Haro Woods - Finnerty Creek, Saanich, BC

DRAFT Overview Environmental Assessment (EA) & Hydrology Assessment

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Submitted to: District of Saanich
Prepared by McElhanney

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EXECUTIVE SUMMARY

McElhanney Ltd. (McElhanney) prepared this report for the District of Saanich (the District), covering the Haro Woods - Finnerty Creek Hydrology Assessment. This report is a combined Overview Environmental Assessment (EA) and Hydraulic Capacity Assessment. The issues currently facing Finnerty Creek and its riparian areas include erosion and degradation of the stream bed primarily due to large flow volume fluctuations and damaging pedestrian/bicycle traffic in the riparian and surrounding areas.

The EA was completed with information obtained from desktop studies, a hydraulic model assessment of existing creek capacities, data collected from a field visit completed on October 31, 2019 and a follow up site visit on January 29, 2020. McElhanney provided weekly environmental monitoring site visits for a portion of Haro Woods owned by the Capital Regional District under a separate project. Relevant observations obtained between February 2019 to February 2020 have been used to supplement conclusions herein.

There was uncertainty as to whether a wetland once existed in the park. In addition to assessing the health of the creek, the area was reviewed for evidence of current or historic wetlands. During the site visit in January 2020, two ponds of standing water were identified on the southern parcel of Haro Woods. Although surface water was encountered, the area lacked wetland vegetation. It was inferred that the ponded water was a result of poor drainage during a period of high precipitation. It is unlikely that surface water persists long enough to influence the establishment of wetland plants. Additional evidence regarding the hydroperiod would be required to classify it as an ephemeral wetland as opposed to temporary pond/puddle. Further investigation on the persistence of water in these ponds was outside of the scope of this assessment. The surface water was in an isolated depression and provided minimal habitat for aquatically adapted species.

The project goals are to assess the historical and current condition of the creek and related riparian areas; understand the creek's current hydrologic dynamics; identify detrimental aspects of the existing creek hydrology related to capacity and erosion potential, and provide recommendations and remedial measures, intended to enhance the environmental health and function of the creek and riparian areas.

The study area (Haro Woods) is an urban wooded area that includes two red-listed ecosystems. It provides important habitat to a variety of mammals and bird species that are adapted to living in urban forests. Finnerty Creek is an ephemeral watercourse that flows in the hours or days after precipitation events. Although the canopy of secondary growth forest in which the creek is located was relatively intact, the creek channel has been denuded by recent recreational use. The creek is confined within a ravine on the western portion of the assessed area. Although impacts were identified in this area, the ravine confines flows to the creek's natural alignment making the western portion of the study area a lower priority for remediation.

As the creek moves northeast towards the Saanich parcel of land, the topography transitions from a ravine to a slope which is less confining for the channel. Day hiker and mountain bike use increases substantially in this area of Haro Woods due to a change in terrain and a larger wooded area. The impacts to the creek are more substantial and result in a braided channel and eventually causes a large portion of the flows to deviate from the natural channel, bisecting the creek into two separate channels. Modelling imagery shows this area to look like that of a river delta, as the flows fan out over a larger area. This flow regime was

confirmed in a follow up site visit during a period of heavy rainfall. Flows were unconfined on the northeastern portion of the creek due to impacts observed and discussed within this report.

Restoration efforts are encouraged in the northeast portion of the assessed area. Impacts substantially change the channel morphology and denude the creek to the extent that the channel bed was barely evident on the ground. This results in minor local flooding of the forest floor during periods of flow. The forest canopy is intact and provides important wildlife habitat, thus, stream restoration efforts should avoid tree removal to the extent possible. By contrast, invasive plant species removal may benefit stream enhancement efforts by favoring the growth of native plant species.

Recommendations and "next steps" to enhance the environmental health and function of the creek and riparian areas are as follows:

- Advance the recommendations presented in this Report to the detailed design stage, based on the Creek Remediation Plan and Profile Drawings in Appendix A. This includes:
    - Confirmation of restoration details regarding the section of existing creek identified for abandonment
    - Arborist assessment of potentially impacted trees along the remediation alignment for required removals and pruning.
    - Concrete protection of a section of the sanitary sewer crossing the Creek to help protect the sewer from future exposure and creek influence.
    - Complete an invasive species removal plan and remediation plantings and riparian management plan.
    - Complete new creek alignment bed and embankment lining design for scour and erosion controls.
    - Develop a construction sequencing strategy to assess the most cost effective and environmentally sound plan for construction access and strategy for dealing with creek flows during construction.
    - Incorporate Best Management Practices (BMP's) in determining strategies to minimize impacts to the creek in relation to pedestrian and bicycle crossings within Haro Woods Park.
    - Obtain Permitting under the *Water Sustainability Act* for rehabilitation of the watercourse. The need for a Notification versus an Approval under the Act will depend on the ultimate remedial details. Additional environmental assessments will be required to support permitting, following the detailed design.
    - It should be noted that the ponded water on southeast parcel of Haro Woods in the January 2020 field assessment was isolated and had no obvious impacts from pedestrian or bicycle use. Due to the lack of wetland vegetation and low habitat values for aquatic species, no specific habitat enhancement or protection efforts are recommended at this time.

Estimated costs have been provided as an order of magnitude approximation for planning purposes and are based on the recommendations listed in this report. All costs shown in Section 6 of this report are "Class D" as defined by EGBC and, as such. a 50% contingency has been added. These estimates have been prepared based on concepts, without completion of detailed designs, nor approved permitting in place.

District of Saanich costs such as procurement, staff time, contingencies and additional operations and maintenance are not included. Cost estimates as presented include engineering, design, planning, assessments, permitting, and construction.

1. INTRODUCTION

McElhanney Ltd. (McElhanney) has been retained by the District of Saanich (the District) to prepare an Overview Environmental Assessment (EA) and a Hydrology Assessment for the Haro Woods - Finnerty Creek located in Saanich, BC (Figure 1). The study area for the creek assessment is outlined on *Figure 2*.

The issues currently facing Finnerty Creek and its riparian areas include erosion and degradation of the stream bed primarily due to large natural occurring rain event flow volume fluctuations from the upstream storm system discharge and damaging pedestrian and bicycle traffic in the riparian and surrounding areas.

Figure 1. The location of the Finnerty Creek on the University of Victoria (UVic) and District of Saanich (Haro Woods) lands, in Saanich, BC.

Figure 2. The Finnerty Creek study area (red outline) located along Arbutus Road, in Saanich, BC (image courtesy of Google Earth).

The District owns two separate parcels of land within Haro Woods (as marked on Figure 1) herein referred to as the northern and southern parcel. The District indicated that there was uncertainty as to whether a historic wetland once existed in the park. McElhanney's Qualified Environmental Professional (QEP) assessed both parcels to determine if a wetland existed within the park under current conditions. The results of both the creek and wetland assessments are described in the following sections.

1.1. GENERAL SETTING

Haro Woods consists of four parcels of land owned separately by the University of Victoria (UVic), The Capital Regional District (CRD) and the District. The parcels within this assessment are owned by UVic on the west and the District on the northeast and south.

The Haro Woods Park parcels owned by the District were dedicated as a park in 2013 (Saanich 2018). Haro Woods is an urban forested area that contains a remnant Douglas-fir / Arbutus (*Pseudotsuga menziezii / Arbutus menziezii*) ecosystem. This park is highly valued by the local community and is used as a greenspace for recreational users. The park is frequented by mountain bikers, dog walkers, and pedestrians. Finnerty Creek and its riparian area are located within the Park and although the forest has been preserved in the park, the recreational use of the area has adversely impacted the stream channel and the riparian forest. The Head of Finnerty Creek is sourced from a storm outfall located on the UVic land parcel. The creek ultimately discharges into an open ditch along Arbutus Road and re-enters the piped storm system near Haro Road. Water from Finnerty Creek, Haro Creek, and stormwater flow through the stormwater main are discharged through an outfall in Finnerty Cove.

A portion of the CRD parcel is undergoing construction for the Sanitation system CSO Tank Attenuation project which will connect into the existing sanitary sewer system. Sanitary sewer infrastructure within this parcel prior to construction included trunks and mains, overflow piping to the Finnerty outfall, and a waste-water metering station. A graphic from Saanich Maps is included in *Figure 3*.

The sanitary gravity mains that run through the study area have created scars on the landscape that are used as pedestrian trails. Due to the presence of underground utilities, the path above the sanitary mains must be cleared of vegetation so that tree roots do not damage the utilities. The pipe crosses the creek on an angled alignment and is a 450 mm asbestos cement pipe (Saanich 2019) as shown in *Figure 3*. This has resulted in a diversion of flows from the natural channel down the trail above the sanitary gravity main lines.

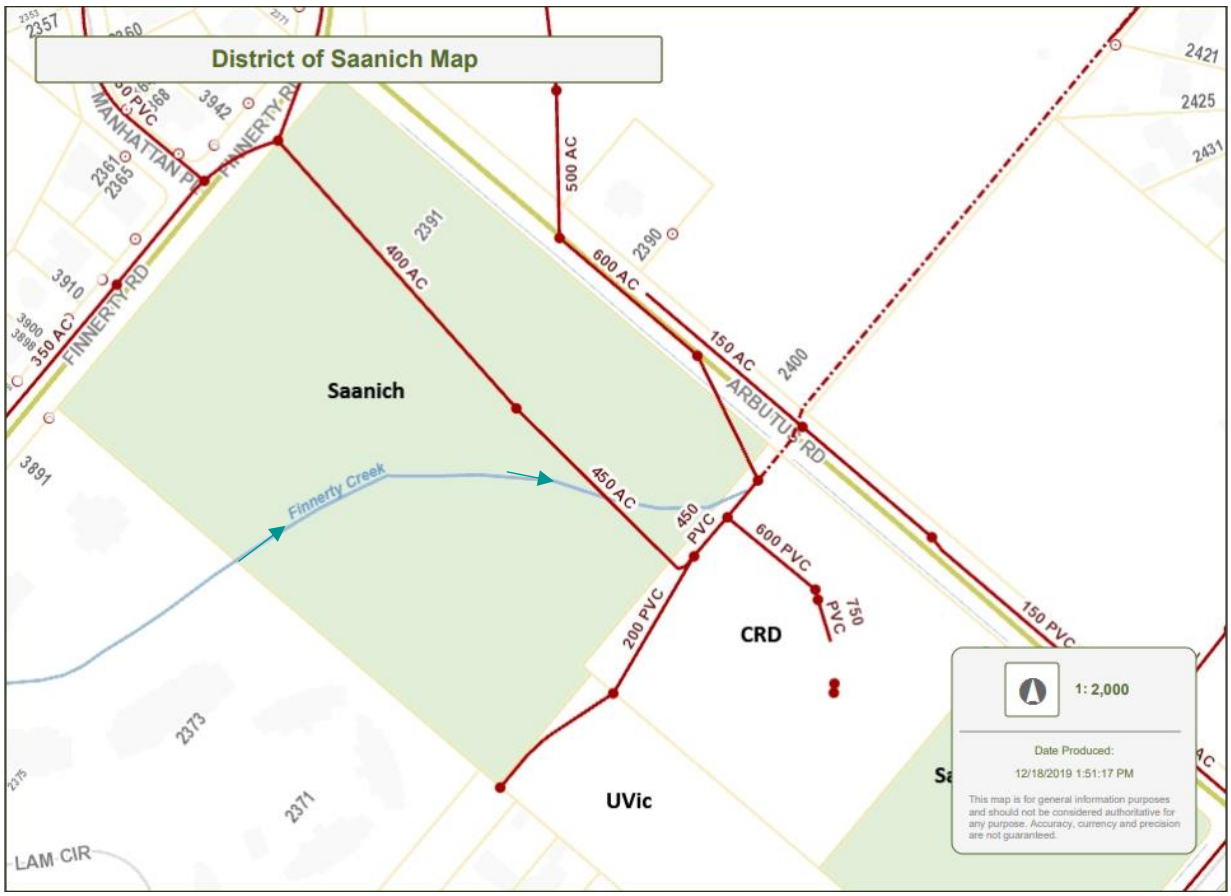


Figure 3. The existing sewer infrastructure (red lines) located in Haro Woods (Saanich 2019).

The park is riddled with “non planned” trails which have been mapped by the District and included in the Haro Woods Park Management Plan. *Figure 4* illustrates the intersections of the trails and the sewer line on the natural channel of Finnerty Creek. Note that Finnerty Creek is mapped in its natural channel on *Figure 4* which differs from the alignment on *Figure 3*.

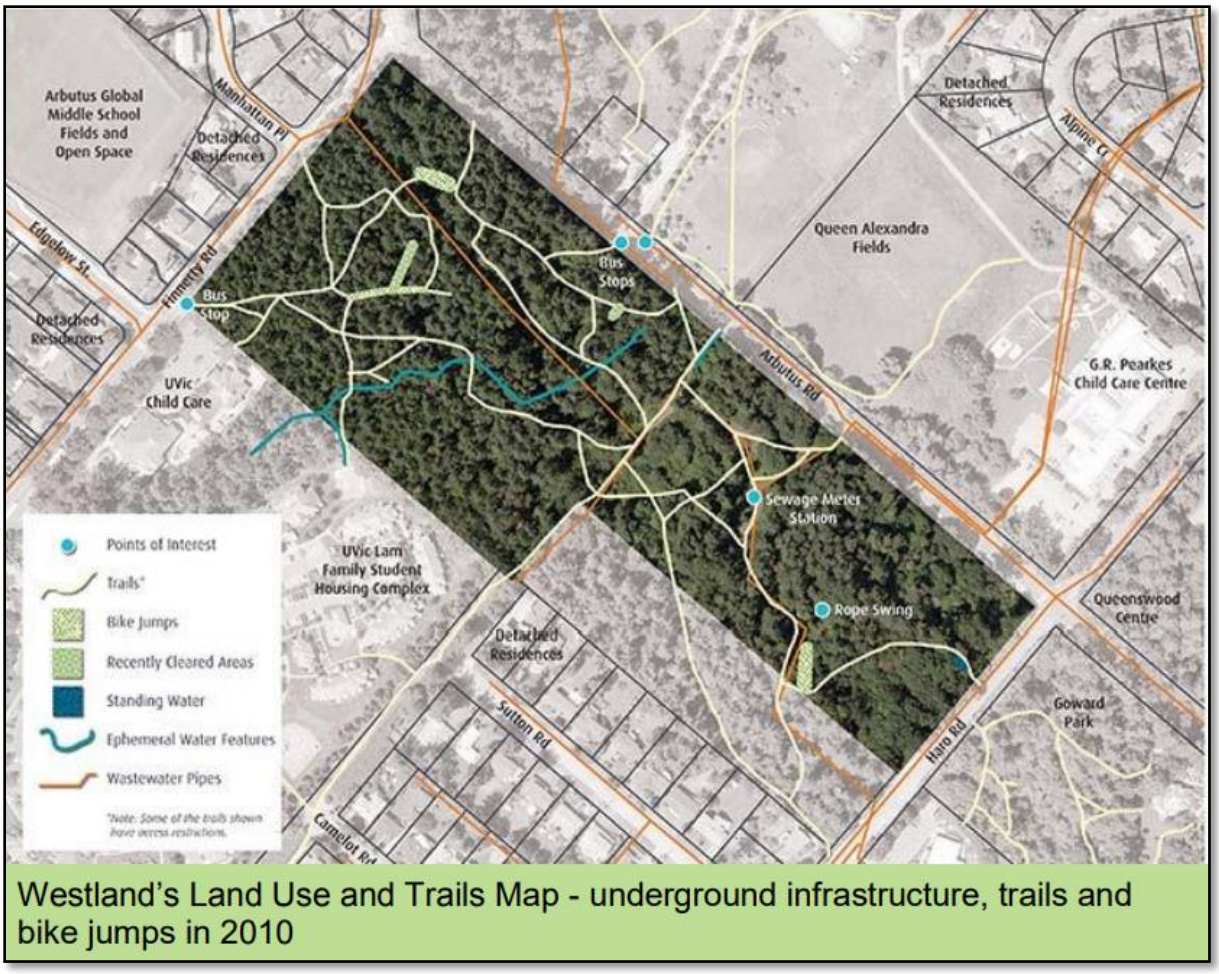


Figure 4. Land use and trail map in Haro Woods (Saanich 2018).

1.2. **OBJECTIVE**

The goals of this project are as follows:

- to assess the historical and current condition of the creek and related riparian and wetland areas (if encountered);
- to understand the creek's current hydrologic dynamics;
- to identify detrimental aspects of the existing creek hydrology, and
- provide recommendations and remedial measures to enhance the environmental health and function of the creek and riparian areas.

1.3. **SCOPE OF WORK**

This report outlines the results of two assessments (a Hydrology Assessment and an EA) conducted by appropriately qualified professionals. The remediation recommendations included in this report are based on the outcome of the hydraulic capacity assessment and input from the QEP regarding creek embankment and riparian area assessments.

1.3.1. Hydrology Capacity Assessment

The Hydrology assessment was intended to fully understand the existing Creek hydraulic capacities and flow dynamics, identify areas of degradation through scouring and erosion, identify the potential causes of creek degradation, and provide remediation recommendations. The scope included the following elements:

- Background Review – District supplied record drawings and catchment areas were reviewed and analyzed.
- Hydraulic Model Setup – A Hydraulic model was setup for the existing Creek flow conditions using background information and site survey data.
- Hydraulic Assessment – Using the hydraulic model, existing Creek capacity was assessed.
- Remediation Condition Hydraulic Assessment – Based on the outcome of the remediation options assessment, a hydraulic assessment was completed on the chosen remediation condition.

1.3.2. Overview Environmental Assessment

The purposes of the Overview EA were to conduct an assessment to characterize the current condition of the Creek and secondly, determine whether wetlands are present on-site. This was achieved by conducting a desktop assessment to review publicly available databases and historical information to determine the extent of disturbance to the study area. A site visit was conducted on October 31st, 2019 to assess current conditions of the watercourse and riparian features, and search for a potential wetland within the study area. A follow up wetland assessment was completed on January 29th, 2020 following a month of heavy rainfall with particular focus on the southern parcel.

The following biophysical components were assessed:

- Stream characteristics as per methodologies outlined in provincial guidance documents,
- Terrestrial and aquatic vegetation resources within the riparian area along Finnerty Creek,
- The study area was reviewed for the potential presence of a wetland with respect to surface water and obligative wetland plant presence,
- The general extent of invasive and exotic plant cover within the assessment area and along its upland edge,
- Terrestrial wildlife and wildlife habitat features including wildlife trees within the riparian zone, and
- The potential presence/habitat of endangered, threatened, or vulnerable rare plants or wildlife species provincially or federally designated.

This report is intended to support strategies to remediate and enhance natural features and functions; to potentially return the Creek and riparian areas to pre-development environmental health and function. Also, this EA will provide insight into the regulatory permits and approvals processes required to implement the recommended remediation measures.

2. REGULATORY AND POLICY SETTING

2.1. MUNICIPAL LEGISLATION

Saanich's Official Community Plan (OCP) Bylaw No. 8940 (Saanich 2008), provided information and requirements for protecting the natural environment and Development Permit Areas (DPAs) that may be applicable to this project. Map 5 of Bylaw No. 8940 shows that the study area is under the Saanich General

DPA. The OCP specified the guidelines respecting special conditions or objectives for each DPA which are summarized below:

- Native vegetation should be retained whenever possible.
- Consideration should be given to reducing impervious surfaces in this area.
- Whenever possible, preserve areas (including buffers) that contain plants and animal habitat which are designated as red listed (endangered) or blue listed (vulnerable) by the Conservation Data Center.
- Where appropriate, the remnant riparian zones and watercourses should be protected or enhanced.

2.2. PROVINCIAL LEGISLATION

2.2.1. Water Sustainability Act

Changes in and about a stream require either notification to or approval from the Ministry of Forest, Lands and Natural Resource Operations & Rural Development (FLNRORD). Notifications to the Province under Section 11 of the *Water Sustainability Act* require a 45-day lead time prior to the commencement of construction unless the Ministry allows expediting the process. Compliance with the terms and conditions outlined in the provincial and federal legislation and best management guidance documents, noted below, is required. The general reduced risk work window for fish on Vancouver Island is between June 15 to September 15 (BC 2011). However, Finnerty Creek is non-fish bearing and adherence to the reduced risk window is not mandatory.

Under the WSA a **stream** is defined as:

- a natural watercourse, including a natural glacier course, or a natural body of water, whether or not the stream channel of the stream has been modified, or
- a natural source of water supply,
- including, without limitation, a lake, pond, river, creek, spring, ravine, gulch, wetland, or glacier, whether or not usually containing water, including ice, but does not include an aquifer.

2.2.2. Wildlife Act

The provincial *Wildlife Act* (BC 1996a), Section 34, protects birds and their nests during the bird breeding season as well as the nests, nest trees and eggs of certain species all year. The provincial *Wildlife Act* Designation and Exemption Regulation (BC 2014b), which indicates exemptions from permitting required under the *Wildlife Act* for nuisance wildlife. Blue heron and raptors, particularly bald eagles, and osprey, require large nest trees near coastal water bodies (BC 2003). Project works will need to ensure that appropriate non-disturbance buffers are kept around any raptor's nests (if identified) to ensure compliance with the *Wildlife Act*.

Adherence to this Act can typically be achieved using provincial Best Management Practices (BMPs) (BC 2018). Vegetation clearing outside of the bird breeding window will be required, or review of the area conducted by a QEP to determine that no breeding birds or their nests will be impacted by the clearing. Providing that there are no active nests on the site or that clearing is conducted outside of the bird breeding window, no specific permitting is required.

2.3. FEDERAL LEGISLATION

2.3.1. Species at Risk Act (SARA)

Federal lands are subject to the protection of species listed under Schedule 1 of *SARA* as extirpated, endangered, or threatened (Canada 2002). It is an offence to kill, harm, harass, capture, or take an individual, and that species has legal protection related to the species' residence and critical habitat as specified in *SARA*. No specific permitting is required for adherence to this Act, however, an understanding of potential *SARA* protected species potentially occurring within the study area and surrounding area is recommended. Adherence to this Act can typically be completed using BMPs during construction.

2.3.2. Migratory Birds Convention Act (MBCA)

The *Migratory Birds Convention Act* (Canada 1994) prohibits the disturbance, destruction, or possession of migratory birds, their nests, or eggs. Also, migratory bird habitat is protected under the *MBCA* which prohibits the deposit of oil, oily waters, or other substances harmful to migratory birds in any areas that they frequent.

No specific permitting is required for adherence to this Act, however, an understanding of potential *MBCA* protected species within the study area and surrounding area is recommended. Adherence to this Act can typically be achieved by adhering to BMPs. Vegetation clearing should be completed during the least risk timing window for breeding birds to remain in compliance with the requirements of this Act. The general regional nesting period on Vancouver Island is between late March and mid-August (Canada 2018).

3. METHODOLOGY

3.1. HYDROLOGY ASSESSMENT METHODS

The hydrologic assessment included rational method calculations, PCSWMM program analysis and 2D HECRAS program modelling. Finnerty Creek has a catchment area of approximately 15 ha (37 acres), including approximately 460 m of storm drain, which exits at the southern-most portion of Finnerty Creek (on University of Victoria property). From there, it flows north-east to Arbutus Road where it is enclosed in pipe and ultimately empties into Finnerty Cove. The only portion of the creek that is not enclosed is on the University of Victoria's property and in Haro Woods. CRD mapping indicates that Finnerty Creek is within watershed #2335. 726.7 ha, defined as "urban influenced drainage to shoreline via storm drain networks". The creek appears to be subject to significant variation in flow levels, and negatively affected by large volumes of water that are collected and discharged over short periods of time. This hydraulic assessment focuses on these large flow volumes.

The rational method is a standard approach to determine peak runoff rates from smaller catchments such as the one for Finnerty Creek at Haro Woods. The calculation utilizes peak rainfall intensities, runoff coefficients with catchment areas to estimate the peak flow rate. Rainfall intensities were derived from Environment and Climate Change Canada's Intensity Duration Frequency (IDF) statistics for the Victoria Gonzales Rain Gauge (ID 1018611). The rational method is intended to be a conservative approach to hydrological analysis. Details of this calculation can be found in section 4.3

The peak flow rate from the rational method calculation was utilized as the upstream boundary condition for the 2D HEC-RAS modelling effort. The Hydrologic Engineering Center's River Analysis System (HEC-

RAS) is a widely used program for river/creek hydraulics that has been developed by the US Army Corps of Engineers. The programs utilize inputs such as surface roughness, and GIS information such as 3D ground elevation mapping to determine flow paths of the water inserted at the upstream boundary condition. The 2D mesh is placed on the surface and refined to allow for greater detail in the important areas. The model then outputs the water surface extents and depths to identify the areas which currently experience floodwater.

Lastly, to derive the required ditch cross section, PCSWMM hydraulic modelling software was utilized. This program utilizes the manning's equation in dynamic wave calculation to derive a hydraulic grade line (HGL) water surface. The HGL is largely governed by the geometry of the proposed creek, surface roughness of the cross section and slope of the creek. The HGL was required to be maintained below the top of the Creek bank with zero freeboard during the design flow event. The design flow is again derived from the previously mentioned rational method calculation. The proposed ditch geometry is then included in a subsequent 3D ground elevation map in the HEC-RAS model to determine the proposed flooding extents and depths.

3.2. OVERVIEW EA METHODS

The EA included a desktop data search of federal, provincial, regional, and municipal web databases to identify any known environmentally sensitive elements in the area. McElhanney completed a field visit on October 31st, 2019, to collect baseline data to provide a general description of the environmental setting and a follow up wetland assessment on January 29th, 2020. The objective of the field visit was to confirm and locate sensitive environmental features, including sensitive aquatic and terrestrial wildlife habitat.

The report is also informed by information collected in the area as part of the CRD Tank Attenuation Project. Site visits were completed in February of 2019 to assess owl presence within and around the study area. In addition, environmental monitoring was completed from August 2019 to October 2020 for the CRD.

Web based sources of information reviewed in the desktop study included:

- District of Saanich Interactive Web Map (SaanichMap 2019),
- Habitat Wizard & iMapBC 4.0 sensitive ecosystem inventory, species at risk, and fish and wildlife habitat records within 500 m of the site center (iMapBC 2019),
- BC Conservation Data Centre database Species and Ecosystems Explorer (CDC 2019),
- BC Ministry of Environment web-based documents,
- E-bird, a worldwide collaborative citizen science database for reporting bird species observations.

The methodologies used for the field and desktop study are described in the following sections.

3.2.1. Vegetation Resources

Vegetation resources were assessed through a Site visit and a review of provincial and federal web-based databases including the following:

- Biogeoclimatic Ecosystem Classification Subzone/Variant Map for the South Island Resource Forest District (FLRNO 2016),
- A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region (Green and Klinka 1994),
- Saanich GIS Map Service (interactive webmap) (Saanich 2019),
- Capital Regional District (CRD) Interactive Regional Webmap (CRD 2019),

- Conservation Data Centre (CDC 2019) database of provincially listed plant species including information from the federal *Species at Risk Act* (Canada 2002) and the Committee on the Status of Endangered Wildlife in Canada [COSEWIC],
- BC Species and Ecosystems Explorer (CDC 2019),
- E-Flora BC: Electronic Atlas of the Plants of British Columbia (E-Flora BC 2019),
- Non-native invasive plant species (as listed in the *Weed Control Act* (BC 1996a),
- Provincially listed ecological communities at risk (as defined in the BC Species and Ecosystem Explorer) (CDC 2019), and
- Presence of wildlife trees supporting Bald Eagles or Osprey nests (WiTS 2019).

Queries were conducted within the CDC Species and Ecosystems Explorer (2019) and iMapBC 2.0 (iMapBC 2019) databases for known at risk ecological communities, vascular plant and non-vascular plant species associated with the Coastal Douglas Fir (CDF) biogeoclimatic zone.

3.2.2. Stream Assessment

The provincial *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Site Card Field Guide* (MOE 2008) was followed to assess Finnerty Creek. The guide assisted in collecting relevant physical data to characterize the stream and fish habitat (or lack there of).

The QEP walked the stream from southwest to northeast and conducted stream assessments at variable intervals. Distance between transects ranged from approximately 25 to 60 m. Transect locations captured regular stream morphology as well as morphological changes attributed to natural or anthropogenic causes. The stream lacked many features consistent with a permanent, well defined channel, thus, a modified list of physical stream data was collected in general accordance with the provincial guidance documents. The following physical data was collected:

- Channel width,
- Wetted width,
- Bank full channel depth,
- Stage of stream discharge,
- Cover, and
- Confinement.

3.2.3. Wetland Assessment

Wetlands are areas where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development (Mackenzie and Moran 2004). Wetlands will have a relative abundance of hydrophytes in the vegetation community and/or soils featuring “hydric” characters.”

The study area was reviewed for the potential occurrence of a wetland by searching for the presence of aquatically adapted vegetation, isolated depressions, and standing water which are indicative of wetland ecosystems. McElhanney conducted a second site visit to search for potential wetland indicators on the southern parcel on January 29th, 2020 following a period of heavy rainfall.

3.2.4. Terrestrial Wildlife Species

The web-based databases considered in the assessment of wildlife use of the area and wildlife habitat include the following:

- CDC database of provincially listed wildlife species (CDC 2019), as well as species listed under the federal *Species at Risk Act* (Canada 2002) and COSEWIC.
- iMapBC 2.0 (iMapBC 2019) databases.
- BC Species and Ecosystems Explorer (CDC 2019).
- E-Fauna BC: Electronic Atlas of the Wildlife of British Columbia (E-Fauna BC 2019).
- Important Bird Areas (IBAs) identified by IBA Canada Program. Important Bird Areas are discrete sites that support specific groups of birds: threatened birds, large groups of birds, and birds restricted by range or by habitat.

The study area was reviewed for incidental observations relating to evidence of wildlife including nests, scat, tracks, and burrows during the site visits. Wildlife habitat conditions were supplemented with information obtained in a literature review for species typical in the CDF biogeoclimatic zone. This information, in combination with the photograph log of the study area was reviewed to define an overview of potential habitat suitability, wildlife movement, and/or level of disturbance.

4. RESULTS

4.1. CLIMATE AND PRECIPITATION

Climatic conditions at the site were inferred based on data provided by Environment Canada, Canadian Climate Normals 1981-2010 (Canada 2018). Recorded precipitation data for the Victoria International station (temperature) and the Francis King station (precipitation) were considered representative of the site based on their proximity to that station.

Mean daily temperatures by month recorded between 1981 and 2010 ranged between 4.0 degrees Celsius (°C) in December to 16.9°C in July. Annual precipitation was 1029.3 mm with monthly average lows of 19.3 mm in July and highs of 208.7 mm in November.

The study area is located within the CDFmm; this subzone is situated in the rain shadow of both the mountains from the Vancouver Island and Olympic Ranges. This results in warm, dry summers and mild, wet winters. The growing season is very long and there are often water deficits at zonal or drier sites (Green and Klinka 1994).

4.2. SOILS

Soil Survey Reports for British Columbia are published by Agriculture and Agri-Food Canada. Available soil survey reports and maps for British Columbia were reviewed to determine surficial geology and soil types at the study area. Map 4-1959 *Soil Map of Vancouver Island British Columbia – Victoria – Saanich Sheet* was reviewed. The study area was classified as having three soils types: the well drained Cadboro soils which are gravelly sandy loams, and a the rapidly drained Esquimalt and Qualicum soils (sandy loam/loamy sand) (*Figure 5*). The soils found on the study area are summarized in *Table 1.* The Cadboro soil series are developed on glacial till, the Esquimalt series on glaciofluvial materials and the Qualicum on coarse textured parent materials.

Table 1. Soil types located within the study area

Soil Name	Material	Description (BC MOE 1985 & BCFS 1973)
Cadboro	• Gravely sandy loam	• Parent material is compact sandy loam glacial till • Well drained; permeability is moderate except in the parent material where it is very slow. Lateral movement of water occurs over the surface of the parent material during the winter season
Esquimalt	• Gravely sandy loam / Sandy loam	• Parent material is coarse textured glaciofluvial material • Rapidly drained, permeability is also rapid.
Qualicum	• Loamy sand / Gravelly loamy sand	• Parent material is coarse textured material • Rapidly drained, permeability is also rapid.

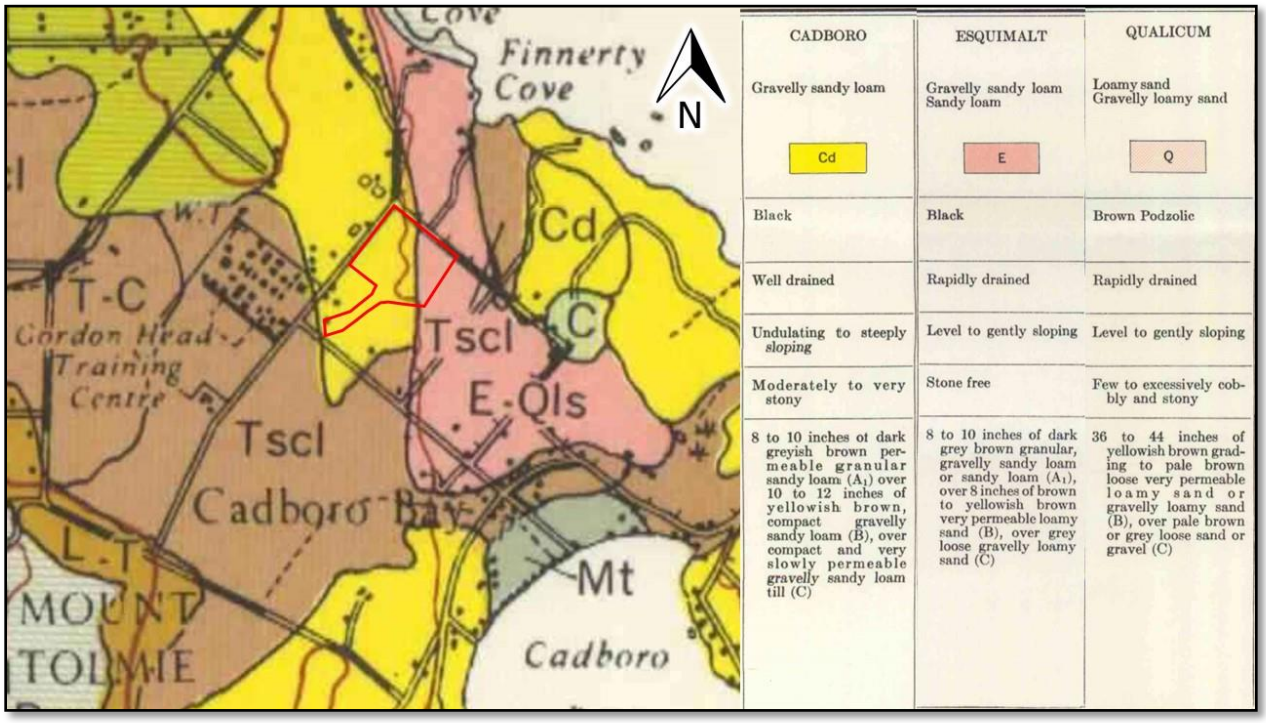


Figure 5. Relevant Soil Map from Agriculture and Agri-Food Canada (bc6Map4 – 1959), Site boundaries marked with red line.

4.3. HYDRAULIC MODEL ASSESSMENT

The model was used to illustrate the existing creek flow conditions and capacities. This data was reviewed by the project team to identify critical areas along the stream alignment where impacts to the channel had negatively affected the stream flows. Data from the field assessment, survey, and modelling analysis

determined that a sanitary main crossing which runs perpendicular to the flows bisects the stream and diverts the flow into a second channel.

There are additional areas where high pedestrian traffic through the network of trails cause impacts to the Creek channel. As the creek flows from west to east towards the Arbutus Rd ditch, it becomes more denuded and eventually flows unconfined over the forest floor, as shown in *Figure 6*.

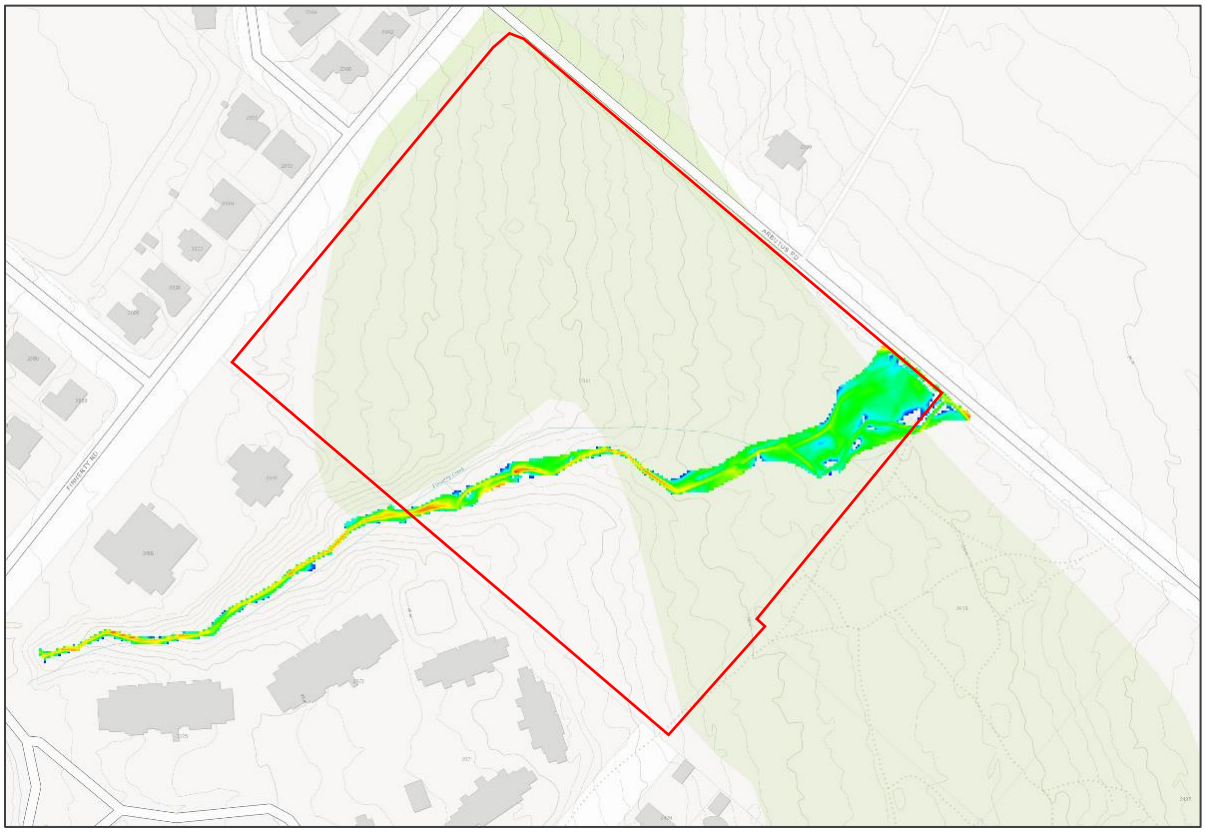


Figure 6: Max Flood Extents During the 25 Year Design Flow Rate

Initial remediation option assessments were conducted to map the flows through the inferred original channel of the creek. This model assumes that remediation will occur to redirect the flows into the main channel and decommission the secondary channel.

The hydraulic assessment commenced with the analysis of the upstream catchment area. The upstream boundary of the analysis is located on Finnerty Road and the downstream boundary condition is located on Arbutus Road. The creek catchment area was inserted into the hydraulic model at the upstream boundary and the downstream boundary is assumed to not restrict the flow in the study area. The first step of the process included the rational method calculation which included the following parameters:

- (A) Area = 15 ha
- (I) Rainfall Intensity (25-year return period with 30 min time of concentration) = 16.3 mm/hr
- (C) Runoff Coefficient = 0.6 (Mainly residential with some higher density areas)
- Design Flow rate = A*I*C/360 = 0.41 cms

The time of concentration was derived using the Hathaway Formula in the BC MOT Supplement to TAC section 1020 and the corresponding rainfall intensity was pulled from Table 2b in the Environment and Climate Change Canada Short Duration Rainfall IDF data (ID 10108611). *Figure 7* highlights at creek's catchment area.

Figure 7: Finnerty Creek Catchment Area

The derived flow rate was then inputted to the HEC-RAS model to approximate the flooding extents of the creek. The study area included a portion of the creek outside the District of Saanich Limits for completeness, however, as shown in the *Figure 7*, the area outside the District's limits is largely contained within the natural creek channel. As is discussed in the previous sections, the creek becomes braided and covers multiple undefined water courses towards Arbutus Road. The 25-year flow rate was sufficient to cover the entire braided section of the creek as shown in *Figure 6*.

As shown in the Proposed Remediation DWG's 1 & 2 in *Appendix A*, a defined ditch cross section is required to deliver the storm water across Haro Park. Modelling efforts using HEC-RAS and PC SWMM were used to help determine the cross-section dimensions and digital elevation surface for the analysis. The modelling effort assumed the following:

- That the existing grade of the creek would not be significantly altered due to the construction of the proposed cross section;
- The proposed creek channel would have a uniform roughness coefficient (manning's n)
    - Manning's N = 0.035 for an excavated earth channel that is winding and fairly uniform

- All flows to the creek are inserted at the upstream boundary of the model (as was done for the 2D analysis)
- The downstream boundary condition (the roadside ditch on Arbutus street), has sufficient capacity and does not impacted the upstream flow hydraulics.

Based on the above, it was determined that a typical cross section 0.45 m (Max) deep, by 0.5 m wide with 1H : 3V side slopes (see *Figure 8*) would be adequate to keep the HGL below the top of the cross section in the 25-year design storm event, with zero freeboard

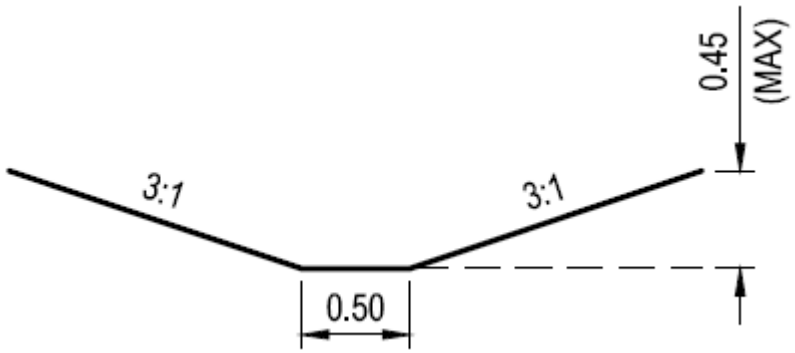


Figure 8: Typical Cross Section

A plan view of the derived from the PCSWMM model is shown in *Figure 9* below. The highlighted section of the model is also shown in profile with the peak HGL displaced with respect to the ditch depth. As shown, the HGL is maintained within the proposed ditch section alignment.

Figure 9: Plan View of PC SWMM Model

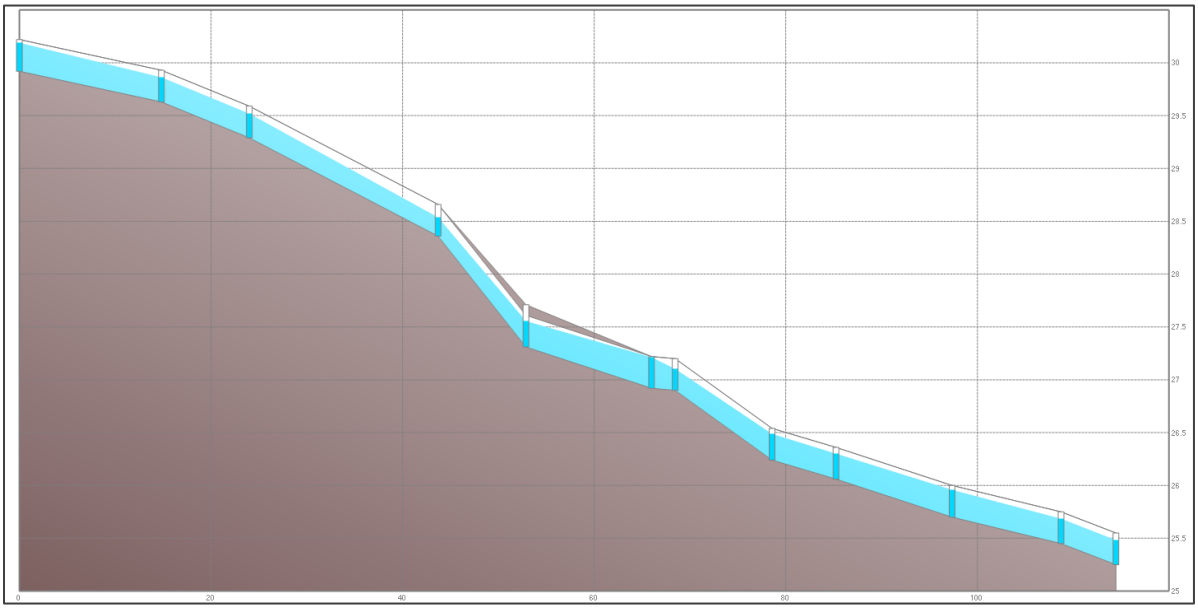


Figure 10: Profile of Proposed Ditch - Peak 25-Year HGL

The proposed ditch cross section was then included with the existing digital elevation model to confirm the confinement of the creek. This is detailed on Creek Plan and Profile Figure in *Appendix A*. As shown in *Figure 11*, the proposed ditch cross section effectively contains the creek flow and defines an alignment that will allow effective environmental protection measures to be completed.

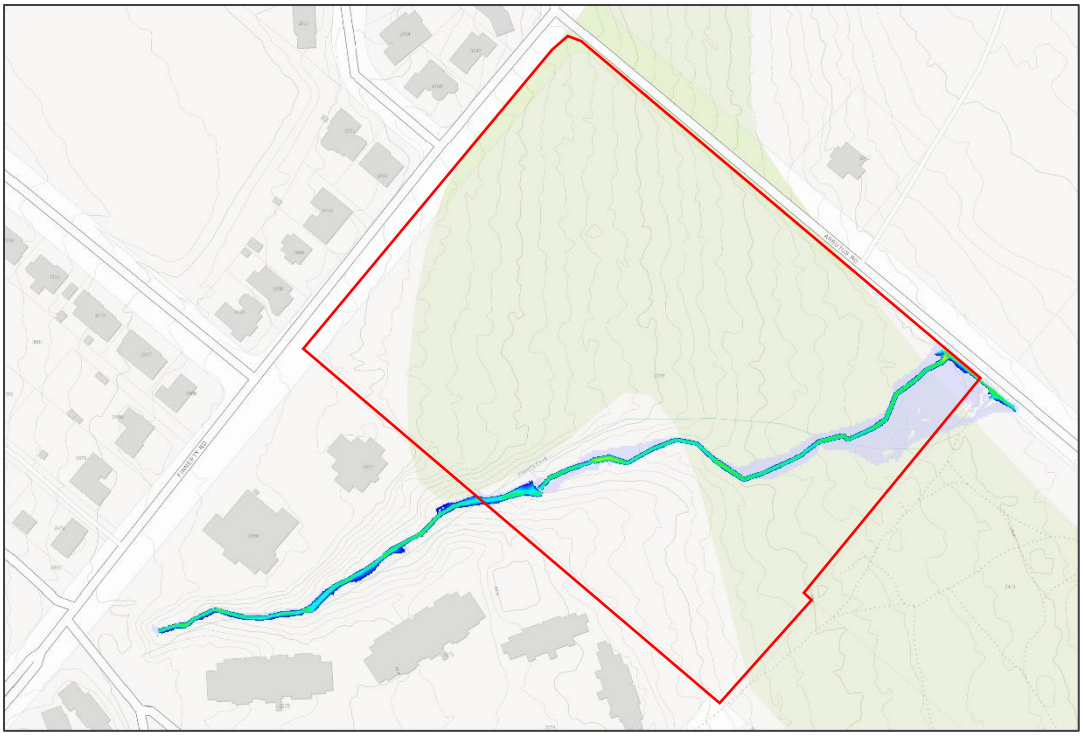


Figure 11: Max Flood Extents During the 25 Year Design Flow Rate with Proposed Creek Cross Section (Existing Flood Extents Shown in Background)

4.4. TERRESTRIAL VEGETATION RESOURCES

The study area was located within the Coastal Douglas Fir (CDF) Moist Maritime (CDFmm) biogeoclimatic zone (Green and Klinka 1994). Typical vegetation in the CDFmm subzone are forests dominated by Douglas fir (*Pseudotsuga menziesii),* Grand fir (*Abies grandis*) and Western redcedar (*Thuja plicata*). The understory is typically dominated by Salal (*Gaultheria shallon*), Dull Oregon-grape (*Mahonia nervosa*), Ocean-spray (*Holodiscus discolor*), and Oregon beaked moss (*Kindbergia oregana*). Many of the vegetation species typical of the CDFmm were present in the study area (Photograph 1), due to the timing of the site visit many herbaceous species typical of the CDFmm were dormant and not identified.

Haro Woods is forested with a stand of mature, second-growth Douglas-fir with a mixture of native and invasive species in the understory. A high prevalence of English Ivy (*Hedera helix*) occurred in the study area. The most dominant plant communities are Douglas-fir/Dull Oregon-grape (CDFmm/01) and Douglas-fir/Arbutus (CDFmm/02) (Saanich 2018).

Photograph 1. Typical riparian vegetation included Douglas fir, Big leaf maple and Dull Oregon-grape (photograph taken at Transect 6)

Vegetation was assessed at each stream transect for a total of ten (10) locations within the study area and are identified in ***Error! Reference source not found.***. *Table 2* provides a list of species observed during the site visit. *Table 3* lists the species encountered at each riparian stream transect.

Table 2. Plant species observed during the October 2019 field visit.

Common Name	Scientific Name	Type of Plant
Douglas fir	*Pseudotsuga menziesii*	Conifer tree
Grand fir	*Abies grandis*	Conifer tree
Big leaf maple	*Acer macrophyllum*	Deciduous Tree
Garry Oak	*Quercus garryana*	Deciduous Tree
Arbutus	*Arbutus menziesii*	Evergreen Tree
Sword fern	*Polystichum munitum*	Fern
Stinging nettle	*Urtica dioca*	Herbaceous
Star flowered lily of the valley	*Maianthenmum stellatum*	Herbaceous
Dull Oregon-grape	*Mahonia nervosa*	Shrub

Common Name	Scientific Name	Type of Plant
English holly*	*Ilex aquifolium*	Shrub
English Ivy*	*Hedera helix*	Shrub
Himalayan blackberry*	*Rubus armeniacus*	Shrub
Ocean spray	*Holodiscus discolor*	Shrub
Spurge-laurel*	*Daphne laureola*	Shrub
Snowberry	*Symphoricarpos albus*	Shrub
Trailing blackberry	*Rubus ursinus*	Shrub

*Invasive species

4.5. STREAM INVENTORY

The study area is underlaid by BC aquifer 680 (Wark – Colquitz) which is an isolated aquifer in fractured bedrock; and BC aquifer 686 which is a confined sand and gravel – glacial aquifer (iMapBC 2020). There were no provincially mapped groundwater wells on the Site according to the databased reviewed.

Finnerty Creek did not appear to have a watershed code in the available databases (CRD Webmap 2020, iMap BC 2020, Habitat Wizard 2020). Finnerty Creek is not identified in the Provincial Freshwater Atlas Stream Network dataset. The stream is an intermittent, non fish bearing watercourse and was not flowing during the October 2019 site assessment. It was observed to be flowing during environmental monitoring in the area in January and February 2020 following periods of heavy rainfall. The transect locations are illustrated on **Error! Reference source not found.** and physical data including photographs from the October 2019 field visit is summarized in *Table 3*.

The median channel width was 1.1 m with a mean of 1.4 m. The channel width ranged from 0.5 m to 2.6 m. This range reflected transects where a primary and secondary channel was encountered. The smaller widths recorded were those of secondary channels. Channel widths above 1.5 m were reflective of anthropogenic disturbances where the channel flattened out along a pedestrian pathway, or similar disturbance type.

As the channel was dry during the assessment, channel depth was difficult to interpret and not frequently recorded. The estimated depth ranged from about 10 cm to 30 cm. Some stream reaches are described as having a step pool morphology. The data in *Table 3* are estimations only, as the actual depths and widths could only be confirmed during times of flow.

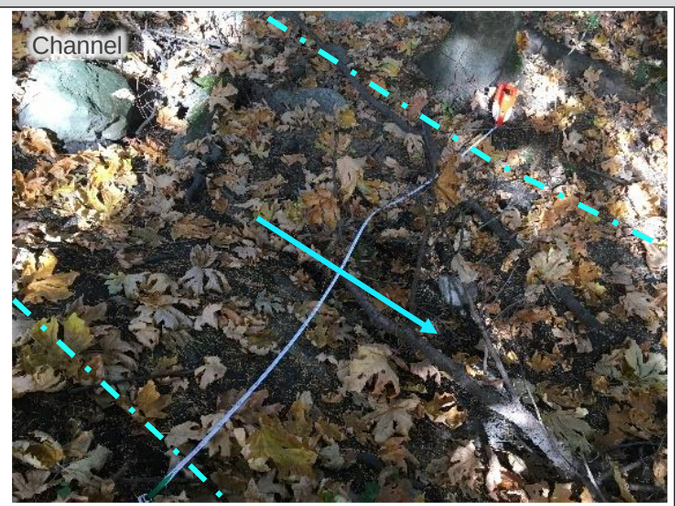
Figure 12. Approximate location of stream survey transect locations along Finnerty Creek (background map courtesy of Google Earth).

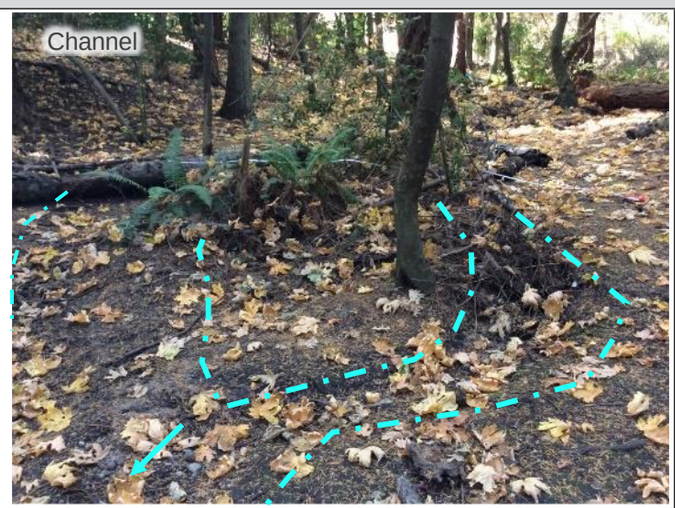
Table 3. Steam assessment results

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 1	•Channel Width (to top of rip-rap): 2.6 m •Wetted width: (estimated – no flows, is width of constructed channel 1.1 m) •Dry/Intermittent flow •Primary Channel •Channel pattern: straight •Confined in a ravine •Bed material: rip-rap	Mature Forest: Douglas fir with > 1 m diameter at breast height Himalayan Blackberry (Dominant) English Ivy Laurel spurge Ocean spray Snowberry Arbutus English holly	• Headwaters through a culvert with flows over rip-rap. • Channel width here is the width of the rip-rap. • There is a retaining wall, upstream flows are subterranean in an engineering piping system. • Dominated by invasive species
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 2	•Channel Width: 1.4 m •Dry/Intermittent flow •Primary Channel •Channel pattern: sinuous •Confined in a ravine •Bed material: fines	Mature Mixed Forest: Douglas fir Big leaf maple English holly English Ivy Laurel spurge Snowberry Stinging nettle Grand fir Ocean spray	• Felled trees were situated directly in the channel
	Photographs		
			

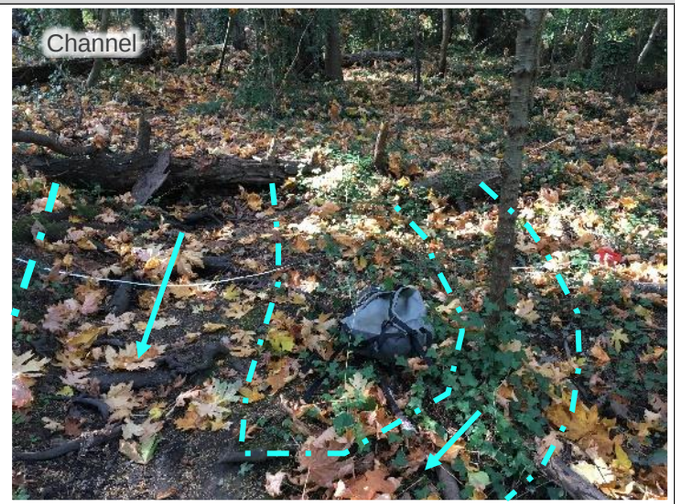
	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 3	•Channel Width: 1.0 m •Dry/Intermittent flow •Primary Channel •Channel pattern: straight •Confined in a ravine •Bed material: fines with some cobbles (3 cm to 50 cm)	Mature Mixed Forest: Douglas fir Big leaf maple Garry oak Arbutus Ocean spray (dominant) Dull Oregon-grape (dominant) Sword fern English Ivy Laurel spurge English holly	• Felled trees were situated directly in the channel • Hiking trail denudes the channel by passing perpendicular through it
	Photographs		
			

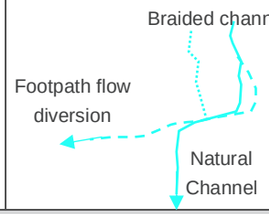
	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 4	•Channel Width: 2.6 m •Dry/Intermittent flow •Primary Channel •Channel pattern: straight •Confined in a ravine •Bed material: fines with some cobbles (20 cm to 50 cm)	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple Ocean spray (dominant) Dull Oregon-grape (dominant) Sword fern English Ivy (dominant) English holly Snowberry	• PVC culvert with headwall, direct stormwater flows into the primary channel. • Rip-rap placement in the engineered stormwater discharge channel (note channel characteristics describe the primary channel)
	Photographs		
			

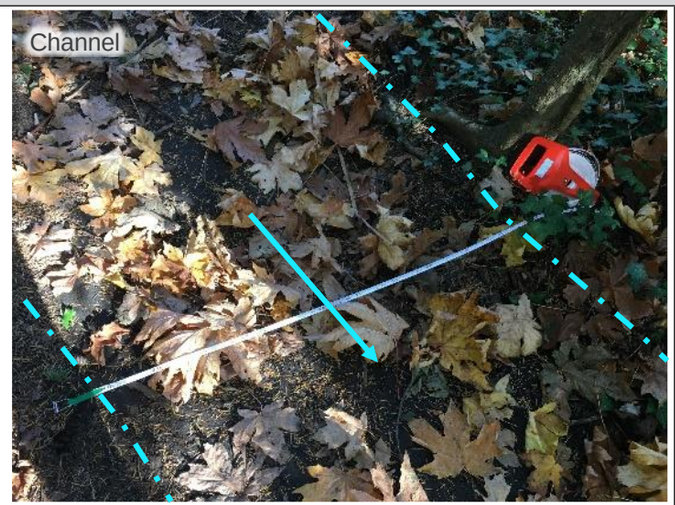
	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 5	•Channel Width: 1.4 m (primary) and 0.7 m (secondary) •Dry/Intermittent flow •Primary Channel undercut on left bank depth approximately 20 cm •Channel pattern: sinuous with occasional islands •Confined or frequently confined •Bed material: fines with some gravel	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple English holly Sword fern Dull Oregon-grape	• The channel is braided at this location. • It is denuded which is inferred to be the result of foot traffic from hikers
	Photographs		
			

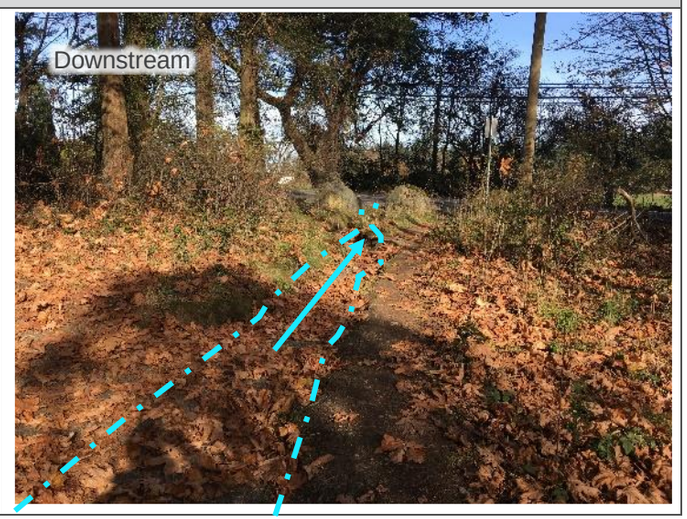
	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 6	•Channel Width: 0.9 m (step), 2.3 m (pool) •Depth approx. 10 cm in step and 30 cm in pool •Dry/Intermittent flow •Primary Channel •Channel pattern: sinuous •Confined •Bed material: gravel	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple Arbutus English holly English Ivy Dull Oregon-grape Sword fern Trailing blackberry Star flowered lily-of-the-valley	The channel was cleared defined at this location. Erosion under a root had caused a step pool morphology that had not been previously noted within the channel.
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 7	•Channel Width: 2.3 m •Estimated depth 12 cm •Dry/Intermittent flow •Primary Channel •Channel pattern: straight •Unconfined •Bed material: fines with gravel	Mature Mixed Forest: Douglas fir (dominant) Grand fir Arbutus English holly (dominant) Ocean spray Big leaf maple English Ivy Dull Oregon-grape Trailing blackberry Snowberry	• A wide hiking trail intersects the channel at this location. • This has caused substantial impacts to the channel. Flows have spread over the width of the footpath with is nearly twice as wide as the typical channel width
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 8	•Channel Width: 1.6 m (primary), 0.5 m (secondary) •Depth of primary channel approx. 18 cm •Depth of secondary channel approx. 10 cm •Dry/Intermittent flow •Primary Channel •Channel pattern: sinuous with occasional islands •Unconfined •Bed material: fines	Mature Mixed Forest: Grand fir Douglas fir (dominant) Big leaf maple English holly (dominant) English Ivy (dominant) Dull Oregon-grape	• The channel in this location is braiding and highly impacted • It is difficult to discern the channel during period of non-flow
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 9	•Channel Width: 1.1 m •Dry/Intermittent flow •Primary Channel •Channel pattern: irregular/braided •Unconfined •Bed material: fines and gravel	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple Arbutus Ocean spray Dull Oregon-grape English Ivy (dominant) English holly (dominant)	• Highly impacted channel due to footpath. • It is difficult to determine the primary channel in this location • A hiking trail perpendicular to the creek has resulted in a 90 degree turn in the flows. • A portion of the flow leaves the natural channel her and follows the footpath • Channel morphology is as follows: 
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Transect 10	•Channel Width: 1.1 m •Depth approx. 6 cm •Dry/Intermittent flow •Primary Channel •Channel pattern: sinuous •Unconfined •Bed material: fines	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple Ocean spray Arbutus Dull Oregon-grape Sword fern English Ivy (dominant) English holly (dominant)	• This is inferred to be the natural channel. Flows have diminished in this area due to the upstream diversion onto the footpath. • Municipal mapping does not indicate that Finnerty Creek is located in this area • Additional footpaths crisscross the stream channel here causing further degradation • Just a few meters away from the ditch along Arbutus Road another footpath crosses the stream perpendicular to flows, this has results in loss of a defined channel. • It is inferred that the flows discharge to the ditch in an eroded footpath as pictured in the downstream photograph.
	Photographs		
			

	Channel Characteristic	Riparian Vegetation	Disturbance
Alternate Discharge Location due to Impacts	•Width of diverted channel variable but typically less than 1 m •Substrate was gravel from footpath •Dry/Intermittent flow •Secondary Channel (not natural channel, resulted due to impacts to stream) •Channel pattern: sinuous •Unconfined •Bed material: gravels from footpath	Mature Mixed Forest: Douglas fir (dominant) Big leaf maple Ocean spray Arbutus Dull Oregon-grape Snowberry English Ivy (dominant) English holly (dominant)	• Another footpath intersects the diverted flows at a 90-degree angle and diverts flows towards the ditch along the footpath • Two large boulders at the trailhead have confined the flows where they discharge to the ditch causing scour/erosion
	Photographs		
			

4.5.1. Additional Stream Observations

McElhanney has conducted weekly site visits on a portion of Haro Woods owned by the CRD since August 2019, as part of environmental monitoring (EM) services for the CRD Tank Attenuation Project. During the weekly EM site visits, McElhanney has assessed flows in the Arbutus Road ditch which Finnerty Creek discharges into. In the seven (7) months of monitoring, intermittent flows in the ditch were observed only in January and February 2020.

The first observance of flows within the creek followed a significant rainfall event which occurred on January 6th, 2020. Rainfall amounted to 36 mm of precipitation which resulted in flows within Finnerty Creek noted on January 7th. Flows were also observed on January 24th and 29th while conducting site visits for the CRD project. Weather data measured by Environment Canada indicates that heavy rain fell on January 22nd and 23rd (21.0 mm and 22.8 mm respectively). It was raining heavily on January 29th and had rained for twelve (12) consecutive days prior to the site visit. On January 31st record breaking rainfall occurred and 38.4 mm of rain fell within a 24 hour, it is inferred that the creek was flowing on and in the days following this storm event. Flows likely had occurred intermittently at other times during periods of heavier rainfall on days when McElhanney was not monitoring.

Photograph 2. January 29th, 2020 Finnerty Creek flowing on a footpath where it has diverted from the natural channel

Heavy ongoing precipitation occurred throughout the month of January 2020. Environment Canada had reported approximately 291.3 mm of precipitation at the Victoria International Airport station for the month. Canadian Climate Normals (1981 to 2010) reported 143.2 mm of precipitation as average for the month of January. Precipitation amounts in January 2020 were some of highest on record and included a record-breaking significant rainfall event that occurred on January 31st, 2019. Flows in Finnerty Creek during January 2020 were likely more persistent than typical for the watercourse given the higher than normal precipitation.

Flows in the creek are observed to be related to precipitation events. Thus, the stream is described as an *ephemeral channel* and only flows for the hours or days immediately following rainfall. The Haro Woods Management Plan states that the creek is subject to significant variation in flow levels and is negatively affected by the large volumes of water that are collected and discharged over short periods of time (Saanich 2018).

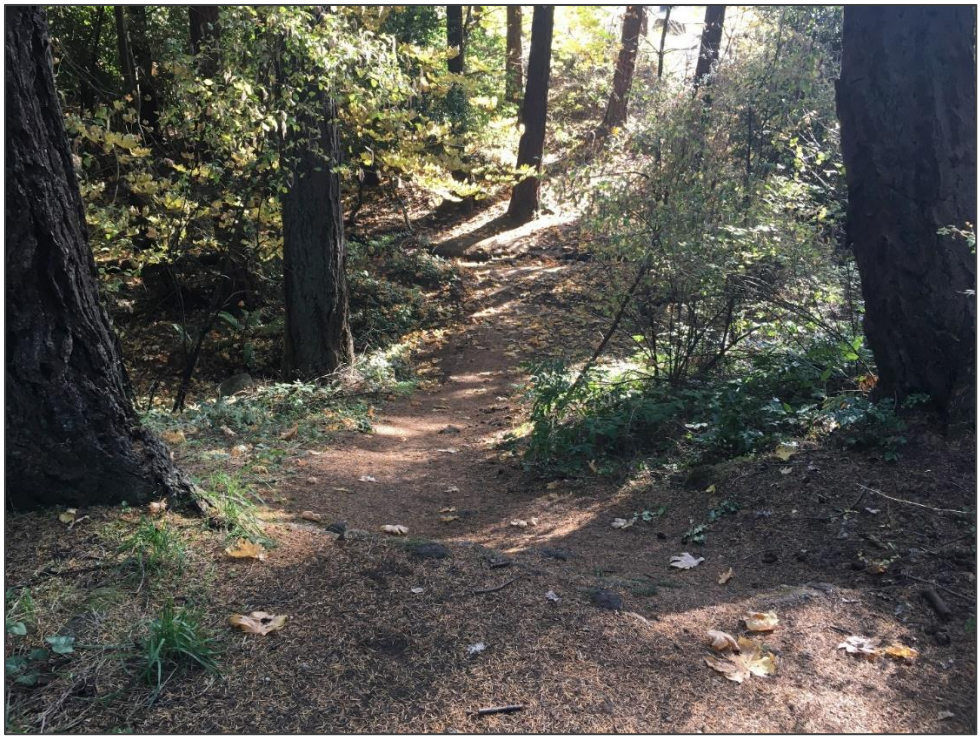
Photograph 3. Finnerty Creek on January 29th, 2020 flowing outside its banks over the forest floor between the original channel and the diverted channel

4.6. WETLAND SURVEY

No evidence of wetland features or wetland ecology were encountered during the October 31, 2019 site visit within the northern parcel of the study area. McElhanney's QEP searched the parcel extensively for evidence of standing/ponded water, wetland plants, and areas where standing water and resulting low soil oxygen levels are the principal determinants of vegetation and soil development. Locations reviewed for the presence of a wetland in the October site assessment are marked on **Error! Reference source not found.**.

The topography of the north end of the Site sloped toward the ravine in which Finnerty Creek was entrenched. Wetlands tend to be situated in low topographical positions due to poor drainage in such areas. The landscape suitable for a wetland was not identified during the October 31st site visit. There were also no locations along Finnerty Creek in which fringe wetlands were identified.

The below photographs show typical upland forest ecosystem encountered in the study area during the October site visit.



Photograph 4. Typical view of sloped topography south towards Finnerty Creek (located at the toe of the slope), encountered during the wetland search.

Photograph 5. Typical view of ecosystem and a footpath in low slope positions where the herbaceous layer is dominated by invasive English Ivy. No evidence of wetland encountered.

Photograph 6. Typical view of ecosystem in upper slope position above the ravine, steeply sloped landscape with no evidence of wetland.

McElhanney conducted a second site visit to search for potential wetland indicators on the southern parcel of Haro Woods on January 29th, 2020. In this follow-up assessment two shallow open water ponds were located side by side in an isolated depression near the center of the search area. The pond is marked on **Error! Reference source not found.** and shown in Photographs 7 and 8.

No hydrophytic vegetation was observed that would confirm that the shallow open water could be classified as a wetland. Obligate indicator species usually always occur in wetlands under natural conditions, whereas facultative wetland species usually occurs in wetlands but can be occasionally found in non-wetlands. The lack of facultative or obligate wetland vegetation indicators suggest that the hydroperiod of the standing water was not long enough to create semi-permanent to permanent wetland features. Herbaceous vegetation was sparse and leaf litter from deciduous trees covered the forest floor in this area including the base of the ponds. The field visit was not completed during the growing season, however desiccated or growing graminoid wetland species would typically be present on southern Vancouver Island in January.

It should also be noted that the ponded surface water was observed at the end of one of the wettest January's on record. Standing water could potentially be a puddle due to poor drainage during heavy rainfall. A single site visit does not provide enough information regarding the persistence of the ponded water observed to state with certainty that it is an ephemeral wetland vs a temporary pond in an area of poor drainage. It could potentially be an ephemeral wetland and is marked as such on **Error! Reference source not found.**. Additional site assessments would be required to accurately characterize this water feature to verify the persistence of standing open water, however the permanence of the hydroperiod was outside the scope of this assessment. It should be noted that it was an isolated basin, completely disconnected from Finnerty Creek or other watercourses. The source of water in this area is inferred to be rainfall runoff.

Photograph 7. Standing open water in isolated depressions identified on January 29, 2020 on the southeast parcel of Haro Woods

Photograph 8. Standing open water in isolated depressions identified on January 29, 2020 – note no hydrophytic vegetation observed

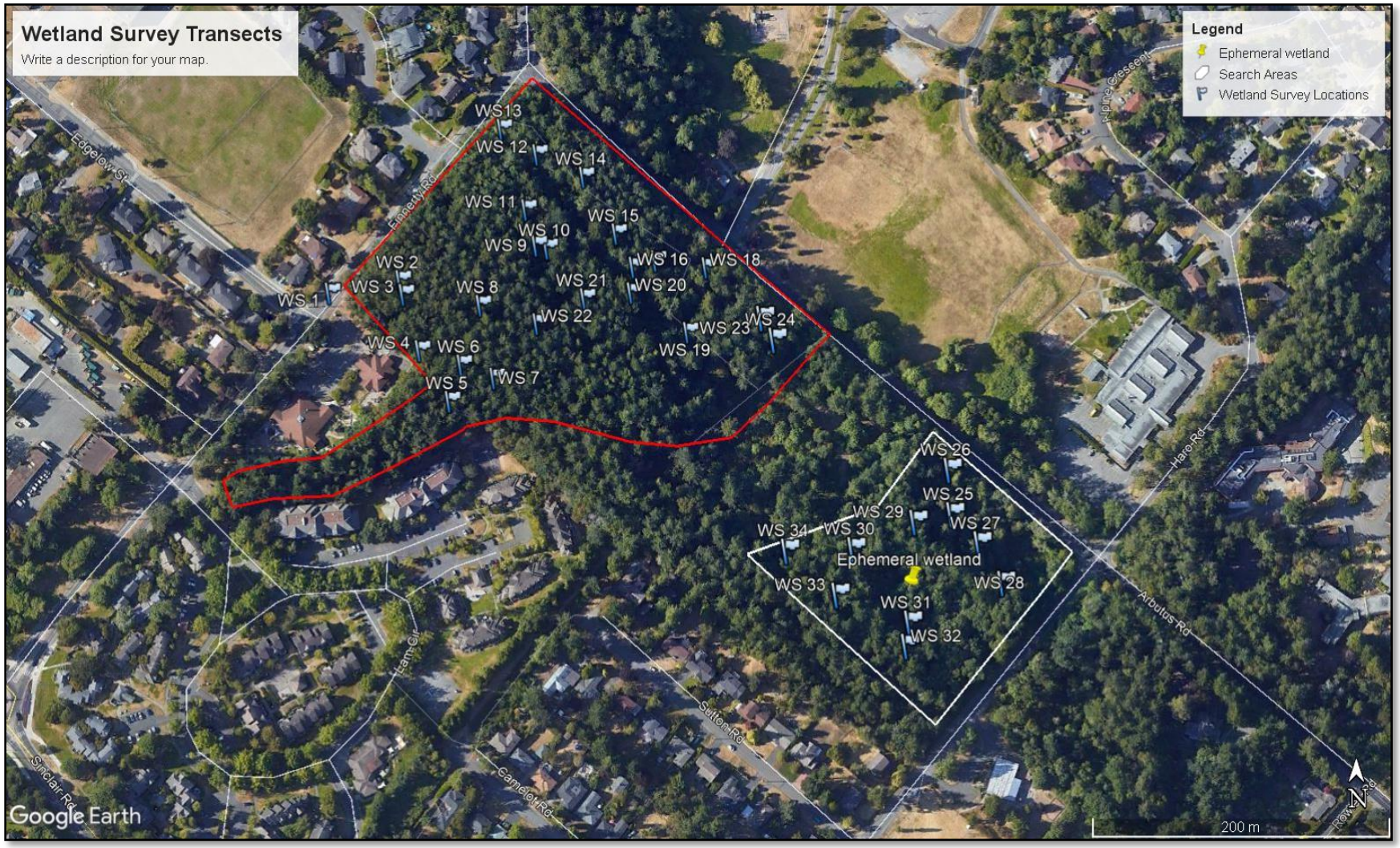


Figure 13. Wetland survey locations and results, the study area including the northern parcel is outlined in red and the southern parcel is outlined in white.

4.7. WILDLIFE & WILDLIFE HABITAT

The study area is described as a mature forest ecosystem with few recent canopy-disturbing activities. It is in an urban area and provides habitat features for local wildlife. It also provides connectivity between low density developments to the east along the shoreline of Haro Strait. A variety of mammals and birds likely use habitat within the study area.

4.7.1. Mammals

Black-tailed deer (*Odocoileus hemionus*) are known to frequent the area, they experience little predation and have a robust population. Deer scat were observed during the site visit. Many smaller mammals such as bats, shrews, mice, racoon (*Procyon lotor*), marten (*Martes caurina*), and red squirrel, all frequent Vancouver Island (Klinkenberg 2018). Suitable habitat was available for bat species with many wildlife trees noted in the study area, however, no specific observations or information was available regarding their presence. Available habitat was observed in the study area and it is anticipated to be used by a variety of small mammals typical to the region.

4.7.2. Birds

In February 2019, McElhanney conducted an owl survey in Haro Woods as part of assessments for the CRD CSO Tank Attenuation Project. Two to three Great Horned Owls *(Bubu virginianus*) and important habitat features were identified during that investigation. Several active roost trees were encountered in Haro Woods, one was directly adjacent to Finnerty Creek. Although their nest was not located during the assessment, that did not exclude the potential for it to be located within the area. Great Horned Owls are resilient to degradation of nesting habitat and are somewhat tolerant to disturbance of nests and roosts. They are often found in well-wooded parkland in urban areas. Great Horned Owls typically do not use the same tree nest in successive years (BC CDC 1996). This is a yellow listed (secure) species but is known to be important to the residents and community that uses Haro Woods.

Many birds winter in the CDF BGC zone (Green and Klinka 1994). Various bird species, including migratory birds, are anticipated to use habitat within and near the study area. An exhaustive inventory of bird species present within the study area was not completed for the purposes of this report, however, the Haro Woods Management Plan lists some common species know to nest and feed in the area including; Great Horned Owl, Cooper's Hawk, Barred Owl, American Robin, Chestnut-backs Chickadee, Pine Sisken, Winter Wren, House Finch, Dark-eyed Junco, Golden-crowned Kinglet, Sptted Towhee, and Red-breated Nuthatch (Saanich 2018). Furthermore, there are 3 inland observation hotspots reported on Ebird – (UVic Compost Trail; University of Victoria--Mystic Vale and UVic) which document considerable bird species diversity in the area.

Important Bird Areas (IBAs) are home to threatened birds, large groups of birds, and birds restricted by range, or by habitat. When bird species occur at a site in sufficient numbers during one or more seasons (winter; migration; breeding), they become known as trigger species, and the site at which they are found can be designated as an IBA. The study area does not occur within an IBA (BSC 2019).

Several high value wildlife trees were observed within the study area. A wildlife tree is defined as 'a standing dead or live tree with special characteristics that provide food and shelter for wildlife' (MOE 2012). Wildlife trees provide important habitat for many mammalian (bats) and bird species. Long after it dies, a tree continues to provide important ecosystem services, including cavity nesting and roosting habitat for bird and mammal species. Standing dead trees present important habitat features for woodpeckers;

woodpeckers are important predators of many species of tree-killing bark beetles (Scott *et al*. 1977). Wildlife trees make a vital contribution to biodiversity by providing protective cover as well as nesting denning, feeding, roosting, and perching sites for a wide variety of species. It takes many decades - in some cases' centuries-before a tree can serve as a wildlife tree (Fenger 2006).

The Wildlife Tree Stewardship Atlas indicated that the closest mapped Bald Eagle nests were approximately 700 m to the northeast of the study area (WiTs 2020).

4.7.3. Amphibians and Reptiles

No observations of herptiles (amphibians or reptiles) were made during the site visit or previous visits to the study area as part of other project assessments. There was minimal habitat available for herptiles identified within the study area (i.e. no deeply incised bedrock, south facing talus slopes, rocky outcrops, or potential hibernacula). Neither the incidental observations nor the survey observation layers for amphibians or reptiles available via iMap BC identified reported observations of amphibians or reptiles in or around the study area.

4.8. ECOSYSTEMS AND SPECIES AT RISK

The CRD area supports diverse rare and sensitive ecosystems that have very high ecological and social values. Vancouver Island, more broadly, supports many unique ecological regions and is characterized by long growing seasons that support many rare species of plants, animals, and plant communities. Development pressures throughout this region have resulted in degradation, fragmentation, and loss of these natural ecosystems. MMcElhanney reviewed the plant and wildlife species at risk data available through iMapBC and the results from the CDC searches. At risk plant, animal species and ecosystems identified in *Appendix B* may potentially occur within or utilize habitat within Haro Woods and the surrounding areas. A more detailed discussion of the database query results is included herein.

4.8.1. At Risk Animal Species

No federally listed wildlife species were observed during the site visit; however, this does not necessarily preclude their presence within the study area. The CDC search results covering a 5 km radius from the study area (iMap BC 2020) show 4 occurrences of At-Risk animal species (*Appendix C*). Three avian species at risk have been documented in the area including the Green Heron (*Butorides virescens*), the Great Blue Heron (*Ardea herodias fannini*), and the American Bittern (*Botaurus lentiginosus*). These are provincially blue-listed species whose preferred habitat are riparian forests, streams/rivers, and wetlands (CDC 1996). Finnerty Creek is ephemeral; therefore, the riparian forest likely does not provide preferred or critical habitat for these species. The study area may be frequented by provincially and federally listed species avian species, however, Critical Habitat for federally listed species has not been identified within the study area or immediately surrounding area.

4.8.2. At Risk Plant Species

Twenty-five (25) occurrences of At-Risk plant species have been documented within a 5 km search radius of the study area. Sixteen (16) rare vascular plant species were identified in the database. McElhanney reviewed the habitat needs for each of the At-Risk vascular plant species located within 5 km search area and determined that there was no available habitat for these At-Risk vascular plant species in the study area.

The majority of the rare vascular plant species identified in the search area were associated with Garry Oak ecosystems and require rocky bluffs or vernal pools as part of their Critical Habitat. Although the western

extent of the Site was identified as a Garry Oak ecosystem in 1997 (iMap 2020), development has degraded the habitat to the extent that it is no longer a Garry Oak ecosystem. It is inferred that the potential for rare vascular species in the study area is low due to the existing level of disturbance.

4.8.3. At Risk Ecosystems

Two at-risk ecosystems were identified in Haro Woods (Saanich 2018). Douglas-fir/Dull Oregon-grape (CDFmm/01) and Douglas-fir/Arbutus (CDFmm/02) are red-listed by the BC Conservation Data Centre (CDC). Red-listed communities are those at greatest risk of being lost, largely due to clearing land and harvesting resources for agriculture and development. In the study area the dominant tree species were Douglas-fir, Bigleaf Maple, Grand Fir, and Arbutus.

Plant communities have not been mapped as part of this EA, as the field assessment focused specifically on the riparian area.

Douglas-fir/Dull Oregon-grape (CDFmm/01)

The Douglas-fir/Dull Oregon-grape plant community is a provincially red-listed (SCCP 2010b), classified as the CDFmm/01 site series. This plant community was once widespread in the drier, warmer portions of the Pacific Coastal formation of western North America (SCCP 2010b). Its decline is due to extensive past timber harvesting, as well as its proximity to high density human populations. The CDFmm lands are highly valued for rural and urban development.

In the assessed area, the tree layer was dominated by Douglas-fir and native species in the shrub layer was largely composed of Dull Oregon-grape, and ocean spray. The herb layer was sparse and usually included some sword fern. There was a prominence of invasive species in the understory, in particular English ivy and English holly.

Douglas-fir/Arbutus (CDFmm/02)

The Douglas-fir/Arbutus is the driest of the forested communities in the CDFmm subzone (SCCP 2010). It is found primarily on hillsides and rocky knolls. This is a provincially red-listed ecosystem, and it is thought that as little as 0.5% of the entire CDF zone remains as mature or old forest state in BC (SCCP 2010).

Arbutus trees were frequently observed in the study area and were associated more typically with the upslope drier topographic positions. There were not frequently encountered directly adjacent to Finnerty Creek.

Garry Oak Ecosystem

The CRD sensitive ecosystem mapping shows that the western extent of Finnerty Creek (on the UVic property) was historically a Garry Oak ecosystem prior to intense development pressures. The iMap BC search results are included in *Appendix C*. A few Garry Oak trees were observed during the Site visit, but the plant community was not found to be consistent with a Garry Oak ecosystem. The iMap BC information did not provide details as to the specific vegetation community that had formerly been noted in the area, thus the ecosystem status is unknown. Collectively Garry Oak ecosystems are among the most endangered in Canada (GOERT 2020)

5. SUMMARY

The study area (Haro Woods) is an urban forest that includes two red-listed ecosystems. It provides important habitat to a variety of mammals and bird species that are adapted to living in urban forests. The area was assessed for potential wetland habitat. No wetland habitat was identified in the wooded area around Finnerty Creek. Standing open water in an isolated depression (potentially an ephemeral wetland) was identified in the southern parcel of Haro Woods. A lack of wetland vegetation indicates that surface water is likely not permanent enough to create wetland features in this area. The area provided minimal aquatic habitat and water in this basin was not connected to water discharging from Finnerty Creek. No additional assessments or remedial efforts are recommended for this feature at this time.

Finnerty Creek runs through the study area and was the primary focus of this assessment. Finnerty Creek is classified as an ephemeral watercourse that flows in the hours or days after precipitation events. The riparian forest along the watercourse was not distinctly different from the terrestrial plant communities within Haro Woods. This is inferred to be due to the intermittent nature of the creek and the impacts to the channel. Water was not consistently present long enough to strongly influence the vegetation species located along the creek banks. Given the absence of obligate hydrophytes along the riparian fringe, channelizing the watercourse is not expected have negative impacts on the vegetation community. Channelizing the watercourse may increase the potential for the area to support riparian vegetation.

Although the canopy of secondary growth forest in which the creek is located was relatively intact, the creek has been denuded via human uses. On the west portion of the assessed area, the watercourse is confined within a ravine. Impacts in this area due to human uses were minimal, with minor impacts caused by footpaths and felled trees. The topography in the area encourages people to walk along the base of the ravine and directly in the channel of the watercourse. As the creek is primarily dry, and the surrounding area is steeply sloped, it would be difficult to encourage hikers to walk elsewhere without the implementation of significant signage or efforts to redirect hikers sway from this specific area. The ravine itself confines the water to its natural alignment and makes this area less of a priority for remediation.

As the creek moves towards the Saanich parcel of land, the topography transitions from a ravine to a slope which is less confining for the channel. Day hiker and mountain bike use increases substantially in this area of Haro Woods due to a change in terrain and a larger wooded area. The impacts to the creek are more substantial and affect the direction and width of the channel in many locations. However, the creek typically stays within its natural alignment within the center of the study area.

There are many braided footpaths as well as a sanitary sewer pipeline that intersect the creek as it moves northeast towards Arbutus Road. The impacts in this area result in a braided channel and eventually causes a large portion of the flows to deviate from the natural channel. Modelling imagery shows this area to look like that of a river delta, as the flows fan out over a larger area. This flow regime was observed in a follow up site visit in January 2020 during a period of heavy rain. There is a high prominence of English Ivy on the forest floor in this area, and during periods when the creek is not flowing, it was barely visible on the ground.

6. RECOMMENDATIONS AND COST ESTIMATE

Recommended creek remediation efforts are primarily located within the northern parcel owned by the District. Existing creek channelization is primarily well defined with little evidence of significant erosion and scouring within the portion of the assessed area owned by the University of Victoria. Much of the western portion of the stream channel can remain in its current condition with minimal consequence to the health of the watershed while mitigating unnecessary remediation capital costs. The western limit of remediation was defined through the hydraulic assessment, at which a portion of the assessed stream is confined in a ravine.

Proposed Remediation Drawings 1 & 2 in *Appendix A* help detail recommended remediation efforts, with context to surrounding property lines, environmental assessment transect locations, existing trails, surveyed mature trees, and the exiting sanitary sewer pipe crossing. Critical sections of the creek are recommended for remediation to encourage flows through a confined channel thereby helping to control and mitigate scour and erosion impacts. The health of the riparian forest may potentially improve following remediation and the implementation of a planting plan to introduce riparian species appropriate to the area. The newly channelized flow will eventually connect to the roadside drainage ditch along Arbutus Road.

Impacts have substantially changed the channel morphology and denuded the creek to the extent that it was barely evident on the ground from approximate station 3+60 to Arbutus Road. The forest canopy is intact and provides important wildlife habitat, thus, remediation efforts should avoid tree removal to the extent possible. By contrast, invasive species removal and riparian species planting may benefit stream enhancement efforts.

The impacts to the creek, that resulted in a braided channel and eventually bisecting the creek into two separate channels, increase the locations in which park users cross the stream. The primary recommendation from this assessment is to remediate the stream into a singular confined channel, reducing the number of stream crossings. Control of the stream crossing locations is recommended to promote long term sustained ecological health of the creek and riparian areas. A reduction in pedestrian and cycling impacts and the enhancement of a confined channel with help in controlling scour and erosion impacts.

Trails that cross the remediated stream are recommended to be managed in a way that park users will not cause further degradation to the channel. Stream crossings such as small bridges, steppingstones, and strategically placed logs are common through municipal, provincial, and federal parks to allow for pedestrian and cycling stream channel crossings.

6.1. RECOMMENDATIONS SUMMARY

- In order to construct the recommended Creek remediation measures, detailed design should be advanced, based on the plan and profile Drawings 1 & 2. Further items to be addressed for the final design include:
    - Restoration details regarding the section of Creek identified for abandonment from STA 3+60 to Arbutus Road should be confirmed with the District of Saanich and align with the Haro Woods Park Management Plan.
    - Engage an arborist to assess potentially impacted trees along the remediation alignment for required removals and pruning. This would also include any additional topographic and/or tree pick up surveys.

- Confirm existing 450mm diameter AC sanitary sewer depth and alignment in the field at approximate STA 3+48, in relation to the proposed creek alignment. Protect the section of the sewer a minimum of 5 m on either side of the creek remediation zone with concrete encasement or a concrete slab. This will help protect the sewer from future exposure and creek influence. There may also be an opportunity at this time to replace this section of pipe with a new section pending District sewer replacement capital project planning.
- Complete an invasive species removal plan and remediation plantings and riparian area management plan.
- Complete new creek alignment bed and embankment lining design for scour and erosion controls.
- Develop a construction sequencing strategy, to assess the most cost effective and environmentally sound plan for construction access and strategy for dealing with creek flows during construction.
- Incorporate Best Management Practices (BMP's) in determining strategies to minimize impacts to the creek due to pedestrian and bicycle crossings within Haro Woods Park. The provincial guidance document *Standards and Best Practices for Instream Works* should used as a guide. The below BMP's are recommended to reduce impacts to the stream with the construction of stream crossings:
    - Cross the stream perpendicular to the channel, not at an angle.
    - Cross the stream where the stream bottom is stable, and the banks are low and intact.
    - Where stream crossings are necessary, install an appropriate structure, a bridge, a culvert, steppingstones, or a pole ford to minimize rutting and erosion.
    - Construct stream crossings during periods of no flow to minimize sediment and erosion.
    - If culverts are used, they must be sized to support storm flows and account for potential increased flows due to climate change.
    - In intermittent streams, ford crossing is often suitable, logs or clean rock for steppingstones can be used. Flow capacity should be re-confirmed when placing objects within the flow path as to not cause a backup or pinch point.
    - Fence off riparian areas to discourage pedestrian crossings at locations that are not specifically designated as stream crossings.
    - As this is not a fish bearing watercourse, the *Fish Stream Crossing Guidebook* (or its equivalent) is not a required best practice document for remediation and the *Fisheries Act* will not be triggered during remediation. However, the Riparian Management Area Guidebook may provide additional BMP's to support remediation of Finnerty Creek.

- Permitting under the *Water Sustainability Act* will be required for rehabilitation of the watercourse. The need for a Notification versus an Approval under the Act will depend on the

ultimate remedial details. Additional environmental assessments will be required to support permitting, following the detailed design.

- It should be noted that the ponded water on southeast parcel of Haro Woods in the January 2020 field assessment had no obvious impacts from pedestrian or bicycle use. Due to the lack of wetland vegetation and low habitat values for aquatic species, no specific habitat enhancement or protection efforts are recommended at this time.

6.2. COST ESTIMATE

Estimated costs have been provided as an order of magnitude approximation for planning purposes and are based on the recommendations listed in this report. All costs shown in Section 6 of this report are "Class D" as defined by EGBC and, as such. a 50% contingency has been added. These estimates have been prepared based on concepts, without completion of detailed designs, and approved permitting in place. District of Saanich costs such as procurement, staff time, contingencies and additional operations and maintenance are not included. Cost estimates as presented include engineering, design, planning, assessments, permitting, and construction.

Table 4. "Class D" Cost Estimate Summary

Item	Description	Estimate (in 2020 Dollars)
Design **Assessments** **Permitting** **Planning**	• *Engineering - Issued for Construction creek remediation plan and profile drawings, incorporation of construction sequencing strategy, sanitary sewer section replacement design, incorporation of tree removals, restoration details, and pedestrian and bicycle creek crossing details.* • *Arborist Report* • *Invasive Species removal and plantings plan* • *Environmental Permitting and accommodation of Regulatory design review requirements*	$50,000
Construction	• *Construction access, clearing and grubbing, and tree removals.* • *Excavation of remediated creek cross section with removal of spoils.* • *Placement of creek bed and embankment lining materials.* • *Sanitary sewer pipe section protection* with concrete encasement • *Restoration including removal of invasive species and plantings.*	$ 150,000
Contingency	• *50% contingency*	$100,000
	TOTAL	**$ 300,000**

7. PROFESSIONAL STATEMENT

The information presented in this report is for use by the District of Saanich and their representatives as part of their proposed the District Haro Woods - Finnerty Creek Hydrology Assessment. This assessment and its recommendations are based on limited data collected from a field review, a review of readily available web databases and a hydraulic modelling assessment. Conclusions and recommendations presented here may change with additional information. We trust the information provided is sufficient to meet your needs at this time.

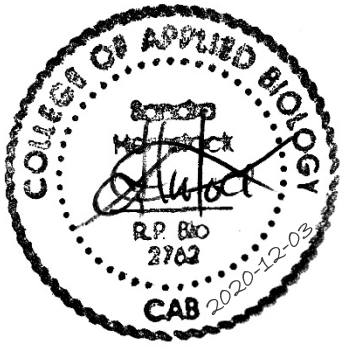
Cost Estimate Limitation of liability - The Class D cost estimate reflects McElhanney's judgement in light of the information available at the time of preparation. The estimate was prepared for the sole use of the District of Saanich and any use which a third party makes of this estimate or any reliance on decisions to be made based on it are the responsibility of such third parties. All parties agree that the consultant cannot and does not warrant or represent that bids or negotiated prices will not vary from the estimate. The parties further agree that nothing in their agreement shall be deemed to be a cost condition or representation that the project can be completed for the amounts within the estimate. the client waives its rights to withhold the consultants fees, either in whole or in part, or to make any claim or commence any action or bring any other proceedings in any court of law against the consultant in connection with the advice or information relating to the estimate whether in contract, tort or otherwise.

Should there be any questions regarding the information within, please do not hesitate to contact the undersigned.

Yours truly,

MCELHANNEY LTD.

EA Prepared by



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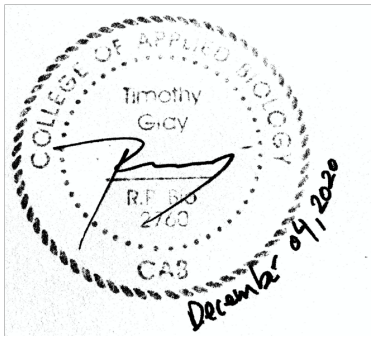

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APPENDIX A: PROPOSED CREEK REMEDIATION PLAN AND PROFILE

EDGELOW RD

FINNERTY RD

ARBUTUS RD

EXISTING TRAIL NETWORK *TYP* AS PER HARO WOODS PARK MANAGEMENT PLAN

400mm DIA AC SAN SEWER

ABANDONED

EX. 300mmØ PVC CULVERT
INLET ELV = 24.16
OUTLET ELV = 24.12

EX. HYDRANT

EX. 250mmØ PVC CULVERT
INLET ELV = 24.16
OUTLET ELV = 24.08

LIMIT OF REMEDIATION

450mm DIA AC SAN SEWER CROSSING FINNERTY CREEK - SEWER ELEV AND ALIGNMENT TO BE CONFIRMED IN THE FIELD

WATER LEVEL AT 25 YR STORM EVENT - REMEDIATED SECTION

EXISTING TRAIL NETWORK *TYP* AS PER HARO WOODS PARK MANAGEMENT PLAN

SMH 000355

EX. GRVL TRAIL

EX. DRAINAGE DISCHARGE FROM UVIC CHILDCARE SERVICES
200mmØ PVC CULVERT
OUTLET ELV = 41.72

EX. 150mmØ PVC STM DISCHARGE
OUTLET ELV = 41.72

LIMIT OF REMEDIATION

TRANSECT BY ML ENVIRONMENTAL BIOLOGIST *TYP*

SMH 0044973

EX. ALTERNATE CREEK ALIGNMENT TO BE ABANDONED AND RESTORED TO ORIGINAL CONDITION.

EX. STM DISCHARGE
350mmØ PVC c/w CONC. HEADWALL AND RIPRAP LINED DITCH
OUTLET ELV = 36.13

WATER LEVEL AT 25 YR STORM EVENT - NON-REMEDIATED SECTION

EX. 600mmØ STM MAIN DISCHARGE
OUTLET ELV = 45.75

DISTRICT OF SAANICH PROPERTY

UNIVERSITY OF VICTORIA PROPERTY

CRD PROPERTY

Rev	Date	Description	Drawn	Design	App'd
0	2020-08-06	ISSUED FOR CLIENT REVIEW	MT/LM	MH/LM	CL

0 1:1,000 50

ORIGINAL DWG SIZE: ANSI B (11" x 17")

McElhanney
Suite 500
3960 Quadra Street
Victoria BC
Canada V8X 4A3
Tel 250 370 9221

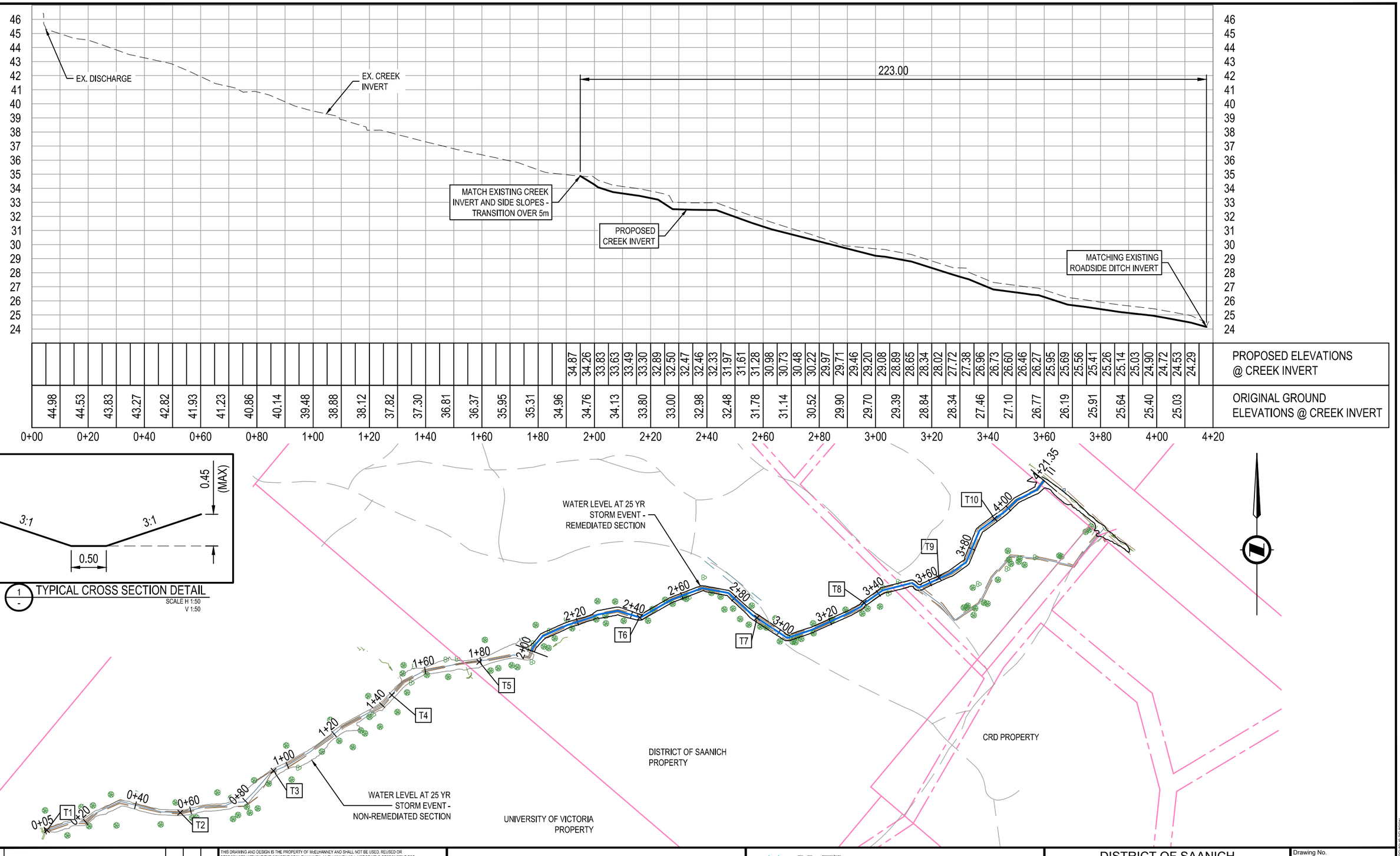
DISTRICT OF SAANICH
1040 McKENZIE AVENUE VICTORIA, BC

HARO WOODS
FINNERTY CREEK HYDROLOGY ASSESSMENT

PROPOSED CREEK REMEDIATION: PLAN

Drawing No.
DWG 1

Project Number	Rev.
2243-16-018-10	PA



Rev	Date	Description	Drawn	Design	App'd
PA	2020-08-06	ISSUED FOR CLIENT REVIEW	MT/LM	MH/LM	CL

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ORIGINAL DWG SIZE: ANSI B (11" x 17")

McElhanney
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Victoria BC
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DISTRICT OF SAANICH
1040 McKENZIE AVENUE VICTORIA, BC

HARO WOODS
FINNERTY CREEK HYDROLOGY ASSESSMENT

PROPOSED CREEK REMEDIATION: PLAN & PROFILE

Drawing No. DWG 2

Project Number 2243-16-018-10

Rev. PA

APPENDIX B: MOE BC SPECIES AND ECOSYSTEMS EXPLORER DATABASE SEARCH RESULTS

Table 5. Ecological communities search results – Terrestrial Ecosystems (CDFmm in the CRD) [bold indicates communities observed on-site]*

Scientific Name	English Name	BC List	BGC	Ecosystem Group
Abies grandis / Berberis nervosa	Grand fir / Dull Oregon-grape	Red	CDFmm/04	Terrestrial Realm - Forest: Coniferous - mesic
Alnus rubra / Rubus spectabilis / Equisetum arvense	Red alder / salmonberry / common horsetail	Blue	CDFmm/09; CDFmm/Fl51	Terrestrial Realm - Flood Group (F): Low Bench Flood Class (Fl)
Arbutus menziesii / Arctostaphylos columbiana	Arbutus / hairy manzanita	Red	CDFmm/00	Terrestrial Realm - Forest: Broadleaf - dry
Populus trichocarpa - Alnus rubra / Rubus spectabilis	Black cottonwood - red alder / salmonberry	Blue	CDFmm/08	Terrestrial Realm - Flood Group (F): Middle Bench Flood Class (Fm); Terrestrial Realm - Forest: Broadleaf - moist/wet
Pseudotsuga menziesii - Arbutus menziesii	**Douglas-fir - arbutus**	**Red**	**CDFmm/02**	**Terrestrial Realm - Forest: Coniferous - dry**
Pseudotsuga menziesii / Berberis nervosa	**Douglas-fir / Dull Oregon-grape**	**Red**	**CDFmm/01**	**Terrestrial Realm - Forest: Coniferous - mesic**
Pseudotsuga menziesii / Melica subulata	Douglas-fir / Alaska oniongrass	Red	CDFmm/03	Terrestrial Realm - Forest: Coniferous - dry
Quercus garryana - Arbutus menziesii	Garry oak - arbutus	Red	CDFmm/00	Terrestrial Realm - Forest: Broadleaf - dry
Quercus garryana / Bromus carinatus	Garry oak / California brome	Red	CDFmm/00	Terrestrial Realm - Forest: Broadleaf - dry
Quercus garryana / Holodiscus discolor	Garry oak / oceanspray	Red	CDFmm/00	Terrestrial Realm - Forest: Broadleaf - dry
Selaginella wallacei / Cladina spp.	Wallace's selaginella / reindeer lichens	Blue	CDFmm;	Terrestrial Realm - Grassland Group (G):
Thuja plicata / Symphoricarpos albus	Western redcedar / common snowberry	Red	CDFmm/07	Terrestrial Realm - Flood Group (F): Highbench Flood; Terrestrial Realm - Forest: Mixed - moist/wet

*CDC. 2019. BC Species and Ecosystems Explorer. B.C. Ministry of Environment Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ Search Criteria

Table 6. Vascular plants search results – Terrestrial* (CDFmm in the CRD)*

Scientific Name	English Name	COSEWIC	BC List	SARA	Habitat Subtype
Allium amplectens	Slimleaf onion		Blue		Garry Oak Woodland
Balsamorhiza deltoidea	Deltoid balsamroot	E (Apr 2009)	Red	1-E (Jun 2003)	Mixed Forest (deciduous/coniferous mix); Garry Oak Woodland
Carex tumulicola	Foothill sedge	E (Mar 2008)	Yellow	1-E (Feb 2010)	Garry Oak Woodland
Cephalanthera austiniae	Phantom orchid	E (Nov 2014)	Red	1-T (Jun 2003)	Conifer Forest - Mesic (average); Mixed Forest (deciduous/coniferous mix)
Epilobium torreyi	Brook spike-primrose	E (Dec 2018)	Red	1-E (Dec 2007)	Conifer Forest - Dry; Garry Oak Woodland
Eurybia radulina	Rough-leaved aster		Red		Conifer Forest - Dry; Garry Oak Woodland

Scientific Name	English Name	COSEWIC	BC List	SARA	Habitat Subtype
Lupinus oreganus var. *kincaidii*	Kincaid's lupine	XT (Nov 2008)	Unknown	1-XX (Feb 2011)	Garry Oak Woodland
Lupinus rivularis	Streambank lupine	E (Nov 2002)	Red	1-E (Jan 2005)	Stream/River; Urban/Suburban; Garry Oak Woodland
Marah oregana	Coast manroot	E (Nov 2009)	Red		Garry Oak Woodland
Plagiobothrys tenellus	Slender popcornflower	T (Nov 2008)	Red	1-T (Feb 2011)	Conifer Forest - Dry; Garry Oak Woodland
Platanthera ephemerantha	White-lip rein orchid		Blue		Conifer Forest - Dry; Garry Oak Woodland
Sabulina pusilla	Dwarf sandwort	E (May 2004)	Red	1-E (Jul 2005)	Conifer Forest - Dry
Sanicula bipinnatifida	Purple sanicle	T (May 2001)	Red	1-T (Jun 2003)	Garry Oak Woodland
Sericocarpus rigidus	White-top aster	SC (Apr 2009)	Blue	1-SC (Jun 2003)	Mixed Forest (deciduous/coniferous mix); Garry Oak Woodland
Silene scouleri ssp. *scouleri*	Coastal Scouler's catchfly	E (May 2003)	Red	1-E (Jan 2005)	Garry Oak Woodland
Tonella tenella	Small-flowered tonella	E (Nov 2003)	Blue	1-E (Jul 2005)	Conifer Forest - Dry; Garry Oak Woodland
Triteleia howellii	Howell's triteleia	E (May 2003)	Red	1-E (Jan 2005)	Conifer Forest - Dry; Garry Oak Woodland
Uropappus lindleyi	Lindley's microseris	E (Mar 2008)	Red	1-E (Feb 2010)	Conifer Forest - Dry
Viola howellii	Howell's violet		Red		Garry Oak Woodland
Viola praemorsa var. *praemorsa*	Yellow montane violet	E (Nov 2007)	Red	1-E (Jun 2003)	Garry Oak Woodland
Zeltnera muehlenbergii	Muhlenberg's centaury	E (Mar 2008)	Red	1-E (Feb 2010)	Garry Oak Woodland

*CDC. 2019. BC Species and Ecosystems Explorer. B.C. Ministry of Environment Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ Search Criteria

Table 7. Vertebrate wildlife search results - (CDFmm in the CRD)*

Class	Scientific Name	English Name	COSEWIC	BC List	SARA	Available Habitat Subtype
Amphibia	*Anaxyrus boreas*	Western Toad	SC (Nov 2012)	Yellow	1-SC (Jun 2018)	Riparian Forest; Stream/River; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix)
Aves	*Accipiter gentilis laingi*	Northern Goshawk, *laingi* subspecies	T (Apr 2013)	Red	1-T (Jun 2003)	Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix);

Class	Scientific Name	English Name	COSEWIC	BC List	SARA	Available Habitat Subtype
	Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	SC (Mar 2008)	Blue	1-SC (Feb 2010)	Riparian Forest; Conifer Forest - Mesic (average); Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Asio flammeus	Short-eared Owl	SC (Mar 2008)	Blue	1-SC (Jul 2012)	Urban/Suburban
	Brachyramphus marmoratus	Marbled Murrelet	T (May 2012)	Blue	1-T (Jun 2003)	Riparian Forest; Stream/River; Conifer Forest - Mesic (average)
	Butorides virescens	Green Heron		Blue		Riparian Forest; Stream/River; Urban/Suburban
	Chordeiles minor	Common Nighthawk	SC (May 2018)	Yellow	1-T (Feb 2010)	Stream/River; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Coccothraustes vespertinus	Evening Grosbeak	SC (Nov 2016)	Yellow	1-SC (May 2019)	Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Contopus cooperi	Olive-sided Flycatcher	SC (May 2018)	Blue	1-T (Feb 2010)	Riparian Forest; Conifer Forest - Mesic (average); Mixed Forest (deciduous/coniferous mix)
	Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	NAR (Dec 2017)	Red	1-SC (Jun 2012)	Stream/River; Urban/Suburban
	Glaucidium gnoma swarthi	Northern Pygmy-owl, *swarthi* subspecies		Blue		Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Hirundo rustica	Barn Swallow	T (May 2011)	Blue	1-T (Nov 2017)	Riparian Forest;Stream/River; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Hydroprogne caspia	Caspian Tern	NAR (May 1999)	Blue		Stream/River; Urban/Suburban
	Megascops kennicottii	Western Screech-Owl, *kennicottii* subspecies	T (May 2012)	Blue	1-T	Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban

Class	Scientific Name	English Name	COSEWIC	BC List	SARA	Available Habitat Subtype
	Patagioenas fasciata	Band-tailed Pigeon	SC (Nov 2008)	Blue	1-SC (Feb 2011)	Riparian Forest; Conifer Forest - Mesic (average); Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Phalacrocorax auritus	Double-crested Cormorant	NAR (May 1978)	Blue		Stream/River; Conifer Forest - Mesic (average); Urban/Suburban
	Progne subis	Purple Martin		Blue		Riparian Forest; Stream/River; Conifer Forest - Mesic (average); Conifer Forest - Dry; Urban/Suburban
	Tyto alba	Barn Owl	T (Nov 2010)	Red	1-T (Jun 2018)	Riparian Forest; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
Mammalia	*Corynorhinus townsendii*	Townsend's Big-eared Bat		Blue		Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
	Mustela erminea anguinae	Ermine, *anguinae* subspecies		Blue		Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix)
	Myotis lucifugus	Little Brown Myotis	E (Nov 2013)	Yellow	1-E (Dec 2014)	Riparian Forest; Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban; Garry Oak Woodland
Reptilia	*Contia tenuis*	Sharp-tailed Snake	E (Nov 2009)	Red	1-E (Jun 2003)	Conifer Forest - Dry

*CDC. 2019. BC Species and Ecosystems Explorer. B.C. Ministry of Environment Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ Search Criteria

Table 8. Invertebrate wildlife search results - (CDFmm in the CRD)*

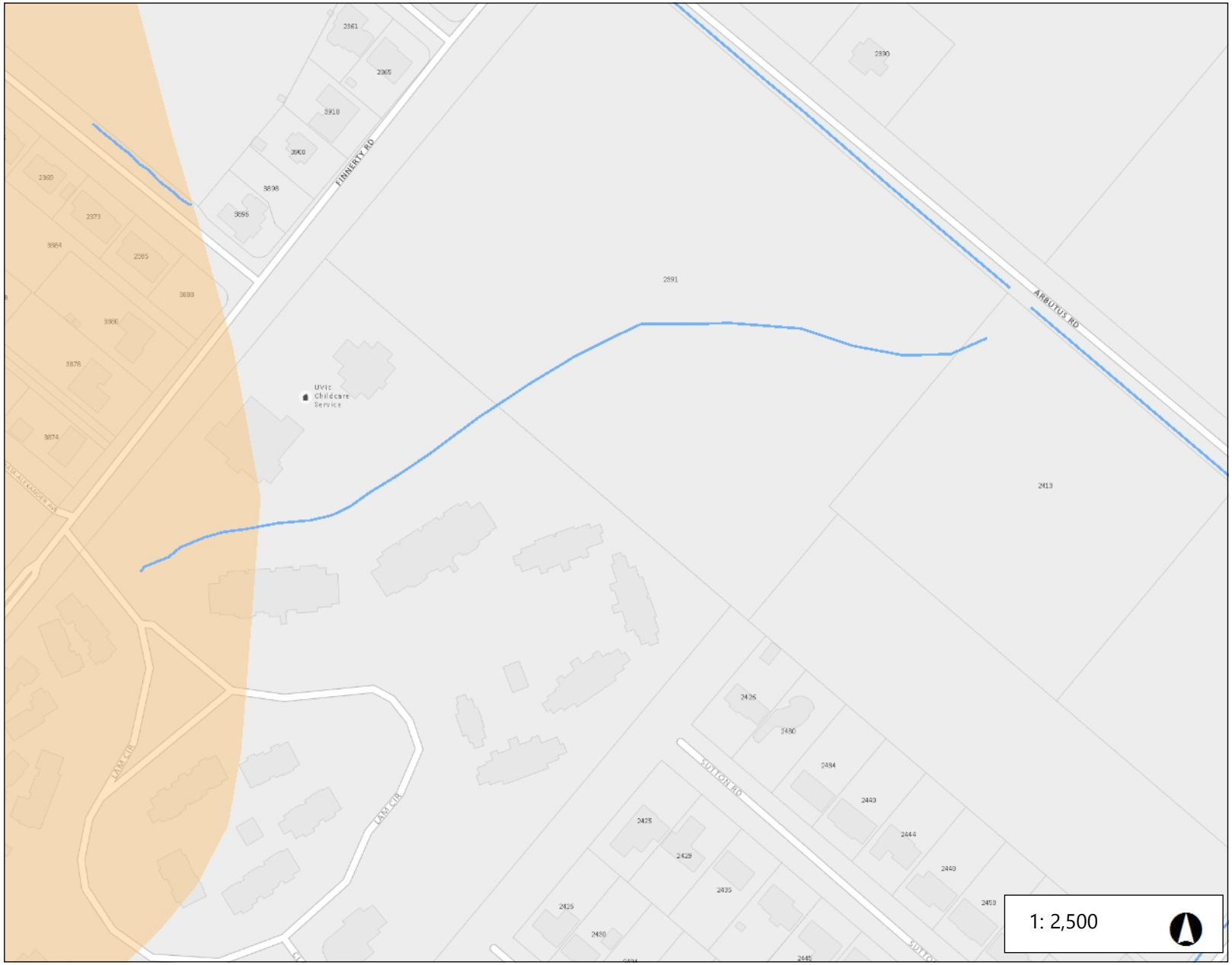
Scientific Name	English Name	COSEWIC	BC List	SARA	Habitat Subtype
Callophrys johnsoni	Johnson's Hairstreak		Red		Conifer Forest - Mesic (average)
Carychium occidentale	Western Thorn		Blue		Mixed Forest (deciduous/coniferous mix)
Cercyonis pegala incana	Common Wood-nymph, *incana* subspecies		Red		Conifer Forest - Dry
Coenonympha tullia insulana	Common Ringlet, *insulana* subspecies		Red		Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix)

Scientific Name	English Name	COSEWIC	BC List	SARA	Habitat Subtype
Cryptomastix devia	Puget Oregonian	XT (Apr 2013)	Red	1-XX (Jan 2005)	Riparian Forest; Mixed Forest (deciduous/coniferous mix)
Epargyreus clarus	Silver-spotted Skipper		Blue		Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix); Urban/Suburban
Erynnis propertius	Propertius Duskywing		Red		Mixed Forest (deciduous/coniferous mix); Garry Oak Woodland
Hemphillia dromedarius	Dromedary Jumping-slug	T (May 2014)	Red	1-T (Jan 2005)	Conifer Forest - Moist/wet
Hemphillia glandulosa	Warty Jumping-slug	SC (Apr 2013)	Red	1-SC (Jan 2005)	Riparian Forest; Mixed Forest (deciduous/coniferous mix)
Nearctula sp. 1	Threaded Vertigo	SC (Apr 2010)	Blue	1-SC (Jul 2012)	Mixed Forest (deciduous/coniferous mix)
Plebejus saepiolus insulanus	Greenish Blue, *insulanus* subspecies	E (May 2012)	Red	1-E (Jun 2003)	Riparian Forest
Pristiloma johnsoni	Broadwhorl Tightcoil		Blue		Conifer Forest - Mesic (average); Conifer Forest - Dry; Mixed Forest (deciduous/coniferous mix)
Prophysaon coeruleum	Blue-grey Taildropper	T (Apr 2016)	Blue	1-E (Dec 2007)	Mixed Forest (deciduous/coniferous mix)
Speyeria zerene bremnerii	Zerene Fritillary, *bremnerii* subspecies		Red		Urban/Suburban
Sympetrum vicinum	Autumn Meadowhawk		Blue		Stream/River; Mixed Forest (deciduous/coniferous mix)
Tramea lacerata	Black Saddlebags		Red		Riparian Forest
Vertigo andrusiana	Pacific Vertigo		Red		Mixed Forest (deciduous/coniferous mix)

APPENDIX C: iMAP BC SEARCH RESULTS

Making a difference...together

CRD Sensitive Ecosystem



Legend

- Watercourses Primary < 20,00
- Watercourses Secondary < 20
- Watercourses < 20,000
- River
- Garry Oak 1800
- Garry Oak 1997

Sensitive Ecosystems

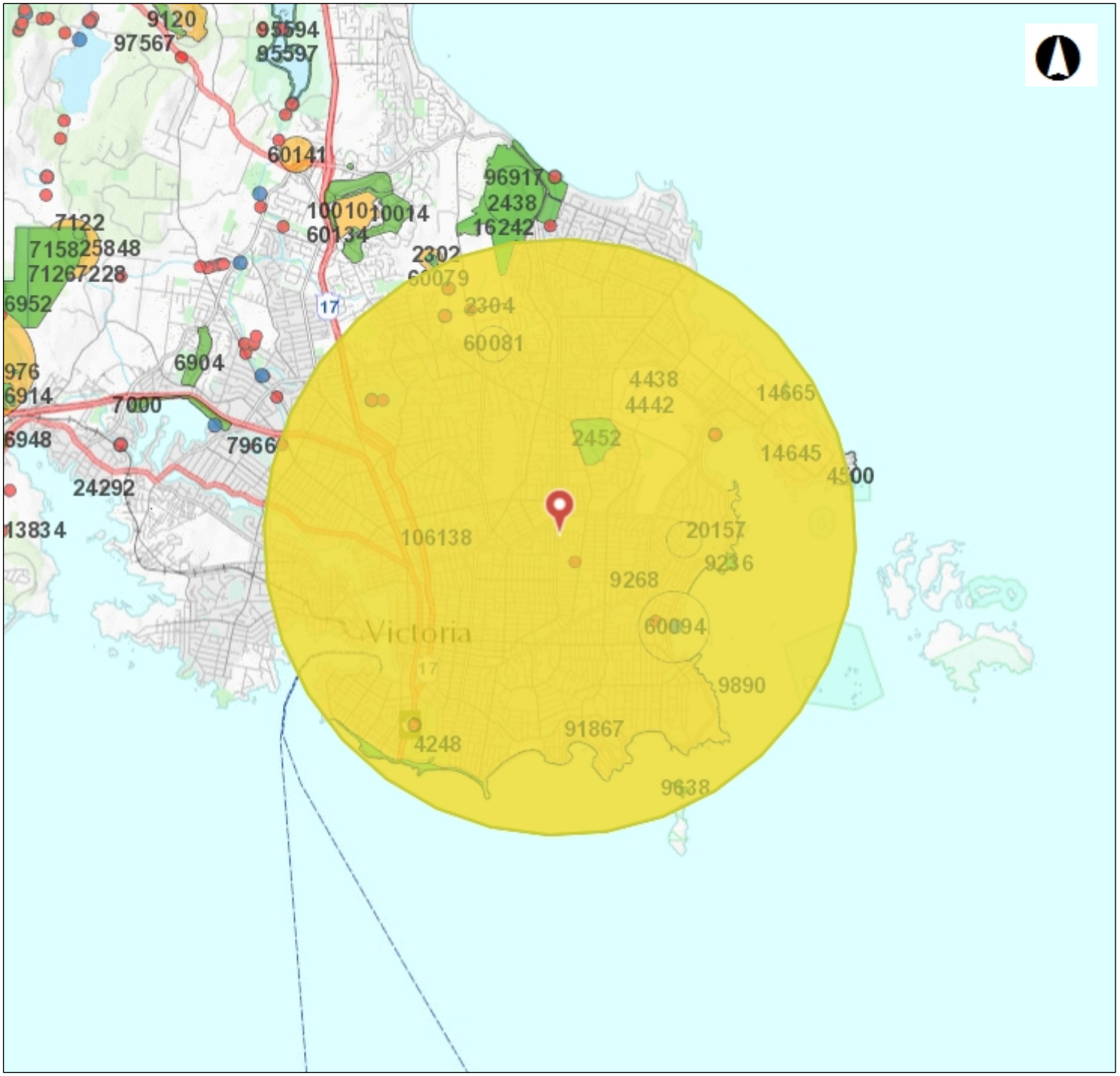
- Coastal Bluffs
- Estuarine
- Intertidal
- Herbaceous
- Mature Forest
- Cliff
- Non-Sensitive
- Fresh Water
- Fringe Forest
- Terrestrial Herbaceous
- Older Forest
- Riparian
- Sparsely Vegetated
- Wetland
- Woodland
- Seasonally Flooded Agricultural
- Older Second Growth

1: 2,500

Notes

0.1 0 0.06 0.1 Kilometres

NAD_1983_UTM_Zone_10N



BRITISH COLUMBIA

habwiz Mapping - SAR map

Legend

All Fish points

POINT_TYPE_CODE

- Observation
- Summary

Contours - (1:250,000)

FCODE

- Contour - Index
- Contour - Intermediate
- Area of Exclusion
- Area of Indefinite Contours

Species and Ecosystems at Publicly Available Occurrenc

FEATURE_CODE

- Animal - Vertebrate
- Animal - Invertebrate

0 2.94 5.87 km

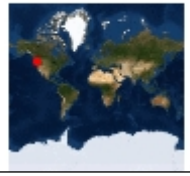
1: 144,448

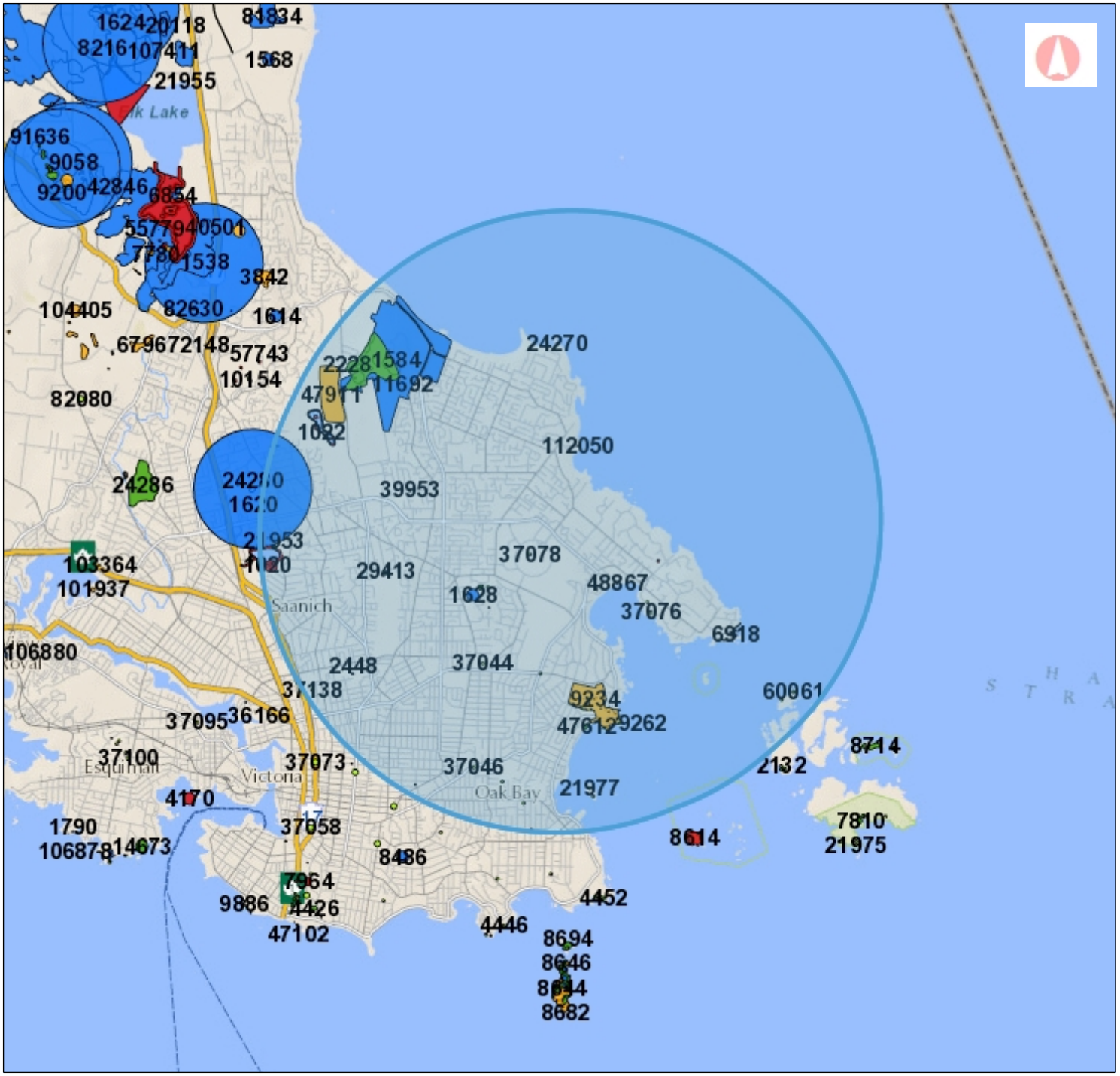
Copyright/Disclaimer

Datum: NAD83

Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

Key Map of British Columbia





BRITISH COLUMBIA

iMapBC Mapping

Legend

Species and Ecosystems at Available Occurrences - CD

FEATURE_CODE

- Animal - Vertebrate
- Animal - Invertebrate
- Plant - Vascular
- Plant - Non-vascular
- Ecological Community

☐ Species and Ecosystems at Available Occurrences - CD

0 2.94 5.87 km

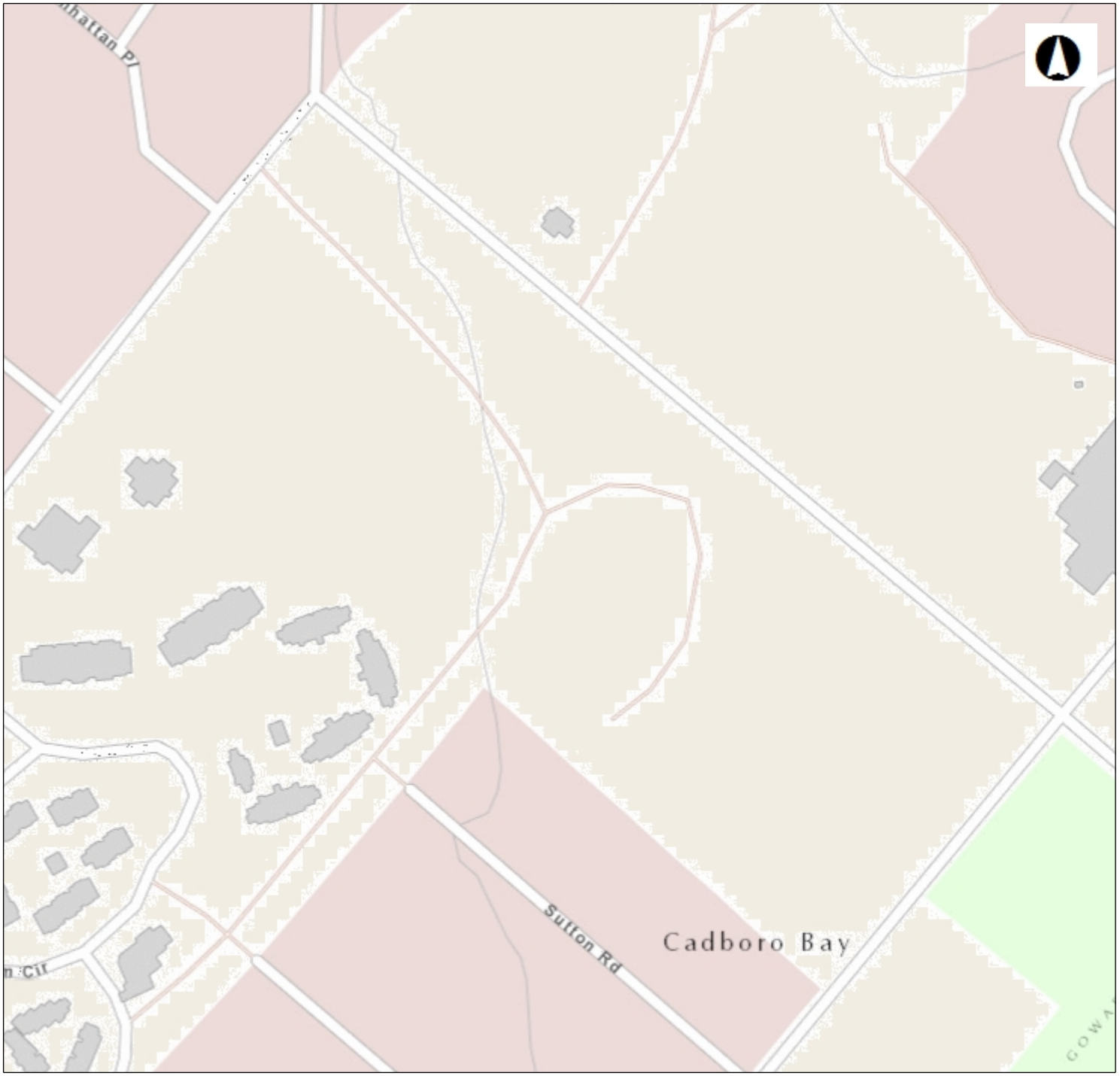
1: 144,448

Copyright/Disclaimer

Datum: NAD83

Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

Key Map of British Columbia



BRITISH COLUMBIA

habwiz Mapping

Legend

All Fish points

POINT_TYPE_CODE

- Observation
- Summary

Stream Centre Line Network

WDIC_SPFTP_CODE

- 100 - Coastline
- 1000 - Single-line blueline, main
- 1050 - Single-line blueline, throu
- 1100 - Single-line blueline, seco
- 1150 - Single-line blueline, seco
- 1200 - Construction line, main fl
- 1250 - Construction line, double
- 1300 - Construction line, second

0 0.09 0.18 km

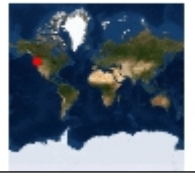
1: 4,514

Copyright/Disclaimer

Datum: NAD83

Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

Key Map of British Columbia



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CANADA'S BEST MANAGED COMPANIES