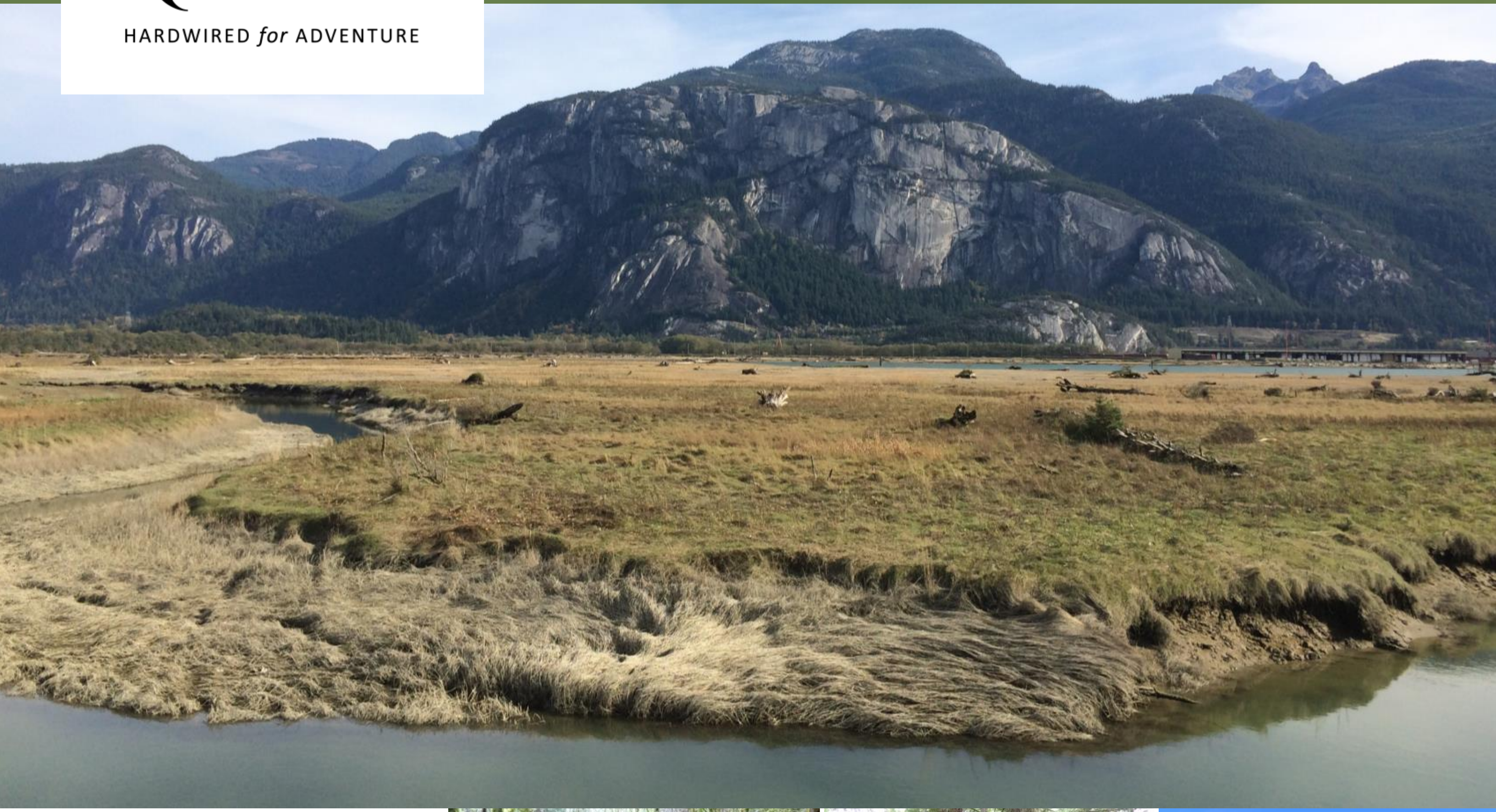
DISTRICT OF SQUAMISH
TERRESTRIAL ECOSYSTEM MAPPING



PHASE 2 - ENVIRONMENTALLY SENSITIVE AREAS MAPPING

Prepared For: District of Squamish

Prepared By:
Durand Ecological LTD. and POLAR Geoscience Ltd.
In Partnership with:
Ecoscape Environmental Consultants Ltd.

January, 2016

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Prepared For:

DISTRICT OF SQUAMISH
Municipal Hall, Engineering
37955 Second Ave
Squamish, BC V8B 0A3

ATTENTION TO: Caroline Ashekian, MSc, R.P.Bio. | Environmental Coordinator

Prepared By:

Ryan Durand, R.P.Bio. (DURAND ECOLOGICAL LTD.) and
Polly Uunila, P.Geo. (POLAR GEOSCIENCE LTD.)

IN PARTNERSHIP WITH:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
102 - 450 Neave Court
Kelowna, BC
V1V 2M2

January, 2016

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EXECUTIVE SUMMARY

The District of Squamish (DOS) identified sensitive habitat mapping as a strategic priority for the anticipated 2016 Official Community Plan update. In September, 2015 Ecoscape Environmental Consultants Ltd., in partnership with Durand Ecological Ltd. and Polar Geoscience Ltd., were retained to complete Environmentally Sensitive Areas (ESA) mapping of the DOS. This report contains the results of the Terrestrial Ecosystem Mapping of the DOS, including bioterrain and ecosystem mapping.

The study area for this project was 10,317 hectares and encompassed the majority of the DOS. It included three Coastal Western Hemlock (CWH) biogeoclimatic subzones: dry maritime, dry submaritime, and very wet maritime (which is further divided into two variants).

A total of 454 sample plots were completed for the project, representing 24% of the total mapped polygons, and 40% of the polygons that were primarily classified by a vegetated ecosystem (i.e. excluding polygons mapped ocean, gravel pit, road, urban, etc.).

ACKNOWLEDGEMENTS

This project was coordinated by Caroline Ashekian (Environmental Coordinator) and Dan Griffin (GIS Manager) from the District of Squamish. Kyle Hawes (Ecoscape Environmental Consultants Ltd.) managed the project and GIS support was provided by Robert Wagner (Ecoscape Environmental Consultants Ltd.). Imagery and PurVIEW models were created by McElhanney and 4DGIS.

We would like to thank Squamish resident and geoscientist, Pierre Friele, M.Sc., P.Geo., for sharing his vast local glacial and post-glacial history knowledge.

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1.0 INTRODUCTION

The District of Squamish (DOS) identified sensitive habitat mapping as a strategic priority for the anticipated 2016 Official Community Plan update. In order to complete the mapping, the DOS identified the following priorities:

- Conducting a gap analysis to identify a plan to complete Terrestrial Ecosystem Mapping (TEM), Sensitive Ecosystem Inventory Mapping (SEI), wetland inventories and mapping, and ecological assessments in general for the District;
- Determining a rating system for inventoried features to help prioritize protection;
- Developing a rating system for aquatic habitat to guide policy, bylaws and zoning; and
- Creating protection measures and guidelines to align existing zoning with environmentally sensitive habitat.

The gap analysis was completed in the spring of 2015 (Hawes and Durand). In September, 2015 Ecoscape Environmental Consultants Ltd., in partnership with Durand Ecological Ltd. and Polar Geoscience Ltd., were retained to complete Environmentally Sensitive Areas (ESA) mapping of the DOS. The project will provide ecological baseline data for the District, in order to establish an inventory of environmental features and their locations. The project includes:

- new Terrestrial Ecosystem Mapping of most of the DOS;
- detailed wetland, estuary and marine shoreline mapping;
- Sensitive Ecosystem Inventory Mapping; and
- modelling of Ecosystem Sensitivity Ratings (ESR).

This report contains the results of TEM mapping, with a subsequent report containing results of the other components of the study.

2.0 STUDY AREA

The DOS is located in the Sea-to-Sky corridor midway between Vancouver and Whistler. It is situated at the north end of Howe Sound and the mouth of the Squamish River in addition to the confluence of four other rivers – the Mamquam, Cheakamus, Stawamus, and Cheekye. The total land area of the District is 11,730 hectares and relief ranging from 0 – 900 m above sea level (Hawes and Durand, 2015).

The ESA study boundary area is 10,317 hectares (Fig. 1). It encompasses the majority of the DOS and includes three biogeoclimatic subzones (Section 4.2).

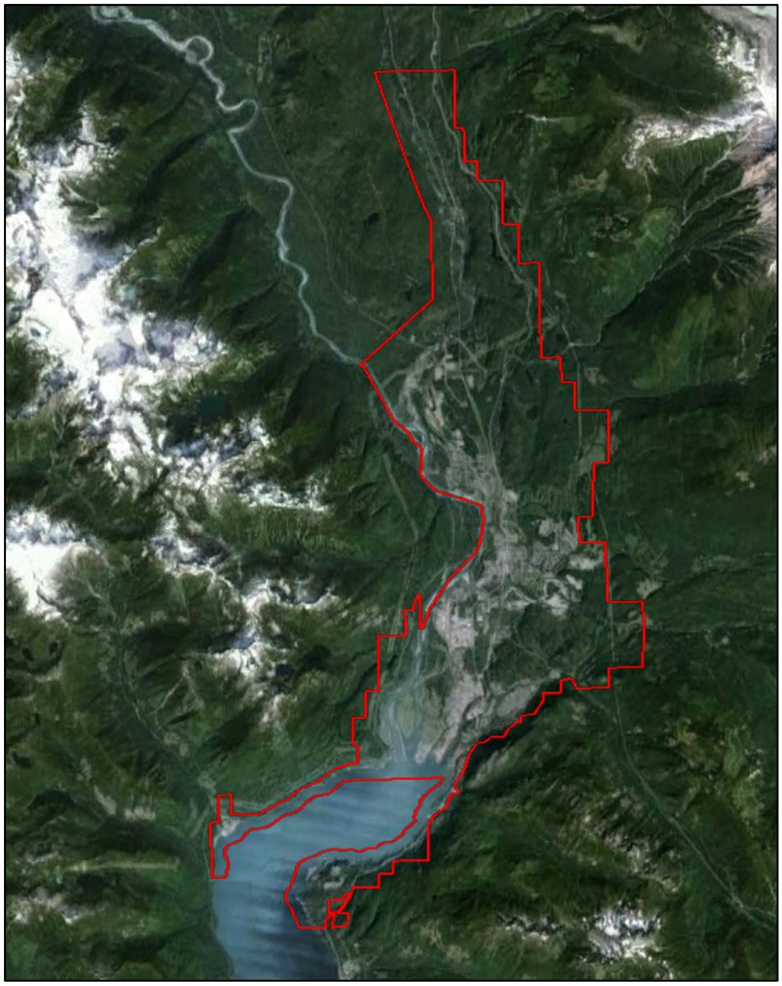

Figure 1. Study Area Boundary (adapted from Google Earth).

3.0 OVERVIEW OF BEDROCK GEOLOGY AND LANDSCAPE EVOLUTION

3.1 Bedrock Geology

The Study Area lies within the Pacific Ranges which are a subdivision of the Coast Mountains Physiographic Region (Holland, 1976). In general, the Pacific Ranges consist of granitic rock types although in the vicinity of Squamish, there are scattered volcanic rock types. Mt. Garibaldi, for example, is a composite volcano that was active at the end of the Pleistocene.

The regional bedrock geology described in this report is based on Massey *et al* (2005) and Journeay and Monger, 1994. Bedrock outcrops are common at the northern end of the study area, between Alice Lake Provincial Park and Garibaldi Highlands, Crumpit Woods, Stawamus Chief Provincial Park, the west side of the Squamish River, and on either side of Howe Sound. Characteristics of the bedrock, including mineral composition and structure, determine the shape and texture of its weathered material. These characteristics influence the shape and size of clasts and the matrix texture of soils that are created.

The northern three quarters of the study area is underlain by Jurassic-aged quartz diorite of the West Coast Belt. Most of the southern end of the study area, including Stawamus Chief Provincial Park, is underlain by Cretaceous-aged granodiorite of the Coast Belt. Where well-jointed, granitic rocks such as quartz diorite and granodiorite break into large blocks and boulders and can produce bouldery tills. On weathering, granitic rock types break down into sand and minor silt and consequently, areas of granitic bedrock tend to produce till with a silty sand matrix. These rock types tend to produce low soil nutrient regimes.

Small areas of Pleistocene-aged volcanic bedrock of the Garibaldi Group are located at Castle Rock on the west side of the Squamish River, at Watt's Point north of Murrin Provincial Park and the Ring Creek lava flow near the confluence of Ring Creek and Mamquam River. Garibaldi Group rock types include andesite, basalt, dacite flows and pyroclastic rocks. A small area of Cretaceous-aged volcanic rocks of the Gambier Group are located southeast of Mt Crumpit at the study area boundary. Volcanic rocks break down into rubble and blocks which weather into silt and clay. Non-siliceous volcanic rock tends to give rise to moderate soil nutrient regimes (ie basalt). Like granitic bedrock, rock with higher silica content (ie rhyolite) gives rise to low soil nutrient regimes.

3.2 Landscape Evolution

Unless otherwise mentioned, the following section on landscape evolution is summarized from Clague (1994).

During the Pleistocene Era (2,000,000 to 10,000 years ago) multiple glaciations scoured the landscape and deposited glacial sediments. Each successive glacial period erased most of the evidence of prior glaciations. The majority of the glacial sediments present in the landscape today are the result of the most recent, Fraser Glaciation. At the Fraser glacial maximum (15,000 years ago), the ice was over 1,500 m thick along the south coast of British Columbia and, the flow of the ice went southwards into the Strait of Georgia. As the glacier advanced, the weight of the ice depressed the land so that relative sea level appeared as much as 100 m higher than today's sea level (Blais-Stevens, pers. comm., 2015) in the vicinity Howe Sound.

Deglaciation commenced about 15,000 years ago and appears to have completely ended by about 11,000 years ago. During the same time period, Mt. Garibaldi underwent multiple volcanic eruptions under and adjacent to the valley glacier. Brooks and Friele (1992) summarize Dr. William Mathews extensive research on Mt. Garibaldi as follows:

- Subglacial eruptions: the Table, youngest flow of the Cheakamus Valley Basalts, the Eeonstruck complex, and dome-shaped knobs of the Paul Ridge complex;
- Eruptions adjacent to glacial ice: Clinker Ridge and Culliton Creek lava flows, and;
- Partially on top of glacial ice: the composite cone of Mt. Garibaldi.

Deglaciation took place by downwasting (i.e., thinning of the glacial ice due to melt) so that tongues of ice in the valley bottoms became thinner and narrower. Friele and Clague (2002b) state that within the Howe Sound and Squamish area, deglaciation consisted of periods of stagnant ice as well as re-advances. As ice melted, pyroclastic deposits and lava flows that built out onto the ice collapsed. These sediments were reworked and eventually deposited along the lower slopes of the CheekyeRiver (upper Cheekyefan, Figure 4) and Mashiter Creek. The dashed line on Figure 2 shows the extent of the valley glacier 12,800 years ago. During this time a temporary glacial lake formed against the ice at the mouths of Mashiter Creek and Mamquam River, and the lower Mamquam River temporarily drained through Valleycliffe. Shortly after 12,800 years ago, Friele and Clague (2002a) state that there was a brief re-advance of the valley glacier which deposited a cap of till on top of the deltaic sediments (glaciofluvial gravels) in the vicinity of Quest University.

After the brief re-advance, the valley glacier began to rapidly melt and retreat. As the ice level lowered, glaciofluvial sediments (middle Cheekyefan) sediments deposited in the vicinity of Alice Lake. These sediments deposited onto remnants of glacial ice. Once the remnants melted, the gravels collapsed. Some of the larger depressions (known as kettles) are the present day locations of the lakes in Alice Lake Provincial Park. Friele *et al*, (1999) state that by 10,200 years ago, the valley ice had completely melted but relative sea level was 45 m higher that today's sea level, i.e., the land was still rebounding after glacial retreat. The head of Howe Sound was located further north in the Squamish River Valley (possibly as far north as the mouth of Ashlu Creek (Friele and Clague, 2002b) so that the lower Cheekyefan was building out into the sea. The fan continued to expand outwards into the Howe Sound as sea level dropped so that by 8,000 to 9,000 years ago, the Cheekyefan had reached about today's extent and by 6,000 years ago about 90% of the sediments were deposited (Friele *et al*, 1999). Squamish River sediments continued to deposit and prograde into Howe Sound so that the river mouth reached the confluence with the Cheakamus River by about 3,000 years ago (Friele *et al*, 1999).

In post-glacial times, the Ring Creek lava flow extending from Opal Cone, formed sometime between 10,700 and 9,300 years ago (Brooks and Friele, 1992). Also during the post-glacial period, natural processes have re-worked some glacial sediments and weathered bedrock to redistribute them as colluvium and fluvial sediments. Streams and rivers have graded to the present day level of the Squamish River, downcutting into glacial deposits and bedrock creating terraces, benches and steep-sided scarps. Colluvium is present on many of the steep slopes in the Study Area and is usually mapped near bedrock outcrops.

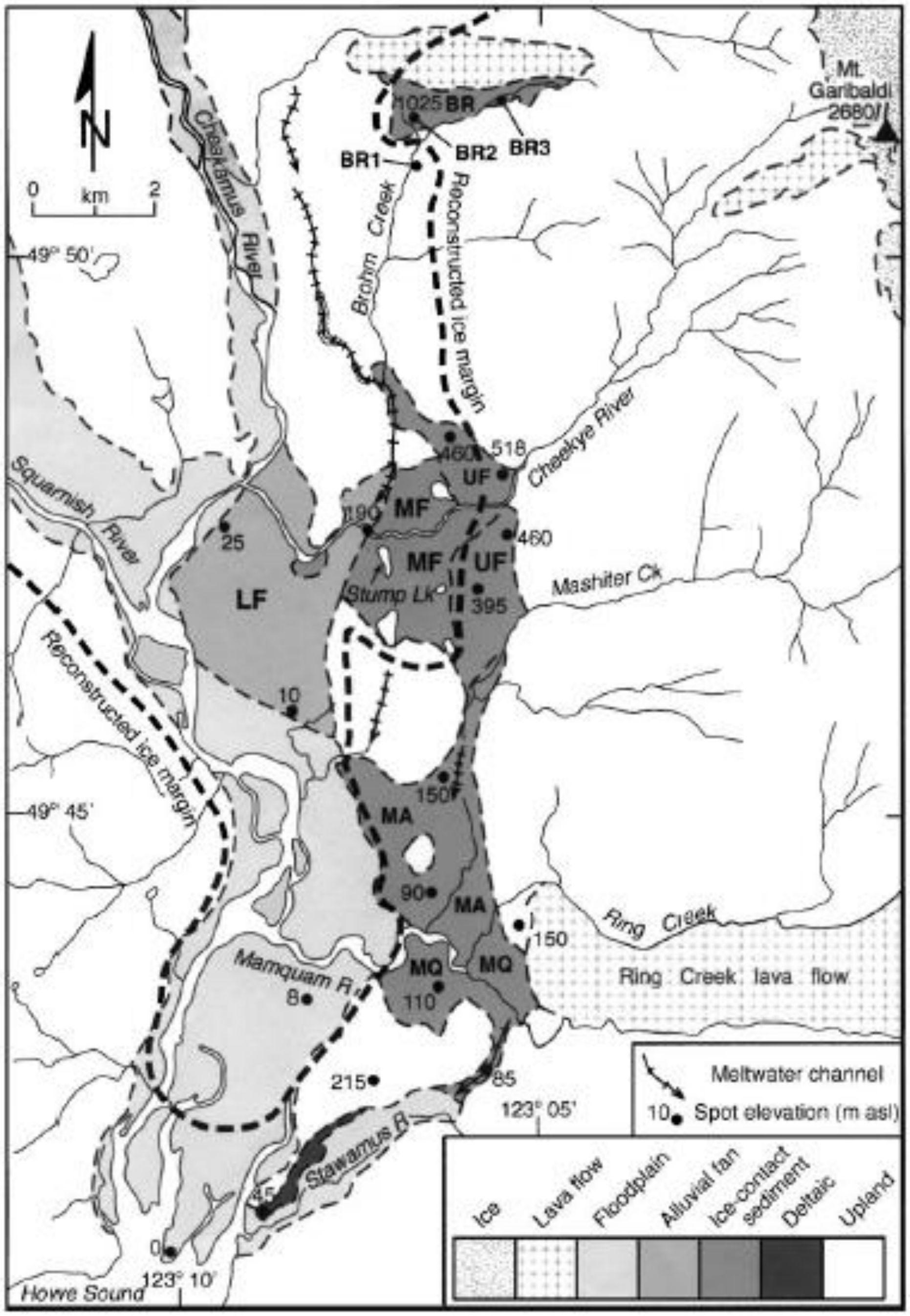

Figure 2. Distribution of glacial (Fraser Glaciation) and post-glacial sediments and the margins of the valley glacier 12,800 years ago. LF – lower Cheekyefan, MF – middle Cheekyefan, UF – upper Cheekyefan, MQ – Mamquam terraces, MA – Mashiter terraces, BR – Brohm terrace. Source: Friele and Clague (2002b).

4.0 METHODOLOGY

In order to map and classify ecosystem units (site series), TEM uses the established BEC system to define the regional zone and provide descriptions of ecosystem types that are expected to occur. Bioterrain mapping (Section 4.1) is the first part of the process, where terrain polygons are delineated on airphotos to map areas of like soils and topology. Ecosystem mapping (Section 4.2) uses the bioterrain polygons (and dividing them into smaller polygons as needed) to map and classify ecosystem types, along with additional descriptors that provide information on the current state and condition of each ecosystem.

4.1 Bioterrain Mapping

Polly Uunila, P.Geo., of Polar Geoscience Ltd. completed bioterrain mapping of the study area. The background information reviewed to complete this work included:

- Bedrock geology completed by Massey *et al*, 2005 and Journeay and Monger, 1994; and

- Terrain mapping by Thompson, 1980a, 1980b, Friele *and* Clague, 2002a, and Blais-Stevens, 2008a, 2008b;

Terrain mapping is a classification system used to describe the surficial material (the loose materials on top of bedrock) and their textures, surface expressions (the three dimensional shape of the surficial materials), and geomorphological processes (the active mechanism that continue to shape the landscape) in a given area.

A terrain map is a map of surficial materials; it shows the surficial material type and thickness combined with surface expression or landform type (and geomorphological processes if applicable). Each surficial material type is classified based on its genesis. It has its own characteristics of deposition and therefore physical properties such as texture and consolidation.

Terrain maps are the basis for many kinds of land use planning, including terrain stability, ecosystem mapping, planning of urban roads and development, assessment of geological hazards, and aggregate mining. Terrain mapping with an ecological emphasis is called bioterrain mapping. Bioterrain mapping forms the basis of terrestrial ecosystem mapping (TEM) by delineating polygons with similar ecological conditions such as soil moisture, aspect, and vegetation characteristics.

Terrain mapping is based on air photo interpretation, which is then ground-truthed in the field. For this project, terrain mapping followed the standard British Columbia procedures for terrain classification (Howes and Kenk, 1997, mapping methods (Resources Inventory Committee, 1996), and bioterrain mapping methodology (Resources Inventory Committee, 1998).

Bioterrain delineation was based on the following:

- terrain type;
- material depths;
- drainage;
- slope breaks;
- slope position;
- aspect: cool (from 285 to 135°) and warm (from135 to 285°);
- geomorphological processes;
- surface expression and slope morphology (e.g., concave or convex);
- vegetation changes;
- riparian zones and corridors;
- any other ecologically significant areas such as cliffs, talus slopes, and ponds.

The bioterrain mapping was performed using 2013 air photos using PurVIEW. Once the polygon boundaries were defined, the following information (i.e., terrain attributes) was identified for each polygon:

1. surficial material;
2. geomorphological process(es) where present; and
3. soil drainage class;

Following field work, bioterrain mapping using PurVIEW was refined by Polly Uunila, P.Geo. based on field observations and air photo interpretation. An expanded legend of the attributes described during bioterrain mapping is located in Appendix 1, along with descriptions of each mapped surficial material, landform and geomorphological process in Appendix 2.

4.2 Ecosystem Mapping

Ryan Durand, R.P.Bio., of Durand Ecological Ltd. completed ecosystem mapping of the study area. Mapping was completed in accordance with the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998). Field inventory procedures followed the *Field Manual for Describing Terrestrial Ecosystems; 2nd Edition* (BC Min. Forests & Range, 2010). Wetland classifications were obtained from *Wetlands of British Columbia: a guide to identification* (MacKenzie & Moran, 2004). Mapping was completed on 2013 digital airphotos using ArcGIS 10.3 and a PurVIEW 3D softcopy system.

TEM uses the provincial Biogeoclimatic Ecosystem Classification (BEC) system which uses a hierarchical classification system to group like components of the landscape into ecosystem categories. BEC groups ecosystems at three levels, regional, local and chronological, based on vegetation, soils, topography, and climate. At the local level, sites are classified based on uniform vegetation, soils, and topography, with site series names given to describe specific local ecosystem units. Vegetation is the most important factor for ecosystem classification; however it is based on climax and zonal theories, where the vegetation observed in a young or disturbed site, may not necessarily reflect the species composition of mature or old site. A detailed description of the ecosystem units, along with various other descriptors, is presented in Appendix 3. (Green and Klinka, 1994; BEC WEB; 2015; RISC, 1998)

The study area is located within the Coastal Western Hemlock (CWH) biogeoclimatic (BGC) zone. The CWH occurs at low to mid elevations along the entire coast of BC, mainly on the eastern slopes of the Coastal Mountains. It occurs from sea level to 900m in elevation, and over 1,000m on leeward slopes. The CWH has the highest average rainfall of any BGC zone in the province, although prolonged summer dry spells are common. Western hemlock (*Tsuga heterophylla*) is the most common tree species, along with western redcedar (*Thuja plicata*) Douglas-fir (*Pseudotsuga menziesii*). Shore pine (*Pinus contorta*) often occurs on very dry sites and bogs, while grand fir (*Abies grandis*), western white pine (*Pinus monticola*), and bigleaf maple (*Acer macrophyllum*) occur in the warmer southern portions of the zone. Red alder (*Alnus rubra*) is common on disturbed sites, while black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and Sitka spruce (*Picea sitchensis*) occur in river floodplains. (Meidinger and Pojar, 1991)

Three CWH subzones are located in the study area (Fig. 3and Table 1); dry maritime, dry submaritime, and very wet maritime (which is further divided into two variants). Biogeoclimatic subzones in the CWH are separated based on precipitation and continentality gradients; hypermaritime, maritime, and submaritime subzones (Meidinger and Pojar, 1991). The following sections describe each in more detail.

Table 1. Summary of BGC Subzones in the Study Area.

Code	Zone	Subzone	Variant	Area (ha)	Percent
CWHdm	Coastal Western Hemlock	Dry Maritime		10,161	98.5
CWHds1	Coastal Western Hemlock	Dry Submaritime	Southern	138	1.3
CWHvm1	Coastal Western Hemlock	Very Wet Maritime	Submontane	14	0.1
CWHvm2	Coastal Western Hemlock	Very Wet Maritime	Montane	5	<0.1

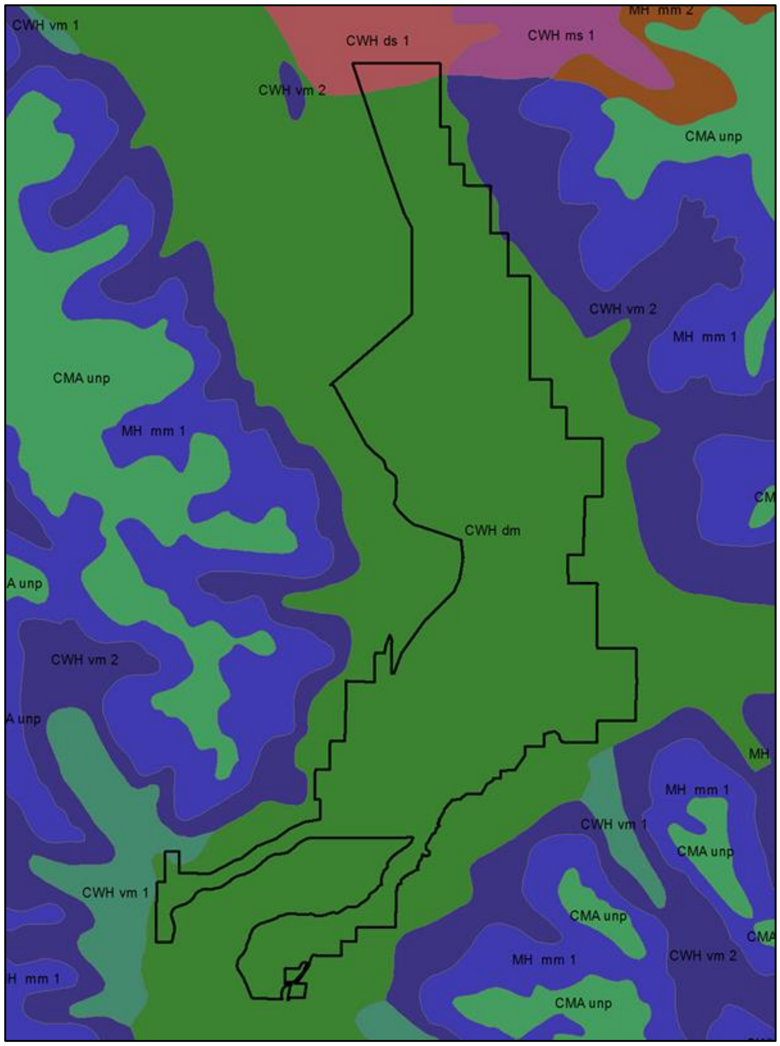

Figure 3. Provincial Biogeoclimatic map with the study area overlain shoing the majority of the study area located in the CWHdm subzone with small portions occurring in the CWHds1 at the north end, CWHvm2 in the northeast, and CWHvm1 in thesouthwest.

Coastal Western Hemlock Dry Maritime Subzone (CWHdm)

The CWHdm occurs at low elevation from Hardwicke Island (northern Vancouver Island) to the Chilliwack River (Fraser Valley). It typically occurs from sea level to about 650m. The CWHdm has relatively warm and dry summers and moist, mild winters, Water deficits are uncommon. Zonal forested sites are dominated by Douglas-fir, western redcedar, and western hemlock, along with an understory of salal (*Gaultheria shallon*), red huckleberry (*Vaccinium parvifolim*), sword fern (*Polystichum munitum*), vine maple (*Acer circinatum*), dull Oregon-grape (*Mahonia nervosa*). Mosses include step moss (*Hylocomium splendens*), Oregon beaked moss (*Kindbergia oregana*), and lanky moss (*Rhytidiadelphus loreus*). (Green and Klinka, 1994)

Coastal Western Hemlock Dry Submaritime Subzone (CWHds1)

The CWHds1 occurs in low elevations from the upper Fraser Valley to eastern portions of the Coast Mountains from Harrison Lake to the Homathko River. It typically occurs from valley bottom to 650m. The CWHds1 is a transitional zone, with a climate that is characterized by warm, dry summers and moist, cool winters. It has less precipitation and a higher potential for water deficits than the adjacent CWHdm. Zonal sites are dominated by Douglas-fir, western hemlock, and some western redcedar. Understory species include falsebox (*Paxistima myrsinites*), prince's pine (*Chimaphila umbellata*), dull Oregon-grape, and queen's cup (*Clintonia uniflora*). Moss layers are well developed, containing step moss, red-stemmed feathermoss (*Pleurozium schreberi*), and lanky moss (Green and Klinka, 1994).

Coastal Western Hemlock Very Wet Maritime Subzone (CWHvm1 and CWHvm2)

The CWHvm1 is one of the most extensive units in the Vancouver Forest Region, occurring from the Fraser Valley to Jordan River (Vancouver Island). It occurs from sea level to about 650m, with CWHvm2 occurring above it (elevations 650 to 1,000 m). The CWHvm1 has a wet, humid climate with mild winters and little snow, while the higher elevation CWHvm2 has shorter summers, with cool winters and high snowfall. CWHvm1 zonal sites are dominated by western hemlock, amabilis fir (*Abies amabilis*), and lesser amounts of western redcedar. The understory is well developed, and contains red huckleberry, Alaskan blueberry (*Vaccinium ovalifolium*), with a sparse herb layer containing species such as deer fern (*Blechnum spicant*), five-leaved bramble (*Rubus pedatus*), bunchberry (*Cornus canadensis*), and queen's cup. Mosses are abundant, and dominated by step moss, and lanky moss. The CWHvm2 has zonal sites that are dominated by western hemlock, amabilis fir, and lesser amounts of western redcedar and yellow cedar. Understory species include Alaskan blueberry, five-leaved bramble, step moss, lanky moss, and pipecleaner moss (*Rhytidiopsis* spp.) (Green and Klinka, 1994).

4.3 Reliability

The bioterrain and ecosystem mapping are based primarily on air photo interpretation with a limited amount of field checking. While the mapping was conducted by an experienced terrain mapping specialist and vegetation ecologist, mapping does not replace the need for on-site assessments for areas of development. Uncertainty is inherent in this type of analysis, which is affected by air photo quality, photo scale, and especially the presence of shadows in forested and high relief terrain. The accuracy of polygon boundaries is limited by the scale and dates of the air photos upon which the mapping was based. The information and analyses contained in this report are based on observations of land-surface conditions and the current understanding of terrain and ecosystem classification. The mapping was completed using high resolution digital air photos. Polygons were drawn at 1:5000 scale in PurVIEW; terrain is intended to be used at this or smaller scale. Wetlands were mapped at 1:1000 scale.

5.0 RESULTS

The following sections provides a summary of the bioterrain and ecosystem mapping. A series of maps accompany this report that depicts the mapping in detail.

5.1 Bioterrain Mapping

The lowest elevations in the study area includes the estuary at the mouth of the Squamish River. This landform was created by deposition of sediments from the Squamish River prograding into Howe Sound. Tidal action from Howe Sound has deposited a layer of fine-grained marine sediments on top of the alluvial sediments. Over the past half century, the estuary has been altered by humans. Fill has been placed on the outer edge of much of the estuary for log sort and dump areas, the Squamish Terminals and other industrial purposes. Waterways around the shipping and boating routes have been dredged. In the early 1970's, a training dyke (the spit) was built to force the Squamish River over to the west side of the valley. This decreased deposition of alluvial sediments during flooding in the estuary on the east side of the Spit. In areas of unaltered and restored estuary, the soil drainage ranges from very poor to imperfectly drained.

The valley bottom in the study area includes the Squamish, Cheakamus, Mamquam and Stawamus River floodplains. The floodplain gradients range from flat near the Howe Sound to approximately 3% further upstream. The gentlest slopes consist of gravelly sands and the steeper gradients are made up of sandy gravels. In many locations, the floodplains are covered by a veneer of silty sand sediments that were deposited during floods. Although alluvial sediments are permeable, soil moisture and drainage on floodplains is highly variable ranging from poorly drained to well drained and is largely due to high water table and low gradients.

Alluvial fans have formed at the mouths of many rivers and creeks at the margins of the above mentioned floodplains. The Cheekyefan, at about 25 km^2 in size, is the largest in the study area. Much of Valleycliffe is located on an alluvial fan of the Stawamus River. The site of the former Woodfibre mill is located on the fan of Mill Creek. Alluvial fans have gradients ranging from near 0% to 25%. Alluvial fan material is made up of a mixture of pebbles, cobbles and sand and may contain boulders. Fans are usually well drained.

Vast areas of glaciofluvial terraces are located within the study area as shown on Figure 2. Elsewhere in the study area there are remnants of glaciofluvial terraces, for example near the mouth of Culliton Creek in Paradise Valley, upslope of the Mamquam Forest Service Road on the east side of the study area and the gravel pits at the higher elevations at Watts Point. These large sand and gravel landforms were deposited in glacial rivers adjacent to the receding valley glacier. The deposits are well drained.

The sediments of the upper Cheekyefan landform shown in Figure 2 are mapped as glaciocolluvial[1] sediments since the material is largely made up of debris flow and rock avalanche material (Friele *et al*, 1999). This landform is generally well drained.

The glaciomarine sediments mapped within the study area closely resemble the glaciofluvial sediments, however the glaciomarine sediments were deltaic sediments depositing into the sea (when land was depressed by the weight of glacial ice and the relative sea level was up to 100 m higher than today). Glaciomarine sediments in the study area comprise the terrace at hospital hill and Stawamus elementary school near the mouth of the Stawamus River, and scattered terraces are located along Highway 99 from the Stawamus River to Watt's Point. These sediments are generally sands and gravels and also contain shells and pieces of wood covered with some barnacles. Fine-grained glaciomarine sediments were found in an excavation in the terrace escarpment below Stawamus Elementary school and stony, fine-grained glaciomarine sediments containing shells were found near Shannon Falls (Friele and Clague, 2002a).

Bedrock outcrops at or near the surface are common at the northern end of the study area, between Alice Lake Provincial Park and Garibaldi Highlands, Crumpit Woods, Stawamus Chief Provincial Park, the west side of the Squamish River, and on either side of Howe Sound. Talus slopes at the bases of steep rock cliffs are common throughout these areas. Some of the larger talus slopes in the study area include, the northwest facing slopes of the Stawamus Chief, the west facing slopes adjacent to the Cheakamus River west of Brohm Lake and upslope of Highway 99 just north of Brohm Lake. A deep-seated bedrock slump is located on the hillslope to the east of Midnight Way in Paradise Valley.

In general, thick deposits of till are uncommon within the study area. Thin pockets of till fill in scattered depressions in the bedrock-controlled terrain mentioned in the above paragraph. A cap of till, deposited during a late-glacial re-advance, is located on the glaciofluvial terraces along the Mamquam River in the vicinity of Quest University.

Organic materials were uncommon in the study area. During field work, it was observed that only some wetlands contained organic materials. Were observed, they were thin and usually less than 40 cm thick.

5.2 Ecosystem Mapping

A total of 454 sample plots were completed for the project, representing 24% of the total mapped polygons, and 40% of the polygons that were primarily classified by a vegetated ecosystem (i.e. excluding polygons mapped ocean, gravel pit, road, urban, etc.). Table 2 contains a summary of the number and type of sample plots completed for the project.

[1] The prefix "glacio-" is added to "colluvial" because the sediments were deposited during Fraser Glaciation.

Figure 4 presents a map of the plot locations. The site series was determined for each of the full and site visit (SIVI) plots, and for most of the visual plots. Appendix 4 contains the complete site description from each full and site visit plot. As the CWHvm1 and vm2 was limited to small fragments on the outskirts of the study area, they were not sampled. One full plot was completed due to time restraints (several hours required per full plot) and a lack of disturbance-free land that was available for field sampling[2].

Table 2. Summary of plots and polygons sampled by subzone.

Description			Number of Plots			*Total*
BGC Subzone	**Area (ha)**	**Polygons**	*Full*	*SIVI*	*Visual*	
CWHdm	10,161.2	1,331	1	58	382	441
CWHds1	137.5	35		2	11	13
CWHvm1	13.8	4				0
CWHvm2	4.9	5				0
Total	**10,317.4**	**1,375**	**1**	**60**	**393**	**454**

The plot data were used to confirm the accuracy of the ecosystem mapping. A total of 57 ecosystem types were mapped for this project. The ecosystems includes those that could be classified to the provincial biogeoclimatic ecosystem system, and others that could only be classified to a higher level (e.g. swamp, floodplain, etc.) due to disturbance history or a poor fit with recognized ecosystems. Plots included:

- 21 forested ecosystems (from three subzones)
- 2 classified and 1 unclassified floodplain ecosystems
- 2 classified and 2 unclassified estuary wetland associations
- 8 wetland associations and 4 unclassified wetlands
- 10 natural non-vegetated ecosystem types
- 7 anthropogenically modified map units

[2] The detailed data collected during a full plot are most beneficial in undisturbed areas with a climax vegetation community.

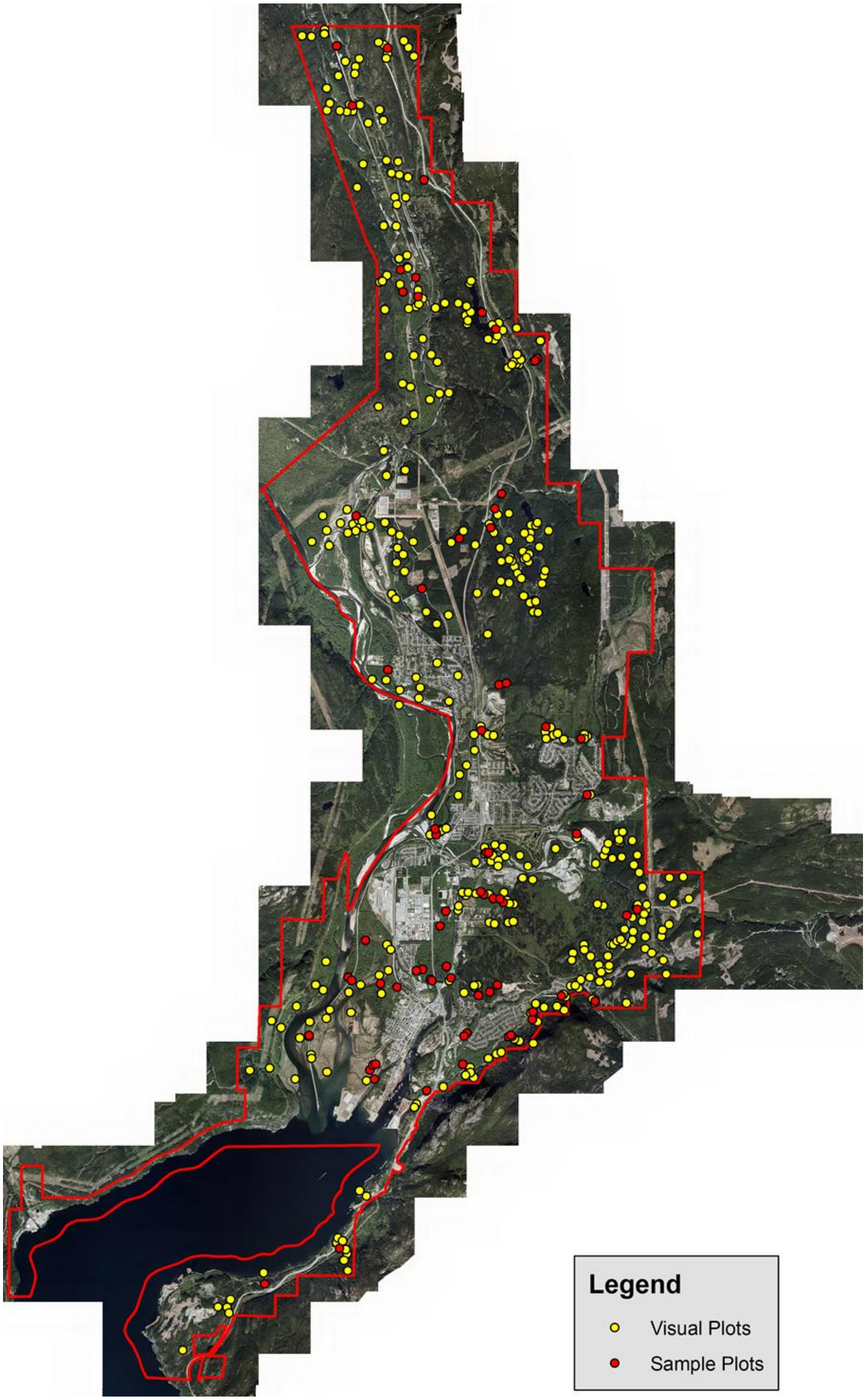

Figure 4. Map of sample plot locations and visual plots.

Tables 3 to 6 contains a summary of the mapped ecosystem types, along with the area mapped, number of polygons they were mapped in (including compound ecosystems), and what percentage of the subzone and total area the ecosystem type occupied.

Table 3. Summary of mapped ecosystem types in the CWHdm.

TEM Code/Number	Map Code	TEM Name	Area (ha)	Polygons	% of CWHdm	% of Study Area
1	HM	Hw - Flat moss	2,009.5	400	19.8%	19.5%
2	DC	FdPl - Cladina	541.6	224	5.3%	5.2%
3	DS	FdHw - Salal	1,073.2	333	10.6%	10.4%
4	DF	Fd - Sword fern	276.3	77	2.7%	2.7%
5	RS	Cw - Sword fern	521.1	137	5.1%	5.1%
6	HD	HwCw - Deer fern	349.9	114	3.4%	3.4%
7	RF	Cw - Foamflower	488.7	142	4.8%	4.7%
8	SS	Ss - Salmonberry	401.5	88	4.0%	3.9%
Ed	Ed	Estuary meadow - unclassified	46.5	13	0.5%	0.5%
Ed01	Ed01	Tufted hairgrass - meadow barley estuary meadow	30.1	9	0.3%	0.3%
Em	Em	Estuary march - unclassified	2.5	4	0.0%	0.0%
Em05	Em05	Lyngbye's sedge estuary marsh	47.1	16	0.5%	0.5%
Fl	Fl	Low bench floodplain - unclassified	38.9	13	0.4%	0.4%
Fl06	Fl06	Sandbar willow low bench floodplain	37.7	24	0.4%	0.4%
09/Fm50	CD/Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	429.8	105	4.2%	4.2%
OW	OW	Shallow open water	5.5	16	0.1%	0.1%
Wf	Wf	Fen - unclassified	0.6	2	0.0%	0.0%
Wm	Wm	Marsh - unclassified	12.8	20	0.1%	0.1%
Wm05	Wm05	Cattail marsh	1.2	3	0.0%	0.0%
Wm06	Wm06	Great bulrush marsh	2.8	4	0.0%	0.0%
Ws	Ws	Swamp - unclassified	74.0	61	0.7%	0.7%
Ws06	Ws06	Sitka willow - Sitka sedge marsh	7.6	2	0.1%	0.1%
Ws50	Ws50	Pink spirea - Sitka sedge swamp	7.2	8	0.1%	0.1%
Ws51	Ws51	Sitka willow - Pacific willow - skunk cabbage swamp	1.2	2	0.0%	0.0%
Ws52	Ws52	Red alder - skunk cabbage swamp	2.7	1	0.0%	0.0%
Ws53	Ws53	Western redcedar - sword fern - skunk cabbage swamp	4.4	2	0.0%	0.0%
Ws54	Ws54	Western redcedar - western hemlock - skunk cabbage swamp	109.4	40	1.1%	1.1%
Non-vegetated Ecosystems						
BE	BE	Beach	5.9	4	0.1%	0.1%
CF	CF	Cultivated field	8.0	4	0.1%	0.1%
CL	CL	Cliff	28.8	17	0.3%	0.3%
ES	ES	Exposed soil	1.5	1	0.0%	0.0%
GB	GB	Gravel bar	75.4	17	0.7%	0.7%
GC	GC	Golf course	66.8	14	0.7%	0.6%
GP	GP	Gravel pit	111.5	18	1.1%	1.1%
MU	MU	Mudflat sediment	6.9	11	0.1%	0.1%

TEM Code/Number	Map Code	TEM Name	Area (ha)	Polygons	% of CWHdm	% of Study Area
OC	OC	Ocean	848.2	14	8.4%	8.2%
PD	PD	Pond	76.4	35	0.8%	0.7%
RI	RI	River	306.1	67	3.0%	3.0%
RN	RN	Railway surface	85.1	24	0.8%	0.8%
RO	RO	Rock outcrop	80.3	48	0.8%	0.8%
RW	RW	Rural	113.4	25	1.1%	1.1%
RZ	RZ	Road surface	316.2	70	3.1%	3.1%
TA	TA	Talus	102.8	36	1.0%	1.0%
UR	UR	Urban / Suburban	1404.4	121	13.8%	13.6%
Total			**10,161.2**	**2,385**	**100.0%**	**98.5%**

Table 4. Summary of mapped ecosystem types in the CWHds1.

TEM Code/Number	Map Code	TEM Name	Area (ha)	Polygons	% of CWHds1	% of Study Area
1	HM	HwFd - Cat's-tail moss	44.1	16	32.1%	0.4%
2	DK	FdPl - Kinnikinnick	22.3	12	16.2%	0.2%
3	FF	FdHw - Falsebox	30.5	9	22.2%	0.3%
4	DF	Fd - Fairybells	6.5	3	4.7%	0.1%
5	RS	Cw - Solomon's seal	4.3	2	3.1%	0.0%
7	RD	Cw - Devil's club	8.0	3	5.8%	0.1%
8	SS	Ss - Salmonberry	1.1	1	0.8%	0.0%
Ws		Swamp - unclassified	1.4	1	1.0%	0.0%
Ws54		Western redcedar - western hemlock - skunk cabbage swamp	0.7	1	0.5%	0.0%
OW		Shallow open water	0.1	1	0.1%	0.0%
Non-vegetated Ecosystems						
RI		River	3.5	2	2.6%	0.0%
RN		Railway surface	4.5	3	3.3%	0.0%
RW		Rural	1.9	2	1.4%	0.0%
RZ		Road surface	3.9	3	2.8%	0.0%
TA		Talus	2.4	2	1.7%	0.0%
UR		Urban / Suburban	2.3	2	1.7%	0.0%
Total			**137.5**	**63**	**100.0%**	**1.3%**

Table 5. Summary of mapped ecosystem types in the CWHvm1.

TEM Code/Number	Map Code	TEM Name	Area (ha)	Polygons	% of CWHvm1	% of Study Area
1	CS	HwBa - Blueberry	10.2	6	74.3%	0.1%
3	HS	HwCw - Salal	2.3	1	16.9%	0.0%
5	AF	BaCw - Foamflower	0.6	1	4.5%	0.0%
Non-vegetated Ecosystems						
RZ		Road Surface	0.6	1	4.2%	0.0%
Total			**13.8**	**9**	**100.0%**	**0.1%**

Table 6. Summary of mapped ecosystem types in the CWHvm2.

TEM Code/Number	Map Code	TEM Name	Area (ha)	Polygons	% of CWHvm2	% of Study Area
1	AB	HwBa - Blueberry	0.3	1	5.9%	0.0%
2	LC	HwPl - Cladina	0.9	3	17.3%	0.0%
3	HS	HwCw - Salal	3.5	4	71.9%	0.0%
Non-vegetated Ecosystems						
TA		Talus	0.2	1	4.9%	0.0%
Total			**4.9**	**9**	**100.0%**	**0.0%**

6.0 CLOSURE

This report has been prepared for the exclusive use of the District of Squamish.

If you have any questions pertaining to this report, you may contact the undersigned at your convenience.

Respectfully Submitted,
ECOSCAPE Environmental Consultants

Prepared By:

Ryan Durand, R.P.Bio.
Senior Ecologist
Durand Ecological Ltd.

Polly Uunila, P.Geo.
Senior Geoscientist
Polar Geoscience Ltd.

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Appendix 1
Legend for Bioterrain Polygon Labels

Appendix 1. Legend for Bioterrain Polygon Labels

surficial material ↘ ↙ *initiation zone*

(1) Terrain Symbol *texture* → **aCk-R"b** ← *geomorphological process subclass*

surface expression ↗ ↖ *geomorphological process*

(2) Soil Drainage Class → **w**

TERRAIN SYMBOL

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit.

Examples:

7Mv 3Rs indicates that the polygons contains approximately 70% "Mv" and 30%"Rs".
6Mb 3Cv 1Rs indicates that the polygons contains approximately 60% "Mb", 30%"Cv", and 10% "Rs".
/Mw
Rk indicates "Rk" is partially buried by "Mw"

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material or bedrock:

e.g., Mv
Rr indicates that "Mv" overlies "Rr".

Note: one or more letters may be used to describe any characteristic other than surficial material, or letters may be omitted if information is lacking.

TEXTURE

Specific Clastic Terms

c	clay	< 2 µm
z	silt	2 - 62.5 µm
s	sand	62.5 µm - 2 mm
p	pebbles	2 - 64 mm; rounded particles
k	cobbles	64 - 256 mm; rounded particles
b	boulders	> 256 mm; rounded particles
a	blocks	> 256 mm; angular particles

Common Clastic Terms

d	mixed fragments	subrounded and subangular particles of all sizes
x	angular fragments	mixture of rubble (r) and blocks (a)
g	gravel	mixture of pebbles (p), cobbles (k), boulders (b) and up to 20% sand
r	rubble	angular particles < 64 mm
m	mud	mixture of sand (s) and silt (z)
y	-	shells or shell fragments

Organic Materials

e	fibric	well preserved fibre; 40% fibre identified after rubbing
u	mesic	intermediate decomposition between fibric and humic
h	humic	decomposed organic material; 10% fibre identified after rubbing.

SURFICIAL MATERIAL

A	Anthropogenic materials	Artificial materials and materials modified by human actions such that their original physical appearance and properties have been drastically altered.
C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits. Includes up to 20% bedrock.
CG	Glaciocolluvial	Debris flow (colluvium) material deposited during Fraser Glaciation.
C1	Slope wash	Slope wash is a result of rainfall events in which non-channelized overland flow carries surface material downslope. Typical texture is silty sand or sandy silt with generally less than 5% coarse fragments.
D	Weathered bedrock	Bedrock modified *in situ* by mechanical and chemical weathering.
E	Eolian sediments	Sand and silt transported and deposited by wind; includes loess.
F	Fluvial sediments	Sands and gravels transported and deposited by streams and rivers; floodplains, terraces and alluvial fans.
FA	"Active" fluvial sediments	Active deposition zone on modern floodplains and fans; active channel zone.
FG	Glaciofluvial sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains.
L	Lacustrine sediments	Fine sand, silt and clay deposited in lakes.
LG	Glaciolacustrine sediments	Fine sand, silt and clay deposited in ice-dammed lakes.
M	Till	Material deposited by glaciers without modification by flowing water. Typically consists of a mixture of pebbles, cobbles and boulders in a matrix of sand, silt and clay; diamicton. Includes up to 20% bedrock and/or colluvium.
M1	Fine-grained glacial materials	The deeply gullied terrain implies that the soils are fine-grained; the soils are likely of glacial origin (i.e. till).
N	Non-classified	Non-classified, for example, lake.
O	Organic materials	Material resulting from the accumulation of decaying vegetative matter; includes peat and organic soils.
R	Bedrock	Outcrops and bedrock within a few centimetres of the surface. Includes up to 20% colluvium.
U	Undifferentiated materials	Different surficial materials in such close proximity that they cannot be separated at the scale of the mapping.
W	Marine sediments	Marine sediments, includes littoral deposits.
WG	Glaciomarine sediments	Sediments of glacial orgins deposited in a marine environment.

SURFACE EXPRESSION

a	moderate slope(s)	predominantly planar slopes; 15-26º (28 - 49%)
b	blanket	material >1-2 m thick with topography derived from underlying bedrock (which may not be mapped) or surficial material
c	cone	a fan-shaped surface that is a sector of a cone; slopes 15º (27%) and steeper
d	depression	enclosed depressions
f	fan	a fan-shaped surface that is a sector of a cone; slopes 3-15º (5-27%)
h	hummocky	steep-sided hillocks and hollows; many slopes 15º (27%) and steeper
j	gentle slope(s)	predominantly planar slopes; 4-15º (6 - 27%)
k	moderately steep slope	predominantly planar slopes; 26-35º (50 - 70%)
m	rolling topography	linear rises and depressions; < 15º (27%)
p	plain	0-3º (0-5%)
r	ridges	linear rises and depressions with many slopes 15º and steeper
s	steep slope(s)	slopes steeper than 35º (> 70%)
t	terrace(s)	stepped topography and benchlands
u	undulating topography	hillocks and hollows; slopes predominantly <15º
v	veneer	material <1-2 m thick with topography derived from underlying bedrock (may not be mapped) or surficial materials; may include outcrops of underlying material
w	mantle	surficial material of variable thickness
x	thin veneer	a subset of v (veneer), where there is a dominance of surficial materials about 10-25 centimetres thick

GEOMORPHOLOGICAL PROCESSES

E	Glacial meltwater channels	Areas crossed by meltwater channels that are too small or too numerous to map individually.
F	Failing	Slope experiencing slow mass movement, such as sliding or slumping
G	Ground Disturbance	Anthropogenic excavations where the remaining exposed surface has remained undisturbed and is *in situ*.
H	Kettled	Depressions due to the melting of buried glacier ice.
L	Surface seepage	Zones of active seepage often found along the base of slope positions.
R	Rapid mass movement	Slope or parts of slope affected by processes such as debris flows, debris slides and avalanches, and rockfall
U	Inundation	Inundation refers to areas that are seasonally flooded, for example marshlands
V	Gullying	Slope affected by gully erosion.

GEOMORPHOLOGICAL PROCESS SUBCLASS

-F"	slow mass movement - initiation zone
-Fk	tension cracks
-Fm	slump in bedrock
-Fu	slump in surficial material
-Fc	soil creep, slow movement in soil
-R	rapid mass movement
-R"	rapid mass movement - initiation zone
-Rb	rock fall
-Rd	debris flow
-Rs	debris slide
-Rfl	debris flood

Soil Drainage Class

x	very rapidly drained	water is removed from the soil very rapidly in relation to supply
r	rapidly drained	water is removed from the soil rapidly in relation to supply
w	well drained	water is removed from the soil readily but not rapidly
m	moderately well drained	water is removed from the soil somewhat slowly in relation to supply
i	imperfectly drained	water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season
p	poorly drained	water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen
v	very poorly drained	water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen
Where two drainage classes are shown: -if the symbols are separated by a comma, e.g., "w,i", then no intermediate classes are present; -if the symbols are separated by a dash, e.g., "w-i", then all intermediate classes are present		

Appendix 2
Terrain (Surficial Geology), Landforms, and Geomorphological Processes

Appendix 2. Terrain (Surficial Geology), Landforms, and Geomorphological Processes

TERRAIN (SURFICIAL GEOLOGY) AND LANDFORMS

Till (M)

Till is deposited directly by glaciers and usually exists as a veneer (Mv), blanket (Mb), or mantle of variable thickness (Mw) over the underlying bedrock surface. It typically consists of a fine-grained matrix (particles <2 mm) that surrounds and supports clasts (particles >2 mm) of a variety of sizes, shapes and rock types. Till characteristics, such as texture (i.e., particle sizes) and consolidation (or bulk density), vary according to specific processes of deposition by glacier ice (e.g., subglacial vs. supraglacial tills). These deposits can be highly variable and gradations in texture and consolidation can vary over short distances.

Basal till (i.e., subglacial till) is deposited at the base of a glacier creating highly consolidated material. As a result, basal till has a relatively low permeability and commonly acts as an impermeable layer. It tends to be the strongest of all surficial materials.

Colluvium (C)

Colluvium has accumulated during post-glacial times as a result of gravity-induced slope movement, for example, rock fall and soil creep. The physical characteristics of colluvium are closely related to its source and mode of accumulation. Four processes generally create colluvial deposits: (1) rockfall from bedrock bluffs, (2) soil creep in weathered bedrock, (3) mass movement processes in surficial materials (debris flows and debris slides), and (4) rockslides and rock slumps. Within the Study Area, colluvial deposits are the most common surficial material.

Rockfall from bedrock bluffs typically forms talus slopes (Ck). Talus is loosely packed rubble or blocks with little interstitial silt and sand near the surface, and is rapidly drained. Colluvial veneers (Cv) and colluvial blankets (Cb) develop where weathered bedrock or surficial materials have been loosened and moved downslope by gravitational processes such as soil creep. It is loosely packed and usually well drained.

Colluvial fans (Cf) and colluvial cones (Cc) form at the base of steep gullies and colluvial materials make up the steeper creek channels (Cj) due to deposition by debris flows (-Rd). These deposits are generally compact, and sorting may range from poorly sorted to well sorted. The deposit may or may not be matrix supported, and the matrix is usually sand.

Deep-seated slumps in bedrock and surficial materials result in hummocky, irregular colluvial deposits (Chu). Rock slumps contain blocks and rubble with little or no interstitial silt and sand.

Glaciocolluvial (CG)

Glaciocolluvial sediments mapped in this project have the same characteristics as colluvial fan and cone sediments mentioned above, however the accumulation took place during Fraser Glaciation. In this project, glaciocolluvial sediments are mapped where debris flow material formed against glacial ice at the former mouth of the CheekyeRiver in the vicinity of Alice Lake Provincial Park. These landforms are raised terraces that have been incised by post-glacial streams which have graded to the present day elevation of the CheekyeRiver and Mashiter Creek. These landforms are generally well drained.

Weathered Bedrock (D)

Weathered bedrock has been modified in situ by mechanical and chemical weathering. The material is generally found as a discontinuous very thin veneer (Dx) overlying gently sloping or undulating bedrock outcrops. It typically contains a high proportion of angular coarse fragments with varying amounts of interstitial silty sand. It is non-cohesive and rapidly to very rapidly drained

Glaciofluvial Materials (FG)

Glaciofluvial materials were deposited by glacial meltwater streams near the end of the most recent glaciation. Sand and gravel accumulated along ice margins and on top of melting ice (FGu) (i.e., ice contact deposits), and downstream of glaciers (FGp) (i.e., outwash plains). Where outwash streams flowed onto flat ground, fans (FGf) were formed. Where outwash streams drained into former lakes, deltas (FGf and FGp) were created. Postglacial streams have incised into some outwash plains and fans transforming them into terraces (FGt) and scarps (FGk).

Glaciofluvial materials consist of sand and gravel with small quantities of finer material and are potential sources of aggregate. Sorting and bedding characteristics are variable depending on the mode and site of deposition. Gravels range from unsorted to well-sorted and bedding can range from absent to well-defined. Glaciofluvial deposits are loose (uncompacted) and clasts tend to be more subrounded than subangular. Ice-contact deposits may have distorted bedding, slump structures and faults as a result of settling and collapse due to the melting of supporting ice. Ice contact deposits may also contain lenses of fine-textured glaciolacustrine sediments and coarse-textured ablation till. Beds in raised deltas are inclined up to 40%, and indicate the frontal slopes of depositional landforms.

Fluvial Materials (F)

Fluvial materials include sands and gravels transported and deposited post-glacially by streams. These sediments are loose, non-cohesive and highly porous and permeable. Associated landforms, such as floodplains (Fp, FAp) and parts of fans that are close to stream-level, have high water tables and are moderately to imperfectly drained. Floodplains are subject to periodic inundation during high flows. Fluvial terraces (Ft) stand above present day creek-levels, are relatively well drained and dry.

Lacustrine Sediments (L)

Lacustrine materials were deposited from standing bodies of water. Fine sand, silt, or clay that have been suspended in the water settle to the lake bed creating sediments that are commonly stratified and fine textured. These sediments may be exposed when the lake is drained. Sediments are also deposited at the margins lakes by wave action. These materials generally consist of sand and gravel.

Glaciolacustrine (LG)

Glaciolacustrine materials have been deposited in glacial or ice-dammed lakes that were present during and shortly after glaciation. Glaciolacustrine materials generally consist of well to moderately well stratified fine sand, silt and/or clay with occasional lenses of till or glaciofluvial material. Glaciolacustrine materials are generally only slowly permeable, and so the presence of even a thin layer of this material is sufficient to cause impeded drainage, perched water tables, and surface seepage. These conditions may promote instability in some situations. These fine-textured materials are also susceptible to surface erosion by running water.

Marine Sediments (W)

Marine deposits include sand, gravel or cobble beaches. Fine textured material (including fine sand, silt and clay) may be found in the tidal zone.

Glaciomarine Sediments (WG)

Glaciomarine sediments consist of sediments that accumulated along the shoreline and underwater off-shore at the end of Fraser Glaciation when relative sea level was higher than present. Fine sand, silt and clay ("rock flour") initially produced by glacial abrasion were transported to the ocean by meltwater streams. Finer sediments tend to remain suspended in the ocean, and then slowly settle to the bottom. Glaciomarine sediments typically consist of interlayered silt, clay and fine sand. Dropstones from floating ice that range from pebble up the boulder-size may be embedded in the finer material. The sediments are usually slowly permeable to impermeable and are generally moderately to highly cohesive, depending on the percentage of clay. Beach sediments tend to be sands and gravels that are loose and porous.

Organic Materials

Organic materials form where decaying plant material accumulates in poorly or very poorly drained areas. Organic materials typically fill depressions in impermeable materials, such as, till and bedrock.

Anthropogenic Material (A)

Anthropogenic materials are deposits that are sufficiently reworked or redistributed by human activities that their original character is lost. Examples include gravel pits and fill used for roads and other construction.

GEOMORPHOLOGICAL PROCESSES

Rapid mass movement refers to downslope movement by falling, rolling or sliding of debris derived from surficial material and/or bedrock. Where a double prime symbol (”) is used with a mass movement process (e.g., -R”s), slope failure has initiated within the polygon. Mass movement symbols without the double prime symbol (e.g., -Rb) indicate a polygon that contains the transport or deposition zone of rapid mass movement. Transportation zones are generally not recognized as areas where landslides initiate; they may contribute additional volume of transported material to a failure. Transport and deposition zones represent hazardous areas downslope of slides or rockfall.

The geomorphological processes mapped in the Study Area are described below.

Debris Slides (-R”s) and Debris Flows (-R”d)

Debris flows (-Rd) generally initiate in steep gullies and debris slides (-Rs) initiate on steep hillsides. They occur when a mass of surficial material slides rapidly downslope often as a result of the loss of soil strength due to high pore water pressure. Debris slides (non-channelized movement of debris) and debris flows (channelized movement of debris) are initiated on steep slopes where material slides along a shear plane. The shear plane often coincides with the boundary between more permeable and less permeable material (e.g. between weathered and unweathered material or between surficial material and bedrock). Debris flows and debris slides are triggered by heavy rain, water from snow melt, and/or rain on snow events, and result from loss of soil strength due to high pore water pressure. During wet conditions, slides are also triggered by wind stress on trees, tree throw, impact of falling rocks from up slope, and vibrations due to earthquakes or human activity.

A debris flow may move downslope for several hundred metres or more before it is arrested by gentler terrain or by de-watering, or it may enter a trunk stream. Debris flows are effective agents of erosion, commonly increasing the volume of material as it progresses downslope. Debris slides and debris flows are significant potential sources of stream sediment and are a hazard to activities or structures (e.g., roads, culverts) located in runout zones.

Rock Fall (-R"b)

Rockfall (-Rb, -R"b) occurs when either a single block or a mass of bedrock falls, bounces and rolls downslope. Rockfall from local outcrops create talus slopes.

Rock Slumps (-F"m) and Tension Cracks (-F"k)

A slump in bedrock refers to a rotational slump where portions of the slide mass remain internally cohesive. Rotational slumps develop due to failure along vertical joints and horizontal weak layers.
Tension cracks are open fissures and lateral spread in bedrock that appear as structural lineations (trough oriented roughly parallel to the contour). These deep-seated features are commonly located near ridge tops. They indicate slow slope spreading, and may be the precursor to potentially catastrophic slope failure.

Abundant Seepage (-L)

Seepage is mapped where relatively wet soils are widespread in a polygon. This commonly occurs where soils are on slowly permeable materials such as till, where thin surficial materials overlie bedrock, and on lower slopes where shallow subsurface water is received from a relatively large catchment area further upslope. They may also occur where groundwater is concentrated at the surface by a physical conduit such as a geological fault. Within the Study Area, areas of widespread seepage were not common and mapped only in polygons 108 and 111.

Gully Erosion (-V)

Gullies are small ravines typically with V-shaped cross sections that can form in either glacial material or bedrock. Gully erosion has been mapped in two kinds of terrain: (i) slopes with several parallel shallow gullies in thick surficial materials (dissected slope) and (ii) single gullies where streams have exploited joints in bedrock or have cut down into thick surficial materials. Gullied terrain is an indicator of either former or active erosion, and the symbol serves to identify material that is potentially subject to erosion or mass movement (e.g., Uk-V). Gully sideslopes and steep headwalls are common sites of slope failures and are classed as potential unstable (Class IV) where there is no evidence of instability and unstable (Class V) where there is evidence of instability.

Channeled by Meltwater (-E, -EV)

Meltwater channels form alongside, beneath, or in front of a glacier or ice sheet. Glacial meltwater channels are typically sinuous in plan, flat-floored, and steep-sided in cross-section. The floors of the meltwater channel may contain glaciofluvial sediments, indicative of the water flow that once took place here. Meltwater channels are present near the valley bottom of Harper Creek.

Kettled (-H)

Kettled topography consists of hummocky undulating terrain, which developed when blocks of glacial ice buried by or surrounded by glaciofluvial gravels and ablation till melted.

Ground Disturbance (-G)

Ground disturbance refers to anthropogenic excavations where the remaining exposed surface has remained undisturbed and is *in-situ*; for example, the cutslopes in gravel pits, housing developments, and road cuts.

Appendix 3
Legend for Ecosystem Mapping Labels

Appendix 3. Legend for Ecosystem Mapping Labels

Figure A3-1 shows the breakdown of a simple ecosystem unit, while Figure A3-2 depicts a compound ecosystem unit. Simple ecosystem units are used for ecosystem polygons that contain a single ecosystem type, while compound units describe polygons that contain multiple ecosystem types. The compound units are used in situations where a clear boundary between ecosystems is difficult to map, where ecosystem types are too small to map individually, or in larger areas that contain a variety of commonly repeating ecosystem types. In these cases deciles are used to describe the percentage of the polygon consisting of a given ecosystem type.

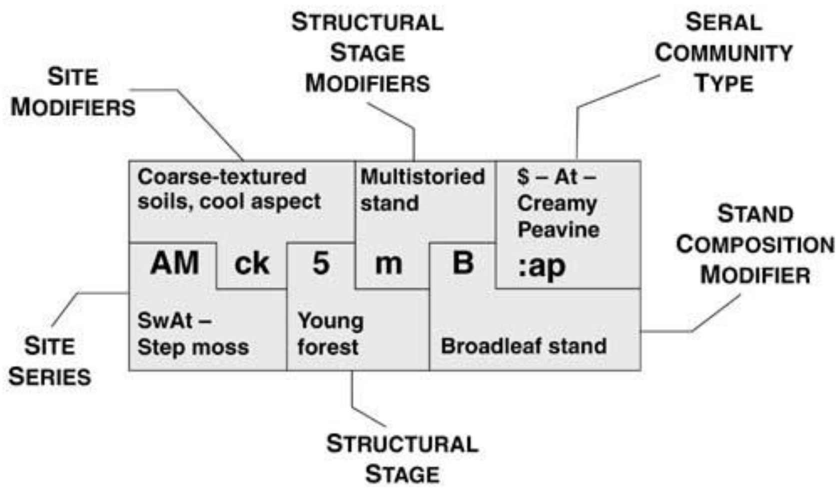

Figure A3-1. Simple Ecosystem Unit (RIC, 1998).

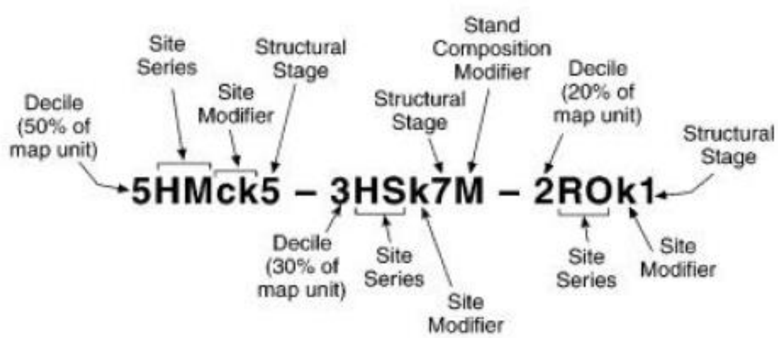

Figure A3-2. Compound Ecosystem Unit (RIC, 1998).

Site Series

Recognized site series of the CWHdm, along with map code, assumed situation, site modifiers, and typical soil moisture regime (BC MFLNRO, 2011; BC MFLNRO, 2006). Additional wetland site series are from MacKenzie and Moran (2006) and non-forested map codes from RIC (1998).

Site Series	Map Code	Site Series Name	Assumed Situation	Assumed Site Modifier(s)	Typical SMR
01	HM	Hw - Flat moss	significant slopes; middle slope position; deep medium textured soils (use aspect modifiers)	d,m	mesic
02	DC	FdPl - Cladina	gentle slope; crest position; shallow soil	j,r,s	xeric
03	DS	FdHw - Salal	significant slope, middle to upper slope position; warm aspect; deep medium textured soils	d,m,w	xeric - subxeric
04	DF	Fd - Sword fern	significant slopes deep medium - textured soils; richer nutrient regime (use aspect modifiers)	d,m	xeric - subxeric
05	RS	Cw - Sword fern	significant slope, middle slope position, deep medium - textured soils; richer nutrient regime (use aspect modifiers)	d,m	submesic - mesic
06	HD	HwCw - Deer fern	gentle slope; lower slope position, receiving moisture, deep medium - textured soils	d,j,m	subhygric - hygric
07	RF	Cw - Foamflower	gentle slope; lower slope position; richer nutrient regime, receiving moisture, medium - textured soil	d,j,m	subhygric - hygric
08	SS	Ss - Salmonberry	active floodplain, high fluvial bench, deep medium - textured soil	a,d,j,m	subhygric - hygric
09	CD/Fm50	Act - Red-osier dogwood	active floodplain, middle fluvial bench, deep medium - textured soil	a,j,m	subhygric - hygric
10	CW	Act - Willow (Fl50 - Sitka willow - False lily-of-the-valley)	active floodplain, low bench, deep coarse - textured soil	a,c,p,j	subhygric - hygric
11	LS	Pl - Sphagnum	organic wetland, bog woodland, forested bog	d,j,p	subhydric
12	RC	CwSs - Skunk cabbage	treed swamp, poorly drained, level to depression, medium - textured mineral soil	d,j,m	subhydric
13	RB	Cw - Salmonberry	lower slope to level; deep, medium - textured soil	d,j,m	subhygric
14	RT	Cw - Black twinberry	lower slope to level, or depression; deep, medium - textured soil	d,j,m	hygric
15	CS	Cw - Slough sedge	depression to flat, treed swamp, poorly drained; deep, medium - textured soil	d,j,m	subhydric
Wm05		Cattail	wetland dominated by emergent vegetation; level or depression; usually mineral soils		

Recognized site series of the CWHds1, along with map code, assumed situation, site modifiers, and typical soil moisture regime (BC MFLNRO, 2011; BC MFLNRO, 2006). Additional wetland site series are from MacKenzie and Moran (2006) and non-forested map codes from RIC (1998).

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
01	HM	HwFd - Cat's-tail moss	gentle slope, mid slope position, deep medium - textured soils	d,i,m	submesic - mesic
02	DK	FdPl - Kinnikinnick	gentle slope, crest position, shallow soil	j,r,s	xeric
03	FF	FdHw - Falsebox	gentle slope, upper to middle slope position, deep medium - textured soils	d,j,m	xeric - subxeric
04	DF	Fd - Fairybells	gentle slope, mid slope position, deep medium - textured soils, richer nutrient regime	d,j,m	xeric - subxeric
05	RS	Cw - Solomon's seal	gentle slope, mid slope position, deep medium - textured soils, richer nutrient regime	d,j,m	submesic - mesic
06	HQ	Hw - Queen's cup	gentle slope, lower slope position, receiving position, deep medium - textured soils	d,j,m	subhydric-hygric
07	RD	Cw - Devil's club	gentle slope, lower slope position, receiving position, deep medium - textured soil, richer nutrient regime	d,j,m	subhydric-hygric
08	SS	Ss - Salmonberry	active floodplain, high fluvial bench, deep medium - textured soil	a,d,j,m	subhygric - hygric
10	CW	Act - Willow (Fl50 - Sitka willow - False lily-of-the-valley)	active floodplain low bench, deep coarse - textured soil	a,c,d,j	subhygric - hygric
11	LS	Pl - Sphagnum	treed bog, organic soil	d,j,p	subhydric
12	RC	CwSs - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	depression to flat, treed swamp, poorly drained, deep, medium - textured mineral soil	d,j,m	subhydric

Recognized site series of the CWHvm1 and vm2, along with map code, assumed situation, site modifiers, and typical soil moisture regime (BC MFLNRO, 2011; BC MFLNRO, 2006). Additional wetland site series are from MacKenzie and Moran (2006) and non-forested map codes from RIC (1998).

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
01	AB	HwBa - Blueberry	gentle slope, middle slope position; deep medium-textured soils (use RG for Salal phase)	d,j,m	submesic - mesic
01	CS	HwBa - Blueberry	gentle slope, middle slope position; deep medium-textured soils (Salal phase)	d,j,m	submesic - mesic
02	LC	HwPl - Cladina	gentle slope; crest position, medium textured, shallow soils	j,m,r,s	very xeric
03	HS	HwCw - Salal	upper slope position; gentle slope on medium textured shallow soils	j,m,s	xeric - subxeric

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
04	RS	CwHw - Sword fern	significant slope, upper slope position; deep mediium textured soils of colluvial (use aspect modifiers)	d,m	xeric - subxeric
05	AF	BaCw - Foamflower	significant slope, middle slope position; deep medium-textured soils; richer nutrient regime (use aspect modifiers)	d,m	submesic - mesic
06	HD	HwBa - Deer fern	significant slope, lower slope position; deep medium - textured soils, seepage (use aspect modifiers)	d,m	subhygric
06	SW	HwBa - Deer fern	significant slope, lower slope position; deep medium - textured soils, seepage (use aspect modifiers)	d,m	subhygric
07	AS	BaCw - Salmonberry	gentle lower receiving slope, deep, medium - textured soil	d,j,m	subhygric - hygric
08	AD	BaSs - Devil's club	gentle receiving slopes; deep, medium - textured soil; seepage	d,j,m	subhygric - hygric
09	SS	Ss - Salmonberry	active floodplain, high bench , deep medium - textured soil	a,d,j,m	subhygric - hygric
10	CD	Act - Red-osier dogwood	active floodplain, middle bench, deep medium - textured soil	a,d,j,m	subhygric - hygric
11	CW	Act - Willow (Fl50 - Sitka willow - False lily-of-the valley)	active floodplain, low bench, deep coarse - textured soil	a,c,d,j	subhydric
12	YG	CwYc - Goldthread	organic bog forest; depression to lower slope	d,j,p	subhygric - hygric
13	LS	Pl - Sphagnum (Wb51 - Plc - Black crowberry - Tough Peat-moss)	treed bog; organic (Fullmore LU TEM and Tahsis LU TEM mapped as CWHvm1, site series 12, LS)	d,j,p	subhydric
14	RC	CwSs - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	swamp forest; level to depression, deep, medium - textured soil; poorly drained	d,j,m	subhydric
15		YcHm - Skunkcabbage (Ws55 - YcHm - Skunkcabbage)			
31	--	Non-forested bog	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES	d,j,p	subhydric
32	--	Non-forested fen/marsh	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES		

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
51	--	Avalanche track	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES		
Wb50		Labrador tea - Bog-laurel - Peat-moss			
Wf50		Narrow-leaved cotton-grass - Peat-moss			
Wf51		Sitka sedge - Peat-moss			
Ws06		Sitka willow - Sitka sedge			

Recognized site series of the CWHvm2.

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
01	AB	HwBa - Blueberry	gentle slope, middle slope position; deep medium - textured soils	d,j,m	submesic - mesic
01	AB	HwBa - Blueberry, Mineral	use fine-textured, medium-textured or coarse-textured site modifier		
01	AB	HwBa - Blueberry, Lithic	use shallow or very shallow site modifier		
02	LC	HwPl - Cladina	gentle slope, crest position; shallow soils	j,r,s	very xeric
03	HS	HwCw - Salal	gentle slope, upper slope position; medium textured shallow soils	j,m,s	xeric - subxeric
04	RS	CwHw - Sword fern	significant slope, ; upper slope position; deep medium - textured soil, richer nutrient regime (use aspect modifiers)	d,m	xeric - subxeric
05	AF	BaCw - Foamflower	significant slope, deep medium - textured soils; richer nutrient regime (use aspect modifiers)	d,m	submesic - mesic
06	HD	HwBa - Deer fern	significant slope, deep medium - textured soils, seepage (use aspect modifiers)	d,m	subhygric
07	AS	BaCw - Salmonberry	gentle slope, lower slope receiving position, deep medium - textured soil; southern and central portion of variant	d,j,m	subhygric - hygric
08	AD	BaSs - Devil's club	gentle receiving slopes; deep, medium - textured soil; seepage	d,j,m	subhygric - hygric
09	YG	CwYc - Goldthread	lower slope; organic bog forest	d,j,p	subhygric - hygric
10	LS	Pl - Sphagnum (Wb51 - Plc - Black crowberry - Tough Peat-moss)	treed bog; organic	d,j,p	subhydric
11	RC	CwYc - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	treed swamp, depression or flat, medium - textured mineral soil, poorly drained	d,j,m	subhydric

Site Series	Map Code	Site Series Name	Assumed Situation	Site Modifiers	Typical SMR
12		YcHm - Skunkcabbage (Ws55 - YcHm - Skunk cabbage)			
31	--	Non-forested bog	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES	d,j,p	subhydric
32	--	Non-forested fen/marsh	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES		subhydric
51	--	Avalanche track	GENERIC MAP UNIT FOR UNDESCRIBED VEGETATION TYPES		subhygric - hygric
Wf51		Sitka sedge - Peat-moss			
Wm09		Inflated sedge			
Ws06		Sitka willow - Sitka sedge			

Site Modifiers

Site modifiers are used to describe atypical conditions for each ecosystem (RIC, 1998). Each site series in the BEC system has a known set of typical conditions. As ecosystem often have a certain amount of variability, site modifiers can be used to describe why a given ecosystem type is being mapped in an atypical condition. The atypical conditions include topography (including aspect), moisture and soils.

Code	Description
c	coarse-textured soils
d	deep soils (> 1m)
f	fine-textured soils
g	gullying
h	hummocky
j	gentle (<25% in the interior; <35% in the CDF, CWH and MH zones)
K	cool aspect (285 – 135°) slope (26% – 100%)
m	medium-textured soils
n	fan/cone
p	peaty material
q	very steep (>100%) cool aspect (135 – 285°) slope
r	ridge
s	shallow soils (20-100 cm)
t	terrace
v	very shallow soils (<20 cm)
w	warm aspect (135 – 285°) slope (26% – 100%)
z	very steep (>100%) warm aspect (135 – 285°) slope

Structural Stage and Modifiers

Structural stage codes and structural stage modifiers are used to describe the vegetation structure and appearance in each ecosystem unit. Structural stage codes describe the relative age of a given ecosystem (i.e. shrub dominated vs. old growth forest) while the modifiers are used to provide additional descriptions of structural stages (RISC, 2010).

Structural Stage

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%.
1a Sparse	Less than 10% vegetation cover;
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).
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.

Structural Stage	Description
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 (5000-15 000+ 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 reinitiation 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 for biogeoclimatic group A and 80-250 years for group B.
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 group A and greater than 250 years for group B.

Structural Stage Modifiers

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
o open	Forest stand with very open main and intermediate crown classes (totaling less than 25% cover); substantial understorey light levels commonly result in well-developed shrub and/or herb understorey.

Stand composition modifiers are used to provide additional descriptions of structural stages 3 to 7 and indicate the dominance of the stand by broadleaf, conifers or a mixed forest (RIC, 2010).

Stand Composition Modifiers

Modifier	Description
C - coniferous	Greater than 3/4 of total tree layer cover is coniferous.
B - broadleaf	Greater than 3/4 of total tree layer cover is broadleaf.
M - mixed	Neither coniferous or broadleaf account for greater than 3/4 of total tree layer cover.

Site Disturbance

Site disturbance codes can be added to the mapped ecosystem to describe events that has caused vegetation or soil characteristics to differ from those expected at climax of the site (RIC, 2010). While these codes do not typically occur on the TEM map, they were included as appropriate for use in the development of the SEI and ESA mapping.

Site Disturbance Codes Used for this Project

Disturbance Class	Subclass
B. Biotic effects	**i.** insects
	v. aggressive vegetation
L. Forest harvesting	**l.** land clearing (includes abandoned agriculture)
	c. clearcut system
	e. selection system
M. Plant or site modification effects	**t.** planted or seeded to trees
S. Soil disturbance	**f.** sidecast/fill
	r. road bed, abandoned
	e. excavation
W. Water-related effects	**d.** water table control (diking, damming)
X. Miscellaneous	Maintained vegetation along powerlines

Appendix 4
Field Data

Plot	Type	Date	Easting	Northing	Accuracy	BGC	SS	SMR	SNR	Elevation	Slope	Aspect
SQ001	Ground	10/15/2015	489617	5506438	3	CWHdm	12	7	D (C)	13	0	999
SQ002	Ground	10/15/2015	489701	5506213	3	CWHdm	3	2	B	16	45	290
SQ003	Ground	10/15/2015	489493	5507212	3	CWHdm	12	7	D	12	0	999
SQ004	Visual	10/15/2015	489603	5507496	3	CWHdm	12	7	D	8	0	999
SQ005	Ground	10/15/2015	489309	5506184	3	CWHdm	00 (Wm06 like)	8	D	15	0	999
SQ006	Visual	10/15/2015	489341	5506159	3	CWHdm	00 (Wm06 like)	7	D	12	0	999
SQ007	Ground	10/15/2015	489154	5506376	3	CWHdm	09?	7	C+	15	0	999
SQ008	Ground	10/15/2015	488230	5504265	3	CWHdm	Em05	8	F	0	0	999
SQ009	Ground	10/15/2015	488143	5504437	4	CWHdm	Mudflat	8	F	1	0	999
SQ010	Ground	10/15/2015	488203	5504534	2	CWHdm	Wm06 (cattail)	8	D	0	0	999
SQ011	Ground	10/15/2015	488254	5504556	3	CWHdm	Em00??	8	F	0	0	999
SQ012	Ground	10/15/2015	486971	5505085	3	CWHdm	Ws06	7	D	0	0	999
SQ013	Ground	10/15/2015	486975	5505104	3	CWHdm	Wm00	7	D	3	0	999
SQ014	Ground	10/15/2015	487726	5506223	3	CWHdm	Fm50	5	D	5	0	999
SQ015	Ground	10/15/2015	488058	5506934	3	CWHdm	7	5	D	11	0	999
SQ016	Ground	10/15/2015	489930	5504553	4	CWHdm	6	5	C+	30	0	999
SQ017	Ground	10/16/2015	487501	5524126	4	CWHds1	1	3	C-	122	10	210
SQ018	Ground	10/16/2015	487802	5522985	5	CWHdm	Fm50	6	C	103	0	999
SQ019	Ground	10/16/2015	489027	5519676	4	CWHdm	5	4	D	53	1	999
SQ020	Ground	10/16/2015	488731	5519821	5	CWHdm	Fm50	6	C+	61	1	999
SQ021	Ground	10/16/2015	488773	5519398	4	CWHdm	5	4	D	80	0	999
SQ022	Ground	10/16/2015	489071	5519314	4	CWHds1	Fl	6	B	63	0	999
SQ023	Ground	10/16/2015	488485	5524087	3	CWHdm	Ws00	7	D	302	0	999
SQ024	Ground	10/16/2015	489183	5521554	4	CWHdm	2	0	A	304	30	271
SQ025	Ground	10/16/2015	490562	5518686	3	CWHdm	Ws50	8	D-	276	0	999
SQ026	Ground	10/16/2015	490299	5519003	4	CWHdm	1	3	C	218	1	999
SQ027	Ground	10/16/2015	491361	5518122	4	CWHdm	3	2	B	334	70	238
SQ028	Ground	10/16/2015	491320	5518075	3	CWHdm	7	5	D	213	6	240

Plot	Type	Date	Easting	Northing	Accuracy	BGC	SS	SMR	SNR	Elevation	Slope	Aspect
SQ029	Ground	10/17/2015	492476	5505766	8	CWHdm	1	3	C	194	30	270
SQ030	Ground	10/17/2015	493079	5507413	4	CWHdm	1	4	C	129	25	88
SQ031	Ground	10/17/2015	493286	5507531	7	CWHdm	6	5	C	76	3	999
SQ032	Ground	10/17/2015	491827	5505864	4	CWHdm	7	5	D	81	5	999
SQ033	Ground	10/17/2015	491263	5505413	3	CWHdm	7	5	D	89	10	243
SQ034	Ground	10/17/2015	490883	5505083	5	CWHdm	1	4	C	52	2	999
SQ035	Ground	10/17/2015	490809	5505081	2	CWHdm	Fm00	6	C	42	2	999
SQ036	Ground	10/17/2015	489237	5504045	3	CWHdm	9 / Fm50	6	D	8	0	999
SQ037	Ground	10/17/2015	486122	5500324	6	CWHdm	1	3	C	71	30	2
SQ038	Ground	10/17/2015	487558	5501009	5	CWHdm	1	4	C	75	15	309
SQ039	Ground	10/17/2015	490010	5505148	4	CWHdm	7	5	D	18	5	999
SQ040	Ground	10/18/2015	490334	5507809	5	CWHdm	7	5	D	59	0	999
SQ041	Ground	10/18/2015	490517	5507739	5	CWHdm	1	4	C	52	25	281
SQ042	Ground	10/18/2015	490383	5508621	4	CWHdm	Fl00	6	C	4	0	999
SQ043	Ground	10/18/2015	490424	5508623	3	CWHdm	Fl00	6	B	21	0	999
SQ044	Ground	10/18/2015	489414	5508997	3	CWHdm	Wm05	8	D	6	0	999
SQ045	Ground	10/18/2015	489415	5508963	3	CWHdm	Ws51	8	D	5	0	999
SQ046	Ground	10/18/2015	489398	5509078	4	CWHdm	Fm50	5	D	13	0	999
SQ047	Ground	10/18/2015	492112	5508981	4	CWHdm	1	3+	C	79	70	200
SQ048	Ground	10/18/2015	492319	5509735	4	CWHdm	1	4	C	97	75	170
SQ049	Ground	10/18/2015	492205	5510811	4	CWHdm	1	4	C	188	35	188
SQ050	Ground	10/18/2015	491529	5511040	4	CWHdm	7	5	D	102	0	999
SQ051	Ground	10/18/2015	490708	5507666	4	CWHdm	2	1	A	77	0 to 90	999
SQ052	Ground	10/18/2015	490641	5507734	4	CWHdm	5	4	D	62	10	999
SQ053	Ground	10/19/2015	490676	5515518	4	CWHdm	1	3 to 4	C	179	7	252
SQ054	Ground	10/19/2015	490546	5515237	5	CWHdm	5	3 to 4	D	159	3	190
SQ055	Full	10/19/2015	490462	5514868	5	CWHdm	1	4	C	140	7	200
SQ056	Ground	10/19/2015	489865	5514661	8	CWHdm	1	3	B	14	5	240

Plot	Type	Date	Easting	Northing	Accuracy	BGC	SS	SMR	SNR	Elevation	Slope	Aspect
SQ057	Ground	10/19/2015	487882	5515095	4	CWHdm	7	5	D	37	2	999
SQ058	Ground	10/19/2015	489143	5513697	5	CWHdm	1	3	B-	73	0	999
SQ059	Ground	10/19/2015	488487	5512137	4	CWHdm	Wm00	8	E	18	0	999
SQ060	Ground	10/19/2015	490287	5510973	3	CWHdm	Ws50	8	D	6	0	999
SQ061	Ground	10/19/2015	490623	5511850	9	CWHdm	1	3	C	67	60	160
SQ062	Ground	10/19/2015	490764	5511876	8	CWHdm	5	4	C to D	69	40	360

Plot	S.Shape	Meso	Floodplain	Exposure	Disturbance	Canopy Composition	Struct. Stage	Success Status	Texture	Surf Material	S. Expression
SQ001	ST	LV	No	NA	Old Harvest	sB	5	YS	sz	F	p
SQ002	CV	LW	No	NA	Old Harvest	sC	5	YC		/C	x
SQ003	ST	LV	No	NA	Old Harvest	tB	5	YS	s	F	p
SQ004	ST	LV	No	NA	Old Harvest		5	YS		F	p
SQ005	ST	LV	Yes	NA	Old Harvest		2b		ds	F	p
SQ006	CC	G	Yes	NA			2b			F	p
SQ007	ST	LV	Yes	NA	Old Harvest	tB	6	MS	zs	F	p
SQ008	ST	LV	Tidal	Wind/Salt	Road		2b		zs	W	p
SQ009	ST	LV	Tidal	Wind/Salt	NA		1a		cz	W	p
SQ010	ST	LV	Tidal	NA	Old Harvest		2b		cz	W	p
SQ011	ST	LV	Tidal	NA	Old Harvest		2b		zs	W	p
SQ012	ST	LV	Yes	NA	Road/Hydrology		3b		sz	FA	p
SQ013	ST	LV	Yes	NA	NA		2b		sz	F	p
SQ014	ST	LV	Yes	NA	NA	tB	5	YC	zs	FA	p
SQ015	ST	LV	No	NA	NA	tM	6	MC	s	F	p
SQ016	ST	LV	No	NA	Old Harvest	tM	5	YS	zgs	F	p
SQ017	CC	Lower	No	NA	Old Harvest	tC	5	YC	s	FG	pj
SQ018	ST	LV	Yes	NA	NA	tB	5	YC	ds	FA	p

Plot	S.Shape	Meso	Floodplain	Exposure	Disturbance	Canopy Composition	Struct. Stage	Success Status	Texture	Surf Material	S. Expression
SQ019	CV	LV	No	NA	Old Harvest	mM	5	YC	zds	FG (orf)	p
SQ020	ST	LV	Yes	NA	NA	tB	5	YC	s	FA	v
SQ021	ST	LV	No	NA	NA	mM	6	MC	s	FA	v
SQ022	ST	LV	Yes	NA	NA		3a		sg	FA	p
SQ023	CC	DP	No	NA	Hydrology/Road		3b		u	O	v
SQ024	CV	UP	No	Wind	Fire	tC	5	YC		D	x
SQ025	CC	DP	No	NA	NA		3a		e	O	vx
SQ026	ST	UP	No	NA	Old Harvest/Fire	mC	6	MC	zds	M	v
SQ027	ST	Mid	No	NA	Old Harvest	tC	5	YC	x	C	k
SQ028	ST	LV	No	NA	Old Harvest	tB	5	YS	zds	F (or C)	f
SQ029	CV	MD	No	NA	Old Harvest	mC	5	YC	sx	C	a
SQ030	CV	LW	No	NA	Old Harvest	mM	5	YC	zds	FG	a
SQ031	ST	LV	No	NA	NA	tC	5	YC	zds	FG	pj
SQ032	ST	LV	Inactive	NA	Old Harvest	tM	5	YC	/zs	F	v
SQ033	CC	T	No	NA	Old Harvest	mM	5	YC	/a	C	v
SQ034	ST	LV	Inactive	NA	Old Harvest	tM	5	YS	sg	FG	t
SQ035	ST	LV	Yes	NA	NA	sB	3b	YC	sg	F	p
SQ036	ST	LV	Yes	NA	NA	tB	5	YC	s	FA	v
SQ037	ST	MD	No	NA	Old Harvest	tC	5	YC	/	C	x
SQ038	ST	UP	No	NA	Old Harvest	tC	5	YC	gs	FG	t
SQ039	ST	LV	Yes	NA	Old Harvest	mM	6	MC	zs	FA	v
SQ040	ST	LV	No	NA	Old Harvest	tB	6	MS	s	F	p
SQ041	ST	MD	No	NA	Old Harvest	sB	5	YS	dzs	M	v
SQ042	ST	LV	Yes	NA	NA	sB	4	YC	s	FA	v
SQ043	ST	LV	Yes	NA	NA	B	3a		spk	F	p
SQ044	ST	DP	Yes	NA	NA		2b		za	F	x
SQ045	ST	LV	Yes	NA	NA		3b		zs	F	x
SQ046	ST	LV	Inactive	NA	NA	tB	5	YC	zs	F "A"	v

Plot	S.Shape	Meso	Floodplain	Exposure	Disturbance	Canopy Composition	Struct. Stage	Success Status	Texture	Surf Material	S. Expression
SQ047	ST	MD	No	NA	Old Harvest	tM	5	YC	gs	C	k
SQ048	ST	MD	No	NA	Old Harvest/Road	mM	5	YC	gs	FG	s
SQ049	CV	LW	No	NA	Old Harvest/Road	tC	5	YC	gs	FG	a
SQ050	ST	LV	No	NA	Old Harvest	sB	5	YS	zds	FG	p
SQ051	CV	CR	No	NA	Old Fire	oC	5	YC		R	h
SQ052	ST	LV	No	NA	Old Harvest/Road	tB	5	YS	ds	FG	jv
SQ053	ST	LV	No	NA	Old Harvest	mC	6	MC	zds	C or F	f
SQ054	ST	LV	No	NA	Old Harvest/Fire	sB	5	YS	ds	F or C	f
SQ055	ST	LV	No	NA	NA	mC	6	MC	ds	F or C	f
SQ056	ST	LV	No	NA	Old Harvest	tC	5	YC	gs	F	f
SQ057	ST	LV	Yes?	NA	Old Harvest/Replanted	tB	5	YS	/ zds	F "A"	v
SQ058	ST	LV	No	NA	Old Harvest	tC	5	YC	gs	F	f
SQ059	CC	DP	Yes	NA	Weeds		2b		zs	F	p
SQ060	CC	DP	Yes	NA	Weeds		3b		sz	F	vx
SQ061	ST	LV	Yes	NA	Old Harvest	tM	5	YC	zds	FG	k
SQ062	ST	Toe	No	NA	Old Harvest	tM	5	YC	zds	FG	a

Plot	Geo Process	Texture	Surf Material	S. Expression	Geo Process	Drainage	Humus	Organic	Humus Thickness	Ah Depth	Ae Depth	Est. Soil Depth
SQ001						P	Only litter		0.5 litter			>2m
SQ002			R	k		R	Mor		5			5 to 15
SQ003						P	Mull		5			>2m
SQ004						P						
SQ005						I	Mull		8			>2m
SQ006						VP						
SQ007						I						>3m
SQ008						VP		Fibric	15			>2m

Plot	Geo Process	Texture	Surf Material	S. Expression	Geo Process	Drainage	Humus	Organic	Humus Thickness	Ah Depth	Ae Depth	Est. Soil Depth
SQ009						VP						>2m
SQ010						VP						>2m
SQ011						VP						>2m
SQ012						P	Mull		2			>2m
SQ013						P	Mull		2			>2m
SQ014						M						>2m
SQ015						M	Mor		8	2		>2m
SQ016						M	Mor		10			>2m
SQ017						W	Mor		5		3	>2m
SQ018						W			1cm litter			>2m
SQ019						M			disturbed			
SQ020		sg	F	pt		M			3cm litter			>2m
SQ021		sg	F	pt		M	Mor		3			>2m
SQ022						I						>2m
SQ023			M or R			VP		Mesic	40			
SQ024			R	h		R						0
SQ025						VP		Fibric				
SQ026						M	Mor		7		4	<1m
SQ027	Rb inactive					R	Mor		5 to 10			
SQ028						M			0	8		>2m
SQ029						W	Mor					
SQ030						M						>2m
SQ031						W	Mor		12		7	>2m
SQ032	Rd	sd	F	j		M	Mor		2			>2m
SQ033		sd	FG	jp	Rb	W			1cm litter	38		
SQ034						W	Mor		12			10m+
SQ035						M			2 cm litter			>2m
SQ036		sg	F	p		W						

Plot	Geo Process	Texture	Surf Material	S. Expression	Geo Process	Drainage	Humus	Organic	Humus Thickness	Ah Depth	Ae Depth	Est. Soil Depth
SQ037			R	ah		R	Mor		20			20
SQ038							Mor		12		5	>2m
SQ039		s	F	p			Mor		3	5		>2m
SQ040						M	Mull		3	3		>2m
SQ041						M	Moder		3	Yes		
SQ042		sg	F	p		M						
SQ043						W						
SQ044		ps	F	p		VP		Mesic	4			>2m
SQ045		ps	F	p		VP		Mesic	4			>2m
SQ046			F	p		M	Moder					
SQ047	Rs					W	Mor		4			10m+
SQ048						W	Mor		12		1	Variable
SQ049						W	Mor		8		1	3m+
SQ050						I	Mor		12	20		>2m
SQ051						R						
SQ052						W	Mor		5	30		
SQ053						W	Mor		4		1	>2m
SQ054						W	Mor		10	5		>2m
SQ055						W	Hr		10		2	
SQ056						W	Mor		8		7	>2m
SQ057			F	t		M	Mull		2	16		>2m
SQ058						W	Mor		10		3	>2m
SQ059						VP						
SQ060	U	gs	F	p		VP			0			
SQ061						W	Mor		14			Variable - 3m+
SQ062						M	Moder		10			

Plot	RZ Soil Text.	RZ CF%	Est. Root Depth	Gleying Depth	Mottle Depth	Seepage Depth	Restrict Layer	Restrict Type	Tree	Shrub	Herb	Moss Lichen
SQ001	SiL	0	>60		>10				60	65	30	50
SQ002	Bedrock and humus	Scattered boulders	15-May				5	Lithic	40	40	10	25
SQ003	S	0	>60			10			20	70	30	15
SQ004												
SQ005	S	35							0	5	85	0
SQ006												
SQ007	L	0	>50		Yes	Signs of seepage			45	60	40	10
SQ008	Si	0	>1m	Yes		3			0	0	90	0
SQ009		0		Yes		3			0	0	0	0
SQ010	Si	0	>1m	Yes		Surface			0	0	80	0
SQ011	Si	0	>1m	Yes	Yes	15			0	0.1	90	0
SQ012	SiL	0	>60	Yes	Yes	60 expected			0	65	40	10
SQ013	SiL	0	>60	Yes	Yes	20			0	0	95	0
SQ014	L	0	60						50	65	5	5
SQ015	S	0	>1m		20				30	80	25	35
SQ016	SL	15	60						40	35	10	5
SQ017	S	5	60						40	55	10	80
SQ018	S	10							30	20	25	0
SQ019	SL	5							50	10	2	5
SQ020	S	0							50	65	1	5
SQ021	S	0							40	25	35	40
SQ022	S	90							0	10	0	0
SQ023									0.1	80	25	10
SQ024			0				Lithic		20	15	0	90
SQ025						Flooded			0	80	15	0
SQ026	SL	15	<1m						30	80	5	75

Plot	RZ Soil Text.	RZ CF%	Est. Root Depth	Gleying Depth	Mottle Depth	Seepage Depth	Restrict Layer	Restrict Type	Tree	Shrub	Herb	Moss Lichen
SQ027		100							50	10	35	80
SQ028	LS	8							40	60	50	25
SQ029	LS	55							45	20	5	90
SQ030	LS	25							30	30	65	25
SQ031	LS	15							50	50	15	90
SQ032	LS	0							35	30	40	65
SQ033	S	20							50	25	50	50
SQ034	S	60							60	30	10	20
SQ035	S	60							10	65	5	75
SQ036	S	0							60	40	0	0
SQ037			20					Lithic	50	10	1	75
SQ038	LS	20							50	25	5	10
SQ039	LS	5							50	30	20	10
SQ040	S	0			Scattered				55	30	25	5
SQ041	L	20							40	50	40	15
SQ042	S	0							30	50	0	0
SQ043	S	60							0	20	0	0
SQ044	S	25		Yes		5			0	0	90	0
SQ045	S	25				33			0	40	60	0
SQ046	SL	0							50	75	10	0
SQ047	S	20	60						50	25	30	40
SQ048	LS	15							40	50	35	35
SQ049	LS	15							50	30	10	80
SQ050	SL	10			Maybe				65	70	20	5
SQ051									10	10	5	90
SQ052	LS	15							45	50	75	5
SQ053	SL	15	40						50	20	40	90
SQ054	LS	10							50	65	15	5

Plot	RZ Soil Text.	RZ CF%	Est. Root Depth	Gleying Depth	Mottle Depth	Seepage Depth	Restrict Layer	Restrict Type	Tree	Shrub	Herb	Moss Lichen
SQ055	LS	35	52						40	40	15	90
SQ056	SL	40	40						60	5	0.1	80
SQ057	SL	10							35	65	20	5
SQ058	SL	35							50	10	5	75
SQ059	SL	0							1	5	65	0
SQ060	SiL	0		Yes		Flooded			0	35	80	0
SQ061	LS	10							60	25	10	5
SQ062	SL	20							40	30	60	15