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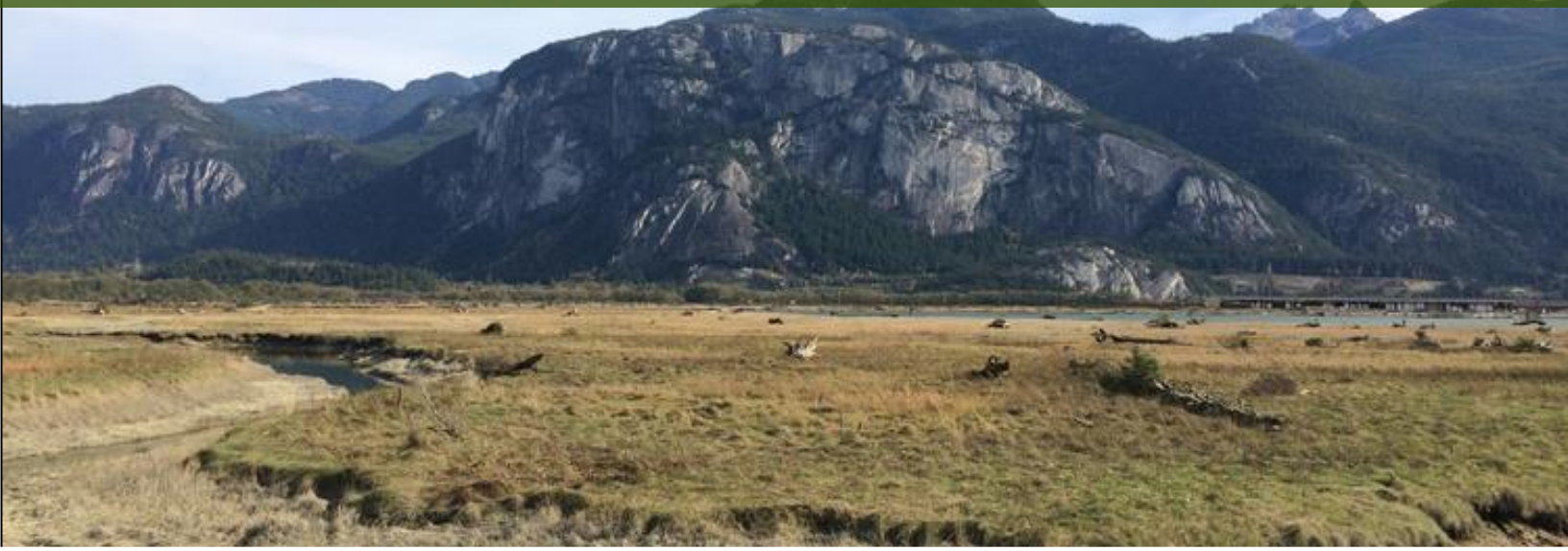
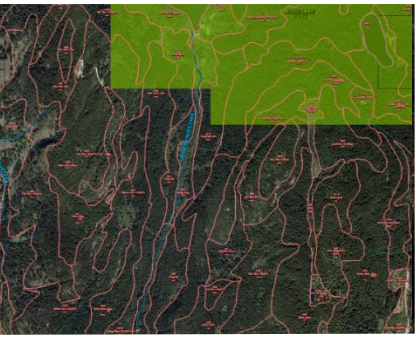
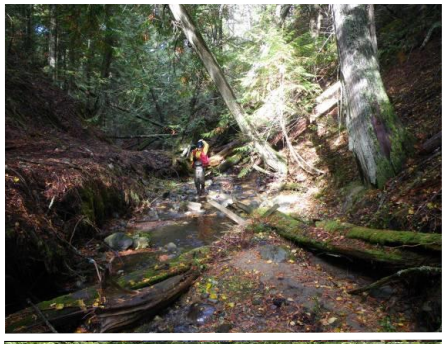
DISTRICT OF SQUAMISH
WETLANDS INVENTORY AND MAPPING AND WATERCOURSE MAPPING







ECOSCAPE
Environmental Consultants Ltd.

Prepared By:
EcoLogic Environmental Consulting and
Ecoscape Environmental Consultants Ltd.

Prepared For:
District of Squamish

December 2016

DISTRICT OF SQUAMISH
WETLANDS INVENTORY AND MAPPING
AND WATERCOURSE MAPPING

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ECOSCAPE
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December, 2016

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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 provided ecological baseline data for the District, in order to establish an inventory of environmental features and their locations, including:

- 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).

In August of 2016 the DOS retained Ecoscape Environmental Consultants Ltd. and EcoLogic Consultants to complete Phase 3 of the project, which involved additional wetland inventory and mapping, as well as modelling of watercourses and riparian setbacks. This report contains the results of the wetland inventory and mapping of the DOS. The modelling of watercourses and riparian wetbacks will be contains in a separate report.

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 - 900m above sea level. (Hawes and Durand, 2015)

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

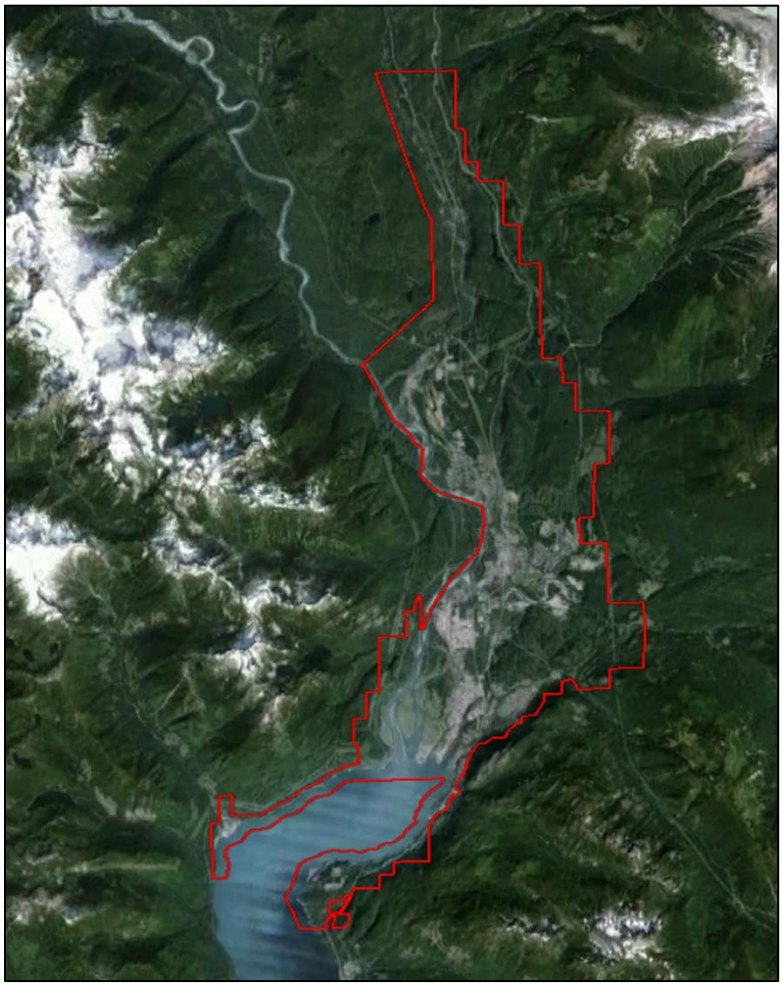

Figure 1. Study Area Boundary (adapted from Google Earth).

Wetland mapping 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. 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. 3 and 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.

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)

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

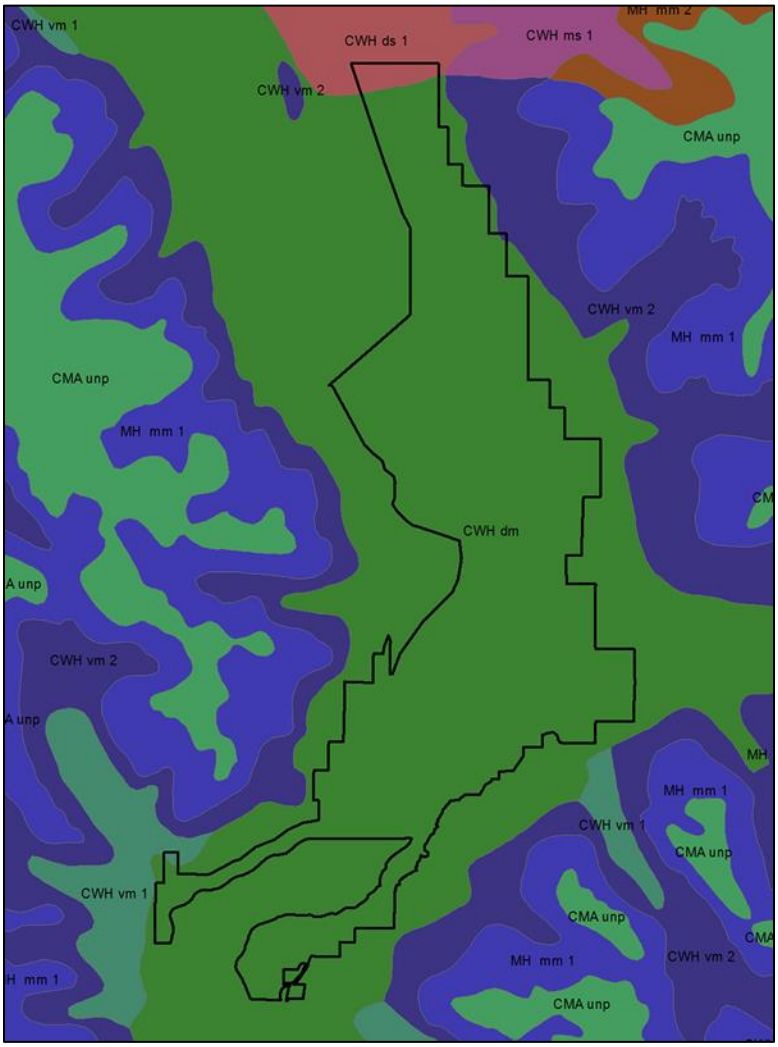

Figure 2. Provincial Biogeoclimatic map with the study area overlain shoing the majority of the study area located in the CWHdm subzone with small portions occurring in the CWHds1 at the north end, CWHvm2 in the northeast, and CWHvm1 in thesouthwest.

Coastal Western Hemlock 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)

3.0 INTRODUCTION TO WETLANDS

A wetland is defined as: *land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment* (National Wetlands Working Group 1988). (Canadian System of Wetland Classification 1997)

Wetland ecosystems are found where soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil. The water influence can be either seasonal or year-round and occurs either at or above the soil surface or within the root zone of plants. Wetlands can be found in depressions, or areas of flat or undulating terrain. There are two broad categories of wetlands as described by the Canadian System of Wetland Classification (National Wetlands Working Group 1997):

Organic wetlands:

- Organic wetlands are more simply referred to as peatlands (Fig. 3). Peatlands contain more than 40 cm of peat accumulation on which organic soils

(excluding Folisols[1]) develop. This depth limit is consistent with soil classification standards established by the Canada Soil Survey Committee (1978).

Mineral wetlands:

- Mineral wetlands are found in areas where an excess of water collects on the surface and which for geomorphic, hydrologic, biotic, edaphic (factors related to soil), or climatic reasons produce little or no organic matter or peat. Gleysolic[2] soils or peaty phases of these soils are characteristics of these wetlands (Fig. 4).

- Mineral wetlands are found in mineral soil areas associated with shallow water, which is generally less than 2 m deep. In some of these wetlands, vegetation is lacking and soils are poorly developed as a result of frequent and drastic fluctuations of water levels, wave action, water flow, turbidity, or a high concentration of salts or other toxic substances in the water or in the soil.

- Mineral wetlands include mineral soil areas that are modified by water control structures (e.g. dams) or that are tilled and planted but if allowed to revert to their original state, become saturated for long periods and are then associated with wet soils (e.g. Gleysols) and hydrophytic vegetation."

The development of wetlands is a dynamic function of climate, hydrology, chemistry, geomorphology, and biology (National Wetlands Working Group 1997). Wetlands are not generally stable ecosystems, rather they are constantly evolving over time (hundreds or thousands of years) as soils develop and water regimes change, resulting in communities that often contain aspects of different wetland types, as well as transitional areas where they are indeterminate between one class or association and another. Therefore, multiple characteristics of wetlands, due to the interaction of various environmental factors, are required to place them in specific classes and associations.

[1] Soils of the Folisolic order are composed of upland organic (folic) materials, generally of forest origin, that are either 40 cm or more in thickness, or are at least 10 cm thick if overlying bedrock or fragmental material (Agriculture and Agri-Food Canada 2014a).

[2] Soils of the Gleysolic order have properties that indicate prolonged periods of intermittent or continuous saturation with water and reducing conditions during their genesis. Saturation with water may result from either a high groundwater table or temporary accumulation of water above a relatively impermeable layer, or both (Agriculture and Agri-Food Canada 2014b).

Figure 3. Example fibric peat over mesic peat in a fen (left). Figure 4. Example of a rich mineral soil from a forested swamp (right).

Wetlands in Canada are classified based on the Canadian System of Wetland Classification using five classes: bog, fen, marsh, swamp, and shallow open water (National Wetlands Working Group 1997), and further refined into associations based on the Wetlands of British Columbia (MacKenzie & Moran 2004). Environmental conditions that have affected wetland development are used to classify wetlands (National Wetlands Working Group 1997), including:

- Morphology – surface forms, pattern, elevation
- Water source
- Water chemistry (nutrients, base saturation, pH)
- Basin depth and shape
- Plant communities and their structure
- Peat and sediment characteristics
- Soil type (organic, gleysol, etc.)

Fig. 5 depicts the edatopic grid that shows the range of soil moisture, soil nutrients, pH, and hydrodynamic index (water flow and permanence) that each wetland class typically occurs within. Note that shallow open waters do not fit the conceptual model presented in the edatopic grid, and are not included (MacKenzie & Moran 2004). Fig. 6 provides an overview of the main environmental features for each wetland class (also known as Site Class), as well as the typical vegetation cover and species groups.

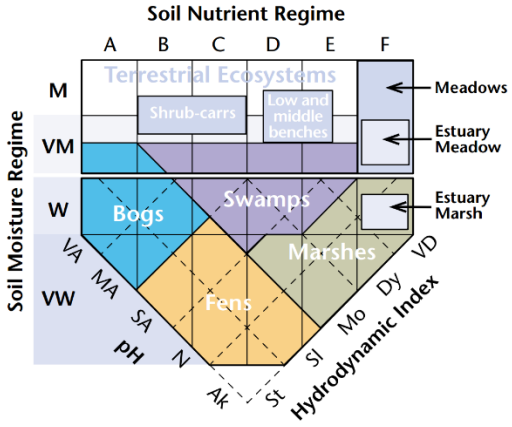

Figure 5. Site Class distribution on the modified edatopic grid (adapted from Wetlands of British Columbia). The grid indicates the typical range of soil moisture, soil nutrients, pH, and water movement for each wetland class.

Site Realm/ Group	Site Class	Environmental features	Cover types	Species groups
Wetland Realm		***Wet or Very Wet SMR***		
	Bogs	+/- ombrotrophic pH < 5.5 > 40 cm fibric/mesic peat	Conifer treed or low shrub	Sphagnum mosses, ericaceous shrubs, and conifers
	Fens	Groundwater-fed pH > 5.0 > 40 cm fibric/mesic peat	Graminoid or low shrub	Deciduous shrubs, sedges, and brown mosses
	Marshes	Mineral soils or well-humified peat Protracted shallow flooding (0.1–2.0 m)	Graminoid or forb	Large emergent sedge, grass, forb, or horse-tail species
	Swamps	Mineral soils or well-humified peat Temporary shallow flooding (0.1–1.0 m) Significant water flow	Tall shrub or forested	Conifers, willows, alders, forbs, grasses leafy mosses
	Shallow waters	Permanent deep flooding (0.5–2 m)	Aquatic	Aquatic species Emergent vegetation < 10% cover
Estuarine Realm		***Tidal, brackish water***		
	Estuarine meadow Class	High intertidal and supratidal zones Brief semi-diurnal tidal flooding by brackish water	Graminoid	Grasses, sedges, and forbs tolerant of di-urnal flooding and brackish water
	Estuarine marsh Class	Intertidal Diurnal tidal flooding by salt water	Graminoid or forb	Salt-tolerant emergent graminoids and suc-culents
Flood Group of Terrestrial Realm		***Riparian flood zone***		
	High bench	Benches above normal waterflow Brief flood period	Coniferous forested	Upland species of seepage sites
	Mid bench	Elevated benches flooded most years for < 21 days Areas of sedimentation	Deciduous treed or forested	Flood-tolerant decid-uous trees and shrubs
	Low bench	Site directly adjacent to watercourse Annual flood >21 days Significant annual erosion and deposition	Tall deciduous shrub	Flood-tolerant shrubs

Figure 6. Summary of characteristics for wetland classes (adapted from Wetlands of British Columbia).

4.0 METHODOLOGY

This project builds on the 2015 TEM and SEI mapping by further refining the wetland portion of the mapping. It included a field portion to field truth mapped polygons and inventory wetlands, and a mapping portion to update and refine the TEM and SEI maps.

4.1 Field Sampling

Wetland classification was completed as per provincial methodology, mainly the *Field Manual for Describing Terrestrial Ecosystems; 2nd Edition* (BC Min. Forests & Range, 2010). Additional information was collected to classify ecosystems to the site association level as per *Wetlands of BC; A Guide to Identification* (MacKenzie & Moran 2004). For wetlands that could not be classified to a site association or site series level, generic federal wetland classes were used.

Field verification will consist of a combination of Full, Site Visit inspection and visual inspections. Full plots are the most comprehensive type of inventory, with a detailed description of site conditions, vegetation, and soils. Full plot are used to describe ecosystem types that have not previously been inventories, or have significant ecological value, as they are time consuming. The Site Visit inspections are the mid-level plot type using provincial methodology that uses a combination of site information, soils, hydrology and vegetation to accurately classify an ecosystem type to the site association level (based on Wetlands of BC). Visual plots are quick assessments that are used to verity ecosystem that are well inventoried and easy to classify based on site conditions and dominant vegetation. They are also used to make minor changes to the existing mapping, or for wetland that can be observed, but are not accessible (either physically or due to private property access constraints).

4.2 Wetland Mapping

Mapping was completed in accordance with the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998). Wetland classifications were obtained from *Wetlands of British Columbia: a guide to identification* (MacKenzie & Moran, 2004) and incorporated newer wetland associations where appropriate from a variety of BC Government publications and databases available on BEC Web. Mapping was completed on 2013 and 2016 digital airphotos using ArcGIS 10.3 and a PurVIEW 3D softcopy system. The 2015 TEM polygons were updated as necessary to reflect the additional information collected in 2016. The majority of the updates consisted of changes to the polygon attribute tables to better reflect what was observed in the field, in addition to changes in polygon boundaries to better reflect wetland community extents. From there, the 2015 SEI mapping was then altered using a similar process to ensure consistent polygons and attributes in both products.

Terrestrial Ecosystem Mapping (TEM)

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. For each TEM polygons up to three ecosystem classifications was be described in the attribute tables, along with modifiers that describe structural stage, composition, disturbance, etc. Whenever possible wetland polygons were drawn as pure units to reduce the inclusion of non-wetland ecosystems in the polygon, but mapping scale and the occurrence of small complexes resulted in both pure and complex units. (Green and Klinka, 1994; BEC WEB; 2015; RISC, 1998)

Sensitive Ecosystems Inventory (SEI) Mapping

SEI mapping was created in 1993 by the Canadian Wildlife Service and the BC Conservation Data Centre. It was created in 'response to a need for inventory of at-risk and ecologically fragile ecosystems, and critical wildlife habitat areas on the east side of Vancouver Island.' Since then, SEI projects have been completed on the Sunshine Coast, the Islands Trust Area, Metro Vancouver, most of the Okanagan, and portions of the Fraser Valley. In 2006 a Standard for Mapping Ecosystems At Risk in British Columbia was created by the Resource Inventory Standards Committee to promote a standardized process province wide (RISC, 2006).

The main purpose of SEI mapping is to describe the ecological diversity of a given area, and determine the type and extent of vulnerable and rare elements (RISC, 2006). The SEI standard describes an overview of the assessment process as follows:

The SEI classification uses two primary groupings of ecosystems: ***Sensitive Ecosystems*** *and* ***Other Important Ecosystems****. Within each of these groups a series of classes and subclasses is defined that provides a general level of ecosystem description that is appropriate for public education and local planning exercises. Sensitive Ecosystem categories are generalized groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecosystem processes, at-risk status, and wildlife habitat values. Criteria for ecological sensitivity include:* ***environmental specificity****, susceptibility to hydrological changes, soil erosion, especially on shallow soils, spread of invasive alien plants, and sensitivity to human disturbance. Other Important Ecosystems have significant ecological and biological values associated with them that can be identified and mapped, although they are not defined as Sensitive Ecosystems because they have been substantially altered by human use.*

Sensitive Ecosystem (SE) classes represent generalized groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity and wildlife habitat values (Iverson and Cadrin, 2003). Ecosystems are classed as sensitive in this report if they have one or more of the following attributes:

- are rare or of restricted distribution
- have high biodiversity
- have high values as habitat, especially for known or potentially occurring species at risk
- are sensitive to disturbance and human impacts

Other Important Ecosystems (OIE) provide values such as habitat, wildlife corridors and ecosystem services but in most cases have been modified by human use and are not usually considered as environmentally significant or sensitive as designated SEs.

The Not Sensitive (NS) class is a generalized catch all for all other mapped polygons that do not contain significant ecological values, or polygons that contain significant recent or historic disturbance such as logging.

5.0 RESULTS

5.1 Field Sampling

A total of 95 sample plots were completed in 2016, including 3 full plots, 30 site visits and 62 visuals (Fig. 7). Appendix 1 contains the complete site description from each full and site visit plot, and basic information for the visual plots. The site series was determined for each of the full and site visit (SIVI) plots, and for most of the visual plots.

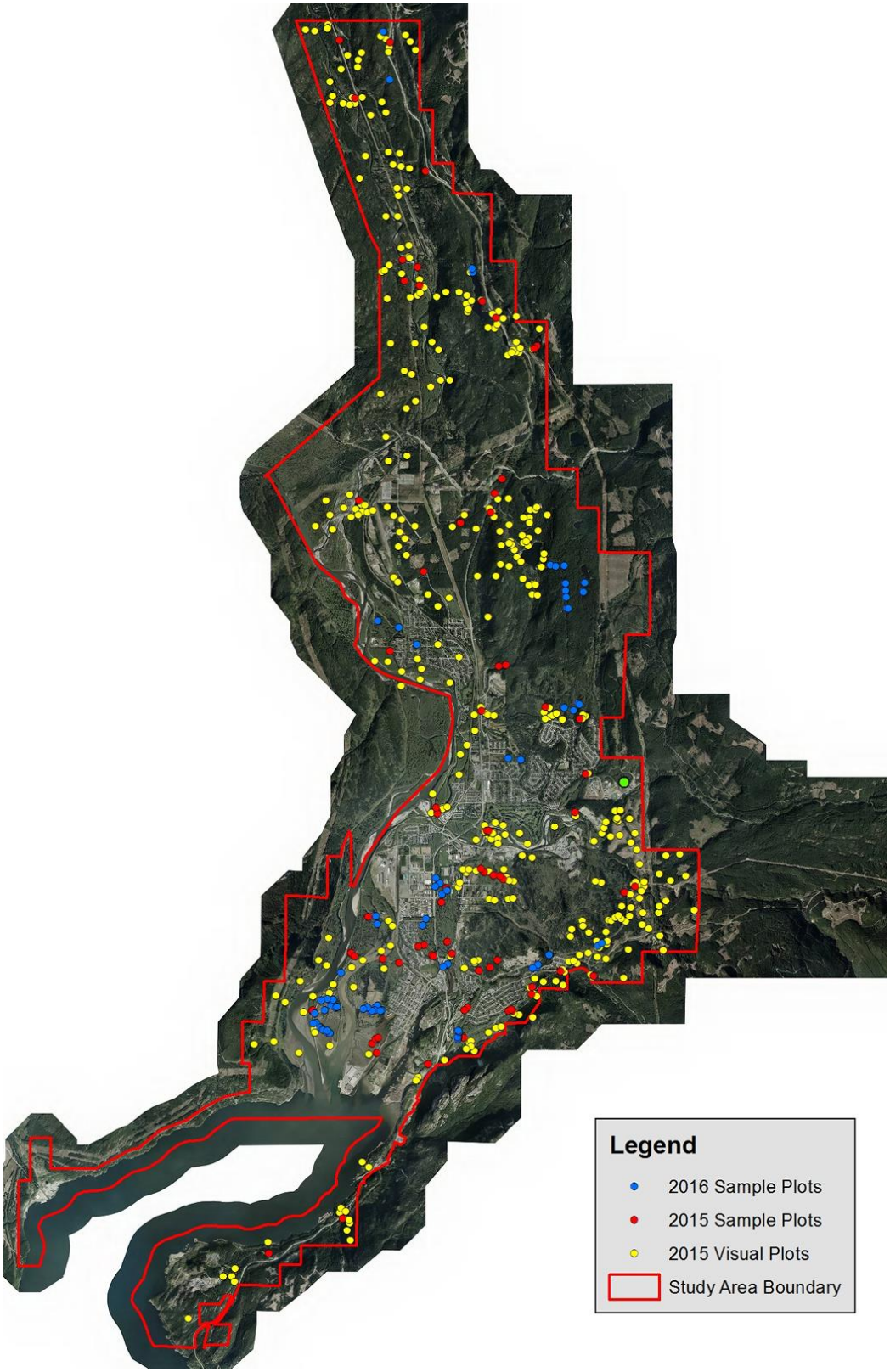

Figure 7.Map of sample plot and visual plot locations.

5.2 Wetland Mapping

The plot data were used to confirm the accuracy of the ecosystem mapping. A total of 19 wetland associations were identified in the DoS in 2015 and 2016, along with a variety of unclassified wetlands, and non-vegetated ecosystems such as ponds, rivers, mudflats and braches that are associated with wetlands (Table 2). In total, wetlands and association ecosystem types comprised 17% (1,750 hectares) of the DoS study area. Appendix 2 contains maps of all known wetlands in the DoS.

The DoS contains a large number of modified wetlands. These areas typically have a high cover of introduced species, and/or physical modifications such as excavations, drainage alterations (ditches, roads, dikes), or historic logging. In some cases they can still be classified using the remnant vegetation and environmental characteristics (mainly soils and water chemistry), more often they were classified as generic swamps, marshes, etc. Most modified wetlands were only classified to the Federal level (bog, fen, marsh, swamp) and were generally not inventoried. Examples of several common modified wetland types are presented within the wetland descriptions that that most closely resemble.

Table 2. Summary of Wetlands mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Bog					
Wb00	Unclassified bog		3	2.2	<0.1
Wb50	Labrador tea – bog-laurel – peatmoss bog	Blue	1	0.2	<0.1
LS	Lodgepole pine – peatmoss bog	Yellow	1	0.1	<0.1
Total			*5*	*2.4*	<0.1
Fen					
Wf53	Slender sedge – white beak-rush fen	Red	1	0.2	<0.1
Total			*1*	*0.2*	<0.1
Marsh					
Wm00	Unclassified marsh		16	10.7	0.1
Wm04	Common spike-rush marsh		1	0.6	<0.1
Wm05	Cattail marsh	Blue	9	5.6	0.1
Wm06	Great bulrush marsh		4	2.7	<0.1
Total			*30*	*19.5*	0.2
Swamp					
Ws00	Unclassified swamp		49	57.3	0.6
Ws06	Sitka willow – Sitka sedge swamp		8	16.6	0.2
Ws50	Pink spirea - Sitka sedge swamp		8	7.2	0.1
Ws51	Sitka willow – pacific willow – skunk cabbage swamp	Red	1	0.3	<0.1
Ws52	Red alder – skunk cabbage swamp		2	3.1	<0.1
Ws53	Western redcedar – sword fern – skunk cabbage swamp	Blue	54	120.9	1.2
Total			*122*	*205.5*	2.0

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Estuarine					
Ed00	Unclassified estuarine meadow		3	7.5	0.1
Ed01	Tufted hairgrass – meadow barley estuarine meadow	Red	9	26.8	0.3
Ed02	Tufted hairgrass – Douglas' aster estuarine meadow	Red	10	30.0	0.3
Em00	Unclassified estuarine marsh		2	4.2	<0.1
Em05	Lyngbye's sedge estuarine marsh	Red	30	47.0	0.5
Em06	Lyngbye's sedge – Douglas' water-hemlock estuarine marsh	Blue	8	21.9	0.2
MU	Intertidal mudflat		16	8.7	0.1
BE	Beach		4	5.9	0.1
Total			*82*	*151.9*	1.5
Shallow Open Water					
OW	Shallow open water		15	5.3	0.1
Total			*15*	*5.3*	0.1
Floodplain					
Fl00	Unclassified low-bench floodplain		13	38.9	0.4
Fl06	Sandbar willow low bench floodplain		24	37.7	0.4
Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	Blue	105	429.8	4.2
SS	Sitka spruce - salmonberry high bench floodplain	Red	95	413.4	4.0
Total			*237*	*919.8*	8.9
Freshwater					
PD	Pond		35	76.4	0.7
RI	River		68	369.7	3.6
Total			*103*	*446.1*	4.3
	Total		***594***	***1750.5***	***17.0***

5.3 Wetland Descriptions

5.3.1 Bog Site Associations

A bog is a nutrient-poor, *Sphagnum*-dominated peatland ecosystem in which the rooting zone is isolated from mineral-enriched groundwater, soils are acidic, and few minerotrophic plant species occur (MacKenzie & Moran 2004). Bogs may or may not contain a cover of slow growing woody, ericaceous shrubs or small stunted trees, generally occurring on hummocks or raised domes. A thick cover of *Sphagnum* (peat moss) is dominant, while other species that are tolerant of acidic, low nutrient conditions also occur. Bogs are typically located in closed basins (where precipitation is the primary water source), on the edges of larger peatlands, or as raised domes (normally within fens). Soils are deep peat deposits, generally with poorly decomposed upper layers (fibric) that remain saturated throughout the year. While some groundwater flow may occur, it is generally limited, resulting in little input of nutrients. (MacKenzie & Moran 2004)

Bogs are uncommon in the Squamish area and in the south coast of BC in general (Table 3). Four of the five bogs mapped in the DoS were sampled in 2016. The bogs were all located in the CWHdm and had some level of historic disturbance. Two of the bogs could not be classified to the site association level (Fig. 8). Located in Alice Lake Provincial Park, they were dominated by western hemlock and Labrador tea, with a thick of sphagnum moss. Slight depressions, containing skunk cabbage and shore sedge, were common, while mounded areas contained the western hemlock along with conifer stumps from historic logging. Soils were thick fibric organic material over deep (over 1m) mesic organic material. Both bogs were considered to have high conservation value, and as they are located within a provincial park, are not threatened.

Table 3. Bog Associations mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Bog					
Wb00	Unclassified bog		3	2.2	<0.1
Wb50	Labrador tea – bog-laurel – peatmoss bog	Blue	1	0.2	<0.1
LS	Lodgepole pine – peatmoss bog	Yellow	1	0.1	<0.1
Total			*5*	*2.4*	<0.1

Figure 8. Unclassified Wb00 western hemlock – Labrador tea bog.

A third bog, also located in Alice Lake Provincial Park, was classified as a complex of two associations (Fig. 9 and 10). It contained patchy open areas of Wb50 Labrador tea – bog-laurel – peatmoss bog with small pools, complexed with a bog similar to those described above as Wb00 unclassified western hemlock – Labrador tea bog. The Wb50 is relatively widespread (with 20 occurrences mapped by the CDC from Campbell River to Richmond), but other than Burn's Bog, generally occurs as small wetlands (MacKenzie & Moran 2004). These bogs lack tree cover, although they occasionally contain stunted lodgepole pine on slight mounds. Labrador tea forms a constant low shrub layer, while small amounts of salal and dwarf shrubs such as bog rosemary, western bog-laurel and bog cranberry are common. Herbs have a variable cover, with sundews and various sedges commonly occurring. An interesting feature of this wetland was the presence of a healthy population of purple pitcher plants, a red-listed species that is only known to occur in bogs in northeastern BC. The pitcher plant population is not considered to be a natural occurrence, and carnivorous plants in general are often planted in suitable habitat (McIntosh & Fenneman 2016). As with most bogs, deep sphagnum peatmoss forms a continuous cover. Soils were thick fibric organic material over deep (over 1.2 m) mesic organic material. The Wb50 is a blue-listed ecosystem in BC and is only known from a single location in the DoS.

Figure 9. Wb50 Labrador tea – bog-laurel – peatmoss bog complexed with Wb00 unclassified western hemlock – Labrador tea bog in Alice Lake Provincial Park.

Figure 10. Typical bog species including bog cranberry (*Vaccinium microcarpum*), peatmoss (*Sphagnum* sp.), and a tiny round-leaved sundew (*Drosera rotundifolia*).

A single occurrence of a modified bog was located along a BC Hydro powerline corridor (Fig. 11). While still possessing many bog species (Labrador tea, deep sphagnum, and various dwarf shrubs) it appears to have a modified hydrological regime. Small amounts of running water was present, and there was a high cover of skunk cabbage, varies sedges, bog orchid, along with western hemlock, western redcedar, lodgepole pine, and red alder. In addition to the right-of-way clearing, we suspect that the construction of the nearby highway altered local drainage patterns resulting in a modified bog-like community. While still of conservation significance due to the local rarity of bogs in the DoS, it is unlikely that this community will return to a true bog form without restoration.

Figure 11. Modified bog-like community under a BC Hydro powerline right-of-way.

A CWHdm/11 lodgepole pine – peatmoss bog was located in complex with the red-listed Wf53 slender sedge – white beak-rush fen north of Brome Lake (Fig. 12). It consisted of a narrow fringe around the pocket fen in a bedrock controlled depression. The bog was dominated by stunted lodgepole pine and occasional western redcedar, with thick Labrador tea and hardhack. Peatmoss formed a continuous layer. The bog was not further sampled as the 11 site series is relatively common and not an at-risk ecosystem type. There is a potential that additional CWHdm/11 bogs occur as small portions of mapped ecosystems in the Brome Lake area, as multiple bedrock controlled wetlands occur in the area that were either not accessible or not field truthed.

Figure 12. CWHdm/11 lodgepole pine – peatmoss bog (background) complexed with a Wf53 fen (foreground).

5.3.2 Fen Site Associations

A fen is a nutrient-medium peatland ecosystem dominated by sedges, cottongrass and brown mosses, where mineral-bearing groundwater is within the rooting zone and minerotrophic plant species are common (MacKenzie & Moran 2004). Fens rely on steady groundwater inflow that provides relatively high nutrient contents, and maintains the watertable near the peat surface for most of the growing season, resulting in soils with richer nutrient regimes. They develop on a variety on landscape positions, including basins, lake and river margins, and seepage slopes. These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses (MacKenzie & Moran 2004), while tall shrubs and trees are absent. Fens are the most commonly occurring wetland type in BC, occurring in all but the warmest regions. (MacKenzie & Moran 2004)

Only one fen was inventoried and mapped in the DoS, the red-listed Wf53 slender sedge – white beak-rush (Table 4). Wf53 fens only occur in the southern coast of BC and are restricted to drier CWH and CDF subzones (Fig. 13). It is characterized by a low diversity with white beak-rush forming continuous dominant cover (Fig. 14). Minor occurrences of round-leaved sundew, shore sedge and other sedges also occurred. The moss layer was largely absent, with patches of peatmoss on slightly elevated mounds. Soils and surrounding vegetation indicated that the site typically has standing water for most of the year, with the dry year in which it was sampled being an exception. Soils were deep (over 1.5m) humic organic material and assumed

to be underlain by bedrock. The fen was in excellent condition and located in a relatively intact landscape. It should be a high priority for conservation based on its quality and overall rarity in the region (and province).

Table 4. Fen Associations mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Fen					
Wf53	Slender sedge – white beak-rush fen	Red	1	0.2	<0.1
Total			*1*	*0.2*	<0.1

Figure 13. Wf53 slender sedge – white beak-rush fen.

Figure 14. Inflorescence of white beak-rush (*Rhynchospora alba*).

5.3.3 Marsh Site Associations

A marsh is a permanently to seasonally flooded mineral wetland dominated by emergent grass-like vegetation (MacKenzie & Moran 2004). Marshes typically contain simplistic vegetation communities that are dominated by a small number of species, often in response to specific water regimes or other favourable conditions. Shrubs, trees and bryophytes (moss) are generally absent or very sparse, while aquatic plants often occur. Marshes occur in dynamic hydrological systems, where there are significant fluctuations in water levels through the year. They are generally nutrient rich and more frequently occur in warmer climates. Marshes occur in a variety of landscape positions, but most often as pond and lake margins and river backwaters as a component of a larger wetland complex. Peat accumulation is generally limited due to warmer climates and the dynamic water levels, both of which promote decomposition of organic material, resulting in most marshes being comprised mainly of mineral soils. Marshes are generally flooded in the spring, while drier months may see a persistent high water table, or substantial drying and substrate exposure.

Three types of freshwater marshes were inventoried in the DoS, along with multiple marshes that could not be classified (Table 5). Marshes were infrequent in the study area, and never extensive.

Table 5. Marsh Associations mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Marsh					
Wm00	Unclassified marsh		16	10.7	0.1
Wm04	Common spike-rush marsh		1	0.6	<0.1
Wm05	Cattail marsh	Blue	9	5.6	0.1
Wm06	Great bulrush marsh		4	2.7	<0.1
Total			*30*	*19.5*	0.2

Wm04 Common spike-rush marsh

Wm04 Common spike-rush marshes are blue-listed ecosystems that occur in a wide variety of sites, ranging from wetland complexes in the interior, to weakly saline estuaries (MacKenzie & Moran 2004). In the DoS it was only located as a complex with Wm05 cattail marshes in upper regions of the Squamish Estuary (Fig. 15). The Wm04 is typically a simplistic community that is always dominated by a sparse to thick cover of common spike-rush and few other species. The community inventoried in the estuary also contained a high cover of creeping bentgrass (*Agrostis stolonifera*) an introduced species, along with minor components of Lyngby's sedge (*Carex lyngbyei*), American bulrush (*Bolboschoenus maritimus*) and minor occurrences of other typical estuarine herbs. The wetland appeared to be typically flooded for most of the year, although it was dry during the survey. Soils were moderately rich with a shallow layer of mesic organic material over deep silts and sands. Due to the presence of introduced species, this community was considered to be in poor condition, however as it was the only wetland of this type found in the DoS, it should be considered to be regionally important.

Figure 15. Wm04 Common spike-rush marsh complexed with Wm05 cattail marsh in upper portions of the Squamish Estuary.

Wm05 cattail marsh

Wm05 cattail marshes are blue-listed ecosystems that are relatively common in the DoS in a variety of sites. Tolerant of a high level of disturbance and variable water levels, cattail marshes typically occur in wetland complexes in permanently flooded areas. They can also be found in slightly saline areas, and are widespread, but rarely extensive in the Squamish Estuary. Most of the sloughs in the DoS contain at least small areas of Wm05 wetlands. The condition of the inventoried Wm05 wetland varied considerably, from pure cattail (*Typha latifolia*) wetlands in good condition (Fig. 16 and 17) in both the estuary and several sloughs, to highly modified marshes that contained a considerable cover of introduced and invasive species. As cattails are highly tolerant of disturbance and high nutrient water, sites that contain the species does not always indicate that it is a Wm05 wetland, or even a wetland at all (such as ditches). Wm05 wetlands are found in areas that experience surface flooding for some or most of the year and typically have a moderate to shallow layer of mesic organic material over rich silty substrates.

Figure 16. Thick Wm05 cattail marsh in upper portions of the Squamish Estuary.

Figure 17. Narrow band of Wm05 cattail marsh on the edges of shallow open water.

Wm06 great bulrush marsh

Wm06 great bulrush marshes are blue-listed (although not tracked in the CWHdm) wetlands that occur in deep, permanently flooded lake and pond margins. In the DoS it was limited to portions of Brome Lake and other small ponds. Wm06 marshes are simple communities that are dominated by sparse to thick cover of bulrush and rarely have other emergent species due to the constant deep (greater than 1.5 m) water they occur in. Soils are generally composed of sandy or loamy substrate, but have high nutrient availability. The Wm06 observed in the DoS appear to be in excellent condition, however it could not be sampled due to the water depth.

Unclassified marsh

Multiple unclassified marshes were identified in the DoS. These marshes were typically communities that occurred in marsh-like conditions (rich, wet mineral soils), but were dominated by introduced species (Fig. 18 and 19). Unclassified marshes were lumped into a single TEM site series (Wm00) and SEI class (Wm) on the mapping. While these sites cannot be classified as provincially recognized ecosystems, and they generally contain a large percentage of introduced or invasive species, they still provide modified ecosystem services such as wildlife habitat and water storage. These wetlands should be targeted for future restoration sites and be managed as wetlands (i.e. avoid disturbing them as possible).

Figure 18. Marsh-like community dominated by a thick cover of orchard grass and bluejoint.

Figure 19. Slough with near stagnant water and few native species forming a marsh-like community.

5.3.4 Swamp Site Associations

A swamp is a nutrient-rich wetland ecosystem where significant groundwater inflow, periodic surface aeration, and/or elevated microsites allow for growth of large trees or tall shrubs under subhydric conditions. Swamps are dominated by conifer or broadleaf trees (often on mounded microsites), or tall shrubs. Herbaceous species are variable, and can range from thick to sparse covers, while bryophytes are generally limited. Tree dominated swamps typically occur as transitional areas between water or other wetlands and upland terrestrial communities, while shrub dominated swamps occur in a wide variety of conditions. Swamps range from moderate to rich communities that have significant groundwater flow and water tables that remain near or above the surface throughout the growing season. They typically occur on mineral soils that have a surface layer of well decomposed organic material. (MacKenzie & Moran 2004)

Swamps were found to be relatively abundant in the DoS (Table 6), with five classified ecosystems types and multiple unclassified associations. They occurred throughout the DoS, but were primarily locate on or near inactive floodplains.

Table 6. Swamp Associations mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Swamp					
Ws00	Unclassified swamp		49	57.3	0.6
Ws06	Sitka willow – Sitka sedge swamp		8	16.6	0.2
Ws50	Pink spirea - Sitka sedge swamp		8	7.2	0.1
Ws51	Sitka willow – pacific willow – skunk cabbage swamp	Red	1	0.3	<0.1
Ws52	Red alder – skunk cabbage swamp		2	3.1	<0.1
Ws53	Western redcedar – sword fern – skunk cabbage swamp	Blue	54	120.9	1.2
Total			*122*	*205.5*	2.0

Ws06 Sitka willow – Sitka sedge swamp

Ws06 Sitka willow – Sitka sedge swamps are uncommon communities that are associated with fluvial systems. It is a blue-listed ecosystem in portions of the CWH, but is not currently tracked by the CDC in the CWHdm. The Ws06 is typically briefly flooded during spring freshets and other large runoff events. T is normally a simplistic community with Sitka willow (*Salix sitchensis*) forming a dense tall shrub cover, with either Sitka sedge (*Carex sitchensis*) and/or common horsetail (*Equisetum arvense*) dominating the herbaceous layer (Fig. 20). Other herbs may occur in minor amounts, while moss is generally absent. Soils are typically fluvial, with thin organic layers comprised of mesic sedge material, on top of deep silty loam and sands. The Ws06 is uncommon in the DoS, with it mapped in eight locations. Several additional communities that loosely resemble it were observed in the DoS, but were covered thick reed canarygrass and other introduced grasses.

Figure 20. Ws06 Sitka willow – Sitka sedge swamp on the outer edge of a slough complex.

Ws50 pink spirea – Sitka sedge swamp

Ws50 pink spirea – Sitka sedge swamp are common low elevation wetlands found throughout the south coast and Georgia Depression in basins and lake margins (MacKenzie & Moran 2004). In the DoS the Ws50 was found in narrow margins around numerous ponds, as a pure ecosystem unit in a closed basin and in multiple disturbed areas with a thick cover of introduced and invasive grasses (Fig. 21 & 22). It occurs in areas that are flooded for the majority of the growing season. Soils are moderately rich silty loams and loams. The W50 is typically a simplistic community dominated by a continuous cover of pink spirea (*Spirea douglasii*) with occasional sweet gale (*Myrica gale*) and sedges (*Carex* spp.), while mosses are generally absent. Classifying wetlands in the DoS as Wf50 can be difficult in some areas, as pink spirea is often a component of disturbed wetlands, beaver ponds, and minor component in other wetlands, however real Wf50 community always contain a near monoculture.

Figure 21. Ws50 pink spirea – Sirka sedge swamp forming a pue ecosystem in valley bottom depression.

Figure 22. Ws50 pink spirea – Sirka sedge swamp forming a narrow band around a pond.

Ws51 Sitka willow – pacific willow – skunk cabbage swamp

Ws51 Sitka willow – pacific willow – skunk cabbage swamps are red-listed in the CWH (CDC 2016b). They occur sporadically in lowland areas, typically associated in transitional areas between rivers and floodplain forests (MacKenzie & Moran 2004). The Ws51 is always dominated by Sitka willow and Pacific willow (*Salix lucida*), while the lush understory may contain skunk cabbage (*Lysichiton americanus*), lady fern (*Athyrium felix-femina*), horsetails and bulrush (Fig. 23). Soils are generally rich, with organic veneers over deep fluvial silts and sands. The only Ws51 sampled in the DoS was located between the Spit Road and Squamish River and was in poor condition. While it contained a healthy shrub layer, the understory was completely covered by reed canarygrass, and drainage was affected by the raised Spit Road.

Figure 23. Dense Ws51 Sitka willow – Pacific willow – skunk cabbage swamp with thick invasive reed canarygrass.

Ws52 red alder – skunk cabbage

Ws52 red alder – skunk cabbage swamps are uncommon on the south coast and Georgia Depression and occur at low elevations along small creeks and depressions (MacKenzie & Moran 2004). In the DoS the Ws52 was identified in two locations, both of which were associated with small streams draws. They are located in areas with rich to very rich silty loam soils that are wet throughout the year, with patchy standing water in slight depressions. The Ws52 is dominated by a continuous layer of red alder (*Alnus rubra*) with sporadic bigleaf maple (*Acer macrophyllum*) and western redcedar (*Thuja plicata*), underlain by abundant salmonberry (*Rubus spectabilis*). The

herbaceous layer contains lush skunk cabbage (*Lysichiton americanus*) and lady fern (*Athyrium felix-femina*), along with a diverse assortment of other species (Fig. 24). The moss layer is typically sparse, but often contains a variety of leafy mosses. The Ws52 can be difficult to differentiate from young Ws53 swamps as red alder is an early successional species that quickly establishes after disturbance. A limited amount of wester redcedar regeneration and a lack of distinctly mounds (mineral soils) with either regenerating conifers or old conifer stumps, is one way to tell them apart.

Figure 24. Ws52 red alder – skunk cabbage swamp.

Ws53 western redcedar – sword fern – skunk cabbage swamp

Ws53 western redcedar – sword fern – skunk cabbage swamps are blue listed ecosystems that are restricted to the Coastal Douglas Fir and very dry Coastal Western Hemlock zones (MacKenzie & Moran 2004). Ws53 swamps occur in receiving sites, such as toes and old river channels, where surface water is present through most of the year. They typically are patchy ecosystems, with wet muddy depressions and drier mounds, and are normally interspersed with CWHdm/07 and 08 and occasionally 06 forests (Fig. 25 and 26). Vegetation was varied, including western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*) on the drier mounds, along with an understory of vine maple (*Acer circinatum*), salmonberry (*Rubus spectabilis*), sword fern (*Polystichum munitum*) and false lily-of-the-valley (*Maianthemum dilatatum*). Wet depressions contain more

characteristic wetland species include a high cover of skunk cabbage (*Lysichiton americanus*) and lady fern (*Athyrium felix-femina*), and a variable cover of rich indicators along with various sedges and horsetails. Moss cover is also variable with the mounded areas often containing leafy mosses and wet depressions absent of any moss. Soils are permanently saturated and typically have a shallow, rich organic layer underlain by silts and loam.

While the Ws53 swamp is relatively common in the DoS, it is an ecosystem type that is experiencing severe and continual decline across its range. Mature and old forests have declined by 85% over the last 80 years and 20% over the last 40 years. They are considered to be under considerable threat by development, and climate change induce hydrological changes may have additional negative effects. In the DoS all Ws53 ecosystems that were sampled were second growth forests, and only a small extent of mature Ws53 was located. Much of the forested area along Loggers Lane contains Ws53 swamps that have a degree of protection; however the multiple fish restoration channels in the area may ben inadvertently having a negative effect on the wetlands by effectively lowering the water table and reducing standing water. Given the well document decline of this ecosystem type, it should be considered a high candidate for conservation in the DoS, especially stands that are older and have intact hydrological regimes. (BC CDC 2016; Ward et al. 1998)

Figure 25. Typical Ws53 western redcedar – sword fern – skunk cabbage swamp with maturing conifer tree canopy.

Figure 26. Younger Ws53 western redcedar – sword fern – skunk cabbage swamp with a mixed stand of western redcedar, western hemlock and bigleaf maple.

Unclassified Swamps

Multiple swamps were inventoried and mapped in the DoS that could not be classified. These wetlands were significantly modified either through logging, clearing, soil modifications, hydrological modifications (ditches, elevated roads, etc.) and invasive species such as reed canarygrass. While some could be loosely classified as site associations (such as Ws50-like swamp shown in Fig. 27), most contained random assemblages of vegetation that did not clearly indicate a particular swamp association (Fig. 28). In addition to modified wetlands, several swamps were encountered that could not be classified to the provincial level. In these situations, it was not obvious that past modifications had altered the community composition; rather they were novel ecosystems that were not classifiable as they did not contain features that strongly indicated any particular association or were not repeated on the landscape.

Figure 27. Hardhack swamp with thick invasive reed canarygrass.

Figure 28. Swamp at the north end of Brome Lake that could not be classified partially due to historic disturbances.

5.3.5 Estuarine and Intertidal Site Associations

Estuarine ecosystems are found at the confluence of rivers with the sea where they are influenced by occasional or diurnal tidal inundation and brackish water. The vegetation reflects the brackish water conditions to varying degrees, depending on the position in the estuary and the magnitude of freshwater outflow. Estuarine ecosystems are distinguished from intertidal ecosystems by the degree of freshwater input; intertidal ecosystems are influenced by saltwater tidal inundation with little to no freshwater input, except by rainfall runoff, while estuarine marshes and meadows that occupy slightly higher elevations, typically have a degree of surface or groundwater freshwater input (Fig. 29). (MacKenzie & Moran 2004)

Estuarine ecosystems are divided into two main groups; meadow or marsh. They are differentiated by slight elevational differences resulting in significantly different vegetation communities. Meadows occupy the upper tidal zone where three is a more significant diurnal drawdown, and in many locations they are not inundated by daily tides. As a result, they tend to be less saline and contain more diverse communities of graminoids and herbs that are not dominated by salt tolerant species. In the Squamish Estuary, meadows also occur as transitional areas where they are complexed with dryer, saline intolerant species making the boundary from meadow to upland community difficult to determine. Estuarine marshes occur at the mid tidal zone where they are strongly influenced by diurnal tides, but also may be influenced by constant freshwater inputs. They typically contain soils with high salinity and are partially or fully flooded at high tide. These communities are always dominated by a small number of salt tolerant emergent graminoids and succulents and normally have significant accumulations of silt.

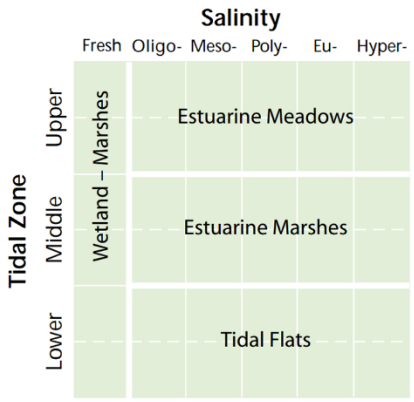

Figure 29. Estuarine and intertidal associations in relation to tidal elevation and salinity (adapted from MacKenzie & Moran 2004).

The Squamish Estuary contains multiple marsh and meadow ecosystems, as well as a variety of intertidal and modified upland communities (Table 7). Many of the meadow and upland communities are not easily classified, at least partially due to the

extensive disturbance history of the estuary. Estuarine and intertidal ecosystems are, by default, quite resilient to constant natural disturbance, however the creation of the numerous training dikes, ditches and elevated roads and railways, have modified the local ecology. While this effect has to some degree been moderated by the creation of flood channels and culverts under the Spit Road for fish rearing purposes, large portions of the upper meadows have been partially of fully blocked from regular flooding. As result, these areas contain communities that loosely fit into the provincial classifications for estuarine meadows, but cannot be consistently classified to the site association level. As well, numerous small upland communities have developed on the ditch spoils and along training dikes that cannot be classified, and wetland communities that better match freshwater communities now occur in areas that no longer strongly affected by salt water.

Table 7. Estuarine and Intertidal mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Estuarine					
Ed00	Unclassified estuarine meadow		3	7.5	0.1
Ed01	Tufted hairgrass – meadow barley estuarine meadow	Red	9	26.8	0.3
Ed02	Tufted hairgrass – Douglas' aster estuarine meadow	Red	10	30.0	0.3
Em00	Unclassified estuarine marsh		2	4.2	<0.1
Em05	Lyngbye's sedge estuarine marsh	Red	30	47.0	0.5
Em06	Lyngbye's sedge – Douglas' water-hemlock estuarine marsh	Blue	8	21.9	0.2
MU	Intertidal mudflat		16	8.7	0.1
BE	Beach		4	5.9	0.1
Total			*82*	*151.9*	1.5

Em05 Lyngbye's sedge estuarine marsh

Em05 Lyngbye's sedge estuarine marsh is a widespread ecosystem that is found throughout estuaries in BC, however it is red-listed in the CWH (CDC 2016c; MacKenzie & Moran 2004). It occurs in the middle tidal zone where is experiences diurnal flooding, often along tidal flats and channel margins. Due to high salinity, the community has low diversity, but it always dominated by a contentious cover of Lyngbye's sedge (*Carex lyngbyei*). Soils are generally rich, with a medium to high salt content, and composed of permanently saturated silt and sand. In the DoS, the Em05 is common, but never extensive. It occurs at lower elevations of the estuary (Fig. 30) and along tidal channels that extend into upland forests (Fig. 31). The majority of the Em05 in the DoS is in good condition, including those areas with modifications such as elevated roads.

Figure 30. Em05 Lyngbye's sedge estuarine marsh occurring between flooded intertidal mudflats and an elevated road.

Figure 31. Em05 Lyngbye's sedge estuarine marsh in a flood channel through a forested portion of the upper estuary.

Em06 Lyngbye's sedge – Douglas' water-hemlock estuarine marsh

Em06 Lyngbye's sedge – Douglas' water-hemlock estuarine marsh is a blue-listed ecosystem in the CWH (CDC 2016d). It occurs infrequently in the Squamish Estuary in the middle tidal zone and is often intermixed with Em05. Em06 represents a more diverse estuarine marsh (relative to the Em05) that is located in similar locations, but experiences less erosion. Dominant species include Lyngbye's sedge (*Carex lyngbyei*) Douglas' water-hemlock (*Cicuta douglasii*), pacific silverweed (*Potentilla egedii*), and tufted hairgrass (*Deschampsia cespitosa*), with numerous other herbaceous species occurring. Species composition is quite similar to the estuarine meadows that occupy a slightly higher elevation and subsequently experience less daily flooding. Soils are similar to the Em05, with moderate salt levels, and a generally rich permanently saturated silts and sands. The Em06 was generally found to be in good condition, although introduced and invasive species were found in some areas.

Ed01 tufted hairgrass – meadow barley estuarine meadow

Ed01 tufted hairgrass – meadow barley estuarine meadow is a red-listed ecosystem in the CWH (CDC 2016e). It occurs in the upper tidal zone where flooding by brackish water is a regular occurrence, but is usually brief. The Ed01 occurs directly above the Em05 and is generally a simplistic community relative to the Ed02 which may occur in similar locations (Fig. 32). Dominant species include tufted hairgrass (*Deschampsia cespitosa*) and meadow barley (*Hordeum brachyantherum*) along with a moderate to high cover of Pacific silverweed (*Potentilla egedii*) and Lyngbye's sedge (*Carex lyngbyei*). Soils were similar to the other estuarine meadows, with think organic layers of rich fluvial silts and sands. The Ed01 was generally in good condition, lacking the high weed cover present in much of the Ed02 and Ed00 that occurred at slightly higher elevations and were more likely to be modified by ditches and dikes.

Figure 32. Ed01 tuffed hairgrass – meadow barley estuarine meadow on the raised areas with Lyngbye's sedge estuarine marsh in the foreground.

Ed02 tufted hairgrass – Douglas' aster estuarine meadow

Ed02 tufted hairgrass – Douglas' aster estuarine meadow a red-listed ecosystem in the CWH (CDC 2016f). It is considered to be the most floristically diverse estuarine ecosystem, occurring in larger estuaries in the upper tidal zone between backshore shrub communities or upland forest (MacKenzie & Moran 2004). The Ed02 sampled in the DoS was diverse and included multiple introduced species such as perennial sow-thistle (*Sonchus arvensis*). Typical species included tufted hairgrass (*Deschampsia cespitosa*), Douglas' aster (*Symphyotrichum subspicatum*), rushes (*Juncus* spp.), seaside arrow-grass (*Triglochin maritima*), giant vetch (Vicia *nigricans var gigantea*) meadow barley (*Hordeum brachyantherum*), Pacific silverweed (*Potentilla egedii*) and Lyngbye's sedge (*Carex lyngbyei*) (Fig. 33). Blue-listed Henderson's checker-mallow (*Sidalcea hendersonii*) also frequently occurred in the Ed02 and Ed00. Soils were similar to the other estuarine meadows, with think organic layers of rich fluvial silts and sands. The condition of Ed02 meadows was variable, ranging from excellent to fair relative to the amount of historic disturbance and introduced species.

Figure 33. Ed02 tufted hairgrass – Douglas' aster estuarine meadow.

Ed00 unclassified estuarine meadow

Ed00 unclassified estuarine meadows occurred in the upper tidal zones in the higher elevations of the Squamish estuary. Most of the areas mapped as Ed00 were located in areas modified by dikes and ditches, and typically contains patches of low shrubs or stunted trees (Fig. 34). These areas contains a high floral diversity similar to the Ed02, but frequently contained a high cover of introduced species. In some areas, particularly in the eastern portions of the estuary, the Ed00 resembled the red-listed tuffed hairgrass – Henderson's checker-mallow ecological community that has been described in the Campbell River estuary. However the description of the differs in some key areas, such as the prevalence of low shrubs, namely black twinberry (*Lonicera involucrata*) roses (*Rosa nutkana, R. pisocarpa*) and sweet gale (*Myrica gale*), in the majority of the areas where Henderson's checker-mallow (Fig. 35) is present (Holm 2016).

Figure 34. Ed00 unclassified estuarine meadow with clumps of sweet gale.

Figure 35. Blue-listed Henderson's checker-mallow (*Sidalcea hendersonii*).

Intertidal ecosystems include mudflats, beaches and rocky shorelines that are influenced by diurnal tidal cycles with little to no freshwater input (primarily through rainfall runoff). The intertidal ecosystems link the marine and terrestrial

environments. Intertidal ecosystems in the DoS include mudflats and beaches. Mud flats are large areas that are exposed during low tide that contain little or no vegetation (Fig. 36). Beaches (including shorelines) include areas along the upper limit of the tidal influence where wood and other debris accumulate (Fig. 37). Many areas mapped as beach in the estuary occur where roads or other elevated areas created conditions favourable to debris accumulations.

Figure 36. Intertidal mudflat at low tide.

Figure 37. Beach with accumulations of logs and woody debris.

5.3.6 Shallow Open Water Wetlands

Shallow open water wetlands are aquatic wetlands permanently flooded by still or slow-moving water and dominated by rooted submerged and floating-leaved aquatic plants (MacKenzie & Moran 2004). These aquatic wetlands are simplistic communities that typically have less than 10% cover of emergent species. Shallow open water wetlands occur as a component of still or slowly moving waterbodies, and are normally a small component of a larger wetland or aquatic complexes, although they occasional occur as pure ecosystem types. They occur in water that is less than two metres deep (deeper water limits light penetration and the ability for most rooted emergent species to grow). There are currently not any formal wetland associations or site series for shallow open water ecosystems.

Few shallow open water wetlands were mapped in the DoS (Table 8), which most areas of standing water classified as ponds with no vegetation. Yellow pond-lily ecosystems were the only shallow open water wetlands observed in the DoS. These communities had a sparse cover of yellow pond-lily and little other vegetation. They ranged from small pockets of open water in a larger wetland complex (Fig 38) to sparse communities along the edges of lakes and ponds (Fig. 39). While not observed, bladderwort (*Utricularia* sp.) likely also occurred in these communities along with the potential for other submerged aquatic species.

Table 8. Shallow Open Water mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Shallow Open Water					
OW	Shallow open water		15	5.3	0.1
Total			*15*	*5.3*	0.1

Figure 38. Small shallow open water with yellow pond lily (*Nuphar lutea*) in a Wb50 bog complex.

Figure 39. Fringe of shallow open water with yellow pond lily (*Nuphar lutea*) on the edge of Stump Lake.

5.3.7 Floodplain Associations

Flood associations are non-wetland ecosystems that occur in riparian areas that are regularly flooded or have seasonally high water tables. They range from low-bench floodplains that flood annually, either accumulates or loose sediment (scoured), and support a low diversity of flood tolerant shrubs (willow, alder, or young cottonwood). Mid-bench floodplains occupy a slightly higher elevation in fluvial floodplains, where they are flooded on an annual basis, but the flood waters are generally slow gradient and do not persist for as long as the low-bench floodplains. As result, the mid-bench flood associations' support forested communities that often have a lush and diverse assemblage of species. Three floodplain ecosystems were mapped in the DoS, along with one unclassified system (Table 9).

Table 9. Floodplain Associations mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Floodplain					
Fl00	Unclassified low-bench floodplain		13	38.9	0.4
Fl06	Sandbar willow low bench floodplain		24	37.7	0.4
Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	Blue	105	429.8	4.2
SS	Sitka spruce - salmonberry high bench floodplain	Red	95	413.4	4.0
Total			*237*	*919.8*	8.9

Fl06 Sandbar willow low bench floodplain

Fl06 Sandbar willow low bench floodplain is an uncommon low bench flood plain association that is a red-listed ecosystem in some regions of the province but not currently tracked in the CWH (CDC 2016h). The Fl06 occurs on small sand bars along large active rivers and is rarely extensive. It contains low plant diversity and is heavily scoured by yearly floods. Willows (*Salix* spp.) are always present, and balsam cottonwood (*Populus balsamifera*) occurs in minor amounts or can be the dominant species. Few other species occur due to flooding and erosion. Soils are poorly developed fluvial sands and gravels. In the DoS the Fl06 was mapped multiple times, however it was considered to be a best-fit classification where further sampling is required to confirm it.

Fl00 unclassified low bench floodplain

Fl00 unclassified low bench floodplain ecosystems were common but never extensive in the DoS. These ecosystems contains a variable cover of balsam cottonwood (*Populus balsamifera*), red alder (*Alnus reubra*) or various willow species (*Salix* spp.). The areas mapped as Fl00 did not contain specific site characteristics or species composition to enable a classification to the provincial level. They contained variable species and were in various stages of development (Fig. 40 and 41).

Figure 40. Unclassified low-bench Floodplain with a sparse cover of low cottonwood shrubs.

Figure 41. Unclassified low-bench Floodplain with dense cover of tall willow shrubs.

Fm50 Cottonwood - red alder - salmon berry mid bench floodplain

Fm50 Cottonwood - red alder - salmon berry mid bench floodplains are blue-listed ecosystems that are found along coastal BC rivers. They occur on mid-bench floodplains that are regularly flooded for moderately long periods and have seasonally high water tables (Fig. 42 and 43). Balsam cottonwood (*Populus balsamifera*) is the dominant species in the Fm50, along with red alder (*Alnus rubra*) and lesser amounts of Sitka spruce (*Picea sitchensis*) and western redcedar (*Thuja plicata*). The understory always contains a thick, continuous shrub layer composed of salmonberry (*Rubus spectabilis*) and variable amounts of red osier dogwood (*Cornus stolonifera*), red elderberry (*Sambucus racemosa*), currents (Ribes spp.), and black twinberry (*Lonicera involucrata*). Herbaceous cover is variable due to limited light penetration and the annual flooding, and include species such as common horsetail (*Equisetum arvense*) and sedges (*Carex* spp.). Mosses are generally absent. The Fm50 is located on active fluvial plains composed of rich loams and sands. (MacKenzie & Moran 2004; CDC 2016i)

Fm50 ecosystems were common in the DoS and in a variety of conditions. They were frequently found in areas that have been separated from rivers by dikes, and contain a variety of new and old disturbances and modifications. Hydrological modifications, clearing, and invasive species were commonly observed.

Figure 42. Mature Fm50 Cottonwood - red alder - salmon berry mid bench floodplain forest with a cottonwood dominated stand.

Figure 43. Young Fm50 Cottonwood - red alder - salmon berry mid bench floodplain forest with a cottonwood and red alder dominated stand along a constructed fish channel.

SS Sitka spruce - salmonberry high bench floodplain

The Sitka spruce – salmonberry high bench floodplain forest is common throughout the DoS in a variety of positions. It is common along the old, inactive fluvial plans thought the DoS in extensive areas, and also occurs as narrow active floodplains along small creeks and streams. This ecosystem is characterized by rich silty soils that only experience occasional minor flooding. The forest canopy always includes Balsam cottonwood (*Populus balsamifera*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*), along with variable amounts of western redcedar (*Thuja plicata*) based on the time since the last major disturbance (Fig. 44). Sitka spruce (*Picea sitchensis*) typically occurs, but is often comprised of sporadic individuals, including large mature trees in many areas. The understory is thick and lush, with a continuous layer of salmonberry (*Rubus spectabilis*), along with vine maple (*Acer circinatum*) and devil's club (*Oplopanax horridus*). Herbaceous cover is variable with lady fern (*Athyrium filix-femina*) and spiny wood fern (*Dryopteris expansa*) typically occurring, while the moss layer is generally sparse or absent. As these ecosystems are productive, rarely wet, and comprise a large portion of the flat, low elevation land in the study area, few intact mature stands remain in the DoS.

Figure 44. Sitka spruce – salmonberry high bench floodplain forest dominated by young red alder with a lush understory including conifer saplings.

5.3.8 Freshwater and River

While not wetland or floodplain ecosystems, freshwater and rivers are almost always associated with or interconnected with them Freshwater ecosystems include bodies

of water such as lakes (greater than 50 hectares) and ponds (less than 50 hectares) that usually lack floating vegetation. Ponds of various sizes are common in the study area, while no lakes were mapped (Figures 45 to 46). Ponds are considered to be naturally (generally) occurring, small body of open water, greater than 2 m deep and generally less than 50 ha, with little to no floating vegetation. Rivers includes mapped channels of any size that have distinguishable banks. Table 10 contains the number and area mapped in the DoS as pond and river.

Table 10. Freshwater and River mapped in the Study Area.

Map Code	Name	CDC Status	Polygons Mapped In	Area (ha)	% of Study Area
Freshwater					
PD	Pond		35	76.4	0.7
RI	River		68	369.7	3.6
Total			*103*	*446.1*	4.3

Figure 45. Small beaver pond with a swamp fringe.

Figure 46. Large pond (Brome Lake) with a rocky, forested shoreline.

6.0 WATERCOURSE MAPPING REFINEMENT

New mapping technology was employed to develop detailed surface topology from LiDAR (Light Detection and Ranging) data to create sub-metric topography maps and to subsequently develop models to identify watercourses and top of bank as well as to provide additional information of fish habitat potential and potential obstructions. This information was incorporated into an expanded database intended to accommodate future mapping initiatives (i.e. SHIM) allowing seamless updating and integration within the DOS GIS system and landuse planning initiatives.

All analysis was performed in ArcGIS Desktop version 10.4.1 (Environmental Systems Research Institute, 2016) and all hydrological modelling used Arc Hydro Tools.

A Digital Elevation Model (DEM) was generated from LiDAR data, this DEM was resampled to 1 m. The 1 m resolution DEM was pre-processed by first filling areas where small lakes are located. Next, the existing stream network for the District of Squamish was burned into the DEM and sinks were filled. The stream network was defined using a Deterministic-8 (D8) flow algorithm and a stream threshold of 30,000 cells or 0.03 km. In addition, the DEM assisted with the identification of stream centerline, top of bank, wetland area boundaries, and riparian assessment buffers.

The model generated watercourses were then manually cross-referenced with existing Terrain Resource Inventory Mapping (TRIM) streams and also verified and

refined (if necessary) using 3-D aerial imagery. Final streamlines (all identified watercourses in the DOS) were digitized using a digitizing tablet and accompanied by expanded geodatabase that includes existing and future watercourse attribute data (e.g. SHIM).

The combined length of watercourses within the DOS (derived from the model and subsequent manual checks and interpretation) totaled 514622 m (Table 11). This combined watercourse length is greater than twice the previous mapped watercourse extents within the DOS.

Table 11. Updated watercourse summary following 2016 GIS analysis and advanced LiDAR DEM, topographic modelling, and air photo interpretation.

Stream/Watercourse Name	Previous Measure			2016 GIS analysis (LiDAR DEM/Air Photo interpretation/Topographic Modelling)		
	Mainstem (m)	Tributaries (m)	Grand Total (m)	Mainstem (m)	Tributaries (m)	Grand Total (m)
Alice Lake		740	740		4706	4706
Brohm Lake		2867	2867		9300	9300
Brohm River	3521	8436	11957	3124	12220	15344
Cheakamus River	13558	25319	38877	17308	53937	71245
Cheekye River	4591	1978	6569	4593	8869	13462
Culliton Creek	365		365	369	658	1027
Dryden Creek	2816	2426	5242	2925	36299	39225
Edith Lake					287	287
Evans Creek	2186		2186	2714	7805	10520
Fawn Lake					234	234
Fries Creek	396		396	492		492
Gonzales Creek	664		664	665	1336	2001
Hop Ranch Creek	3223	638	3861	3467	6799	10266
Howe Sound		33010	33010		60322	60322
Hut Creek	348		348	392		392
Judd Slough	2123		2123	2198		2198
Little Stawamus Creek	5659	9960	15619	5708	21667	27376
Magnolia Creek	772		772	785	277	1062
Mamquam River	13461	26875	40336	14218	62013	76230
Mashiter Creek	5739	9836	15575	9433	21300	30733
Mill Creek	653		653	510	1070	1579
Monmouth Creek	2009	1121	3130	2003	2255	4258
Olesen Creek	1453	1220	2673	755	2854	3609
Raffuse Creek	1412	1837	3249	1541	2665	4206
Ring Creek	1680	984	2664	1883	856	2739
Shannon Creek	835	775	1610	836	2045	2881
Squamish Creek		989	989			
Squamish River	16123	14456	30579	24753	64188	88941
Stawamus River	4996	947	5943	4974	12437	17411
Swift Creek	1984	1213	3197	2177	6060	8238
Stump Lake					127	127
Tenderfoot Creek	1158	1480	2638	1149	2953	4103
Woodfibre Creek	110		110	110		110
Grand Total	91835	147107	**238942**	109084	405539	**514622**

6.1 Top of bank Modelling, Interpretation and Digitization

Slope models were created from the DEM and the top of bank was defined using the following criteria, as recognized by the Ministry of Environment and Department of Fisheries and Oceans Canada:

i) The point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break;

ii) For a floodplain area not contained within a ravine, the edge of the active floodplain of a stream where the slope of the land beyond the edge is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the edge; or,

iii) The first significant break in a ravine slope where the break occurs such that the grade beyond the break is flatter than 3:1 for a minimum distance of 15 metres measured perpendicularly from the break, and the break does not include a bench within the ravine that could be developed.

The map book illustrating watercourse top of bank was not included within this report but provided to DoS).

6.2 Riparian Assessment Areas

Watercourses were buffered by 30-m from both the left and right interpolated (from DEM and orthoimagery) bankfull levels (map book not included within this report but provided to DoS).

6.3 Fish Presence

A preliminary data search (Ecoscape 2015) indicated that fish frequent the majority of watercourses in the District where sufficient flows and residual habitat support general living and reproduction. Upstream migration barriers were not investigated during this project phase since, from the perspective of stream and riparian habitat management, all watercourses with a surface water connection to a fish bearing stream are themselves also regarded as fish habitat.

A further background review of existing watercourse information (e.g. Provincial fisheries databases and report catalogues, Scientific Fish Collection Permit summary reports and available reports, and correspondence from the DOS, which contribute to public record) was carried out and maps were updated accordingly. The map book of fish presence is not included within this report but was provided to DoS.

7.0 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,
EcoLogic Environmental Consulting and
Ecoscape Environmental Consultants

Prepared by:

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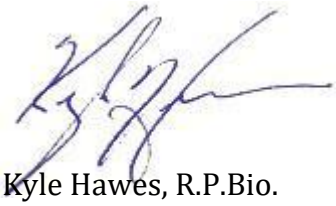
Senior Ecologist
EcoLogic Environmental Consulting



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8.0 REFERENCES

B.C. Conservation Data Centre. 2016a. Conservation Status Report: *Thuja plicata / Polystichum munitum - Lysichiton americanus*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (Accessed Oct 7, 2016).

B.C. Conservation Data Centre. 2016b. Ecological Community Summary: *Salix sitchensis - Salix lasiandra* var. *lasiandra / Lysichiton americanus*. B.C. Minist. of Environment. Available:http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016c. Ecological Community Summary: *Carex lyngbyei Herbaceous Vegetation*. B.C. Minist. of Environment. Available:http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016d. Ecological Community Summary: *Carex lyngbyei - Cicuta douglasii*. B.C. Minist. of Environment. Available:http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016e. Ecological Community Summary: *Deschampsia cespitosa* ssp. *beringensis - Hordeum brachyantherum*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016f. Ecological Community Summary: *Deschampsia cespitosa ssp. beringensis - Symphyotrichum subspicatum*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016g. Ecological Community Summary: *Deschampsia cespitosa - Sidalcea hendersonii*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016h. Ecological Community Summary: *Salix exigua* Shrubland. B.C. Minist. of Environment. Available:http://a100.gov.bc.ca/pub/eswp/ (accessed Oct 11, 2016).

B.C. Conservation Data Centre. 2016i. Ecological Community Summary: *Populus trichocarpa - Alnus rubra / Rubus spectabilis*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/(accessed Oct 11, 2016).

Holm, J. 2016. Personal communications.

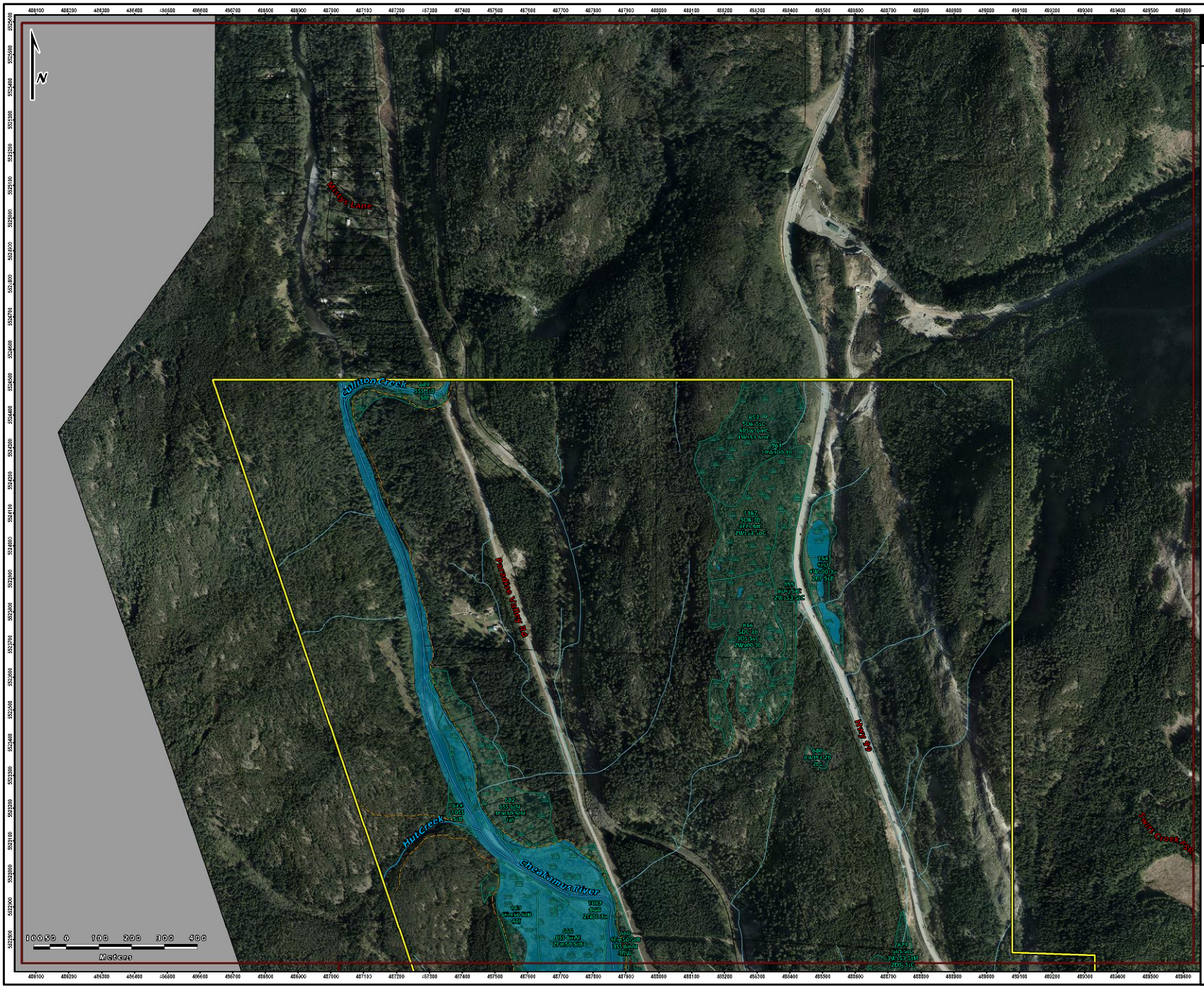
McIntosh, T. & J. Fenneman. 2016. Personal communications.

Mouton, A. 2005. Generating Stream Maps Using LiDAR Derived Digital Elevation Models and 10-m USGS DEM. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science University of Washington Program Authorized to Offer Degree: College of Forest Resources

Stacey, J. 2016. Personal communications. BC Conservation Data Centre.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth, and C. Cadrin. 1998. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands 1993-1997. Volume 1: Methodology, Ecological Descriptions and Results. Tech. Rep. Ser. No. 320, Can. Wildl. Serv., Pac. and Yukon Reg., BC.

MAPSHEETS



District of Squamish

Mapsheet - 1

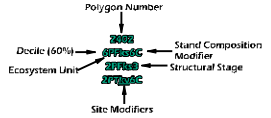
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

Wetland Ecosystem Polygon Key



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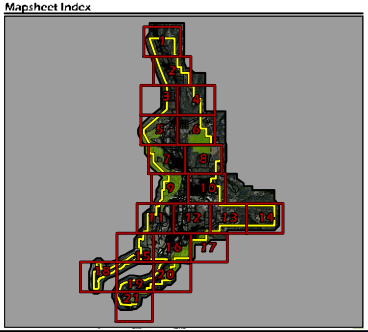
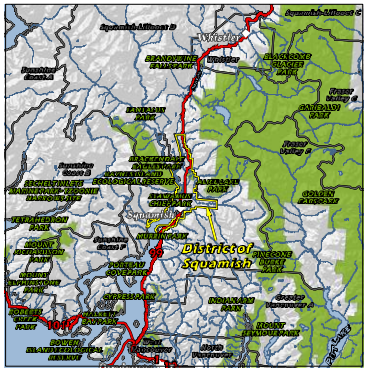


District of Squamish Regional Location



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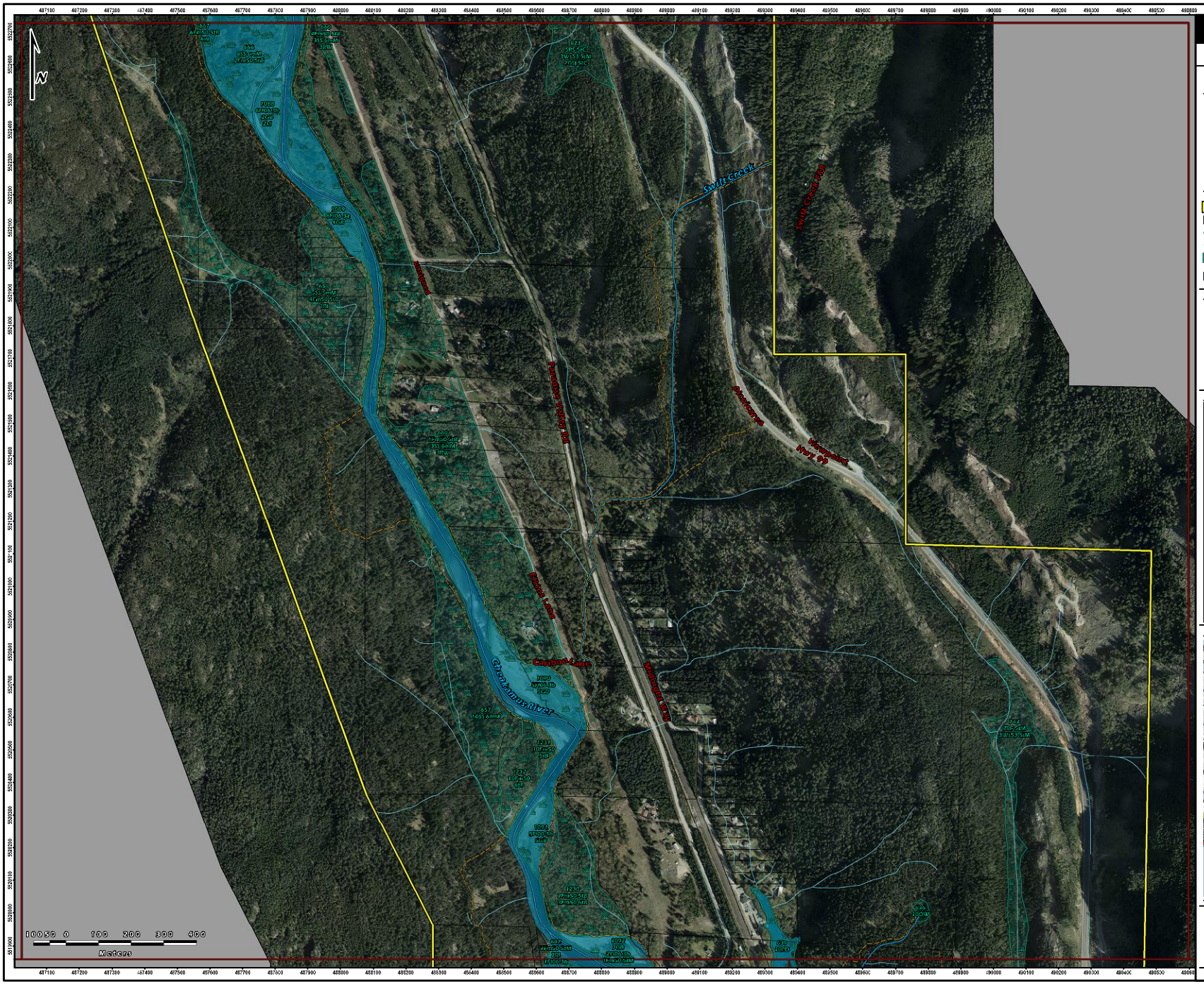
ECOSCAPE
Environmental Consultants Ltd.



District of Squamish

Mapsheet - 2

Watercourses and Wetland Ecosystems

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Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
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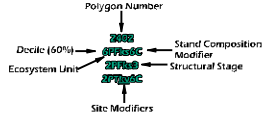
Wetland Ecosystem Polygon Key



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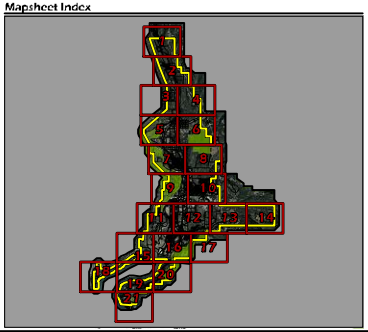
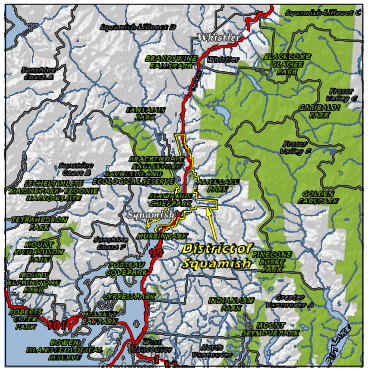


District of Squamish Regional Location



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District of Squamish

Mapsheet - 3

Watercourses and Wetland Ecosystems

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Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
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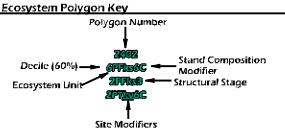
Wetland Ecosystem Polygon Key



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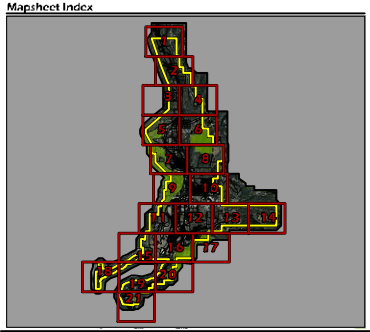

District of Squamish Regional Location

SQUAMISH
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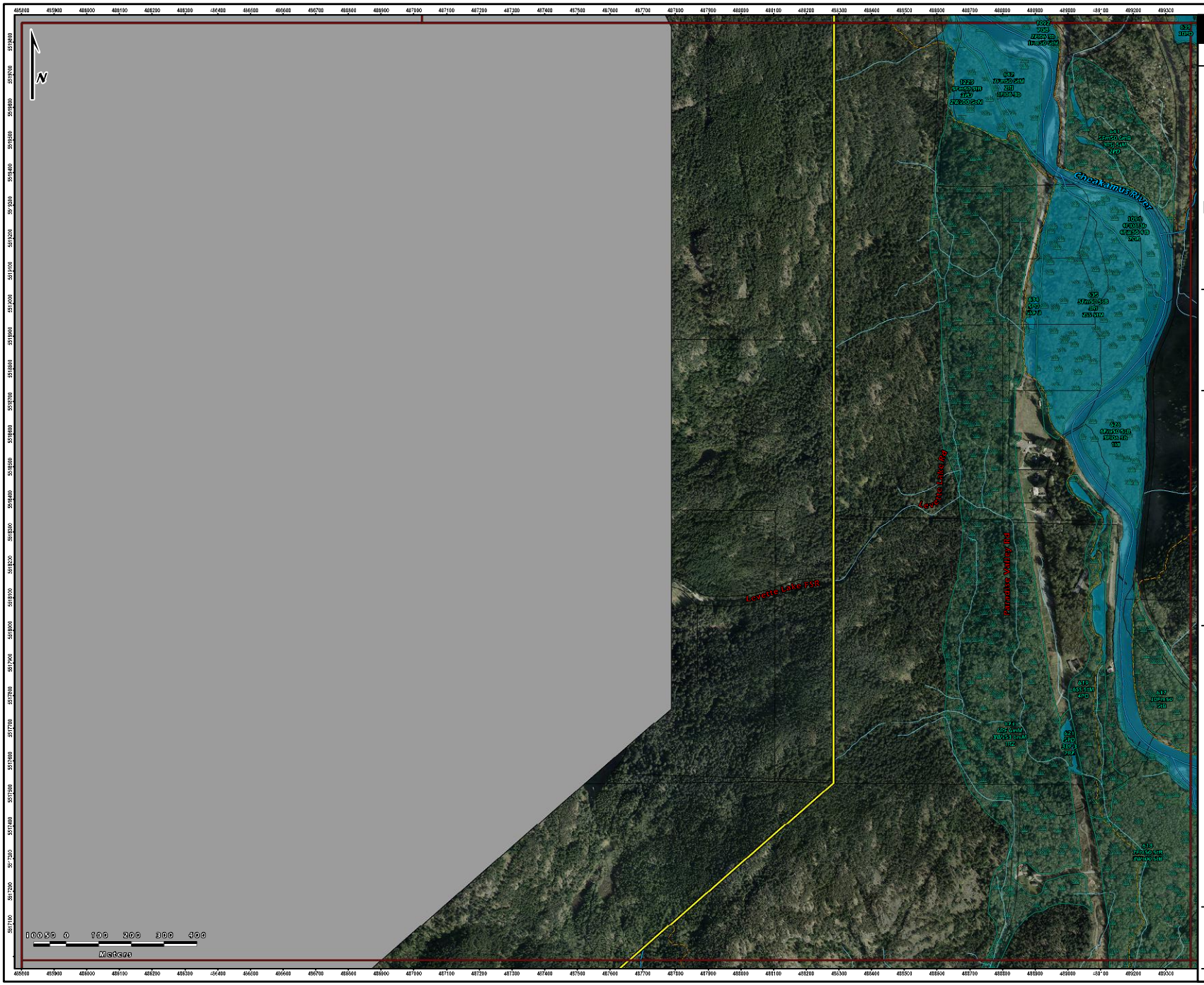

District of Squamish

Mapsheet - 4

Watercourses and Wetland Ecosystems

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Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

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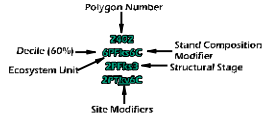
Wetland Ecosystem Polygon Key



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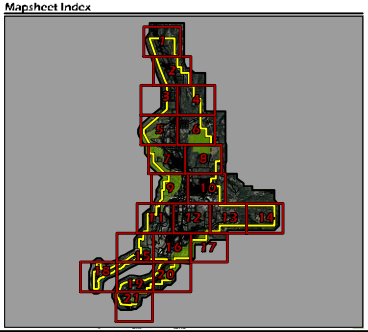
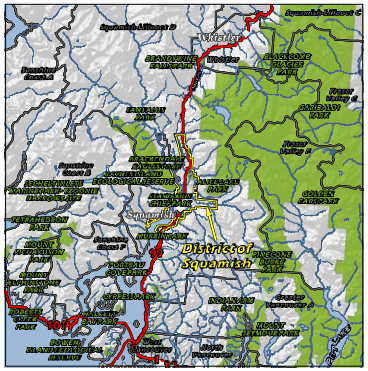


District of Squamish Regional Location



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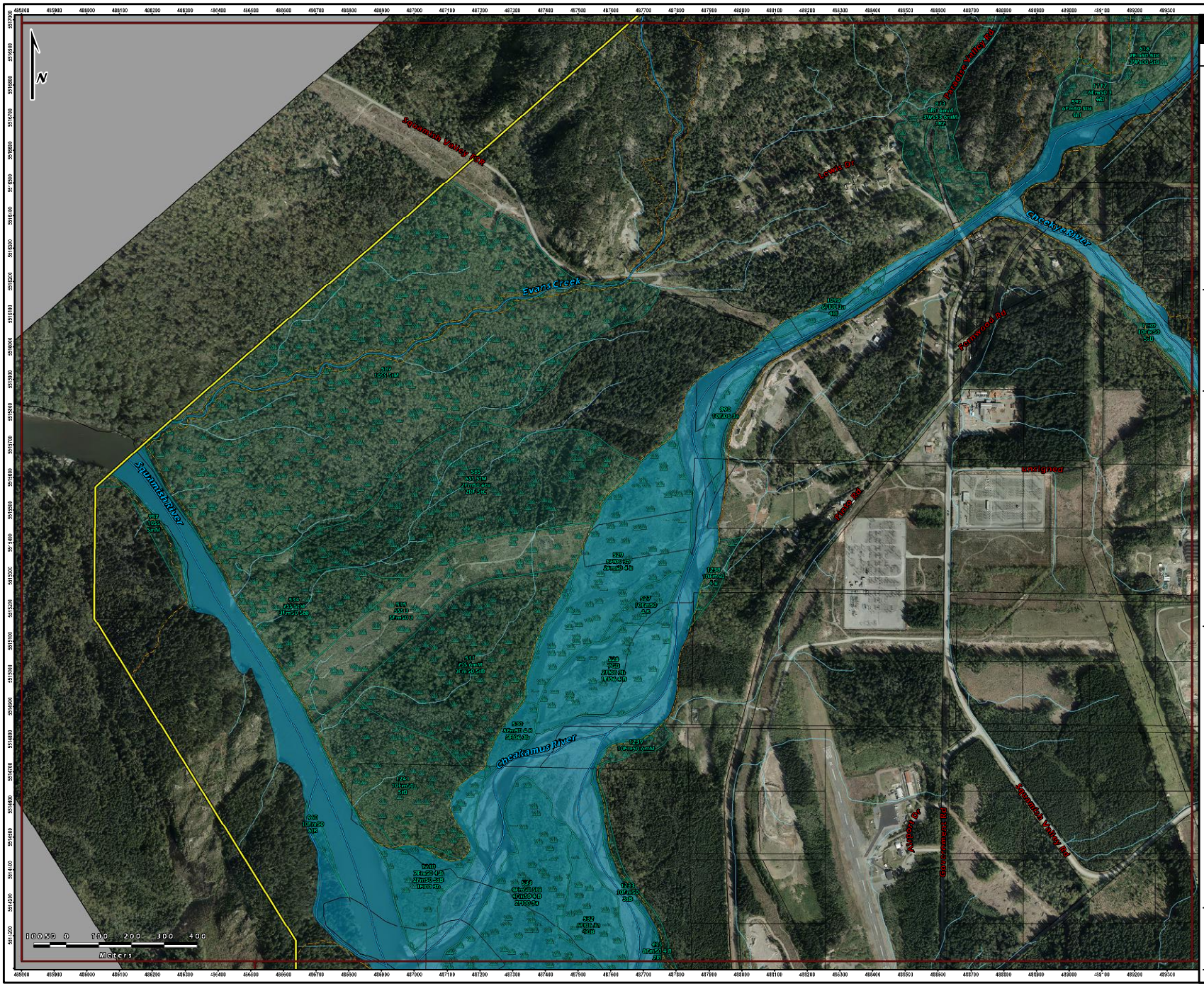


District of Squamish

Mapsheet - 5

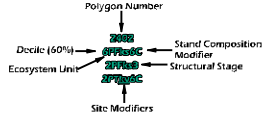
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

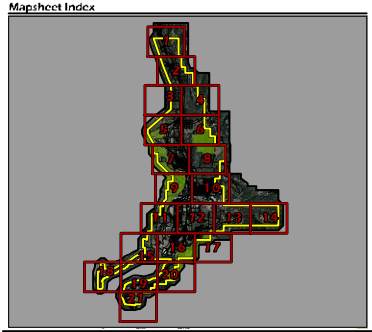
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location

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Environmental Consultants Ltd.

District of Squamish

Mapsheet-6

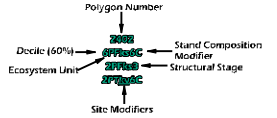
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

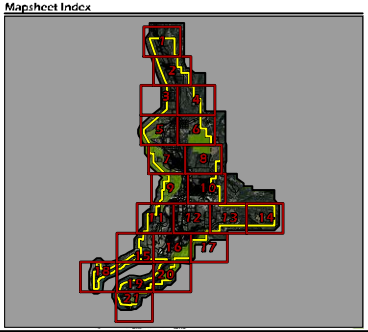
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

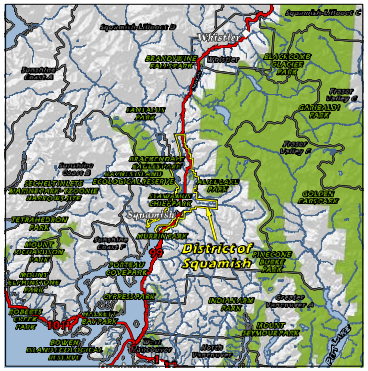
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



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Environmental Consultants Ltd.

District of Squamish

Mapsheet-7

Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

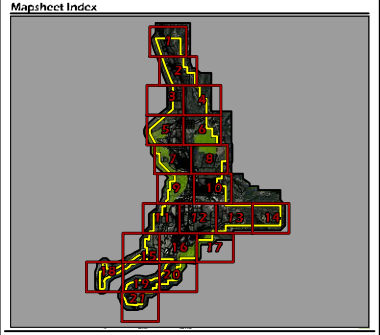
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

Wetland Ecosystem Polygon Key

Polygon Number
Decile (60%) — Stand Composition Modifier
Ecosystem Unit — Structural Stage
Site Modifiers

Mapsheet Index



District of Squamish Regional Location

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Environmental Consultants Ltd.

District of Squamish

Mapsheet - 8

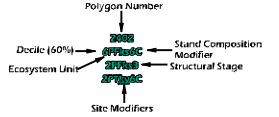
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

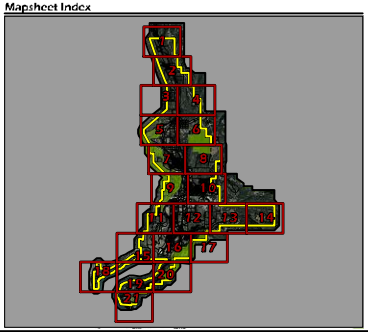
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

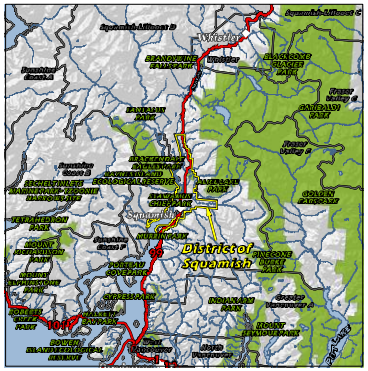
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



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District of Squamish

Mapsheet-9

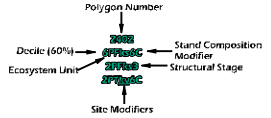
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

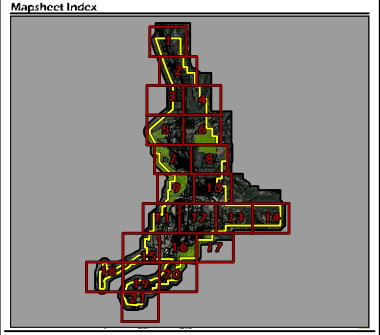
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

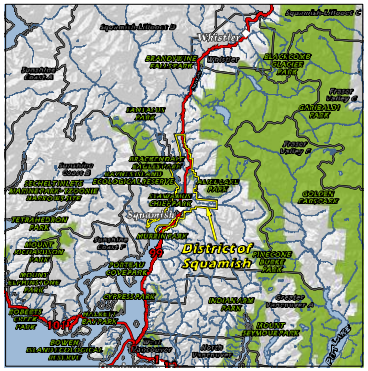
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



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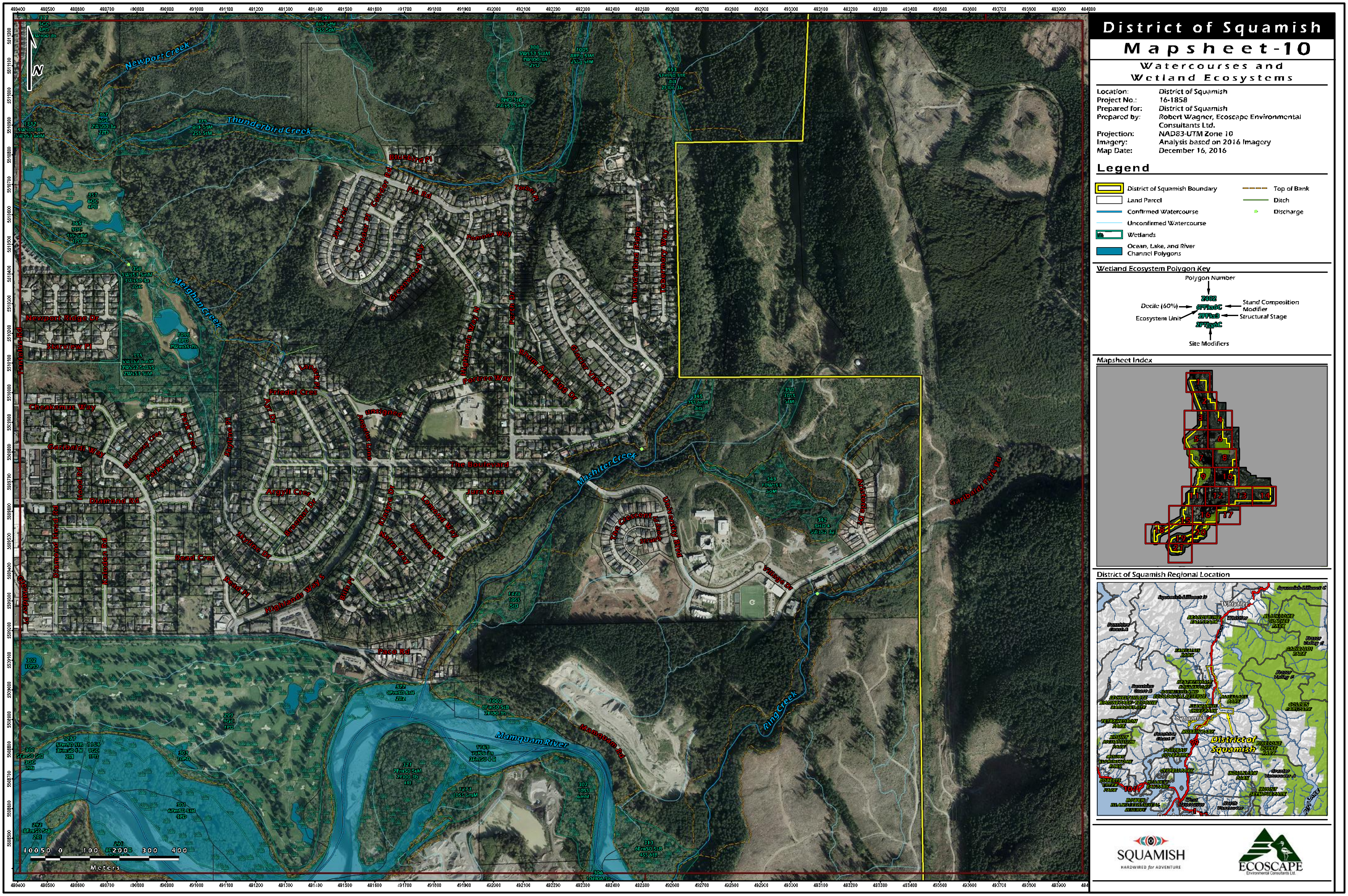
District of Squamish
Mapsheet-10
Watercourses and Wetland Ecosystems
Location: District of Squamish
Project No.: 16-1858
Prepared for: District of Squamish
Prepared by: Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection: NAD83-UTM Zone 10
Imagery: Analysis based on 2016 Imagery
Map Date: December 16, 2016
Legend
District of Squamish Boundary
Land Parcel
Confirmed Watercourse
Unconfirmed Watercourse
Wetlands
Ocean, Lake, and River Channel Polygons
Top of Bank
Ditch
Discharge
Wetland Ecosystem Polygon Key
Polygon Number
Decile (60%)
Ecosystem Unit
Stand Composition Modifier
Structural Stage
Site Modifiers
Mapsheet Index
District of Squamish Regional Location
SQUAMISH
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ECOSCAPE
Environmental Consultants Ltd.
Newport Creek
Thunderbird Creek
Meighan Creek
Mashiter Creek
Mamquam River
Ring Creek
The Boulevard
Meters

District of Squamish

Mapsheet-11

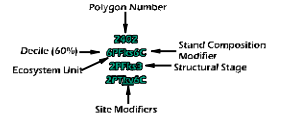
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

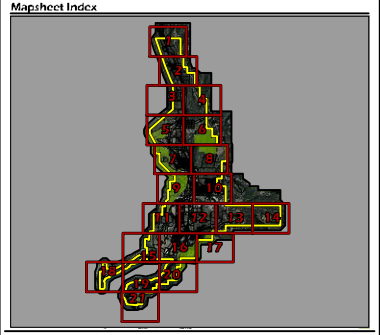
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location

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District of Squamish

Mapsheet-12

Watercourses and Wetland Ecosystems

Location: District of Squamish
Project No.: 16-1858
Prepared for: District of Squamish
Prepared by: Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection: NAD83-UTM Zone 10
Imagery: Analysis based on 2016 Imagery
Map Date: December 16, 2016

Legend

- District of Squamish Boundary
- Land Parcel
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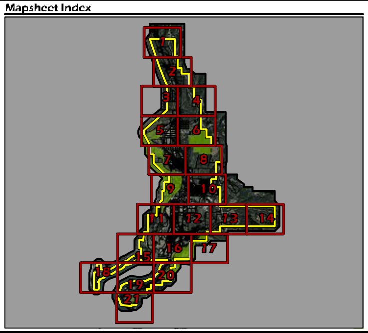
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

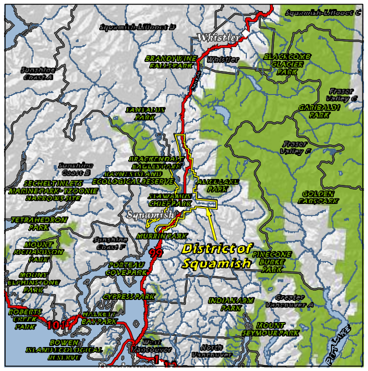
Wetland Ecosystem Polygon Key

Polygon Number
2402
6PFks6C
2PFks3
2PTkv6C
Decile (60%)
Ecosystem Unit
Stand Composition Modifier
Structural Stage
Site Modifiers

Mapsheet Index



District of Squamish Regional Location



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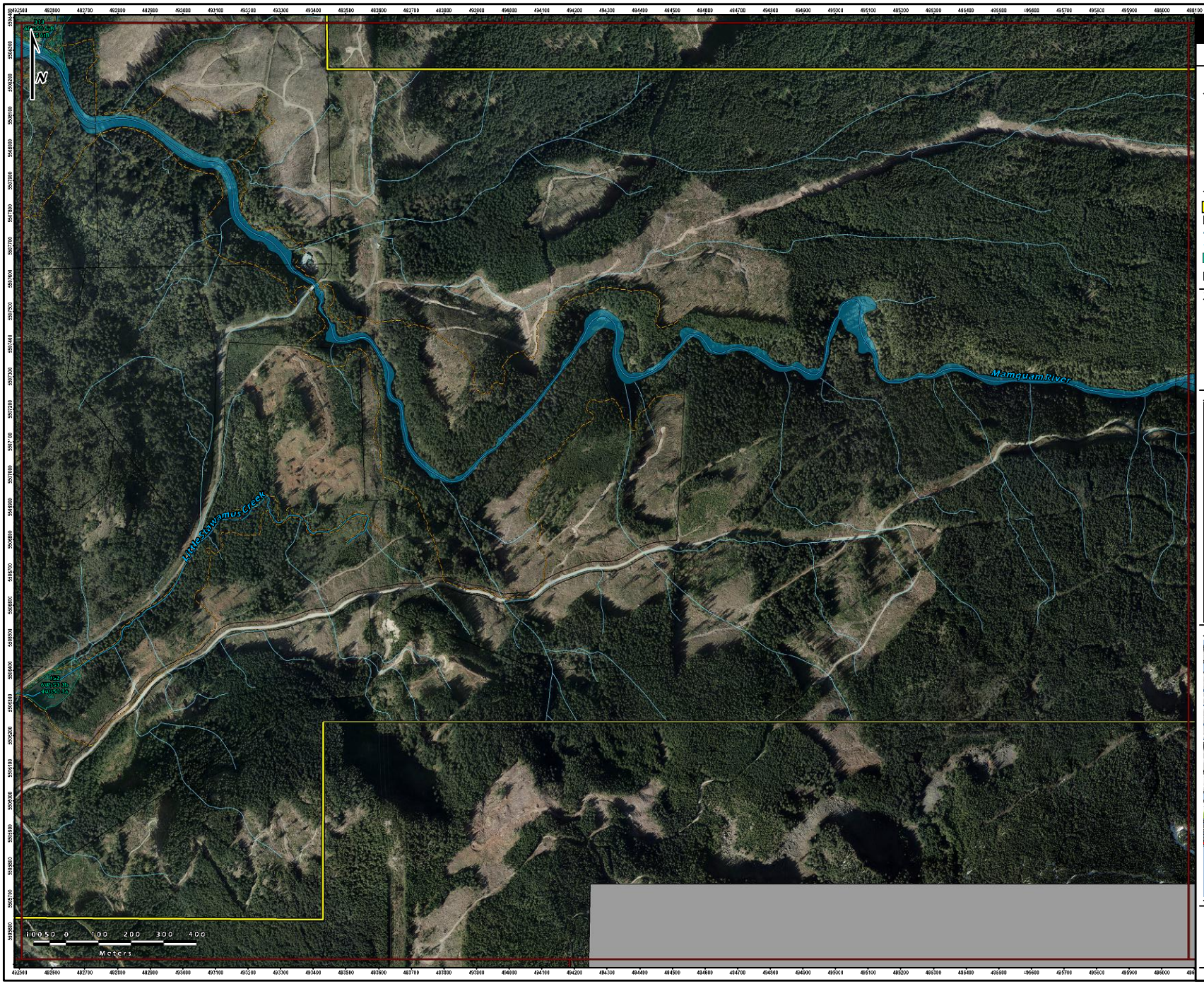

District of Squamish

Mapsheet-13

Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
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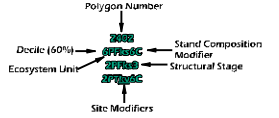
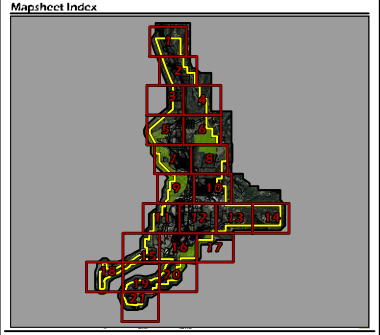
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

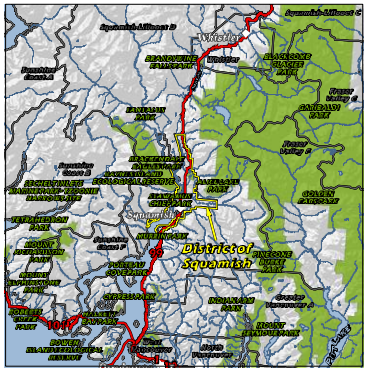
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



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Environmental Consultants Ltd.

District of Squamish

Mapsheet-14

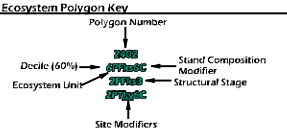
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

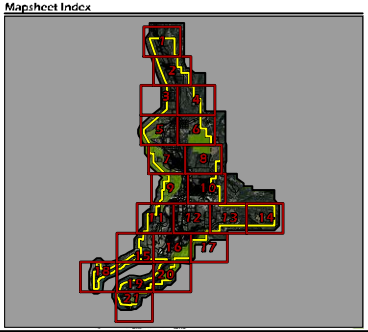
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

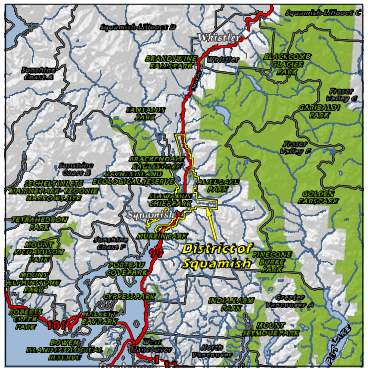
Wetland Ecosystem Polygon Key

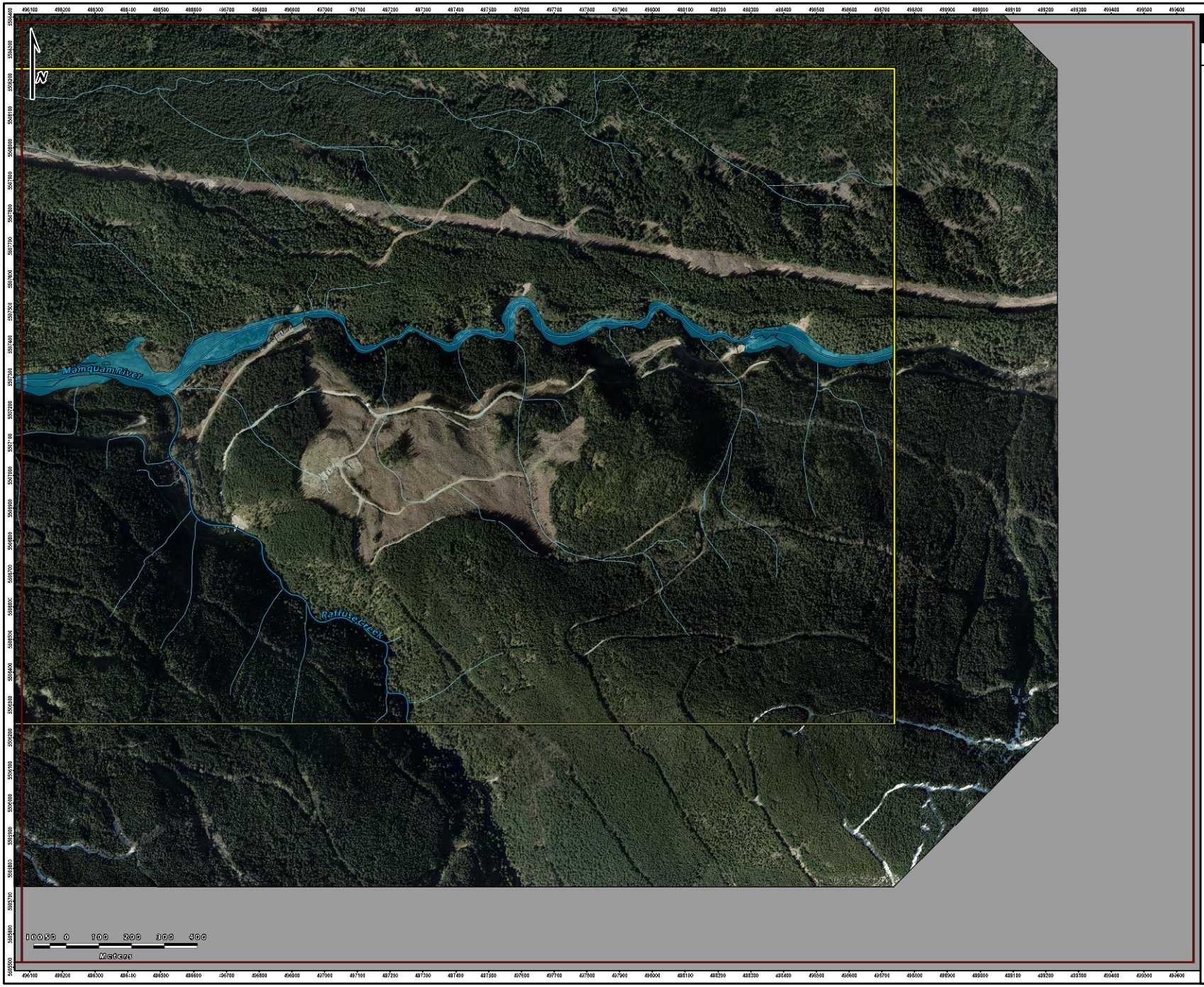


Mapsheet Index



District of Squamish Regional Location





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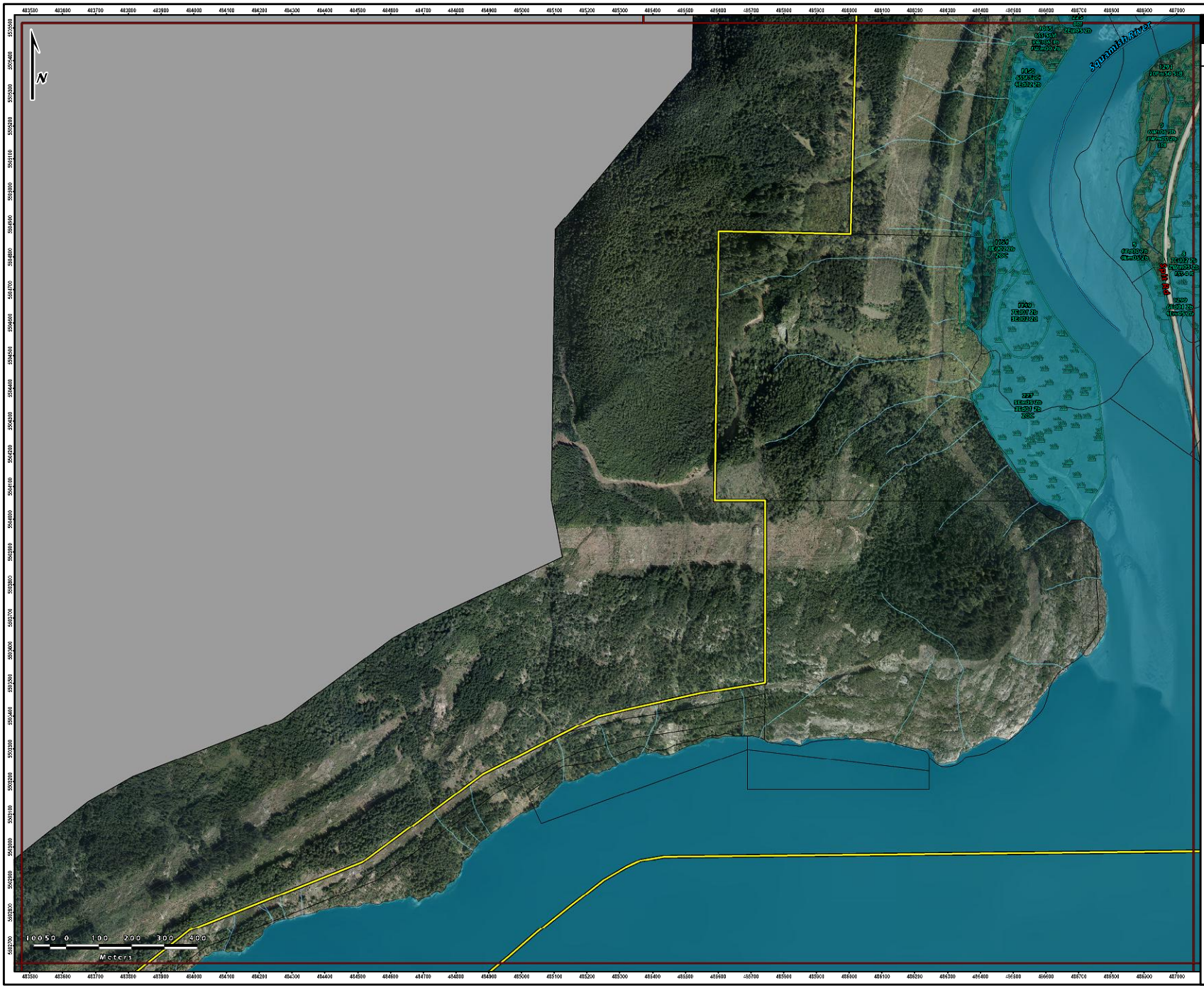
Environmental Consultants Ltd.



District of Squamish

Mapsheet-15

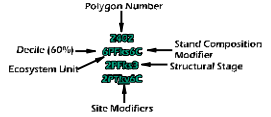
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

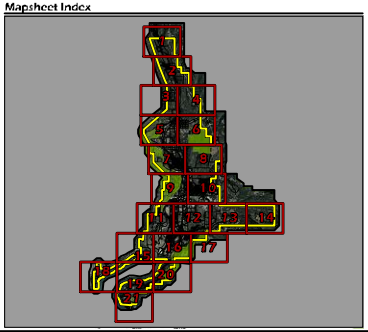
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

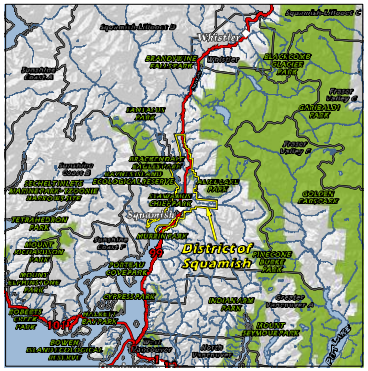
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



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Environmental Consultants Ltd.

District of Squamish

Mapsheet-16

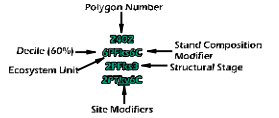
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

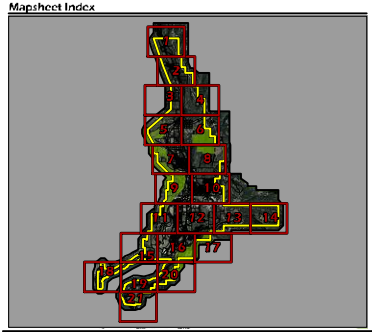
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location

SQUAMISH
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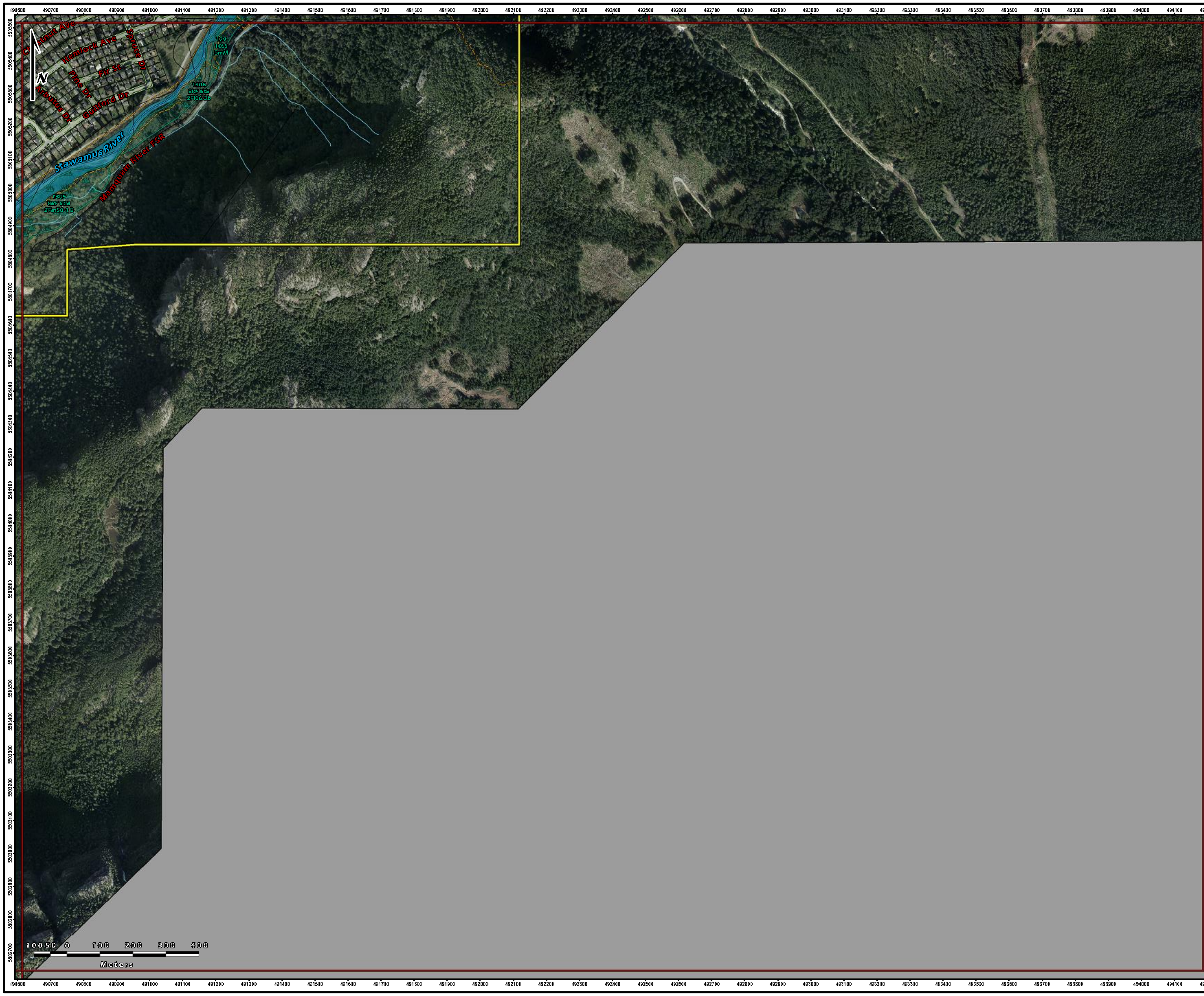
ECOSCAPE
Environmental Consultants Ltd.



District of Squamish

Mapsheet-17

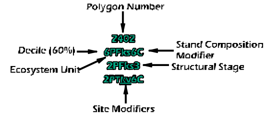
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

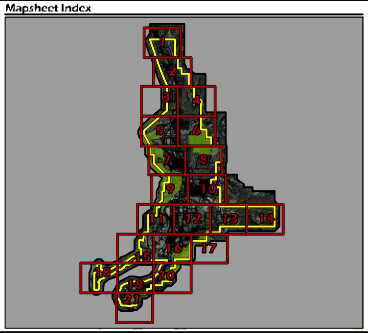
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

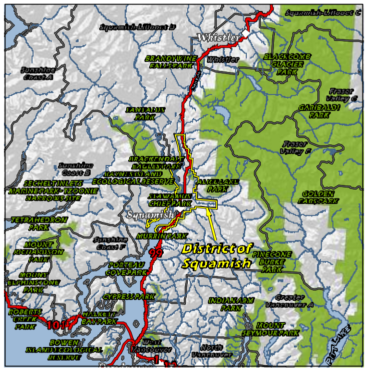
Wetland Ecosystem Polygon Key



Mapsheet Index

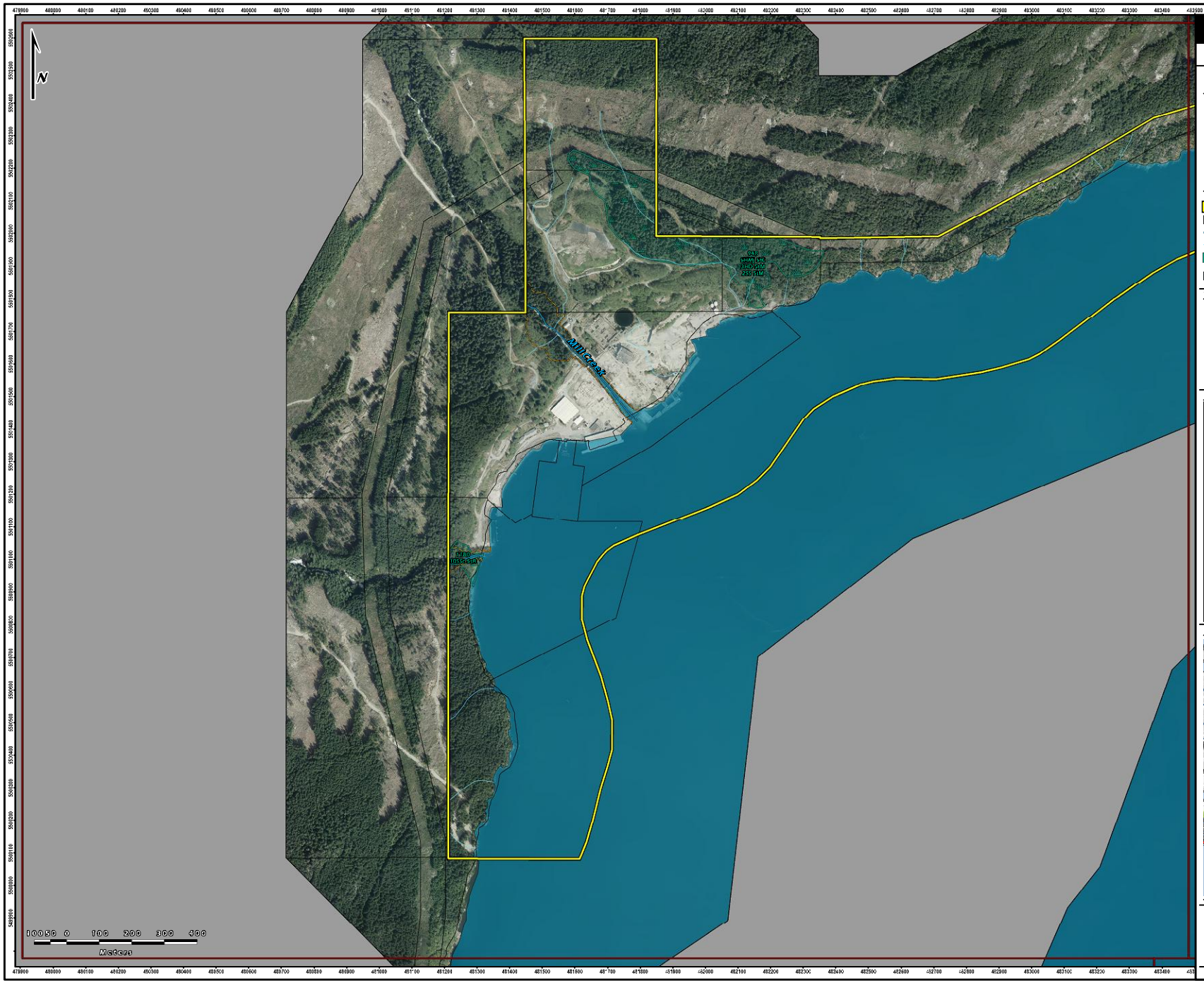


District of Squamish Regional Location



SQUAMISH
HARDWIRED for ADVENTURE

ECOSCAPE
Environmental Consultants Ltd.



District of Squamish

Mapsheet-18

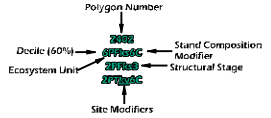
Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

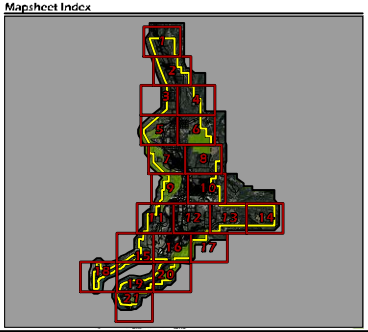
Legend

- District of Squamish Boundary
- Land Parcel
- Confirmed Watercourse
- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
- Top of Bank
- Ditch
- Discharge

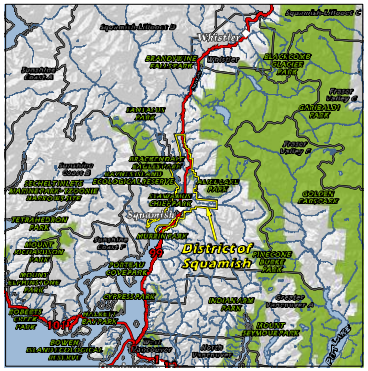
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



SQUAMISH
HARDWIRED for ADVENTURE

ECOSCAPE
Environmental Consultants Ltd.

District of Squamish

Mapsheet-19

Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

Legend

- District of Squamish Boundary
- Land Parcel
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- Unconfirmed Watercourse
- Wetlands
- Ocean, Lake, and River Channel Polygons
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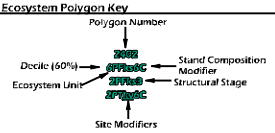
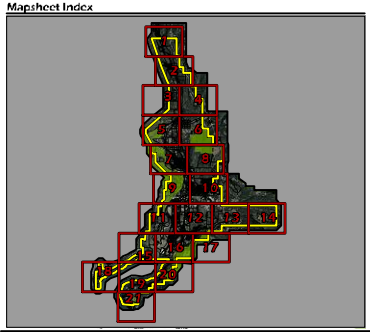
- Discharge

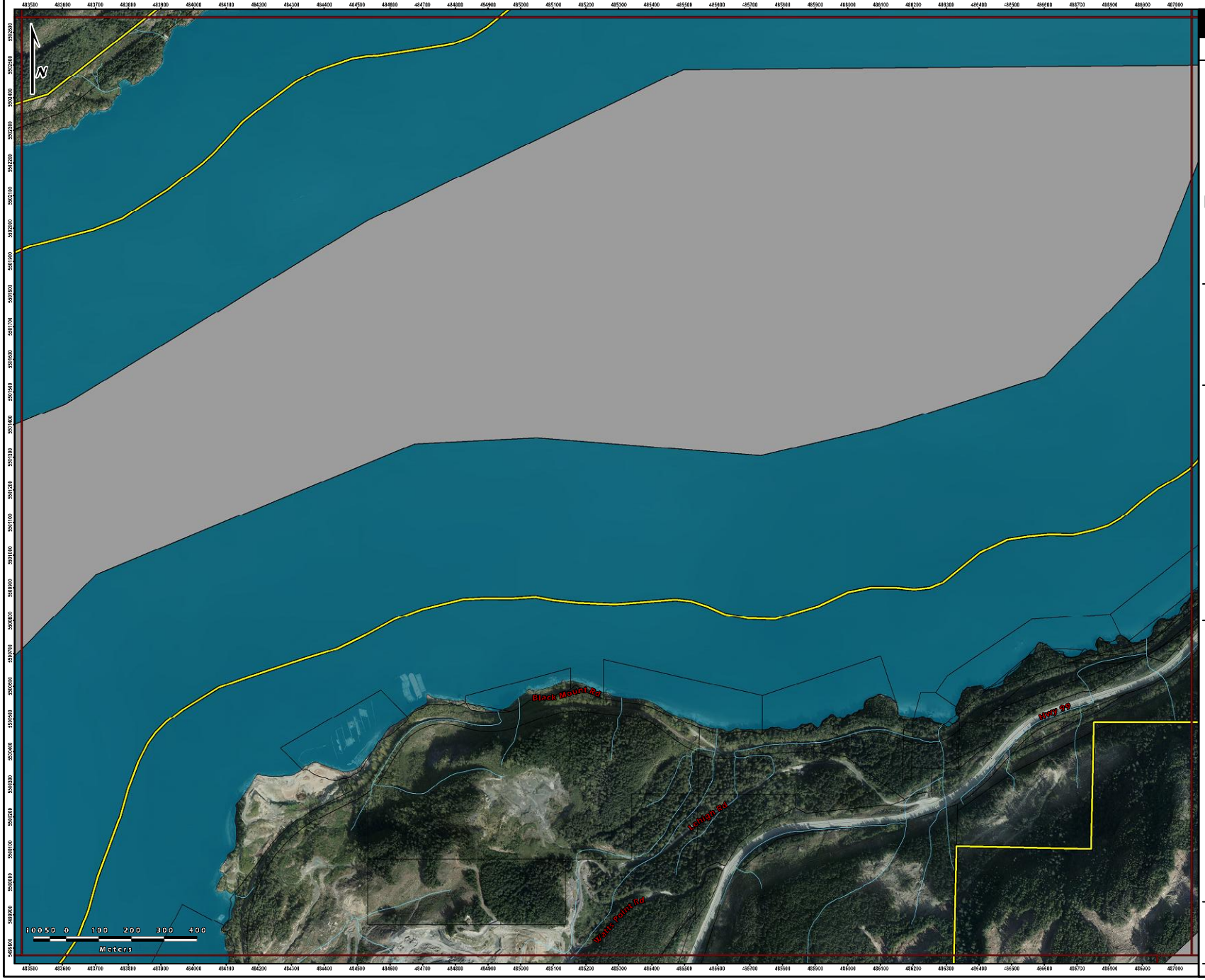
Wetland Ecosystem Polygon Key



Mapsheet Index

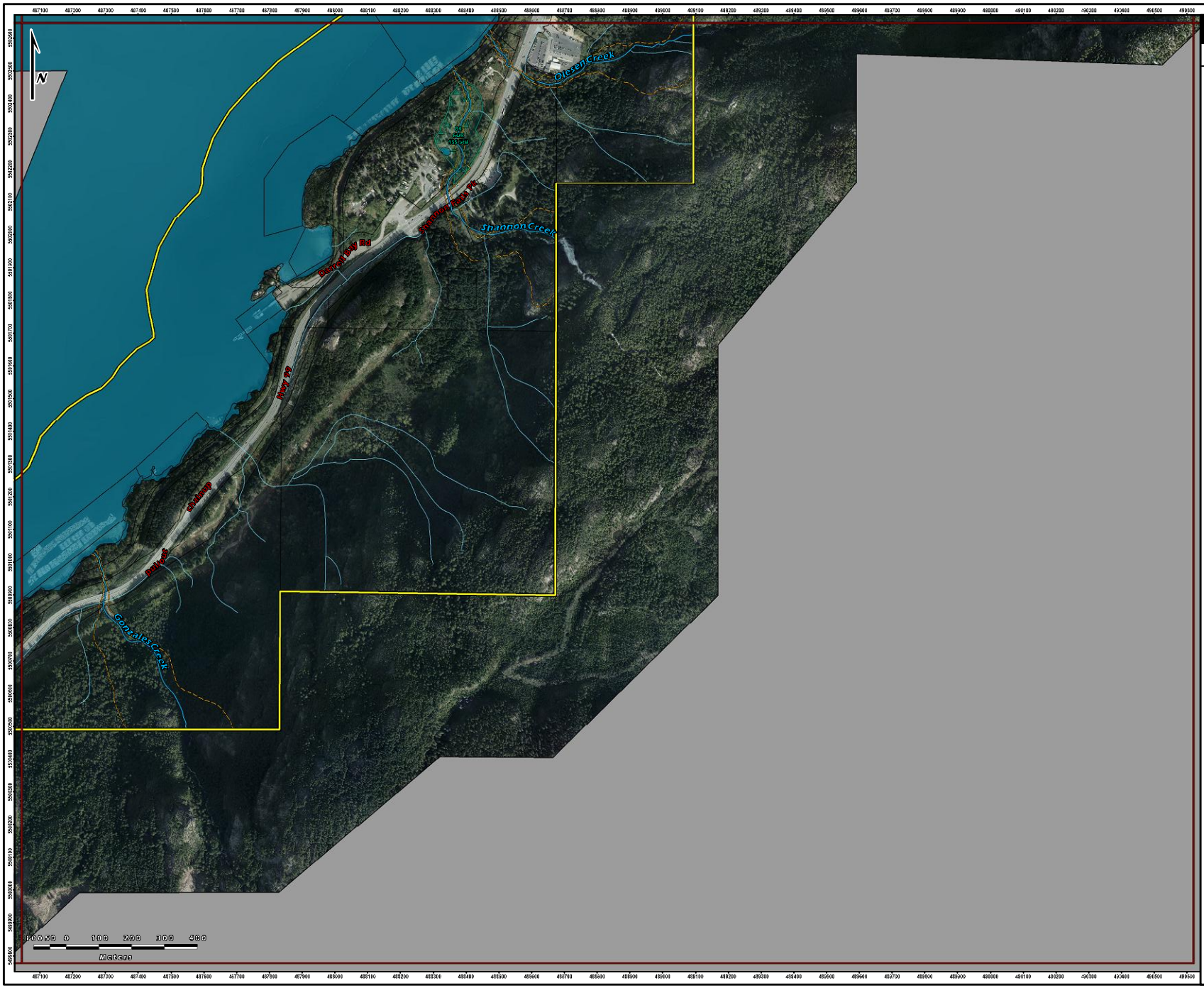


District of Squamish Regional Location



SQUAMISH
HARDWIRED for ADVENTURE

ECOSCAPE
Environmental Consultants Ltd.



District of Squamish

Mapsheet-20

Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

Legend

- District of Squamish Boundary
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- Unconfirmed Watercourse
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- Ditch
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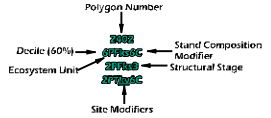
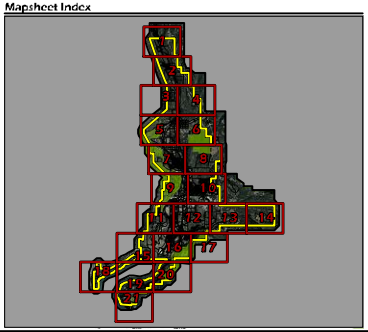
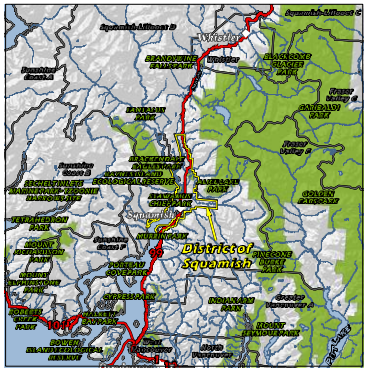
Wetland Ecosystem Polygon Key



Mapsheet Index

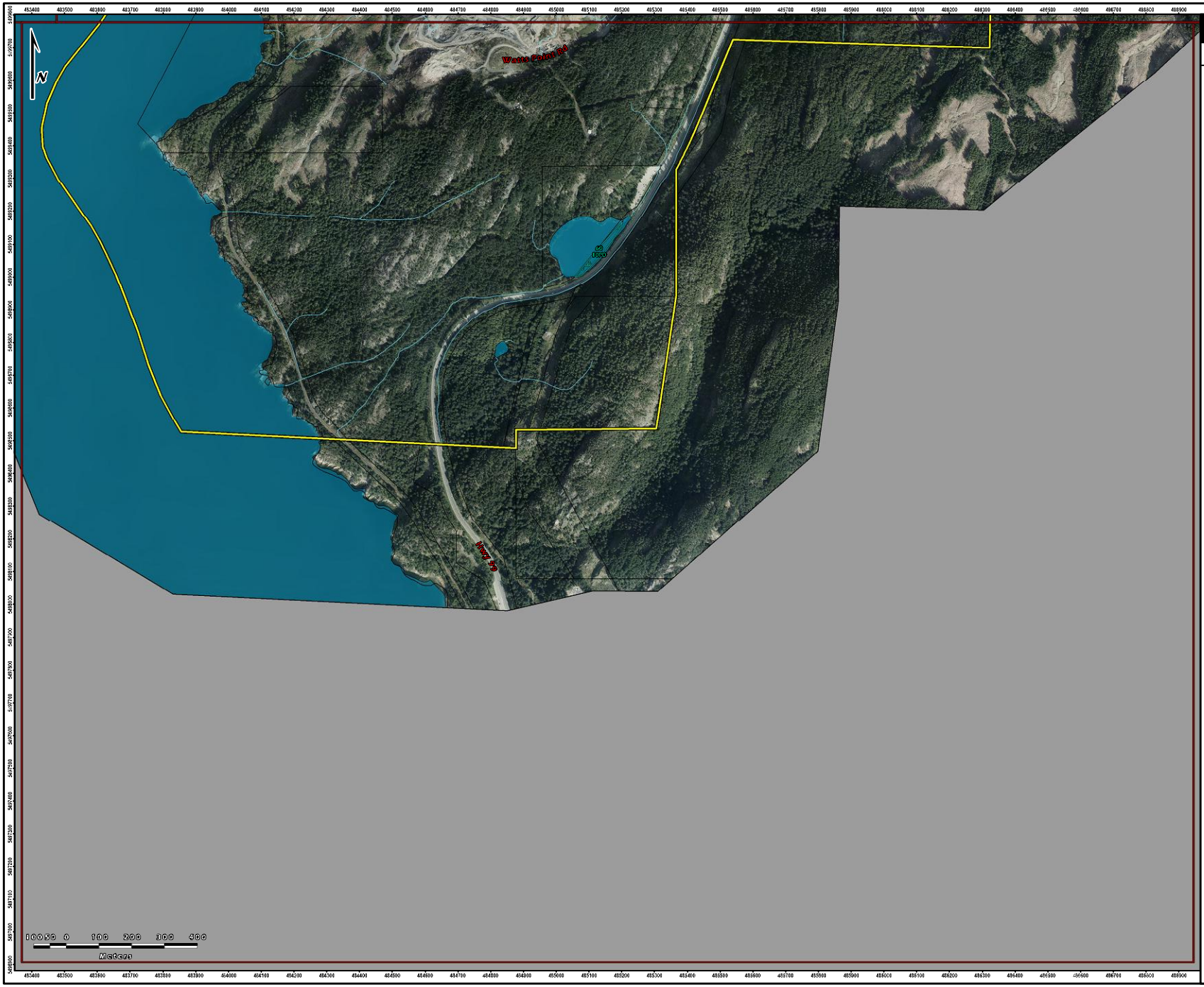


District of Squamish Regional Location



SQUAMISH
HARDWIRED for ADVENTURE

ECOSCAPE
Environmental Consultants Ltd.



District of Squamish

Mapsheet-21

Watercourses and Wetland Ecosystems

Location:	District of Squamish
Project No.:	16-1858
Prepared for:	District of Squamish
Prepared by:	Robert Wagner, Ecoscape Environmental Consultants Ltd.
Projection:	NAD83-UTM Zone 10
Imagery:	Analysis based on 2016 Imagery
Map Date:	December 16, 2016

Legend

- District of Squamish Boundary
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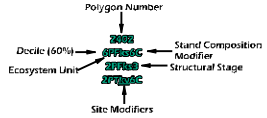
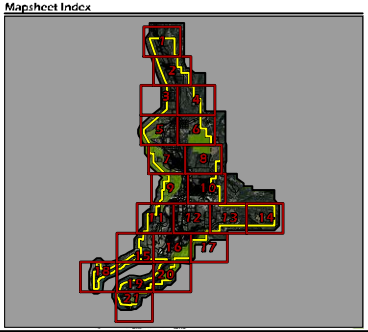
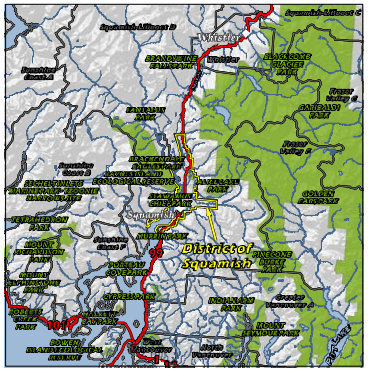
Wetland Ecosystem Polygon Key



Mapsheet Index



District of Squamish Regional Location



SQUAMISH
HARDWIRED for ADVENTURE

ECOSCAPE
Environmental Consultants Ltd.

APPENDICES

Appendix 1. 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
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

Plot	Type	Date	Easting	Northing	Accuracy	BGC	SS	SMR	SNR	Elevation	Slope	Aspect
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
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
2016-12	Full	8/16/2016	487460	5505161	3	CWHdm	0	7	D	14	0	999
2016-16	Full	8/19/2016	488492	5523345	3	CWHdm	Wf53	7	D	316	0	999
2016-19	Full	8/19/2016	491937	5513332	4	CWHdm	Wb00	7	C-	369	0	999
2016-01	Wetland	8/17/2016	491608	5506191	4	CWHdm	Ws54	7	D	35	3	999
2016-02	Wetland	8/17/2016	489827	5504705	4	CWHdm	Ws00	8	C	26	0	999
2016-03	Wetland	8/17/2016	489628	5506001	4	CWHdm	Em05	8	F	0	0	999
2016-04	Wetland	8/17/2016	489523	5505949	3	CWHdm	Ws53	7	D	16	0	999
2016-05	Wetland	8/17/2016	489615	5507450	4	CWHdm	8	6	C	7	0	999
2016-06	Wetland	8/18/2016	487126	5504772	4	CWHdm	Em05	8	F	0	0	999
2016-07	Wetland	8/18/2016	487311	5504651	5	CWHdm	Em06	8	F	0	0	999
2016-08	Wetland	8/18/2016	487050	5504851	4	CWHdm	Em00	8	F	1	0	999
2016-09	Wetland	8/18/2016	486998	5504844	4	CWHdm	Ed02	8	F	1	0	999

2016-10	Wetland	8/18/2016	487216	5505103	4	CWHdm	Ed00	7	C	5	0	999
Plot	**Type**	**Date**	**Easting**	**Northing**	**Accuracy**	**BGC**	**SS**	**SMR**	**SNR**	**Elevation**	**Slope**	**Aspect**
2016-11	Wetland	8/18/2016	490806	5510039	4	CWHdm	Ws00	6	D	31	0	999
2016-14	Wetland	8/19/2016	490119	5519577	4	CWHdm	Ws50	8	D	281	0	999
2016-15	Wetland	8/19/2016	490105	5519643	4	CWHdm	Ws53	7	D	289	0	999
2016-17	Wetland	8/19/2016	488363	5524298	4	CWHdm	Ws00	8	D	320	0	999
2016-18	Wetland	8/19/2016	491932	5513470	4	CWHdm	Ws53	7	D+	351	0	999
2016-20	Wetland	8/19/2016	491954	5512981	4	CWHdm	Wb00	8	C	367	0	999
2016-21	Wetland	8/19/2016	488200	5505155	4	CWHdm	Ed00	7	C-	3	0	999
2016-22	Wetland	8/19/2016	488241	5505194	5	CWHdm	Ed/Wm	7+	C	3	0	999
2016-23	Wetland	8/19/2016	488188	5505077	4	CWHdm	Em06	8	F	0	0	999
2016-24	Wetland	8/19/2016	492561	5506366	4	CWHdm	Ws50	7	D	70	0	999
2016-25	Wetland	8/19/2016	492635	5506411	5	CWHdm	Ws53	7	D	76	0	999
2016-26	Wetland	8/19/2016	448669	5512610	4	CWHdm	Wm00	8	D	11	0	999
DN1	Wetland	13/06/2016	491635	5514844		CWHdm	Wb50	8	A	330	0	999
DN3	Wetland	14/06/2016	487760	5505422		CWHdm	Em06	8	E	2	0	999
DN5	Wetland	14/06/2016	491275	5506216		CWHdm	Ws54	8	D		0	999
DN6	Wetland	27/06/2016	490918	5517991		CWHdm	Wm05 Ws50	8	C		0	999
DN7	Wetland	20/07/2016	493065	5509573		CWHdm	Ws53	8	D	474	7	999

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
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
Plot	**S.Shape**	**Meso**	**Floodplain**	**Exposure**	**Disturbance**	**Canopy Composition**	**Struct. Stage**	**Success Status**	**Textu re**	**Surf Material**	**S. Expression**
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
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
2016-12	ST	LV	No	NA	Modified drainage	oC	5	YC	z	W	p
2016-16	DP	CC	No	NA	No		2b	OC	h	O	b
2016-19	DP	CC	No	NA	Old Harvest		3b	YC	f	O	bd
2016-01		LV				tM	5			O	
2016-02		DP	Yes		Beaver pond, Weeds, Trails		3b		s	F	p
2016-03		LV	Tidal		Modified drainage		2b		z	W	p
2016-04		LV			Old harvest, Ditches	sB	5	YS	gs	F	p
2016-05		LV			Old harvest	tM	5	YC	s	F	p
2016-06		LV	Tidal		Modified drainage		2b		s	W	x
2016-07		LV	Tidal		Modified drainage		2b		z	W	v
2016-08		LV	Tidal		Modified drainage		2b		z	W	x
2016-09		LV	Tidal		Modified drainage		2b		z	W	v
2016-10		LV	Tidal		Modified drainage		2a		s	F	p
2016-11		LV			Old Harvest	sB	5	YS			

2016-14		LV			Modfified Drainage?		3a		h	O	b
Plot	**S.Shape**	**Meso**	**Floodplain**	**Exposure**	**Disturbance**	**Canopy Composition**	**Struct. Stage**	**Success Status**	**Textu re**	**Surf Material**	**S. Expression**
2016-15		LV			Old Harvest	tC	6	MC	h	O	b
2016-17		DP					3b		m	O	b
2016-18		LV			Old Harvest	tC	5	YC	m	O	v
2016-20		DP					3b	OC	m	O	b
2016-21		LV	Tidal		Modified drainage		2b		m	O	x
2016-22		LV			Modified drainage		2b		m	O	v
2016-23		LV	Tidal		Modified drainage		2a		f	O	x
2016-24		DP					3a				
2016-25		DP			Old Harvest		3b	YS			
2016-26		LV					2b		s	F	p
DN1		Dp					3b				
DN3							2b		Silty Clay		
DN5		Level					3b		Silty Loam		
DN6		Level					2a 3a		Loam y Silty		
DN7		Dp					3a				

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
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						
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		
Plot	**Geo Process**	**Texture**	**Surf Material**	**S. Expression**	**Geo Process**	**Drainage**	**Humus**	**Organic**	**Humus Thickness**	**Ah Depth**	**Ae Depth**	**Est. Soil Depth**
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			
2016-12		sg	F	p		P			0	0		60+
2016-16			R	b		VP		Humic				150+
2016-19						VP		Fibric		0		80+
2016-01		s	F	p		P		Humic	25			60+
2016-02						VP				15		50+
2016-03		s	F	p		VP				0		100+
2016-04						P				0		50+
2016-05						I				0		60+
2016-06		s	F	p		VP						90+
2016-07		s	F	p		VP						80+
2016-08		s	F	p		VP						50+
2016-09		s	F	p		VP						80+
2016-10						I						50+
2016-11						I	Mull		1	15		50+

2016-14						VP		Humic	120			120
Plot	**Geo Process**	**Texture**	**Surf Material**	**S. Expression**	**Geo Process**	**Drainage**	**Humus**	**Organic**	**Humus Thickness**	**Ah Depth**	**Ae Depth**	**Est. Soil Depth**
2016-15						P		Humic	100+			100+
2016-17						VP		Mesic	120+			120+
2016-18						P		Mesic	30+			30+
2016-20						VP		Mesic	30+			100+
2016-21		zs	F	p		VP		Mesic	15			80+
2016-22		zs	F	p		P		Mesic	12			80+
2016-23		zs	W	p		VP		Fibric	4			60+
2016-24						P			0			60+
2016-25						P	Mull		1	3		60+
2016-26						P			0			80+
DN1						P		Fibric				140
DN3		SiC										100
DN5		SiL										100
DN6		L										25
DN7						I		Humic				100

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			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
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
Plot	**RZ Soil Text.**	**RZ CF%**	**Est. Root Depth**	**Gleying Depth**	**Mottle Depth**	**Seepage Depth**	**Restrict Layer**	**Restrict Type**	**Tree**	**Shrub**	**Herb**	**Moss Lichen**
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
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
2016-12	Si	0	40+	5	5	Tidal			10	20	80	0
2016-16	Oh	0	15			0			0	5	80	50
2016-19	Of	0	20+			0			3	80	35	60
2016-01	Oh	0							30	50	20	0
2016-02		0	25+			10			0	80	30	0
2016-03	SiL	0	35	0	0	Tidal			0	0	75	0
2016-04	SiL	<20	10	2	9				5	80	5	0
2016-05	LS	<20	5	20	20				20	70	35	0
2016-06	S	<20	10	0	0	Tidal			0	0	90	0
2016-07	Si	0	30	0	0	Tidal			0	0	90	0
2016-08	SiL	<20	20	0	0	Tidal			0	0	80	0
2016-09	SiL	0	30	0	0	Tidal			0	0	95	0
2016-10	S	<20	20	2	2	Tidal			0	15	80	0
2016-11	SiL	<20	20	15		15			60	40	60	0

2016-14	Oh	0	30						0	80	25	0
Plot	**RZ Soil Text.**	**RZ CF%**	**Est. Root Depth**	**Gleying Depth**	**Mottle Depth**	**Seepage Depth**	**Restrict Layer**	**Restrict Type**	**Tree**	**Shrub**	**Herb**	**Moss Lichen**
2016-15	Oh	0				60			23	60	40	0
2016-17	Om	0				0			3	20	65	0.1
2016-18	Om	0							60	20	10	40
2016-20	Om	0							10	75	25	80
2016-21	Om	0	15			Tidal			0	0	100	0
2016-22	Om	0	20	12		12			0	0	90	0
2016-23	Si	<20	40	4		Tidal			0	0	100	0
2016-24	SiL	<20	20+	2					0	90	0	0
2016-25	SiL	0	20						3	90	5	0
2016-26	LS		20+			0			0	3	75	0