, IR021, IR027, IR030, IR035, IR037, IR039, IRO66, IR067, IR068, IR076, IR081, IR103, PC07TWB, PC09TWB, PC10TWB, PC11TWB, PC24TWB, PC25TWB, PC26TWB, PC29TWB, PC30TWB, PC32TWB, PC33TWB, PC34TWB, PC35TWB, PC38TWB, PC39TWB, PC40TWB, PC41TWB, PC77TWB, PC14LRB, PC15LRB, PC45LRB, PC6ILRB, PC63LRB, QA11, QA13, QA15, QA16, VTF01, VTF12, IR116, IR118, IR122, IR224, IR227, IR232, IR234, PC06TWB, PC20LRB

Site Information	
Elevation (masl)	769 - 1078
Slope	0 – 9 - 72
Aspect	None, Various
Slope Position	**MD, LV,** LW, UP, GU
Structural Stage	3a, **3b, 4,** 5, **6,** 7
Surficial Material	**M**, FG, F
Drainage	**w, m**, i
Rooting zone particle size	**FL, CL, CLS, SS**, FSI, S
Seepage	none
Humus form	**Mor**, Moder
SMR	(3)-**4**
SNR	(B)-**C**

Plot Numbers

14-3922, AD013, AD015, AD016, AD017, AD022, AD024, AD026, AD033, AD036, AD040, AD042, AD053, AD057, AD062, AD063, AD064, AD065, AD066, AD067, AD078, AD080, AD084, AD089, AD094, AD095, AD100, AD122, AD123, AD129, AD133

Tree Layer (0 - 80)	Shrub Layer (8 - 95)	Herb Layer (5 - 90)	Moss Layer (1 - 95)
Picea engelmannii x glauca, Abies lasiocarpa, Pinus contorta, Populus tremuloides, Populus trichocarpa	*Alnus viridis* ssp. *sinuata, Rubus parviflorus, Lonicera involucrata, Vaccinium membranaceum, Viburnum edule, Ribes lacustre, Menziesia ferruginea*	*Cornus canadensis, Arnica cordifolia, Linnaea borealis, Petasites frigidus var. palmatus, Rubus pedatus, Tiarella trifoliata*	*Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**01c**	**SB**	**Hybrid white spruce - Huckleberry (Sxw - Huckleberry) (submesic phase)**	**151.0**

Site Photo

Soil Pit Photo

Hybrid white spruce - Huckleberry, submesic phase, forests are fairly widespread in the study area. They mostly occur on level to gently sloping morainal and glaciofluvial deposits. The sites all tend to have a submesic moisture regime and a medium to poor soil nutrient regime, and are well or rapidly drained. The humus form is Mor.

Much forest harvesting has occurred in this ecosystem leading to a range of structural stages, plant species and layer cover values. In natural stands lodgepole pine (*Pinus contorta*) usually dominates the canopy, but hybrid white spruce (*Picea engelmannii x glauca*) or subalpine fir (*Abies lasiocarpa*) are leading or a significant component in some stands. Trembling aspen (*Populus tremuloides*) and black cottonwood (*Populus trichocarpa*) may also be present.

The shrub layer can contain a wide range of species. There is usually some subalpine fir regeneration; black huckleberry (*Vaccinium membranaceum*), black twinberry (*Lonicera involucrata*), Sitka alder (*Alnus viridis* ssp. *sinuata*), prickly rose (*Rosa acicularis*), soopolallie (*Shepherdia canadensis*), thimbleberry (*Rubus parviflorus*) and highbush-cranberry (*Viburnum edule*) are present on many sites.

The herb layer nearly always contains bunchberry (*Cornus canadensis*), with twinflower (*Linnaea borealis*), heart-leaved arnica (*Arnica cordifolia*), dwarf blueberry (*Vaccinium caespitosum*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), bastard toadflax (*Geocaulon lividum*) and kinnikinnick (*Arctostaphylos uva-ursi*) occurring frequently.

Feathermosses are most dominant in the moss layer, including red-stemmed feathermoss (*Pleurozium schreberi*), knight's plume (*Ptilium crista-castrensis*) and step moss (*Hylocomium splendens*). A number of lichen species may be present including freckled pelt (*Peltigera aphthosa*), Cladonia (*Cladonia* spp.) and Cladina (*Cladina* spp.).

Site Information

Elevation (masl)	755 - 1100
Slope	0 - 11 - 80
Aspect	None, Various
Slope Position	**LV, MD,** UP, CR
Structural Stage	**3b, 4,** 5, 6, 7a
Surficial Material	**M, FG**, C
Drainage	**w, r,** m
Rooting zone particle size	**CLS, CL, SS**, F, FL, FLS, S
Seepage	none
Humus form	Mor
SMR	(2)-**3**-(4)
SNR	**B, C**

Plot Numbers

AD070, AD081, AD086, AD103, AD143, AD144, AD146, AD156, IR036, IR040, IR056, IR058, IR060, IR077, IR079, IR082a, IT088, IR099, IR104, IR108, IR111, QA02, QA04, QA19, QA20, QA25, QA27

Tree Layer (0 - 65)	Shrub Layer (1 - 75)	Herb Layer (1 - 95)	Moss Layer (0 - 100)
Picea engelmannii x glauca, Abies lasiocarpa, Pinus contorta, Populus tremuloides, Populus trichocarpa	*Vaccinium membranaceum, Lonicera involucrata, Alnus viridis* ssp. *sinuata , Rosa acicularis, Shepherdia canadensis, Rubus parviflorus, Viburnum edule*	*Cornus canadensis, Arnica cordifolia, Linnaea borealis, Vaccinium caespitosum, Petasites frigidus* var. *palmatus, Geocaulon lividum, Arctostaphylos uva-ursi*	*Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens, Peltigera aphthosa, Cladonia* spp., *Cladina* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**02**	**PH**	**Lodgepole pine - Huckleberry - Cladonia (Pl - Huckleberry - Cladonia)**	**1.7**

Site Photo

Soil Pit Photo

Lodgepole pine - Huckleberry - Cladonia forests are uncommon in the study area, occurring on the driest sites in the area. These sites have shallow or coarse soils that are dry or moderately dry and have a poor or very poor soil nutrient regime.

The sites where this ecosystem was found may have lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), hybrid white spruce (*Picea engelmannii x glauca*) and trembling aspen (*Populus tremuloides*) trees; these species were also present in the shrub layer. There were also scattered black cottonwood (*Populus trichocarpa*) on some sites.

The shrub layer also contained black huckleberry (*Vaccinium membranaceum*), thimbleberry (*Rubus parviflorus*), false azalea (*Menziesia ferruginea*), soopolallie (*Shepherdia canadensis*), common juniper (*Juniperus communis*) and dwarf birch (*Betula glandulosa*).

The herb layer was dominated by bunchberry (*Cornus canadensis*), crowberry (*Empetrum nigrum*), kinnickinnik (*Arctostaphylos uva-ursi*), heart-leaved arnica (*Arnica cordifiolia*) and dwarf blueberry (*Vaccinium caespitosum*) with twinflower (*Linnaea borealis*) and palmate coltsfoot (*Petasites frigidus* var. *palmatus*).

The moss layer has several moss species including heron's bill moss (*Dicranum* spp.), red-stemmed feathermoss (*Pleurozium schreberi*) and knight's plume (*Ptilium crista-castrensis*), but is characterized by the numerous lichen species including eyed foam (*Stereocaulon tomentosum*), toad pelt (*Peltigera scabrosa*), pebbled pixie cup (*Cladonia 4yxidate*), Lesser green reindeer (*Cladina mitis*) and grey reindeer (*Cladina rangiferina*).

Site Information	
Elevation (masl)	872 - 1042
Slope	9 - 10
Aspect	**Warm, Cool**
Slope Position	**CR**
Structural Stage	**3b, 4**
Surficial Material	**M, FG**
Drainage	**w, r**
Rooting Zone Particle Size	**CLS**
Seepage	none
Humus form	**Mor**
SMR	**1-2**
SNR	**A-B**

Plot Numbers

IR041, IR233, QA18

Tree Layer (3 - 50)	**Shrub Layer** (17 - 22)	**Herb Layer** (35 - 50)	**Moss Layer** (6 - 60)
Pinus contorta, Abies lasiocarpa, Picea engelmannii x glauca, Populus tremuloides, Populus trichocarpa	*Vaccinium membranaceum, Menziesia ferruginea, Betula glandulosa, Juniperus communis, Rubus parviflorus, Shepherdia canadensis*	*Arctostaphylos uva-ursi, Arnica cordifiolia, Empetrum nigrum, Vaccinium caespitosum, Linnaea borealis, Cornus canadensis, Petasites frigidus* var. *palmatus, Cladina mitis*	*Dicranum* spp., *Pleurozium schreberi , Stereocaulon tomentosum, Ptilium crista-castrensis, Peltigera scabrosa, Cladonia 4yxidate, Cladina rangiferina*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**03**	**BM**	**Black spruce - Lodgepole pine - Feathermoss (SbPl - Feathermoss)**	**58.4**

Site Photo

Soil Pit Photo

Black spruce - Lodgepole pine - Feathermoss forests are found on mesic to moist sites with a poor to very poor nutrient regime. The sites are level to slightly sloping, with morainal materials that are mostly well-drained. These sites may have been harvested but tree growth of the regeneration is not great.

The tree layer can be a combination of black spruce (*Picea mariana*), hybrid white spruce (*Picea engelmannii x glauca*), lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*) and trembling aspen (*Populus tremuloides*). On harvested sites the shrub layer contains white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*), otherwise the shrub layer is quite sparse.

The shrub species present includes Labrador tea (*Rhododendron groenlandicum*), prickly rose (*Rosa acicularis*), Sitka alder (*Alnus viridis*), black twinberry (*Lonicera involucrata*), soopolallie (*Shepherdia canadensis*), black huckleberry (*Vaccinium membranaceum*), Sitka mountain-ash (*Sorbus sitchensis*) and willows (*Salix* spp.).

The herb layer can be dominated by crowberry (*Empetrum nigrum*) or bunchberry (*Cornus canadensis*) but will have a variety of other species including false toad-flax (*Geocaulon lividum*), fireweed (*Epilobium angustifolium*), kinnikinnick (*Arctostaphylos uva-ursi*), twinflower (*Linnaea borealis*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), five-leaved bramble (*Rubus pedatus*) and dwarf blueberry (*Vaccinium caespitosum*).

The moss layer has several moss species including red-stemmed feathermoss (*Pleurozium schreberi*) and step moss (*Hylocomium splendens*) but is characterized by the numerous lichen species including freckle pelt (*Peltigera aphthosa*), Lesser green reindeer (*Cladina mitis*), grey reindeer (*Cladina rangiferina*), boreal pixie-cup (*Cladonia borealis*) and miner's funnel (*Cladonia cenotea*).

Site Information

Elevation (masl)	785 - 848
Slope	0 - 2 - 3
Aspect	None
Slope Position	**LV**, MD
Structural Stage	**3b, 4**, 6
Surficial Material	**M**, FG
Drainage	**w**, I, r
Rooting Zone Particle Size	**CLS**, FLS
Seepage	None
Humus form	Mor
SMR	(2)-**3-4-**(5)
SNR	(A)-**B**

Plot Numbers

12-2623, AD050, AD051, AD052, AD059, AD102, AD147, PC62LRB, QA24

Tree Layer (0 - 18)	Shrub Layer (20 - 50)	Herb Layer (18 - 50)	Moss Layer (15 - 40)
Picea mariana, Picea engelmannii x glauca, Pinus contorta, Abies lasiocarpa, Populus tremuloides	*Lonicera involucrata, Rhododendron groenlandicum, Shepherdia canadensis, Vaccinium membranaceum, Rosa acicularis, Sorbus sitchensis, Salix planifolia, Alnus viridis, Salix* spp.	*Empetrum nigrum, Cornus canadensis, Geocaulon lividum, Arctostaphylos uva-ursi, Linnaea borealis, Petasites frigidus var. palmatus, Rubus pedatus, Vaccinium caespitosum, Epilobium angustifolium*	*Pleurozium schreberi, Hylocomium splendens, Peltigera aphthosa, Cladonia borealis, Cladina rangiferina, Cladina mitis, Cladonia cenotea*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**05**	**TC**	**Hybrid white spruce - Twinberry - Coltsfoot (Sxw - Twinberry - Coltsfoot)**	**55.6**

Site Photo

Soil Pit Photo

Hybrid white spruce - Twinberry - Coltsfoot forests occur on mesic to moist sites with a medium to rich nutrient regime. The sites are gently sloping mid-slope to lower slopes with a cool aspect and are moderately-well to imperfectly drained.

The canopy of these ecosystems contains hybrid white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*), with minor amounts of lodgepole pine (*Pinus contorta*), black cottonwood (*Populus trichocarpa*) and trembling aspen (*Populus tremuloides*).

The shrub layer is dominated by black twinberry (*Lonicera involucrata*), Sitka alder (*Alnus viridis* ssp. *6ryopte*) and thimbleberry (*Rubus parviflorus*), but also contains regenerating subalpine fir, black gooseberry (*Ribes lacustre*), willows (*Salix* spp.), highbush-cranberry (*Viburnum edule*) and false azalea (*Menziesia ferruginea*).

The herb layer can contain a wide range of species including bunchberry (*Cornus canadensis*), twinflower (*Linnea borealis*), Arnica (*Arnica* spp.), oak fern (*Gymnocarpium dryopteris*), five-leaved bramble (*Rubus pedatus*), foamflower (*Tiarella trifoliata*), and fireweed (*Epilobium angustifolium*).

Red-stemmed feathermoss (*Pleurozium schreberi*) can dominate the moss layer that can also contain knight's plume (*Ptilium crista-castrensis*), short-leaved ragged moss (*Brachythecium oedipodium*) and heron's bill moss (*Dicranum* spp.).

Site Information	
Elevation (masl)	762 - 1046
Slope	3 - 8 - 13
Aspect	Cool
Slope Position	**MD**, LW
Structural Stage	3, **4, 6**, 7a
Surficial Material	**M**, FG
Drainage	**m, w**, i
Rooting Zone Particle Size	**FL**, CL, S
Seepage	none
Humus form	**Mor,** Moder, Mull
SMR	(4)-**5**-(6)
SNR	(C)-**D**-(E)

Plot Numbers

12-8647, AD041, AD158, PC23TWB, PC42TWB, QA03, QA12, VTF02

Tree Layer (0 - 50)	**Shrub Layer** (40 - 85)	**Herb Layer** (15 - 65)	**Moss Layer** (0 - 75)
Picea engelmannii x glauca, Abies lasiocarpa, Pinus contorta, Populus trichocarpa, Populus tremuloides	*Lonicera involucrata, Alnus viridis ssp. 6ryopte, Rubus parviflorus, Ribes lacustre, Salix* spp., *Viburnum edule, Menziesia ferruginea*	*Cornus canadensis, Linnea borealis, Arnica cordifolia, Arnica mollis, Gymnocarpium dryopteris, Rubus pedatus, Tiarella trifoliata, Epilobium angustifolium*	*Pleurozium schreberi, Brachythecium oedipodium, Dicranum* spp., *Ptilium crista-castrensis*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**06**	**SO**	**Hybrid white spruce - Oak fern (Sxw - Oak fern)**	**365.7**

Site Photo

Soil Pit Photo

Hybrid white spruce – Oak fern forests are common in the study area on morainal blanket parent materials with a variety of slopes and aspects. The mesoslope position is usually mid to lower slope. The soils are moist to very moist and rich, imperfectly to moderately-well drained, with a Moder humus form. Root restricting compacted layers are fairly common. The forests have often been harvested, and as a result have a variety of structural stages and plant species.

In natural stands the tree canopy is dominated by hybrid white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*), with some stands having a minor component of trembling aspen (*Populus tremuloides*), black cottonwood (*Populus trichocarpa*), lodgepole pine (*Pinus contorta*) or Scouler's willow (*Salix scouleriana*).

Harvested sites are usually planted to hybrid white spruce and lodgepole pine. Subalpine fir is often regenerating in the shrub layer. Other prominent shrub species include black twinberry (*Lonicera involucrata*), black gooseberry (*Ribes lacustre*), highbush-cranberry (*Viburnum edule*), Sitka alder (*Alnus viridis* ssp. *7ryopte*), thimbleberry (*Rubus parviflorus*), false azalea (*Menziesia ferruginea*) and black huckleberry (*Vaccinium membranaceum*). Devil's club (*Oplopanax horridus*) and red-osier dogwood (*Cornus stolonifera*) are occasionally present.

Oak fern (*Gymnocarpium dryopteris*) and bunchberry (*Cornus canadensis*) are nearly always present in the herb layer, with foamflower (*Tiarella trifoliata*), five-leaved bramble (*Rubus pedatus*), common horsetail (*Equisetum arvense*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), clasping twistedstalk (*Streptopus amplexifolius*), baneberry (*Actaea rubra*) and stiff clubmoss (*Lycopodium annotinum*) also frequently occurring.

The moss layer is dominated by the feathermosses red-stemmed feathermoss (*Pleurozium schreberi*), knight's plume (*Ptilium crista-castrensis*) and step moss (*Hylocomium splendens*); leafy mosses (*Mnium* spp.) are fairly frequent, with electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) short-leaved ragged moss (*Brachythecium oedipodium*) also occurring.

Plot Numbers (Cont'd):

AD126, AD127, AD130, AD151, AD153, IR018, IR023, IR028, IR050, IR061, IR065, IR069, IR093, PC17LRB, PC18LRB, PC28TWB, PC31TWB, PC36TWB, PC73TWB, PC74TWB, PC75TWB, PC76TWB, PC78TWB, QA01, QA05, QA06, QA10, QA14, QA17, VTF09, VTF10, VTF11

Site Information

Elevation (masl)	739 – 1126
Slope	1 - 10 - 85
Aspect	Various
Slope Position	MD, LV, LW, GU, TO
Structural Stage	3a, 3b, 4, 5, 6, 7a
Surficial Material	M, F, FG, O
Drainage	I, m, p
Rooting Zone Particle Size	FL, CL, CLS, FLS, FSI
Seepage	739 – 1126
Humus form	1 - 10 - 85
SMR	**4-5**
SNR	**C-D**

Plot Numbers

12-8643, 12-8644, AD023, AD025, AD028, AD034, AD035, AD037, AD038, AD043, AD044, AD045, AD071, AD073, AD087, AD088, AD093, AD098, AD099, AD121,

Tree Layer (0 - 70)	**Shrub Layer** (10 - 100)	**Herb Layer** (7 - 95)	**Moss Layer** (2 - 100)
Picea engelmannii x glauca, Abies lasiocarpa, Populus tremuloides, Populus trichocarpa, Pinus contorta, Salix scouleriana	*Lonicera involucrata, Rubus parviflorus, Alnus viridis* ssp. *7ryopte, Viburnum edule, Vaccinium membranaceum, Ribes lacustre, Menziesia ferruginea, Oplopanax horridus, Cornus stolonifera*	*Gymnocarpium dryopteris, Cornus canadensis, Tiarella trifoliata, Rubus pedatus, Equisetum arvense, Petasites frigidus* var. *palmatus, Streptopus amplexifolius, Actaea rubra, Lycopodium annotinum*	*Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens, Mnium* spp., *Rhytidiadelphus triquetrus, Brachythecium oedipodium*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**07**	**BF**	**Hybrid white spruce - Scrub birch - Feathermoss (Sxw - Scrub birch - Feathermoss)**	**41.9**

Site Photo

Soil Pit Photo

Hybrid white spruce – Scrub birch – Feathermoss forests are uncommon in the area, occurring in very moist, nutrient poor sites often adjacent to wetlands. Soils are imperfectly drained and the trees shallowly rooted.

Hybrid white spruce (*Picea engelmannii x glauca*) is the dominant tree species with subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus trichocarpa*) and trembling aspen (*Populus tremuloides*) also occurring. in the understory.

Hardhack (*Spirea douglasii*) and Sitka alder (*Alnus viridis* ssp. *sinuata*) are the dominant shrubs with false azalea (*Menziesia ferruginea*), black twinberry (*Lonicera involucrata*) and Labrador tea (*Rhododendron groenlandicum)* also present.

The herb layer contains common horsetail (*Equisetum arvense*), oak fern (*Gymnocarpium dryopteris*), bunchberry (*Cornus canadensis*), three-leaved foamflower (*Tiarella trifoliata*) and twinflower (*Linnaea borealis*).

The moss layer is dominated by the feathermosses red-stemmed feathermoss (*Pleurozium schreberi*), step moss (*Hylocomium splendens*) and knight's plum (*Ptilium crista-castrensis*), with occasional peat-moss (*Sphagnum* spp.) mounds.

Site Information

Elevation (masl)	780 - 844
Slope	0 - 1 - 3
Aspect	None
Slope Position	Level
Structural Stage	**3b, 4, 7a**
Surficial Material	**FG, M**
Drainage	**i**
Rooting Zone Particle Size	**FLS, CLS**
Seepage	**None**, 38
Humus form	**Mor, Moder**
SMR	(5)-**6**
SNR	(A)-**B**-(C)

Plot Numbers

AD082, AD134, AD136, AD137, AD149

Tree Layer (25 - 35)	**Shrub Layer** (30 - 35)	**Herb Layer** (10 - 20)	**Moss Layer** (7 - 90)
Picea engelmannii x glauca, Abies lasiocarpa, Populus trichocarpa, Populus tremuloides	*Spirea douglasii, Alnus viridis* spp. *sinuata, Menziesia ferruginea, Lonicera involucrata, Rhododendron groenlandicum*	*Equisetum arvense, Gymnocarpium dryopteris, Cornus canadensis, Tiarella trifoliata, Linnaea borealis, Senecio triangularis, Streptopus amplexifolius, Lycopodium annotinum*	*Pleurozium schreberi, Hylocomium splendens, Ptilium crista-castrensis, Sphagnum* spp

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**09a / 09b (00)**	**SD**	**Hybrid white spruce - Devil's club (Sxw - Devil's club) (fluvial phase, morainal phase)**	**24.3 / 82.3 (12.4)**

Site Photo

Soil Pit Photo

Hybrid white spruce – Devil's club forests occur on moist to very moist sites with a rich nutrient regime. These sites occur on toe to lower slopes that have a gentle to moderate gradient. Parent material are usually morainal but may be fluvial, and have a silty loam to silty clay loam soil texture. A root restricting layer due to compact soils occurs fairly commonly, and soils are imperfectly to moderately-well drained. Humus forms are Moders or Mors and can be fairly thick. Two phases of this site series are mapped: fluvial (09a) and morainal (09b). While not described in the SBSdk, several areas in the SBSdk were sampled and mapped. The sites in the SBSdk are coded 00 and are morainal.

These forests are usually dominated by hybrid white spruce (*Picea engelmannii x glauca*) with subalpine fir (*Abies lasiocarpa*) as a sub-dominant. Black cottonwood (*Populus trichocarpa*), trembling aspen (Populus tremuloides) and lodgepole pine (*Pinus contorta*) may be present. Devil's club (*Oplopanax horridus*) is usually dominant in the shrub layer, but alder (*Alnus* ssp.), thimbleberry (*Rubus parviflorus*), black twinberry (*Lonicera involucrata*) and false azalea (*Menziesia ferruginea*) dominate some sites, and highbush-cranberry (*Viburnum edule*) and black gooseberry (*Ribes lacustre*) are often present.

The herb layer usually has a high cover of oak fern (*Gymnocarpium dryopteris*), and three-leaved foamflower (*Tiarella trifoliata*), bunchberry (*Cornus canadensis*) and five-leaved bramble (*Rubus pedatus*) are usually present. Other species that may be present includes sweet-scented bedstraw (*Galium triflorum*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), clasping twistedstalk (*Streptopus amplexifolius*) and common horsetail (*Equisetum arvense*).

The moss layer is dominated by red-stemmed feathermoss (*Pleurozium schreberi*) or large leafy moss (*Rhizomnium glabrescens*), with knight's plume (*Ptilium crista-castrensis*), step moss (*Hylocomium splendens*) also frequently present.

Site Information

Elevation (masl)	680 - 1035
Slope	0 - **2** - 10
Aspect	**None**, cool
Slope Position	**TO, LW, MD**, GU
Structural Stage	6, 7
Surficial Material	**M**, F, C, O
Drainage	**i**, **m**, w
Rooting Zone Particle Size	**FL**, FLS, SS
Seepage	None
Humus form	**Moder**, Mor
SMR	(5)-**6**
SNR	**D-(**E)

Plot Numbers

12-8646, AD014, AD018, AD039, AD154, IR016, IR024, IR025, IR070, IR127, IR129, IR215, QA30

Tree Layer (15 - 50)	Shrub Layer (22 - 85)	Herb Layer (35 - 85)	Moss Layer (4 - 95)
Picea engelmannii x glauca, Abies lasiocarpa, Populus trichocarpa, Populus tremuloides, Pinus contorta	*Oplopanax horridus, Alnus* ssp.*, Rubus parviflorus, Lonicera involucrata, Menziesia ferruginea, Viburnum edule, Ribes lacustre*	*Gymnocarpium dryopteris, Tiarella trifoliata, Cornus canadensis, Rubus pedatus, Petasites frigidus* var. *palmatus, Galium triflorum, Streptopus amplexifolius, Equisetum arvense*	*Pleurozium schreberi, Rhizomnium glabrescens, Ptilium crista-castrensis, Hylocomium splendens*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**10a / 10b**	**SH**	**Hybrid white spruce - Horsetail (Sxw - Horsetail) (fluvial phase, lacustrine/morainal phase)**	**68.0 / 136.3**

Site Photo

Soil Pit Photo

Hybrid white spruce – Horsetail forests occur on very moist and rich toe slopes and level areas. The parent materials can be fluvial, morainal or lacustrine, but the soils tend to be fine textured and be imperfectly or poorly drained. The humus form is Moders or Mors and can be quite thick, as can be the Ah horizon. Two phases of this site series are mapped: fluvial (10a) and lacustrine/morainal (10b).

The canopy is a mixture of hybrid white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*) and may contain black cottonwood (*Populus trichocarpa*), lodgepole pine (*Pinus contorta*) or paper birch (*Betula papyrifera*). The shrub layer usually has some subalpine fir regeneration but may also have hybrid white spruce and lodgepole pine.

The shrub layer usually contains black twinberry (*Lonicera involucrata*) and may contain alder (*Alnus* ssp.), devil's club (*Oplopanax horridus*), black gooseberry (*Ribes lacustre*) thimbleberry (*Rubus parviflorus*) and high-bush cranberry (*Viburnum edule*).

The herb layer always has a high cover of common horsetail (*Equisetum arvense*) with bunchberry (*Cornus canadensis*) and oak fern (*Gymnocarpium dryopteris*), and may have common 10ryopteri (*Mitella nuda*), three-leaved foamflower (*Tiarella trifoliata*), sweet-scented bedstraw (*Galium triflorum*), lady fern (*Athyrium filix-femina*), spiny wood fern (*Dryopteris expansa*), clasping twistedstalk (*Streptopus amplexifolius*), dwarf red raspberry (*Rubus pubescens*) and palmate coltsfoot (*Petasites frigidus* var. *palmatus*).

The moss layer is dominated by red-stemmed feathermoss (*Pleurozium schreberi),* knight's plume (*Ptilium crista-castrensis*) and step moss (*Hylocomium splendens*), but leafy mosses (*Mnium* spp.) also frequently occur, and peat-mosses (*Sphagnum* spp.) are occasionally present.

The lacustrine/morainal phase (10b) of this ecosystem is described as the Spruce - Common horsetail - Leafy mosses in Mackenzie and Moran (2004).

Site Information

Elevation (masl)	745 - 1052
Slope	0 - **1** - 10
Aspect	**None**, Cool
Slope Position	**LV, TO, DP,** LW, DP
Structural Stage	3b, 4, 5, **6, 7a**
Surficial Material	**F, M, L**, LG, O
Drainage	**I, p**, m
Rooting Zone Particle Size	**FL**, CL, FC, CS, SS
Seepage	12 – **29** - 38
Humus form	**Moder, Mor**, Mull
SMR	(5)-**6**-(7)
SNR	C, **D**, E

Plot Numbers

12-8534, AD020, AD054, AD056, AD074, AD076, AD128, AD131, AD152, AD157, IR020, IR029, IR034, IR042, IR074, IR085, IR086, IR089, IR095, IR112, IR114, IR120, IR225, QA08, QA09

Tree Layer (0 - 60)	Shrub Layer (8 - 100)	Herb Layer (10 - 95)	Moss Layer (5 - 100)
Picea engelmannii x glauca, Abies lasiocarpa, Populus trichocarpa, Pinus contorta, Betula papyrifera	*Lonicera involucrata, Alnus* ssp.*, Oplopanax horridus, Ribes lacustre, Rubus parviflorus, Viburnum edule*	*Equisetum arvense, Cornus canadensis, Gymnocarpium dryopteris, Mitella nuda, Tiarella trifoliata, Galium triflorum, Athyrium filix-femina, Dryopteris expansa, Streptopus amplexifolius, Rubus pubescens, Petasites frigidus* var. *palmatus*	*Pleurozium schreberi, Rhizomnium glabrescens, Ptilium crista-castrensis, Hylocomium splendens, Mnium* spp., *Sphagnum* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**51**	**WT**	**Scouler's willow - Thimbleberry**	**10.5 / 17.6**

Site Photo

Soil Pit Photo

The **Scouler's willow - Thimbleberry** ecosystem is found on medium to rich sites with a mesic to subhygric moisture regime. The soils are Orthic Eutric Brunisols. These sites are often found on cool aspects and may have late snow retention. This ecosystem is uncommon in the study area.

This ecosystem has a sparse subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus trichocarpa*), trembling aspen (*Populus tremuloides*) or hybrid white spruce (*Picea engelmannii x glauca*) canopy over Scouler's willow (*Salix scouleriana*) that are short trees or tall shrubs.

The remainder of the shrub layer can be dominated by thimbleberry (*Rubus parviflorus*), alder (*Alnus* spp.), black twinberry (*Lonicera involucrata*), highbush-cranberry (*Viburnum edule*), prickly rose (*Rosa acicularis*) and false azalea (*Menziesia ferruginea*).

The herb layer can contain a variety species including oak fern (*Gymnocarpium dryopteris*), foam flower (*Tiarella trifoliata*), Indian hellebore (*Veratrum viride*), baneberry (*Actaea rubra*), common horsetail (*Equisetum arvense*), sweet-scented bedstraw (*Galium triflorum*), heart-leaved arnica (*Arnica cordifolia*), false Solomon's seal (*Maianthemum racemosum*) and five-leaved bramble (*Rubus pedatus*).

The sparse moss layer contains red-stemmed feathermoss (*Pleurozium schreberi*), curly heron's-bill moss (*Dicranum fuscescens*), and large leafy moss (*Rhizomnium glabrescens*).

Site Information	
Elevation (masl)	676 - 1064
Slope	0 - 20 - 65
Aspect	**Cool**, None
Slope Position	LV, LW, MD, UP
Structural Stage	3a, **5, 6**
Surficial Material	FG, M
Drainage	m, i, w
Rooting Zone Particle Size	FSI, FLS, CL
Seepage	none
Humus form	Mor, Moder
SMR	(4)-**5**-6
SNR	**C-D**-E

Plot Numbers

12-8533, 12-8638, AD031, AD159, IR072, IR133, IR148, IR206, IR231

Tree Layer (15 - 35)	**Shrub Layer** (45 - 90)	**Herb Layer** (5 - 90)	**Moss Layer** (1 - 3)
Abies lasiocarpa, Salix scouleriana, Populus tremuloides, Populus trichocarpa, Picea engelmannii x glauca	*Salix scouleriana, Lonicera involucrata, Alnus incana, Alnus viridis, Viburnum edule, Menziesia ferruginea, Rubus parviflorus*	*Gymnocarpium dryopteris, Actaea rubra, Galium triflorum, Equisetum arvense, Arnica cordifolia, Veratrum viride, Rubus pedatus*	*Pleurozium schreberi, Rhizomnium glabrescens*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**52**	**AN**	**Mountain alder - Stinging nettle**	**0.8 / 2.3**

Site Photo

Soil Pit Photo

Mountain alder – Stinging nettle ecosystems occurs on rich, very moist sites that may have seepage. The aspect is cool and the drainage poor. This ecosystem is uncommon in the study area.

This ecosystem may have a tree canopy of paper birch (*Betula papyrifera*), black cottonwood (*Populus trichocarpa*), hybrid white spruce (*Picea engelmannii x glauca*) or be a tall shrub ecosystem dominated by mountain alder (*Alnus incana*) and Douglas maple (*Acer glabrum* var. *douglasii*). Devil's club (*Oplopanax horridus*) has a high cover, with other shrubs including black twinberry (*Lonicera involucrata*), red elderberry (*Sambucus racemosa*) and black gooseberry (*Ribes lacustre*).

Herbs include lady fern (*Athyrium filix-femina*), common horsetail (*Equisetum arvense*), oak fern (*Gymnocarpium dryopteris*) and stinging nettle (*Urtica dioica*).

The moss layer contains large leafy moss (*Rhizomnium glabrescens*), ragged moss (*Brachythecium* spp.) and red-stemmed feathermoss (*Pleurozium schreberi*).

Site Information	
Elevation (masl)	500 - 997
Slope	8 – 18 - 30
Aspect	Cool
Slope Position	MD, TO, LV
Structural Stage	4, 3b
Surficial Material	C, M, F
Drainage	p
Rooting Zone Particle Size	SIS, FC
Seepage	None, 5
Humus form	Mull, Moder
SMR	6
SNR	D-E

Plot Numbers

IR053, IR203, QA45

Tree Layer (0 - 45)	**Shrub Layer** (35 - 95)	**Herb Layer** (9 - 84)	**Moss Layer** (0.1 - 20)
Betula papyrifera, Populus trichocarpa, Picea engelmannii x glauca, Alnus incana	*Alnus incana, Acer glabrum* var. *douglasii, Lonicera involucrata, Oplopanax horridus, Sambucus racemosa, Ribes lacustre*	*Equisetum arvense, Athyrium filix-femina, Gymnocarpium dryopteris, Urtica dioica*	*Rhizomnium glabrescens, Brachythecium* spp., *Pleurozium schreberi*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**01a**	**SP**	**Hybrid white spruce - Spirea - Purple peavine (Swx - Spirea - Purple peavine) (fine-textured phase)**	**219.1**

Site Photo

Soil Pit Photo

Hybrid white spruce - Spirea - Purple peavine forests, fine-textured phase, are common in the study area. They occur on level to gently sloping sites with glaciolacustrine and morianal parent materials. Soils are usually mesic dry, with a medium nutrient regime, and moderately-well drained. Many of these stands have been impacted by the mountain pine beetle (*Dendroctonus ponderosae*), or have been harvested.

These forests have a canopy of lodgepole pine (*Pinus contorta*), hybrid white spruce (*Picea engelmannii x glauca*) and trembling aspen (*Populus tremuloides*); these species are also usually present on harvested sites. Paper birch (*Betula papyrifera*) and black cottonwood (*Populus trichocarpa*) may also be present.

The shrub layer contains a variety of species with prickly rose (*Rosa acicularis*), black twinberry (*Lonicera involucrata*), soopolallie (*Shepherdia canadensis*), common snowberry (*Symphoricarpos albus*), highbush-cranberry (*Viburnum edule*), saskatoon (*Amelanchier alnifolia*) and thimbleberry (*Rubus parviflorus*) being the most common.

The herb layer also has a variety of species including northern bedstraw (*Galium boreale*), bunchberry (*Cornus canadensis*), wild sarsaparilla (*Aralia nudicaulis*), purple peavine (*Lathyrus nevadensis*), palmate coltsfoot (*Petasites frigidus*), dwarf red raspberry (*Rubus pubescens*), Queen's cup (*Clintonia uniflora*), twinflower (*Linnaea borealis*), and western meadowrue (*Thalictrum occidentale*).

The moss layer is usually dominated by feathermosses including red-stemmed feathermoss (*Pleurozium schreberi*), electrified cats-tail moss (*Rhytidiadelphus triquetrus*) and knight's plume (*Ptilium crista-castrensis*), step moss (*Hylocomium splendens*).

Site Information	
Elevation (masl)	531 – 783
Slope	0 - 7 - 30%
Aspect	**N, NW**, NE, S
Slope Position	**Level, MD**, CR, GU, LW, TO
Structural Stage	3a, 3b, 4, **5**, 6
Surficial Material	**LG, M**, F
Drainage	**m**, w, r
Rooting Zone Particle Size	**CL. FC. FL**, FLS, FSI
Seepage	none
Humus form	**Mor, Moder**, Mull
SMR	**3-4**
SNR	**B-C**

Plot Numbers

12-8640, AD116, AD117, AD141, AD150, AD163, AD164, AD168, AD173, AD175, AD176, AD177, IR153, IR164, IR217, PC03TWB, PC05TWB, PC49TWB, PC59TWB, PC60TWB, PC70TWB, PC71TWB, PC72TWB, PC47LRB, PC65LRB, QA46, QA47, QA54, VTF16

Tree Layer (10 - 55)	Shrub Layer (20 - 80)	Herb Layer (10 - 85)	Moss Layer (1 - 90)
Pinus contorta, Picea engelmannii x glauca, Populus tremuloides, Betula papyrifera, Populus trichocarpa	*Rosa acicularis, Lonicera involucrate, Shepherdia canadensis, Symphoricarpos albus, Amelanchier alnifolia, Viburnum edule, Rubus parviflorus*	*Galium boreale, Cornus canadensis, Aralia nudicaulis, Lathyrus nevadensis, Petasites frigidus, Rubus pubescens, Linnaea borealis, Clintonia uniflora, Thalictrum occidentale*	*Pleurozium schreberi, Ptilium crista-castrensis, Rhytidiadelphus triquetrus, Hylocomium splendens*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**01b**	**SP**	**Hybrid white spruce - Spirea - Purple peavine (Swx - Spirea - Purple peavine) (coarse-textured phase)**	**102.7**

Site Photo

Soil Pit Photo

Hybrid white spruce - Spirea - Purple peavine forests, coarse-textured phase, are relatively common in the study area. They occur on level to gently sloping sites that mostly have glaciofluvial parent materials. Soils are usually mesic or slightly dry, with a medium or poor nutrient regime, and well or moderately-well drained. Many of these stands have been impacted by the mountain pine beetle (*Dendroctonus ponderosae*) or have been harvested.

These forests have a canopy of lodgepole pine (*Pinus contorta*), hybrid white spruce (*Picea engelmannii x glauca*) and trembling aspen (*Populus tremuloides*); these species are also usually present on harvested sites. Black cottonwood (*Populus trichocarpa*) is occasionally present.

The shrub layer contains a variety of species with soopolallie (*Shepherdia canadensis*), prickly rose (*Rosa acicularis*), saskatoon (*Amelanchier alnifolia*), black twinberry (*Lonicera involucrata*) and highbush-cranberry (*Viburnum edule*) being the most common.

Similarly, the herb layer also has a variety of species including northern bedstraw (*Galium boreale*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), wild strawberry (*Fragaria virginiana*), dwarf blueberry (*Vaccinium caespitosum*), purple peavine (*Lathyrus nevadensis*), palmate coltsfoot (*Petasites frigidus*), heart-leaved arnica (*Arnica cordifolia*), blue wildrye (*Elymus glaucus),* rough-leaved ricegrass (*Oryzopsis asperifolia*) and kinnikinnick (*Arctostaphylos uva-ursi*).

The moss layer is usually dominated by red-stemmed feathermoss (*Pleurozium schreberi*), but also commonly contains some lichen species including Cladonia (*Cladonia* spp.), Cladina (*Cladina* spp.) and Pelt lichens (*Peltigera* spp.).

Site Information

Elevation (masl)	520 – 792
Slope	0 - 4 - 50%
Aspect	**None**, NW, NE, NNW. E
Slope Position	**Level**, LW
Structural Stage	3a, 3b, 4, **5**
Surficial Material	**FG**, F, M
Drainage	**w**, m, r
Rooting Zone Particle Size	**CL, FL, CLS**
Seepage	none
Humus form	**Moder, Mor**, Mull
SMR	(2-3)-**4**
SNR	(B)-**C**

Plot Numbers

12-8536, 12-8642, AD002, AD004, AD006, AD010, AD011, AD138, AD185, IR005, IR007, IR008, IR144, IR202, IR237a, IR248, QA22, QA23

Tree Layer (0 - 60)	Shrub Layer (20 - 45)	Herb Layer (20 - 90)	Moss Layer (0 - 80)
Pinus contorta, Picea engelmannii x glauca, Populus tremuloides, Populus trichocarpa	*Shepherdia canadensis, Rosa acicularis, Amelanchier alnifolia, Lonicera involucrata, Viburnum edule*	*Galium boreale, Cornus canadensis, Linnaea borealis, Fragaria virginiana, Vaccinium caespitosum, Lathyrus nevadensis, Petasites frigidus, Arnica cordifolia, Elymus glaucus, Oryzopsis asperifolia, Arctostaphylos uva-ursi*	*Pleurozium schreberi, Cladonia* spp., *Cladina* spp., *Peltigera* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**02**	**LJ**	**Lodgepole pine - Juniper - Ricegrass (Pl - Juniper - Ricegrass)**	**0.4**

Site Photo

The Lodgepole pine - Juniper - Ricegrass is a blue-listed ecosystem that was only mapped in one location in the study area. It is located on a rocky knob with shallow soils over bedrock, that is very rapidly drained. The soils are moderately dry and very poor.

The open tree canopy is dominated by lodgepole pine (*Pinus contorta*) with saskatoon (*Amelanchier alnifolia*), kinnikinnick (*Arctostaphylos uva-ursi*) and spreading dogbane (*Apocynum androsaemifolium*) in the understory.

The vegetation was not described in detail.

Site Information

Elevation (masl)	573
Slope	-
Aspect	Warm
Slope Position	CR
Structural Stage	5
Surficial Material	D
Drainage	x
Rooting Zone Particle Size	SiL
Seepage	-
Humus form	Mor
SMR	2
SNR	A

Plot Numbers

AD174

Tree Layer	Shrub Layer	Herb Layer	Moss Layer

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**03**	**LC**	**Lodgepole pine - Feathermoss - Cladina (Pl - Feathermoss - Cladina)**	**17.6**

Site Photo

Soil Pit Photo

The **Lodgepole pine - Feathermoss - Cladina** ecosystem occurs on gravelly glaciofluvial deposits or warm slopes with shallow soils over bedrock. The soils are slightly to moderately dry with a poor to medium nutrient regime, and are rapidly to well-drained. Most of the sites have been previously harvested, and may have been used for agriculture but are now regenerating to trees.

Lodgepole pine (*Pinus contorta*) dominates these fairly open stands in both the tree and shrub layer. The shrub layer also contains prickly rose (*Rosa acicularis*), saskatoon (*Amelanchier alnifolia*), soopolallie (*Shepherdia canadensis*), and Scouler's willow (*Salix scouleriana*).

The herb layer has a variety of species including dwarf blueberry (*Vaccinium caespitosum*), kinnikinnick (*Arctostaphylos uva-ursi*), northern bedstraw (*Galium boreale*), wild strawberry (*Fragaria virginiana*), yarrow (*Achillea millefolium*), narrow-leaved hawkweed (*Hieracium umbellatum*), field pussytoes (*Antennaria neglecta*) and short-awned ricegrass (*Piptatherum pungens*).

The moss layer contains red-stemmed feathermoss, (*Pleurozium schreberi*), juniper haircap moss (*Polytrichum juniperinum*), fire-moss (*Ceratodon purpureus*), ectomorphic reindeer lichen (*Cladina mitis*) and gray reindeer lichen (*Cladina rangiferina*).

Site Information

Elevation (masl)	515 - 518
Slope	0
Aspect	none
Slope Position	Level
Structural Stage	3, 4
Surficial Material	F, M
Drainage	r, w
Rooting Zone Particle Size	S, LS, FS
Seepage	none
Humus form	Mor, Mormoder, Rhizomull
SMR	2-3
SNR	B-C

Plot Numbers

IR251, IR252, IR253, IR254, IR259

Tree Layer (0 - 25)	Shrub Layer (15 - 50)	Herb Layer (30 - 65)	Moss Layer (25 - 45)
Pinus contorta	*Amelanchier alnifolia, Pinus contorta, Rosa acicularis, Salix scouleriana, Shepherdia canadensis*	*Achillea millefolium, Antennaria neglecta, Arctostaphylos uva-ursi, Fragaria virginiana, Galium boreale, Hieracium umbellatum, Piptatherum pungens, Vaccinium caespitosum*	*Ceratodon purpureus, Cladina mitis, Cladina rangiferina, Pleurozium schreberi, Polytrichum juniperinum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**05**	**SF**	**Hybrid white spruce - Spirea - Feathermoss (Sxw - Spirea - Feathermoss)**	**1.6**

Site Photo

Soil Pit Photo

Hybrid white spruce - Spirea - Feathermoss forests occur on somewhat dry and poor sites with sandy soils that are rapidly drained. The parent material is glaciofluvial.

In the study area these forests are relatively young and dominated by lodgepole pine (*Pinus contorta*), with some hybrid white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*) understory regeneration. The shrub layer contains soopolallie (*Shepherdia canadensis*), prickly rose (*Rosa acicularis*) and highbush-cranberry (*Viburnum edule*).

The herb layer is dominated by stiff clubmoss (*Lycopodium annotinum*), and also contains purple peavine (*Lathyrus nevadensis*), dwarf red raspberry (*Rubus pubescens*), American vetch (*Vicia americana*), wild sarsaparilla (*Aralia nudicaulis*) and bunchberry (*Cornus canadensis*).

The moss layer contains red-stemmed feathermoss (*Pleurozium schreberi*).

Site Information	
Elevation (masl)	522 - 525
Slope	0 – 1
Aspect	999
Slope Position	LV
Structural Stage	5
Surficial Material	FG
Drainage	r, w
Rooting Zone Particle Size	S
Seepage	none
Humus form	Mor, Moder
SMR	3
SNR	B

Plot Numbers

IR004, IR152

Tree Layer (10)	**Shrub Layer** (17)	**Herb Layer** (65)	**Moss Layer** (30)
Pinus contorta	*Shepherdia canadensis, Rosa acicularis, Picea glauca, Viburnum edule, Abies lasiocarpa*	*Lycopodium annotinum, Rubus pubescens, Vicia americana, Aralia nudicaulis, Cornus canadensis*	*Pleurozium schreberi*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**06**	**ST**	**Hybrid white spruce - Twinberry - Coltsfoot (Sxw - Twinberry - Coltsfoot)**	**234.2**

Site Photo

Soil Pit Photo

Hybrid white spruce - Twinberry - Coltsfoot occur on a range of parent materials with glaciofluvial and glaciolacustrine being the most common. These sites are usually level or slightly sloping, are moderately-well to well drained, have a mesic to moist moisture regime, and a medium to rich nutrient regime.

The tree canopy is composed of a mixture of hybrid white spruce (*Picea engelmannii x glauca*) and trembling aspen (*Populus tremuloides*) with some black cottonwood (*Populus trichocarpa*), paper birch (*Betula papyrifera*) and lodgepole pine (*Pinus contorta*).

The shrub layer is a mixture of black twinberry (*Lonicera involucrata*), thimbleberry (*Rubus parviflorus*), devil's club (*Oplopanax horridus*), Saskatoon (*Amelanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*), Sitka alder (*Alnus viridis*), prickly rose (*Rosa acicularis*), highbush-cranberry (*Viburnum edule*) and Scouler's willow (*Salix scouleriana*).

The herb layer contains oak fern (*Gymnocarpium dryopteris*), purple peavine (*Lathyrus nevadensis*), sarsaparilla (*Aralia nudicaulis*), clasping twistedstalk (*Streptopus amplexifolius*), baneberry (*Actaea rubra*) and western meadowrue (Thalictrum occidentale).

The moss layer contains red-stemmed feathermoss (*Pleurozium schreberi*), knight's plume (*Ptilium crista-castrensis*), electrified cats-tail moss (*Rhytidiadelphus triquetrus*), and woodsy ragged-moss (*Brachythecium hylotapetum*).

Plot Numbers (Cont'd):

PC09LRB, PC10LRB, PC11LRB, PC12LRB, PC43LRB, QA33

Site Information	
Elevation (masl)	525 - 718
Slope	0 - 12- 52
Aspect	None, Cool
Slope Position	**MD, LV,** LW, GU
Structural Stage	**5, 6**
Surficial Material	**FG, LG**, F, M, C
Drainage	**m**, w
Rooting Zone Particle Size	**FL, FC,** SS, CL
Seepage	None
Humus form	**Moder**, Mull, Mor
SMR	**4-**5
SNR	(C)-**D-**(E)

Plot Numbers

AD005, AD161, AD162, AD167, AD171, AD172, IR130, IR141, IR165, IR167, IR218, IR220, PC01TWB, PC02TWB, PC04TWB, PC43TWB, PC44TWB, PC45TWB, PC46LRB, PC48TWB, PC61TWB, PC62TWB, PG69TWB, PC78TWB,

Tree Layer (20 - 50)	**Shrub Layer** (18 - 90)	**Herb Layer** (10 - 70)	**Moss Layer** (0 - 95)
Populus tremuloides, Picea engelmannii x glauca, Populus trichocarpa, Populus trichocarpa, Betula papyrifera	*Abies lasiocarpa, Lonicera involucrata, Amelanchier alnifolia, Cornus stolonifera, Oplopanax horridus, Rosa acicularis, Viburnum edule, Shepherdia canadensis, Alnus viridis, Salix scouleriana*	*Gymnocarpium dyopteris, Lathyrus nevadensis, Aralia nudicaulis, Streptopus amplexifolius, Actaea rubra, Thalictrum occidentale, Petasites frigidus* var. *palmatus*	*Rhytidiadelphus triquetrus, Pleurozium schreberi, Ptilium crista-castrensis, Brachythecium hylotapetum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**07a / 07b**	**SH**	**Hybrid white spruce - Horsetail (Sxw - Horsetail) (freely-drained phase/poorly drained phase)**	**40.0 / 5.9**

Site Photo

Soil Pit Photo

Hybrid white spruce - **Horsetail** forests occur on moist to very moist, rich to very rich sites. These sites are level to gently sloping toe or lower slopes, that are often adjacent to small to larger creek. The parent materials are usually fluvial or glaciofluvial but can also be glaciolacustrine or organic. Water tables can be seasonally high and drainage imperfect to poor; trees often grow on mounds. Two phases of this site series are mapped: freely-drained (07a) and poorly-drained (07b).

The forest canopy is dominated by hybrid white spruce (*Picea engelmannii x glauca*) trees but may also contain black cottonwood (*Populus trichocarpa*), trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*) and lodgepole pine (*Pinus contorta*).

The shrub layer contains black twinberry (*Lonicera involucrata*), devil's club (*Oplopanax horridus*), red-osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*), high-bush cranberry (*Viburnum edule*), and alder (*Alnus* spp.).

The herb layer always contains horsetails, usually common horsetail (*Equisetum arvense*) but also meadow horsetail (*Equisetum pratense*). It may contain the ferns oak fern (*Gymnocarpium dryopteris*) and lady fern (*Athyrium filix-femina*), as well as palmate coltsfoot (*Petasites frigidus*), trailing raspberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), stinging nettle (*Urtica dioica*).

The moss layer may contain red-stemmed feathermoss (*Pleurozium schreberi*) and leafy mosses (*Mnium* spp.).

The poorly drained phase (07b) of this ecosystem is described as the Spruce - Common horsetail - Leafy mosses swamp wetland (Ws07) in Mackenzie and Moran (2004).

Site Information	
Elevation (masl)	541 - 684
Slope	0 - 3 - 5
Aspect	None, cool
Slope Position	**LV**, TO, LW
Structural Stage	3b, **5**, **6**
Surficial Material	**FG, F**, LG, O
Drainage	**I, p**
Rooting Zone Particle Size	**FC**
Seepage	none
Humus form	**Mor, Mull Moder**
SMR	**5-6**
SNR	(C)**-D-E**

Plot Numbers

AD170, IR128, IR145, IR146, IR147, IR149, IR174, PC47TWB, QA48

Tree Layer (5 - 45)	**Shrub Layer** (25 - 100)	**Herb Layer** (25 – 60)	**Moss Layer** (0 - 70)
Picea engelmannii x glauca, Populus trichocarpa, Populus trichocarpa, Populus tremuloides, Betula papyrifera	*Lonicera involucrata, Oplopanax horridus, Cornus stolonifera, Rosa acicularis, Viburnum edule, Alnus* spp.	*Equisetum arvense, Gymnocarpium dryopteris, Athyrium filix-femina, Equisetum pratense, Petasites frigidus, Rubus pubescens, Cornus canadensis, Urtica dioca*	*Pleurozium schreberi, Mnium* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**53**	**AM**	**Mountain alder - Mitrewort**	**11.8**

Site Photo

Soil Pit Photo

The **Mountain alder - Mitrewort** ecosystem occurs on rich sites with a mesic to subhygric moisture regimes that have a cool aspect but may be level.

This ecosystem has a canopy that can be deciduous or a mixture of deciduous and coniferous species, that includes black cottonwood (*Populus trichocarpa*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), hybrid white spruce (*Picea engelmannii x glauca*), and lodgepole pine (*Pinus contorta*).

The shrub layer usually has devil's club (*Oplopanax horridus*), thimbleberry, (*Rubus parviflorus*), high-bush cranberry (*Viburnum edule*), red-osier dogwood (*Cornus stolonifera*) and black twinberry (*Lonicera involucrata*).

The herb layer usually has false Solomon's seal (*Maianthemum racemosum*), purple peavine (*Lathyrus nevadensis*), common horsetail (*Equisetum arvense*) and rosy twistedstalk (*Streptopus lanceolatus*).

The moss layer is dominated by the feathermosses electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), red-stemmed feathermoss (*Pleurozium schreberi*), knight's plume (*Ptilium crista-castrensis*), and step moss (*Hylocomium splendens*).

Site Information	
Elevation (masl)	578 – 680
Slope	0 - 80
Aspect	**Cool**, None
Slope Position	**MD, LW**, LO, TO
Structural Stage	5, 6
Surficial Material	**M**, F
Drainage	**m**, w, i
Rooting Zone Particle Size	FL, CLS
Seepage	None
Humus form	Moder, Mull
SMR	(4)-**5**
SNR	(C)-**D**

Plot Numbers

AD108, IR125, IR126, IR132, IR169, QA39, QA41

Tree Layer (17 - 60)	**Shrub Layer** (35 - 90)	**Herb Layer** (20 - 68)	**Moss Layer** (4 - 6)
Betula papyrifera, Populus trichocarpa, Populus tremuloides, Picea engelmannii x glauca, Pinus contorta	*Oplopanax horridus, Lonicera involucrata, Cornus stolonifera, Rubus parviflorus, Viburnum edule*	*Equisetum arvense, Lathyrus nevadensis, Maianthemum racemosum, Streptopus lanceolatus*	*Rhytidiadelphus triquetrus, Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**81**	**SW**	**Saskatoon - Slender wheatgrass**	**1.1**

Site Photo

The **Saskatoon - Slender wheatgrass** ecological community is Red-listed and occurs on steep slopes across the Telkwa River from the proposed outfall. This site was not visited.

Site Information	
Elevation (masl)	
Slope	
Aspect	
Slope Position	
Structural Stage	
Surficial Material	
Drainage	
Rooting Zone Particle Size	
Seepage	
Humus form	
SMR	
SNR	

Plot Numbers

None

Tree Layer	Shrub Layer	Herb Layer	Moss Layer

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**82**	**BW**	**Bluegrass - Slender wheatgrass**	**0.5**

Site Photo

Soil Pit Photo

Bluegrass slender - wheatgrass grasslands are a red-listed ecological community. Haeussler (1998) mapped 5 occurrences of the Bluegrass slender - wheatgrass grasslands in the Bulkley TSA, including this one but indicated that these occurrences only marginally fit the description of the Bluegrass – Slender wheatgrass ecological community. Despite marginally fitting the classification, these grasslands are rare and should be treated as the Bluegrass - Slender wheatgrass ecosystem. This plant community was found near the Telkwa River close to Goathorn Creek.

There were no trees and the moderate shrub layer had a mixture of hybrid white spruce (*Picea engelmannii x glauca*), lodgepole pine (*Pinus contorta*), Prickly rose (*Roca acicularis*), saskatoon (*Amelanchier alnifolia*), soopolallie (*Shepherdia canadensis*), and snowberry (*Symphoricarpos albus*).

The herb layer was dominated by timber oatgrass (*Danthonia intermedia*), with strawberry (*Fragaria virginiana*), northern bedstraw (*Galium boreale*), Lindley's aster (*Symphyotrichum ciliolatum*), spreading needlegrass (*Achnatherum richardsonii), Yarrow (Achillea millefolium) and several other herbs*.

The moss layer had a mixture of red-stemmed feathermoss (*Pleurozium schreberi*), grey reindeer lichen (*Cladonia rangiferina*) and juniper haircap moss (*Polytrichum juniperinum*).

Site Information	
Elevation (masl)	569
Slope	0
Aspect	n/a
Slope Position	LV
Structural Stage	3a
Surficial Material	F
Drainage	r
Rooting Zone Particle Size	SS
Seepage	-
Humus form	ZL
SMR	2
SNR	B

Plot Numbers

AD182

Tree Layer (0)	Shrub Layer (25)	Herb Layer (40)	Moss Layer (25)
	Amelanchier alnifolia, Picea engelmannii x glauca, Pinus contorta, Roca acicularis, Shepherdia canadensis, Symphoricarpos albus	*Achillea millefolium), Achnatherum richardsonii, Danthonia intermedia, Fragaria virginiana, Galium boreale, Symphyotrichum ciliolatum*	*Cladonia rangiferina, Pleurozium schreberi, Polytrichum juniperinum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**Atcv**	**Atcv**	**Trembling aspen - Canada violet ($At - Canada violet seral association)**	**1.1 / 133.0**

Site Photo

Soil Pit Photo

Trembling aspen – Canada violet ecosystems occur on rich sites with a mesic to subhygric moisture regime. They are level to moderately steep slopes. Soils are silty loam to sandy loam Orthic Eutric Brunisols or Orthic Melanic Brunisols. Some sites are grazed and contain agronomic grasses.

The canopy of this ecosystem is dominated by trembling aspen (*Populus tremuloides*) but may also have a significant component of black cottonwood (*Populus trichocarpa*) or paper birch (*Betula papyrifera*). Minor amounts of hybrid white spruce (*Picea engelmannii x glauca*), lodgepole pine (*Pinus contorta*) and subalpine fir (Abies lasiocarpa) may occur in the tree and shrub layers.

The shrub layer can also contain thimbleberry (*Rubus parviflorus*), black twinberry (*Lonicera involucrata*), red-osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*), highbush-cranberry (*Viburnum edule*), red raspberry (*Rubus idaeus*), saskatoon (*Amelanchier alnifolia*), MacKenzie willow (*Salix prolixa*) and soopolallie (*Shepherdia canadensis*).

The herb layer can contain a wide variety of species including purple peavine (*Lathyrus nevadensis*), blue wildrye (*Elymus glaucus*), Canada violet (*Viola canadensis*), showy aster (*Eurybia conspicua*), Canada goldenrod (*Solidago canadensis*), American vetch (*Vicia americana*), purple sweet-cicely (*Osmorhiza purpurea*), Sarsaparilla (*Aralia nudicaulis*) and Lindley's aster (*Symphyotrichum ciliolatum*).

The sparse moss layer contains ragged moss (*Brachythecium* spp.*)*.

Site Information	
Elevation (masl)	524 – 759
Slope	0 - 24 - 65
Aspect	**None, Cool,** Warm
Slope Position	**LW, MD,** LV, UP
Structural Stage	**5**, 6, 3a
Surficial Material	**FG, F**, C, D, M
Drainage	**w**, m
Rooting Zone Particle Size	**CL**, S, FSI, CLS
Seepage	none
Humus form	**Moder, Mull**, Mor
SMR	(3)-**4-5**
SNR	**D**

Plot Numbers

12-8535, 12-8537, AD113, AD114, AD115, AD118, IR131, IR207, IR214, IR216, PC35LRB, QA29, QA40

Tree Layer (0 - 65)	**Shrub Layer** (5 - 80)	**Herb Layer** (20 - 100)	**Moss Layer** (0 - 6)
Populus tremuloides, Populus trichocarpa, Betula papyrifera, Picea engelmannii x glauca, Pinus contorta	*Cornus stolonifera, Lonicera involucrata, Rosa acicularis, Viburnum edule, Rubus parviflorus, Rubus idaeus, Amelanchier alnifolia, Salix prolixa, Picea glauca, Pinus contorta*	*Lathyrus nevadensis, Elymus glaucus, Viola canadensis, Solidago canadensis, Vicia americana, Osmorhiza purpurea, Aralia nudicaulis, Eurybia conspicua, Symphyotrichum ciliolatum*	*Brachythecium* spp.*, Pleurozium schreberi*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**Atha**	**Atha**	**Trembling aspen - Hardhack ($At - Hardhack seral association)**	**27.1 / 9.4**

Site Photo

Soil Pit Photo

Trembling aspen - Hardhack occurs on level to slightly sloping sites in gullies or depressions that may have a high water table in spring but dry-out over the summer. The soils tend to be finer textured and not as well-drained as more productive sites. The parent materials are usually glaciolacustrine or fluvial over glaciolacustrine. A root restriction due to water or hardpan may be present. Most of the site visited have been harvested.

Trembling aspen (*Populus tremuloides*) or black cottonwood (*Populus trichocarpa*) dominate these sites though lodgepole pine (*Pinus contorta*) or hybrid white spruce (*Picea engelmannii x glauca*) are also often present.

Hardhack (*Spiraea douglasii*) forms a dense shrub layer with black twinberry (*Lonicera involucrate*), willows (*Salix* spp.), highbush-cranberry (*Viburnum edule*), prickly rose (*Rosa acicularis*) and alder (*Alnus* spp.) also prominent.

The herb layer can contain a variety of species including bluejoint reedgrass (*Calamagrostis canadensis*), common horsetail (*Equisetum arvense),* fowl bluegrass (*Poa palustris*), oak fern (*Gymnocarpium dryopteris*), lady fern (*Athyrium filix-femina*), sedges (*Carex* spp.), northern bedstraw (*Galium boreale*), and heart-leaved arnica (*Arnica cordifolia*).

The moss layer may contain leafy mosses (*Mnium* spp.), peat moss (*Sphagnum* spp.), golden fuzzy fen moss (*Tomentypnum nitens*), yellow star-moss (*Herzogiella adscendens*) and golden ragged moss (*Brachythecium salebrosum*)

Site Information

Elevation (masl)	562 - 793
Slope	0 - 1 - 5
Aspect	**None**, Cool
Slope Position	**LV, DP**, GU, MD
Structural Stage	**3**, 4, 5
Surficial Material	**F**, LG, FG
Drainage	**I, p**, m
Rooting Zone Particle Size	FL, FC, FSI, CSI
Seepage	**None**, 16 - 29
Humus form	**Moder**, Mull, Mor
SMR	(3), **5-6**
SNR	**C-D**

Plot Numbers

AD132, AD139, AD140, AD142, AD145, AD166, IR105, IR123, QA21, QA26, QA28

Tree Layer (0 - 10)	Shrub Layer (70 - 100)	Herb Layer (4 - 35)	Moss Layer (0 - 30)
Populus tremuloides, Populus trichocarpa, Picea engelmannii x glauca, Pinus contorta	*Spiraea douglasii, Viburnum edule, Lonicera involucrata, Salix scouleriana, Salix planifolia, Alnus incana, Alnus viridis, Rosa acicularis*	*Calamagrostis canadensis, Galium boreale, Arnica cordifolia, Equisetum arvense, Gymnocarpium dryopteris, Athyrium filix-femina, Carex canescens, Carex utriculata, Arnica cordifolia*	*Aulacomnium palustre , Tomentypnum nitens, Sphagnum* spp.*, Herzogiella adscendens, Brachythecium salebrosum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Atki**	**Atki**	**Trembling aspen - Kinnikinnick ($At - Kinnikinnick seral association)**	**0.9**

Site Photo

Soil Pit Photo

The **Trembling aspen - Kinnikinnick** ecosystem is rare in the study area, being mapped in only one location. This location had a canopy of lodgepole pine (*Pinus contorta*) with trembling aspen (*Populus tremuloides*) in the canopy and the shrub layer. Also in the shrub layer were soopolallie (*Shepherdia canadensis*), common juniper (*Juniperus communis*) and prickly rose (Rosa acicularis).

The herb layer was dominated by kinnikinnick (*Arctostaphylos uva-ursi*), and arnica (*Arnica cordifolia*) but also contained yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), Indian paintbrush (*Castilleja 25iniate*) and American vetch (*Vicia americana*).

Site Information	
Elevation (masl)	516
Slope	2
Aspect	None
Slope Position	LW
Structural Stage	4
Surficial Material	FG
Drainage	r
Rooting Zone Particle Size	
Seepage	
Humus form	Mor
SMR	2
SNR	B

Plot Numbers

QA52

Tree Layer (12)	**Shrub Layer** (28)	**Herb Layer** (23)	**Moss Layer**
Pinus contorta, Populus tremuloides	*Juniperus communis, Populus tremuloides, Shepherdia canadensis*	*Achillea millefolium), Arctostaphylos uva-ursi, Arnica cordifolia, Castilleja miniate, Vicia americana*	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Atlf**	**Atlf**	**Trembling aspen - Lady fern ($At - Lady fern seral association)**	**2.5**

Site Photo

Soil Pit Photo

The **Trembling aspen - Lady fern** ecosystem was found in two locations in the project area. One was in a slight depression in an abandoned back channel of the Bulkley River, and the other in a more active backchannel of the Telkwa River. These rich sites have a high water table in the spring with some standing water.

The tree layer is dominated by black cottonwood (*Populus trichocarpa*) or paper birch (*Betula papyrifera*), with some trembling aspen (*Populus tremuloides*) and hybrid white spruce (*Picea engelmannii x glauca*).

Red-osier dogwood (*Cornus stolonifera*), mountain alder (Alnus tenuifolia) or black twinberry (*Lonicera involucrata*), dominate the shrub layer that may also contain prickly rose (*Rosa acicularis*), soopolallie (*Shepherdia canadensis*) and black gooseberry (*Ribes lacustre*).

The herb layer has abundant meadow horsetail (*Equisetum pratense*) and common horsetail (*Equisetum arvense*), and also contains lady fern (*Athyrium filix-femina*), bluejoint reedgrass (*Calamagrostis canadensis*), trailing raspberry (*Rubus pubescens*), common miterwort (*Mitella nuda*), arrow-leaved coltsfoot (*Petasites frigidus* var. *sagittatus*) and Lindley's aster (*Symphyotrichum ciliolatum*).

The moss layer is dominated by leafy mosses (*Mnium* spp.) with some red-stemmed feathermoss (*Pleurozium schreberi*).

Site Information	
Elevation (masl)	549, 569
Slope	0
Aspect	None
Slope Position	DP, GU
Structural Stage	5, 6
Surficial Material	F
Drainage	I, p
Rooting Zone Particle Size	SI
Seepage	60
Humus form	-
SMR	5
SNR	D-E

Plot Numbers

AD178, AD181

Tree Layer (20 - 25)	**Shrub Layer** (55 - 65)	**Herb Layer** (30 - 85)	**Moss Layer** (1 - 50)
Populus trichocarpa, Populus tremuloides, Picea engelmannii x glauca, Betula papyrifera	*Alnus tenuifolia, Cornus stolonifera, Lonicera involucrata, Rosa acicularis, Shepherdia canadensis, Ribes lacustre, Rubus idaeus, Rubus parviflorus*	*Athyrium filix-femina, Equisetum pretense, Equisetum arvense, Calamagrostis canadensis, Heracleum maximum, Rubus pubescens, Mitella nuda, Petasites frigidus* var. *sagittatus, Symphyotrichum ciliolatum*	*Mnium* spp., *Pleurozium schreberi*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Atpw**	**Atpw**	**Trembling aspen - Pink wintergreen ($At - Pink wintergreen seral association)**	**107.5**

Site Photo

Soil Pit Photo

Trembling aspen - Pink wintergreen forests are fairly common near the Telkwa River and Goathorn Creek in the study area on mesic or submesic sites with a medium nutrient regime. These sites are usually mid-slope with soils that are well or moderately-well drained.

The tree canopy is dominated by trembling aspen (*Populus tremuloides*) often with a component of paper birch (*Betula papyrifera*) and hybrid white spruce (*Picea engelmannii x glauca*), and possibly black cottonwood (*Populus trichocarpa*), sub-alpine fir (*Abies lasiocarpa*), Scouler's willow (*Salix scouleriana*) or lodgepole pine (*Pinus contorta*).

The shrub layer contains highbush-cranberry (*Viburnum edule*), thimbleberry (*Rubus parviflorus*), red-osier dogwood (*Cornus stolonifera*), black twinberry (*Lonicera involucrata*), prickly rose (*Rosa acicularis*), Douglas maple (*Acer glabrum* var. *douglasii*), common snowberry (*Symphoricarpos albus*), saskatoon (*Amelanchier alnifolia*) and Scouler's willow (*Salix scouleriana*).

The herb layer contains a wide variety of species including sarsaparilla (Aralia nudicaulis), false Solomon's seal (*Maianthemum racemosum*), purple peavine (*Lathyrus nevadensis*), fireweed (*Epilobium angustifolium*), Queen's cup (*Clintonia uniflora*), showy aster (*Eurybia conspicua*), blue wildrye (*Elymus glaucus*), western meadowrue (*Thalictrum occidentale*) and mountain sweet-cicely (*Osmorhiza berteroi*).

The moss layer can contain ragged moss (*Brachythecium* spp.), knight's plume (*Ptilium crista-castrensis*) and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*).

Site Information	
Elevation (masl)	553 - 730
Slope	0 - 22 - 70
Aspect	**None, cool**
Slope Position	**MD**, LV, UP
Structural Stage	4, **5, 6**
Surficial Material	**FG, LG, M**, C
Drainage	**w, m**, r
Rooting Zone Particle Size	**FL, S, CLS**
Seepage	none
Humus form	**Moder**, Mor, Mull
SMR	(3)-**4**
SNR	(B)-**C**

Plot Numbers

AD107, AD112, AD160, AD165, IR201, IR212, IR213, IR219, QA34, QA38, QA42. QA43, QA53

Tree Layer (20 - 60)	**Shrub Layer** (20 - 95)	**Herb Layer** (20 - 70)	**Moss Layer** (0 - 6)
Populus tremuloides, Betula papyrifera, Picea engelmannii x glauca, Populus trichocarpa, Salix scouleriana, Abies lasiocarpa, Pinus contorta	*Viburnum edule, Rubus parviflorus, Cornus stolonifera, Rosa acicularis, Symphoricarpos albus, Amelanchier alnifolia, Acer glabrum var. douglasii, Salix scouleriana,*	*Aralia nudicaulis, Eurybia conspicua, Lathyrus nevadensis, Maianthemum racemosum, Elymus glaucus, Thalictrum occidentale, Osmorhiza berteroi, Epilobium angustifolium, Clintonia uniflora*	*Brachythecium* spp., *Rhytidiadelphus triquetrus, Ptilium crista-castrensis*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Atss**	**Atss**	**Trembling aspen - Saskatoon - Snowberry ($At - Saskatoon - Snowberry seral association)**	**17.4**

Site Photo

Soil Pit Photo

Trembling aspen - Saskatoon - Snowberry forests are uncommon in the study area. They occur on rapidly to well drained sites with a variety of parent materials. These sites have sandy soils or silty loam soils that have sandier soils at depth.

These forests have a trembling aspen (*Populus tremuloides*) canopy that may have some hybrid white spruce (*Picea engelmannii x glauca*), lodgepole pine (*Pinus contorta*) or black cottonwood (*Populus trichocarpa*).

Saskatoon (*Amelanchier alnifolia*), soopolallie (*Shepherdia canadensis*), and prickly rose (*Rosa acicularis*) are dominant in the shrub layer that also may contain common snowberry (*Symphoricarpos albus*), red-osier dogwood (Cornus stolonifera) and common juniper (*Juniperus communis*).

The herb layer contains Kentucky bluegrass (*Poa pratensis*), northern bedstraw (*Galium boreale*), creamy peavine (*Lathyrus ochroleucus*), purple peavine (*Lathyrus nevadensis*), showy aster (*Eurybia conspicua*), spreading needlegrass (*Achnatherum richardsonii*), bunchberry (*Cornus canadensis*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), veiny meadowrue (*Thalictrum venulosum*) and blunt-fruited sweet-cicely (*Osmorhiza 28epauperate*).

The moss layer may contain lesser tamarisk moss (*Thuidium recognitum*) and golden ragged-moss (*Brachythecium salebrosum*).

Site Information	
Elevation (masl)	516 - 675
Slope	0 - 20 - 57
Aspect	**SW**, None
Slope Position	**LV, UP, LW**
Structural Stage	**4, 5**
Surficial Material	**LG, FG, C**
Drainage	r, w
Rooting Zone Particle Size	**FL**
Seepage	None
Humus form	**Mull, Moder, Mor**
SMR	**2-4**
SNR	**B-C**

Plot Numbers

IR221, 09-779, QA36, QA52

Tree Layer (12 - 40)	**Shrub Layer** (50 - 65)	**Herb Layer** (40 - 80)	**Moss Layer** (0 - 2)
Populus tremuloides, Picea engelmannii x glauca, Populus trichocarpa, Pinus contorta	*Symphoricarpos albus, Amelanchier alnifolia, Shepherdia canadensis, Rosa acicularis, Cornus stolonifera, Juniperus communis*	*Poa pratensis, Lathyrus ochroleucus., Lathyrus nevadensis, Eurybia conspicua, Achnatherum richardsonii, Cornus canadensis, Galium boreale, Petasites frigidus* var. *palmatus, Thalictrum venulosum, Osmorhiza depauperata*	*Thuidium recognitum, Brachythecium salebrosum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**CA**	**CA**	**Cow parsnip - Large-leaved avens**	**3.8**

Site Photo

Soil Pit Photo

Cow parsnip - Large-leaved avens ecosystems are uncommon in the study area. They occur on moderately well drained fluvial deposits with a with very rich soils. These sites have sandy loam soils.

They can have scattered cottonwood (*Populus trichocarpa*) and hybrid white spruce trees (*Picea engelmannii x glauca)*, but have dense shrub and herb layers.

The shrub layer is dominated by red raspberry (*Rubus idaeus*) and thimbleberry (*Rubus parviflorus*), with some black twinberry (*Lonicera involucrata*), prickly rose (*Rosa acicularis*) and red elderberry (*Sambucus racemosa*).

The herb layer is dominated by cow parsnip (*Heracleum maximum*), with Canada violet (*Viola canadensis*), stinging nettle (*Urtica dioica*), common horsetail *(Equisetum arvense*), western meadorue (*Thalictrum occidentale*), bluejoint reedgrass (*Calamagrostis canadensis*) and false Solomon's seal (*Maianthemum racemosum*). The moss layer is absent.

Site Information	
Elevation (masl)	564
Slope	0
Aspect	0
Slope Position	LV
Structural Stage	3a
Surficial Material	F
Drainage	mw
Rooting Zone Particle Size	SL
Seepage	-
Humus form	mormoder
SMR	5
SNR	E

Plot Numbers

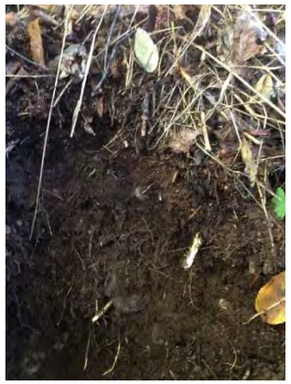
AD189

Tree Layer (2)	Shrub Layer (85)	Herb Layer (70)	Moss Layer (-)
Picea engelmannii x glauca, Populus trichocarpa	*Rosa acicularis, Lonicera involucrata, Rubus idaeus, Rubus parviflorus, Sambucus racemosa*	*Calamagrostis canadensis, Equisetum arvense, Heracleum maximum, Maianthemum racemosum, Thalictrum occidentale, Urtica dioica, Viola canadensis*	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Epdm**	**Epdm**	**Paper birch - Douglas maple ($Ep - Douglas maple seral association)**	**11.3**

Site Photo

Soil Pit Photo



Paper birch - Douglas maple ecosystems usually occur on the upper portions of moderate to steep, rapidly to well drained slopes with a high coarse fragment content with a cool aspect.

Paper birch (*Betula papyrifera*) forms the canopy of these ecosystems that may have some hybrid white spruce (*Picea engelmannii x glauca*), trembling aspen (*Populus tremuloides*) and lodgepole pine (*Pinus contorta*).

The tall shrub layer contains Douglas maple (*Acer glabrum* var. *douglasii*), with red-osier dogwood (*Cornus stolonifera*), highbush-cranberry (*Viburnum edule*), thimbleberry (*Rubus parviflorus*), common snowberry (*Symphoricarpos albus*) and black gooseberry (*Ribes lacustre*) in the low shrub layer.

The herb layer contains wild sarsaparilla (*Aralia nudicaulis*), false Solomon's seal (*Maianthemum racemosum*), purple peavine (*Lathyrus nevadensis*), showy aster (*Eurybia conspicua*), blue wildrye (*Elymus glaucus*), creamy peavine (*Lathyrus ochroleucus*), trailing raspberry (*Rubus pubescens*) and mountain sweet-cicely (*Osmorhiza berteroi*).

The moss layer may contain red-stemmed feathermoss (*Pleurozium schreberi*), ragged moss (*Brachythecium* spp.), electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) and knight's plume (*Ptilium crista-castrensis*).

Site Information	
Elevation (masl)	569 - 653
Slope	40 - 60 - 75
Aspect	**Cool**
Slope Position	**UP**, LW
Structural Stage	**5**, 4
Surficial Material	**C**, FG, D
Drainage	**r, w**
Rooting Zone Particle Size	**SS, CLS, F**
Seepage	none
Humus form	**Moder, Mor**
SMR	**2-3**
SNR	(A-B)-**D**

Plot Numbers

AD106, IR134, IR138, IR202, QA49

Tree Layer (22 - 55)	**Shrub Layer** (20 - 33)	**Herb Layer** (20 - 52)	**Moss Layer** (1 - 5)
Betula papyrifera, Picea engelmannii x glauca, Populus tremuloides, Pinus contorta	*Acer glabrum* var. *douglasii, Cornus stolonifera, Rubus parviflorus, Symphoricarpos albus, Viburnum edule, Ribes lacustre*	*Aralia nudicaulis, Elymus glaucus, Maianthemum racemosum, Lathyrus nevadensis, Eurybia conspicua, Lathyrus ochroleucus, Osmorhiza berteroi, Rubus pubescens,*	*Brachythecium* sp., *Ptilium crista-castrensis, Pleurozium schreberi, Rhytidiadelphus triquetrus*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**FI01**	**FI01**	**Mountain alder - Common horsetail**	**4.4 / 17.7**

Site Photo

Mountain alder - Common horsetail sites occur along high gradient streams in the study area. They are flooded annually and may have a flashy flooding regime, responding to weather events. The substrate is cobbles and gravels.

There are no trees or mosses and the shrub layer is dominated by mountain alder (*Alnus incana*) and may contain black cottonwood (*Populus trichocarpa*). The herb layer may contain broad-leaved willowherb (*Epilobium latifolium*), common horsetail (*Equisetum arvense*), bluejoint reedgrass (*Calamagrostis canadensis*), oak fern (*Gymnocarpium dryopteris*) and cow parsnip (*Heracleum maximum*). Mosses are usually absent.

Site Information

Elevation (masl)	553 - 880
Slope	0 - 5
Aspect	**None**
Slope Position	**GU, LV**
Structural Stage	**3a, 3b**
Surficial Material	**F**
Drainage	**m, i**
Rooting Zone Particle Size	**CL**
Seepage	**none**
Humus form	**none**
SMR	**5-6**
SNR	**B-D**

Plot Numbers

AD019, AD125, AD184, QA44

Tree Layer (0)	Shrub Layer (30 - 65)	Herb Layer (8 - 25)	Moss Layer (0)
	Alnus incana, Populus trichocarpa	*Calamagrostis canadensis, Epilobium latifolium, Equisetum arvense, Gymnocarpium dryopteris, Heracleum maximum*	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Fm02 (08)**	**Fm02 (08)**	**Black cottonwood - Hybrid white spruce / Red-osier dogwood (Act - Sxw - Red-osier dogwood) (Black cottonwood - Dogwood - Prickly rose (Act - Dogwood - Prickly rose))**	**87.1**

Site Photo

Soil Pit Photo

Black cottonwood - Dogwood - Prickly rose floodplain forests are a Red-listed ecosystem that occurs along the Bulkley and Telkwa Rivers, and lower Goathorn Creek. They are occasionally flooded, and show multiple layers in the soil profile from repeated sediment deposition. The soils are Cumulic Regosols with a sandy loam or sandy texture.

These forests have a canopy of black cottonwood (*Populus trichocarpa*) and hybrid white spruce (*Picea engelmannii x glauca*) over a shrub layer of mountain alder (*Alnus incana*), black twinberry (*Lonicera involucrata*), red-osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*), devils' club (*Oplopanax horridus*), highbush-cranberry (*Viburnum edule*) and thimbleberry (*Rubus parviflorus*)

The herb layer contains common horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), oak fern (*Gymnocarpium dryopteris*), clasping twisted stalk (*Streptopus amplexifolius*), false Solomon's seal (Maianthemum racemosum), bluejoint reedgrass (*Calamagrostis canadensis*) and Lindley's aster (*Symphyotrichum ciliolatum*).

The moss layer can absent because of frequent soil deposit but may contain red-stemmed feathermoss (*Pleurozium schreberi*), ragged mosses (*Brachythecium* spp.), leafy mosses (*Mnium* spp.) or knight's plume (*Ptilium crista-castrensis*).

This ecosystem is described as the Cottonwood - Spruce - Red osier dogwood middle bench floodplain ecosystem (Fm02) in Mackenzie and Moran (2004) and is identified as the Black cottonwood - Hybrid white spruce / Red-osier dogwood floodplain (Fm02) ecosystem by the BC CDC (2020).

Site Information

Elevation (masl)	525 - 688
Slope	0 - 2
Aspect	None
Slope Position	LV
Structural Stage	**6**, 5
Surficial Material	**F**
Drainage	**w, m**, i
Rooting Zone Particle Size	**CL**
Seepage	none
Humus form	**Mull**, Moder
SMR	**5**
SNR	**D**

Plot Numbers

AD008, AD109, AD110, AD111, AD119, AD183, IR161, QA31, QA32, QA35

Tree Layer (18 - 45)	Shrub Layer (30 - 100)	Herb Layer (6 - 80)	Moss Layer (0 - 4)
Populus trichocarpa, Picea engelmannii x glauca	*Cornus stolonifera, Rosa acicularis, Viburnum edule, Alnus incana, Amelanchier alnifolia, Lonicera involucrata, Oplopanax horridus, Rubus parviflorus*	*Equisetum arvense, Symphyotrichum ciliolatum, Heracleum maximum, Gymnocarpium dryopteris. Maianthemum racemosum, Streptopus amplexifolius*	*Pleurozium schreberi, Brachythecium* spp., *Mnium* spp. *Ptilium crista-castrensis*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**Wb01**	**Wb01**	**Black spruce - Creeping snowberry - Peat-moss**	**2.8**

Site Photo

Soil Pit Photo

Black spruce - Creeping snowberry – Peat-moss bogs are a blue-listed ecosystem that are uncommon in the study area. They occur in depressions that are very poorly drained. The peat is wet with a poor nutrient regime. The peat is poorly decomposed.

Scattered and stunted black spruce (*Picea mariana*) and lodgepole pine (*Pinus contorta*) may make into the tree layer.

The shrub layer always contains green alder (*Alnus viridis*), Labrador tea (*Rhododendron groenlandicum*) and black twinberry (*Lonicera involucrata*), and may contain dwarf birch (*Betula glandulosa*), prickly rose (*Rosa acicularis*), hardhack (*Spirea douglasii*) and a variety of willows (*Salix* spp.).

The herb layer always contains crowberry (*Empetrum nigrum*), bog cranberry (*Vaccinium microcarpum*) and bunchberry (*Cornus canadensis*), but also may have twinflower (*Linnaea borealis*), creeping-snowberry (*Gaultheria hispidula*) and a variety of sedge species such as hare sedge (*Carex ovalis*), soft-leaved sedge (*C. disperma*), sparse-flowered sedge (*C. tenuiflora*) and water sedge (*C. aquatilis*).

The moss layer is usually dominated by peat-mosses (*Sphagnum* spp.) but may have a significant component of red-stemmed feathermoss (*Pleurozium schreberi*).

Site Information	
Elevation (masl)	805 - 854
Slope	0
Aspect	**None**
Slope Position	**DP**
Structural Stage	**3b, 6, 7a**
Surficial Material	**O**
Drainage	**vp**
Rooting Zone Particle Size	**mesic**
Seepage	**20**
Humus form	**-**
SMR	**7**
SNR	**B**

Plot Numbers

14-3909, AD049, AD058, AD101

Tree Layer (0 - 8)	**Shrub Layer** (45 - 65)	**Herb Layer** (20 - 40)	**Moss Layer** (60 - 90)
Picea mariana, Pinus contorta	*Alnus viridis, Rhododendron groenlandicum, Lonicera involucrata, Betula glandulosa, Rosa acicularis, Spirea douglasii, Salix* spp.	*Empetrum nigrum, Cornus canadensis, Linnaea borealis, Vaccinium microcarpum, Gaultheria hispidula, Carex ovalis, C. disperma, C. tenuiflora, C. aquatilis*	*Sphagnum capillifolium , Sphagnum girgensohnii, Pleurozium schreberi*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**Wb05**	**Wb05**	**Black spruce - Water sedge - Peat-moss**	**9.2**

Site Photo

Soil Pit Photo

Black spruce - Water sedge - Peat-moss bogs are uncommon in the study area, occurring in higher elevation depressions. The peat is poorly decomposed and contains much wood. The surface is slightly hummocked.

The tree and tall shrub layer contain scattered stunted black spruce (*Picea mariana*) and hybrid white spruce (*Picea engelmannii x glauca*) and may have some lodgepole pine (*Pinus contorta*). The shrub layer also contains mountain alder (*Alnus incana*), hardhack (*Spiraea douglasii*), dwarf birch (*Betula glandulosa*), black twinberry (*Lonicera involucrata*), Labrador tea (*Rhododendron groenlandicum*) and bilberry willow (*Salix myrtillifolia*).

The herb layer contains a variety of sedges including soft-leaved sedge (*Carex disperma*), Ross's sedge (*Carex rossii*), beaked sedge (*Carex utriculata*), hairlike sedge (*Carex capillaris*), bristle-stalked sedge (*Carex leptalea*), inland sedge (*Carex interior*), and Chamisso's cotton-grass (*Eriophorum chamissonis*). Other species includes common horsetail (*Equisetum arvense*), bluejoint reedgrass (*Calamagrostis canadensis*), crowberry (*Empetrum nigrum*) and fireweed (*Epilobium angustifolium*).

The moss layer is dominated by peat-mosses, including poor-fen peat-moss (*Sphagnum angustifolium*) and common red peat-moss (*Sphagnum capillifolium*), with golden fuzzy fen moss (*Tomentypnum nitens*) and glow moss (*Aulacomnium palustre*) also prominent.

Site Information	
Elevation (masl)	834 - 956
Slope	0
Aspect	**None**
Slope Position	**DP**
Structural Stage	**3a**
Surficial Material	**O**
Drainage	**v, p**
Rooting Zone Particle Size	**Fibric**
Seepage	**20 - 34**
Humus form	**-**
SMR	**7**
SNR	**B-C**

Plot Numbers

AD085, IR119, PC19LRB, QA07

Tree Layer (4 - 32)	Shrub Layer (35 - 85)	Herb Layer (10 - 60)	Moss Layer (60 - 90)
Picea mariana, Picea engelmannii x glauca, Pinus contorta	*Alnus incana, Spiraea douglasii, Betula glandulosa, Lonicera involucrata, Rhododendron groenlandicum, Salix myrtillifolia,*	*Carex disperma, Carex rossii, Carex utriculata, Carex interior, Carex leptalea, Eriophorum chamissonis, Carex capillaris, Equisetum arvense, Calamagrostis canadensis, Rubus arcticus, Empetrum nigrum, Epilobium angustifolium*	*Sphagnum angustifolium. Sphagnum capillifolium, Tomentypnum nitens, Aulacomnium palustre*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2	**Wf01**	**Wf01**	**Water sedge - Beaked sedge**	**1.6**

Site Photo

Water sedge - Beaked sedge fens are uncommon in the study area, occurring in two adjacent palustrine basins in the upper parts of the SBSmc2. The soils have an organic veneer over glaciolacustrine or morainal materials. These sites are annually inundated by shallow waters and that experience some late-season drawdown.

Marsh cinquefoil (*Comarum paustre*) is prominent on these sites with water sedge (*Carex aquatilis)* and swamp horsetail (*Equisetum fluviatile*) having high cover.

Site Information

Elevation (masl)	1070
Slope	0
Aspect	999
Slope Position	DP
Structural Stage	2b
Surficial Material	Organic
Drainage	v
Rooting Zone Particle Size	-
Seepage	18
Humus form	-
SMR	8
SNR	D

Plot Numbers

WF12

Tree Layer	Shrub Layer	Herb Layer	Moss Layer
		Comarum palustre, Carex aquatilis, Equisetum fluviatile, Utricularia spp.	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Wm01**	**Wm01**	**Beaked sedge - Water sedge**	**2.1**

Site Photo

Beaked sedge - Water sedge marshes are uncommon in the study area occurring in several small depressions and beside Goathorn Creek.

Beaked sedge (*Carex utriculata*) and water sedge (*Carex aquatilis*) dominate the sites; wild calla (*Calla palustris*) can also be abundant. Other herbaceous species includes lesser bladder sedge (*C. vesicaris*), common spike rush (*Eleocharis paulstris*), bluejoint reedgrass (*Calamagrostis canadensis*) and northern mannagrass (*Glyceria borealis*).

They have scattered black twinberry (*Lonicera involucrata*) and Pacific willow (*Salix lucida*) shrubs. Small open water areas may contain cattail (*Tyhpa latifolia*), ribbon-leaved pondweed (*Potamogeton epihydrus*), floating bur-reed (*Sparganium natans*) and swamp horsetail (*Equisetum fluvitile*).

Site Information

Elevation (masl)	515 - 518
Slope	0
Aspect	**999**
Slope Position	**Depression**
Structural Stage	**2b**
Surficial Material	**-**
Drainage	**Very poor**
Rooting Zone Particle Size	**-**
Seepage	**Surface**
Humus form	**n/a**
SMR	**6-8**
SNR	**B-C**

Plot Numbers

AD105, AD180, IR163, IR168

Tree Layer (0 - 1)	Shrub Layer (1 - 4)	Herb Layer (90 - 95)	Moss Layer (0 - 60)
	Salix lucida, Lonicera involucrata	*Calla palustris, Carex utriculata, C. vesicaris, Eleocharis paulstris, Calamagrostis canadensis, Glyceria borealis, Tyhpa latifolia, Potamogeton epihydrus, Sparganium natans, Equisetum fluvitile*	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**Wm02**	**Wm02**	**Swamp horsetail - Beaked sedge**	**0.4 / 3.9**

Site Photo

Swamp horsetail - Beaked sedge marshes are uncommon in the study area. They occur in wet depression with standing water.

There have scattered hybrid white spruce (*Picea engelmannii x glauca*) and red-osier dogwood (*Cornus stolonifera*) with swamp horsetail (*Equisetum fluvitile*), Douglas' water-hemlock (*Cicuta douglasii*), bluejoint reedgrass (*Calamagrostis canadensis*), wild calla (*Calla palustris*), trailing raspberry (*Rubus pubescens*) and oak fern (*Gymnocarpium dryopteris*) dominating the site. Ragged mosses (*Brachythecium* spp.) can be common in the moss layer.

Site Information	
Elevation (masl)	569 - 572
Slope	0
Aspect	None
Slope Position	DP
Structural Stage	2a
Surficial Material	L
Drainage	Aqueous, subaqueous
Rooting Zone Particle Size	n/a
Seepage	-15 - -8
Humus form	n/a
SMR	8
SNR	C

Plot Numbers

WF04, WF05

Tree Layer (40)	**Shrub Layer** (10 - 15)	**Herb Layer** (8 - 60)	**Moss Layer** (10 - 25)
Picea engelmannii x glauca	*Cornus stolonifera*	*Calamagrostis canadensis, Equisetum fluvitile, Cicuta douglasii, Calla palustris, Rubus pubescens, Gymnocarpium dryopteris*	*Brachythecium* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Wm05**	**Wm05**	**Cattail**	**0.6**

Site Photo

Cattail marshes are uncommon in the study area, occurring in depressions with standing water.

The shrubs or stunted trees that may be present include pink spirea (*Spiraea douglasii),* black twinberry (*Lonicera involucrate),* hybrid white spruce *(Picea engelmannii x glauca*) and prickly rose *(Rosa acicularis).*

The small open water areas contain cattail (*Typha latifolia*), wild calla (*Calla palustris*), beaked sedge (*Carex utriculata*), bluejoint reedgrass (*Calamagrostis canadensis*), (*Comarum palustre*), Douglas' water-hemlock (*Cicuta douglasii*), common horsetail (*Equisetum arvense*) and green sedge (*Carex viridula*).

Site Information

Elevation (masl)	559 - 572
Slope	0
Aspect	None
Slope Position	DP
Structural Stage	2b, 2c
Surficial Material	n/a
Drainage	Aqueous, subaqueous
Rooting Zone Particle Size	n/a
Seepage	-15 - -27
Humus form	Saprimoder
SMR	6-8
SNR	D

Plot Numbers

WF01, WF07

Tree Layer (0)	Shrub Layer (1)	Herb Layer (95)	Moss Layer (0)
	Lonicera involucrate, Picea glauca, Rosa acicularis, Spiraea douglasii	*Calamagrostis canadensis, Calla palustris, Carex utriculata, Carex viridula, Cicuta douglasii, Comarum palustre, Equisetum arvense, Typha latifolia*	

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**Ws02**	**Ws02**	**Mountain alder - Pink spirea - Sitka sedge**	**0.9 / 0.2**

Site Photo

Mountain alder - Pink spirea - Sitka sedge swamps are uncommon in the study area. It occurs in imperfectly to poorly drained depressions, beaver-flooded flats of small creeks, and peripherally in a backchannel wetland of Goathorn Creek. The soils are organic veneers over glaciolacustrine or fluvial deposits.

Small-flowered bulrush (*Scirpus microcarpus*) is prominent in one site and swamp horsetail (*Equisetum fluviatile*) in another. A significant cover of water sedge (*Carex aquatilis) and* bluejoint reedgrass (*Calamagrostis canadensis)* are common in all the sites and Mountain alder (*Alnus incana*) forms an open to sparse canopy.

Site Information

Elevation (masl)	680 - 1080
Slope	0
Aspect	0
Slope Position	DP, GU
Structural Stage	2c, 3b
Surficial Material	Organic
Drainage	i, p
Rooting Zone Particle Size	-
Seepage	0 - 16
Humus form	-
SMR	6-8
SNR	D

Plot Numbers

WF08, WF11, WF17

Tree Layer	Shrub Layer	Herb Layer	Moss Layer
Abies lasiocarpa	*Alnus incana, Spirea douglasii*	*Scirpus microcarpus, Carex aquatilis, Equisetum fluviatile, Calamagrostis canadensis, Glyceria* spp.	*Mnium* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSmc2 / SBSdk	**Ws03**	**Ws03**	**Bebb's willow - Bluejoint**	**0.3 / 1.0**

Site Photo

The **Bebb's willow - Bluejoint** swamp ecosystem is a blue-listed ecosystem that occurs in an old backchannel of the Bulkley River. It is in a slight depression that may have open water in the spring, with the water table dropping through the summer. The soils are very rich and very moist.

There are scattered hybrid white spruce (*Picea engelmannii x glauca*) trees over a dense red-osier dogwood (*Cornus stolonifera*) shrub layer that also contains Scouler's willow (*Salix scouleriana*), mountain alder (*Alnus incana*), northern black currant (*Ribes hudsonianum*), red raspberry (*Rubus idaeus*) and prickly rose (*Rosa acicularis*).

The herb layer contains arrow-leaved coltsfoot (*Petasites frigidus* var. *sagittatus*), common horsetail (*Equisetum arvense*), purple-leaved willowherb (*Epilobium ciliatum*), bluejoint reedgrass (*Calamagrostis canadensis*), northern bedstraw (*Galium boreale*) and stinging nettle (*Urtica dioica*). The moss layer contains leafy mosses (*Mnium* spp.).

Site Information	
Elevation (masl)	542
Slope	0
Aspect	**None**
Slope Position	**DP**
Structural Stage	**3b**
Surficial Material	**F**
Drainage	**p**
Rooting Zone Particle Size	**-**
Seepage	**-**
Humus form	**-**
SMR	**6**
SNR	**E**

Plot Numbers

AD179

Tree Layer (1)	**Shrub Layer** (70)	**Herb Layer** (35)	**Moss Layer** (10)
Picea engelmannii x glauca	*Cornus stolonifera, Salix scouleriana, Alnus incana, Ribes hudsonianum, Rubus idaeus, Rosa acicularis*	*Petasites frigidus* var. *sagittatus, Equisetum arvense, Epilobium ciliatum, Calamagrostis canadensis, Galium boreale, Urtica dioica*	*Mnium* spp.

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Ws04**	**Ws04**	**Drummond's willow - Beaked sedge**	**0.2**

Site Photo

Drummond's willow - Beaked sedge swamps are uncommon in the study area, occurring in poorly-drained to subaqueous depressions that may have standing water.

There are no trees, the shrub layer may have Drummond's willow (*Salix drummondiana*) and plane-leaved willow (*Salix planifolia*), along with paper birch *(Betula papyrifera),* hybrid white spruce (*Picea engelmannii x glauca),* lodgepole pine (*Pinus contorta)* and black cottonwood (*Populus trichocarpa*).

The herb layer is dominated by Comarum palustre), and Calla palustris; bluejoint reedgrass (*Calamagrostis canadensis*), Rocky Mountain pond-lily (*Nuphar polysepala*), small-flowered woodrush (*Luzula parviflora*), beaked sedge (*Carex utriculata*), swamp horsetail (*Equisetum fluvitile*), tall mannagrass (*Glyceria elata*) and (*Carex pauciflora*) may also be present. The moss layer may have giant water-moss (*Calliergon giganteum*), shaggy peat moss *(Sphagnum squarrosum).*

Site Information

Elevation (masl)	547 – 557
Slope	0
Aspect	None
Slope Position	DP
Structural Stage	3a
Surficial Material	L, O
Drainage	p, v, subaqueous
Rooting Zone Particle Size	O
Seepage	-50 - 0
Humus form	n/a
SMR	7, 8
SNR	D

Plot Numbers

QA55, WF03

Tree Layer (0)	Shrub Layer (50 - 80)	Herb Layer (60 - 70)	Moss Layer (65)
	Betula papyrifera, Picea engelmannii x glauca, Pinus contorta, Populus trichocarpa, Salix drummondiana, Salix planifolia	*Calamagrostis canadensis, Calla palustris, Carex pauciflora, Carex utriculata, Comarum palustre, Equisetum fluviatile, Glyceria elata, Luzula parviflora, Nuphar polysepala*	*Calliergon giganteum, Sphagnum squarrosum*

BGC Subzone	Site Series	Map Code	Site Series Name	Area mapped (ha)
SBSdk	**Xs**	**Xs**	**Disclimax Shrub**	**0.3**

Site Photo

This disclimax shrub ecosystem occurs in one location along the haul route. The site has a gentle slope with a south aspect on glaciolacustrine parent materials.

This ecosystem occurs in a small opening in the forest with a mixture of shrubs and grasses, including black twinberry *(Lonicera involucrata*), hardhack (*Spiraea douglasii*), timothy (*Phleum pratense*) and blue wildrye (*Elymus glaucus*). There was no sign of forest harvesting.

Site Information	
Elevation (masl)	546
Slope	5
Aspect	**180**
Slope Position	**MD**
Structural Stage	**3a**
Surficial Material	**LG**
Drainage	**m**
Rooting Zone Particle Size	**SiC**
Seepage	**None**
Humus form	**Rhizomull**
SMR	**4**
SNR	**D**

Plot Numbers: AD169

Tree Layer	Shrub Layer	Herb Layer	Moss Layer
	Lonicera involucrata, Spiraea douglasii	*Phleum pratense, Elymus glaucus*	

REFERENCES

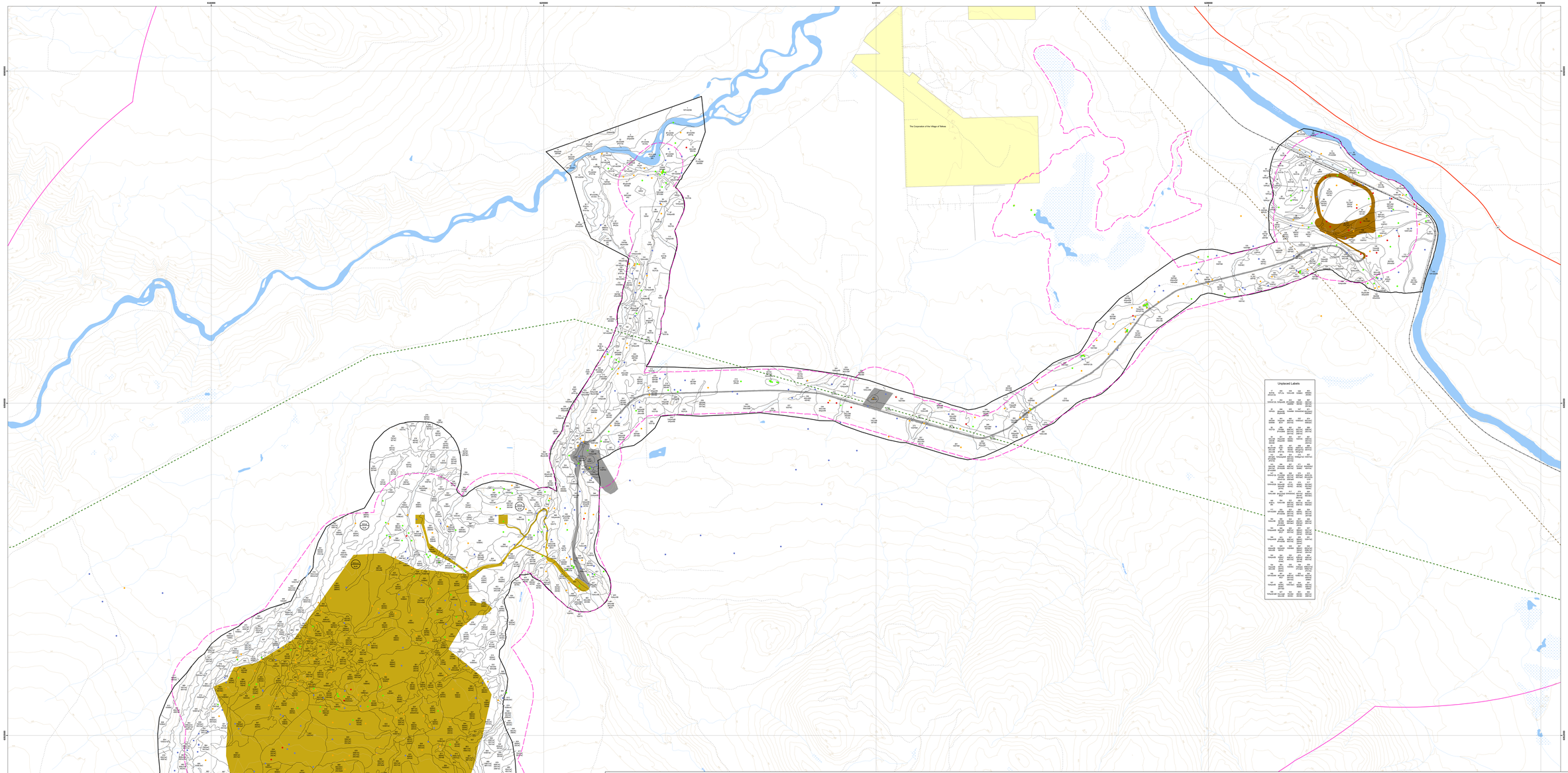
Banner, A. W.H. Mackenzie, S. Haeussler, S. Thomson, J. Pojar and R. Trowbridge. 1993. A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region. B.C. Min. For., Victoria, B.C. Land Management Handbook 26.

BC Conservation Data Centre (BC CDC). 2020. BC Species and Ecosystems Explorer. B.C. Ministry of Environment, Victoria B.C. Available: http://a100.gov.bc.ca/pub/eswp/. Accessed: February, 2020

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: A Guide to Identification. Land Management Handbook 52. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Victoria, BC.

Terrestrial Ecosystem Information Unit (TEIU). 2020. Terrestrial Ecosystem Information (TEI): Coding Updates for Non-Vegetated, Sparsely Vegetated, and Anthropogenic Units. Version 1.1. Ministry of Environment and Climate Change Strategy, Knowledge Management Branch, Ecosystem Information Section.

Appendix C 1:10,000 Terrestrial Ecosystem Map



Tenas Project

Terrain Stability Mapping
Telkwa Coal LSA

Legend

Base Map Features

- Highway
- Rail Line
- Road
- Resource Road
- 138 kV Transmission Line
- 500 kV Transmission Line
- Contour Lines (20 m)
- Watercourse
- Waterbody
- Wetland
- Municipal Area
- General Private Property

Ecosystem Mapping

- Vegetation LSA
- Vegetation RSA

Proposed Development Features

- Access Corridor
- Minesite
- Rail Infrastructure

Field Assessments

- Full Plot (FSBB2)
- SIVI Ground
- SIVI Visual
- Field Note
- Ecosystem Polygon

Notes

All mapped features are approximate and should be used for discussion purposes only.

This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Map production date: January 18, 2022

This terrestrial ecosystem map has been prepared and reviewed for Telkwa Coal Ltd. by:

Adrian de Groot, R.P.Bio. and Laurence Turney, R.P.Bio.

N

Original Map Scale 1:10,000

0 200 400 600 800 1,000
Meters

NAD 1983 UTM Zone 9N
Page Size 44" x 76"

TELKWA COAL LIMITED

ARDEA BIOLOGICAL CONSULTING

Introduction

This project provides detailed ecosystem mapping of the proposed Tenas Project located about 25 kilometres south of Smithers and 7 kilometres southwest of the village of Telkwa in northwestern British Columbia. Mapping was completed following the methods outlined in *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998). Field work was completed on June 7 to June 9, September 27 to September 29, 2018, and June 1 to August 2019 using a multi-disciplinary field team. The rail infrastructure area was completed using survey intensity level 1 and the minesite and access corridor areas were completed using survey level 2.

Terrestrial Ecosystem Map Label Descriptions

Ecosection and Biogeoclimatic Units Label

Ecosection: SBSmc2 — Biogeoclimatic Unit

Ecosection Unit Label

Polygon Number: 640 — Ecosystem Code
Component 1: 45HB4C — Structural Stage
Component 2: 35DA0C — Structural Modifier
Component 3: 35BN4C — Stand Type
Decile (30% of map unit): — Ecosystem Modifier

Ecosection and Biogeoclimatic Unit Map Boundary

Ecosections

BUR: Bulkley Basin
BURr: Bulkley Ranges

Biogeoclimatic Units

SBSmc2: Sub-Boreal Spruce zone moist cold subzone Babine variant
SBSdk: Sub-Boreal Spruce zone dry cool subzone

Site Modifiers

Code	Description	Code	Description
Ecosystem Topography			
a	Active floodplain; or fluvial deposit that may have coarse-textured soils	y	Very steep cool aspect
c	Coarse-textured soils	s	Shallow soil
f	Fine-textured soils	w	Warm aspect
g	Gullying occurring	x	Drier than typical
h	Hummocky terrain	y	Moister than typical
k	Cool aspect	z	Very steep warm aspect
p	Peaty material, deep organics or a peaty surface over mineral materials		
Stand Composition			
B	Broadleaf: >75% of total tree cover is broadleaf	M	Mixed: neither broadleaf nor coniferous species account for >75% of total tree cover
C	Coniferous: >75% of total tree cover is coniferous		
Canopy Structure			
h	Anthropogenic: recent human -induced modification to stand structure	m	Multistoried: closed or open forest stand with all crown classes represented
i	Irregular: very open-overstory and understory of <30% cover	o	Open: forest stand with very open main or intermediate crown classes totalling less than 25% cover

Structural Stage

Code	Structural Stage	Code	Structural Stage
1	Sparse	3b	Tall Shrub (3 - 10m)
2a	Herb - Forb Dominated	4	Pole/Sapling
2b	Herb - Graminoid Dominated	5	Young Forest
2c	Herb - Aquatic	6	Mature Forest
3a	Low Shrub (< 3 m)	7a	Old Forest

SBSmc2 - Sub-Boreal Spruce zone moist cold subzone Babine variant

Map Code	Site Series	Ecosystem Name	Site Description	SMR	SNR
SB	01a/1b	Hybrid white spruce - Huckleberry (mesic; fine textured phase)	Widespread and common in the study area, this ecosystem type occurs on level to gently sloping morainal surficial materials but also on glaciofluvial and glaciolacustrine deposits. Soils are fresh to medium nutrient regime with a range of particle sizes. Soil drainage is usually well or moderately well, and the humus form Mor. All polygons are coded 01a in the attribute table but could be either fine (01a) or coarse-textured (01b) phase.	(3)-4	C-(B)
SB	01c	Hybrid white spruce - Huckleberry (submesic phase)	Fairly widespread in the study area, this ecosystem type occurs on level to gently sloping morainal and glaciofluvial deposits. The sites all tend to have a submesic moisture regime and a medium to poor soil nutrient regime, and are well or rapidly drained. The humus form is Mor.	(2)-3(4)	B-C
PH	02	Lodgepole pine - Huckleberry - Cladonia	Uncommon in the study area, and occurring on the dried sites in the area, these sites have shallow or rapidly drained soils, are submesic to xeric, and have a poor or very poor soil nutrient regime.	1-2	A-B
BM	03	Black spruce - Lodgepole pine - Feathermoss	Occur on mesic to moist sites with a poor to very poor nutrient regime. The sites are level to slightly sloping, with morainal materials that are moderate-drained.	(2)-3-4-(5)	(A)-B
TC	05	Hybrid white spruce - Twinberry - Coltsfoot	Occur on mesic to moist sites with a medium to rich nutrient regime. The sites are gently sloping midslope to lower slopes with a cool aspect and are moderately-well to imperfectly drained.	4-5	C-D
SO	06	Hybrid white spruce - Oak fern	A common ecosystem in the study area, occurring on morainal blanket parent materials with a variety of textures. Soils are fresh to moist and have a usually mid to lower slope. The soils are moist to very moist and rich, imperfectly to moderately-well drained, with a Mixder humus form. Root restricting compacted layers are fairly common. The forests have often been logged in the past, and can have a variety of structural stages and plant species.	(4)-5-(6)	(A)-B-(C)
BF	07	Hybrid white spruce - Scrub birch - Feathermoss	Occurring in very moist, nutrient poor sites, often adjacent to wetlands. Soils are imperfectly drained and the trees shallowly rooted.	(5)-6	(A)-B-(C)
SD	09a	Hybrid white spruce - Devil's club (fluvial phase)	Occur on moist to very moist sites with a rich nutrient regime. These sites occur on toe to lower slopes that have a gentle to moderate gradient. Parent material are usually morainal but may be fluvial, and have a Mixder humus form. Root restricting compacted restricting layer due to compact soils occurs fairly commonly, and soils are imperfectly to moderately well drained. Humus forms are Mders and Mor and can be fairly thick. Two phases of this site series are mapped: fluvial (09a) and morainal (09)..	(5)-6-(7)	(C)-D-(E)
SH	10a	Hybrid white spruce - Horsetail (fluvial phase)	Occurs on very moist and rich toe slopes and level areas. The parent material is fluvial or glaciofluvial or lacustrine, but the soils tend to be fine textured and to imperfectly or poorly drained. The humus form is Moders or Mors and can be quite thick, akan be the Ah horizon. Two phases of this site series are mapped: fluvial (10a) and lacustrine/morainal (10b).	(5)-6-(7)	(C)-D-(E)
SH	10b	Hybrid white spruce - Horsetail (lacustrine/morainal phase)			
WT	51	Scouler's willow - Thimbleberry	Occurs on medium to rich sites with a mesic to subhygric moisture regime. The soils are Orthic Eutric Brunisols. These sites are often found on cool aspects and have a seepage component. This ecosystem is uncommon in the study area.	(4)-5-(6)	C-(D-(E)
AN	52	Mountain alder - Stinging nettle	Occurs on rich, very moist sites that may have seepage. The aspect is cool and the drainage poor. This ecosystem is uncommon in the study area.	6	D- E

SBSmc2- Sub-Boreal Spruce zone moist cold subzone Babine variant

Map Code	Site Series	Ecosystem Name	Site Description	SMR	SNR
Atcv	Atcv	Trembling aspen - Canada violet	Occurs on rich sites with a mesic to subhygric moisture regime. They are love to lower slopes that have a gentle to moderate gradient. Parent material is morainal or colluvial. The soils are fresh to silty loam to loamy clay loam soil texture. A root restricting layer due to compact soils occurs fairly commonly. The soils are imperfectly to moderately well drained. Humus forms are Mders or Mors and can be fairly thick. White root described in the SBSdk, several areas in the SBSdk were sampled and mapped.	(3)-4-5	D
Atha	Atha	Trembling aspen - Hardhack	Occurs on level to gently sloping sites in gullies or depressions that may have a high water table in spring but dry-out over the summer. The soils tend to be finer textured and not as well-drained as more productive sites. The parent materials are usually glaciolacustrine or fluvial over glaciolacustrine. A root restriction due to water or hardpan may be present.	(3)-4-5	D
FI01	FI01	Mountain alder - Common horsetail	Occurs along high gradient streams in the study area. They are floodedperiodically and may have a flashy hydrograph in response to weather events. The substrate is cobbles and gravels.	5-6	B-D
WIs01	WIs01	Black spruce - Creeping snowberry - Peat-moss	An uncommon blackland bog occurring in poorly drained depressions. The peat is well and poorly decomposed with a poor nutrient regime.	7	B
WIs05	WIs05	Black spruce - Water sedge - Peat-moss	An uncommon blackland bog occurring in higher elevation depressions. The peat is poorly decomposed and contains much wood. The surface is slightly hummocked.	7	B-C
WE1	WE1	Water sedge - Beaked sedge	The wetland guidebook (Mackenzie and Moran 2004 describes this ecosystem as being the moistmoron and widespread fen site association in the province. The soils are fine textured mineral soils that are usually inundated by shallow, lowenergy flowing waters and that experience some lateseason drawdown.	8	D
Wm02	Wm02	Swamp horsetail - Beaked sedge	An uncommon site association occurring in backchannels of sediment laden, low gradient streams.	8	C
Wv02	Wv02	Mountain alder - Pink spirea - Sitka sedge	This site association occurs on beaver floded flats of small creeks,peripherial zones of wetlands, and lakeshores, where there is early season flooding, continuous seepage near the surface, and poor drainage.	6-8	D
Ww03	Ww03	Bebb's willow - Bluejoint reedgrass	An uncommon blackland ecosystem that occurs in an old backchannel of the Bulkley River. It is in a slight depression that may have open water in the spring, with the water table dropping through the summer. The soils are very rich and very moist.	6	E
FxI02 (C02)	FxI02 (B8)	Black cottonwood - Red-osier dogwood / Red-osier dogwood (Black cottonwood - Douglas maple - Prickly rose)	A Red-listed floodplain forest occurring along the Bulkley River and its tributary Goathorn Creek. They are occasionally flooded, and show multiple layers in the soil profile from repeated depositional events. The soils are Cumulo Regosols with a sandy loam or sandy texture.	5	D
SW	81	Saskatoon - Slender wheatgrass	Occurs on dry rocky sites with favourable warm aspects over base-rich parent materials. In the study area, this Red-listed ecosystem occurs on the steep slopes adjacent to the Telkwa River.	1-2	C-D-E
BW	82	Bluegrass - Slender wheatgrass	A red-listed ecological community that marginally fits the Bluegrass - Slender wheatgrass - Slender wheatgrass ecological community.	2	B
Atcv	Atcv	Trembling aspen - Canada violet	Occurs on rich sites with a mesic to subhygric moisture regime. They are level to moderately steep slopes. Soils are silty loam to sandy loam Orthic Eutric Brunisols or Orthic Melanic Brunisols. Some sites are gravel and contain agrimonia grassed.	(3) -4-5	D
Atha	Atha	Trembling aspen - Hardhack	Occurs on level to gently sloping sites in gullies or depressions that may have a high water table in spring but dry-out over the summer. The soils tend to be finer textured and not as well-drained as more productive sites. The parent materials are usually glaciolacustrine or fluvial over glaciolacustrine. A root restriction due to water or hardpan may be present.	(3)-5-6	C-D
AIs1	AIs1	Trembling aspen - Kinnikinnick	A rare ecosystem in the study area, being mapped in only one location.	2	B
AIf	AIf	Trembling aspen - Lady fern	Rich sites with a high water table in the spring with some standing water found in only two locations in the project area: in a slight depression in an abandoned back channel of the Bulkley River, and in an active backchannel of the Telkwa River.	5	D-E
Alpw	Alpw	Trembling aspen - Pink wintergreen	Uncommon ecosystems in the study area, occurring on rapidly to well drained sites with a variety of parent materials. Soils are Orthic Eutric Brunisols or silty loam soils that have sandier soils at depth.	(3)-4	(B)-C
Abs	Abs	Trembling aspen - Saskatoon - Snowberry	Uncommon in the study area, this ecosystem occurs on moderately well drained fluvial deposits with a with very rich, sandy loam soils.	2, 3, 4	B-C
CA	CA	Cow parsnip - Large-leaved avens	Uncommon in the study area, this ecosystem occurs on moderately well drained fluvial deposits with a with very rich, sandy loam soils.	5	E
Epdm	Epdm	Paper birch - Douglas maple	Usually occurs on the upper portions of moderate to steep, rapidly to well drained slopes with a high coarse fragment content with a cool aspect.	2, 3	A-B(-C)-D
Wm01	Wm01	Beaked sedge - Water sedge	Occurs uncommonly in the study area in several small depressions and beside Goathorn Creek.	6-7-8	B-C
Wm02	Wm02	Swamp horsetail - Beaked sedge	An uncommon site association occurring in backchannels of sediment laden, low gradient streams.	8	C
Wm05	Wm05	Cattail	Occurs uncommonly in the study area in depressions with standing water.	6-7-8	D
Wv02	Wv02	Mountain alder - Pink spirea - Sitka sedge	This ecosystem occurs on beaver-flooded flats of small creeks, peripheral zones of wetlands, and lakeshores, where there is early season flooding, continuous seepage near the surface, and poor drainage.	7	C-D
Ww03	Ww03	Bebb's willow - Bluejoint reedgrass	An uncommon blue-listed ecosystem that occurs in an old backchannel of the Bulkley River. It is in a slight depression that may have open water in the spring, with the water table dropping through the summer. The soils are very rich and very moist.	6	E
Ww04	Ww04	Drummond's willow - Bearded sedge	Uncommon in the study area, this ecosystem occurs in poorly-drained to subaqueous depressions that may have standing water.	7-8	D
Xs	Xs	Discklmas Shrub	This ecosystem occurs in one location along the haul road. The site is a steep, rocky with a south aspect on glaciolacustrine parent materials.	4	D

SBSdk - Sub-Boreal Spruce zone dry cool subzone

Map Code	Site Series	Ecosystem Name	Site Description	SMR	SNR
SD	00	Hybrid white spruce - Devil's club (moraine phase)	Occur on moist to very moist sites with a rich nutrient regime. These sites occur on toe to lower slopes that have a gentle to moderate gradient. Parent material are usually morainal but may be fluvial, and have a silty loam to sandy clay loam soil texture. A root restricting layer due to compact soils occurs fairly commonly. The soils are imperfectly to moderately well drained. Humus forms are Mders or Mors and can be fairly thick. White root described in the SBSdk, several areas in the SBSdk were sampled and mapped.	(5)-6	D-(E)
SP	01a	Hybrid white spruce - Spirea - Purple peavine (fine-textured phase	Fine-textured phase, occurring on level to gently sloping sites with glaciolacustrine and mor aimal parent materials. The soils are Orthic Eutric Brunisols with a medium nutrient regime, and moderately - well drained.	(3-4)	(B)-C
SP	01b	Hybrid white spruce - Spirea - Purple peavine (coarse-textured phase)	Coarse-textured phase, occurring on level to gently sloping sites that mostly have glaciofluvial parent materials. Soils are usually mesic or slightly dry, with a medium nutrient regime, and well or moderately- well drained.	(2)-3-4	(B)-C
LJ	02	Lodgepole pine - Juniper - Rosegraas	An open -canopied blue -listed ecosystem that occurs on warm aspects with moderately dry and very poor shallow soils over bedrock.	2	A
LC	03	Lodgepole pine - Feathermoss - Cladina	Occurs on gravelly glaciofluvial deposits or warm aspects with very poor soil nutrient regime. The soils are slightly to moderately dry with a poor to medium nutrient regime, and are rapidly to well -drained.	2-3	B-C
SF	05	Hybrid white spruce - Spirea - Feathermoss	Occurs on somewhat dry and poor sites with sandy soils that are rapidly drained. The parent material is glaciofluvial.	3	B
ST	06	Hybrid white spruce - Twinberry - Coltsfoot	Occurs on a range of parent materials with glaciofluvial and glaciolacustrine being the most common. These sites are usually level or slightly sloping, are moderately -well to well drained, have a mesic to moist moisture-regime, and a medium to rich nutrient regime.	4-(5)	(C)-D-(E)
SH	07a	Hybrid white spruce - Horsetail (freely drained phase)	Occurs on level to very moist, rich to very rich sites. These sites are level to gently sloping toe or lower slopes, which are often adjacent to small to large creek. The parent materials are usually fluvial or colluvial, but may be morainal, lacustrine or organic. Water tables can be seasonally hig h and drainage imperfect to poor; trees often grow on hummocks. The soils are Gleyed Eutric Brunisols freely-drained (07a) and poorly -drained (07b).	5-6	(C)-D-E
SH	07b	Hybrid white spruce - Horsetail (poorly-drained phase)			
FI01	FI01	Mountain alder - Common horsetail	Occurs along high gradient streams in the study area. They are flooded annually and may have a flashy flooding regime, responding to weather events. The substrate is cobbles and gravels.	5-6	B-D
FxI02 (C02)	FxI02 (B8)	Black cottonwood - Red-osier dogwood / Red-osier dogwood (Black cottonwood - Douglas maple - Prickly rose)	A Red-listed floodplain forest occurring along the Bulkley River and its tributary Goathorn Creek. They are occasionally flooded, and show multiple layers in the soil profile from repeated depositional events. The soils are Cumulo Regosols with a sandy loam or sandy texture.	5	D
WT	51	Scouler's willow - Thimbleberry	Occurs on medium to rich sites with a mesic to subhygric moisture regime. The soils are Orthic Eutric Brunisols. These sites are often found on cool aspects and have a seepage component. This ecosystem is uncommon in the study area.	(4)-5-(6)	C-D-(E)
AN	52	Mountain alder - Stinging nettle	Occurs on rich, very moist sites that may have seepage. The aspect is cool and the drainage poor. This ecosystem is uncommon in the study area.	6	D-E
AM	53	Mountain alder - Mirewort	Occurs on rich sites with a mesic to subhygric moisture regimes that have a cool aspect but may be level.	(4)-5	(C)-D

SBSdk - Sub-Boreal Spruce zone dry cool subzone

Map Code	Site Series	Ecosystem Name	Site Description	SMR	SNR
SW	81	Saskatoon - Slender wheatgrass	Occurs on dry rocky sites with favourable warm aspects over base-rich parent materials. In the study area, this Red-listed ecosystem occurs on the steep slopes adjacent to the Telkwa River.	1-2	C-D-E
BW	82	Bluegrass - Slender wheatgrass	A red-listed ecological community that marginally fits the Bluegrass - Slender wheatgrass - Slender wheatgrass ecological community.	2	B
Atcv	Atcv	Trembling aspen - Canada violet	Occurs on rich sites with a mesic to subhygric moisture regime. They are level to moderately steep slopes. Soils are silty loam to sandy loam Orthic Eutric Brunisols or Orthic Melanic Brunisols. Some sites are gravel and contain agrimonia grassed.	(3) -4-5	D
Atha	Atha	Trembling aspen - Hardhack	Occurs on level to gently sloping sites in gullies or depressions that may have a high water table in spring but dry-out over the summer. The soils tend to be finer textured and not as well-drained as more productive sites. The parent materials are usually glaciolacustrine or fluvial over glaciolacustrine. A root restriction due to water or hardpan may be present.	(3)-5-6	C-D
AIs1	AIs1	Trembling aspen - Kinnikinnick	A rare ecosystem in the study area, being mapped in only one location.	2	B
AIf	AIf	Trembling aspen - Lady fern	Rich sites with a high water table in the spring with some standing water found in only two locations in the project area: in a slight depression in an abandoned back channel of the Bulkley River, and in an active backchannel of the Telkwa River.	5	D-E
Alpw	Alpw	Trembling aspen - Pink wintergreen	Uncommon ecosystems in the study area, occurring on rapidly to well drained sites with a variety of parent materials. Soils are Orthic Eutric Brunisols or silty loam soils that have sandier soils at depth.	(3)-4	(B)-C
Abs	Abs	Trembling aspen - Saskatoon - Snowberry	Uncommon in the study area, this ecosystem occurs on moderately well drained fluvial deposits with a with very rich, sandy loam soils.	2, 3, 4	B-C
CA	CA	Cow parsnip - Large-leaved avens	Uncommon in the study area, this ecosystem occurs on moderately well drained fluvial deposits with a with very rich, sandy loam soils.	5	E
Epdm	Epdm	Paper birch - Douglas maple	Usually occurs on the upper portions of moderate to steep, rapidly to well drained slopes with a high coarse fragment content with a cool aspect.	2, 3	A-(B)-C-D
Wm01	Wm01	Beaked sedge - Water sedge	Occurs uncommonly in the study area in several small depressions and beside Goathorn Creek.	6-7-8	B-C
Wm02	Wm02	Swamp horsetail - Beaked sedge	An uncommon site association occurring in backchannels of sediment laden, low gradient streams.	8	C
Wm05	Wm05	Cattail	Occurs uncommonly in the study area in depressions with standing water.	6-7-8	D
Wv02	Wv02	Mountain alder - Pink spirea - Sitka sedge	This ecosystem occurs on beaver-flooded flats of small creeks, peripheral zones of wetlands, and lakeshores, where there is early season flooding, continuous seepage near the surface, and poor drainage.	7	C-D
Ww03	Ww03	Bebb's willow - Bluejoint reedgrass	An uncommon blue-listed ecosystem that occurs in an old backchannel of the Bulkley River. It is in a slight depression that may have open water in the spring, with the water table dropping through the summer. The soils are very rich and very moist.	6	E
Ww04	Ww04	Drummond's willow - Bearded sedge	Uncommon in the study area, this ecosystem occurs in poorly-drained to subaqueous depressions that may have standing water.	7-8	D
Xs	Xs	Discklmas Shrub	This ecosystem occurs in one location along the haul road. The site is a steep, rocky with a south aspect on glaciolacustrine parent materials.	4	D

Non-vegetated and Anthropogenic Units

Map Code	Site Series Name	Description
CF	Cultivated field	Flat or gently rolling, nonforested, open area subject to human agricultural practices
ES	Exposed soil	Area of exposed soil, not included in any of theother definitions
GB	Gravel bar	Biophysical landform generated by waves and currents; a mix of cobbles, pebbles, stones, and/or sand
GP	Gravel pit	An area exposed through the removal of sand and gravel
OW	Open water	Wetland of permanent shallow open water water (< 2 m deep); lacking extensive emergent plant cover
PA	Pasture	Flat or gently rolling, nonforested open area that is used for the grazing of livestock.
RI	River	Watercourse formed when water flows between meandrous, definable banks
RN	Railway surface	Roadbed with fixed rails for possibly single or multiple rail lines
RZ	Road surface	Area cleared and compacted for vehicle transport
RW	Rural	Area of residences and other human developments scattered and intermingled with forest, range, farm land, and native vegetation or cultivated crops
TL	Transmission line	A managed, partially vegetated electrical transmission line corridor with an access road

Data Sources

This project wascompleted using 3D mapping software with the most current orthophotos, LiDAR (Light Detection and Ranging) and Terrain Resource Inventory Mapping (TRIM) base mapsobtained from Allegiance Coal and Geographic Data BC.

Credits

This project was completed by Telkwa Coal Ltd. by Ardea Biological Consulting Ltd.(Ardea), Smithers, BC. Biotemain mapping was completed by Wetland Terrain Sciences, soils mapping by Irene Ronalds Ecological Consultant the ecosystem mapping by, de Groot ofDreams Ecological Consulting,L. Turney (Ardea) and I. Ronalds. Field work was completed by C. Quinn and O. Holt (Ardea), F. Doyle (Wildlife Dynamics) and, Rachel Terrasche Environmental Solutions Ltd. (Terrasche) Final Map production was completed by L. Rad(Ferrandino and L. Turney (Ardea).

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Appendix D Wetland Function Assessment Data

Table D-1: Wetland function field assessment data parameter descriptions.

Parameter	Description		
Wetland Size	The size of the wetland or wetland complex	Perimeter track in the field using GPS, review with GIS using LiDAR and TRIM	
Hydrogeomorphic System (see Mackenzie and Moran 2004)	Describes the topographic position and hydrology of the site	Fluvial Lacustrine Palustrine, Basins and Hollows Palustrine, Seepage Slopes Palustrine, Ponds and Potholes	
Hydrodynamic Index (see Mackenzie and Moran 2004)	Describes the magnitude of vertical and lateral water movement in the soil	Stagnant (St) Sluggish (Sl) Mobile (Mo) Dynamic (Dy) Very Dynamic (Vd)	
Soil Moisture Regime (see Mackenzie and Moran 2004)	Average amount of soil water available for evapo-transpiration by vascular plants over several years	Moist (M) Very Moist (VM)	Wet (W) Very Wet (VW)
Soil Nutrient Regime (see Mackenzie and Moran 2004)	Essential soil nutrients available to vascular plants over a period of several years	Very Poor (A) Poor (B) Medium (C)	Rich (D) Very Rich (E) Hyper Rich (F)
pH (see Mackenzie and Moran 2004)	A correlate measure of base cation availability - An indication of site productivity	Very Acidic (VA): <4.5 pH Moderately Acid (MA): 4.5-5.5 pH Slightly Acid (SA): 5.5-6.5 pH Neutral (N): 6.5-7.4 pH Alkaline (AK): >7.4 pH	
Soil Drainage Classes (see BCMOFR and MOE 2010; Table 2.16)	Describes the speed and extent to which water is removed from a mineral soil in relation to additions	Imperfectly Drained (i) Poorly Drained (p) Very Poorly Drained (v)	
Sub Moisture Subclasses (see BCMOFR and MOE 2010; Table 2.17)	Describes the timing and duration of soil saturation	Aqueous (aq) Peraquic (pa) Aquic (ac)	Subaquic (sa) Perhumid (ph) Humid (hu)
Plant Inventory (see BCMOFR and MOE 2010)	Species and % cover list collected at aquatic and upland plots	Site Visit (SIVI; FS1333)	
Wildlife Assessments (see BCMOFR and MOE 2010)	An assessment of the value of the wetland for select wildlife species (ungulates, birds, amphibians)	Wildlife Habitat Assessment (FS882(5)) Tree Attributes for Wildlife (FS882(6)) Coarse Woody Debris (FS882(7))	

Table D-2: Wetland function field data collected.

Wetland ID	BGC Zone	Site Series	Structural Stage	Hydrological				Biochemical		
				Stream Connection	Complex	Hydrodynamic Index	Hydrogeomorphic System	pH	Soil Nutrient	Temp. (°C)
WF01	SBSdk	Wm05 / 06	2b/2c	Ephemeral Channel	Y	Mo	Palustrine Ponds and Potholes	6.24	Org over Mineral	13.9
WF02	SBSdk	Wm01 / Atpw	2b/2c	Ephemeral Channel	Y	Mo	Palustrine Basins and Hollows	7.06	Org over Mineral	20.5
WF03	SBSdk	Wm01 / Ws04 /06(01)	2c/2b/3a	Ephemeral Channels	Y	Sl/Mo	Palustrine Basins and Hollows / ~Fluvial	6.2 / 5.61	Org over Mineral	16.4/15.7
WF04 and WF05	SBSdk	Ws07 /07a /06	2b (3a)	No	N	Sl/Mo	Palustrine Basins and Hollows	6.0 / 6.2	8 cm Org/Mineral	17.3
WF06	SBSdk	Wm01 / 07a	2b (3a)	Ephemeral Channel	Y	Sl/Mo		6.1	5 cm Org/Mineral	17.6
WF07	SBSdk	Wb01 / Wm05	2b/2c	Ephemeral Channels	Y	Sl	Palustrine Basins and Hollows	6.06	Organic	17.2
WF08	SBSmc2	Wm02 / Ws02	2b/2c	On stream	Y	Mo	Fluvial	7.15	5 cm Org/Mineral	15.3
WF19	SBSdk	depression/07a	2b	No	N	St/Sl	Pond / Depression			
WF09	SBSmc2	Wb05 / Wb01	7a	Yes	N	Dy	Seepage Slope		Organic (Peat)	
WF10	SBSdk	Fl02 / (52/51)	3b	Yes	Y	Dy	Fluvial	7	2 cm Organic/Sand	12.2
WF11	SBSdk	Marsh /Swamp	2b/3b	Goathorn Crk	Y	Dy	Fluvial		Muck/Sand	
WF12	SBSdk	Ww / Wm01 (Wb01)	2b/2c (4)	Yes	Y	Sl/Mo	Lacustrine	7.35	Mineral	17.8
WF13-14	SBSdk	Wb01	6	Yes	Y	St	Lacustrine	6.9	6 cm Organic/Mineral	15
WF15	SBSdk	O8 (Atpw)	2c	No	N	St/Sl	Pond / Depression	7.83	Mineral/Rock	15
WF16	SBSmc2	04 /Ws03	3b	Ephemeral	Y	Mo	Fluvial		Mineral	
WF17	SBSmc2	Wb05 /Ws02 /SO/01	3b/4	Ephemeral Channels	Y	St/Sl	Depression / Lacustrine		Organic/Mineral	
WF18	SBSmc2	10	6	No	N	St/Sl	Depression	7.54	Organic/Mineral	18.2

Table D-3: Wildlife habitat assessment ratings.

Wetland ID	Western Toad			Northern Goshawk			Moose			Elk			Snowshoe Hare			Lynx			Marten			Fisher			Mule Deer			Caribou			Black Bear			Grizzly Bear		
	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T	F	S	T
WF01	1	1	1	2	2	2	1	1	1	3	2	2	2	3	2	2	2	2	1	2	2	2	3	3	1	1	1	4	5	4	2	1	1	3	1	1
WF03	1	1	1	2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2	2	2	NR			2	2	2	5	4	5	3	2	2	4	2	2
WF04	1	1	1	2	2	2	3	2	2	3	3	3	2	2	2	2	2	2	3	2	2	NR			3	2	2	5	4	5	3	2	2	4	2	2
WF06	1	1	1	2	3	2	1	1	1	3	2	2	3	2	2	3	2	2	2	1	1	2	2	2	2	2	2	3	5	5	2	2	2	3	2	2
WF07	2	1	2	4	4	4	4	2	2	4	4	4	3	3	3	3	3	3	3	4	4	3	3	3	3	3	3	4	3	2	4	3	2	4	3	2
WF08-1	2	2	2	3	4	2	3	3	2	3	3	3	3	2	2	3	3	3	3	2	2	3	3	3	4	3	3	4	4	4	4	3	2	4	3	2
WF08-2	2	2	2	3	4	2	3	3	2	3	3	3	3	2	2	3	3	3	3	2	2	3	3	3	4	3	3	4	4	4	4	3	2	4	3	2
WF09	1	1	3	2	4	3	3	3	3	5	4	3	2	3	2	3	3	3	3	3	3	3	4	4	3	3	3	5	3	3	3	3	3	3	3	3
WF10	1	1	1	2	4	2	2	2	2	2	2	2	3	3	3	3	3	3	2	3	3	2	3	2	2	3	3	3	4	3	2	3	2	4	2	2
WF11	1	2	2	2	4	2	3	3	2	3	2	2	2	3	3	3	3	3	2	3	3	2	3	2	2	2	3	3	4	3	4	3	2	3	2	2
WF12	2	3	4	3	4	3	2	3	3	4	3	3	4	3	4	4	3	3	3	3	3	3	4	4	3	3	3	3	4	4	3	5	4	3	4	4
WF15	2	1	3	2	4	2	2	3	3	2	2	2	2	3	3	3	3	3	2	2	2	2	2	2	2	2	2	5	5	4	3	2	2	4	2	2
WF16	1	1	2	2	4	2	3	4	3	3	3	3	1	1	1	1	1	1	2	2	2	3	4	3	3	3	3	3	3	4	4	4	2	4	4	2
WF18	2	2	2	4	4	4	4	2	2	4	4	4	3	2	3	3	3	3	2	2	2	NR			3	3	2	4	5	3	4	3	3	4	2	3

Notes: F = Feeding Habitat, S = Security Habitat, T= Thermal Habitat

Table D-4: Summary of wildilfe observations and use during wetland function assessments.

Wetland ID	Species Group	Species	Sign/Visual/ Heard	Plot Activity
WF01	Amphibian	Wood Frog	V	Breeding
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Bird	Brown Creeper	V, H	Nesting
	Ungulate	Moose	S	Browse
	Range Animal	Cow	S	Travel Path
	Ungulate	Mule Deer	S	Pellets
	Bat	Unidentified	V	TF
	Bear	Black Bear	S	Feeding
	Invertebrate	Aquatic insects (including several dragonfly Species)	V	Living, Breeding
	Feature	Wildlife Trails	S	High Use
WF02	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Amphibian	Wood Frog	V	Breeding
	Invertebrate	Aquatic insects	V	Living, Breeding
	Feature	Wildlife Trails		Moderate Use
	Bear	Black Bear	S	Scat, Tracks, Territorial
	Ungulate	Moose	S	Tracks, Pellets
WF03	Ungulate	Moose	S	Living, Body Parts
	Bear	Black Bear	S	Scat, Tracks
	Amphibian	Wood Frog	V	Breeding
	Amphibian	Columbia Spotted Frog, Western Toad	V	Breeding, Living
	Song Bird	Numerous unspecified	H	Nesting
WF04	Amphibian	Columbia Spotted Frog	S	Breeding, Living
	Bird	Numerous unspecified	H	Nesting
	Ungulate	Moose	S	Browse
	Feature	Wildlife Trail	S	Moderate
	Small Mammal	Red Squirrel	V, H	Living
	Bear	Black Bear	S	Scat, Tracks
	Ungulate	Elk	S	Pellets
WF05	Bird	Numerous unspecified	H	Nesting
	Invertebrate	Aquatic insects	V	Living, Breeding
WF06	Bird	Cedar Waxwing,	S	Flying
	Bird	Pine Siskin	H	Living
	Bird	Numerous unspecified	H	Nesting
	Hawk	Cooper's hawk	H	Nesting
	Ungulate	Moose	S	Browse, Pellets

Wetland ID	Species Group	Species	Sign/Visual/ Heard	Plot Activity
WF06	Small Mammal	Snowshoe Hare	S	Pellets
	Bear	Unidentified	S	Scat
	Bear	Black Bear	S	Scat, Tracks
	Amphibian	Columbia Spotted Frog	V	Breeding
	Invertebrate	Aquatic insects	V	Living, Breeding
WF07	Bird	American Redstart, Common Yellowthroat, Pine Siskin	H	Living
	Owl	Northern Pygmy Owl	H	Territorial
	Ungulate	Moose	S	Pellets, Browse, Tracks
	Ungulate	Elk	S	Pellets, Tracks
	Amphibian	Wood Frog, Long-toed Salamander	V	Breeding
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
WF08	Birds	Pine Siskin, Red-breasted Nuthatch	H	Territorial, Nesting
	Canine	Wolf	S	Pellets, Tracks
	Bear	Grizzly Bear	S	Territorial
	Ungulate	Moose	S	Tracks, Body Parts, Pellets
	Aquatic Mammal	Beaver	S	DAM, Lodge
	Bear	Unidentified	S	Scat
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Feature	Wildlife Trails	S	High Use
WF09	Ungulate	Moose	S	Browse, Pellets
	Bear	Unidentified	S	Scat
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
WF10	Bird	American Robin, Black-capped Chickadee, Least Flycatcher, Red-breasted Nuthatch	S	Flying
	Bird	Numerous unspecified	H	Nesting
	Ungulate	Moose	S	Pellets, Tracks
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Invertebrate	Aquatic insects	V	Living
	Feature	Wildlife Trails	S	High Use
WF11	Bird	Black-capped Chickadee	H	Territorial, Nesting
	Small Mammal	Snowshoe Hare	S	Pellets
	Ungulate	Moose	S	Tracks
	Reptile	Garter Snake	V	Hunting
WF11	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Bird	Numerous unspecified	H	Nesting
	Invertebrate	Aquatic insects	V	Living

Wetland ID	Species Group	Species	Sign/Visual/ Heard	Plot Activity
WF12	Aquatic Bird	Solitary Sandpiper, Short-billed Dowitcher, unidentified	H	Territorial, Nesting
	Bird	Black-capped Chickadee, Brown Creeper, Western Wood-Pewee	H	Territorial, Nesting
	Ungulate	Moose	S	Browse, Tracks
	Amphibian	Long-toed Salamander	V	Breeding
	Invertebrate	Several dragonfly species	V	Living
	Fish	Unidentified fry	V	Swimming
WF13	Ungulate	Moose	S	Pellets, Browse
	Ungulate	Elk	S	Pellets
WF14	Ungulate	Moose	S	Pellets, Browse
	Ungulate	Elk	S	Pellets
	Owl	Unidentified Owl	S	Body Parts - feather
WF15	Owl	Barred Owl	S	Body Parts - feather
	Bird	Pine Siskin	H	Living
	Ungulate	Moose	S	Pellets
	Bear	Unidentified	S	Feeding
	Ungulate	Moose	S	Tracks, Browse, Pellets
	Small Mammal	Meadow Vole	V	Living
	Amphibian	Long-toed Salamander	V	Breeding
	Invertebrate	several dragonfly species	V	Living, Breeding
WF16	Bird	Warbling Vireo	H	Territorial, Nesting
	Ungulate	Moose	S	Tracks, Browse, Pellets
	Small Mammal	Snowshoe Hare	S	Living
	Bear	Black Bear	S	Scat, Tracks
	Bear	Grizzly Bear	S	Tracks
	Amphibian	Columbia Spotted Frog	V	Living, Breeding
WF17	Ungulate	Moose	S	Tracks, Pellets
	Ungulate	Mule Deer	S	Tracks, Pellets
	Bear	Black Bear	S	Scat
	Bear	Grizzly Bear	S	Tracks
	Ungulate	Elk	S	Pellets
	Amphibian	Long-toed Salamander	V	Breeding
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Invertebrate	Several dragonfly species	V	Living, Breeding
	Feature	Wildlife Trails	S	Moderate use
WF18	Bird	American Redstart, American Robin, Northern Waterthrush, Swainson's Thrush, Varied Thrush	H	Territorial, Nesting

Wetland ID	Species Group	Species	Sign/Visual/ Heard	Plot Activity
WF18	Small Mammal	Red Squirrel	S	Midden
	Bear	Black Bear	S	Tracks
	Ungulate	Moose	S	Tracks, Pellets
	Amphibian	Columbia Spotted Frog	V	Breeding, Living
	Invertebrate	Several dragonfly species	V	Living, Breeding
	Feature	Wildlife Trails	S	High use

REFERENCES

BC Ministry of Forests and Range and BC Ministry of Environment (BC MOFR and BC MOE). 2010. Field Manual for Describing Terrestrial Ecosystems, 2nd edition. BC Ministry of Forests and Range and BC Ministry of Environment, Victoria, BC. Land Management Handbook 25.

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: A Guide to Identification. Land Management Handbook 52. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Victoria, BC.

Appendix E Invasive Plant Plot Data and Plant Descriptions

Table E-1: Invasive plant survey data.

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2017-07-28	AD INV01_17	618635	6051570				x											
2017-08-02	AD INV02_17	617520	6050721				x	x	x									
2017-08-02	AD INV03_17	617695	6049973						x									
2017-08-02	AD INV04_17	616895	6050176						x									
2017-08-02	AD INV05_17	616854	6050157				x											
2017-08-02	AD INV06_17	616610	6050170						x	x								
2017-08-02	AD INV07_17	617052	6050592	x					x									
2017-08-02	AD INV08_17	617251	6050673				x		x									
2017-08-02	AD INV09_17	617515	6050721				x	x	x									
2017-08-02	AD INV10_17	617895	6050726				x		x									
2017-08-02	AD INV11_17	618885	6051189	x			x		x									
2017-08-02	AD INV12_17	618625	6051630				x											
2017-08-02	AD INV13_17	618621	6051742				x											
2017-08-02	AD INV14_17	618562	6051758				x											
2017-08-02	AD INV15_17	618504	6051735				x											
2017-08-02	AD INV16_17	618306	6051811				x		x									
2017-08-02	AD INV17_17	617956	6051711				x											
2017-08-03	AD INV18_17	615854	6051810				x											
2017-08-03	AD INV19_17	615843	6051932				x		x									
2017-08-03	AD INV20_17	616052	6052185						x									
2017-08-03	AD INV21_17	616977	6052389						x									
2017-08-03	AD INV22_17	617210	6052401	x			x		x									
2017-08-03	AD INV23_17	617682	6052520						x									
2017-08-03	AD INV24_17	617879	6052441						x									
2017-08-03	AD INV25_17	618257	6052881						x									

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2017-08-03	AD INV26_17	618845	6052747						x									
2017-08-04	AD INV27_17	621302	6058131				x											
2017-08-04	AD INV28_17	621300	6057785											x				
2017-08-04	AD INV29_17	621330	6057879						x									
2017-08-04	AD INV30_17	621329	6057978				x		x					x				
2017-08-04	AD INV31_17	621395	6058332				x		x					x				
2017-08-04	AD INV32_17	621295	6058056													x		
2017-08-04	AD INV33_17	621140	6057022				x		x					x				
2017-08-04	AD INV34_17	621085	6056748									x						
2017-08-04	AD INV34_17	621249	6057606											x				
2017-08-04	AD INV35_17	621062	6056669						x			x		x				
2017-08-04	AD INV36_17	620522	6053819						x									
2017-08-04	AD INV37_17	620401	6053981	x			x											
2017-08-04	AD INV38_17	620346	6054132				x		x									
2017-08-04	AD INV39_17	620385	6054867				x											
2017-08-04	AD INV40_17	620404	6055017				x											
2017-08-04	AD INV41_17	620378	6055418				x		x									
2017-08-04	AD INV42_17	620521	6055621				x		x									
2017-08-04	AD INV43_17	620757	6056152				x		x									
2017-08-09	AD INV44_17	629966	6057970						x									
2017-08-09	AD INV45_17	629791	6058539					x	x									
2017-08-09	AD INV46_17	629808	6058600					x	x									
2017-08-09	AD INV47_17	629863	6058696					x	x								x	
2017-08-09	AD INV48_17	629893	6058787					x	x									
2017-08-09	AD INV49_17	630131	6058476						x									
2017-08-09	AD INV50_17	629796	6057798				x		x									

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2017-08-09	AD INV50_17	630339	6058388					x	x									
2017-08-09	AD INV51_17	630124	6057381				x											
2017-08-09	AD INV52_17	630006	6057495											x				
2017-08-09	AD INV53_17	629832	6057787		x													
2018-07-18	AD INV01_18	621285	6058096				x				x					x		
2018-07-18	AD INV02_18	620392	6053800				x		x									
2018-07-18	AD INV03_18	620241	6053941				x	x	x									
2018-07-18	AD INV04_18	620026	6054216				x											
2018-07-18	AD INV05_18	620043	6054477				x											
2018-07-18	AD INV06_18	620033	6054510				x											
2018-07-18	AD INV07_18	619077	6053615					x	x									
2018-07-18	AD INV08_18	617909	6053570					x	x									
2018-07-18	AD INV09_18	617540	6053492					x	x									
2018-07-18	AD INV10_18	618446	6053375					x	x	x								
2018-07-18	AD INV11_18	617837	6052449					x	x									
2018-07-18	AD INV12_18	617209	6052385	x			x	x	x									
2018-07-18	AD INV12b_18	616205	6052626					x	x									
2018-07-18	AD INV13_18	617047	6051996					x	x									
2018-07-18	AD INV14_18	616852	6051653					x	x									
2018-07-18	AD INV15_18	616803	6051710				x											
2018-07-18	AD INV16_18	615707	6050783				x											
2018-07-18	AD INV17_18	615512	6050424					x	x									
2018-07-18	AD INV18_18	617061	6051776				x	x										
2018-07-18	AD INV19_18	616976	6051898				x											
2018-07-25	AD INV20_18	619670	6055052					x	x									
2018-07-25	AD INV21_18	619560	6054506					x	x									

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2018-07-25	AD INV22_18	619667	6054035					x	x									
2018-07-25	AD INV23_18	618531	6053480				x	x	x									
2018-07-25	AD INV24_18	618927	6052724				x	x	x									
2018-07-25	AD INV25_18	619250	6052409					x	x									
2018-07-25	AD INV26_18	618750	6052040					x	x									
2018-07-25	AD INV27_18	618619	6051627				x	x	x									
2018-07-25	AD INV28_18	619591	6051140					x	x									
2018-07-25	AD INV29_18	619174	6051260				x											
2018-07-25	AD INV30_18	618887	6051195				x	x	x									
2018-07-25	AD INV31_18	618733	6050717					x	x									
2018-07-25	AD INV32_18	618401	6050740				x	x	x				x					
2018-07-25	AD INV33_18	618293	6050873					x	x									
2018-07-25	AD INV34_18	618292	6050712				x											
2018-07-25	AD INV35_18	617504	6049956						x									
2018-07-25	AD INV36_18	617218	6050024					x	x									
2018-07-25	AD INV37_18	616982	6050201					x										
2018-07-25	AD INV38_18	616418	6050103					x	x									
2018-07-25	AD INV39_18	616567	6050218				x	x	x									
2018-07-25	AD INV40_18	617013	6050598				x	x	x									
2018-07-25	AD INV41_18	617094	6050613				x	x	x									
2018-07-25	AD INV43_18	617258	6050680				x	x	x									
2018-07-25	AD INV43_18	617378	6050831				x	x	x									
2018-07-25	AD INV45_18	617897	6050730				x	x	x									
2018-07-25	AD INV46_18	617847	6050860					x	x									
2018-07-25	AD INV47_18	618074	6050730				x											
2018-07-30	AD INV48_18	627932	6057701					x	x									

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2018-07-30	AD INV49_18	628053	6057496					x	x									
2018-07-30	AD INV50_18	628398	6057370				x											
2018-09-03	FD INV01_18	621985	6056125				x											
2018-09-03	FD INV02_18	617542	6052589				x											
2018-09-03	FD INV03_18	621426	6058852				x											
2018-09-03	FD INV04_18	618609	6054167				x											
2018-09-03	FD INV05_18	617525	6051763				x											
2018-09-19	AD INV51_18	621479	6056120				x	x	x									
2018-09-19	AD INV52_18	621510	6056098	x			x							x				
2018-09-19	AD INV53_18	621896	6056116				x											
2018-09-19	AD INV54_18	621993	6056112				x											
2018-09-19	AD INV55_18	622148	6056127				x	x	x					x				
2018-09-19	AD INV56_18	622883	6056148				x	x	x									
2018-09-19	AD INV57_18	623141	6056180				x											
2018-09-19	AD INV58_18	623203	6056222				x		x									
2018-09-19	AD INV59_18	623248	6056190				x		x									
2018-09-19	AD INV59_18	623607	6056107	x			x	x	x		x							
2018-09-19	AD INV61_18	623832	6056053	x		x	x	x	x		x							
2018-09-19	AD INV62_18	625117	6055650				x	x	x		x							
2018-09-19	AD INV63_18	625324	6055597				x											
2018-09-19	AD INV64_18	625186	6055586				x	x	x									
2018-09-19	AD INV65_18	623404	6056089					x	x									
2018-09-19	AD INV66_18	623177	6056153				x		x									
2018-09-19	AD INV67_18	622713	6056126				x											x
2018-09-19	AD INV68_18	621196	6056088				x		x									
2018-09-19	AD INV69_18	621103	6055813				x	x	x									

Survey Date (YMD)	Plot ID	Easting	Northing	Invasive Species Codes[1]														
				BT	CD	CL	CT	MH	OD	OH	SH	SJ	SM	SO	TC	TH	WG	YT
2018-09-19	AD INV70_18	620941	6056131				x											
2018-09-20	AD INV71_18	629281	6058938				x							x				
2018-09-20	AD INV72_18	629657	6058741					x							x			x
2018-09-20	AD INV73_18	629565	6058565					x	x									

Notes: 1) BT = Bull thistle; CD = Curled dock; CL = Cluster tarweed; CT = Canada thistle; MH = Meadow hawkweed; OD = Oxeye Daisy; OH = Orange hawkweed; SH = Scentless chamomille; SJ = St. John's wort; SM = Smooth hawkweed; SO = Annual sow-thistle; TC = Common tansey; TH = Tall hawkweed; WT = Western goat's-beard; YT = Yellow toadflax

Table E-2: Descriptions of invasive plants identified within the V-LSA.

Annual sow thistle (*Sonchus oleraceus*)

Annual sow thistle is an annual forb that grows up to one metre tall that only reproduces by seed. Plants can produce over 8,000 wind-dispersed seeds, which can remain viable for 30 months when buried. Seed production can be reduced by mowing, and repeated spring tillage can deplete the seed bank (BC MAFF 2002, GISD 2018a). Annual sow thistle was found in a number of patches along Goathorn Road, and along Lawson Road and near the railway tracks in the rail infrastructure area.

(Photo by Jim Riley)

Bull thistle (*Cirsium vulgare*)

Bull thistle is a biennial forb that grows up to 2 m tall on mesic to dry disturbed areas, roadsides, fields and pastures. Its seeds are wind dispersed and can travel long distances. Manual control is possible through cutting the taproot below the crown before seed-set. Small patches containing several plants were found in seven locations, three in the pit/plant area, three along the access corridor and one near the Goathorn Creek crossing.

Canada thistle (*Cirsium arvense*)

Canada thistle is a perennial forb that is between 0.3 to 2 m tall. It has both horizontal roots that produce shoots and vertical roots that store nutrients. It primarily reproduces accessed from its roots which can grow up to 6 m in one year; it also reproduces by wind-dispersed seeds (BC MAFF 2002, GISD 2018d). Control can be difficult; repeated cutting can be effective, with herbicide treatment also used (BC MAFF 2002). Canada thistle is a widespread species that was found in all survey areas, usually in dense patches but occasionally as scattered individuals.

Cluster tarweed (*Madia glomerate*)

Cluster tarweed is a native annual herb that grows up to 0.8 m tall. It is strongly scented and is covered with many sticky glands. It has narrow leaves and inconspicuous yellow flowers. It grows on roadsides open slopes and forest openings (ISCBC and IMISWG 2016, Klinkenberg 2018). Cluster tarweed may displace desirable vegetation and become weedy on overgrazed and disturbed areas (Lass and Prather 2007 *In* Ross 2012). Cluster tarweed was found along the access corridor.

(Photo by Jim Riley)

Common tansy (*Tanacetum vulgare*)

Common tansy is a perennial forb that grows to 1.5m tall that has clusters of yellow button-like flowers that lack ray flowers. Its leaves are deeply divided, and it has rhizomatous roots. It is undesirable to livestock and may be toxic to them. It grows best in full sun on rich well-drained soils (BC MAFF 2002). Mowing will prevent seed production but will not kill the plant. It was found near the railway tracks in the rail infrastructure area. Common tansy was found near the railway tracks in the rail infrastructure area.

Curled dock (*Rumex crispus*)

Curled dock is a perennial forb that has a fleshy taproot that grows up to 1.6 m tall. It produces between 30,000 and 60,000 seeds per plant that are extremely long-lived when buried in the soil. Seed dispersal is primarily by wind and water, though the seeds can also adhere to fur and feathers or be ingested. Root fragments can also be viable (BC MAFF 2002). A few plants were found in one location in the rail infrastructure area.

Meadow hawkweed (*Hieracium caespitosum*)

Meadow hawkweed is a perennial forb that has many small yellow flower heads in a cluster on top of mostly leafless stems. It has a short rhizome and long leafy solons and produces from 12 to 50 seeds per flower head. Seeds are dispersed by wind, animals and humans. It reproduces through seeds, adventitious root buds, rhizomes, stolons and root fragments (Province of British Columbia 2008; Stone 2011, AAF 2018). The presence of stolons, rhizomes, and adventitious root buds complicates the control of meadow hawkweed as they may sprout following treatments (Stone 2011). Meadow hawkweed is present on disturbed ground over most of the project area.

Orange hawkweed (*Hieracium aurantiacum*)

Orange hawkweed is a perennial forb that is covered in stiff hairs and has an orange flower. It produces several hundred seeds that though they are plumed are thought to be primarily dispersed by people, animals and hay. It reproduces by seeds, stolons and rhizomes (BC MAFF 2002). Early detection and eradication are thought to be most effective for preventing spread. Small infestations can be controlled with hand-pulling taking care to not spread roots and stolons; mowing increases vegetative reproduction (BC MAFF 2002, GISD 2018e). Scattered plants were found in two locations in the Pit / Plant area.

Oxeye daisy (*Leucanthemum vulgare*)

Oxeye daisy is a short-lived perennial forb with white ray flowers and yellow disc flowers. Plants produce over 500 seeds that can remain viable for several years. Manual control is possible if done before seed production and with removal of as much of the root system as possible (BC MAFF 2002). Oxeye daisy was present and abundant on disturbed ground over most of the project area.

Scentless chamomile (*Matricaria perforate*)

Scentless Chamomile is an odourless annual to short-lived perennial that grows to 1 m tall. It has finely-divided fern-like leaves, white ray flowers and yellow disc flowers that resemble those of oxeye daisy, and an extensive fibrous root system. It can produce 10,000 to 200,000 seeds per plant. It grows in disturbed areas and is unpalatable to livestock. Control can be achieved by frequent shallow tillage, especially during dry weather (BC MAFF 2002). It was found in several locations along the access corridor route and beside Coalmine Road.

St. John's-wort (*Hypericum perforatum*)

St. Johns-wort is poisonous to livestock in large doses. It is a perennial forb that grows to 1 m tall that has a rhizomatous stem and a deep taproot. It has numerous bright yellow flowers and produces 39,000 sticky seeds per plant that remain viable for 6 to 10 years (BC MAFF 2002; GISD 2018b). Mechanical control is not recommended as it can resprout from its extensive underground rhizomatous root system (GISD 2018b). St John's-wort was found in two 15 m long patches beside Coalmine Road.

Tatarian honeysuckle (*Lonicera tatarica*)

Tatarian honeysuckle is a shrub native to eastern Asia that can grow to 3 metres tall. It has become invasive in North America where it readily invades open woodlands, old fields and other disturbed sites (CISEH 2018) but is not yet recognized as invasive in British Columbia. It has white, pink or crimson tubular flowers and orange or red berries that are spread by birds (CISEH 2018). Control can be done manually for light infestations, preferably before seed dispersal in late summer (USDA n.d.). One occurrence was found along Coalmine Road.

Western goatsbeard (*Tragopogon dubius*)

Western goatsbeard is a biennial forb that grows up to 1 m tall and has a solitary terminal yellow inflorescence. It has a taproot and grows on dry open sites such as meadows and roadsides (NWIPC 2018, TIPC 2018). Mechanical control involves mowing as soon as the flowers appear and again later (TIPC 2018), though other sources indicate this will not control the plant and chemical treatments are required (NWIPC 2018). Scattered Western goat's-beard plants were found in a field in the rail infrastructure area near the railway tracks.

Yellow toadflax (*Linaria vulgaris*)

Yellow toad flax (aka butter and eggs) is a perennial forb, with bright yellow and orange flowers, that grows up to 80 cm tall. It has long taproots, and long lateral roots from which it can reproduce vegetatively. A mature plant can produce 30,000 seeds that can be dormant for 10 years. Seeds primarily land within 50 cm of the parent plant, but can be dispersed by wind, water and ants. Cutting and mowing will reduce seed production, but do not kill the plant and are not recommended as they can stimulate vegetative reproduction (BC MAFF 2002, GISD 2018c). Yellow toadflax was found in two locations in the rail infrastructure area, and along the access corridor.

(Photo by Larry Halverson)

REFERENCES

Alberta Agriculture and Forestry (AAF). 2018. Alberta Weed Monitoring Network, Meadow Hawkweed (*Hieracium caespitosum*). https://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/prm13964

BC Ministry of Agriculture, Food and Fisheries (BC MAFF). 2002. Guide to Weeds in British Columbia. Ministry of Agriculture, Food and Fisheries, Victoria, BC.

Centre for Invasive Species and Ecosystem Health (CISEH). 2018. Tatarian honeysuckle (*Lonicera tatarica* L.) Available: https://www.invasive.org/browse/subinfo.cfm?sub=3043. Accessed Nov. 19, 2018.

Global Invasive Species Database (GISD). 2018a. Species profile: *Sonchus oleraceus*. http://www.iucngisd. org/gisd/speciesname/Sonchus+oleraceus. Accessed Mar. 12, 2018.

Global Invasive Species Database (GISD). 2018b. Species profile: *Hypericum perforatum*. http://www.iucngisd. org/gisd/speciesname/Hypericum+perforatum accessed 12-03-2018.

Global Invasive Species Database (GISD). 2018c. Species profile: *Linaria vulgaris*. http://www.iucngisd.org/gisd/speciesname/Linaria+vulgaris. Accessed Mar. 12, 2018.

Global Invasive Species Database (GISD). 2018d. Species profile: *Cirsium arvense*. http://www.iucngisd.org/gisd/speciesname/Cirsium+arvense. Accessed Mar. 12, 2018.

Global Invasive Species Database (GISD). 2018e. Species profile: *Hieracium aurantiacum*. http://www.iucngisd.org/gisd/speciesname/Hieracium+aurantiacum. Accessed Mar. 12, 2018.

Invasive Species Council of BC and Inter-Ministry Invasive Species Working Group (ISCBC and IMISWG). 2019. Field guide to Noxious Weeds and other Invasive Plant of British Columbia, 10th edition. Available: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/publications/field_guide_to_noxious_weeds_10th_edition_32619.pdf

Klinkenberg, B. (Editor). 2018. E-Flora BC: Electronic Atlas of the Flora of British Columbia [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Available: https://ibis.geog.ubc.ca/biodiversity/eflora/

Northwest Invasive Plant Council (NWIPC). 2018. Tragopogon identification and control. Available: http://nwipc.org/ documents/Tragopogon_ID_sheet_Finalversion.docx

Province of BC. 2008. Forest Range and Practices Act Invasive Plants Identification Field Guide for use with Invasive Plants Resource Stewardship Monitoring Cards. FRPA Resource Evaluation Program. BC Ministry of Forests, Victoria, BC.

Ross, T.C. 2012. Plant guide for mountain tarweed (*Madia glomerata)*. USDA-Natural Resources Conservation Service, Plant Materials Center, Corvallis, OR.

Stone, K.R. 2011. *Hieracium caespitosum*. *In:* Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory Available: http://www.fs.fed.us/database/feis/plants/forb/hiecae/all.html. Accessed Mar. 12, 2018.

Tennessee Invasive Plant Council (TIPC). 2018. *Tragopogon dubius* Scop. Available: http://tnipc.org/invasive-plants/plant-details/?id=118. Accessed Mar. 12, 2018.

United States Department of Agriculture (USDA). n.d. Weed of the Week - Exotic bush Honeysuckles. USDA Forest Service, Forest Health Staff, Newtown Square, PA. https://www.fs.usda.gov/naspf/sites/default/files/naspf/pdf/bush_honeysuckle.pdf

Appendix F Plants Important for Cultural Use

Table F-1: Lookup table for identification of potential ecosystems and structural stage combinations containing culturally important plant speices.

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Black Huckleberry *Vaccinium membranaceum*	ESSFmcw	01	FL	Bl - Huckleberry - Leafy liverwort - Heron's bill							x			x	x	x
	ESSFmcw	02	FC	Bl(PaPl) - Huckleberry - Crowberry - Lichen							x			x	x	x
	ESSFmcw	03	FJ	Bl(PaPl) - Huckleberry - Juniper - Lichen										x	x	x
	ESSFmc	01	FB	Bl - Huckleberry - Leafy liverwort							x			x	x	x
	ESSFmc	03	FC	Bl - Huckleberry - Crowberry							x			x	x	x
	ESSFmc	04	HH	Bl - Huckleberry - Heron's-bill							x				x	x
	ESSFmc	05	FT	Bl - Huckleberry - Thimbleberry							x					x
	ESSFmc	06	FO	Bl - Oak fern - Heron's-bill							x			x	x	x
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	x
	SBSmc2	01	SB	Sxw - Huckleberry							x		x		x	x
	SBSmc2	01a	SB	Sxw - Huckleberry (Mesic, fine-textured)								x	x		x	x
	SBSmc2	01c	SB	Sxw - Huckleberry (Submesic)								x	x	x	x	x
	SBSmc2	02	PH	Pl - Huckleberry - Cladonia							x		x	x	x	x
	SBSmc2	07	BF	Sxw - Scrub birch - Feathermoss							x		x	x		x
	SBSdk	01	SP	Sxw - Spirea - Purple peavine							x	x	x			
	SBSdk	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)								x	x			
	SBSdk	01b	SP	Sxw - Spirea - Purple peavine (Coarse-textured)								x	x			
Buckbean *Menyanthes trifoliata*	SBSmc2	00	OW	Shallow Open Water	x											
	SBSmc2	00	PD	Pond	x											
	SBSmc2	12	SS	SbSxw - Scrub birch - Sedge									x			
	SBSmc2	31	WE	Non-forested bog									x			
	SBSmc2	Wb05	Wb05	Sb - Water sedge - Peat-moss								x	x			
	SBSdk	00	LA	Lake	x											
	SBSdk	00	OW	Shallow Open Water	x											
	SBSdk	00	PD	Pond	x											
	SBSdk	10	SS	Sb - Soft-leaved sedge - Sphagnum							x		x			

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Cow Parsnip *Heracleum maximum*	ESSFmcp	00	HM	Herbaceous Meadow				x								
	ESSFmcp	00	WM	Wet meadow					x							
	ESSFmcw	00	HM	Herbaceous Meadow				x								
	ESSFmcw	04	FV	Bl - Valerian - Leafy moss							x			x	x	x
	ESSFmc	05	FT	Bl - Huckleberry - Thimbleberry							x					
	ESSFmc	06	FO	Bl - Oak fern - Heron's-bill							x			x		
	ESSFmc	07	FD	Bl - Devil's club - Lady fern							x			x		
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	x
	SBSmc2	52	AN	Mountain alder - Stinging nettle									x			
	SBSmc2	52	SL	Sitka alder - Lady Fern							x	x	x			
	SBSmc2	Fl01	Fl01	Mountain alder - Common horsetail									x			
	SBSmc2	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSdk	00	CA	Cow parsnip - Large-leaved avens				x				x				
	SBSdk	08	CD	Act - Dogwood - Prickly rose							x			x	x	x
	SBSdk	53	AM	Mountain alder - Mitrewort											x	x
	SBSdk	Atlf	Atlf	$At - Lady fern seral association											x	x
	SBSdk	Fl01	Fl01	Mountain alder - Common horsetail								x	x			
	SBSdk	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
Devils Club *Oplopanax horridus*	ESSFmc	07	FD	Bl - Devil's club - Lady fern											x	x
	ESSFmc	52	SL	Sitka alder - Lady Fern								x	x			
	SBSmc2	06	SO	Sxw - Oak fern										x	x	x
	SBSmc2	09	SD	Sxw - Devil's club							x	x		x	x	x
	SBSmc2	09a	SD	Sxw - Devil's club (Fluvial)												x
	SBSmc2	09b	SD	Sxw - Devil's club (Morainal)									x	x	x	x
	SBSmc2	10	SH	Sxw - Horsetail											x	x
	SBSmc2	10a	SH	Sxw - Horsetail (Fluvial)												x
	SBSmc2	10b	SH	Sxw - Horsetail (Lacustrine/Morainal)											x	x

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Devils Club *Oplopanax horridus*	SBSmc2	51	WT	Scouler's willow - Thimbleberry									x	x	x	x
	SBSmc2	52	AN	Mountain alder - Stinging nettle									x			
	SBSmc2	52	SL	Sitka alder - Lady Fern							x	x	x			
	SBSmc2	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSdk	00	SD	Sxw - Devil's club (Morainal)							x			x	x	x
	SBSdk	06	ST	Sxw - Twinberry - Coltsfoot											x	x
	SBSdk	07	SH	Sxw - Horsetail											x	x
	SBSdk	07a	SH	Sxw - Horsetail (Freely drained)											x	x
	SBSdk	07b	SH	Sxw - Horsetail (Poorly drained)											x	
	SBSdk	08	CD	Act - Dogwood - Prickly rose							x			x	x	x
	SBSdk	51	WT	Scouler's willow - Thimbleberry								x	x		x	x
	SBSdk	52	AN	Mountain alder - Stinging nettle									x	x		
	SBSdk	52	SL	Sitka alder - Lady Fern									x			
	SBSdk	53	AM	Mountain alder - Mitrewort											x	x
	SBSdk	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
Fireweed *Epilobium angustifolium*	ESSFmcp	00	HM	Herbaceous Meadow				x								
	ESSFmcw	00	HM	Herbaceous Meadow				x								
	ESSFmcw	01	FL	Bl - Huckleberry - Leafy liverwort - Heron's bill							x			x	x	x
	ESSFmcw	04	FV	Bl - Valerian - Leafy moss							x			x	x	x
	ESSFmc	01	FB	Bl - Huckleberry - Leafy liverwort							x			x		
	ESSFmc	05	FT	Bl - Huckleberry - Thimbleberry							x					
	ESSFmc	06	FO	Bl - Oak fern - Heron's-bill							x			x		
	ESSFmc	07	FD	Bl - Devil's club - Lady fern							x			x		
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	x
	ESSFmc	52	SL	Sitka alder - Lady Fern								x	x			
	ESSFmc	82	BW	Bluegrass - Slender wheatgrass								x				
	SBSmc2	05	TC	Sxw - Twinberry - Coltsfoot							x	x	x			

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Fireweed	SBSmc2	06	SO	Sxw - Oak fern							x	x	x			
Epilobium angustifolium	SBSmc2	10	SH	Sxw - Horsetail							x				x	x
	SBSmc2	10a	SH	Sxw - Horsetail (Fluvial)									x			x
	SBSmc2	10b	SH	Sxw - Horsetail (Lacustrine/Morainal)								x	x		x	x
	SBSmc2	82	BW	Bluegrass - Slender wheatgrass							x	x				
	SBSmc2	Atcv	Atcv	$At - Canada violet seral Association											x	
	SBSmc2	Atha	Atha	$At - Hardhack seral association								x	x	x		
	SBSdk	00	CB	Cutbank		x										
	SBSdk	01	SP	Sxw - Spirea - Purple peavine			x		x		x	x	x			
	SBSdk	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)								x	x			
	SBSdk	01b	SP	Sxw - Spirea - Purple peavine (Coarse-textured)								x	x			
	SBSdk	06	ST	Sxw - Twinberry - Coltsfoot							x	x	x		x	x
	SBSdk	07	SH	Sxw - Horsetail							x				x	x
	SBSdk	07a	SH	Sxw - Horsetail (Freely drained)								x			x	x
	SBSdk	07b	SH	Sxw - Horsetail (Poorly drained)											x	
	SBSdk	82	BW	Bluegrass - Slender wheatgrass					x			x				
	SBSdk	Atcv	Atcv	$At - Canada violet seral Association								x			x	x
	SBSdk	Atss	Atss	$At - Saskatoon - Snowberry seral association								x		x	x	
Highbush Cranberry	SBSmc2	05	TC	Sxw - Twinberry - Coltsfoot							x	x	x	x	x	x
Viburnum edule	SBSmc2	09	SD	Sxw - Devil's club							x	x		x	x	x
	SBSmc2	09a	SD	Sxw - Devil's club (Fluvial)												x
	SBSmc2	09b	SD	Sxw - Devil's club (Morainal)									x	x	x	x
	SBSmc2	51	WT	Scouler’s willow - Thimbleberry									x	x	x	x
	SBSmc2	Atcv	Atcv	$At - Canada violet seral Association											x	
	SBSmc2	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSdk	00	SD	Sxw - Devil’s club (Lacustrine/Morainal)							x			x	x	x
	SBSdk	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)								x	x	x	x	x

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Highbush Cranberry *Viburnum edule*	SBSdk	06	ST	Sxw - Twinberry - Coltsfoot							x	x	x	x	x	x
	SBSdk	07	SH	Sxw - Horsetail							x			x	x	x
	SBSdk	07a	SH	Sxw - Horsetail (Freely drained)								x		x	x	x
	SBSdk	07b	SH	Sxw - Horsetail (Poorly drained)											x	
	SBSdk	08	CD	Act - Dogwood - Prickly rose							x			x	x	x
	SBSdk	51	WT	Scouler's willow - Thimbleberry								x	x		x	x
	SBSdk	53	AM	Mountain alder - Mitrewort											x	x
	SBSdk	Atcv	Atcv	$At - Canada violet seral Association								x			x	x
	SBSdk	Atpw	Atpw	$At - Pink wintergreen seral association								x	x	x	x	x
	SBSdk	Epdm	Epdm	Paper birch - Douglas maple										x	x	
	SBSdk	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
Indian Hellebore *Veratrum viride*	BAFAun	00	HM	Herbaceous Meadow				x								
	ESSFmcp	00	HM	Herbaceous Meadow				x								
	ESSFmcp	00	WM	Wet meadow					x							
	ESSFmcw	00	HM	Herbaceous Meadow				x								
	ESSFmcw	04	FV	Bl - Valerian - Leafy moss							x			x	x	x
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	x
Kinnickinnick *Arctostaphylos uva-ursi*	ESSFmcw	03	FJ	Bl(PaPl) - Huckleberry - Juniper - Lichen										x	x	x
	ESSFmc	00	CB	Cutbank		x										
	ESSFmc	00	ES	Exposed Soil		x					x					
	ESSFmc	00	RO	Rock Outcrop		x										
	ESSFmc	02	LC	BlPl - Juniper - Cladonia							x				x	x
	ESSFmc	03	FC	Bl - Huckleberry - Crowberry							x			x	x	x
	SBSmc2	00	CB	Cutbank		x										
	SBSmc2	00	ES	Exposed Soil		x										
	SBSmc2	00	RO	Rock Outcrop		x										
	SBSmc2	03	BM	SbPl - Feathermoss							x	x	x	x	x	x

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Kinnickinnick	SBSdk	00	CB	Cutbank		x										
Arctostaphylos uva-ursi	SBSdk	00	ES	Exposed Soil		x										
	SBSdk	02	LJ	Pl - Juniper - Ricegrass							x			x	x	x
	SBSdk	03	LC	Pl - Feathermoss - Cladina			x				x	x	x	x	x	x
	SBSdk	Atki	Atki	$At - Kinnikinnick seral association									x			
	SBSdk	Atss	Atss	$At - Saskatoon - Snowberry seral association								x		x	x	
Oval-leaved Blueberry	ESSFmcw	01	FL	Bl - Huckleberry - Leafy liverwort - Heron's bill							x			x	x	x
Vaccinium ovalifolium	ESSFmcw	04	FV	Bl - Valerian - Leafy moss							x			x	x	x
	ESSFmcw	05	FG	Bl - Mixed shrub - Glow moss										x	x	x
	ESSFmc	01	FB	Bl - Huckleberry - Leafy liverwort							x			x	x	x
	ESSFmc	05	FT	Bl - Huckleberry - Thimbleberry							x					x
	ESSFmc	06	FO	Bl - Oak fern - Heron's-bill							x			x	x	x
	ESSFmc	07	FD	Bl - Devil's club - Lady fern							x			x	x	x
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	x
	ESSFmc	10	FH	Bl - Horsetail - Leafy moss							x			x	x	x
Red Raspberry	ESSFmc	00	CB	Cutbank		x										
Rubus idaeus	ESSFmc	05	FT	Bl - Huckleberry - Thimbleberry							x					
	ESSFmc	06	FO	Bl - Oak fern - Heron's-bill							x			x	x	
	ESSFmc	08	FV	Bl - Valerian - Sickle moss							x			x	x	
	SBSmc2	00	CB	Cutbank		x										
	SBSmc2	01	SB	Sxw - Huckleberry							x		x		x	
	SBSmc2	01a	SB	Sxw - Huckleberry (Mesic , Fine-textured)								x	x		x	
	SBSmc2	05	TC	Sxw - Twinberry - Coltsfoot							x	x	x		x	
	SBSmc2	06	SO	Sxw - Oak fern							x	x	x		x	
	SBSmc2	10	SH	Sxw - Horsetail							x				x	
	SBSmc2	10a	SH	Sxw - Horsetail (Fluvial)									x			
	SBSmc2	10b	SH	Sxw - Horsetail (Lacustrine/Morainal)								x	x		x	

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Red Raspberry *Rubus idaeus*	SBSmc2	Atcv	Atcv	$At - Canada violet seral Association											x	
	SBSmc2	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSdk	00	CA	Cow parsnip - Large-leaved avens								x				
	SBSdk	00	CB	Cutbank		x										
	SBSdk	01	SP	Sxw - Spirea - Purple peavine							x	x	x		x	
	SBSdk	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)								x	x		x	
	SBSdk	06	ST	Sxw - Twinberry - Coltsfoot							x	x	x		x	
	SBSdk	07	SH	Sxw - Horsetail							x				x	
	SBSdk	07a	SH	Sxw - Horsetail (Freely drained)								x			x	
	SBSdk	Atcv	Atcv	$At - Canada violet seral Association								x			x	
	SBSdk	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
Soopolallie *Shepherdia canadensis*	ESSFmc	02	LC	BlPl - Juniper - Cladonia							x				x	x
	SBSmc2	01	SB	Sxw - Huckleberry							x		x		x	x
	SBSmc2	01c	SB	Sxw - Huckleberry (Submesic)									x	x	x	x
	SBSmc2	02	PH	Pl - Huckleberry - Cladonia							x		x	x	x	x
	SBSdk	01	SP	Sxw - Spirea - Purple peavine							x	x	x		x	x
	SBSdk	01a	SP	Sxw - Spirea - Purple peavine (Fine-textured)								x	x		x	x
	SBSdk	01b	SP	Sxw - Spirea - Purple peavine (Coarse-textured)								x	x	x	x	
	SBSdk	03	LC	Pl - Feathermoss - Cladina							x	x	x	x	x	x
	SBSdk	05	SF	Sxw - Spirea - Feathermoss							x			x	x	x
	SBSdk	Atpw	Atpw	$At - Pink wintergreen seral association									x	x	x	x
	SBSdk	Atss	Atss	$At - Saskatoon - Snowberry seral association								x		x	x	
	SBSdk	Epdm	Epdm	Paper birch - Douglas maple										x	x	
Willow species *Salix* spp.	ESSFmcp	00	WL	Wetland								x				
	ESSFmcw	05	FG	Bl - Mixed shrub - Glow moss										x		
	ESSFmcw	31	WE	Non-forested wetland								x				
	ESSFmc	00	SS	SbSxw - Scrub birch - Sedge							x		x		x	x

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Willow species	ESSFmc	00	WF	Willow - Sedge fen										x		
Salix spp.	ESSFmc	09	HG	Bl - Horsetail - Glow moss							x		x			
	ESSFmc	31	WE	Non-forested wetland								x				
	ESSFmc	32	LS	Non-forested bog								x				
	ESSFmc	52	SL	Sitka alder - Lady Fern								x	x			
	SBSmc2	00	DM	Drummond's willow - Mountain alder									x			
	SBSmc2	00	RS	Riparian Shrub									x			
	SBSmc2	00	WF	Willow - Sedge fen								x	x			
	SBSmc2	12	SS	SbSxw - Scrub birch - Sedge									x		x	x
	SBSmc2	31	WE	Non-forested bog									x			
	SBSmc2	32	LS	Non-forested bog								x				
	SBSmc2	51	WT	Scouler's willow - Thimbleberry									x	x	x	x
	SBSmc2	52	AN	Mountain alder - Stinging nettle									x			
	SBSmc2	52	SL	Sitka alder - Lady Fern							x	x	x			
	SBSmc2	Atcv	Atcv	$At - Canada violet seral Association											x	
	SBSmc2	Atha	Atha	$At - Hardhack seral association								x	x	x		
	SBSmc2	Fl01	Fl01	Mountain alder - Common horsetail									x			
	SBSmc2	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSmc2	Ws03	Ws03	Bebb's willow - Bluejoint reedgrass									x			
	SBSdk	00	DM	Drummond's willow - Mountain alder									x			
	SBSdk	00	WF	Willow - Sedge fen								x	x			
	SBSdk	07	SH	Sxw - Horsetail							x			x	x	x
	SBSdk	07a	SH	Sxw - Horsetail (Freely drained)								x		x	x	x
	SBSdk	07b	SH	Sxw - Horsetail (Poorly drained)											x	
	SBSdk	10	SS	Sb - Soft-leaved sedge - Sphagnum							x		x	x	x	x
	SBSdk	31	WE	Non-forested bog									x			
	SBSdk	32	LS	Non-forested bog								x				

Culturally Important Plant Species	BGC Subzone	Site Series	Map Code	Ecosystem Name[1]	Structural Stage[2]											
					0	1/1a	2	2a	2b	2d	3	3a	4	5	6	7/7a
Willow species *Salix* spp.	SBSdk	51	WT	Scouler's willow - Thimbleberry								x	x		x	x
	SBSdk	52	AN	Mountain alder - Stinging nettle									x	x		
	SBSdk	52	SL	Sitka alder - Lady Fern									x			
	SBSdk	Atcv	Atcv	$At - Canada violet seral Association								x			x	x
	SBSdk	Atha	Atha	$At - Hardhack seral association										x	x	
	SBSdk	Atlf	Atlf	$At - Lady fern seral association											x	x
	SBSdk	Atss	Atss	$At - Saskatoon - Snowberry seral association								x		x	x	
	SBSdk	Epdm	Epdm	Paper birch - Douglas maple										x	x	
	SBSdk	Fl01	Fl01	Mountain alder - Common horsetail								x	x			
	SBSdk	Fm02	Fm02	ActSxw - Red-osier dogwood									x	x	x	x
	SBSdk	Wm01	Wm01	Beaked sedge - Water sedge								x				
	SBSdk	Ws03	Ws03	Bebb's willow - Bluejoint reedgrass									x			
	SBSdk	Ws04	Ws04	Drummond's willow - Beaked sedge								x				
	SBSdk	Xs	Xs	Disclimax shrub								x				

Note: 1) Act = Black Cottonwood, At = Trembling Aspen, Bl = Subalpine Fire, Pa = Whitebark Pine, Pl = Lodgepole Pine, Sb = Black Spruce, Sxw = Hybrid White Spruce
2) 0 = no structure (water, anthropogenic); 1/1a = Sparse/bryoid; 2/2a/2b/2d = Herb/Forb/Graminoid/Dwarf shrub (< 20 to 100+ years old); 3/3a/3b = Shrub/Low Shrub/Tall Shrub (< 20 to 40 years old); 4 = Pole/Sapling (< 40 to 100+ years old); 5 = Young Forest (< 40 to 100+ years old); 6 = Mature Forest (80 to 140 years in SBS, 80 to 250 years in ESSF); 7/7a = Old Forest > 140 years in SBS, > 250 years in ESSF (RIC 1998).

Table F-2: Summary of ecosystem area potentially containing culturally important plant species within the V-RSA and V-LSA.

Culturally Important Plant Species	V-RSA							V-LSA			
	BAFAun Area (ha)	ESSFmcp Area (ha)	ESSFmcw Area (ha)	ESSFmc Area (ha)	SBSmc2 Area (ha)	SBSdk Area (ha)	Total V-RSA Area (ha)	ESSFmc Area (ha)	SBSmc2 Area (ha)	SBSdk Area (ha)	Total V-LSA Area (ha)
Black Huckleberry			764.3	4,013.0	4,979.5	777.8	**10,534.7**	10.5	671.6	28.4	**710.4**
Buckbean					27.1	379.7	**406.8**		7.8	22.3	**30.0**
Cow Parsnip		51.3	186.4	334.8	79.2	438.9	**1,090.5**	0.0	3.4	59.4	**62.9**
Devil's Club				174.5	2,662.0	4,160.1	**6,996.7**	0.0	478.2	407.4	**885.5**
Fireweed		41.5	670.5	996.1	1,501.3	4,970.4	**8,179.8**	1.1	268.7	481.5	**751.3**
Highbush Cranberry					3,046.0	5,717.1	**8,763.1**		171.5	813.0	**984.4**
Indian Hellebore	28.6	51.3	186.4	87.9			**354.2**	0.0	0.0	0.0	**0.0**
Kinnickinnick			29.8	139.2	87.1	1,375.9	**1,632.0**	5.4	58.3	31.3	**95.0**
Oval-Leaved Blueberry			4,878.2	893.1	3,985.1		**4,878.2**	5.1			**5.1**
Red Raspberry				280.3	3,286.9	4,716.5	**8,283.8**	0.0	307.8	417.7	**725.6**
Soopolallie				71.0	4,378.1	7,025.0	**11,474.1**	0.0	177.8	402.9	**580.7**
Willow spp.		0.1	10.4	86.8	166.3	1,167.2	**1,430.8**	0.0	43.2	455.0	**498.2**
Total Area (ha)	***28.6***	***144.1***	***6,726.0***	***7,076.9***	***24,198.6***	***30,728.6***	***64,024.7***	***22.1***	***2,188.3***	***3,118.8***	***5,329.2***

Appendix G: Vegetation Trace Metals Data

Trace Metal Concentrations for Leaf/Stem Tissues with 10 or more Samples

Table G-1: Summary of trace metal concentrations in black twinberry tissue samples (n=15).

Analyte[1, 2]	Average	Median	Minimum	Maximum	Standard Deviation
Moisture	68.54	68.40	60.39	73.30	3.24
Aluminum	31.90	11.98	2.65	147.80	44.34
Antimony	0.00	0.00	0.00	0.01	0.00
Arsenic	0.03	0.02	0.01	0.11	0.04
Barium	94.44	81.65	30.63	229.45	61.15
Beryllium	0.00	0.00	0.00	0.00	0.00
Bismuth	0.03	0.03	0.03	0.04	0.00
Boron	18.21	19.35	7.00	29.05	6.16
Cadmium	0.09	0.10	0.01	0.29	0.07
Calcium	12,763.86	11,434.54	7,780.96	20,746.45	4,509.49
Chromium	0.40	0.24	0.06	1.14	0.38
Cobalt	0.05	0.04	0.01	0.12	0.04
Copper	4.42	4.40	3.21	5.99	0.85
Iron	82.35	49.06	28.17	253.76	75.73
Lead	0.03	0.01	0.01	0.12	0.04
Magnesium	3,250.24	2,962.03	2,431.28	4,824.77	871.58
Manganese	40.34	36.54	18.09	85.13	19.44
Mercury	0.01	0.00	0.00	0.01	0.00
Molybdenum	2.39	1.68	0.44	6.90	2.04
Nickel	1.97	1.60	0.51	5.92	1.37
Phosphorus	4,185.09	4,140.33	2,099.07	6,211.74	1,265.88
Potassium	22,745.61	23,860.76	10,148.51	29,545.52	4,663.16
Selenium	0.04	0.03	0.03	0.10	0.02
Silver	0.02	0.02	0.01	0.02	0.00
Sodium	4.19	3.18	2.52	8.57	2.10
Strontium	80.20	69.11	42.41	205.49	42.90
Thallium	0.00	0.00	0.00	0.00	0.00
Tin	0.03	0.03	0.03	0.04	0.00
Titanium	2.15	0.68	0.24	8.64	2.86
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.12	0.04	0.03	0.54	0.17
Zinc	34.31	34.08	16.73	47.60	8.54

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-2: Summary of trace metal concentrations in subalpine fir tissue samples (n=10).

Analyte[1, 2]	Average	Median	Minimum	Maximum	Standard Deviation
Moisture	64.54	63.65	56.4	77.5	6.34
Aluminum	33.59	21.85	0.48	91.28	34.86
Antimony	0.00	0.00	0.00	0.00	0.00
Arsenic	0.01	0.01	0.01	0.01	0.00
Barium	23.81	32.38	0.85	48.32	19.32
Beryllium	0.00	0.00	0.00	0.00	0.00
Bismuth	0.03	0.03	0.02	0.04	0.01
Boron	9.54	12.53	0.31	20.58	8.01
Cadmium	0.05	0.04	0.00	0.21	0.06
Calcium	2,244.72	3,384.47	153.59	3,928.57	1,789.20
Chromium	0.02	0.01	0.01	0.04	0.01
Cobalt	0.04	0.02	0.00	0.12	0.05
Copper	2.72	2.49	0.14	7.11	2.57
Iron	14.44	15.53	1.20	31.11	12.34
Lead	0.01	0.01	0.00	0.01	0.00
Magnesium	686.98	835.37	47.15	1,363.64	574.95
Manganese	344.08	207.66	7.15	829.61	348.63
Mercury	0.01	0.00	0.00	0.01	0.00
Molybdenum	0.08	0.06	0.01	0.21	0.08
Nickel	0.61	0.78	0.03	1.51	0.52
Phosphorus	2,125.19	2,752.58	79.90	4,488.89	1,764.20
Potassium	8,028.70	11,400.77	569.38	15,511.11	6,517.66
Selenium	0.03	0.03	0.02	0.04	0.01
Silver	0.01	0.01	0.01	0.02	0.00
Sodium	2.92	2.75	2.29	4.44	0.63
Strontium	5.96	6.78	0.39	14.84	5.19
Thallium	0.01	0.00	0.00	0.01	0.00
Tin	0.03	0.03	0.02	0.04	0.01
Titanium	0.18	0.19	0.06	0.38	0.12
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.03	0.03	0.02	0.04	0.01
Zinc	29.86	40.38	1.73	61.78	24.62

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-3: Summary of trace metal concentrations in fireweed tissue samples (n=19).

Analyte[1, 2]	Average	Median	Minimum	Maximum	Standard Deviation
Moisture	76.92	77.60	68.52	85.30	4.67
Aluminum	22.41	10.38	1.00	118.75	33.97
Antimony	0.00	0.00	0.00	0.01	0.00
Arsenic	0.03	0.01	0.01	0.14	0.04
Barium	50.06	34.39	0.88	140.18	47.31
Beryllium	0.00	0.00	0.00	0.01	0.00
Bismuth	0.05	0.04	0.03	0.07	0.01
Boron	15.11	15.06	0.33	40.80	12.60
Cadmium	0.01	0.01	0.00	0.09	0.02
Calcium	9,360.40	11,126.76	548.51	17,074.83	5,999.28
Chromium	0.33	0.11	0.02	1.62	0.49
Cobalt	0.02	0.01	0.01	0.11	0.03
Copper	4.75	5.16	0.26	9.29	3.15
Iron	73.60	65.53	1.67	284.82	79.50
Lead	0.02	0.01	0.01	0.09	0.02
Magnesium	2,795.69	3,076.02	172.91	5,541.14	1,882.69
Manganese	65.16	66.03	2.52	216.87	52.56
Mercury	0.01	0.01	0.00	0.02	0.01
Molybdenum	1.17	0.71	0.02	9.33	2.09
Nickel	0.51	0.49	0.02	1.41	0.40
Phosphorus	3,334.33	3,758.04	177.61	8101.27	2,327.39
Potassium	14,295.96	15,232.07	675.59	3,3469.39	9,774.43
Selenium	0.08	0.05	0.03	0.44	0.12
Silver	0.02	0.02	0.02	0.03	0.00
Sodium	12.15	14.35	3.18	26.01	6.81
Strontium	50.25	56.34	2.01	125.02	35.29
Thallium	0.00	0.00	0.00	0.00	0.00
Tin	0.05	0.04	0.03	0.07	0.01
Titanium	1.16	0.40	0.08	7.28	2.02
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.09	0.05	0.03	0.49	0.13
Zinc	20.56	20.88	0.97	41.94	14.63

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-4: Summary of trace metal concentrations in common horsetail tissue samples (n=15).

Analyte[1, 2]	Average	Median	Minimum	Maximum	Standard Deviation
Moisture	80.20	80.59	72.70	83.70	2.62
Aluminum	55.69	12.39	0.73	313.17	87.98
Antimony	0.01	0.01	0.00	0.01	0.00
Arsenic	0.18	0.05	0.01	0.70	0.22
Barium	61.08	62.35	2.46	136.18	36.83
Beryllium	0.01	0.01	0.00	0.07	0.02
Bismuth	0.05	0.05	0.04	0.06	0.01
Boron	21.81	22.32	1.55	43.70	13.19
Cadmium	0.10	0.06	0.00	0.41	0.12
Calcium	19,706.68	24,002.50	878.64	32,613.64	11,648.04
Chromium	0.97	0.81	0.02	3.30	0.84
Cobalt	0.80	0.21	0.01	4.25	1.42
Copper	4.91	5.67	0.42	8.87	2.56
Iron	148.38	92.40	1.83	476.86	146.02
Lead	0.04	0.01	0.01	0.13	0.04
Magnesium	6,199.39	6,932.52	307.69	12,518.29	3,495.28
Manganese	177.58	81.56	7.48	962.89	248.37
Mercury	0.01	0.01	0.00	0.02	0.00
Molybdenum	0.59	0.65	0.02	1.46	0.48
Nickel	1.26	0.52	0.02	6.33	1.94
Phosphorus	1,784.17	1,961.49	126.74	3,380.37	975.09
Potassium	28,812.42	35,226.38	1,689.32	41,029.41	14,131.71
Selenium	1.73	0.06	0.04	23.04	5.90
Silver	0.03	0.03	0.02	0.03	0.00
Sodium	61.65	51.02	3.66	257.09	60.80
Strontium	123.20	144.37	4.37	221.19	68.65
Thallium	0.01	0.00	0.00	0.11	0.03
Tin	0.08	0.05	0.04	0.39	0.09
Titanium	1.39	0.64	0.09	6.56	1.99
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.17	0.05	0.04	0.99	0.27
Zinc	23.18	23.79	2.39	41.27	12.36

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-5: Summary of trace metal concentrations in Scouler's willow tissue samples (n=12).

Analyte[1, 2]	Average	Median	Minimum	Maximum	Standard Deviation
Moisture	73.26	71.42	65.30	83.90	7.05
Aluminum	3.91	3.67	0.58	8.82	3.20
Antimony	0.00	0.00	0.00	0.01	0.00
Arsenic	0.02	0.01	0.01	0.06	0.02
Barium	22.11	12.72	0.98	102.63	29.87
Beryllium	0.00	0.00	0.00	0.01	0.00
Bismuth	0.04	0.04	0.03	0.06	0.01
Boron	18.29	20.27	0.29	57.16	16.90
Cadmium	0.93	0.48	0.06	5.75	1.57
Calcium	6,738.42	7,573.92	541.14	14,371.07	5,070.08
Chromium	0.04	0.03	0.01	0.09	0.03
Cobalt	0.47	0.42	0.03	1.14	0.41
Copper	3.96	4.75	0.17	9.13	3.07
Iron	39.87	45.28	1.44	88.99	31.83
Lead	0.01	0.01	0.01	0.01	0.00
Magnesium	1,800.72	2,037.93	115.43	3,390.91	1,345.86
Manganese	139.46	48.76	2.84	652.11	197.99
Mercury	0.00	0.00	0.00	0.01	0.00
Molybdenum	0.13	0.12	0.01	0.29	0.10
Nickel	2.98	2.29	0.14	12.22	3.38
Phosphorus	3,561.31	3,048.88	136.02	10,958.08	3,465.93
Potassium	18,452.64	15,170.87	881.84	53,173.65	16,675.74
Selenium	0.16	0.05	0.03	1.32	0.37
Silver	0.02	0.02	0.01	0.03	0.01
Sodium	6.37	3.60	2.88	18.41	5.07
Strontium	42.49	29.70	2.70	128.73	40.55
Thallium	0.00	0.00	0.00	0.00	0.00
Tin	0.04	0.04	0.03	0.06	0.01
Titanium	0.44	0.39	0.07	0.99	0.31
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.04	0.04	0.03	0.06	0.01
Zinc	67.82	67.84	4.70	164.78	56.73

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Trace Metal Concentrations for Berry Samples

Table G-6: Summary of trace metal concentrations in berry species tissue samples with 1 to 2 samples.

Common Name	Black Gooseberry	Black Huckleberry		Black Twinberry	Devils Club	Red Raspberry	
Tissue	Berries	Berries		Berries	Berries	Berries	
Sample ID	TC-V-032	TC-V-046	TC-V-049	TC-V-008	TC-V-030	TC-V-088	TC-V-116
Plot	IR001	Metals4	WF09U	AD041	BR13	LTVeg09	LTVeg19
Sample Date	17-07-24	18-08-08	18-08-07	17-07-26	18-08-17	19-08-08	19-08-09
Location	Rail Loadout	Goathorn Creek	Minesite	Minesite	Minesite	Minesite	Minesite
Analyte[1, 2]							
Moisture	80.8	68.9	86.3	81.8	74.7	76.5	82.7
Aluminum	1.042	0.643	1.460	1.099	0.791	0.850	1.158
Antimony	0.005	0.003	0.007	0.005	0.004	0.004	0.006
Arsenic	0.013	0.008	0.018	0.014	0.010	0.011	0.014
Barium	0.365	3.170	0.307	18.681	0.996	10.077	12.798
Beryllium	0.005	0.003	0.007	0.005	0.004	0.004	0.006
Bismuth	0.052	0.032	0.073	0.055	0.040	0.043	0.058
Boron	0.521	0.965	0.730	11.154	1.107	14.329	16.504
Cadmium	0.005	0.003	0.007	0.031	0.004	0.123	0.166
Calcium	166.146	215.434	40.876	2,835.165	147.036	1,743.266	1,824.164
Chromium	0.026	0.016	0.036	0.027	0.020	0.021	0.029
Cobalt	0.010	0.006	0.015	0.011	0.008	0.029	0.062
Copper	0.161	0.212	0.190	6.648	0.474	3.729	3.909
Iron	2.604	1.608	3.650	30.220	1.976	35.291	32.430
Lead	0.010	0.006	0.015	0.011	0.008	0.009	0.012
Magnesium	55.729	62.058	23.358	1,439.560	93.676	1,292.568	1,575.151
Manganese	0.438	2.325	1.387	13.132	1.992	139.461	295.920

Common Name	Black Gooseberry	Black Huckleberry		Black Twinberry	Devils Club	Red Raspberry	
Tissue	Berries	Berries		Berries	Berries	Berries	
Sample ID	TC-V-032	TC-V-046	TC-V-049	TC-V-008	TC-V-030	TC-V-088	TC-V-116
Plot	IR001	Metals4	WF09U	AD041	BR13	LTVeg09	LTVeg19
Sample Date	17-07-24	18-08-08	18-08-07	17-07-26	18-08-17	19-08-08	19-08-09
Location	Rail Loadout	Goathorn Creek	Minesite	Minesite	Minesite	Minesite	Minesite
Analyte[1, 2]							
Mercury	0.005	0.003	0.007	0.005	0.004	0.004	0.006
Molybdenum	0.026	0.048	0.036	0.258	0.020	0.293	0.214
Nickel	0.026	0.016	0.036	1.654	0.055	0.935	1.210
Phosphorus	191.667	110.611	18.248	3,269.231	265.613	3,027.331	3,630.956
Potassium	973.958	659.164	372.263	13,296.703	1,600.791	8,248.626	1,2161.096
Selenium	0.052	0.032	0.073	0.055	0.040	0.043	0.058
Silver	0.026	0.016	0.036	0.027	0.020	0.021	0.029
Sodium	5.208	3.215	7.299	5.495	3.953	4.252	5.791
Strontium	0.719	1.135	0.036	23.407	0.506	7.313	6.602
Thallium	0.003	0.002	0.004	0.003	0.002	0.002	0.003
Tin	0.052	0.032	0.073	0.055	0.040	0.043	0.058
Titanium	0.130	0.080	0.182	0.137	0.099	0.106	0.145
Uranium	0.003	0.002	0.004	0.003	0.002	0.002	0.003
Vanadium	0.052	0.032	0.073	0.055	0.040	0.043	0.058
Zinc	0.677	0.965	0.365	17.088	0.711	22.918	28.260

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-7: Summary of trace metal concentrations in berry species tissue samples with 3 to 4 samples.

Common Name	Red Elderberry				Soopolallie		
Tissue	Leaves/ Berries				Berries		
Sample ID	TC-V-029	TC-V-087	TC-V-115	TC-V-120	TC-V-001	TC-V-003	TC-V-033
Plot	BR13	LTVeg09	LTVeg19	LTVeg20	AD001	AD006	IR006
Sample Date	18-08-17	19-08-08	19-08-09	19-08-09	17-07-24	17-07-24	17-07-24
Location	Minesite	Minesite	Minesite	Minesite	Rail Loadout	Rail Loadout	Rail Loadout
Analyte[1, 2]							
Moisture	75	79.6	81.6	80.5	71.3	74.2	75.3
Aluminum	0.800	24.964	39.491	40.219	9.512	3.953	0.810
Antimony	0.004	0.005	0.005	0.005	0.007	0.004	0.004
Arsenic	0.010	0.012	0.014	0.013	0.009	0.010	0.010
Barium	3.548	92.695	202.629	172.952	3.352	4.380	0.417
Beryllium	0.004	0.005	0.005	0.005	0.003	0.004	0.004
Bismuth	0.040	0.049	0.054	0.051	0.035	0.039	0.040
Boron	0.880	28.054	41.397	56.798	14.878	15.543	1.053
Cadmium	0.004	0.005	0.005	0.005	0.022	0.015	0.004
Calcium	210.400	9,759.921	13,671.992	12,331.762	1,292.683	1,065.891	87.045
Chromium	0.020	0.069	0.027	0.056	0.077	0.070	0.020
Cobalt	0.008	0.010	0.052	0.028	0.007	0.008	0.008
Copper	0.328	3.889	3.775	5.936	3.624	6.783	0.251
Iron	2.000	127.026	55.015	53.728	41.812	37.597	2.024
Lead	0.008	0.010	0.011	0.010	0.007	0.008	0.008
Magnesium	121.200	3,594.986	5,087.506	3,991.193	623.693	612.403	38.866
Manganese	2.328	192.746	500.580	425.727	13.693	14.225	1.032
Mercury	0.004	0.010	0.011	0.011	0.003	0.004	0.004
Molybdenum	0.096	1.089	0.665	0.901	3.474	2.899	0.117

Common Name	Red Elderberry				Soopolallie		
Tissue	Leaves/ Berries				Berries		
Sample ID	TC-V-029	TC-V-087	TC-V-115	TC-V-120	TC-V-001	TC-V-003	TC-V-033
Plot	BR13	LTVeg09	LTVeg19	LTVeg20	AD001	AD006	IR006
Sample Date	18-08-17	19-08-08	19-08-09	19-08-09	17-07-24	17-07-24	17-07-24
Location	Minesite	Minesite	Minesite	Minesite	Rail Loadout	Rail Loadout	Rail Loadout
Analyte[1, 2]							
Nickel	0.020	0.966	1.329	1.944	2.073	2.853	0.235
Phosphorus	280.000	6,915.321	8,333.924	8,238.231	2,752.613	3,069.767	166.802
Potassium	1,232.000	5,0025.726	42,214.318	51,680.830	12,264.808	9,922.481	538.462
Selenium	0.040	0.049	0.054	0.051	0.206	0.143	0.040
Silver	0.020	0.025	0.027	0.026	0.017	0.019	0.020
Sodium	4.000	4.904	12.528	5.117	3.484	3.876	4.049
Strontium	0.980	57.382	75.169	64.473	6.760	5.155	0.348
Thallium	0.002	0.002	0.003	0.003	0.002	0.002	0.002
Tin	0.040	0.049	0.054	0.051	0.035	0.039	0.040
Titanium	0.100	0.441	0.708	0.778	0.662	0.260	0.101
Uranium	0.002	0.002	0.003	0.003	0.002	0.002	0.002
Vanadium	0.040	0.049	0.054	0.051	0.035	0.039	0.040
Zinc	0.760	26.926	28.924	37.149	11.777	12.442	0.891

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples.

Table G-8: Summary of trace metal concentrations in highbush cranberry samples (n=11).

Analyte[1, 2]	Average	Median	Min	Max	Standard Deviation
Moisture	81.73	83.10	71.70	85.95	4.32
Aluminum	3.42	2.78	0.71	9.25	3.02
Antimony	0.01	0.01	0.00	0.01	0.00
Arsenic	0.01	0.01	0.01	0.02	0.00
Barium	10.60	11.88	0.24	25.85	9.33
Beryllium	0.01	0.01	0.00	0.01	0.00
Bismuth	0.06	0.06	0.04	0.07	0.01
Boron	8.11	10.26	0.35	17.61	6.56
Cadmium	0.02	0.02	0.00	0.05	0.01
Calcium	1,155.13	1,468.75	72.08	2,402.07	881.20
Chromium	0.04	0.03	0.02	0.11	0.03
Cobalt	0.01	0.01	0.01	0.01	0.00
Copper	2.09	2.29	0.13	4.24	1.61
Iron	11.51	14.09	1.77	21.35	7.40
Lead	0.01	0.01	0.01	0.01	0.00
Magnesium	662.60	868.25	31.06	1324.31	513.81
Manganese	2.56	2.28	0.15	6.76	2.07
Mercury	0.01	0.01	0.00	0.01	0.00
Molybdenum	0.15	0.11	0.02	0.42	0.13
Nickel	0.33	0.27	0.03	0.92	0.29
Phosphorus	1,165.69	1,275.00	101.04	2,382.84	911.44
Potassium	7,177.57	10,063.80	508.83	13,877.09	5,332.66
Selenium	0.06	0.06	0.04	0.07	0.01
Silver	0.03	0.03	0.02	0.04	0.01
Sodium	7.26	5.92	3.53	24.19	5.71
Strontium	6.74	7.44	0.20	14.26	5.59
Thallium	0.00	0.00	0.00	0.00	0.00
Tin	0.06	0.06	0.04	0.07	0.01
Titanium	0.19	0.15	0.09	0.45	0.11
Uranium	0.00	0.00	0.00	0.00	0.00
Vanadium	0.06	0.06	0.04	0.07	0.01
Zinc	5.56	7.70	0.26	11.69	4.38

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples

Comparison of Trace Metal Concentrations for Plant Species Obtained from the Same Plot

Table G-9: Summary of trace metal concentrations in plant tissues from Plot LTVeg05, lower Goathorn Creek area.

Analyte[1, 2]	Black Twinberry Leaves/ Stems	Cow Parsnip Leaves/ Stems	Fireweed Leaves/ Stems	Highbush Cranberry Berries	Western Mountain-ash Leaves/ Stems
Moisture	67.7	72.3	77.6	84.0	67.6
Aluminum	11.98	71.84	118.75	7.19	49.07
Antimony	0.003	0.004	0.004	0.006	0.003
Arsenic	0.020	0.073	0.143	0.016	0.053
Barium	60.06	164.98	140.18	23.88	354.94
Beryllium	0.003	0.004	0.004	0.006	0.003
Bismuth	0.031	0.036	0.045	0.063	0.031
Boron	20.43	17.73	7.28	7.38	17.65
Cadmium	0.041	0.092	0.012	0.019	0.182
Calcium	10,279	16,065	16,250	1,469	21,636
Chromium	0.291	0.231	1.616	0.113	0.568
Cobalt	0.025	0.108	0.110	0.013	0.053
Copper	5.82	4.08	5.94	2.14	4.66
Iron	52.63	173.29	284.82	16.88	135.80
Lead	0.031	0.057	0.093	0.013	0.054
Magnesium	2,510.8	3,368.2	2,866.1	756.3	4,629.6
Manganese	20.5	98.6	98.7	3.0	592.6
Mercury	0.009	0.008	0.013	0.006	0.015
Molybdenum	1.55	7.15	9.33	0.30	5.49
Nickel	1.54	1.48	0.58	0.44	1.74
Phosphorus	2,099	6,137	4,464	1,275	10,093
Potassium	24,427	46,570	16,518	11,000	19,691
Selenium	0.031	0.036	0.045	0.063	0.031
Silver	0.015	0.018	0.022	0.031	0.015
Sodium	3.10	10.83	14.73	6.25	3.09
Strontium	42.41	71.48	69.20	7.44	106.79
Thallium	0.002	0.002	0.002	0.003	0.002
Tin	0.031	0.036	0.045	0.063	0.031
Titanium	0.68	5.60	7.28	0.37	2.07
Uranium	0.002	0.002	0.002	0.003	0.002
Vanadium	0.031	0.300	0.491	0.063	0.151
Zinc	33.75	29.68	16.38	5.19	44.14

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples

Table G-10: Summary of trace metal concentrations in plant tissues from Plot LTVeg06, lower Goathorn Creek area.

Analyte[1, 2]	Black Twinberry	Common Horsetail	Cow Parsnip	Fireweed	Tea-leaved Willow
	Leaves/ Stems	Leaves/ Stems	Leaves/ Stems	Leaves/ Stems	Leaves/ Stems
Moisture	68.4	82.4	52.9	85.3	72.4
Aluminum	106.96	12.39	4.73	9.86	4.42
Antimony	0.008	0.006	0.002	0.007	0.004
Arsenic	0.113	0.033	0.012	0.017	0.020
Barium	200.95	63.07	31.85	108.84	53.26
Beryllium	0.003	0.006	0.002	0.007	0.004
Bismuth	0.032	0.057	0.021	0.068	0.036
Boron	10.00	32.44	25.69	25.92	23.48
Cadmium	0.095	0.412	0.017	0.007	1.145
Calcium	13,924	32,614	11,465	17,075	10,797
Chromium	1.139	0.585	0.034	0.102	0.058
Cobalt	0.115	0.151	0.092	0.014	0.311
Copper	4.72	5.67	9.53	8.10	5.54
Iron	229.11	74.43	76.43	113.61	53.62
Lead	0.076	0.032	0.012	0.014	0.016
Magnesium	2,962.0	5,170.5	3,949.0	4,605.4	2,572.5
Manganese	85.1	72.7	72.0	100.7	103.6
Mercury	0.009	0.006	0.004	0.022	0.004
Molybdenum	6.90	0.69	0.89	0.73	0.33
Nickel	2.52	0.52	1.83	0.76	3.01
Phosphorus	5,791	1,432	6,476	3,803	2,359
Potassium	23,861	37,727	40,340	33,469	22,754
Selenium	0.032	0.057	0.021	0.068	0.036
Silver	0.016	0.028	0.011	0.034	0.018
Sodium	8.23	70.45	5.73	19.05	3.62
Strontium	75.00	147.73	33.33	60.41	50.00
Thallium	0.002	0.003	0.001	0.003	0.002
Tin	0.032	0.057	0.021	0.068	0.036
Titanium	7.94	0.99	1.35	1.27	0.79
Uranium	0.002	0.003	0.001	0.003	0.002
Vanadium	0.437	0.057	0.021	0.068	0.036
Zinc	37.66	39.38	34.39	22.38	86.23

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples

Table G-11: Summary of trace metal concentrations in plant tissues from Plot LTVeg09, minesite area.

Analyte[1, 2]	Black Twinberry Leaves/ Stems	Fireweed Leaves/ Stems	Highbush Cranberry Berries	Red Elderberry Leaves/ Berries	Red Raspberry Berries	Western Mountain-ash Leaves/ Stems
Moisture	68.4	71.3	85.8	79.6	76.5	66
Aluminum	1.74	14.06	6.97	24.96	0.85	8.24
Antimony	0.001	0.003	0.007	0.005	0.004	0.003
Arsenic	0.003	0.009	0.018	0.012	0.011	0.007
Barium	25.80	63.33	25.85	92.69	10.08	101.18
Beryllium	0.001	0.003	0.007	0.005	0.004	0.003
Bismuth	0.010	0.035	0.070	0.049	0.043	0.029
Boron	5.46	18.96	17.61	28.05	14.33	19.56
Cadmium	0.023	0.008	0.019	0.005	0.123	0.162
Calcium	2,830	9,778	2,402	9,760	1,743	11,941
Chromium	0.034	0.094	0.035	0.069	0.021	0.124
Cobalt	0.002	0.007	0.014	0.010	0.029	0.019
Copper	1.27	4.87	3.83	3.89	3.73	2.78
Iron	8.90	46.63	14.09	127.03	35.29	47.94
Lead	0.002	0.007	0.014	0.010	0.009	0.013
Magnesium	796.0	3,076.0	1,324.3	3,595.0	1,292.6	4,205.9
Manganese	13.0	105.4	6.8	192.7	139.5	750.0
Mercury	0.001	0.007	0.007	0.010	0.004	0.011
Molybdenum	0.16	0.37	0.20	1.09	0.29	0.60
Nickel	0.51	0.33	0.72	0.97	0.94	2.66
Phosphorus	1,370	3,758	2,346	6,915	3,027	7,824
Potassium	6,510	14,127	13,877	50,026	8,249	18,471
Selenium	0.010	0.035	0.070	0.049	0.043	0.029
Silver	0.005	0.017	0.035	0.025	0.021	0.015
Sodium	1.00	6.96	7.04	4.90	4.25	2.94
Strontium	14.90	48.02	13.45	57.38	7.31	48.82
Thallium	0.001	0.002	0.004	0.002	0.002	0.001
Tin	0.010	0.035	0.070	0.049	0.043	0.029
Titanium	0.12	0.30	0.18	0.44	0.11	0.79
Uranium	0.001	0.002	0.004	0.002	0.002	0.001
Vanadium	0.010	0.035	0.070	0.049	0.043	0.029
Zinc	11.70	20.88	11.69	26.93	22.92	19.38

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples

Table G-12: Summary of trace metal concentrations in plant tissues from Plot LTVeg19, minesite area.

Analyte[1, 2]	Black Twinberry	Fireweed	Red Elderberry	Red Raspberry	Western Mountain-ash
	Leaves/ Stems	Leaves/ Stems	Leaves/ Berries	Berries	Leaves/ Stems
Moisture	67.6	68.5	81.6	82.7	68.5
Aluminum	8.75	9.31	39.49	1.16	6.86
Antimony	0.003	0.003	0.005	0.006	0.003
Arsenic	0.008	0.008	0.014	0.014	0.008
Barium	132.27	133.12	202.63	12.80	129.84
Beryllium	0.003	0.003	0.005	0.006	0.003
Bismuth	0.031	0.032	0.054	0.058	0.032
Boron	22.75	22.94	41.40	16.50	22.92
Cadmium	0.103	0.089	0.005	0.166	0.205
Calcium	11,435	11,692	13,672	1,824	11,651
Chromium	0.105	0.108	0.027	0.029	0.133
Cobalt	0.019	0.021	0.052	0.062	0.069
Copper	3.92	3.91	3.77	3.91	3.33
Iron	34.92	34.31	55.01	32.43	71.43
Lead	0.006	0.006	0.011	0.012	0.023
Magnesium	2,435.2	2,522.6	5,087.5	1,575.2	3,555.6
Manganese	47.0	46.7	500.6	295.9	1314.3
Mercury	0.003	0.010	0.011	0.006	0.013
Molybdenum	0.71	0.77	0.66	0.21	2.72
Nickel	1.35	1.41	1.33	1.21	1.46
Phosphorus	6,212	64,81	8,334	3,631	6,635
Potassium	24,043	24,845	42,214	12,161	21,683
Selenium	0.031	0.032	0.054	0.058	0.032
Silver	0.015	0.016	0.027	0.029	0.016
Sodium	3.09	3.18	12.53	5.79	3.17
Strontium	58.41	59.41	75.17	6.60	48.25
Thallium	0.002	0.002	0.003	0.003	0.002
Tin	0.031	0.032	0.054	0.058	0.032
Titanium	0.59	0.58	0.71	0.14	0.73
Uranium	0.002	0.002	0.003	0.003	0.002
Vanadium	0.031	• 0.032	0.054	0.058	0.032
Zinc	43.88	41.94	28.92	28.26	31.75

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples

Table G-13: Summary of trace metal concentrations in plant tissues from Plot LTVeg21 (access corridor area).

Analyte[1, 2]	Black Cotton-wood Leaves/ Stems	Black Twinberry Leaves/ Stems	Highbush Cranberry Berries	Prickly Rose Leaves/ Stems	Red-osier Dogwood Leaves/ Stems	Scouler's Willow Leaves/ Stems
Moisture	65.7	65.6	83.1	67.8	66.0	68.2
Aluminum	7.15	16.45	2.78	8.02	8.49	8.82
Antimony	0.003	0.003	0.006	0.003	0.003	0.003
Arsenic	0.007	0.020	0.015	0.016	0.017	0.016
Barium	59.25	71.50	7.87	40.11	63.15	21.66
Beryllium	0.003	0.003	0.006	0.003	0.003	0.003
Bismuth	0.029	0.029	0.059	0.031	0.029	0.031
Boron	16.90	25.58	14.20	18.09	14.75	9.64
Cadmium	0.989	0.156	0.022	0.011	0.003	0.370
Calcium	22,037	20,142	1,450	16,478	20,562	10,738
Chromium	0.181	0.238	0.030	0.062	0.091	0.091
Cobalt	0.601	0.055	0.012	0.006	0.013	0.276
Copper	7.56	5.99	3.65	2.77	5.14	3.14
Iron	33.86	65.40	15.39	53.16	49.94	46.47
Lead	0.006	0.013	0.012	0.006	0.006	0.006
Magnesium	4,465.9	4,824.8	946.9	3,824.0	4,083.0	3,390.9
Manganese	80.0	42.7	2.3	120.9	32.9	37.4
Mercury	0.003	0.014	0.006	0.003	0.003	0.003
Molybdenum	0.12	1.88	0.07	0.37	0.77	0.29
Nickel	3.85	0.76	0.27	0.22	0.56	3.23
Phosphorus	3415	3139	1728	2307	4200	2914
Potassium	20,841	19,822	10,889	16,136	1,1544	14,286
Selenium	0.029	0.029	0.059	0.031	0.029	0.144
Silver	0.015	0.015	0.030	0.016	0.015	0.016
Sodium	2.92	2.91	5.92	3.11	2.94	3.14
Strontium	227.96	205.49	14.26	189.03	212.96	128.73
Thallium	0.001	0.001	0.003	0.002	0.001	0.002
Tin	0.029	0.029	0.059	0.031	0.029	0.031
Titanium	0.52	1.10	0.15	0.67	0.66	0.79
Uranium	0.001	0.001	0.003	0.002	0.001	0.002
Vanadium	0.029	0.058	0.059	0.031	0.029	0.031
Zinc	140.11	38.95	8.29	11.01	28.32	25.84

Note: 1) Moisture reported in % wet weight, all other values in mg/kg dry
2) Metals below method detection limit were replaced with half the wet tissue method detection limit converted for dry weight of individual samples