Appendix 13-A

Terrestrial Ecosystem Mapping Report

Terrestrial Ecosystem Mapping Report

Crown Mountain Coking Coal Project
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1 Introduction

Terrestrial ecosystem mapping (TEM) stratifies a landscape into map polygons based on ecological features including climate, vegetation, physiography, surficial material, bedrock geology, and soil (Ecosystems Working Group, 1998). It is based on the Biogeoclimatic Ecosystem Classification (BEC) system which was developed in British Columbia to classify and manage sites based on ecosystem features. TEM involves more detailed information than Predictive Ecosystem Mapping (PEM), as it requires direct air-photo interpretation and field surveys of ecosystem attributes to verify ecosystem identification and boundaries (Ecosystems Working Group, 1998). The map products offer valuable information for various uses, such as forest management, wildlife capability and suitability mapping, and potential rare species mapping (Ecosystems Working Group, 1998).

Keefer Ecological Services Ltd. (KES) was retained by NWP Coal Canada Ltd. (NWP) to complete Crown Mountain Coking Coal Project TEM. Mapping needs were reviewed by local regulators to ensure the product that has been created is acceptable for submission to the Environmental Assessment (EA) process. Initial field sampling was conducted during the summer and autumn of 2014. Subsequent site visits, up to the present, for a range of studies, have provided additional observations to verify and refine mapping. After the final publication of the BEC for the East Kootenay (MacKillop et al., 2018), classifications were adjusted where required.

The project objective was to create a survey intensity level four, 1:20,000 scale TEM (Ecosystems Working Group, 1998) for the Local Study Area (LSA; Figure 1-1) around NWP's coal licence and disturbance footprint area. The total area covered by the TEM is 12,886 hectares (ha). The study area was identified by adding a 1-kilometer (km) buffer around all coal licenses and potential transportation corridors at the request of Deb Mackillop, Research Ecologist, Kootenay/Boundary Region, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. The TEM will be used for habitat modeling, effects assessment, mitigation, and management plans.

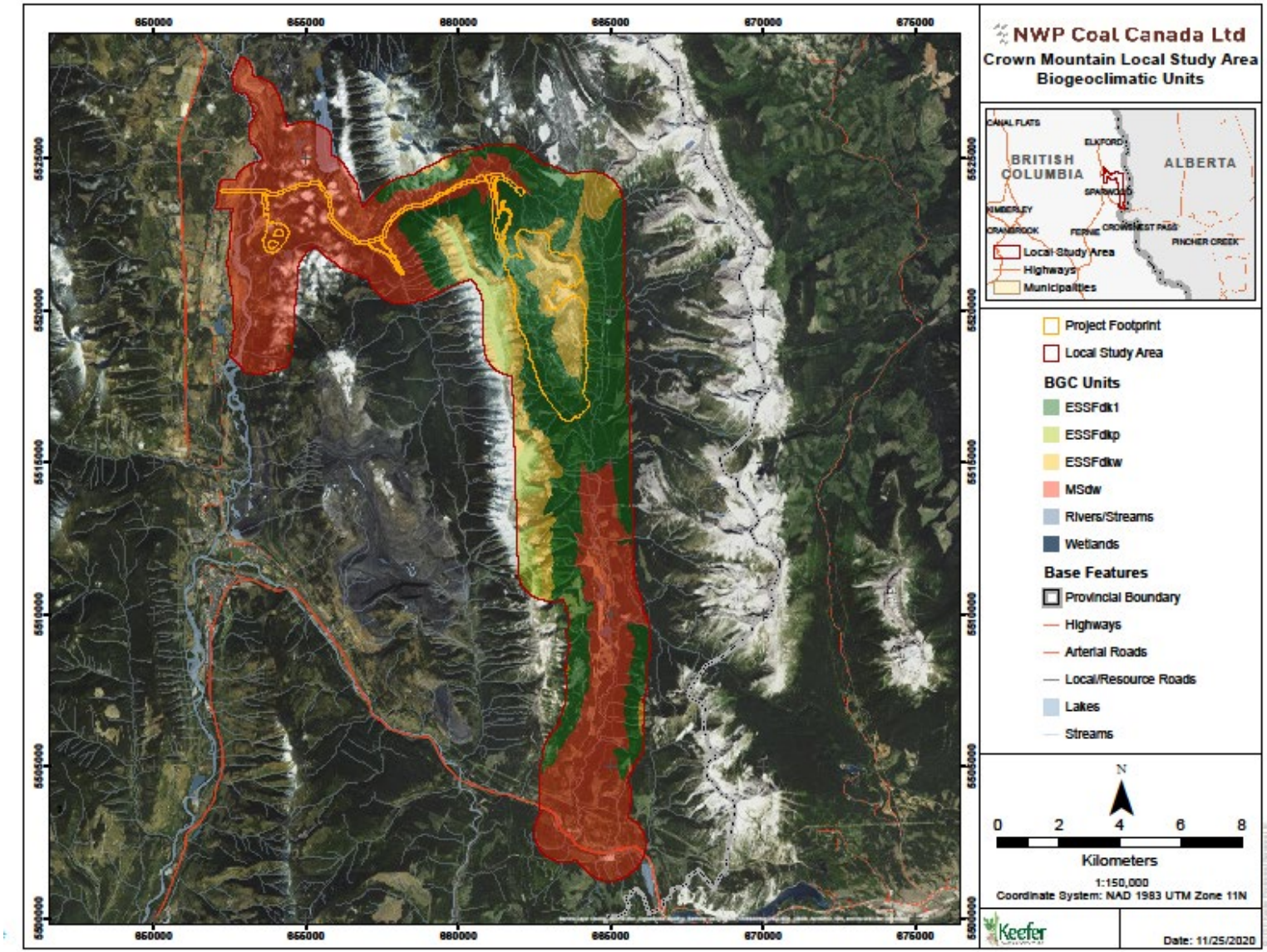

Figure 1-1 Map of study area showing distribution of BEC subzones and variants.

1.1 Study Area Biogeoclimatic (BGC) Units

Dry Warm Montane Spruce (MSdw)

The Dry Warm Montane Spruce (MSdw) subzone is located at low to mid-elevations from valley bottom to the Engelmann Spruce-Subalpine Fir zone (about 1,600 meters (m)). The MSdw is characterised by dry, cool winters and dry, warm summers and autumns. Winter snowpacks are moderately deep and frequently persist from late November through March (MacKillop et al., 2018). The MSdw covers a wide range of ecosystems from isolated warm aspect grasslands to rock outcrops, wetlands, and forests. Common tree species are hybrid white spruce, Douglas-fir, lodgepole pine, western larch, trembling aspen, and black cottonwood. Non-forested grassland or brushland communities are infrequent and associated with steep warm aspects often in upper to crest slope positions, apart from Grave Prairie, a level river terrace just south of the confluence of Grave Creek and the Elk River. Avalanche paths rarely extend into the MSdw, with a few runout zones and lower portions of avalanche tracks found well to the south of Crown Mountain. Wetlands are small and rare but provide important landscape variability. The MSdw provides important early season foraging habitat for grizzly bears and critical connectivity in an area that still supports bear populations (Clayton Apps, personal communication, 2018). Drier open grasslands and forests are important for American badger and other at-risk species including common nighthawk and barn swallow. Rocky substrates (cliffs, talus, and rock outcrops), found in the MSdw in the Grave Creek canyon, may be key features used for nesting, denning, roosting, and/or cover for a range of species.

Elk Dry Cool Engelmann Spruce-Subalpine Fir (ESSFdk1)

Above the Montane Spruce zone is the Engelmann Spruce-Subalpine Fir (ESSF) zone, which is the uppermost forested zone in the interior of British Columbia (Coupé et al., 1991). Moist summers and cold winters with heavy snowfall characterize the zone's climate. Subalpine fir and white spruce dominate climax zonal forests. Following fire, lodgepole pine is a common seral species. Whitebark and limber pine may also occur in this zone, typically on dry sites. Snow avalanche tracks are common in the steeper, high-snowfall, mountainous areas of the variant. Avalanche tracks are widespread north and south of Gaff Peak immediately west of Crown Mountain and on the east facing slopes of Crown Mountain. Avalanche and riparian areas provide good habitat for grizzly bears and early seral stages are primary summer habitat for deer, elk, and moose (Braumandl et al., 1992). The ESSFdk1 variant is the lowest elevational band of the ESSF zone in the LSA. It is found between roughly 1,600 m to 1,900m. Over 80% of the ESSFdk1 is comprised of forested ecosystems.

Dry Cool Woodland Engelmann Spruce-Subalpine Fir (ESSFdkw)

The Dry Cool Woodland Engelmann Spruce-Subalpine Fir (ESSFdkw) subzone occurs above the Elk Dry Cool variant (ESSFdk1) at elevations between about 1,900 m and 2,200 m. A substantial portion of Crown Mountain proposed infrastructure is found within this subzone. It is like the ESSFdk1, but due to its higher elevation it is generally characterized by shorter growing seasons and lower productivity. Considerably less area is found in productive forest compared to lower elevations (65% rather than 81% for the ESSFdk1). Species common on upper ESSFdk1 sites are also prevalent in the ESSFdkw. Species, such as mountain heathers, widespread at alpine elevations start to be found here. This subzone is typically at the upper limits of, or beyond, the merchantable forest with respect to timber harvest. Non-forested ecosystems become more frequent with avalanche tracks common on steeper ground, while brushland ecosystems are found on and near the ridgetop of Crown Mountain.

Dry Cool Parkland Engelmann Spruce-Subalpine Fir (ESSFdkp)

The Dry Cool Parkland Engelmann Spruce-Subalpine Fir (ESSFdkp) subzone occurs above the Dry Cool Woodland subzone (ESSFdkw) on the highest ridges around Gaff Peak and Erickson Ridge at elevations greater than 2,100 m. This subzone is characterized by thin soils, short growing seasons, with cliffs and bedrock outcrops common, especially on east-facing slopes of Gaff Peak. Trees are typically of low stature and are found in tree islands, as is found frequently on west aspects of the ridges of Gaff Peak.

1.2 Site Series

Within a BGC unit (subzone or variant), a range of ecosystems are found due to site, soil and disturbance factors. The recurring pattern of these ecosystems is controlled in large part by changes in soil moisture and these ecosystems are referred to as site series. The distribution of site series, within a BGC unit, according to a range of soil moisture and soil nutrient regimes can be depicted on an edatopic grid (Figure 1-2, example for the MSdw subzone). The forested site series described for each BGC unit can produce the same forest vegetation community at later stages of succession (MFLNRO Forest Service Research Branch, 2015). For example, each site identified as the 101-site series in the MSdw subzone (Figure 1-2) will reach a similar vegetation community upon maturation (see vegetation community description in Table 2-1). TEM also displays map entities representing non-forested and sparsely vegetated ecosystems; and anthropogenic sites. These may include sites where abiotic factors limit forest establishment such as avalanche paths; areas where vegetation will not establish such as lakes; and continually human maintained settings such as powerline corridors.

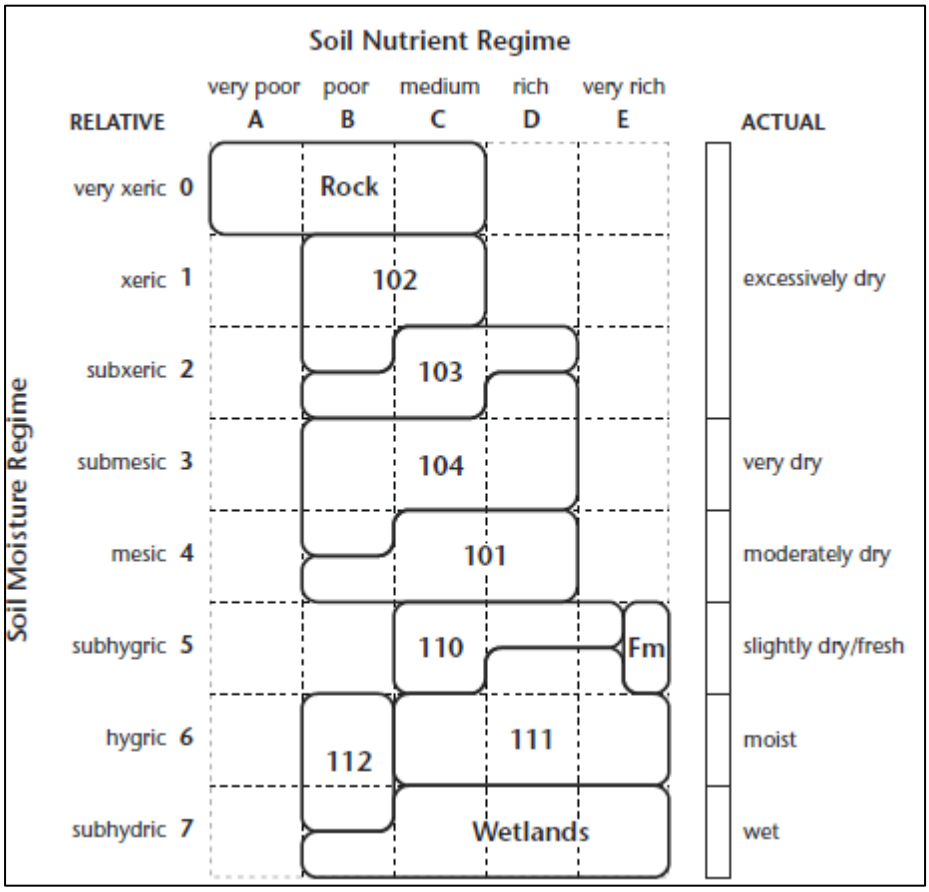

Figure 1-2 Edatopic grid for MSdw (numbers, e.g., 102, refers to site series).

1.2.1 Site Modifiers

Site modifiers are used to describe site conditions within a site series, including topography, moisture, and soil (Ecosystems Working Group, 1998). For example, for most circum-mesic site series, the typical and assumed setting is on gentle slopes with moderate to deep soils; however, deviations from these conditions can be described using modifiers. For example, a site series of 101w is a warm aspect representation of a mesic site; this site series typically is found on cool or neutral aspects so for this site series to be found on a warm aspect site there may be inputs of soil moisture to compensate for the warm aspect which typically results in an ecosystem with drier characteristics (e.g., vegetation and soil development). Table 1-1, found in Ecosystems Working Group (1998), describes the various site modifiers used to describe site conditions within a site series.

Table 1-1 Site modifiers used in this study to describe variations within site series. Obtained from Ecosystems Working Group (1998).

TOPOGRAPHY	
Code	**Criteria**
g	Gullying[1] occurring – the site series occurs within a gully, indicating a certain amount of variation from the typical, or the site series has gullying throughout the area being delineated.
h	Hummocky[1] terrain – the site series occurs on hummocky terrain, suggesting a certain amount of variability. Commonly, hummocky conditions are indicated by the terrain surface expression but occasionally they occur in a situation not described by terrain features.
j	Gentle slope – the site series occurs on gently sloping topography (less than 25%).
k	Cool aspect – the site series occurs on cool, northerly or easterly aspects (285°–135°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
q	Very steep cool aspect – the site series occurs on very steep slopes (greater than 100% slope) with cool, northerly or easterly aspects (285°–135°).
r	Ridge[1] (optional modifier) – the site series occurs throughout an area of ridged terrain, or it occurs on a ridge crest.
w	Warm aspect – the site series occurs on warm, southerly or westerly aspects (135°–285°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
z	Very steep warm aspect – the site series occurs on very steep slopes (greater than 100%) on warm, southerly or westerly aspects (135°–285°).
SOIL	
Code	**Criteria**
s	Shallow soils – the site series occurs where soils are shallow to bedrock (20–100 cm).
v	Very shallow soils – the site series occurs where soils are very shallow to bedrock (less than 20 cm).

[1] Howes and Kenk, 1997

[2] Soil textures have been grouped specifically for the purposes of ecosystem mapping.

[3] Agriculture Canada - Canada Soils Survey Committee, 1987

1.2.2 Structural Stages

Structural stages are used to describe the appearance of an ecosystem based on dominant life forms often reflecting disturbance history (Table 1-2; Ecosystems Working Group, 1998). All vegetated site series were attributed for structural stages; in general, the naming protocols of non-forested sites also provides an additional description of expected structural stages. For example, shrub or herb-dominated avalanche paths were characterized by herb (2) and shrub (3) structural stages. The following table, obtained from the Ecosystems Working Group (1998), describes the various structural stages and codes.

Table 1-2 Structural stages and codes used in this map. Obtained from Ecosystems Working Group (1998).

Structural Stage		Description
Post-disturbance stages or environmentally induced structural development		
1	Sparse/Bryoid	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
Stand initiation stages or environmentally induced structural development		
2	Herb	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
2a	Forb-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b	Graminoid-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c	Aquatic	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d	Dwarf shrub	Communities dominated (greater than 1/2 of the total herb cover) by dwarf woody species such as *Phyllodoce empetriformis, Cassiope mertensiana, Arctostaphylos uva-ursi, Vaccinium scoparium*, and *Rubus pubescens* (see list of dwarf shrubs assigned to the herb layer in the Field Manual for Describing Terrestrial Ecosystems (BCMoFR, MOE, 2010)).
3	Shrub/Herb	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
3a	Low shrub	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.
3b	Tall shrub	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.

Stem exclusion stages		
4	Pole/Sapling	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually less than 40 years for normal forest succession; up to 100+ years for dense (5,000–15,000+ stems per hectare) stagnant stands.
5	Young forest	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
Understory re-initiation stage		
6	Mature forest	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years.
Old-growth stage		
7	Old forest	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years for biogeoclimatic units relevant to the LSA.

1.2.3 Structural Stage Modifiers

Structural stage modifiers are used to further differentiate tree-dominated structural stages when necessary (Ecosystems Working Group, 1998). The modifiers describe five stand structure types based on the relative development of overstory, intermediate, and suppressed crown classes (Table 1-3; Ecosystems Working Group, 1998).

Table 1-3 Structural stage modifiers and codes used in this map. Obtained from Ecosystems Working Group (1998).

Structural Stage Modifier		Description
s	single storied	Closed forest stand dominated by the overstory crown class (dominant and co-dominant trees); intermediate and suppressed trees account for less than 20% of all crown classes combined; advance regeneration in the understory is generally sparse.
t	two storied	Closed forest stand co-dominated by distinct overstory and intermediate crown classes; the suppressed crown class is lacking or accounts for less than 20% of all crown classes combined; advance regeneration is variable.
m	multistoried	Closed forest stand with all crown classes well represented; each of the intermediate and suppressed classes account for greater than 20% of all crown classes combined; advance regeneration is variable.
i	irregular	Forest stand with very open overstory and intermediate crown classes (totaling less than 30% cover), and well-developed suppressed crown class; advance regeneration is variable.
h	shelterwood	Forest stand with very open overstory (less than 20% cover) and well-developed suppressed crown class and/or advance regeneration in the understory; intermediate crown class is generally absent.

1.2.4 Stand Composition Modifiers

Stand composition modifiers identify conifer-dominated stands (C), broadleaf-dominated stands (B) or mixed stands (M).

2 Methods

The methodology for the TEM was developed in consultation with the BC Ministry of Forest Lands, Natural Resource Operations and Rural Development (MFLNRO) regional ecologist (Deb MacKillop), prior to initiating the work. The survey planned was a survey-intensity level four TEM, for the LSA around NWP's coal license and footprint areas, totalling 12,886 ha. The study area provides a 1-km buffer around all current coal licences and existing or proposed major infrastructure. A survey intensity level four equates to a minimum of 124 field inspections distributed over the study area on an area-based approach.

A sampling plan was developed to ensure representative sampling of all BGC units found in the LSA. During this process a new BEC for the southern East Kootenay was being drafted by the province thus sampling was initially conducted using an interim classification (D. MacKillop, personal communication, 2014). The final sampling and classification were completed using the final published version (MacKillop et al., 2018).

Surveys of listed (rare and endangered) plant species occurred during the TEM field surveys and the presence of traditional-use and invasive species was noted for inclusion in other reports related to these features. Map polygon delineation and editing (photointerpretation, pre-typing, and post-

attribution edits) and attribution was initially provided by Tipi Mountain Eco-Cultural Services Ltd. and was transferred to KES in 2017. After the publication of the new East Kootenay BEC (MacKillop et al., 2018), BGC mapping changes were examined and refined classification of non-forested ecosystem were attributed, where possible. In 2018, KES conducted a thorough review of polygon delineation and attribution and revised a substantial proportion of the TEM. Additional sampling was carried out in 2019, to better classify avalanche tracks and wetlands to aid in interpretation of wildlife habitat.

2.1.1 Polygon Delineation and Attribution

Polygons were delineated to Resources Information Standards Committee standards (Ecosystems Working Group, 1998), including a maximum of three ecosystem types (map entities) per polygon. No high-resolution current imagery was available. Imagery used was BC bark beetle 2004[1]. BGC linework used was BEC version 10 which was updated to the current version 11 (August 2018)[2].

Polygons were delineated by identifying generally homogeneous units using ortho-imagery. Discrete polygons were then delineated by considering the interactions of slope, aspect, vegetation cover, structural stage, ecosystem type, and other factors observed on the orthophotos. This was then modified by examination of Google Earth imagery (with a stated image date of between 2009 and 2011) to ensure that polygons did not contain more than three site series/ecosystem components wherever possible.

Timber harvest at a relatively low rate is ongoing in the study area. Current harvest data (to October 2018) was obtained from the local licensee Canfor (Jordan Kirk, personal communication, 2018). This data was used to correct structural stage data to October 2018 status. Provincial Vegetation Resource Inventory (VRI) age class data were used where available to assess the presence of old growth forest structural stage.

2.1.2 Field Sampling and Data Entry

Field inspections to support ecosystem attribution involved ground plots and visual inspections. On the more detailed ground plots, site visit forms (SIVI, Appendix A-1) were completed. Information collected included site factors such as elevation, slope and aspect, floristic survey, BEC site series with modifiers, soil classification, seral and structural stage classification, and other relevant fields used to characterize ecosystems. Visual inspections only captured key features necessary for site series/map code determination. This included slope and aspect, BEC site series with modifiers, and a partial floristic survey. All field procedures adhere to provincial standards (BCMoFR, MOE, 2010).

[1] Imagery WMS.(2004). “bc_barkbeetle_xc1m_bcalb_2004”, B.C. Map Services. Retrieved from http://openmaps.gov.bc.ca/imagex/ecw_wms.dll
[2] Retrieved from https://catalogue.data.gov.bc.ca/dataset/biogeoclimatic-ecosystem-classification-bec-map We used BEC version 10 which uses the same linework as version 11 but updated BGC labels to version 11.

Field sampling targeted one inspection per 100 ha at a ratio of 1:3 ground to visual plots. Field data were entered into the provincial VENUS database for full ground plots and for visual inspections.

2.1.3 Ecosystem Attribution and Polygon Edits

Ecosystem attribution adhered to the provincial RISC Standards (Ecosystems Working Group, 1998) and included structural stage and site modifiers. Polygons were classified with up to three ecosystem components. The percentage of each ecosystem component was assigned a decile. Components with less than 5% occurrence were not noted. Vegetated site series were also classified to structural stage, which included structural stage, structural stage modifiers, and stand composition. Collectively, the BGC unit, site series with modifiers, and structural stage classifications for up to three units per polygon were used to generate an ecosystem label for each polygon. Site series and map code descriptions used for the attribution of ecosystems are described in the tables below (Tables 2-1 to 2-6). For several non-forested ecosystems, more generalized site classes are mapped (e.g., Brushland (Gb)) where detailed ground observations do not exist; while site associations (e.g., Choke cherry – Snowberry – Bluebunch wheatgrass (Gb04)) were mapped where detailed observations recorded species composition. This pertains to grasslands (Gg), wetland swamps (Ws), brushlands (Gb), krummholz (Sk), and herb and shrub avalanche tracks (Vh and Vs). All descriptions, excluding non-vegetated, sparsely vegetated, and anthropogenic groups, were obtained from MacKillop et al. (2018). Descriptions for non-forested ecosystems were obtained from Mackenzie (2012). KES modified the classification of avalanche chute ecosystems to aid in wildlife habitat assessment. With limited accessibility to steep avalanche chutes, it was in most cases impossible to classify to the site association level. This relies on identification of vegetation species. However, it was possible to distinguish lush, moist herb avalanche track ecosystems (Vhm) from drier sparser herb/graminoid dominated ecosystems (Vhd). Non-vegetated, sparsely vegetated, and anthropogenic groups follow Ecosystems Working Group (1998), apart from anthropogenic codes which were supplied by Deb MacKillop (personal communication, 2015). Krummholz site association descriptions (Table 2-4) were also provided by Deb MacKillop (personal communication, 2015).

Attribution relied on image interpretation of the circa 2004 ortho-imagery and Google Earth imagery (2009 to 2011 datums) and reference to ground sample data.

Table 2-1 Dry Warm Montane Spruce (MSdw) Forested Site Series.

Site Series/ Map Code	Name	Site Description	Moisture Regime	Vegetation Community
101	Sxw – Arnica – Pinegrass	Occurs on mid slopes of neutral to cool aspects and on gentle sites with deep, moderate-textured soils. Due to compensating factors, it also occurs on lower, warm-aspect slopes. Soils are typically moderately well drained with silt loam, sandy loam, sandy loam or loam textures. Eutric brunisols are common where soils are derived from calcareous parent materials and Orthic Humo-ferric Podzols are typical or non-calcareous materials. Coarse fragment content is generally low to moderate.	Mesic	Hybrid white spruce is typically present and abundant in mature stands with moderate western larch and subalpine fir with varying amounts of Douglas-fir and lodgepole pine. Shrub cover is variable with low to moderate cover of a range of species including the thimbleberry, birch-leaved spirea, and white spruce and subalpine fir regeneration. Arnica, bunchberry, grouseberry, low bilberry and/or pinegrass are usually present with < 10% cover each. Moss cover is variable, with low to moderately high cover of red-stemmed feathermoss common.
102	Fd - Juniper	Occurs on warm aspect sites where soils are very shallow and/or coarse. Sites usually have extensive talus and/or exposed bedrock and occur on convex mid to upper slope positions or crests. Soil textures are variable depending on bedrock geology but tend towards silt loam or sandy loam.	Xeric to subxeric	Douglas-fir dominates the tree layers although lodgepole pine is often present. Shrub cover varies with Saskatoon and juniper commonly present, often with snowberry and/or Oregon grape. Pinegrass is usually present along with minor cover of a variety of dryland herb species such as kinnikinnick, yarrow, small-flowered penstemon, pussytoes, stonecerops and round-leaved alumroot. Bluebunch wheatgrass is often present with minor cover. Clad and pelt lichens are typically present with a variety of mosses including hair-cap mosses and Heron's-bill mosses.
103	Fd(LwPl) – Pinegrass	Occur on upper to mid slopes on moderately steep to steep warm aspects occasionally on warm and shallow crests. Soils are typically coarse and deep.	Subxeric to submesic	Douglas-fir is typically the leading species and is often also present in the understory. Western larch and lodgepole pine are typically present, but lodgepole pine is rarely dominant in mature stands. Hybrid white spruce and subalpine fir are usually sparse or absent. Shrub cover is typically high, with birch-leaved spirea, Saskatoon, tall Oregon-grape, and common juniper most abundant. Pinegrass typically dominates the understory, with small amounts of kinnikinnick, pussytoes, strawberry, and/or showy aster.

Site Series/ Map Code	Name	Site Description	Moisture Regime	Vegetation Community
104	Pl(Lw) – Pinegrass – Twinflower	Occur on gentle to moderately sloped warm aspect sites with medium to coarse textured soils. Due to compensating factors, this unit also occurs on cool to neutral aspects on upper, shedding sites, or with coarse to very coarse textured soils.	Subxeric to mesic	Lodgepole pine is common, along with varying cover of Douglas-fir and Western larch. Soopolallie, birch-leaved spirea, and Saskatoon are common shrubs, while pinegrass is typically dominant in the herb layer. Grouseberry and/or low bilberry can be abundant, although cover varies (see Variability below). Twinflower and showy aster usually have moderate cover, with minor amounts of arnica and prince's pine.
110	SxwBl – Azalea – Bunchberry	Occurs on toe and lower slopes in moist sites with seasonal seepage at depth. They are often associated with riparian areas. Soils are usually deep with silt loam or sandy loam soil textures and variable coarse fragment content. Gleyed Brunisols and Podzols are common.	Subhygric	Hybrid white spruce and subalpine fir dominate the canopy, although minor lodgepole pine, Douglas-fir, and western larch may be present. Western redcedar can be abundant. Black gooseberry, thimbleberry, false azalea, and/or black twinberry are usually present, along with bunchberry, arnica, meadowrues, and minor amounts of sweet-scented bedstraw, baneberry, and/or clasping twistedstalk.
111	Sxw – Horsetail	Occurs on gentle to level receiving sites with the water table typically near the surface or within the top 30 cm of the soil profile. Sites are usually associated with riparian floodplains and have a thin to thick, peaty, organic veneer over mineral soils. Soils are typically sandy to silt textured Gleysols or Gleyed Regosols and are derived from fluvial materials. Coarse fragments are usually sparse to absent but may be high at depth.	Subhygric to hygric	Hybrid white spruce is dominant in the overstory while horsetails characterize the understory. Red-osier dogwood may be present in the shrub layer with black twinberry and high-bush cranberry. Minor cover of willows (Salix spp.) is also common. Bunchberry, dwarf red raspberry, cow-parsnip, and clasping twistedstalk are often present. A wide variety of other herb species, each with minor cover, is also typical of these sites.

Table 2-2 Elk Dry Cool Engelmann Spruce - Subalpine Fir (ESSFdk1) Forested Site Series.

Site Series	Name	Site Description	Moisture Regime	Vegetation Community
101	BlSe - Azalea	Occurs on mid slopes of neutral to cool aspects with deep, moderate textured soils. This site also occurs on lower slopes of warm aspects due to compensating factors.	Mesic	Subalpine fir and Engelmann spruce are abundant, although lodgepole pine is common in earlier seral stands, false azalea cover is typically high, while other shrubs such as white rhododendron and black huckleberry vary. Grouseberry is usually present but tends to have less cover. Arnicas are usually present and can be co-dominant or dominant with grouseberry. Grouseberry cover often increases with elevation.
102	PlFd – Juniper – Douglas maple	Occurs on forested sites with exposed bedrock or occasionally coarse talus and root restricting layers at or near the surface. Soils are rocky and growing conditions are very dry on warm aspect sites.	Xeric to subxeric	Douglas-fir and lodgepole pine typically occur in the overstory sometimes with subalpine fir and minor amounts of whitebark pine and Engelmann spruce. Soopolallie, common juniper, Saskatoon, Douglas maple, common juniper, and falsebox are common shrubs, and occur with a variety of dry herb species such as round-leaved alumroot, pinegrass, saxifrage, and occasionally bluebunch wheatgrass or shrubby penstemon. Clad lichens, pelt lichens and rock-mosses are common.
103	BlPl – Grouseberry	Occur on upper to mid slopes on moderately steep or steep, warm aspects, typically with coarse and/or shallow soils, and occasionally on warm and/or dry crests.	Subxeric	Lodgepole pine and subalpine fir occur in the overstory tree layer, often with minor Engelmann spruce. Grouseberry and/or pinegrass are present, with minor cover of arnicas. False azalea is typically sparse of absent. Beargrass may be present, particularly in the southern extent of the ESSFdk1.
104	BlPl – Azalea – Grouseberry	Occurs on moderately sloped warm aspect sites with medium to coarse textured deep soils. Due to compensating factors, this unit also occurs on cool to neutral aspects on upper, shedding sites, or with shallow and/or coarse to very coarse textured soils.	Subxeric to submesic	Subalpine fir, Engelmann spruce, and lodgepole pine typify the canopy, while false azalea is frequently abundant in the shrub layer, along with subalpine fir and Engelmann spruce regen. Minor whitebark pine may be present. Grouseberry is usually abundant, with minor cover of arnicas. Bear-grass can be abundant, particularly in the southern extent of the ESSFdk1.
110	BlSe – Azalea – Foamflower	Occurs on lower and toe slopes in moist sites with seasonal seepage at depth. Sites are usually gentle to moderately sloped and are often associated with riparian areas. Soils are typically moderately well to imperfectly drained Gleysols or Gleyed Brunisols derived from fluvial or sometimes morainal materials.	Subhygric	Engelmann spruce and subalpine fir dominate the canopy, while black gooseberry, black twinberry, and subalpine fir are typically in the shrub layer. Understory herbs can be diverse and variable, often with moderate cover of foamflower and arnicas, and minor amounts of cow-parsnip, false hellebore, and/or arrow-leaved groundsel. Ragged mosses, red-stemmed feathermoss, and leafy liverworts comprise much of the moss layer.

111	Se – Horsetail – Bluejoint	The 111 occurs on gentle toe slopes and level sites, usually adjacent to streams, ponds, non-forested wetlands, or lakes. Soils are Gleysols, Humic Regosols, or occasionally Organic, and most sites experience occasional flooding (usually > 5-year intervals).	Hygric to Subhydric	Engelmann spruce is dominant in the open overstorey, while horsetails are distinctive in the understorey. Bluejoint reedgrass is often present and abundant, while arrow-leaved groundsel, foamflower, arnicas, mitreworts, and a diversity of herbs occur with low to moderate cover. Moss cover is variable, often with a high diversity of species, usually including ragged-mosses.

Table 2-3 Dry Cool Woodland Engelmann Spruce - Subalpine Fir (ESSFdkw) Forested Site Series

Site Series/Map Code	Name	Site Description	Moisture Regime	Vegetation Community
101	BlSe – Grouseberry – Leafy liverwort	Occurs on mid slopes of neutral-aspect sites with medium to moderately coarse-textured soils. It also occurs on upper slopes with deep soils and on lower slopes with coarse-textured soils.	Mesic	Subalpine fir and Engelmann spruce occur in the tree layers. White-flowered rhododendron, false azalea, and/or black huckleberry are commonly present, often with higher cover on cool to neutral aspects where snowpacks are deeper and snow persists longer. Grouseberry/low bilberry and arnicas are typically abundant. Mountain-heathers occur sporadically, and woodrushes may be present with Leafy liverworts, ragged-mosses, and heron's bill-mosses are typically part of the moderately well-developed moss layer and may have high cover on some sites.
102	BlLa – Grouseberry	Occurs on rocky sites with shallow, coarse soils. It is most common on upper slopes and crests, usually on neutral or warm aspects, and occasionally on cool slopes. Soil textures vary but usually have high or fragmental coarse content. Large boulder and/or exposed bedrock are common.	Xeric to subxeric	Subalpine fir and/or subalpine larch dominate the tree layers, often with minor Engelmann spruce. Subalpine fir regeneration and grouseberry/low bilberry are usually abundant in the understory. Mountain-heathers and minor amounts of pussytoes, saxifrages, and /or stonecrops may be present.
103	BlSePa – Grouseberry	Occurs on steep, warm-aspect slopes with shallow and/or rocky, coarse-textured soils. It also occurs on shallow, coarse-textured, moisture-shedding crests and upper slopes on neutral aspects. Soils are typically Eutric or Dystric Brunisols with silt, loam, or sandy loam textures and moderate to high coarse fragment content.	Subxeric	Subalpine fir, Engelmann spruce, and whitebark pine typify the tree layers. Subalpine larch may occur however it is not dominant. Shrub cover is usually low, sometimes with minor amounts of juniper, white-flowered rhododendron, and/or black huckleberry. Grouseberry/low billberry are usually present with moderate to high cover, and often occur with fireweed, arnicas, and minor amounts of wild strawberry, yarrow, and/or pussytoes. Moss cover is variable, but usually low.
110	BlSe – Grouseberry – Valerian	Occurs on lower and mid-slope positions where seepage is present in the upper 30-70 cm of the soil. Sites can be associated with riparian areas, but often occur in mid-slope seepage areas. Soils are usually Gleyed Brunisols or Gleyed Podzols.	Mesic to subhygric	Subalpine fir and Engelmann spruce dominate the overstorey, with valerian, arrow-leaved groundsel, meadowrues, subalpine daisy, globeflower, arnicas, and/or mitreworts in the understorey. False hellebore, Anemone spp., and a variety of wildflowers are also commonly present. White-flowered rhododendron and black huckleberry often occur. Low to moderate cover of grouseberry/low bilberry is common. Moss cover is variable, with ragged-mosses and leafy liverworts the most common species.

Table 2-4 Dry Cool Parkland Engelmann Spruce – Subalpine Fir (ESSFdkp) Forested Site Series.

Site Series/Map Code	Name	Site Description	Moisture Regime	Vegetation Community
Sk	Krummholz	Krummholz ecosystems occur at the upper elevation extremes for conifer tolerance. Trees grow slowly due to harsh climatic conditions, including cold growing-season temperatures, winter frost, and wind exposure and damage. Krummholz sites are typically well to rapidly drained, with thin or coarse-textured soils.	subxeric to mesic	Trees occur in clumpy patches and can be upright with stunted growth (more common at lower elevations) or deformed, shrubby, and gnarled with dwarf stature (shrub-size) (more common at upper elevations). Bl is typically the most common tree species, although Se is common and Pa or La may occur. Individual krummholz trees can exceed 10 m in height in southern British Columbia, but stands are significantly less productive than woodland forests at lower elevations.
Sk02	Krummholz Subalpine Fir – Grouseberry – White Mountain Heather	Commonly occurs on submesic and slightly raised microsites on treeline slopes in southern dry subzones.	Submesic to mesic	Dominant tree is Bl. Common understory species are grouseberry and white mountain heather.
Sk10	Krummholz Whitebark Pine – Subalpine Fir – White Mountain Avens	Occurs on limestone geology in dry southern subzones.	Xeric to submesic	Dominant trees are Pa and Bl. Dominant forb is white mountain avens.
Sk20	Krummholz Alpine Larch – Subalpine fir – Mountain Heathers	Occurs on cool aspects or areas that accumulate more snow than other Alpine larch types.	Submesic to subhygric	Mountain-heather, primarily western bell heather is dominant though yellow mountain-heather is dominant on some sites, common to other large stands present.

Table 2-5 Non-forested and related ecosystems.

Site Series/Map Code	Name	Site Description	Vegetation Community
Alpine Group			
Af	Alpine fellfield	Fellfields are ecosystems of exposed locations where the dynamics of frost (freeze and thaw cycles) and of wind give rise to characteristic low plant cover in a rocky or mineral soil matrix. Thin snowpack leads to active freeze–thaw cycles that act to push plants out of the soil. High porosity or lack of soil makes a fellfield a difficult place for plants to grow.	Fellfields are commonly populated by cushion plants (tufted perennials that grow close to the ground) and cryptogams.
Am	Alpine meadow	These ecosystems occur on fresh to moist usually well-developed soils that have continuous winter snowpack. Sites with seepage or unstable soils favor the Alpine Meadow Class over alpine heath ecosystems.	Alpine meadow ecosystems are forb-dominated (or large sedge–dominated) ecosystems of subalpine and alpine elevations. Vegetation typically has high cover and stature.
As	Late snowbed	Areas with very deep or persistent snowpacks that last well into the growing season commonly support plant communities of low cover and low species diversity. These sites generally occur on cool aspects and in sheltered locations where snowmelt is slow.	Few species can tolerate the short growing season and harsh environmental conditions. Erosion during snowbed melting (nivation) and growing-season cryoturbation (soil mixing from freeze–thaw cycles) is extreme due to lack of vegetation cover and high soil moisture. Graminoids are most common; black alpine sedge (*Carex nigricans*) often forms a near-pure plant community on late-snowbed sites.
At	Alpine tundra	Alpine tundra ecosystems occur on relatively exposed, cold, submesic to mesic sites with moderate snow cover. They often occur on windswept, gentle terrain such as high-elevation plateaus and rounded ridges and summits.	Alpine tundra ecosystems are relatively well-vegetated ecosystems of mixed life-form composition, commonly with an abundance of dwarf shrubs and sedges (*Carex* spp.) mixed with forbs and grasses.
Flood Group			
Ff	Fringe Flood	Fringe flood ecosystems develop on sub-irrigated but rarely flooded nonalluvial soils next to lakes and other still waters, or in slope draws and gullies in areas with dry climates.	High soil moisture and modified climates produce tall broadleaf shrub or low treed ecosystems that are distinct from the adjacent upland.
Fl	Low Bench Flood	Low bench ecosystems occur on sites that are flooded for moderate periods (< 40 days) of the growing season—conditions that limit the canopy to tall shrubs, especially willows or alders. Annual erosion and deposition of sediments (sands and silts) generally limit understorey and humus development.	Tall shrubs, willows or alders are often dominant.

Site Series/Map Code	Name	Site Description	Vegetation Community
Fl01	Low bench Mountain alder – common horsetail	Mountain alder – Common horsetail low benches are common throughout the Interior at elevations below 1500 m. They occur on gravel or sand bars adjacent to relatively high-gradient creeks and streams that can have a "flashy" flood regime. Flood events are short during annual spring flooding and occur occasionally during summer storms. Soils are coarse-textured, often gravelly, Cumulic Regosols and Rego Gleysols.	Speckled alder is the dominant shrub and forms a continuous canopy on most sites. The understory can be well developed or sparse depending on recent flood history, but common horsetail usually persists. The moss layer is often very sparse or absent because of high litterfall and recurring sediment deposition.
Fl04	Low bench - Sitka willow – Red-osier dogwood – Horsetail	The Fl04 occurs on levees and sand or gravel bars in the active floodplains of sluggish, low-gradient streams. Soils are typically fine-sandy textured, well-drained, and saturated at depth for most of the growing season.	Sitka willow is the dominant shrub, and often occurs with moderate cover of red-osier dogwood and black twinberry. Mountain alder, Drummond's willow, and Pacific willow can also be common, and sometimes have high cover. Horsetails (common and meadow [*Equisetum pratense*]) and/or bluejoint reedgrass are typically present on most sites, along with a variety of other herbs, except where herb cover is sparse due to recent flooding and sediment deposition.
Fm02	Middle bench Cottonwood – Spruce – Red-osier dogwood	The most common middle bench community of low elevations throughout the Interior on suitable sites. It occurs on sandy or gravelly fluvial materials adjacent to streams and rivers with short flood durations followed by continual subirrigation. Soils are Cumulic Regosols or Gleyed Brunisols.	Black cottonwood forms an open canopy with scattered interior spruce. Red-osier dogwood and speckled alder are dominant in the shrub layer, but frequently with some cover of highbush-cranberry, prickly rose, and black twinberry. Along smaller river systems, red-osier dogwood is often sparse and speckled alder dominates. The herb layer can be well developed or sparse depending on recent flood history, but common horsetail usually persists. The moss layer is always poorly developed.
Grassland Group			
Ga03$	Field sedge (seral) alkaline grassland	A disturbed moist meadow ecosystem that typically occurs on toe slopes adjacent to wetlands. The Ga03 occurs on sites that are briefly inundated and are moderately saline. Soils are loamy or fine textured, have little or no coarse fragments, and are usually gleyed.	The one example of this ecosystem found in the study area is dominated by Kentucky bluegrass, with common silverweed and graceful cinquefoil also common.
Gb	Brushland	Occurs outside of warm semi-arid climates and are dominated (> 10%) by drought-tolerant woody shrubs of moderate stature.	Typical shrub species include Saskatoon, junipers, cherries, and snowberry.

Site Series/Map Code	Name	Site Description	Vegetation Community
Gb04	Choke cherry – Snowberry – Bluebunch wheatgrass	The Gb04 occurs infrequently on moderate to steep, warm aspects with coarse loamy or sandy soils. Soils are generally rich with thick Ah layers, and most sites have some moisture at depth (SMR 3).	The vegetation is very shrubby and is dominated by snowberry and choke cherry with low cover of saskatoon and roses. The sparse herb layer is characterized by scattered bluebunch wheatgrass and silky lupine.
Gb20	Saskatoon – Soopolallie – Juniper	The Gb20 occurs at upper elevations on steep, warm slopes with rocky soils.	This shrubby brushland site association is dominated by moderate cover of saskatoon, common juniper, and soopollalie with minor covers of birchleaved spirea and/or prickly rose. Forbs and grasses are sparse and scattered, and usually consist of strawberry, yarrow, penstemons, and nodding onion. Occasionally, kinnikinnick, pinegrass, and sulphur buckwheat are present.
Gg	Grassland	Occurs in semi-arid climates and on very dry sites within non-grassland climates. Dry, warm aspects. Primarily occurs on rapidly draining, deep soils. If shrubs occur, they are sparse (< 10%) or of lower stature than grasses. On thinner soils, communities tend to border Rock/Talus Group.	Graminoid dominated (fescues, bluebunch wheatgrass), shrub covers less than ten percent has mixed drought-tolerant forbs.
Gg12	rough fescue - (bluebunch wheatgrass) - yarrow - clad lichens association	the Gg12 typically occurs on level and gently sloping sites in the IDFxk, IDFdm2, IDFdk5, and occasionally in the MSdw, particularly in the Flathead valley.	Late seral vegetation is dominated by abundant rough fescue with spreading needlegrass, junegrass, and diverse scattered forbs such as pussytoes, yarrow, nodding onion, and yellow penstemon; kinnikinnick is sometimes present and can be abundant. Scattered rose and saskatoon are common. The biological soil crust is moderately well developed and dominated by clad lichens, sidewalk screw-moss, and pelt lichens.
Rock Group			
Rc	Rock cliff	Cliff ecosystems are vertical rock sites, commonly with high bryophyte cover (rock crusts).	Small pockets of soils may support vascular vegetation
Ro	Rock outcrop	Occurs in areas with bluffs and knobs of bedrock. Limited soil development and high cover of exposed rock.	Drought-tolerant bryophytes and lichens are often prominent, while herbs and shrubs are usually restricted to pockets of soil or cracks in the rock surface.
Rt	Rocky talus	Occurs in areas with active and inactive talus and scree.	Low herb cover with some cover of deciduous trees and shrubs; generally high cover of cryptograms and bryophytes.

Site Series/Map Code	Name	Site Description	Vegetation Community
Avalanche Group			
Vhd	Avalanche dry herb meadow	Often occurs in the upper and central track of avalanche paths where mobile substrates and thin soils limit the establishment of shrubs or trees. Rocky talus cones affected by avalanches are placed in the Talus Class.	Avalanche dry herb meadows are ecosystems in avalanche tracks that are dominated by forbs, graminoids, and/or dwarf woody shrubs.
Vhm	Avalanche moist herb meadow	Often occurs in the central track or run-out zone of avalanche paths where snow accumulates or where mobile substrates limit the establishment of shrubs or trees. Soils are generally moist and soils maybe deep. Rocky talus cones affected by avalanches are placed in the Talus Class.	Avalanche herb meadows are ecosystems in avalanche tracks that are dominated by lush forbs such as cow-parsnip, false-hellebore, Sitka valerian and/or graminoids, such as blue wildrye and bluejoint reedgrass.
Vh01	Cow-parsnip – Fireweed – Nettle Avalanche Herb Meadow	The Vh01 is common in run-out zones and lower-track sections in the ICH, MS, and lower ESSF. It occurs on nutrient-rich soils with mesic to moist moisture regimes.	Cow-parsnip is usually found with abundant fireweed and varying amounts of stinging nettle and meadowrues. Bluejoint reedgrass can have high cover but may be absent.
Vs	Avalanche moist shrub thicket	Most frequently associated with the track and lateral run-out portions of the avalanche path where deep snow lay occurs infrequently, but site conditions are fresh or wetter.	Avalanche shrub thickets are ecosystems in avalanche tracks that are dominated by tall deciduous shrubs, Sitka alder or less frequently willows, may have a lush herb layer if enough light penetrates the tall shrub canopy.
Vs10	Willow – Cow-parsnip – Fireweed	Sites are often associated with run-out zones adjacent to wetlands and riparian areas, but can also occur on moist, lower avalanche slopes.	Vs10 sites are dominated by willows—usually Sitka or Barclay's—and commonly contain black twinberry, fireweed, cow-parsnip, western meadowrue, valerian, and stinging nettle.
Vt	Avalanche treed	Occur where areas are continually exposed to avalanches. This does not include young forests recovering from a single extreme avalanche event. Site conditions are typically dry.	Avalanche treed ecosystems are dominated by shrub-sized trees that are continually pruned by snow slides and are prevented from becoming forest. This does not include young forests that are regenerating from single extreme events; such forests are seral ecosystems. Trees in Vt ecosystems show evidence of pruning and bark damage from chronic avalanche events.
Wetland Group			
Wa	Alpine Wetland	Alpine wetlands occur in the IMA, the ESSF parkland and woodland, and occasionally in cold-air basins in the upper portions of the ESSF. They occur on seeps and saturated flats that have site characteristics that are similar to lower-elevation swamps or	Dwarf willows, forbs, mosses; also, black alpine sedge.

Site Series/Map Code	Name	Site Description	Vegetation Community
		marshes, including gleyed mineral soils, often with a thin organic capping and a persistent high-water table during the growing season.	
Wf	Fen Wetland	Fens are peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone. Fens develop in basins, lake margins, river floodplains, and seepage slopes, where the water table is usually at or just below the peat surface for most of the growing season.	These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses.
Wf01	Water sedge – Beaked sedge Fen	The Wf01 occurs in depressions, adjacent to small water bodies, and along lakeshores. Wf01 sites are saturated to the surface in the spring but typically experience drawdown later in the season.	Sites are characterized by very abundant water sedge and/or beaked sedge. If other herb species occur, they generally have low cover.
Wf02	Scrub birch – Water sedge Fen	Sites are hummocky, often occurs adjacent to the Wf01, generally on slightly drier sites.	Vegetation is comprised of scrub birch, stunted Sxw trees, and minor cover of various shrub species growing on mounds. Water sedge is abundant, often with beaked sedge and minor cover of marsh cinquefoil and/or bluejoint reedgrass. Brown mosses, especially golden fuzzy fen moss (*Tomentypnum nitens*), dominate the dense moss layer, often with lesser amounts of peat mosses and/or glow moss.
Wf04	Barclay's willow – Water sedge – Glow moss Fen	Wf04 sites are found in frost-prone basins or on gentle areas adjacent to streams.	Sites are characterized by an abundance of willows, primarily Barclay's willow, under-green willow, or serviceberry willow. The herb layer is diverse, but water sedge and/or bluejoint reedgrass are usually dominant, and beaked sedge and common horsetail (*Equisetum arvense*) may be present.
Wm	Marsh Wetland	Marsh is a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes, with early season high water tables dropping through the growing season. Exposure of the substrate in late season or during dry years is common. The substrate is usually mineral but may have a well-decomposed organic veneer derived primarily from marsh emergents.	Marshes have > 10% cover of emergent grasses, rushes, sedges, or (occasionally) forbs or horsetails. The tree, shrub, and bryophyte layers in marshes are usually absent or very sparse (< 10%). Aquatic plants are common, especially in marshes that retain standing water for most or all of the year.
Wm01	Beaked sedge – Water sedge Marsh	Wm01 occurs on seasonally flooded sites with some late-season drawdown, typically near ponds, along lake margins, on floodplains with slow-moving flood water, and in flooded basins. The Wm01	It is dominated by an abundance of beaked sedge and/or water sedge. A scattering of other species is common but variable, and generally of low cover. The Wm01 contains the same vegetation

Site Series/Map Code	Name	Site Description	Vegetation Community
		occurs on mineral soils (often with a < 40 cm thick organic layer) with deeper flooding and more dynamic hydrology than the Wf01.	complex as the Wf01, although beaked sedge is often more prominent in the Wm01.
Wm05	Cattail Marsh	It occurs in depressions and along lakeshores and pond edges.	Cattail marshes are easily recognized by an abundance of common cattail. Other species typically have low cover.
Wm06	Great bulrush Marsh	The Wm06 occurs along lake margins and in depressions in areas with warm and dry summers. Floodwaters can be up to 1.5 m deep in spring, but sites dry up significantly into the growing season.	The vegetation community is characterized by hard-stemmed bulrush and/or soft-stemmed bulrush. Overall, plant species diversity is low.
Ws	Wetland Swamp	A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs on sites with a flowing or fluctuating, semi-permanent, near-surface water table. Swamps have abundant available nutrients from groundwater and often have surface standing water. Swamps may be underlain with peat, but it is well decomposed, woody, and dark.	Tall-shrub swamps are dense thickets, while forested swamps have large trees occurring on elevated microsites and lower cover of tall deciduous shrubs.
Ws03	Bebb's willow – Bluejoint Swamp	It is most common along lake or pond margins, seasonal creeks, and fluvial terraces, and in depressions.	Bebb's willow dominates the shrub layer, often with black twinberry. Mountain alder and red-osier dogwood may be present. Scattered Sxw trees can occur. Bluejoint reedgrass and/or beaked sedge have high cover in the herb layer; horsetails and a diversity of forbs frequently occur.
Ws04	Drummond's willow – Beaked sedge Swamp	The Ws04 occurs where water is stagnant, usually in depressions or adjacent to low-gradient streams.	Drummond's willow dominates the shrub layer, although other willows may be present. The herb layer is typically dominated by beaked sedge and/or water sedge. Bluejoint reedgrass may occur.
Ws07	Spruce – Horsetail – Leafy moss Swamp	The Ws07 is found on gentle or level sites, lower or toe slopes, and margins of non-forested fens.	Sxw is dominant in the overstorey, with Sxw and some Bl in the understorey. Mountain alder, red-osier dogwood, and black twinberry are often present with low to moderate cover. Horsetails are always present and abundant with a diversity of other wetland and upland species, including bluejoint reedgrass, bunchberry, mitreworts (*Mitella* spp. and *Pectiantia* spp.), and twinflower (*Linnea borealis*).
Ww	Shallow water	Shallow water wetlands are permanently flooded by still or slow-moving water and are dominated by submerged and floating-leaved aquatic plants. Ww ecosystems are most commonly found at the edges of ponds and lakes and are often bordered by marshes or swamps where emergent vegetation has > 10% cover.	Although grass-like plants such as sedges or cattails may be present, their cover does not exceed 10%. Shallow water plant communities are typically species-poor, and are usually dominated by yellow pondlily (*Nuphar lutea*), although bladderworts (*Utricularia* spp.) or

Site Series/Map Code	Name	Site Description	Vegetation Community
			pondweeds (*Potamogeton* spp.) can be present and occasionally dominate the plant communities.
Disclimax			
Xv	Vegetation Disclimax	The vegetation disclimax class describes ecosystems where vegetation competition rather than environmental constraints maintains the non-forested state. Vegetation is generally lush enough to preclude tree establishment through shading, litter fall, or some other resource factor. The Xv ecosystems found on steeply sloping sites are likely the result of slope failures.	Two types of vegetation disclimax occur within the study area: a graminoid dominated, circum-mesic meadow and a Sitka alder tall shrub field. The latter type is far more widespread in the study area than the meadow type. While the Sitka alder Xv ecosystem resembles a tall shrub avalanche track, these ecosystems are not subject to avalanching. Soil moisture regimes are frequently wetter than mesic leading to lush shrub cover that excludes tree regeneration.

Table 2-6 Non-vegetated, sparsely vegetated, and anthropogenic groups.

Map Code	Name	Site Description
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.
ES	Exposed soil	Any area of exposed soil that is not included in any of the other definitions. It includes areas of recent disturbance, such as mud slides, debris torrents, avalanches, and human-made disturbances (e.g., pipeline rights-of-way) where vegetation cover is less than 5%.
LA	Lake	A naturally occurring static body of water, greater than 2 m deep in some portion. The boundary for the lake is the natural high-water mark.
PD	Pond	A small body of water greater than 2 m deep, but not large enough to be classified as a lake (e.g., less than 50 ha).
RE	Reservoir	An artificial basin created by the impoundment of water behind a human-made structure such as a dam, berm, dyke, or wall.
RI	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial. An area that has an ephemeral flow and no channel with definable banks is not considered a river.
RM	Reclaimed mine	A mined area that has plant communities composed of a mixture of agronomic or native grasses, forbs and shrubs.
RN	Railway	A roadbed with fixed rails for possibly single or multiple rail lines.
RZ	Roadway	Permanent to near-permanent roadways. Includes all paved surfaces and major logging roads.

Map Code	Name	Site Description
Xa	Anthropogenic disturbance	Human caused disturbance that generally maintains the ecosystem in a permanently disturbed state, e.g., pipelines, powerlines, building sites.

3 Results

3.1 Polygon delineation

A total of 936 polygons were delineated for an average polygon size of 13.8 ha. Most polygons were in the MSdw (n=363) with the lowest number of polygons in the ESSFdkp (n=67; Table 3-1). The MSdw occupied the largest area at 6,064 ha. See Appendix A-2 for a legend providing the site series, modifiers, structural stages, structural stage modifiers, and stand composition per BEC unit and Appendix A-3 for the ecosystem labels of each mapped polygon. Display maps of the TEM are found in Appendix A-4.

Table 3-1 Summary of TEM polygons.

Biogeoclimatic Unit	Number of Polygons	Area (ha)	% of Study Area	Mean Polygon Area (ha)	Ground Plots	Visual Plots	Total Plots
MSdw	363	6,064	47	16.7	60	53	113
ESSFdk1	350	4,704	37	13.4	26	54	80
ESSFdkw	156	1,554	12	10.0	11	13	24
ESSFdkp	67	564	4	8.4	0	0	0
Total	936	12,886	100	13.8	97	120	217

3.2 Field Sampling

A total of 217 field plots were established for the project or accessed from previously conducted surveys in the area with a total of 97 ground and 120 visual plots (Figure 3-1). Sampling ranged from valley bottom to ridge tops and a full suite of sites were sampled, apart from the ESSFdkp which is not accessible from the ground. This plot sampling ratio of ground plots to visuals was close to 1:1; a higher proportion of ground plots were established than were planned (1:3). The sampling intensity level was three on an area basis (Ecosystems Working Group, 1998). 217 plots over a 12,886 ha study area resulted in a sample intensity of one plot per 59 ha, within the one plot per 30-59 ha range provided in the TEM standard (Ecosystems Working Group, 1998) (Table 3-2). This level of sampling intensity slightly exceeded the level planned for. Many additional observations of ecosystem composition have been collected for a variety of other reports, such as listed plant and sensitive ecological community mapping (KES, 2019). These additional samples have also been used to further “ground-truth” the TEM. This sampling intensity is sufficient for the intended use of the map product and exceeded the proposed target.

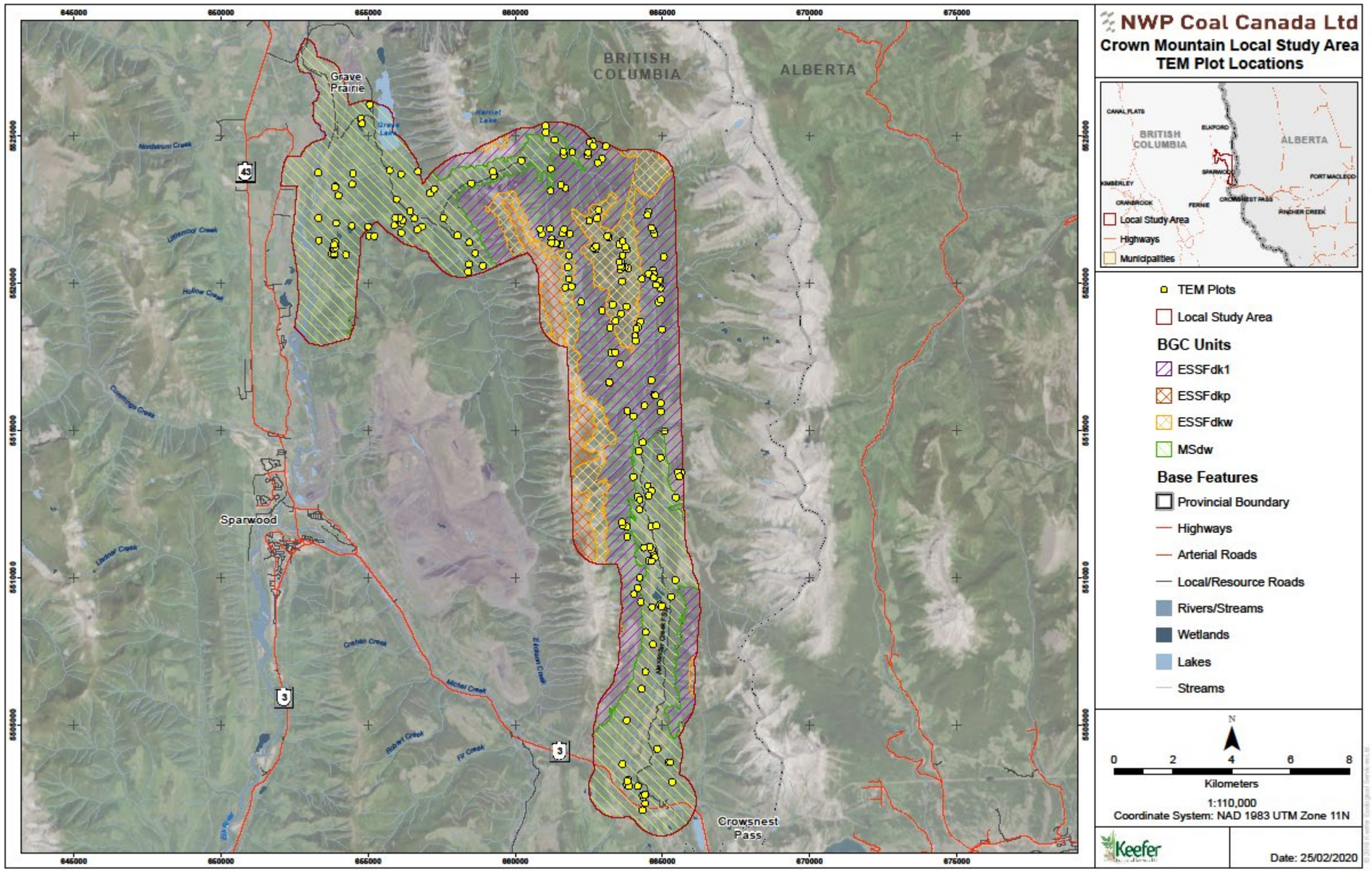

Figure 3-1 Map showing locations of field plots throughout the study area.

Table 3-2 Summary of field plots and sampling intensity.

Study Area	Sampling	Result	Survey Intensity	Interpretation
12,886 hectares	217 plots	59 ha / inspection	3*	Sample intensity suitable for: wildlife capability assessment, local resource planning, habitat enhancement prescriptions

*Based on 1:20,000 display scale

3.3 Ecosystem Attribution

A map entities list including all mapped site modifiers, structural stage and modifiers, and stand composition used in the TEM is provided in the expanded legend found in Appendix A-2. All map entities, their areas and percentage of the BGC unit are provided in Tables 3-3 to 3-6. Results are presented below in order of increasing elevation.

3.3.1 MSdw

The MSdw, the largest and lowest elevation BGC unit, comprises 47% of the study area. In the MSdw, the most mapped ecosystem was site series 101 followed by 104 (Table 3-3). These two site series accounted for 66% of the MSdw subzone. A broad range of ecosystem types were mapped ranging from grasslands to forests and a range of anthropogenic types. Wetlands and grassland/brushlands are rare components of the landscape each comprising 2% of the subzone (115 and 145 ha, respectively). Avalanche ecosystems and rock ecosystems occur even less frequently at these elevations, accounting for <1 and 1% of the subzone, respectively. Flood and riverine ecosystems are uncommon and comprise 5% of the MSdw.

Table 3-3 Summary of mapped ecosystems in the MSdw.

Mapped Site Series	Name	Mapped Area (ha)	% of Subzone
Forested Site Series			
101	Sxw – Arnica – Pinegrass	2,186	36
102	Fd - Juniper	22	0.4
103	Fd(LwPl) – Pinegrass	349	6
104	Pl(Lw) – Pinegrass – Twinflower	1,815	30
110	SxwBl – Azalea – Bunchberry	406	7
111	Sxw – Horsetail	84	1
Flood Ecosystems			
Ff	Flood Association - Fringe	1	0.01
Fl	Flood Association – Low bench	17	0.3

Mapped Site Series	Name	Mapped Area (ha)	% of Subzone
Fl01	Flood Association – Low bench -Mountain Alder – Common Horsetail	5	0.1
Fl04	Flood Association--Sitka willow – Red-osier dogwood – Horsetail	0.4	0.01
Fm02	Flood Association – Middle bench Cottonwood – Spruce – Dogwood	167	3
Grassland/Brushland Ecosystems			
Ga03$	Alkaline meadow – Field sedge (seral)	2	0.03
Gb	Grassland Group – Brushland Class	52	1
Gb04	Choke cherry – Snowberry – Bluebunch wheatgrass Association	58	1
Gg	Grassland Group – Grassland Class	6	0.1
Gg12	Rough fescue - (Bluebunch wheatgrass) - Yarrow - Clad lichens association	27	0.4
Wetland Ecosystems			
Wf	Wetland - Fens	17	0.3
Wf01	Water sedge – Beaked sedge Fen	8	0.1
Wf02	Scrub birch – Water sedge Fen	2	0.03
Wf04	Barclay's willow – Water sedge – Glow moss Fen	4	0.1
Wm	Wetland - Marsh	1	0.01
Wm01	Beaked sedge – Water sedge Marsh	13	0.2
Wm05	Cattail Marsh	0.3	0.004
Wm06	Great bulrush Marsh	1	0.01
Ws	Wetland - Swamp	31	0.5
Ws03	Bebb's willow – Bluejoint Swamp	7	0.1
Ws04	Drummond's willow – Beaked sedge Swamp	9	0.2
Ws07	Spruce – Horsetail – Leafy moss Swamp	19	0.3
Ww	Shallow water	4	0.1
Avalanche Ecosystems			
Vhm	Avalanche Moist Herb Meadow	1	0.01
Vs	Avalanche Shrub Thicket Class	8	0.1
Vt	Avalanche Treed Class	5	0.1
Disclimax Sites			
Xv	Vegetation Disclimax	5	0.1
Non-Vegetated Sites			
ES	Exposed Soil	3	0.1
LA	Lake	74	1
OW	Open Water	1	0.02

Mapped Site Series	Name	Mapped Area (ha)	% of Subzone
RE	Reservoir	6	0.1
RI	River	90	1.5
Rock Ecosystems			
Ro	Rock - Outcrop	11	0.2
Rt	Rock Group – Talus Class	46	1
Anthropogenic Sites			
CF	Cultivated Field	184	3
RM	Reclaimed Mine	65	1
RN	Railway	22	0.4
RZ	Road	32	0.5
Xa	Anthropogenic Disturbance	166	3

3.3.2 ESSFdk1

In the ESSFdk1, which comprises 37% of the study area, the 101 site series was the most commonly mapped unit. The next most abundant map entity was 104 (Table 3-4). These two site series comprise 66% of the variant. Avalanche and rock ecosystems comprise a greater proportion of the ESSFdk1 than at lower elevations (i.e., MSdw). Both these ecosystem groups each cover about 8% of this variant.

Table 3-4 Summary of mapped ecosystems in the ESSFdk1.

Mapped Site Series	Name	Mapped Area (ha)	% of Variant
Forested Site Series			
101	BlSe – Azalea	1,647	35
102	PlFd – Juniper – Douglas maple	42	1
103	BlPl – Grouseberry	264	6
104	BlPl – Azalea – Grouseberry	1,449	31
110	BlSe – Azalea – Foamflower	368	8
111	Se – Horsetail – Bluejoint	36	1
Flood Ecosystems			
Fm02	Flood Association – Middle bench Cottonwood – Spruce – Dogwood	1	0.02
Grassland/Brushland Ecosystems			
Gb	Grassland Group – Brushland Class	6	0.1

Mapped Site Series	Name	Mapped Area (ha)	% of Variant
Gb20	Saskatoon – Soopolallie – Juniper brushland association	23	0.5
Wetland Ecosystems			
Wf	Wetland - Fens	2	0.04
Wm01	Beaked sedge – Water sedge Marsh	1	0.03
Ws	Wetland--Swamp	1	0.02
Avalanche Ecosystems			
Vh01	Cow-parsnip – Fireweed – Nettle Avalanche Herb Meadow	5	0.1
Vhd	Avalanche Dry Herb Meadow	12	0.3
Vhm	Avalanche Moist Herb Meadow	33	1
Vs	Avalanche Group – Avalanche Shrub Thicket Class	239	5
Vs10	Willow – Cow-parsnip – Fireweed Association	8	0.2
Vt	Avalanche Group – Avalanche Treed Class	102	2
Disclimax Sites			
Xv	Vegetation Disclimax	64	1
Non-Vegetated Sites			
ES	Exposed Soil	1	0.01
OW	Open Water	1	0.02
RI	River	23	0.5
Rock Ecosystems			
Rc	Rock Group – Cliff Class	45	1
Ro	Rock Group – Rock Outcrop Class	141	3
Rt	Rock Group – Talus Class	172	4
Anthropogenic Sites			
RM	Reclaimed Mine	5	0.1
Xa	Anthropogenic Disturbance	5	0.1

3.3.3 ESSFdkw

In the ESSFdkw, which comprises 12% of the study area, the most mapped site series was 101. The 103 site series was the next most widespread map unit with both site series combined covering more than half of the subzone (60%; Table 3-5). In the ESSFdkw, non-forested ecosystems become more common, relative to the biogeoclimatic units at lower elevations, with 65% of this subzone forested compared to over 75% for the units below. Rock and avalanche ecosystems account for 18 and 10% of the ESSFdkw subzone, respectively.

Table 3-5 Summary of mapped ecosystems in the ESSFdkw.

Mapped Site Series	Name	Mapped Area (ha)	% of Subzone
Forested Site Series			
101	BlSe – Grouseberry – Leafy liverwort	492	32
102	BlLa – Grouseberry	37	2
103	BlSePa – Grouseberry	434	28
110	BlSe – Grouseberry – Valerian	53	3
Alpine Ecosystems			
Af	Alpine Group – Alpine Fellfield Class	11	1
Am	Alpine Group – Alpine Meadow Class	1	0.1
As	Alpine Group – Late Snowbed Class	0.2	0.02
At	Alpine Group – Alpine Tundra Class	34	2
Avalanche Ecosystems			
Vhd	Avalanche Dry Herb Meadow	26	2
Vhm	Avalanche Moist Herb Meadow	12	1
Vs	Avalanche Group – Avalanche Shrub Thicket Class	79	5
Vt	Avalanche Group – Avalanche Treed Class	43	3
Subalpine Shrub Group			
Sk02	Krummholz Subalpine Fir – Grouseberry – White Mountain Heather	6	0.4
Grassland/Brushland Ecosystems			
Gb20	Saskatoon – Soopolallie – Juniper brushland association	25	2
Wetland Ecosystems			
Wa	Alpine Wetland	2	0.1
Disclimax Sites			
Xv	Vegetation Disclimax	1	0.1
Rock Ecosystems			
Rc	Rock Group – Cliff Class	42	3
Ro	Rock Group – Rock Outcrop	103	7
Rt	Rock Group – Talus Class	140	9
Anthropogenic Sites			
RZ	Road	12	1

3.3.4 ESSFdkp

The ESSFdkp, the smallest BGC unit, is found only along the Gaff Peak and Mount Erickson ridges to the west of Crown Mountain. It comprises just 4% of the study area. Rock cliff (Rc) was the most common map entity followed by the Sk02 (Krummholz Subalpine Fir – Grouseberry – White Mountain Heather), covering 26 and 17% of the subzone, respectively (Table 3-6). In this subzone, no productive forest was found, and ecosystem types shifted to low vegetation and open/stunted forests. Krummholz ecosystems covered 33% of the subzone. Alpine ecosystems covered 20% of the subzone.

Table 3-6 Summary of mapped ecosystems in the ESSFdkp.

Mapped Site Series	Name	Mapped Area (ha)	% of Subzone
Alpine Ecosystems			
Af	Alpine Group – Alpine Fellfield Class	64	11
At	Alpine Group – Alpine Tundra Class	47	8
Avalanche Ecosystems			
Vhd	Avalanche Dry Herb Meadow	7	1
Vs	Avalanche Group – Avalanche Shrub Thicket Class	16	3
Vt	Avalanche Group – Avalanche Treed Class	9	2
Rock Ecosystems			
Rc	Rock Group – Cliff Class	145	26
Ro	Rock Group – Rock Outcrop Class	78	14
Rt	Rock Group – Talus Class	17	3
Subalpine Shrub Group			
Sk	Krummholz Class	37	7
Sk02	Krummholz Subalpine Fir – Grouseberry – White Mountain Heather	94	17
Sk10	Krummholz Whitebark Pine – Subalpine Fir – White Mountain Avens	38	7
Sk20	Alpine Larch – Subalpine fir – Mountain Heathers Krummholz Association	11	2

4 Quality Assurance and Map Reliability

The quality assurance for this project included the following:

- Appropriate and most current Biogeoclimatic Mapping Standards – updated BGC linework and ecosystem classification units were obtained from the regional ecologist prior to implementing any attribution or mapping work.
- Field classification – field plots were reviewed by the senior ecologist checking field cards and discussing field call options.
- Appropriate ecosystem classification designations (site series) – field plots were used to inform the attribution process to ensure attribution accounted for both field and photo interpretation.
- Comparisons were made with the PEM classifications to identify alignment; this QA approach was only applied 'generally' as PEM classification is raster rather than polygon based.
- The TEM database was reviewed to confirm all attributions were appropriate for the BGC unit and deciles added to 10.
- Appropriate structural stage designations – structural stage classification was cross-referenced with field plots and up to date (October 2018) harvest mapping to confirm structural stage classification.
- Polygon delineation and attribution was checked by a recognized provincial expert in BEC and TEM who revised approximately one half of the initial polygons.

5 Limitations

The primary limitation related to this project relates to other industry operating in the region and dynamic features on the landscape:

- Logging activity is on-going in the area and will affect the structure of the forest and hence habitat conditions. Road building associated with ongoing logging and mineral exploration activities will also impact various values.
- Some features are naturally dynamic, particularly water courses; thus, any mapping of streams and rivers may have some level of error. Considering the base data for these

features was derived from the BC TRIM, which is 20-years old, the feature boundaries may have shifted over time.

- The mapping of the ESSFdkp relied entirely on photo interpretation.

6 References

Agriculture Canada Expert Committee on Soil Survey. (1987). *The Canadian system of soil classification*. Second Edition. Publication 1646. Ottawa, ON: Agriculture Canada.

Braumandl, T.F., Curran, M.P., Davis, G.D., Quesnel, H.J., Woods, G.P., DeLong, D.L., and Ketcheson, M.V. (1992). Biogeoclimatic subzones and variants of the Nelson Forest Region. In T.F. Braumandl and M.P. Curran (Eds.), *A field guide for site identification and interpretation for the Nelson Forest Region.* Land Mgmt. Handb. 20. Victoria, BC: BC Ministry of Forests.

British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment. (BCMoFR, MOE) (2010). Field manual for describing terrestrial ecosystems. 2nd edition. Victoria, BC.

Coupé, R., Stewart, A.C., and Wikeem, B.M. (1991). Chapter 15: Engelmann spruce-subalpine fir zone. In D.V. Meidinger and J. Pojar (Eds.), *Ecosystems of British Columbia*. Special Report Series No. 6. Victoria, BC: BC Ministry of Forests. Retrieved May 16, 2018, from https://www.for.gov.bc.ca/hfd/pubs/docs/srs/srs06.htm

Ecosystems Working Group. (1998). *Standard for terrestrial ecosystem mapping in British Columbia.* Victoria, BC: Resources Inventory Committee. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/tem_man.pdf

Hope, G.D., Mitchell, W.R., Lloyd, D.A., Harper, W.L. and Wikeem, B.M. (1991). Chapter 12: Montane spruce zone. In: D.V. Meidinger and J. Pojar (Eds.), *Ecosystems of British Columbia*. Special Report Series No. 6. Victoria, BC: BC Ministry of Forests. Retrieved May 16, 2018, from https://www.for.gov.bc.ca/hfd/pubs/docs/srs/srs06.htm

Howes, D.E., and Kenk, E. (1997). *Terrain classification system for British Columbia*. Victoria, BC: British Columbia Ministry of Environment.

Keefer Ecological Services (KES). (2019). *Listed plant species, listed ecological communities and sensitive ecosystem baseline surveys*.

MacKenzie, W.H. (2012). *Biogeoclimatic ecosystem classification of non-forested ecosystems in British Columbia*. Victoria, BC: Province of BC. Tech. Rep. 68. www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr068.pdf

MacKillop, D.J., Ehman, A.J., Iverson, K.E., and McKenzie, E.B. (2018). *A field guide to site classification and identification for southeast British Columbia: East Kootenay*. Victoria, BC: Province of BC. Land Management Handbook 71.

Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) Forest Service Research Branch. (2015). *How BEC works.* Retrieved November 17, 2017, from https://www.for.gov.bc.ca/hre/becweb/system/how/index.html.