Review of Mayne Island Riparian Area Regulation Requirements - Recommendations Resulting from Application of the Detailed RAR Assessment Methodology

PREPARED FOR:

Mr. Gary Richardson – Island Planner
Islands Trust
200-1627 Fort Street
Victoria, BC
V8R 1H8

PREPARED BY:

Trystan Willmott, B.Sc. A.Sc.T.
MADRONE ENVIRONMENTAL SERVICES LTD.

March 7, 2017

MADRONE ENVIRONMENTAL SERVICES LTD.
1081 CANADA AVENUE • DUNCAN • BC • V9L 1V2
TEL 250.746.5545 • FAX 250.746.5850 • WWW.MADRONE.CA

DOSSIER: 16.0418

TABLE OF CONTENTS

Review of Mayne Island Riparian Area Regulation Requirements - Recommendations Resulting from Application of the Detailed RAR Assessment Methodology

1 Introduction

1.1 Riparian Areas Regulation (RAR) Overview

The Riparian Areas Regulation (RAR) is the basis of streamside protection in British Columbia. The RAR was enacted in 2004 under Section 12 of the Fish Protection Act. The RAR is a joint initiative with Fisheries and Oceans Canada (DFO), the Ministry of Environment (MoE) and local government. The RAR uses a science-based approach to help ensure land development activities do not result in a harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes. In BC, the definition of fish habitat includes all aquatic and terrestrial areas that affect fish life processes. Fish habitat, therefore, includes the area directly adjacent to a stream (*i.e.*, the riparian area) because it provides food, nutrients, and other functions vital to fish survival.

Since the inception of the RAR, local governments throughout BC have enacted bylaws associated with RAR implementation, usually through the establishment of Development Permit Areas (DPAs). The default standard, as per the RAR, is that development activities within the "Riparian Assessment Area" (RAA), which extends for a distance of 30 m back from the High Water Mark (HWM) of a "stream" (as defined under the RAR) trigger the completion of an assessment using RAR assessment methodology. The "Detailed Assessment" methodology establishes a site-specific Streamside Protection and Enhancement Area (SPEA), which is generally based on the average bankfull width of a stream, or default setbacks associated with wetlands, ponds and lakes. Under the Detailed Assessment, the SPEA ranges from a minimum of 10 m to a maximum of 30 m for lotic systems (streams) and a minimum of 15 m to a maximum of 30 m for lentic systems (wetlands, ponds and lakes). Ditches are associated with narrower SPEAs, usually between 2 m – 5 m, depending on fish-bearing status.

The Detailed Assessment methodology considers three Zones of Sensitivity (ZOS), which provide biological function to the adjacent water body when establishing the SPEA: shade; Large Woody Debris (LWD) input/bank stability; and litter fall/insect drop. The shade ZOS applies to the south side of streams, wetlands and lakes and is based on a value that is three times the average channel width for lotic systems, but for lentic systems, the ZOS for shade is 30 m on southern banks. The LWD/bank stability ZOS is also based on a value that is three times the average channel width in lotic areas, up to a maximum of 30 m and a minimum of 10 m. Channel morphology (e.g. riffle-pool, cascade-pool or step-pool) affects the maximum LWD/bank stability ZOS, with the maximum for a cascade-pool system, for example, set at 15 m. For a riffle-pool system, this ZOS could extend to the maximum of 30 m, depending on the bankfull width. For lentic systems, the ZOS for LWD/bank stability is 15 m. The litter fall/insect drop ZOS is established at 15 m for lentic systems and is calculated on lotic systems as being three times the average channel width, up to a maximum of 15 m and a minimum of 10 m. The SPEA is always set at the maximum of the three ZOS.

For small streams with average bankfull widths that are less than approximately 3.3 m, the SPEA (extending from the HWM) would be 10 m under the Detailed Assessment methodology, considering the influence of the three different ZOS. As part of the Detailed Assessment, a suite of site -specific SPEA-protection measures that consider erosion and sediment control, tree protection, danger tree management, windthrow, slope stability, stormwater management, encroachment and floodplain concerns are recommended to help ensure that the SPEA remains biologically functional during and after any development proposal that occurs within the RAA. As noted, Detailed Assessments are generally triggered by a development proposal inside the RAA, and the various measures are prescribed by a Qualified Environmental Professional (QEP) as part of a report submitted to the Riparian Areas Regulation Notification System.

The "Simple Assessment" methodology is another process used to determine the width of the SPEA, and is based on potential riparian vegetation width, stream periodicity and fish presence or absence. Based on the rural nature of Mayne Island and depth of potential riparian vegetation, both lotic and lentic systems would likely be associated with SPEAs between 15 – 30 m through implementation of the Simple Assessment. The wider SPEAs that generally result from applying the Simple Assessment methodology in part reflect the fact that there are no specific SPEA protection measures associated with the Simple Assessment.

"Development" activities, which would trigger an assessment under RAR, include the following (as regulated under Part 26 of the *Local Government Act* for residential, commercial and industrial activities):

- removal, alteration, disruption or destruction of vegetation;
- disturbance of soils;
- construction or erection of buildings and structures;
- creation of non-structural impervious or semi-impervious surfaces;
- flood protection works;
- construction of roads, trails, docks, wharves and bridges;
- provision and maintenance of sewer and water services;
- development of drainage systems;
- development of utility corridors; and
- subdivision as defined in section 872 of the *Local Government Act*.

The regulation does not apply to a development permit or development variance permit issued only for the purpose of enabling reconstruction or repair of a permanent structure described in section 911 (8) of the Local Government Act if the structure remains on its existing foundation. It is also important to note that the regulation does not apply to farming-related activities consistent with the *Right to Farm Act*, institutional development proposals or forestry activities on private land governed by the *Private Managed Forest Land Act* or on woodlot or tree farm licences managed under the *Forest Act*.

Existing land-uses and structures that are located inside a RAA or SPEA are considered legally non-conforming; land within the RAA or SPEA can be used as it has been historically, but one of the goals of the RAR is to enhance degraded habitat. If any new development activities are proposed within a RAA, that is when the RAR would apply. Similarly, if a non-farming-related activity were proposed on agricultural land, the RAR would apply.

The RAR only considers development activities adjacent to freshwater habitat and does not apply to saltwater. The upper limit of tidal influence is relevant, therefore, in the implementation of the RAR, as per the RAR assessment methods:

> *"The Riparian Areas Regulation does not apply to marine or estuarine shorelines; these waters are still considered fish habitat under the Fisheries Act and DFO should*

> *be contacted regarding appropriate setback widths to ensure that development activities do not result in a harmful alteration, disruption or destruction of fish habitat. The boundary between freshwater habitats and estuarine habitats is considered the upstream extent of tidal influence."*

Fish and fish habitat are also protected by the Federal Fisheries Act. Where the RAR do not apply in freshwater habitat (e.g. on farm land) the Fisheries Act is applicable. Specifically, the Fisheries Act affords protection to fish that form part of a commercial, recreational or Aboriginal fishery, which includes fish that support such a fishery. It is unlawful to cause "Serious Harm" to fish (unless Authorized under specific circumstances), which is defined under the Fisheries Act as "…the death of fish or any permanent alteration to, or destruction of, fish habitat." Upland activities adjacent to freshwater areas (even if the stream were to be non-fish-bearing) that cause the introduction of deleterious substances (which includes sediment) into the marine environment would be subject to the Fisheries Act.

The Water Sustainability Act regulates instream works, such as (but not limited to): culvert placement; construction of irrigation ponds; bank armouring; channel maintenance; and water withdrawal. Any instream works are required to obtain either Approvals or Notifications under Section 11 of the Water Sustainability Act. In addition to considering potential ecological impacts from instream works (including the maintenance of fish passage), the Section 11 process also considers potential downstream effects to landowners (e.g. impacts that may be related to increased erosion or flooding from dam breaches etc.). The Section 11 process also applies to related works in the riparian area. For example, a driveway being placed across a stream requiring the placement of a crossing structure (e.g. culvert) would necessitate the unavoidable disturbance of riparian vegetation within a SPEA. In this particular example, the disturbance would be considered and permitted as part of the Section 11 application.

1.2 Objectives

Islands Trust requested that Madrone Environmental Services Ltd. (Madrone) complete an assessment of selected stream networks on Mayne Island to determine the applicability of the streams to the RAR. Another objective was to complete an overview RAR Detailed Assessment on applicable streams to help establish refined DPAs that would be reflective of specific stream characteristics and RAR assessment methodology – specifically bankfull width and associated SPEA dimensions. The selected streams consisted of Campbell Creek, Horton Creek (Hunt Brook) and Deacon Creek (Village Bay Creek). The scope of the project did not involve stream mapping or correcting any previous stream mapping that had been conducted.

1.3 Definition of a Stream under RAR

In order to determine applicability of the selected streams to the RAR, the definition of a "stream" as listed under the RAR, was used as a standard. As per Section 1.4.2 of the RAR Assessment Methodology; (http://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/riparian-areas-regulations/rar_assessment_methods.pdf), a "stream" is defined as follows:

"…any watercourse – natural or human made – that provides fish habitat that contains water on a perennial or seasonal basis, is scoured by water or contains observable deposits of mineral alluvium, or has a continuous channel bed including a watercourse that is obscured by overhanging or bridging vegetation or soil mats. A watercourse may not itself be inhabited by fish, but may provide water, food and nutrients to streams that do support fish."

The RAR further identifies a stream as:

"…any of the following that provides fish habitat:

(a) a watercourse, whether it usually contains water or not;

(b) a pond, lake, river, creek, brook;

(c) a ditch, spring or wetland that is connected by surface flow to something referred to in paragraph (a) or (b).

It is important to note that a "stream" under the RAR is not necessarily fish bearing. If a watercourse connects by surface flow to potential fish habitat, it is considered a "stream" under the RAR. If a barrier (either definitive or non-permanent) to the migration of fish is identified, a watercourse is classified as a stream above the barrier if there is potential fish habitat downstream of the barrier. Any part of a watercourse that is not inhabited by fish (e.g. above a barrier) that connects by surface flow to fish habitat is considered a stream under the RAR process.

If low gradient habitat (less than 20%) occurs on a stream at tidewater (even if the stream only exhibits seasonal flow), it would be expected to provide potential habitat for anadromous fish capable of completing their life cycle in seasonal streams (e.g. chum – *Oncorhynchus keta* – and pink – *Oncorhynchus gorbuscha* salmon). Sexually immature anadromous life-phase coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) could also potentially use any seasonal streams that connect directly to the ocean (assuming access is possible from the ocean). Sexually immature coastal cutthroat trout can exhibit "wandering" tendencies and overwinter in streams that may not necessarily be their natal systems prior to showing fidelity to their natal streams during spawning runs once sexually

mature (Johnston 1982; cited in Slaney and Roberts 2005). Where a natural barrier occurs at tidewater, which precludes the entry of any anadromous fish, either due to excessive gradient or a singular feature, a stream would not be expected to provide fish habitat, unless suitable potential habitat for resident fish occurred above the barrier.

It is also important to consider the definition of a "ditch" as opposed to a "stream". Under the RAR (http://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/fish-fish-habitat/riparian-areas-regulations/rar_assessment_methods.pdf), ditches are defined as follows: *"Ditches are characterized as being manmade and straight, with no significant headwaters or springs. They were constructed to drain property (they often form property boundaries) or roadways and while connected to natural streams they are not part of the natural historic drainage pattern."*

If a ditch connects by surface flow to a potentially fish-bearing stream, it is considered under the regulation (albeit with reduced setbacks). Channelized or ditched segments of the historic drainage network or ditched portions of watercourses that are naturally fed by springs or are associated with headwaters are not considered "ditches". It is possible, therefore, to have long, straight segments of ditching or channelization on a natural stream; if segments of natural stream channel remain either upstream or downstream of a ditched segment, the system would be classified as a "stream" as opposed to a "ditch".

2 Methodology

2.1 Background Research

Based on the history of the RAR-implementation process on Mayne Island (over the past 8-10 years), previous QEP reports were reviewed prior to conducting a field assessment of the selected streams. These reports consisted of: Mayne Island Stream Survey Report - Prepared by Kathleen Reimer, March 2007; Review of Riparian areas Regulation for Streams on Mayne Island - Prepared by Swell Environmental Consulting, February 16th 2010; Mayne Island Fish Presence Assessment - Prepared by D.R. Clough Consulting, July 2010; and Mayne Island Fish Presence Survey – Salmon Spawner Survey 2011 - Prepared by D.R. Clough Consulting, January 20th 2012. Background research was also carried out using the Habitat Wizard database (http://maps.gov.bc.ca/ess/sv/habwiz/) to determine whether any documented fish distribution data existed for the focus streams.

2.2 Assessment Area

The assessment area included the existing stream network provided by Islands Trust for the Campbell Creek, Deacon Creek (Village Bay Creek) and Horton Creek (Hunt Brook) watersheds. An overview of the assessment area is shown in Figure 1.

2.3 Landowner Contact

Prior to the field assessment, a database containing landowner information was provided by Islands Trust for landowners with streams on their property. Affected landowners were contacted by telephone, advised of the objectives of the assessment and asked for access permission. Field maps were modified accordingly to reflect those properties where access was permitted and those where access had been denied. Attempts were made to contact all affected property owners, although there were several instances where landowners were absent during the landowner contact phase, or contact information could not be found. During fieldwork, further efforts were made to contact property owners by knocking on doors and explaining the objectives of the assessment. This approach was not always practical, based on the fact that many landowners were absent. Properties were not included in the assessment unless explicit permission had been provided beforehand, or was given during the fieldwork.

2.4 Field Assessment Procedures

The field assessment took place between February 13th and 14th 2017 and was completed by Trystan Willmott, B.Sc., A.Sc.T. and Justin Lange, B.Sc., R.P.Bio. Both crew members have completed the provincial RAR-implementation training course and are Qualified Environmental Professionals (QEPs) under the RAR.

The field assessment was carried out during a period of relatively high stream flow, at a time when the seasonal watercourses on Mayne Island contained flowing water. The outlet of each stream was assessed to determine whether access for anadromous fish was possible. Based on a review of the previous QEP reports, this appeared to be most critical at the mouth of Campbell Creek, where there were conflicting opinions as to whether a physical barrier to upstream fish movement was present or not.

Where property access had been allowed, measurements of bankfull width were completed on the subject RAR-applicable streams to determine the width of the SPEA under the Detailed Assessment RAR methodology. Where sufficient area was available on each accessible property, eleven measurements of bankfull width were taken. The average bankfull width was then calculated by removing the maximum and minimum values and

dividing the total by the remaining number of values (nine). Stream gradient was also measured to determine channel type, as this (in addition to bankfull width) affects the calculation of the SPEA. Observations of riparian vegetation characteristics and land use were also noted, to help in the consideration of recommended DPA dimensions.

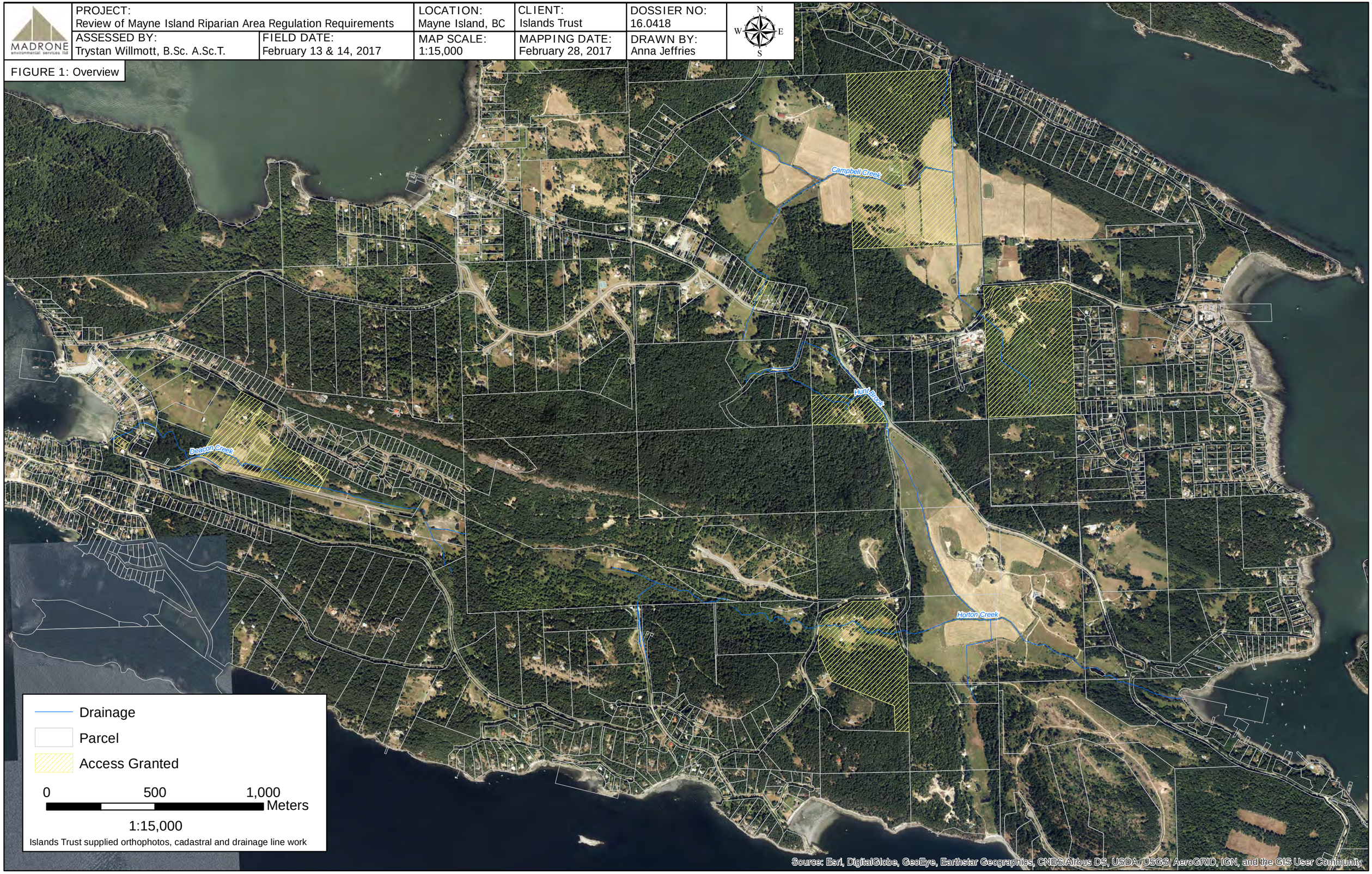
The reach breaks included in Swell (2010) were used as a basis in describing and determining the SPEA for each stream segment. In cases where property access was not possible, descriptions of the stream channels from Clough (2010) and Swell (2010), which included bankfull width, were used to determine the SPEA (where practical to do so). Field observations and measurements were also completed where possible (e.g. from road right of ways).

As the field assessment was not based on any specific development activities, specific SPEA-protection "measures" (which usually represent part of the Detailed Assessment procedure) were not completed for each of the assessed areas; rather, the Detailed Assessment methodology was used to determine the dimensions of the SPEAs for incorporation into Islands Trust's RAR implementation strategy (*i.e.* determination of DPAs). Figures 2 and 3 show the dimensions of the SPEAs on applicable streams. Detailed instream habitat assessment notes were not collected, based on the significant volume of existing data (e.g. Swell 2010; Clough 2010, 2012).

While the scope of the assessment did not include mapping the location of streams, where inconsistencies or additional unmapped drainages were observed, general locational data was noted using the GPS function on an I-Pad. Discrepancies and general corrections have been highlighted in Figures 2 and 3. Representative site photographs were also taken during the field assessment Appendix 1).

MADRONE environmental services ltd	PROJECT: Review of Mayne Island Riparian Area Regulation Requirements		LOCATION: Mayne Island, BC	CLIENT: Islands Trust	DOSSIER NO: 16.0418
	ASSESSED BY: Trystan Willmott, B.Sc. A.Sc.T.	FIELD DATE: February 13 & 14, 2017	MAP SCALE: 1:15,000	MAPPING DATE: February 28, 2017	DRAWN BY: Anna Jeffries

FIGURE 1: Overview



3 Results

3.1 Documented Fish Distribution Data and Previous Fish Sampling Work

Campbell Creek is a documented, gazetted stream (Watershed Code 925-259000-77400). Horton Creek is also a gazetted system (Watershed Code 925-259000-91200). Research using Habitat Wizard (2017) indicated documented observations of coastal cutthroat trout in several reaches of Horton Creek (observation date of 1995). There is no available data that would suggest that these fish were artificially introduced to the system (stocked), indicating that the observed fish were likely part of a natural population. Chum salmon are also documented as occurring in Horton Creek (observation date of 1995), which is likely attributable to a "Salmon in The Classroom" project (Reimer 2007). According to Reimer (2007), there was one anecdotal record of chum salmon returning to this creek as a result of the project.

Documented occurrences of rainbow trout (*Oncorhynchus mykiss*) are listed for Campbell Creek (1995 observation date), which were apparently "naturalized" progeny of fish that were stocked historically in constructed ponds on the 380 Campbell Bay Road property (Reimer 2007). There are no documented occurrences of fish in Deacon Creek, but Reimer (2007) stated that chum salmon fry from the Goldstream River hatchery had previously been stocked regularly into this system. Clough (2010) noted that there had been no evidence of long-term success of this initiative.

Fish sampling work completed by Clough (2010, 2012) did not return any fish in any of the focus streams. The Clough (2010) assessment, which was carried out during low flow in the summer months, would suggest that any remnant naturalized fish from the rainbow trout stocking efforts in the Campbell Creek system did not persist. An adult salmon spawner assessment completed in December 2011 did not return any evidence of spawning salmon in Deacon Creek or Horton Creek (Clough 2012). Despite the results of these assessments, in the absence of a definitive barrier at tidewater, it would be extremely difficult to prove a permanent lack of fish use, especially for anadromous species that do not rely on perennial freshwater habitat (e.g. chum and pink salmon).

Horton Creek has been documented as supporting coastal cutthroat trout in the past (Habitat Wizard 2017), which indicates that there is the obvious potential for salmonids to occur in the future, especially if restrictions associated with artificial barriers and habitat degradation were removed. As noted, it is very unlikely that these observed fish originated from introduced hatchery stock. In addition, it would be extremely difficult to prove that

fish use is not occurring on a temporary basis, in cases where there are no natural barriers restricting access from the ocean. For example, immature coastal cutthroat trout may seek winter refuge habitat in streams that may not be their natal system, and only use the streams for a relatively short period of time. Based on low numbers of these "wandering" fish and the season of use (winter), it would be extremely difficult to detect them and confidently be able to disprove their presence on a permanent basis. This life-history trait exhibited by coastal cutthroat trout would allow the fish to use the habitat on a temporary basis during a time where restrictions associated with low flows, water temperature or dissolved oxygen would not be limiting factors. Furthermore, winter freshwater "refuge" migrations of coastal cutthroat trout are thought to involve very little feeding behaviour (Slaney and Roberts 2005). This indicates that even habitat that contains little in the way of available food items as a result of habitat limitations could offer potential habitat values.

3.2 Assessment Summary

3.2.1 Campbell Creek

During the field assessment, the landowner at 380 Campbell Bay Road was very accommodating and helpful. We were able to access the tidal segment of the stream on that property to assess the cascade that had been noted in previous QEP reports (Reimer 2007, Swell 2010, Clough 2010).

At tidewater, the stream drops steeply via a bedrock cascade, which has an average gradient of 23 % over a distance of 15 m. Within that 15 m stretch, the maximum gradient increases to 26 % over a distance of 9.6 m. The characteristics of the cascade are such that there are numerous segments where the water flow is very shallow (~ 10 cm deep) over smooth bedrock. There is a small pool at the base of the steeper section of the cascade, which had a maximum depth of 40 cm on the day of the assessment (during relatively high flows). There are no pools over the length of the steeper part of the cascade.

Based on the fact that there are no plunge-pools that would afford fish the opportunity to gain momentum to ascend the cascade, the presence of very shallow, high-velocity flow over bedrock and the overall gradient of the feature, the cascade represents a natural barrier to the upstream movement of fish. As such, there is no potential for anadromous fish to use Campbell Creek, even on a seasonal basis. This finding concurs with the assessment completed by Clough (2010).

Above the cascade, the gradient of the stream decreases to 4 % for a distance of approximately 30 m. The gradient then increases sharply to 25 % over a short cascade (4. 8 m), which represents the outflow of a constructed pond over what appears to be imported dam-construction material (large cobbles). Significant erosion and down-cutting has occurred through the pond outlet feature, which has partially failed. This failure has decreased the gradient of the stream over the pond outlet structure (confirmed by the landowner), which was noted by Clough (2010) to be 45 %.

Based on the presence of the barrier at tidewater, Campbell Creek would only be applicable to the RAR if resident fish occurred above the barrier. As noted, rainbow trout were historically stocked in constructed ponds located on the property at 380 Campbell Bay Road and may have "naturalized" in the stream. The fish sampling work completed by Clough (2010) in Campbell Creek did not result in any fish capture above the barrier (which included the constructed ponds). As any resident fish would have been concentrated in available habitat during the summer fish sampling conducted by Clough (2010), it is apparent that the stocked fish, any subsequent naturalized population, or any wild population of resident fish do not occur above the barrier. As such, Campbell Creek should not be considered a "stream" under the RAR.

3.2.2 Deacon Creek (Figure 2)

The landowner at 535 Dalton Road was accommodating and allowed access to the beach at the outflow of Deacon Creek. At tidewater, a weir structure has been installed, apparently to prevent seaweed from blocking the channel (Swell 2010). There is no barrier at tidewater, and potential fish habitat occurs in the low gradient stream. The upper limit of tidal influence (as provided by Islands Trust) occurs close to the western limit of the 535 Dalton Road property. Small gravel and cobble comprise the stream substrate, which shifts to predominantly sand and silt further upstream.

Up to Dalton Road, which represents Reach 1 (as per Swell 2010), the riparian area has been historically impacted by human activities (i.e. vegetation removal and landscaping) and only a narrow fringe of vegetation remains. The bankfull width of the stream on the accessed property reaches a maximum of 2.4 m, with an average of 2.2 m. The channel represents a riffle-pool morphology (based on gradient), but habitat degradation has limited normal channel-forming processes.

Based on the average channel width and channel morphology (riffle-pool), the maximum SPEA for Reach 1 of Dalton Creek is 10 m as per the Detailed Assessment methodology.

The 10 m SPEA is represented by the maximum ZOS associated with the functions of LWD/bank stability and litter fall/insect drop.

At Dalton Road, the stream flows under the road via a 1500 mm metal culvert, which is not a barrier to fish passage. The bankfull width immediately upstream of the culvert inlet in the Dalton Road right of way was measured at 2 m. The landowner was amenable to allowing access onto his property (524 Dalton Drive), but wanted to be present during the assessment. Unfortunately, the landowner was not able to be on Mayne Island on the dates of the field assessment. Based on observations of the stream from Dalton Road through the property immediately upstream of the road crossing (Reach 2 – Swell 2010), the riparian zone appeared intact for at least 10 – 15 m, with red alder (*Alnus rubra*) dominating. The observable channel upstream of Dalton Road was in good condition, with a substrate of gravel and cobble and a riffle-pool morphology.

The remainder of Reach 2 could not be accessed, but the average channel width from Clough (2010) was measured at 1.3 m. The channel was also inspected from Merryman Road at the point where it flows off agricultural land and into the forested area that extends over the majority of the property to the immediate north of Merryman Road. At this point, the channel appeared to be less than 2 m wide. The riparian zone throughout Reach 2 is intact, with the red alder patch immediately upstream of Dalton Road changing to a continuous mature stand of coniferous forest.

Based on the average channel width (as per Clough 2010), the measurement of bankfull width at Dalton Road and observations of the channel from Merryman Road, the SPEA for Reach 2 of Dalton Creek is 10 m. This represents the maximum ZOS for LWD/bank stability and litter fall/insect drop.

Two unmapped roadside ditches, each carrying significant flow, join Deacon Creek close to the point where the stream parallels Merryman Road. One ditch, which flows along the south side of Merryman Drive, enters via a perched culvert under Merryman Road. The second ditch, which flows along the north side of Merryman Road, joins Deacon Creek close to the point where the road bends to the north. These roadside ditches would be applicable to the RAR, based on the fact that they connect by surface flow to potential fish habitat. The maximum SPEAS under the Detailed Assessment would be dependent upon the fish-bearing potential of the ditches. Based on the characteristics of the ditches, lack of habitat attributes and lack of accessibility for fish from the main-stem drainage, it is extremely unlikely that fish would ever be present in these ditches, even if access barriers were removed. The ditches should, however, be associated with 5 m maximum SPEAs, using a conservative approach.

The entire length of Reach 3 (Swell 2010) could be accessed, as the landowners provided permission (316 Wood Dale Drive and 305 Merryman Road). Reach 3 consists of a channelized stream, with low natural sinuosity and a lack of fish habitat attributes. The channel flows over an organic substrate, with minimal riparian vegetation. The surrounding land use consists of pasture/hay fields, which extend close to the edge of the channel. The maximum channel width through this reach was 2.0 m and the average was 1.4 m. The channel gradient suggests a default riffle-pool morphology, but channelization has removed any natural channel form. The average channel width and default channel morphology through Reach 3 result in a 10 m SPEA, based on the maximum ZOS for litter fall/insect drop and LWD/bank stability.

Reach 4 (Swell 2010) consists of a constructed irrigation pond approximately 90 m long and 25 m wide, which supports limited riparian vegetation. This pond occurs on 305 Merryman Road, which was accessible during the assessment (the landowner provided access permission). Due to the size of the pond, it should be considered a separate feature, as opposed to an "in-line" feature that is part of the stream channel. Under the Detailed Assessment methodology, the SPEA for this feature would be set at 30 m for the south side (based on the shade ZOS) and 15 m for the north, east and west sides (ZOS for litter fall/insect drop and LWD/bank stability). In reality, any biological function of the SPEA on the south side would be truncated by Merryman Road, which occurs approximately 18 m to the south.

Reach 5 (Swell 2010) was accessible, as the landowner gave permission during the field assessment (325 Merryman Road). The landowner was helpful and accommodating during the assessment. The stream has been historically channelized, with the western segment flowing through an intact riparian zone consisting of red alder and second growth Douglas-fir (*Pseudotsuga menziesii*). Agricultural land use (horse pasture) lies adjacent to the south side of the stream in the eastern segment of the property, where riparian vegetation is limited to a fringe of red alder.

The substrate in the stream consists of sand and small gravel, but fish habitat attributes are lacking. In the approximate centre of the property, channel definition decreases through a low gradient area consisting mainly of slough sedge (*Carex obnupta*).

The maximum bankfull channel width through Reach 5 was 1.6 m and the average 1.2 m. The gradient of the channel indicates a default riffle-pool morphology, but there are no typical riffle-pool characteristics, based on the low stream magnitude and historical channelization. The maximum SPEA in Reach 5, indicated by the default channel

morphology and bankfull width, is 10 m (as per the maximum ZOS for LWD/bank stability and litter fall/insect drop).

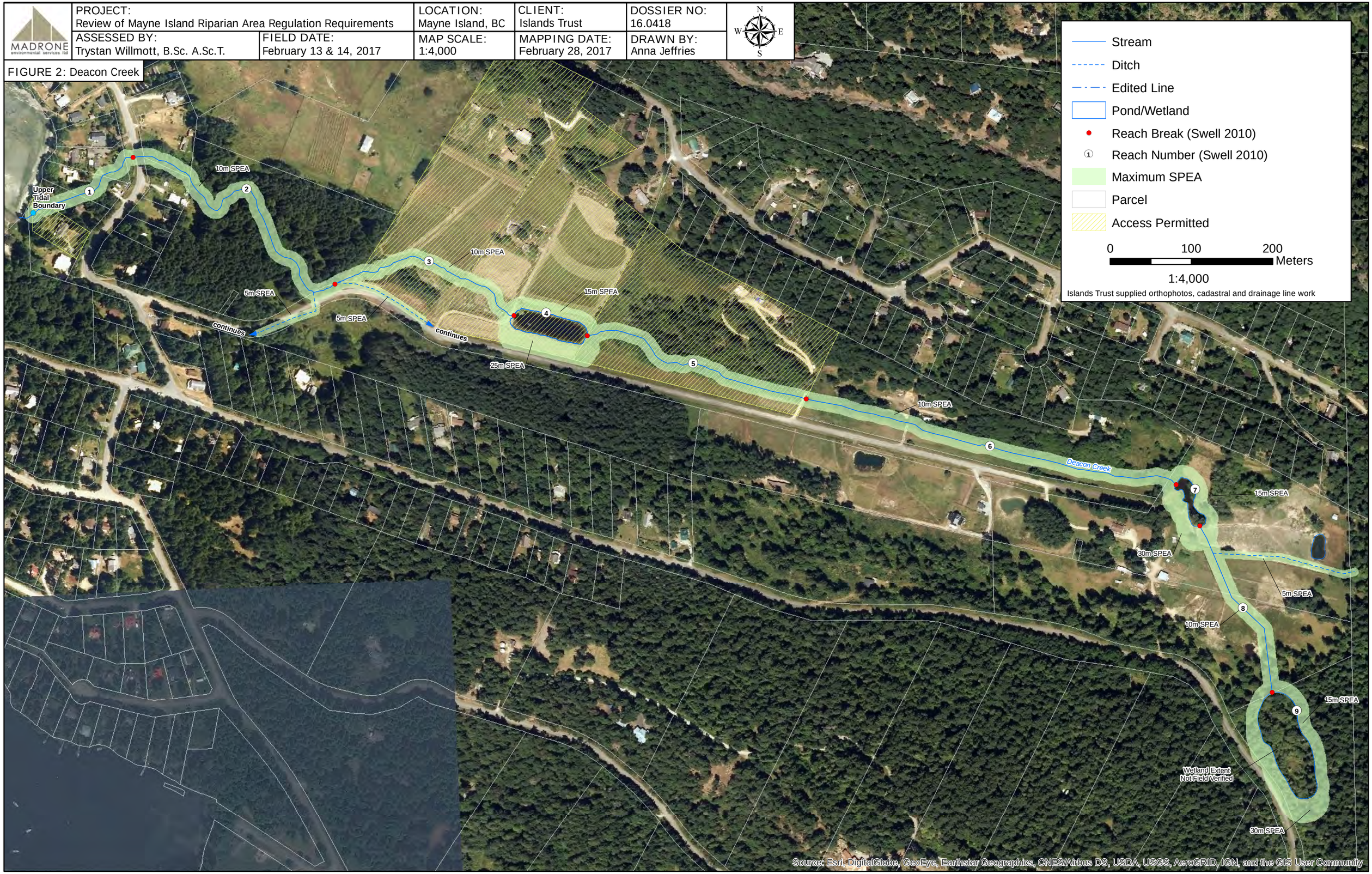
Reach 6 (Swell 2010) could not be accessed during the assessment (361 Merryman Drive), but based on observations from the neighbouring property and Merryman Road, the stream represents a low gradient (default "riffle-pool") channelized system up to a maximum of 1.5 m wide (bankfull width). The SPEA for Reach 6 is also 10 m, based on the default channel type and maximum ZOS associated with litter fall/insect drop and LWD/bank stability.

Reaches 7-9 (Swell 2010), which occur on 380 Merryman Road and 385 Mariners Way, could not be accessed during the assessment, or viewed from a nearby road right of way. Swell (2010) describes Reach 7 as being a dug-out irrigation pond, Reach 8 as a series of ditches flowing into the pond and Reach 9 as a natural wetland connecting by a ditch to the pond comprising Reach 7.

The natural wetland is associated with default maximum SPEAs of 15 m for LWD/bank stability/litter fall/insect drop on the east, north and west banks and 30 m for the shade ZOS on the south bank. The pond in Reach 7 appears to represent a significant feature (based on orthophoto interpretation) that would indicate default 15 m SPEAs on the east, west and north banks and 30 m on the south bank. The ditches described in Reach 8 are associated with 5 m maximum SPEAs. The "ditch" connecting the wetland to the pond is considered a channelized stream, as it originates from natural headwaters and is therefore associated with the 10 m stream SPEA.

MADRONE environmental services ltd	PROJECT: Review of Mayne Island Riparian Area Regulation Requirements		LOCATION: Mayne Island, BC	CLIENT: Islands Trust	DOSSIER NO: 16.0418
	ASSESSED BY: Trystan Willmott, B.Sc. A.Sc.T.	FIELD DATE: February 13 & 14, 2017	MAP SCALE: 1:4,000	MAPPING DATE: February 28, 2017	DRAWN BY: Anna Jeffries

FIGURE 2: Deacon Creek



3.2.3 Horton Creek Main-stem (Figure 3)

The mouth of this creek into the marine environment could not be accessed (670 Horton Bay Road), but the upper limit of tidal influence has been previously mapped at the Horton Bay Road culvert (location provided by Islands Trust). During the field assessment, it was confirmed that tidal influence occurs at least up to the culvert. Based on observations from the Horton Bay Road crossing through the tidal reach (Reach 1 – Swell 2010), there are no barriers preventing anadromous fish access into the stream, at least on a seasonal basis. The culvert is partially collapsing at the outflow, but it is not a barrier to fish movement, and would be submerged during high tides. Reach 1 is vegetated with a mature stand of conifers, which is providing proper riparian function. Reach 1 is not applicable to RAR, as it occurs entirely within the area that is influenced by saltwater.

Reach 2 (Swell 2010) could not be accessed during the assessment (flows through the 655 Horton Bay Road property), but the eastern-most segment was observed from the Horton Bay Road crossing. The bankfull width is 4.0 m at the culvert inlet, but this area is likely wider due to the influence of the culvert and the fact that tidewater backs up behind the culvert. Observations of the stream further upstream indicated that the bankfull width narrowed. Bankfull width measurements completed by Clough (2010) and Swell (2010) indicated an average bankfull width of 1.5 m through Reach 2.

The stream flows through intact riparian vegetation consisting mainly of mature bigleaf maple (*Acer macrophyllum*), western redcedar (*Thuja plicata*) and red alder for approximately 100 m before reaching a dug-out pond (distance based on orthophoto interpretation). The observed portion of Reach 2 from the road appeared in good condition, with no signs of apparent instability, with a riffle-pool channel morphology. Based on field observations of Reach 2, bankfull width measurements reported by Swell (2010) and Clough (2010) and the riffle-pool channel type, the SPEA is 10 m. This reflects the maximum ZOS for LWD/bank stability and litter fall/insect drop.

Reach 3 (Swell 2010), which was also inaccessible during the assessment (also occurs on the 655 Horton Bay Road property), consists of a constructed pond approximately 75 m long and 25 m wide (dimensions based on orthophoto interpretation). The outlet of this feature is described as a barrier to the upstream movement of fish (perched culvert) by Clough (2010). It should be noted that the culvert would not be considered a permanent, definitive barrier to fish movement. Based on the dimensions of the pond, it should be considered a separate feature as opposed to an "in-line" segment of the stream. The SPEA is set at 30 m (for the maximum shade ZOS) on the south side of the pond and 15 m for

the north, east and west banks, as per the maximum ZOS for LWD/bank stability and litter fall/insect drop.

Reach 4 (Swell 2010) extends through the Glenwood Farm property, which was not accessible during the assessment. Descriptions of the reach (Clough 2010, Swell 2010) and observations from the Simpson Road crossing indicate historical channelization (ditching) through the farmland. The bankfull width is up to 2 m (Swell 2010) and the low gradient suggests a riffle-pool channel type. In actuality, observations of the channel did not indicate a typical riffle-pool channel, due to the historical channelization. Riparian vegetation is lacking throughout the farm area. Despite a lack of access along Reach 4, observations made during the field assessment, in addition to descriptions provided by Clough (2010) and Swell (2010) indicate a 10 m SPEA. This is based on the maximum ZOS for litter fall/insect drop and LWD/bank stability.

Reach 5 (Swell 2010) was accessible during the assessment, as the landowner at 622 Gallagher Bay Road provided permission. The landowner was helpful and accommodating during the field visit. The lower segment of this reach (downstream of the residence) is confined through a shallow gully. This feature does not represent a "ravine" as per RAR standards, as the slopes are discontinuous and not consistent on both sides of the stream. At Simpson Road, the culvert crossing structure is perched, which represents a barrier (at least on a temporary basis) to the potential upstream movement of fish. The gully is vegetated with mature conifers, which extend up to the top of bank. Beyond the top of bank, agricultural land persists (livestock pasture).

Through the gully, the gradient of the stream almost qualifies the stream as a cascade-pool system, but the minimal width results in a riffle-pool classification. The stream consists of a gravel/cobble bed through the gully, but fish habitat diversity is lacking. Mid-way through the treed gully, an impoundment has created a small pond approximately 15 m wide and 25 m long in the stream channel. The outlet structure of this pond represents a barrier to the upstream movement of fish, with a culvert emptying out over a constructed embankment consisting of large boulders (in excess of 40 % gradient).

The natural gully ends at the property access driveway and residence on 622 Gallagher Bay Road, with the stream representing more of a channelized system throughout the remainder of the property. Riparian vegetation is lacking through the western segment of the property, with the channel flowing mainly over a grassy substrate with segments of alluvium. A small pond (approximately 8 m by 8 m) occurs close to the western property boundary.

The average bankfull width throughout Reach 5 is 1.5 m, with a maximum width of 3.1 m. The SPEA, based on this average channel width and riffle-pool channel type is 10 m (as per the maximum ZOS for LWD/bank stability and litter fall/insect drop). In this case, the 10 m SPEA also applies to the two small ponds, which are not of a large enough magnitude to be considered as being separate from the lotic system.

Reach 6 (Swell 2010) could not be accessed during the field assessment. The stream in this area was also not assessed by Swell (2010) or Clough (2010). The stream was accessed where it flows under Gallagher Bay Road. At this point, the stream is 1.2 m wide (bankfull width) and consists of a well-defined historically channelized system with an alluvial substrate (mainly small gravel). Where it flows through the 631 Gallagher Bay Road property, the majority of the stream appears to flow through intact young forest, with some disturbance around the eastern segment of the property associated with farming activities and a residence (based on orthophoto interpretation). A small pond occurs in this area, which is approximately 10 m by 10 m. A larger pond is evident close to the north western property boundary, which is approximately 70 m long and 30 m wide (dimensions based on orthophoto interpretation).

The headwaters of the stream were also observed from Tinker Road, where a watershed divide occurs close to two small (10 m by 10 m) circular ponds located on the 414 Heck Hill Road property in a moist area consisting of hydrophytic vegetation. Drainage from this moist area has been channelized along the western side of Tinker Road (the existing mapping incorrectly shows the mapping on the eastern side of the road). The channelized stream flows beyond the northern terminus of Tinker Road onto the 540 Glen Echo Road property, which could not be accessed. It appears that existing mapping shows the stream branching on the 540 Glen Echo Road property.

Based on observations of the stream beyond the end of Reach 5 (Swell 2010), which included bankfull width measurements taken along Tinker Road and at the Gallagher Bay Road crossing, the SPEA is 10 m throughout the remaining stream area. The smaller eastern-most pond observed on the orthophoto on the 631 Gallagher Bay Road property is considered part of the stream channel (10 m SPEA). The more significant pond in the north western corner of the property is associated with a 30 m SPEA (maximum shade ZOS) adjacent to the south side and 15 m SPEAs on the north, east and west sides (ZOS for litter fall/insect drop and LWD/bank stability). Only the northern circular constructed pond close to the west side of Tinker Road is considered under RAR, as the other pond does not connect by surface flow to the channelized stream. The RAR-applicable pond is not considered as a separate feature, but rather part of the lotic system, based on the small size of the pond (10 m SPEA).

3.2.4 Horton Creek North Fork (Hunt Brook) (Figure 3)

Reach 1 (Swell 2010) could not be accessed during the field assessment. This reach flows through Glenwood Farm, where it represents similar characteristics as Reach 4 (Swell 2010) on the main-stem drainage. The stream was observed from Gallagher Bay Road, where it flows from channelized roadside ditches onto the farm property. Based on observations of the Reach 1 channel from the road, it has been channelized through the farmland and is less than 2 m wide (bankfull width). From these observations, the channelized stream is associated with a 10 m SPEA, resulting from the maximum ZOS for LWD/bank stability and litter fall/insect drop.

Reach 2 (Swell 2010) represents channelized flow along the west side of Horton Bay Road. The stream at this location exhibits minimal riparian vegetation and severely lacks fish habitat values, based on the fact that it has been channelized along the road edge. A perched culvert carries the drainage underneath the driveway that accesses 523 Horton Bay Road. The stream continues as a steep (15 %) channelized system along the north side of the driveway, where it is deeply incised. The stream then emerges from forested habitat as a more natural stream channel (the beginning of Reach 3 – Swell 2010), where it flows through moist forested habitat located on the property to the north (515 Horton Bay Road). The landowners at 523 Horton Bay Road were accommodating and helpful, but we were unable to access the 515 Horton Bay Road property or the property to the west.

The existing stream mapping for the lower segment of Reach 3 is inaccurate, as the point at which the stream exits the 523 Horton Bay Road property and flows onto 515 Horton Bay Road is further to the east. As the 515 Horton Bay Road property could not be accessed, the route of the stream through that property, or the property to the west, could not be confirmed.

The average bankfull width through Reach 2 is 1.1 m, and the gradient over the whole reach indicates a "riffle-pool" channel type. This default channel morphology is not represented in reality, based on the fact that the stream has been channelized. Based on the average channel width and default channel type, the SPEA for Reach 2 is 10 m and is represented by the maximum ZOS for LWD/bank stability and litter fall/insect drop.

Swell (2010) adds three further reach descriptions (reaches 4-6), but existing mapping (Swell 2010) indicates only three reaches in total for the north fork of Horton Creek (Hunt Brook). For purposes of this summary, only three reaches are described (as per the existing mapping layer). The remainder of Reach 3 was assessed from Mount Parke Regional Park and also along Montrose Road, as access permission was not provided for

515 Horton Bay Road or the neighbouring property to the west. Access was also not confirmed for the 521 Montrose Road property.

From the Montrose Road right of way, observations of the stream where it flows through the property to the south of Montrose Road indicate that the stream is very poorly defined and flows over an organic substrate. This drainage is currently effectively blocked by a foot trail through the park. Above the trail, the stream is poorly defined over an organic substrate and is fed by a small (approximately 15 m by 15 m) constructed pond close to the park boundary. Based on observations of the poorly-defined "channel" from Montrose Road to the park, the remainder of Reach 3 is associated with a 10 m SPEA, with the constructed pond also associated with a 10 m SPEA (not considered a separate system in this case).

A constructed ditch now captures surface flow coming from the top of Reach 3 (originating from the pond) to the north of the blockage associated with the trail. While it should be noted that this ditch is directly located on the Reach 3 stream channel, a ditch classification has been applied at the point where the ditch has been constructed along the north side of Montrose Road. The more "natural" stream channel continues to the south of Montrose Road below the trail blockage, connecting with Reach 2 on 523 Horton Bay Road.

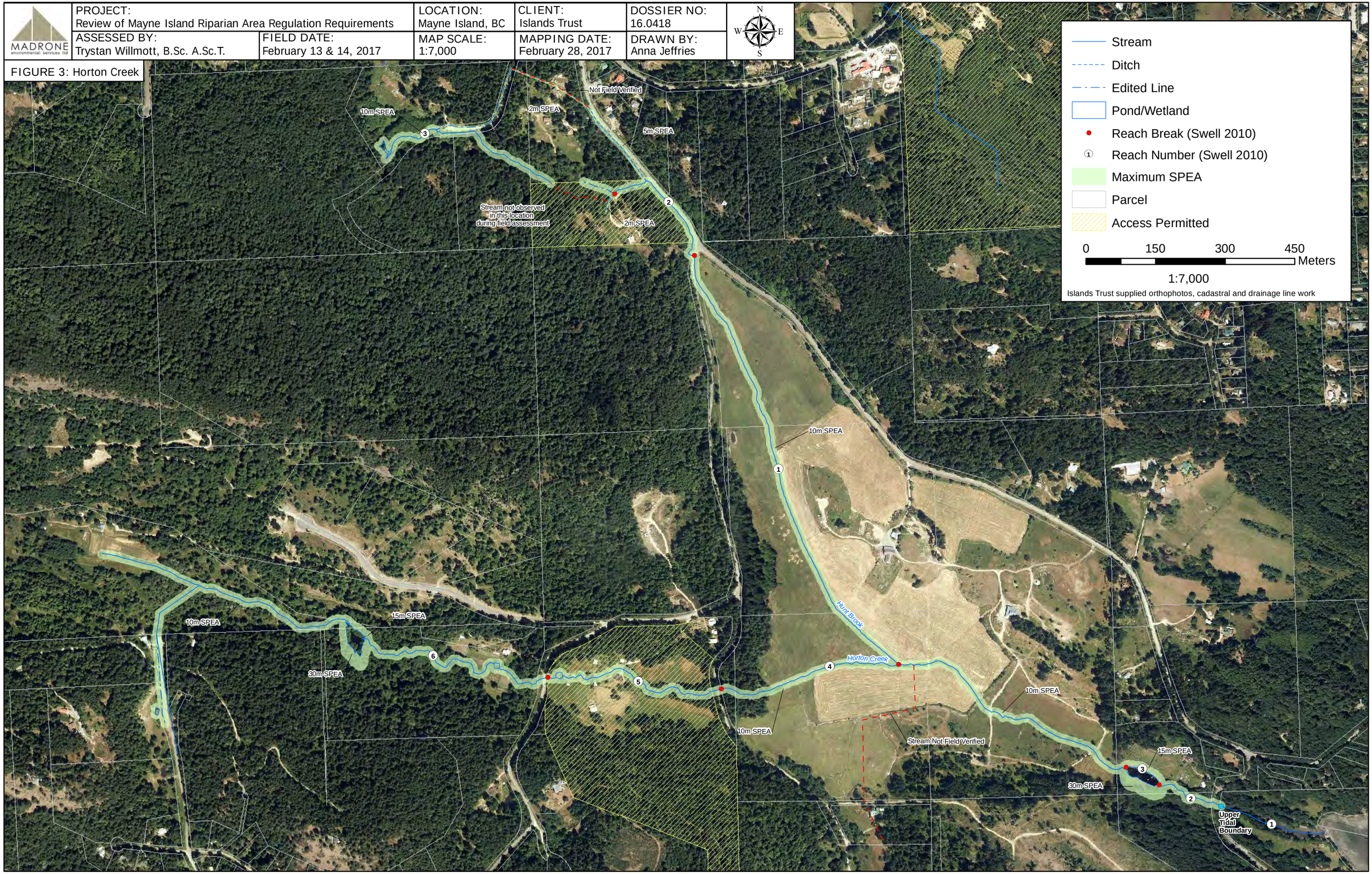
The ditch continues along the north side of Montrose Road prior to flowing under the road via a culvert discharging onto the property to the immediate west of 515 Horton Bay Road. The ditch was observed flowing off the 515 Horton Bay Road property, where it is directed along the west side of Horton Bay Road. This ditch joins with the channelized segment of Reach 2 at the bottom of the 523 Horton Bay Road property driveway. This ditch was previously unmapped, which may indicate that the work was done after the 2010 assessments completed by Clough and Swell.

Notwithstanding any temporary barriers to the movement of fish located further downstream on the Horton Creek system (e.g. Reach 3 pond outlet on the main-stem), the gradient of the ditch where it flows through the 515 Horton Bay Road property precludes any potential for fish use. The constructed ditch is, therefore, associated with a maximum 2 m SPEA from the point where it flows off the 515 Horton Bay Road property, based on excessive gradient. Along Horton Bay Road, the constructed ditch would be associated with a 5 m SPEA (very conservative approach), based on the fact that there are no natural barriers precluding fish access, at least on a seasonal basis. It should be noted that it is extremely unlikely that fish would ever be present in the ditch, even if downstream barriers were removed.

An additional ditch was discovered on the 523 Horton Bay Road property, which joins the main-stem along the property driveway close to the break between Reach 2 and 3. This ditch is very short (approximately 50 m) and drains a moist area close to the top of the driveway. This ditch is associated with a 2 m SPEA, as it is located above the steep segment of the main-stem, which precludes any potential for fish access.

MADRONE environmental services ltd	PROJECT: Review of Mayne Island Riparian Area Regulation Requirements		LOCATION: Mayne Island, BC	CLIENT: Islands Trust	DOSSIER NO: 16.0418
	ASSESSED BY: Trystan Willmott, B.Sc. A.Sc.T.	FIELD DATE: February 13 & 14, 2017	MAP SCALE: 1:7,000	MAPPING DATE: February 28, 2017	DRAWN BY: Anna Jeffries

FIGURE 3: Horton Creek



4 Discussion and recommendations

Based on the observations of Deacon Creek, Campbell Creek and Horton Creek, both Horton Creek and Deacon Creek provide potential fish habitat (especially in the lower reaches) and are, therefore, applicable to the RAR. All tributary drainages in these watersheds are also considered "streams" under the RAR, as a stream does not necessarily need to support fish in order for it to be included. If a non-fish bearing stream connects by surface flow to potential fish habitat, it qualifies under the regulation.

Fish use in the applicable streams is currently restricted, based on low stream magnitude (seasonal flow), a lack of habitat diversity and the presence of obstacles and barriers to upstream fish movement. To permanently classify these streams as being non-fish-bearing would remove any potential for any future restoration or improvement of current conditions, which have mainly resulted from anthropogenic influences.

Currently, any fish use would be limited to seasonal occupancy by anadromous species that do not rely upon perennial habitat or temporary use by anadromous cutthroat trout, which could potentially use the lower reaches in very low numbers on an intermittent basis. Trying to establish permanent year-round non-fish presence in a stream where there are no physical barriers preventing the seasonal (or temporary) movement of fish into the stream from the ocean would be extremely difficult.

In cases where there are significant, naturally occurring year-round, permanent limitations associated with water quality that are beyond tolerable thresholds, fish would not be expected to occur. This is not the case on Mayne Island, where there may be seaosnal limitations to water quality on a reach by reach basis, but no permanent or significant threshold breaches that would preclude seasonal fish use of lower stream reaches.

Data from April 2008 (included in Clough 2010) for Horton Creek showed pH within the preferred range of salmonids for Reach 1, Reach 2 and Reach 3 (pH values of 6.7, 6.5 and 7 respectively). Similarly, dissolved oxygen was shown to be well within the levels preferred by salmonids in the same reaches (10.8, 9.2 and 11.2 Mg/l respectively). A "farm ditch" segment of Reach 2 was shown to have lower water quality during the same period, with a pH of 5.7 and dissolved oxygen level of 1.6 Mg/L (Clough 2010). Summer water quality data for Horton Creek compiled by Clough (2010) indicates much lower dissolved oxygen levels for Reach 1 of Horton Creek that would be well within the avoidance range of salmonids over the summer period. This would be expected, based on lower flows and higher temperatures and the range in oxygen levels that commonly occurs

in most streams over the course of a season. Seasonal use of the same habitat (considering the more favourable water quality data from April 2008) cannot be discounted.

Determining fish presence or absence above a physical, natural barrier is a much more feasible undertaking. There is no potential for use of Campbell Creek on a seasonal or temporary basis by any life phase of anadromous fish, based on the presence of a natural barrier to upstream fish movement at tidewater. The Campbell Creek system was sampled for fish during an optimal time of year in available habitat (Clough 2010), which resulted in no fish capture. Based on the fish sampling results and presence of the permanent, natural barrier at tidewater, Campbell Creek (including tributary systems) does not apply to the RAR. Any rainbow trout that were stocked historically in the ponds on the 380 Campbell Bay Road property (or naturalized offspring) are no longer present.

Based on average bankfull widths and application of the Detailed Assessment methodology under the RAR, SPEAs for the subject streams (Horton Creek and Deacon Creek) are 10 m. Significant ponds and wetlands connected to these systems are associated with SPEAs of 30 m on the south banks and 15 m on east, west and north banks. True ditches identified during the assessment are associated with either 2 m SPEAs for non-fish-bearing ditches or 5 m SPEAs, using a conservative "potentially fish-bearing" approach where applicable. The dimensions of all SPEAs are indicated in Figures 2 and 3. Reaches downstream of the upper tidal limits provided by Islands Trust are not applicable to SPEAs or the RAR. Inconsistencies were noted in the provided stream mapping data, and corrections have been included in Figures 2 and 3. It should be noted that not all areas could be field verified or assessed, based on a lack of property access. For the most part, orthophoto coverage allowed for an interpretation of the stream network, and observations of inaccessible properties from neighbouring properties or roadsides also provided useable data. Previous reports prepared by Reimer (2007), Clough (2010) and Swell (2010) were also very useful.

The SPEA data can be used by Islands Trust as a planning tool to help implement bylaws that "meet or beat" the RAR. It is important to note that any bylaw that is set up would need to account for the fact that under the detailed RAR assessment methodology, a suite of development-specific measures are considered that help ensure the integrity of the SPEA during development activities. One potential planning opportunity would be to add depth to the edge of the SPEA boundary, to create a Development Permit Area that exceeds the SPEA widths that have been provided in this project. This would help ensure the integrity of the SPEA is maintained in the absence of Detailed Assessment measures.

A suggested DPA width would be 15 m for streams associated with a 10 m SPEA, 10 m for the default fish-bearing ditches and 5 m for non-fish-bearing ditches. For significant wetlands and ponds, a 20 m DPA is recommended on east, west and north banks, whereas a 30 m DPA is suggested for south banks. Landowners would then have the opportunity to complete a development-specific Detailed Assessment by a QEP if they were not prepared to accept the default bylaw DPA. If a Detailed Assessment were completed, the SPEA would be 10 m for streams, and would vary between 2 m and 5 m for constructed ditches. For the identified significant ponds and wetlands, the SPEA would range between 15 m and 30 m (no reasonable potential to decrease the 30 m DPA on the south sides of the identified wetlands and ponds). If the default "meet or beat" setback option is accepted by a landowner, a site visit by a planner, building inspector or QEP may be required to ensure that the setback is being maintained and is being measured from the correct location. If a landowner chooses to complete a Detailed Assessment by a QEP to reduce the DPA down to the SPEA value, the precise location of the HWM and SPEA would be identified as part of the Detailed Assessment reporting procedure.

Setting up DPAs would also need to take into account the fact that some riparian areas are currently developed, or encroached upon. The RAR does not apply to existing land uses and structures, as these are considered legally non-conforming. Landowners can continue to use their land (including areas inside SPEAs) as it has been used historically. Any new developments inside a previously developed SPEA or established DPA would trigger the RAR, and the new development would be subject to the RAR. Riparian enhancement is encouraged, especially adjacent to sensitive areas, or areas that are experiencing erosion due to the removal of riparian vegetation.

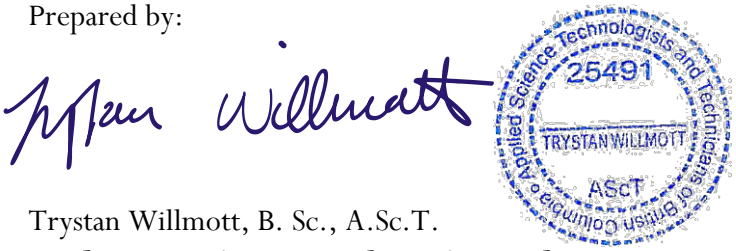
Landowners adjacent to streams often do not realize the financial incentives of maintaining a functioning riparian zone. For example, intact riparian vegetation can help prevent lateral bank movement, thus protecting valuable property from erosion. Potential hazards associated with flooding can also be ameliorated as a result of maintaining a functioning riparian area. These benefits, in addition to wildlife and vegetation values, would also apply to Campbell Creek, despite the fact that it does not apply under the RAR. Enhancement of riparian areas using appropriate techniques (e.g. replanting with native vegetation to stabilize banks) is encouraged in previously impacted riparian areas. Enhancement operations are not subject to the RAR.

It is worth noting the expanse of agricultural land on Mayne Island, as farming-related activities are not subject to the RAR. Farming activities are, however, applicable to the federal Fisheries Act and provincial Water Sustainability Act (including any potential impacts to connected marine habitats). Any instream works and associated riparian

disturbance (e.g. culvert/driveway construction) would be considered under the Water Sustainability Act and not the RAR. On-going activities that are associated with farming, such as (but not limited to) channel drainage maintenance to maintain the value of adjacent agricultural land can continue, but such activities would be considered under the Water Sustainability Act (instream works) as opposed to the RAR. It is important to note that permitting requirements for instream works on Campbell Creek would still apply under the Water Sustainability Act, as it qualifies as a stream under the Act, despite the fact that the stream does not support fish.

If you have any questions or comments about the project, please do not hesitate in contacting the undersigned.

Prepared by:



Trystan Willmott, B. Sc., A.Sc.T.
Madrone Environmental Services Ltd.

References

Clough, D. 2010. Mayne Island Fish Presence Assessment, July 2010. D.R. Clough Consulting.

Clough, D. 2012. Mayne Island Fish Presence Survey – Salmon Spawner Survey 2011. D.R. Clough Consulting.

Malmkvist, L. 2010. Review of Riparian Areas Regulation for Streams on Mayne Island. Swell Environmental Consulting Ltd.

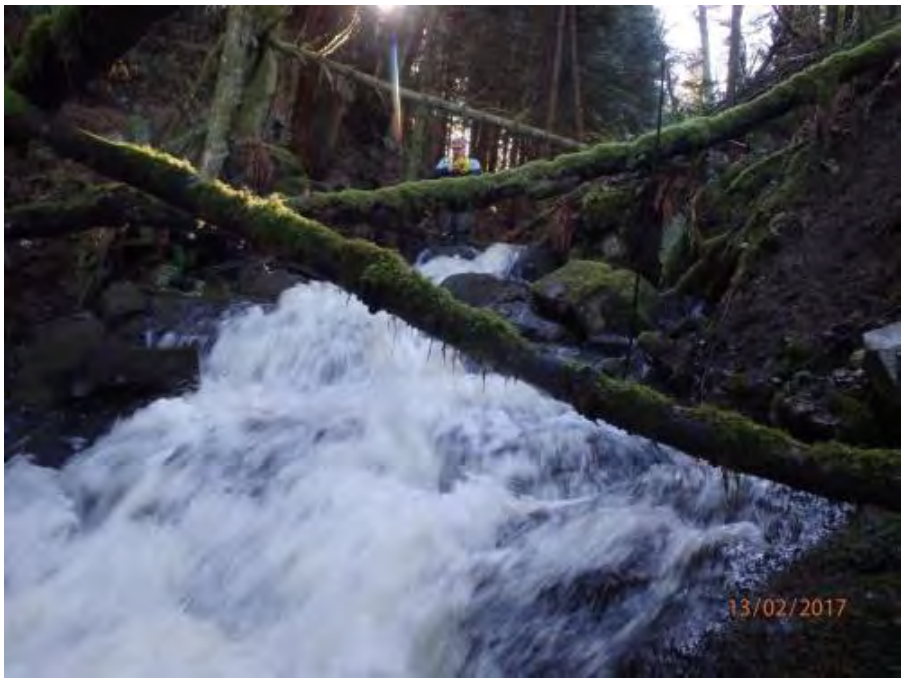
Reimer, K. 2007. Mayne Island Stream Survey Report.

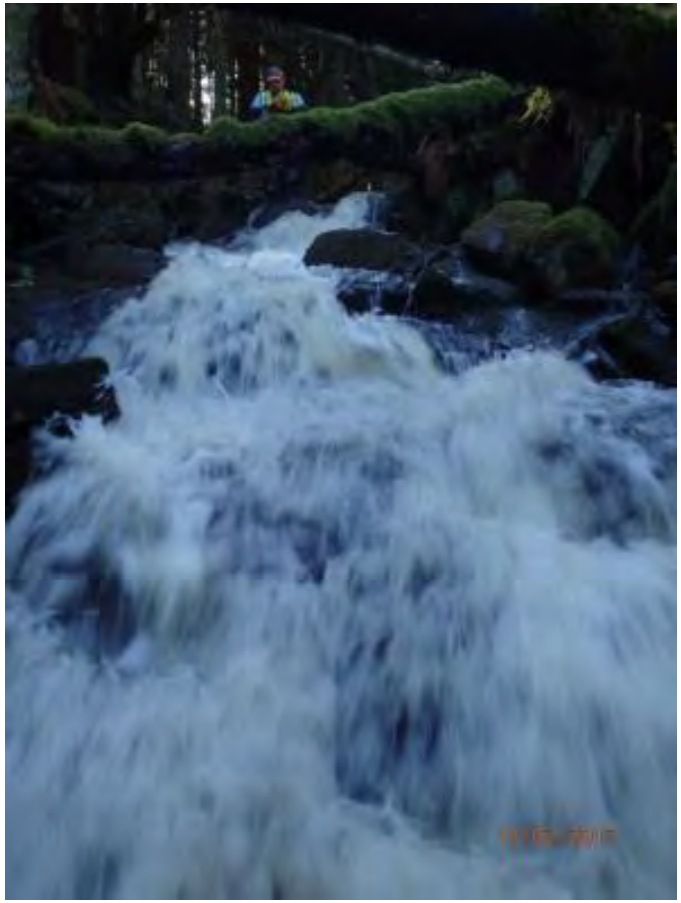
Slaney, P and J.Roberts. 2005. Coastal Cutthroat Trout as Sentinels of Lower Mainland Watershed Health. Strategies for Coastal Cutthroat Trout Conservation, Restoration and Recovery.

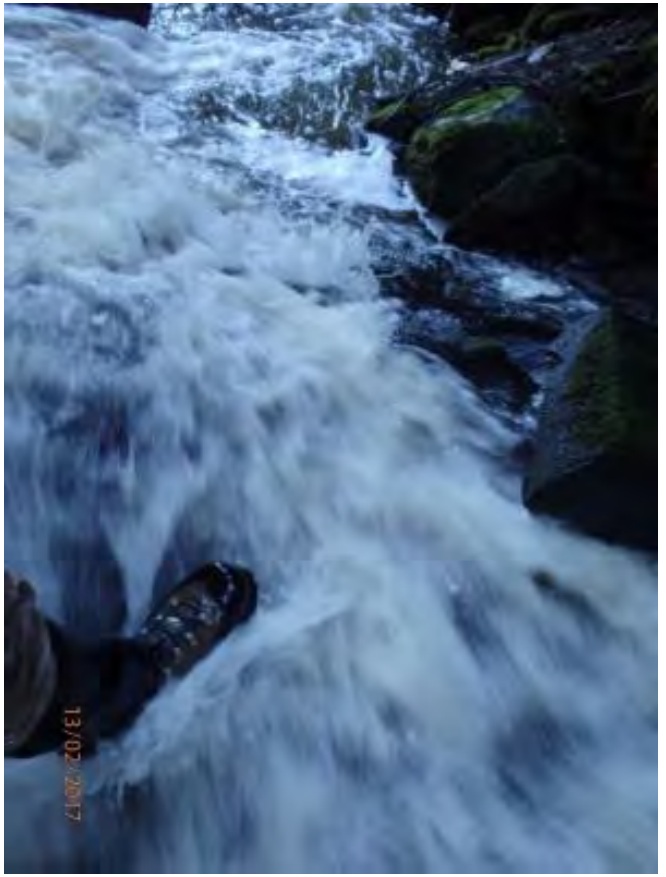
APPENDIX 1 - PHOTOS

Campbell Creek

Above and below (following 2 photos): looking upstream along the cascade barrier to upstream fish movement located at tidewater on Campbell Creek. Note shallow, high-velocity cascading flow over bedrock.







Examples of shallow, high-velocity flow over smooth bedrock through the cascade at tidewater on Campbell Creek.

Deacon Creek

Looking upstream towards the weir located at the mouth of Deacon Creek.

Above and below: looking upstream through the lower segment of Reach 1.

Channel characteristics in the lower segment of Reach 1 where it flows through the 535 Dalton Road property.

Looking upstream through the lower segment of Reach 2 from Dalton Road. Note the presence of a functioning riparian zone.

Looking upstream through the lower segment of Reach 2 from the Dalton Road culvert inlet. Note stable channel characteristics.

Looking downstream through the upper segment of Reach 2 from Merryman Road. Note presence of a continuous, functioning riparian zone.

Looking upstream through the lower segment of Reach 3 where it flows through agricultural land on the 316 Wood Dale Drive property.

Above and below: looking downstream through the channelized segment of Deacon Creek (Reach 3) where it flows through agricultural land located on the 316 Wood Dale Drive property.

Looking upstream over the irrigation pond representing Reach 4 of Deacon Creek (305 Merryman Road).

Above and below: typical channelized characteristics of Reach 5 where it flows through the 325 Merryman Road property.

Perched culvert and inflow of ditch flowing along the south side of Merryman Road into Deacon Creek.

Looking upstream (west) along the ditch flowing along the south side of Merryman Road.

Looking upstream (east) along the ditch flowing along the north side of Merryman Road immediately upstream of its confluence with Deacon Creek.

Horton Creek - Mainstem

Looking downstream along tidal Reach 1 from the Horton Bay Road crossing.

Partially collapsed culvert carrying Horton Creek underneath Horton Bay Road. This culvert will be submerged during high tides.

Above and below: looking upstream through the lower segment of Reach 2 from the Horton Bay Road crossing. Note evidence of tidal inundation in the upper photo.

Looking downstream along the channelized segment of Reach 4 from Simpson Road where it flows through the Glenwood Farm property.

Looking downstream along the upper segment of Reach 4 from Simpson Road. Note more natural channel conditions, natural drainage draw and functioning riparian vegetation.

Outflow of perched culvert carrying Horton Creek underneath Simpson Road. This feature represents a barrier to the upstream movement of fish, but is located well above the pond outlet barrier located in Reach 3.

Looking downstream through natural stream draw typical of the lower segment of Reach 5 where it flows through the 622 Gallagher Bay Road property.

Dam and culvert outlet representing a barrier to upstream fish movement located mid-way through Reach 5 (622 Gallagher Bay Road). This feature is located well above the pond outlet barrier located in Reach 3 and also the perched culvert barrier located at Simpson Road.

The dam shown above impounds water to form a small irrigation pond located mid-way through Reach 5.

Typical channel and substrate characteristics (gravel/cobble) throughout the lower segment of Reach 5 (622 Gallagher Bay Road).

Functioning riparian vegetation growing along the natural draw associated with the lower segment of Reach 5 (622 Gallagher Bay Road).

Typical channel characteristics and lack of riparian vegetation evident through the upper segment of Reach 5 (622 Gallagher Bay Road).

Typical gravel/cobble substrate exhibited throughout the majority of Reach 5.

Small constructed irrigation pond located close to the upper limit of Reach 5 on the 622 Gallagher Bay Road property.

Characteristics of Reach 5 where the stream flows into the pond pictured above.

Well-defined channel (historically channelized) and gravel substrate noted at the Gallagher Bay Road crossing (beginning of Reach 6).

Small ponds located in a moist area close to the terminus of Tinker Road representing part of the headwaters of Horton Creek. The pond in the background does not connect by surface flow to the drainage network.

Looking downstream (north) along the headwaters of Horton Creek from Tinker Road.

Looking upstream towards the moist area representing part of the headwaters of Horton Creek.

Horton Creek – North Fork (Hunt Brook)

Looking south east along the upper segment of Reach 1 where it has been channelized through agricultural land on the Glenwood Farm property.

Looking downstream (south east) along Gallagher Bay Road close to the intersection with Horton Bay Road. The channelized stream flows underneath Gallagher Bay Road via two culverts at this location and represents the lower segment of Reach 2.

Looking downstream (south east) where the lower segment of Reach 2 flows alongside Gallagher Bay Road prior to flowing onto agricultural land.

Looking downstream (south east) along the upper segment of Reach 2 where it has been channelized along Horton Bay Road.

Looking upstream (north west) along the upper segment of Reach 2 where a culvert carries the flow underneath a property access driveway (523 Horton Bay Road).

Above and below: looking upstream (west) along the upper segment of Reach 2 where it becomes incised along the edge of the 523 Horton Bay Road property driveway.

Confluence of the ditch (to the left) flowing into the main-stem drainage on the 523 Horton Bay Road property (beginning of Reach 3).

Upper segment of the ditch located on the 523 Horton Bay Road property.

Moist area drained by the ditch located on the 523 Horton Bay Road property.

Characteristics of the upper segment of Reach 3 from the Montrose Road right of way.

Reach 3 immediately downstream (east) of a foot trail through Mount Parke Regional Park.

Foot trail to the immediate west of the photo shown above. Water is now directed via a constructed ditch along the north side of Montrose Road.

Upper segment of Reach 3 along the Mount Parke foot trail.

Headwaters of Hunt Brook draining a pond located close to the Mount Parke boundary.

Outlet of the ditch draining the Mount Parke area where it flows off the 515 Horton Bay Road property into a ditch located along Horton Bay Road.

Looking upstream (west) through the 515 Horton Bay Road property from Horton Bay Road along the ditch draining the Mount Parke area.

Looking downstream (east) along the ditch at the point where it flows out of the culvert under Montrose Road and onto private property.

Looking upstream (south west) along the ditch that drains the Mount Parke area along the edge of Montrose Road.

Looking downstream (north east) along the constructed ditch along the edge of Montrose Road close to the Mount Parke Regional Park parking area.

Looking upstream (west) along the beginning of the ditch draining the Mount Parke area taking water along the northern side of Montrose Road.