Salt Spring Island
Riparian Areas Regulation Mapping Project

Prepared for:

Stefan Cermak, Planner
Islands Trust
Suite 200 – 1627 Fort Street
Victoria, BC. V8R 1H8

Prepared by:

Dori Manley, RPBio.
Monica Stewardson, RPBio, CPESC

MAINSTREAM Biological Consulting

COLLEGE OF APPLIED BIOLOGY
Monica C. Stewardson
25/02/14
R.P. Bio
#1291
CAB

1310 Marwalk Crescent,
Campbell River, BC. V9W 5X1
Phone: (250) 287-2462 Fax: (250) 287-2452
Email: info@mainstreambio.ca

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Summary

This report presents the results of a stream mapping project completed on behalf of the Salt Spring Island Local Trust Committee. This is the third and final project aimed at developing detailed mapping of streams located within 26 *Riparian Areas Regulation (RAR) applicable* watersheds identified on Salt Spring Island, BC. In addition to mapping streams and other features included under the Riparian Areas definition of a stream (such as creeks, rivers, ditches, wetlands, ponds and lakes), habitat information was collected in order to determine preliminary Streamside Enhancement and Protection Areas (SPEAs) for the mapped drainages. This information is being used for the development and implementation of an *RAR* bylaw for proposed future development on Salt Spring Island where the *RAR* would be applicable.

This project involved the mapping of all streams in 19 watersheds on Salt Spring Island, which was completed in November 2013. Mapping was completed according to project specifications aimed at locating streams with a high level of accuracy (1 – 5 m) using Trimble GeoXT receivers. Habitat assessment included measuring channel or ditch widths, gradients and describing substrate and instream cover. Significant permanent barriers to fish migration were noted, and reach breaks were determined to mark significant changes in habitat or channel morphology, including the location of ravines.

In total, 79 km of stream (including ditches) and 7.5 ha of ponds and wetlands were mapped in the field, with additional areas interpreted from orthophotos and light detection and ranging (LIDAR) based flow modelling. Interpretation of the stream network was required in areas where access to properties was not granted, where fenced and locked properties were encountered in the field and areas that were deemed unsafe for mapping to proceed. Most of the drainages mapped for this project represented small channel systems (bankfull widths less than 3 m) where the minimum Streamside Protection and Enhancement Areas (SPEAs) prescribed by the *RAR* assessment methodology would be 2 m (non-fish bearing ditches) to 10 m (streams).

Recommendations have been provided to assist with the final stages of the *RAR* bylaw development. These generally include continuing to educate local government staff and island residents about the *RAR* and how it is related to proposed development on Salt Spring Island, clearly defining how the bylaw is to be applied (including provisions for an alternate simplified process when justified by site specific conditions and the proposed development activities), and

including actions to be taken when the conditions of an *RAR* report and associated development permit are not followed by developers.

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1.0 Introduction

The *Riparian Areas Regulation (RAR)* came into effect in designated areas of British Columbia on March 31, 2005. The regulation is intended to provide local governments with a legislated framework for the protection of fish and fish habitat for new residential, commercial and industrial land under local government jurisdiction (BC WLAP, 2006).

In order to be compliant with the requirements of the regulation, the Salt Spring Island Local Trust Committee (LTC) has initiated the process of *RAR* implementation. The first step in this process was the identifying and mapping of *RAR* watersheds. A total of 26 watersheds on Salt Spring Island were identified in 2010 by the provincial government as applicable to the *RAR*, however existing mapping within these watersheds was limited and incomplete.

Beginning in 2012, the Salt Spring Island LTC initiated a series of projects to collect accurate and detailed mapping of the 26 "*RAR* designated watersheds". Seven of the watersheds were mapped in 2012 (Reimer, 2012) and early 2013 (Willmott et al, 2013).

This project represents the conclusion of the large scale mapping project. A total of 19 watershed areas were mapped in November 2013 by Mainstream Biological Consulting (MBC) on behalf of the Salt Spring Island LTC. The results of the mapping project, including watershed maps and descriptions, are presented in this report.

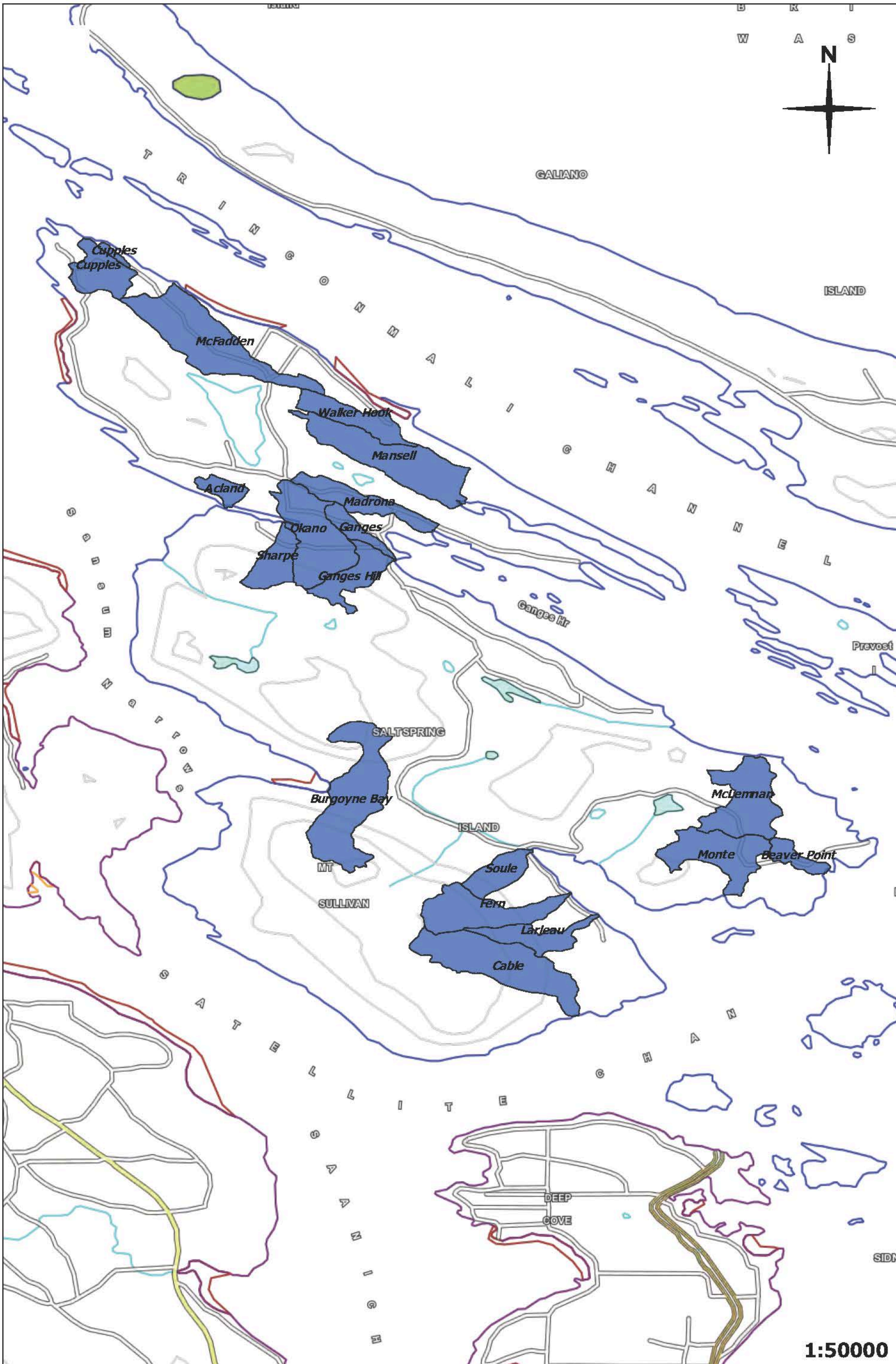
1.1 Overview of project area

Salt Spring Island is a southern Gulf Island located in the Strait of Georgia adjacent to Vancouver Island in southwestern BC. The 20,000 hectare island has a mild climate and supports a population of approximately 10,000 people. The 19 watersheds mapped during this project were spread throughout the island and included areas within urban development, farms, residential areas, ecological reserves, and parks (Table 1, Figure 1).

Table 1. Watersheds included in this *RAR* mapping project on Salt Spring Island, BC.

Watershed (local name)	Watershed Code	Existing Fish Information[a]
Soule Creek	-	CO, CT[1]
Larleau Creek	-	CT[1]
Fern Creek	-	Historical CT Potential[1]
Okano Creek	925-258500-23215	CO, CT[1]
Madrona Creek	925-258500-64224	CT[1]
McFadden Creek	925-258500-37900	TSB, CT[2]
Burgoyne Bay Creek (Larsen Creek, Lee Creek and Narnia Creek)	-	CO, CM, CT[1]
Cable Creek	925-258500-97400	RB, CT[1]
McLemnan Creek	-	CT[1]
Monte Creek	-	Historical CT[1]
Swanson Creek	-	CT, CM[1]
Ganges Creek	925-258500-69591	
Mansell Creek	925-258500-54091-03167	CO[2]
Sharpe Creek	925-258500-22798	
Walker Hook Creek	-	
Cupples Creek	-	CT[1]
Beaver Point Creek	-	Potential Fish Habitat[1]
Acland Brook	-	RB

[a]Fish Species Codes: CM – chum salmon, CO – coho salmon, CT – cutthroat trout, RB – rainbow trout, TSB – threespine stickleback.
[1]Fish status indicated on Island Trust maps (Boothe and Reimer, 1996).
[2]Fisheries Inventory Summary System



Legend

Mapped Watersheds

Figure 1. Overview map showing the 19 watershed areas mapped duirng this assessment of RAR designated streams on Salt Spring Island, November 2013.

Survey Datum: WGS 84
Projection: WGS 84
Map Base: Developed from 1:125000 NTS
Watershed boundaries: Islands Trust

Map created
15/01/2014

MAINSTREAM Biological Consulting

1.2 Scope of work

The project scope was well defined in the General Service Contract and included the following terms for the *RAR* applicable streams within the 19 identified watersheds on Salt Spring Island:

- Contact property owners and receive permission to access their properties.
- Applying *RAR* standards assess and identify the location of all fish bearing streams, potentially fish bearing streams and streams flowing into them.
- Map all streams identified as fish bearing streams, potentially fish bearing streams and streams flowing into them only to the length in which a *RAR* SPEA is required, this includes mapping of streams in protected areas.
- Map stream locations according to the Global Positioning System (GPS) specifications included in the RFP as in Schedule G of the service contract template.

An *RAR* applicable stream is defined in the regulation as:

"…any of the following that provides fish habitat:

a. *A watercourse, whether is 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)*.

Side channels, intermittent streams, seasonally wetted contiguous areas are included by the definition of a stream which includes active floodplains and wetlands connected to streams."

1.3 Deliverables

Project deliverables for the *RAR* mapping project were detailed in the General Service Contract and include the following:

- Based on stream mapping, prepare a report summarizing the findings of the *RAR* stream mapping. The report will outline the methodology used, and provide recommendations for drafting a *RAR* implementation bylaw including SPEA width options.
- Provide electronic shape files that include raw data from the field collection showing location of streams, including notes on data limitations or corrections made to the data.
- Maps of *RAR* applicable streams, as well as the provision of final stream location documentation to the Salt Spring Island Local Trust Committee.
- The Qualified Environmental Professional (QEP) assigned to the project (Monica Stewardson, RPBio) must present the findings at a Local Trust Committee meeting.

2.0 Methods

A number of reference documents were used to direct the collection and management of data for this project. These references include, but are not limited to:

- *Riparian Areas Regulation – Assessment Methods* (May 2006)
- *Riparian Areas Regulation Implementation Guidebook* (January 2006)
- *Reconnaissance (1:20000) Fish and Fish Habitat Inventory: Standards and Procedures* (Version 2.0, Resources Inventory Standards Committee, April 2001, errata 2009)
- *Province of British Columbia Standards, Specifications and Guidelines for Resource Surveys using Global Positioning System (GPS) Technology* (Resource Information Standards Committee, Integrated Land Management Bureau, 2008)
- *Comprehensive GPS Training for Resource Mapping* (Resources Information Standards Committee, 2008)
- *Salt Spring Island Local Trust Committee Service Contract Schedule G: Global Positioning System Specifications*

2.1 Pre-field Preparation

2.1.1 Existing information collection

The Salt Spring Island LTC supplied MBC with base mapping information including watershed boundaries, property ownership data, OCP stream mapping, modelled flow accumulation based on light detection and ranging (LIDAR) and orthophotos for Salt Spring Island. This data was used to create field maps for watersheds to be mapped and supported the collection of known fish information from the provincial Fisheries Information Summary System[1]. Monica Stewardson, MBC Project Manager, met with Stefan Cermak, Islands Trust Planner, on November 5, 2013 to review the conditions of the mapping program.

2.1.2 Property owner contact

Using the existing mapping information provided by the Salt Spring Island LTC, property owners with mapped streams (either from the Terrain Resource Information Management (TRIM) base or LIDAR modelled flow accumulation) within their property boundaries were contacted either by phone or by mail requesting permission to access their property in order to map the identified stream or wetland. Property owner contact was attempted prior to the start of field work within a watershed and the objectives of the mapping project were outlined to the landowners. Letters were used as a method of landowner contact for the Swanson, Ganges, McFadden and Madrona watersheds. Telephone calls were used as the method of property

[1] Fisheries Information Summary System (FISS) - www.env.gov.bc.ca/fish/fiss/index.html

owner contact for the remaining watersheds. In addition, postings were made on the Salt Spring Island page of the Islands Trust web site as well as on the Salt Spring Island Exchange website[2] describing the objectives of the *RAR* mapping project, the watersheds where mapping was to occur and the timing of the field activities. Through all methods of contact, property owners were provided with contact names for both the Islands Trust and MBC as sources of additional information on the mapping project.

2.2 Field procedures

2.2.1 RAR stream mapping

Field *RAR* mapping was completed using Trimble GeoXT GPS receivers loaded with TerraSync software (Versions 3.21 or 5.41). A portion of the mapping was completed using a 2005 series GeoXT but due to challenges with achieving the desired accuracy for the project (less than 5 m) and meeting the project timeline, the majority of the mapping was completed using two 6000 series receivers. All receivers were set to collect features using the following data parameters, based on the specifications given in Schedule G of the General Service Contract:

- Minimum satellite elevation of 15°,
- HDOP 5,
- Minimum SNR of 39.

A minimum of 30 fixes were recorded when collecting static point features. When collecting line or polygon features via a dynamic survey, the Trimble units were set to collect position fixes every 2 m.

When problems with collection of GPS data were encountered, the operators sometimes modified the GPS settings in order to be able to capture data or paused to wait for better satellite geometry. These modifications most often included decreasing the minimum satellite elevation or reducing the SNR setting. When significant limitations with GPS data collection occurred, the crew either suspended data collection to wait for better satellite geometry or abandoned the survey at that location and marked the area for orthophoto and map interpretation if it could not be re-visited during the field program.

RAR mapping of the 19 watersheds included in this project was completed between November 5 and 29, 2013. Streams were located in the field using maps provided by Islands

[2] Salt Spring Island Exchange – www.Salt Springexchange.com

Trust as well as with a GPS enabled tablet showing crew members field location relative to mapped streams. Field maps were marked with the location of properties where permission to access was not obtained. The tablet was used to confirm the location of the crew members relative to property boundaries as well to ensure that properties where access was not permitted were not entered. Field crews carried a letter from the Islands Trust indicating the objectives of the project and explaining the activities field crews were conducting, for sharing with the public if requested.

All streams, channelized streams, ponds, wetlands and ditches with surface connection to fish bearing, or potentially fish bearing streams were mapped within the 19 watersheds identified for this *RAR* mapping project. Crewmembers attempted to locate all mapped drainages within the watershed boundary as well as any unmapped drainages with surface connection to potentially fish bearing streams. Surface connection may be seasonal and as field assessment was conducted during a dry fall, flow was not at a high level. Surface connection was determined in the field using substrate characteristics, presence of banks and lack of seasonal vegetation growth as indicators of continuous surface flow during higher water flow conditions.

The center lines of *RAR* applicable drainages were mapped to the origin of the watercourse, or to the point where the drainage no longer met the definition of an *RAR* stream. When determining when a drainage no longer met the definition of an *RAR* stream, the end of the potential surface flow in a channel was determined to be at point after multiple 10 m long sections lacking sign of surface flow, including continuous scour or defined banks.

In some locations the density of overhanging vegetation or large woody debris prevented field crews from traversing the centerline of a stream. When this was encountered field crews paused the collection of GPS data, re-entered the stream channel where possible and resumed data collection. These gaps were limited to less than 10 m between successive position fixes whenever possible but occasional longer sections between positions did occur.

At the confluence of two channels, the mainstem of a watershed was differentiated from tributaries based on the volume of flow present or potentially present in each channel. The primary or mainstream channel was consistently the channel carrying more flow than tributary channels. Tributaries were numbered sequentially from the downstream end as were reaches.

For wetlands and ponds, the perimeter of the feature was mapped at the high water mark, as defined by *RAR*. The high water mark for wetlands or ponds was determined based on the plant community present and the changes in the vegetation structure. The five year flood level was determined based on the presence of hydrophytes and a lack of woody stemmed plants. No lakes were located within the 19 watersheds included in this *RAR* mapping project.

Significant point features were noted and described, including natural or human made permanent barriers that could not be reasonably modified to allow fish passage. Field crews also made note of areas where streams were within a steep sided ravine, which is defined as a steep sided valley with banks that have a slope of greater than 3:1.

2.2.2 Habitat assessment

During the mapping of *RAR* streams habitat data was collected in order to provide a description of the drainage and determine preliminary SPEA widths for each watercourse. In general, habitat assessment included the measurement and description of:

- Channel bankfull width – measured at representative locations in order to determine an average for each reach,
- Gradient – a minimum of one upstream and one downstream measurement taken over as long a distance as possible,
- Cover – description of the type and amount,
- Bed material – description of the dominant and subdominant bed material,
- Any other significant features identified in the field, such as a barrier to fish migration, were documented and described.

Channel widths (bankfull) were measured approximately every 20 - 50 m, depending on the variability of width encountered, over the length of the surveyed reach. For ditches, the channel width was measured midpoint between the ditch invert and the top of the ditch bank.

The drainage was assessed to make a preliminary determination of what type of feature it was, i.e. stream, channelized stream or ditch. Channelized stream reaches are considered the same as streams under *RAR* and therefore were assigned SPEAs using the same criteria as streams and recorded as streams in the watershed summary tables. Fish observations were recorded when they occurred.

2.3 Preparation of deliverables

The collected stream habitat data was collated for each watercourse within a watershed. Each watershed was reviewed and reach breaks were finalized and mapped. Reach breaks have been delineated at a course scale and include major changes in channel morphology, confluences of major tributaries, significant changes in gradient or the most downstream potential barrier to fish migration. Efforts were made to define reaches based on the presence of stream banks with a slope greater that 33% or 3:1 in order to identify stream segments within a ravine. Reaches were numbered sequentially starting from 1 at the mouth of the stream moving upstream.

GPS data was managed using Pathfinder Office software (ver. 5.40). Field GPS data was corrected post-mission using data from the Nanaimo WCDA base station. All corrected data was then reviewed to identify areas where positions exceeded the horizontal accuracy standard of 5 m. Positions generally failed to meet the required accuracy for one of two reasons:

- Operator procedure – Operators occasionally failed to pause data recording of line features when stopped to record habitat data or when they encountered significant obstacles to movement (i.e. dense shrub thicket or steep cascades / falls). This resulted in the collection of multiple positions centred on their actual position, many of which exceeded the 5 m accuracy standard. This was notably significant when the GPS antenna was lowered when the operator placed it on the ground or attempted to navigate over or under obstacles.

- Environmental conditions – The reception of the satellite signals was influenced by the proximity of the watercourse to structures, in ravines or steep bedrock sections, under thick tree cover and at certain geographical orientations. Whenever possible the operator would adapt their traversing procedure to account for the signal interference but this did not always resolve the situation adequately enough to collect positions at the desired level of accuracy for a section of the survey.

In order to reduce the effect of operator procedure or environmental conditions on locating the centre line of mapped watercourses or the high water mark of wetlands and ponds, the corrected GPS data was reviewed and positions exceeding 5 m were generally deleted from the data set. When the removal of positions would result in an extended length of stream between positions (greater than 10 – 20 m), positions with accuracies between 5 and 10 m were occasionally retained in order to provide an approximate location for the watercourse. In an effort to improve the accuracy of stream mapping areas or reaches where poor accuracy was noted were re-mapped in January 2014. In some sections re-mapping did not improve the accuracy due to environmental conditions and these areas are summarized in Appendix 1 and identified on watershed maps as areas with lower accuracy by a blue hatched line with a black outline. Stream centre line positions in areas with accuracy concerns were also compared to modelled flow location and orthophoto details to evaluate if further locational correction was required for the final mapping product.

Portions of the survey area that were not able to be accessed by the field crew were photo interpreted, along with the boundaries of some wetlands and ponds where access to the high water mark was impeded by dense vegetation. Photo interpretation was performed using existing water course information from Terrain Resource Information Management (TRIM) stream and contour mapping and LIDAR based flow modelling as well as the 2009 orthophotos of Salt Spring Island. A combination of all sources were used when interpreting the location of drainages, wetlands or ponds that were unable to be mapped in the field in order to obtain the most accurate representation as possible. This photo interpreted information was saved as separate stream and wetland shape files, in order to distinguish it from the mapped field data.

Recommendations on the drafting of a *RAR* implementation bylaw on Salt Spring Island by the Salt Spring Island LTC have been presented based on information provided within the *RAR* implementation guidebook and our experience with how the *RAR* has been implemented in several different cities and regional districts on eastern Vancouver Island. We have presented preliminary SPEA widths by reach for mapped drainages based solely on channel widths and gradient. The presented SPEAs are not the result of a detailed *RAR* assessment and must be considered preliminary. A full *RAR* assessment would be required for any development proposed within 30 m of the mapped drainages within these 19 watersheds, or as required according to the *RAR* implementation protocols adopted for Salt Spring Island by the Salt Spring Island LTC.

3.0 Limitations of Data

3.1 Equipment

Handheld GPS receivers were set to collect positions at 5 m accuracy but at times field crews were in conditions that limited the accuracy of collected data due to ravines, thick overhead cover, and the loss of connection when crawling over / under things or poor satellite geometry. Areas where data accuracy was below contract standards have been noted in Appendix 1 along with the corrective actions taken.

3.2 Conditions

Field mapping was completed in November of 2013. Due to drier than typical fall weather, surface flow was not at a high level as is generally expected at this time of year. Mapping was completed following drainages to their source guided primarily by visible surface flow but also using evidence of seasonal flow as an indicator. Evidence of seasonal surface flow included visible sign of scour, definable banks, alluvial deposits and mineral substrate. It is not expected that the less than ideal flow conditions will have resulted in missing any of the primary stream and ditch drainages. Very small, seasonally wetted channels that were dry at the time of the survey may have not been observed where they connected to the primary channels, particularly when the immediate watercourse banks were heavily vegetated. When mapping wetlands or ponds vegetation was used to determine the high water mark so the dry conditions should not notably limit the accuracy of the boundaries of these features.

3.3 Property access

A total of 1536 properties were identified within the 19 watershed boundaries for this mapping project. Existing mapping was used to determine which properties had a mapped stream based on TRIM mapping or flow modelling within their boundaries and a total of 421 properties were identified. As a result of property owner contact, 20 landowners did not provide permission to access their properties in order to map a stream or wetland. Lack of permission does not relieve the landowner of any obligations under the *RAR* or any regulations adopted in the future by the Salt Spring Island Local Trust Committee in order to comply with *RAR*.

Field crews also encountered fences and locked gates which limited access to some areas to map streams or wetlands. Any areas that were unable to be mapped in the field have been interpreted using orthophotos (2009) provided by Islands Trust and modelled LIDAR based flow accumulation mapping. As these areas were not mapped in the field, additional small drainages may be present that were not identified by existing mapping sources as well as barriers to upstream fish migration.

3.4 Watercourse classification

Field assessment of each drainage was completed to determine if the feature was a stream, ditch or channelized stream. This assessment was based on the conditions at the time of the survey and may be interpreted differently in the future by a Qualified Environmental Professional (QEP) during a detailed assessment of the drainage. The collection of additional field or historical data beyond the scope of this assessment could lead to a change in watercourse classification, therefore the classifications presented in this report should be considered preliminary. This is particularly true for ditches that could represent sections of channelized stream.

3.5 Fish Distribution

Fish status and distribution within the 19 watersheds included in this *RAR* mapping project was limited to existing sources of information from FISS or as indicated on the maps supplied by the Islands Trust. The watersheds selected to be mapped where chosen based on interpretative watershed mapping received by the Salt Spring Island LTC in March 2010 that indicated that these watersheds were applicable to the *RAR*. The determination of potential fish habitat was based on interpreted stream gradient, with areas deemed to have gradients less than 20% considered potential freshwater fish habitat.

No fish sampling was conducted as part of this project to confirm the absence of fish upstream of identified barriers. Given that fish sampling was not included in the scope of this project, only significant permanent barriers were documented and only gradients greater than 30% were used to classify a reach as non-fish bearing. While a maximum gradient of 20% is used to define potential fish habitat under the Simple Assessment methodology for a *RAR* assessment, it is common for local species of fish (including cutthroat and rainbow trout, both of which have been reported on Salt Spring Island) to be found in areas with gradients between 20 and 30% when suitable habitat is present. As *RAR* requires that any stream reach supporting fish be “identified, classified and managed as a fish bearing reach regardless of its slope”, stream reaches with gradients less than 30% were assumed to be fish bearing in order that all potentially fish bearing reaches be included in the mapping until further evaluation of fish presence or absence can be completed.

Fish distribution only impacts SPEA determination in the case of ditches. Non-fish bearing ditches receive a minimum 2 m SPEA while a fish bearing ditch SPEA is two times the average channel width with a minimum SPEA of 5 m and a maximum of 10 m. For the purpose of this assessment all ditches have been defaulted as fish bearing because fish sampling was not conducted. In order to confirm the absence of fish within mapped ditches additional sampling by a QEP would be required.

3.6 Preliminary SPEA determination

Preliminary SPEA determination was based on a one time inspection under low to moderate flow conditions. The presented SPEAs are preliminary only and do not replace the requirement of a *RAR* assessment by a QEP in the future if development is proposed within 30 m of a mapped stream, ditch, wetland or pond. The preliminary SPEAs do not consider specific development activities, existing conditions and other factors that would be used to determine a SPEA through a detailed assessment and measures to protect the SPEA as required in an *RAR* assessment are not included.

4.0 Results Summary

RAR mapping was completed for 19 watersheds on Salt Spring Island in November 2013. A total of 79 km of *RAR* streams were mapped in the field, with an unknown length of streams that were interpreted in areas where field crews could not access. In addition, 7.5 ha of wetlands and ponds were mapped in the field, with additional wetland and ponds photo interpreted. Mapping and collected field habitat data are presented for each watershed in the following watershed summaries. Any known or existing fish information is summarized in the watershed summaries as well as the observation of any fish by field crews. Permanent barriers to upstream fish migration have been mapped and described within the watershed summaries and are indicated on maps. The first or downstream-most fish barrier often represents a reach break as well.

This mapping data provides certainty to the Salt Spring Island LTC on the location of the *RAR* applicable streams and wetlands within the 19 watersheds included in this project. This represents the first step in identifying where an *RAR* assessment would be required if future development is proposed within 30 m of these mapped streams or wetlands. This assessment report and suggested SPEAs do not replace the findings of a detailed *RAR* assessment by a QEP but the 30 m Riparian Assessment Area (RAA) applied to the mapped stream and wetlands will indicate the areas where proposed development may trigger the requirement for additional assessment.

The 30 m RAA is generally measured as a horizontal distance from the high water mark of a stream, wetland, pond or lake and the top of bank of a ditch or a stream where the bank has a slope of greater than 33%. Mapping conducted as part of this project was done along the centerline of a stream and did not include mapping or flagging of the high water mark or top of bank of streams where applicable. Wetlands, ponds and lakes were mapped at the high water mark and the 30 m RAA would be established in relation to the mapped boundaries.

Some streams were located within ravines with side slopes having gradients greater than 33%. In a ravine situation, the RAA is measured from the top of the ravine bank. If the ravine is less than 60 m wide, the RAA is 30 m and if the ravine is greater than 60 m wide the RAA is 10 m. Again, application of the 30 m RAA to the stream centerline may under represent the RAA as it should be measured from the top of the ravine bank, which was not mapped in this project. The scope of this project did not include surveying the width of identified ravines but it is unlikely that any of the ravines encountered during field mapping were greater than 60 m wide. Stream reaches that are located within ravines have been identified in the watershed summaries and data tables. If development is proposed within 30 m of the mapped centerline of these reaches a QEP will need to determine the top of the ravine bank and adjust the 30 m RAA according to the site conditions within the development property.

Preliminary SPEAs based solely on channel widths and gradients are presented in the data tables within the watershed summaries. The minimum SPEA for an *RAR* applicable stream is 10 m and the maximum is 30 m. All ditches have been assumed to be fish bearing and preliminary SPEAs have been assigned as two times the average width. All ditches mapped in these 19 watersheds had average widths that were less than 2.5 m and were assumed to be fish bearing, resulting in the minimum ditch SPEA of 5 m. The SPEA of wetlands, ponds and lakes is a minimum of 15 m to the east, north and west and 30 m on all southern boundaries of these features as per the *RAR* assessment methodology for SPEA determination and layout.

Drainages were mapped within parks on Salt Spring Island and preliminary SPEAS have been determined for these reaches. Parks and parkland are subject to other legislation and may be exempt from the *RAR*. However activities such as commercial development with a park may still be subject to the regulation. Development proposals within parks and whether the *RAR* applies will depend on the specific proposal and will need to be reviewed on a case by case basis.

5.0 Watershed Summaries

General summaries describing the potential habitat found in each watershed, including a table summarizing the specific characteristics of each mapped watercourse, are presented in the following sections. Stream reaches that are within a ravine, defined as a stream section with banks greater than 33%, have been identified in the watershed tables within the Reach column and the row is shaded to highlight these ravine reaches. Mapping and report deliverables, including digital mapping files in the specified formats are also included on the enclosed project CD. Maps of each watershed, showing the resulting drainage network, are presented in Appendix 3. Tributary map labels have been abbreviated from Tributary to “T” in order to accommodate labels on short streams and ditches within the map scale.

5.1 Acland Brook

The Acland Brook watershed is located on the northwestern side of Salt Spring Island within an area of residential development. Acland Brook is the only stream within the watershed which collects water flow from five ditches in the downstream section. The first reach of Acland Brook is channelized within ditches and culverts along roads and driveways. A fenced property with a locked gate precluded mapping of Acland Brook just downstream of Booth Road. This portion of the stream has been interpreted. Reach 2 represents a more natural flow pathway but has also been subject to human influence in the form of three manmade ponds. These ponds were mapped and are contained by manmade dams. An 8 foot high fence prevented access to the pond at the headwaters of Acland Brook so this portion of the drainage was photo interpreted. Surveys of the area upstream of the headwater pond were conducted and no ditches or drainages were found upstream of the pond. No barriers to upstream fish migration were found within Acland Brook other than manmade dam structures to create ponds which may or may not be barriers to fish passage. These features are not permanent so the entire length of Acland Brook is considered fish bearing. In total 1.36 km of stream and ditches were mapped within the Acland Brook watershed (Table 1; Appendix 3 Map 1).

Table 1: A summary of habitat characteristics for drainages within the Acland Brook watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Acland Brook	Stream	1	0.9	6.5	10	F	Narrow entrenched channelized stream through residential properties.
Acland Brook	Stream	2	1.1	5.5	10	F, G	Mucky vegetated channel. Sword fern and salal OV.
Tributary 1	Ditch	1	0.3	2	5	F	Driveway ditch filled with leaf litter.
Tributary 2	Ditch	1	0.2	2	5	F	Driveway ditch.
Tributary 3	Ditch	1	0.9	2	5	F	Small vegetated swale along road.
Tributary 3A	Ditch	1	0.3	14	5	G	Ditch drains down a steep driveway.
Tributary 3A1	Ditch	1	0.3	12	5	F	Mossy ditch.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.2 Beaver Point Creek

The Beaver Point Creek watershed is located on the southeastern tip of Salt Spring Island. Permission to access a large property at the mouth of Beaver Point Creek was not granted therefore the downstream portions of this watershed were interpreted using the orthophoto and LIDAR mapping. A portion of this watershed is located within a Provincial Park and information on the application of the *RAR* within a park is given in Section 4.0. One section of Beaver Point Creek and a ditch were mapped within the no access property as they were located within a road right of way. Drainages upstream of this property were mapped in the field and included Beaver Point Creek and one ditch drainage totalling 649 m (Table 2; Appendix 3 Map 2). It is unknown if there are any additional streams, tributaries or barriers to upstream fish migration within the lower reaches of Beaver Point Creek watershed where field mapping could not be conducted due to lack of permission from property owner but no barriers were identified within the sections of the stream that were mapped in the field. The lengths of the northern and western boundaries of the no access property were surveyed in the field and no streams were located in the locations shown on the modelled flow accumulation mapping.

Table 2: A summary of habitat characteristics for drainages within the Beaver Point Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Beaver Point Creek	Stream	1	1.0	5.7	10	G, F	Shallow 2-5 cm banks. Limited pools. Salal OV.
Tributary 1	Ditch	1	0.6	14	5	F	Grassy ditch.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.3 Burgoyne Bay

The Burgoyne Bay watershed is located on the southwestern portion of Salt Spring Island. Three watercourses draining into Burgoyne Bay and their tributaries were mapped, totalling 6.44 km within this watershed (Appendix 3 Map 3). The watersheds have been identified as Burgoyne Bay North Creek, Burgoyne Bay Creek and Burgoyne Bay South Creek for the purpose of this report. The watershed is located in an area of rural development including agricultural properties. Portions of the mapped drainages were modified as ditches and several streams and ditches originate as drainage from farm fields.

The first reach of Burgoyne Bay North Creek is within a moderately steep forested ravine. The channel in Reach 2 has a lower gradient and is characterized as field drainage. Four tributaries of Burgoyne Bay North Creek were mapped, including three ditches and one short stream (Table 3). No barriers to upstream fish movement were identified during the field surveys.

Burgoyne Bay Creek enters the ocean through an embedded 2000 mm culvert and is contained within a constructed cobble channel for the first 50 m. The first reach is within a ravine up to the road crossing. Reach 2 consists of a low gradient mucky channel that meanders through farming fields with dense overhanging vegetation. In addition to the main creek, one stream tributary and eight ditches were mapped (Table 4). Tributary 1A is potentially a non-fish bearing ditch due to the steep gradient and lack of habitat. Fish sampling was not conducted as part of this project so this status will need to be confirmed. Reach 1 of Tributary 7 is channelized through a field and alongside a road, while Reach 2 is a natural stream within a forested area.

Burgoyne Bay South Creek enters Burgoyne Bay at a point just south of Burgoyne Bay Creek. This stream includes three tributaries and one ditch at the headwaters (Table 5). The mapped portion of Burgoyne Bay South Tributary 1 represents a fish bearing reach within this stream. Upstream of this point, the gradient of the watercourse is 70% which would be a barrier to upstream fish passage. No other barriers to fish were identified during field mapping of this stream and associated tributaries. The upper reaches of Tributary 1 were not mapped in the field due to safety concerns related to the steep gradient but have been interpreted and included with the mapping data. The stream was subsurface at the point where field mapping ended but additional assessment upstream may be required to determine if there is seasonal surface flow upstream. The area upstream of the field mapped section of Tributary 1 is within an area of Crown Land and Capital Regional District Ownership. If development is proposed within 30 m of the interpreted stream line additional assessment will be required to confirm the location of this tributary in its headwaters and to determine if the *RAR* applies.

Table 3: A summary of habitat characteristics for Burgoyne Bay North Creek and its tributaries. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Burgoyne Bay North Creek	Stream	1 **Ravine Reach**	1.7	11.5	10	G, C	Stream is within a forested ravine with low flow and limited pools. Sword fern, salmonberry and blackberry OV.
Burgoyne Bay North Creek	Stream	2	1.3	2	10	F	Vegetated moss channel with low flow and only 2 cm banks. 100% salmonberry OV. Stream originates in a grassy field. Flow upstream of the road is directed towards Burgoyne Bay Creek.
Tributary 1	Ditch	1	0.4	12	5		Dry mossy ditch along road/trail.
Tributary 2	Ditch	1	0.9	2	5	F, G	Narrow channel with 100% salmonberry OV.
Tributary 3	Ditch	1	0.6	17	5	F	Seepage flow within a leaf filled ditch.
Tributary 4	Stream	1	0.9	3	10	F	Stream originates as drainage from a grassy field.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

Table 4: A summary of habitat characteristics for Burgoyne Bay Creek and its tributaries. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate [1]	Comments[2]
Burgoyne Bay Creek	Stream	1 **Ravine Reach**	1.9	5.3	10	C, G	Cedar and sword fern OV. Small pools and abundant LWD.
Burgoyne Bay Creek	Stream	2	1.5	1.25	10	F	Salmonberry, blackberry and pacific ninebark OV. Stream originates in a small pond.
Tributary 1	Ditch	1	1.0	4.0	5	F	Fern OV. Abundant LWD.
Tributary 1A	Ditch	1	0.6	38	5	F	Origins of stream are field drainage.
Tributary 2	Ditch	1	1.3	9	5		Narrow grass filled ditch along road.
Tributary 3	Ditch	1	0.7	2	5	G	Square ditch around a field.
Tributary 3A	Ditch	1	0.7	2	5	F	Mucky shallow ditch.
Tributary 4	Ditch	1	0.6	1	5	G	Narrow vegetated ditch.
Tributary 5	Ditch	1	0.5	2	5	F	Mucky ditch collecting field drainage.
Tributary 6	Ditch	1	0.5	2	5		Narrow grassy ditch with abundant Nootka rose.
Tributary 7	Stream	1	1.4	2	10	G, F	
Tributary 7	Stream	2	2.3	21	10	C, G	Steep stream with limited cover.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

Table 5: A summary of habitat characteristics for Burgoyne Bay South Creek and its tributaries. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Burgoyne Bay South Creek	Stream	1	0.4	4	10	F	Abundant LWD. Fern OV. Origins of the stream are ditch seepage from the road.
Tributary 1	Stream	1	2.3	17.5	10	G, C	Fern and cedar OV. Abundant LWD. Flow is subsurface and continues steeply upslope but could not be followed due to gradient and safety concerns.
Tributary 2	Stream	1	0.9	5.3	10	G	Abundant LWD and fern OV.
Tributary 2A	Stream	1	0.8	2	10	G	Salmonberry and fern OV.
Tributary 3	Ditch	1	1.6	0	5		

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.4 Cable Creek

The Cable Creek watershed is located at the southern tip of Salt Spring Island. In total 9.76 km of streams and ditches were mapped within the Cable Creek watershed (Table 6; Appendix 3 Map 4). Reaches 1 and 2 of Cable Creek are within a ravine and the RAA and determined SPEA would be measured from the top of the ravine bank. A series of 2, 3 and 5 m waterfalls present in the second reach of Cable Creek create a barrier to upstream fish migration within the watershed. A section of Cable Creek with gradients ranging from 32-65% and a 6 m bedrock cascade within a ravine are a definite barrier to upstream fish migration and are identified as the break between Reaches 3 and 4. Several barriers were identified within Tributary 3 of Cable Creek which alternates between steep bedrock sections and lower gradient sections with cobble and gravel substrate within Reach 1. The gradient of the drainage decreases in Reach 2 and a portion of this reach flows through an area previously mapped during an *RAR* assessment in preparation for new development. Supplemental stream and wetland mapping was received from Polaris Land Surveying that was conducted under the direction of Kathy Reimer (RPBio) to support an *RAR* assessment report that was submitted to the provincial notification system (2929A) for the Skywater Capital Corp. for a residential subdivision on Musgrave Road and Anna’s Drive in the headwaters of Cable Creek (Reimer, 2013). This data has been provided separately to the Salt Spring Island LTC and a figure showing this area is included in Appendix 2.

Table 6: A summary of habitat characteristics for drainages within the Cable Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Cable Creek	Stream	1 **Ravine Reach**	4.3	13	12.9	G, C	Stream is in a steep ravine.
Cable Creek	Stream	2 **Ravine Reach**	4.4	18.2	13.2	B, C	Stream is within a ravine. Small boulder pools with limited OV. Abundant LWD.
Cable Creek	Stream	3	3.2	6.3	10	C, G	Not in a ravine. Salal and sword fern OV. Good pool habitat. Abundant LWD.
Cable Creek	Stream	4	1.5	7	10	F	Salal OV. Abundant LWD. Origin of stream is a wetland.
Tributary 1	Stream	1	1.8	17	10	G, C	Falls at mouth prevent fish access into stream. Abundant LWD, no OV. Origin of stream is a spring in a mucky, wet forest.
Tributary 2	Stream	1	0.6	18	10	F, G	Barely scoured seepage down a narrow gully. Sword fern OV. Steep gradient at mouth would prevent fish access into stream. Stream originates from the base of a cedar in a salal forest.
Tributary 3	Stream	1	2.3	18.3	10	B, C, G	Abundant OV. Occasional LWD. Some sections of multiple braids. Laminar flow over bedrock in some locations. The stream alternates between steep bedrock sections and lower gradient gravel and cobble sections in this reach.
Tributary 3	Stream	2	2.1	4.4	10	G	Low gradient habitat within new subdivision.
Tributary 3A	Stream	1	0.8	12.5	10	S	Low flow within shallow banks. Sections of subsurface flow.
Tributary 3A1	Stream	1	0.7	15.5	10	F	Cedar and salal OV. Origin of stream is a wetland.

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 4	Ditch	1	0.6	1	5		Grassy leaf filled ditch. Sword fern OV.
Tributary 5	Stream	1	1.1	10	10	C, G	Dry channel that would be fed by driveway ditch. Rafted SWD.
Tributary 5A	Ditch	1	0.5	1	5		Dry driveway ditch.
Tributary 6	Stream	1	0.9	11.5	10	F	Stream runs through an open forest. Abundant SWD but no OV.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.5 Cupples Creek

The Cupples Creek watershed is located at the northern tip of Salt Spring Island within an area of rural development including farms and residential properties. The watershed includes two streams that have direct surface connection to the ocean, Cupples Creek and Cupples Creek East (Table 7; Appendix 3 Map 5). The Cupples Creek estuary includes a large intertidal marsh but only the area where the *RAR* would apply was mapped, upstream of the intertidal zone. One barrier was found in Cupples Creek just upstream of North End Road and has been designated as a reach break. The 9 m long bedrock cascade is a potential barrier to anadromous fish. Cupples Creek mapping included two tributaries, one wetland with beaver activity, two ponds and three short ditch sections. Cupples Creek East mapping included the mainstem and one pond. No barriers to fish migration were identified during field surveys of Cupples Creek East. A total of 3.89 km of stream was mapped within these watersheds.

Table 7: A summary of habitat characteristics for drainages within Cupples Creek and Cupples Creek East watersheds. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Cupples Creek	Stream	1	2.4	2	10	F, G	Sword fern, young cedar and salmonberry OV. Limited LWD. Deeply entrenched where the stream flows through a field.
Cupples Creek	Stream	2	1.2	7.3	10	F, G	Stream originates in a flooded field with no sign of a channel upstream. Deeply entrenched channel with abundant sword fern and salal OV.
Tributary 1	Stream	1	1.2	10.5	10	F	Vegetated channel with shallow scoured banks. Channelized stream through a field.
Tributary 1	Stream	2	1.1	4	10	F	Mucky shallow channel with ponded sections.
Tributary 1A	Ditch	1	0.5	2	5		Narrow grassy ditch.
Tributary 1B	Ditch	1	0.6	2	5		Narrow grassy ditch.
Tributary 1B1	Ditch	1	0.4	5	5		Grass lined driveway ditch.
Tributary 2	Stream	1	0.6	10	10	F	Mucky channel with small mossy banks. Sword fern OV. No pools. Stream originates in a wet sedge forest.
Cupples Creek East	Stream	1	0.8	1	10	F	Stream originates as field drainage. Narrow channelized stream along the edge of a field then flows through a diked field to the ocean.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.6 Fern Creek

The Fern Creek watershed is located in the southern portion of Salt Spring Island and flows through an area of large properties with existing modification limited to road crossings. Cutthroat trout were observed within Reach 1 of Fern Creek and a potential barrier to upstream fish migration was found, marking the downstream end of Reach 2 just upstream of Musgrave Road. This 20 m long 42% gradient cascade is a barrier to upstream fish migration. Several additional barriers were identified within Reach 2 of Fern Creek including a 3 m waterfall, eight bedrock cascades and one 2 m hanging culvert at a road crossing. Mapping of this watershed included Fern Creek and four tributaries totalling 3.32 kms (Table 8; Appendix 3 Map 6). A section within Reach 1 of Fern Creek has been interpreted as permission to access a property to map this portion of the stream was not granted by the property owner.

Table 8: A summary of habitat characteristics for drainages within the Fern Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Fern Creek	Stream	1	2.7	8	10	C, G, F	Cutthroat trout observed within Reach 1. Abundant LWD and salmonberry OV.
Fern Creek	Stream	2	2.2	6	10	C, R	Several falls and cascades within this reach at bedrock sections. Fern and salmonberry OV. Abundant LWD. Stream originates from a small spring.
Tributary 1	Stream	1	1.8	18	10	G, F	Short, steep stream.
Tributary 2	Stream	1 **Ravine Reach**	1.7	20	10	C, R	Steep gradient (42%) within a ravine at the confluence of this tributary would restrict fish access into this short stream.
Tributary 3	Stream	1	2.5	26	10	F	Poorly scoured connection to Fern Creek. Limited potential for fish access.
Tributary 4	Stream	1	2.9	3	10	F	Abundant leaf litter in the stream at the time of the assessment.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.8 Ganges Creek and Swanson Creek Watershed

This watershed has three principle watercourses: Swanson Creek, Ganges Creek and a main tributary draining from Mount Belcher. Swanson Creek flows through Ganges, which is the urban center of Salt Spring Island. Extensive modifications of the stream have occurred due to urban development including underground culverts and ditches. Habitat limitations within this drainage include large sections of stream that flow underground as well as grates present at the downstream end of the stream limiting the size of a fish able to migrate into Swanson Creek. Where the drainage was contained in underground pipes, the drainage pathway was determined by marking the location of catch basins and culvert outlets and the final stream centre line for these areas was interpreted from these points. Measures are required to protect water quantity and quality within ditches and the upper reaches of Swanson Creek but given the already modified nature of the downstream section of the drainage, additional protection through the *RAR* process may not provide any significant additional protection of fish habitat and may therefore not be warranted for many development activities. For example, the determined SPEA for the downstream section of Swanson Creek is 10 m, which in most cases would be difficult to achieve given the existing development within this portion of the drainage. Establishment of a 2 m buffer including measures for the protection of water quality and quantity, such as erosion and sediment control may be more practical. Additional discussion of this concept and how it relates to the implementation of the *RAR* is included in Section 6.0 of this report.

Swanson Creek was mapped including three stream tributaries and 16 ditches that had direct surface connections totalling 6.46 km of mapped stream within this watershed (Table 9; Appendix 3 Map 7). Access to map a pond known as Swanson Pond was prevented as permission was not granted by the owner. An outlet connecting the pond to Swanson Creek was not observed at the time of the field survey, possibly due to the low flow levels. Information provided by Salt Spring Island LTC staff indicates that the pond connects to a ditched section of Swanson Creek during high flow conditions. Swanson Pond was photo interpreted and included with the mapping data as the *RAR* would apply to this pond if the surface connection is confirmed.

Ganges Creek is identified as Tributary 1A for the mapping generated during this project. At the downstream end of this drainage flow is contained within ditches along Drake Road and Seaview Avenue eventually entering a culvert that passes under Seaview Road to the north connecting to Tributary 1 of Swanson Creek via a culvert. The constructed nature of the lower portion of this drainage would make fish access into the more natural portions of this stream difficult but as there is a direct connection to downstream fish habitat within Swanson Creek and Tributary 1 the *RAR* applies to this stream.

Tributary 1B is another main tributary within the watershed that collects drainage from Mount Belcher. Flow within Tributary 1B splits within Mouat Park and some flow is directed towards the ditched portion of Reach 2 of Tributary 1 along Rainbow Road (which could not be mapped in the field due to fencing) while some flow continues to the east along the trails within the park and joins Tributary 1 further downstream through a culvert on the upstream side of McPhillips Avenue. A gradient barrier within Reach 2 of Tributary 1B would prevent upstream movement of fish within this stream. There is also a non-permanent barrier to fish in the form of a hanging culvert at a road crossing on Tributary 1B in the upper portion of Reach 1.

Table 9: A summary of habitat characteristics for drainages within the Swanson Creek and Ganges Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Swanson Creek	Stream	1	1.9	3.3	10	C, G, F	Stream enters ocean under a 3.5 m bridge and concrete box culvert. Grated flow in creek - could limit fish entry into system. Downstream portions of drainage go through urban commercial area of Ganges. Highly modified drainage with portions underground and drainage pathways controlled by urban development. Blackberry, Nootka rose, and alder OV. Aquatic IV. Grassy banks. Some sections armoured with cobble. Origins of Swanson Creek are three pipe outlets from a manufactured home park, Brinkworthy Place.
Tributary 1	Stream	1	1.8	2	10	F	Mucky channel with soft banks. Abundant blackberry OV. In an urban setting with scattered human garbage.

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 1	Ditch	2	2.1	3	5	F, G	Drainage is contained within a culvert under a condo parking lot or a roadside ditch adjacent to Rainbow Road. Vegetated ditch with grassy banks flows through multiple driveway culverts. End of survey at height of land. No headwaters.
Tributary 1A (Ganges Creek)	Stream	1	0.9	8	10	C, G	Connects to Trib. 1 of Swanson Creek via an underground culvert from a ditch on the south side of Seaview Ave. Lower portions of the drainage are contained within ditches along Drake Road and Seaview Road. Blackberry and fern OV.
Tributary 1A1	Ditch	1	0.6	3	5		
Tributary T1A2	Ditch	1					
Tributary T1A2A	Ditch	1	0.6		5		Origin of drainage is an area of ivy and blackberry.
Tributary 1A3	Ditch	1	1.0	7	5		
Tributary 1A4	Ditch	1	1.2	10	5	C	
Tributary 1A5	Ditch	1	0.9	1	5		Young alder and sword fern OV.
Tributary 1B	Stream	1	1.7	5.8	10	C, G, F	Stream runs through the disc golf area adjacent to a trail within a park.
Tributary 1B	Stream	2 **Ravine Reach**	2.0	37	10	C, B	Steep reach within a ravine. Abundant LWD.
Tributary 1B	Stream	3	1.0	3.3	10	C, F	Abundant LWD and sword fern OV.
Tributary 1C	Ditch	1	0.3	3	5	F	Small mucky ditch adjacent to a condo development,

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
							Murakami Gardens. No fish habitat but direct connection to T1.
Tributary 2	Ditch	1	1.2	5	5		Poor connection to Swanson Creek through lots of vegetation and shallow grassy swale. Likely NFB. Dry, may only flow in response to heavy rainfall. End of ditch at road intersection. No headwaters.
Tributary 3	Ditch	1	1.0	3	5		Dry roadside swale connected to Swanson Creek on downstream side of Jackson Ave. Poorly defined ditch ingrown with vegetation - grasses, reeds and blackberry. Likely only flows in direct response to rainfall. Likely NFB. End of ditch at intersection. No headwaters, local drainage only.
Tributary 4	Ditch	1	1.3	4	5		Open grassy swale. Source of water is perimeter drain discharge and field runoff. No headwaters.
Tributary 5	Ditch	1	1.6	6.5	5		Dry ditch along Kanaka Road. Very thick grass and reeds in ditch. Narrow flow path but probably only flows in direct response to rainfall. End of ditch at height of land. No headwaters.
Tributary 6	Ditch	1	1.0	7	5		Ditch beside Park Road. No headwaters.
Tributary 7	Ditch	1	0.8	6	5	F	Thick blackberry on banks. Very marginal drainage. At least 50% is culverted.
Tributary 8	Ditch	1	1.9	9	5	F	Low flow with thick aquatic and terrestrial vegetation in ditch. Flows through multiple driveway culverts.

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 9	Ditch	1	0.6	6	5		Ditch along Lower Ganges Road. Seepage flow in a grassy swale. Likely NFB but a 5 m SPEA has been applied until additional sampling to confirm fish status.
Tributary 10	Ditch	1	1.0	4	5	F	Grassy ditch with very low flow. Blackberry and bracken fern on banks. Origin is a drain pipe from Brinkworthy Place.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool, NFB = non-fish bearing

5.9 Larleau Creek

Larleau Creek is located in the southern portion of Salt Spring Island and drains through an area of large rural properties. Larleau Creek and two stream tributaries were mapped totalling 1.35 km (Table 10; Appendix 3 Map 8). Reach 2 of Larleau Creek is within a ravine and the RAA and preliminary SPEAs would be measured from the top of the ravine bank as per the *RAR* assessment methodology. A 30 m high waterfall was located within Larleau Creek downstream of any tributaries, which is a barrier to upstream fish migration. This waterfall within a bedrock canyon is identified as Reach Break 2, the location of which was interpreted because it was unsafe to access in the field. All habitat upstream is potentially non-fish bearing as no lakes or ponds are mapped in the headwaters that could support resident fish populations. Reach 3 of Larleau Creek returns to lower gradient habitat and is not within a ravine. Larleau Creek was mapped working upstream to a property where permission to access was not provided. The stream did continue upstream of the last mapped location and has been interpreted and included with the mapping data. Surveys upstream of this property along Dubois Road were completed and no additional *RAR* applicable streams were identified. A drainage was found near the intersection of Dubois Road and Musgrave Road but it does not connect to any of the mapped drainages downstream and therefore the *RAR* does not apply to this drainage.

Table 10: A summary of habitat characteristics for drainages within the Larleau Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Larleau Creek	Stream	1	2.8	6	10	G, C	Sword fern OV. Occasional mossy boulder and LWD.
Larleau Creek	Stream	2 **Ravine Reach**	3.1	21.5	10	C	Stream is within a ravine.
Larleau Creek	Stream	3	2.2	6.6	10	C, G	Sword fern and salmonberry OV. Small pools and multiple channels in this reach. Moderate LWD.
Tributary 1	Stream	1	1.2	1	10	F	Mucky channel filled with leaf litter.
Tributary 2	Stream	1	1.3	1	10	F, G	Abundant SWD and leaf litter. Sword fern OV.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.10 Madrona Creek

The Madrona Creek watershed is located on the eastern side of Salt Spring Island and originates as field drainage through a series of small ponds in the headwaters. Mapping of the watershed included Madrona Creek as well as two stream tributaries, four ditches and seven ponds or wetlands totalling 4.26 km (Table 11; Appendix 3 Map 9). No barriers to upstream fish migration were identified. Reach 2 of Madrona Creek is within a ravine and the RAA and determined SPEA would be measured from the top of the ravine bank in this reach.

Table 11: A summary of habitat characteristics for drainages within the Madrona Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Madrona Creek	Stream	1	2.3	8.8	10	G, F	Sword fern and salmonberry OV. Moderate LWD.
Madrona Creek	Stream	2 **Ravine Reach**	2.2	4	10	F, G	Stream is in a ravine. Abundant salmonberry OV.
Madrona Creek	Stream	3	1.4	4.8	10	G, C, F	Grassy banks where channel runs through a BC Hydro right of way. Limited OV through an open forest. Field ditch in upper reaches.
Tributary 1	Ditch	1	0.7	4	5	F	Seepage flow through a field. Connects to a pond.
Tributary 2	Ditch	1	1.0	0	5	F	Grass lined ditch filled with leaf litter. Drains a small pond.
Tributary 3	Stream	1	0.6	3	10	F	Seepage in a mucky channel. Salmonberry OV.
Tributary 4	Ditch	1	1.0	10	5		Grassy ditch adjacent to Upper Ganges Road.
Tributary 5	Ditch	1	0.8	10	5		Grassy ditch adjacent to Upper Ganges Road.
Tributary 6	Stream	1	1.5	6	10	G, F	Moderate sword fern OV. Large wetland is headwaters of stream.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.11 Mansell Creek

The Mansell Creek watershed contained numerous ponds and wetlands and extensive low gradient fish habitat. Beaver activity is responsible for some of the pond features. The watershed includes Mansell Creek and one other main tributary plus 13 ditches and two smaller stream tributaries. A total of 10 ponds and one wetland were mapped within the watershed, in addition to the stream and ditch pathways resulting in 7.76 km in total mapped within the watershed boundaries (Table 12; Appendix 3 Map 10). FISS records indicate that coho salmon are present within Mansell Creek. The only barrier to upstream fish migration was a 20 m section of subsurface flow in Mansell Creek Tributary 3 immediately upstream of Pond 2. This may limit fish distribution during dry periods but the stream is likely connected during high flow conditions and therefore the *RAR* would apply to the upstream portions of Tributary 3 and the associated pond.

Table 12: A summary of habitat characteristics for drainages within the Mansell Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Mansell Creek	Stream	1	2.1	3.7	10	F, G, C	Abundant fern, alder, cedar and blackberry OV. Deep pools in some sections and abundant LWD.
Mansell Creek	Stream	2	1.1	2	10	F	Long grass IV/OV. Abundant LWD and SWD.
Mansell Creek	Stream	3	2.3	1	10	F, G	Fern and cedar OV. Abundant LWD and SWD.
Mansell Creek	Stream	4	2.4	2	10	F, G	Abundant blackberry and alder OV.
Mansell Creek	Stream	5	1.3	1	10	F, G	Abundant alder, salmonberry and blackberry OV.
Mansell Creek	Stream	6	1.3	1	10	F, G	In a forested area. Abundant LWD. Cedar, salal and sword fern OV.
Mansell Creek	Stream	7	0.6	4	10	F	Stream originates from a grassy swale.
Tributary 1	Ditch	1	0.5	3.7	5	F	Dry grassy ditch along a grassy field. Abundant leaf litter.
Tributary 2	Ditch	1	0.5	3	5	F	Short, dry mossy channel.
Tributary 3	Stream	1	1.1	4	10	F	Abundant OV. Field ditch.
Tributary 3	Stream	2	2.0	3.7	10	G, F	Abundant blackberry OV. Grass IV.
Tributary 3	Stream	3	1.6	3	10		Headwaters of stream is a pond.

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 4	Ditch	1	0.8	10	5		Dry grassy ditch. Sword fern and salmonberry OV.
Tributary 5	Ditch	1	0.75	10	5		Dry grassy ditch. Nootka rose and fern OV.
Tributary 6	Ditch	1	0.9	1	5	F	Grass IV. Channel ends in a grassy swale.
Tributary 7	Ditch	1	0.4	2	5		Ditch lined with tall grass.
Tributary 8	Ditch	1	0.85	17	5	F	Seepage flow in a grassy ditch.
Tributary 9	Ditch	1	1.2	15	5	F	Grassy ditch with young alders.
Tributary 10	Ditch	1	0.8	0	5		Grassy ditch with young alder OV.
Tributary 11	Ditch	1	1.1	15	5	F, R	Grassy ditch with sections of bedrock.
Tributary 12	Ditch	1	1.4	16	5		Grassy ditch with young alder OV.
Tributary 13	Stream	1	1.0	4	10	F	Short stream with no flow. Fern OV.
Tributary 14	Stream	1	0.9	23	10	F, G	Salmonberry and fern OV. Stream ends in a grassy swale.
Tributary 15	Ditch	1	0.5	12	5	F, G	Grassy ditch that originates from a pond.
Tributary 16	Ditch	1	0.5	10	5		Grassy ditch that originates from a perimeter drain.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.12 McFadden Creek

The McFadden Creek watershed is located at the northern end of Salt Spring Island within an area of residential and agricultural development. FISS records indicate that threespine stickleback and cutthroat trout are present within McFadden Creek. McFadden Creek has no barriers to upstream fish migration other than a section upstream of North End Road where flow is subsurface seasonally but this area floods during high water conditions and cutthroat trout have been observed upstream (FISS). The watershed contains two large ponds with evidence of beaver activity. Several tributaries, including ponds and ditches were mapped within the watershed totaling 10.61 km (Table 13; Appendix 3 Map 11).

Table 13: A summary of habitat characteristics for drainages within the McFadden Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
McFadden Creek	Stream	1	1.8	1.5	10	F, G, C	At the mouth the stream parallels the beach for 40 m behind a shell berm. Salmonberry, blackberry, willow, salal OV. Channelized and entrenched in sections. Some flooding due to beaver activity.
Tributary 1	Ditch	1	0.6	2	5	F	Ditch dug along edge of property.
Tributary 2	Ditch	1	1.1	5.5	5	G, C	Deeply entrenched ditch. Salmonberry and sword fern OV. Origin is a pond.
Tributary 2A	Ditch	1	1.0	3	5	F	Ditch between field and access road. Sword fern OV.
Tributary 2B	Stream	1	0.8	9.5	10	G	First 100 m is a natural watercourse then the remainder of the drainage is a grassy ditch through a field. 2 m falls 100 m from confluence.
Tributary 3	Ditch	1	0.5	2	5	F	Barely scoured organic channel. Sword fern OV.
Tributary 4	Stream	1	1.2	3	10	F	Sword fern and salmonberry OV. Upstream of the pond the channel is mucky with only seepage flow through a field.
Tributary 5	Ditch	1	0.9	4.3	5	F	100% Nootka rose, blackberry and grass OV. Upstream of the pond the drainage is a mucky

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
							roadside swale beside an access road.
Tributary 5A	Ditch	1	1.75	4	5		Grass lined ditch adjacent to road with Nootka rose and blackberry OV.
Tributary 5B	Ditch	1	1.75	1	5		Grassy ditch adjacent to road with blackberry and salmonberry OV.
Tributary 6	Ditch	1	0.8	3	5	F	Thick blackberry and salmonberry OV.
Tributary 7	Ditch	1	0.6	1	5		Grassy ditch with blackberry OV.
Tributary 8	Ditch	1	0.3	3	5		Blackberry, salmonberry and willow OV. Hedgerow ditch.
Tributary 9	Stream	1	0.5	3	10		Seepage only at the time of survey.
Tributary 10	Stream	1	0.5	3	10	F	Blackberry and salmonberry OV. Multiple seepage points.
Tributary 11	Ditch	1	0.4	3	5		Grassy ditch.
Tributary 12	Ditch	1	0.8	4	5		Grassy ditch.
Tributary 13	Ditch	1	0.6	2.3	5		Grassy ditch adjacent to road.
Tributary 13A	Ditch	1	0.5	7.5	5		Grassy ditch.
Tributary 14	Ditch	1	0.38	0	5		Grassy ditch adjacent to road.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.13 McLemnan Creek

The McLemnan Creek watershed is located in the southeastern portion of Salt Spring Island with both residential and agricultural development. The watershed includes McLemnan Creek, two stream tributaries and two ditches as well as five mapped wetlands / ponds totalling 4.18 km (Table 14; Appendix 3 Map 12). A 3 m high bedrock waterfall was identified in the lower reaches of McLemnan Creek that, combined with a 10 m long 28% bedrock cascade, forms a barrier to upstream fish migration. Resident populations of trout could potentially be found above this barrier as large ponds are present upstream. Reaches 1 and 2 of McLemnan Creek are within a ravine and the RAA and determined SPEAs would be measured from the top of the ravine bank. The upper extent of McLemnan Creek was not accessible as field crews did not have permission to map within a property upstream of the large wetland. This portion of the drainage has been interpreted using a combination of LIDAR based flow modelling, TRIM stream mapping and the 2009 orthophoto and is included with the mapping data.

Table 14: A summary of habitat characteristics for drainages within the McLemnan Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate [1]	Comments[2]
McLemnan Creek	Stream	1 **Ravine Reach**	3.9	5	11.7	G, C	Limited OV and occasional LWD. Stream flows in gently sloped ravine. Moderate sized pools available.
McLemnan Creek	Stream	2 **Ravine Reach**	3.6	4.5	10.8	G, C	Within a ravine.
McLemnan Creek	Stream	3	2.2	3	10	G, F	Long backwatered glides present in this reach. 100% Nootka rose OV in ditched sections.
Tributary 1	Stream	1	1.1	8.7	10	G, F	Salmonberry, grass and sword fern OV. Abundant LWD in lower section where the channel is deeply entrenched. Stream originates from multiple seepage points from a sedge filled wet forest.
Tributary 1A	Ditch	1	0.7	11	5		Grassy ditch adjacent to road.
Tributary 2	Ditch	1	0.2	3	5		Grassy ditch.
Tributary 3	Stream	1	1.1	9.2	10	C, G, F	Alder, sword fern and blackberry OV. Stream at upper end but channelized in the lower sections. Origins of stream are seepage from the base of an old cedar stump.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.14 Monte Creek

The Monte Creek watershed in located in the southeastern portion of Salt Spring Island and has been documented as historically supporting cutthroat trout. The watershed includes one stream and three ditches totalling 2.66 km mapped within this watershed (Table 15;

Appendix 3 Map 13). The watershed is located in an area of rural development with residential and agricultural uses within the watershed boundaries. Portions of Monte Creek were channelized within a ditch bordering a field. Permission to access the residential property at the mouth of the stream was not obtained so mapping was initiated immediately upstream of the property boundary. The downstream section of Monte Creek has been interpreted using LIDAR based flow modelling, TRIM stream mapping and the 2009 orthophoto and is included with mapping data. A barrier to upstream fish migration was found downstream of Bridgeman Road. The barrier is a 36% gradient cascade with a 2.5 m vertical falls at the top. Fish sampling was not conducted as part of this project so it is not possible to confirm that the drainage upstream is non-fish bearing until further sampling is completed. Upstream of this barrier the stream was mapped until the boundary of the property where permission to access was not granted. The stream does continue upstream but could not be mapped in the field and has been interpreted using the same source mentioned above and is included on the watershed map. As the watershed boundary is contained within this property no attempts were made to locate Monte Creek upstream of the property. No stream tributaries were located during mapping but three *RAR* ditches were mapped adjacent to Bridgeman Road. The mapped ditches do not contain fish habitat and are located upstream of a barrier to fish migration, but they have a surface connection to Monte Creek and would directly contribute water to this drainage so are deemed to be *RAR* drainages. A manmade pond was found adjacent to Monte Creek but could not be mapped as it was located inside a fenced area so it has been photo interpreted and included with the mapping data.

Table 15: A summary of habitat characteristics for drainages within the Monte Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Monte Creek	Stream	1	2.1	4	10	C, G	Some OV and abundant LWD.
Monte Creek	Stream	2	2.0	4	10	C, G	Ditched within a field in some sections.
Tributary 1	Ditch	1	0.6	8	5		Mossy grass ditch with no signs of flow.
Tributary 2	Ditch	1	0.4	9	5		Roadside ditch.
Tributary 3	Ditch	1	0.7	6	5		Roadside ditch.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.15 Okano Creek

The Okano Creek watershed is in an area with mixed residential, agricultural and recreational use (Table 16). The headwaters of Okano North Creek are located in a golf course where the drainage has been extensively modified (Table 17). These drainages have been included in the *RAR* mapping but in future detailed *RAR* assessments a QEP may determine that full application of the *RAR* may not be warranted and that a reduced riparian leave area (less than the *RAR* prescribed SPEA) to protect water quality and quantity may be appropriate. Mapping included Okano Creek and Okano North Creek, which both drain into Booth Inlet, as well as several ditches and ponds totalling 6.62 kms (Appendix 3 Map 14). No permanent barriers to upstream fish migration were identified in the field but habitat modification due to ditching and culverts may limit fish distribution within the watershed.

Table 16: A summary of habitat characteristics for drainages within the Okano Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Okano Creek	Stream	1	1.9	2	10	F, G, C	Alder, cedar and sword fern OV. Deeply scoured in a horse pasture with multiple bank disturbances at the downstream end.
Tributary 1	Ditch	1	1.2	4	5	F, G	Fern OV. Abundant SWD and LWD.
Tributary 2	Stream	1	1.4	7.4	10	F, G, C	Vegetated channelized stream. Salmonberry and blackberry OV.
Tributary 2A	Ditch	1	1.2	1	5	F	Mucky ditch with seepage flow.
Tributary 2B	Stream	1	0.8	2	10	F	Mucky barely scoured channel filled with leaf litter. Salmonberry and alder OV.
Tributary 2C	Ditch	1	1.5	3	5		Wide grassy ditch adjacent to road.
Tributary 2D	Ditch	1	1.5	3	5		Grassy roadside ditch.
Tributary 2E	Stream	1	1.4	3	10	F	Dry mucky channel with barely scoured banks. Salmonberry and blackberry OV.
Tributary 2F	Ditch	1	1.3	3	5	F	Ditch flow emerges from a pipe. Salmonberry, blackberry and sword fern OV.
Tributary 2G	Ditch	1	0.6	2	5		Narrow ditch beside parking lot.
Tributary 2H	Ditch	1	0.6	2	5	F	Narrow mucky ditch beside turn around.
Tributary 2I	Ditch	1	1.1	3	5	G, C	Nearly dry ditch along an old fence line. Sword fern OV.
Tributary 2J	Ditch	1	0.9	6	5		Ditch around a riding ring.
Tributary 2K	Ditch	1	0.6	1	5		

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 3	Ditch	1	0.9	8	5		Dry grassy ditch.
Tributary 3A	Ditch	1	0.9	8	5		Grassy ditch.
Tributary 3B	Ditch	1	0.9	8	5		Grassy ditch.
Tributary 3B1	Ditch	1	0.9	8	5		Grassy ditch.
Tributary 4	Ditch	1	1.9	3	5		Roadside ditch.
Tributary 5	Ditch	1	1.6	2	5		Ditch originates at a concrete plant.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

Table 17: A summary of habitat characteristics for drainages within the Okano North Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Okano North Creek	Stream	1	1.5	3.5	10	F, G, C	Stream is piped at the mouth. Highly eroded banks at the downstream end. Salmonberry and grass OV. Some sections are channelized. Origin is a culvert.
Tributary 1	Ditch	1	0.9	3	5		Blackberry OV and tall grass IV. Runs through a golf course with long culverted sections.
Tributary 1A	Ditch	1	0.6	10	5	G, F	Dry ditch. Blackberry OV.
Tributary 1A1	Ditch	1	1.0	4	5	F	Abundant blackberry OV.
Tributary 1B	Ditch	1	0.8	5	5	F	
Tributary 1B1	Ditch	1	1.7	4	5		Grass IV. Ditch drains two ponds.
Tributary 1C	Ditch	1	0.6	5	5	F	Ditch originates in a mucky area with abundant blackberry, grasses and horsetail.
Tributary 1D	Ditch	1	0.6	1	5	F, G	Salal, blackberry and fern OV.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.16 Sharpe Creek

The Sharpe Creek watershed is located on the western side of Salt Spring Island and contains good quality fish habitat in the lower reaches. The watershed is in an area of rural development and includes residential and agricultural use. The watershed includes the Sharpe Creek mainstem and one main tributary as well as three small tributaries and three ditches (Table 18; Appendix 3 Map 15). Two manmade ponds and one wetland were also mapped within the watershed boundaries. In total 3.37 km were mapped within this watershed. A 15 m high waterfall, which is a barrier to upstream fish migration, was identified within Sharpe Creek upstream of the main tributary. Resident fish may be present above this barrier as there is potential habitat present in a wetland at the origin of this stream and fish sampling was not completed to confirm the absence of fish above this waterfall. Reaches 1, 2 and 3 of Sharpe Creek are within a ravine.

Table 18: A summary of habitat characteristics for drainages within the Sharpe Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Sharpe Creek	Stream	1 **Ravine Reach**	3.0	2	10	G, C	Salmonberry OV. Limited LWD and pools but good fish habitat. Stream is in a ravine.
Sharpe Creek	Stream	2 **Ravine Reach**	2.0	13.5	10	G, C	Stream is in a ravine. Sword fern and salmonberry OV. Abundant LWD. Fish barrier in this reach.
Sharpe Creek	Stream	3 **Ravine Reach**	2.2	36	10	B, C	Stream in a steep ravine. Sword fern OV.
Sharpe Creek	Stream	4	1.2	13	10	C, G	Grassy channel through alder forest. Salal and sword fern OV.
Sharpe Creek	Stream	5	1.1	15	10	F	Vegetated channel emerges from a small wetland with sedges and bulrushes at the base of a rock bluff.
Tributary 1	Stream	1	1.2	10.3	10	G, C, F	Small U shaped banks. Salal and sword fern OV. Originates from a spring from a sidehill.
Tributary 1A	Stream	1	0.4	4	10	G	Barely scoured connection to T1.
Tributary 1B	Stream	1	0.9	5	10	F	Mucky, poorly scoured channel connected to cattle pond.
Tributary 1C	Ditch	1	0.9	8	5		Ditch collects surface water and seepage from an old road. Salal and sword fern OV.
Tributary 2	Stream	1	0.8	50	10	C	Rafted SWD and sword fern OV. Stream originates from a pile of stumps.

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Tributary 3	Ditch	1	1.2	8	5		Grass and sedge filled ditch.
Tributary 4	Ditch	1	0.9	15	5	F	Scoured to clay.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.17 Soule Creek

Soule Creek is located in the southern portion of Salt Spring Island and flows through an area of farms. The lower 100 m of Soule Creek is ditched and culverted along Fulford-Ganges Road. The watershed includes Soule Creek and three tributaries, one ditch and a manmade pond. In total 2.43 km were mapped within this watershed (Table 19; Appendix 3 Map 16). A French drain (gravel covered drainage pipe) interrupts the surface flow of Soule Creek within a farm field, and is currently a barrier to upstream fish migration. This feature is not a permanent barrier and fish presence upstream is to be assumed. A gradient barrier is present within Tributary 2 which would prevent upstream movement of fish within this stream. Portions of Soule Creek and the confluence with Tributary 1 were interpreted as field crews did not have permission to access a property. Field crews experienced mapping challenges in the upper reaches of Soule Creek related to poor satellite reception so this portion of the stream was interpreted.

Table 19: A summary of habitat characteristics for drainages within the Soule Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Soule Creek	Stream	1	1.7	5	10	F, G	First 100 m of stream are contained in ditches and culverts. Upstream the channel is deeply downcut through a cleared field. Salmonberry and blackberry OV.
Soule Creek	Stream	2	2.5	15	10	G, C, B	Abundant salmonberry and sword fern OV. Well defined channel with 1.5 m banks. Water flow is subsurface in some sections.
Tributary 1	Stream	1 **Ravine Reach**	1.3	15.5	10	C, G	Stream flows through a natural forested area in a small ravine. Abundant LWD and sword fern OV. The stream originates from seepage at the head of the ravine.
Tributary 1A	Stream	1	1.2	8	10	F, G	Narrow, shallow channel. Salmonberry and sword fern OV. Poorly confined. Origin is ground water seepage from a slope.
Tributary 1B	Ditch	1	0.7	25	5	F, G, C	Overflow channel from a constructed pond as well as field drainage. Ditch is flat adjacent to the pond then drops over a steep bank (49%) to T1.
Tributary 2	Stream	1	2.0	16	10	C, G	Stream flows through a natural forest with sword fern OV. Flow is subsurface in some sections.
Tributary 2	Stream	2	1.4	56.5	10	C, B	No fish habitat due to steep gradient.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

5.18 Walker Hook Creek

The Walker Hook Creek watershed is located on the northeastern portion of Salt Spring Island and contains one main creek with one stream tributary and six ditch tributaries. A total of 3.88 km was mapped within this watershed (Table 20; Appendix 3 Map 17). The lower portions of Walker Hook Creek contained spawning gravel with good fish habitat provided by well defined pools. Upstream the creek is modified by roads and residential development. A 10 m long 40% bedrock cascade barrier to upstream fish migration was identified downstream of Walker Hook Road. This barrier marks the beginning of Reach 2 of Walker Hook Creek, which like Reach 1 is within a ravine. Reach 3 of Walker Hook Creek is not confined within a ravine and the stream flows through farm fields in a grassy channel which serves as field drainage. In this reach several manmade ponds are present which were not mapped due to their small size (less than 20 m by 20 m). As they have a direct surface connection to Walker Hook Creek the *RAR* would apply to these features.

Table 20: A summary of habitat characteristics for drainages within the Walker Hook Creek watershed. W_b = bankfull width

Drainage	Drainage Type	Reach	Avg. W_b (m)	Avg. gradient (%)	Prelim. SPEA (m)	Substrate[1]	Comments[2]
Walker Hook Creek	Stream	1 **Ravine Reach**	2.6	7	10	G, F	In a ravine. Salmonberry and sword fern OV.
Walker Hook Creek	Stream	2 **Ravine Reach**	2.1	5.75	10	F, C, G	In a ravine. Sword fern and salmonberry OV. Shallow organic banks.
Walker Hook Creek	Stream	3	1.5	1.3	10	F	Salmonberry, sword fern, and cedar OV. Limited pools and LWD through a wet forest. Upper reaches are channelized through a field.
Tributary 1	Ditch	1	0.6	25.7	5		Grassy ditch drains from edge of ravine. Gradient up ravine edge is 60%. No fish habitat.
Tributary 1A	Ditch	1	0.3	2	5		Grassy ditch.
Tributary 1B	Ditch	1	0.4	10	5		Grass filled ditch.
Tributary 1C	Ditch	1	0.8	4	5		Grassy ditch.
Tributary 2	Stream	1	1.1	32	10	G, F	Entrenched. Sword fern OV.
Tributary 3	Ditch	1	1.0	6	5		Grassy ditch.
Tributary 4	Ditch	1	1.0	6	5		Grassy ditch.

1 – dominant substrate followed by subdominant substrate: F = fines, G = gravel, C = cobble, B = boulders, R = boulders larger than 4 m and bedrock, A = anthropogenic (rip-rap, dikes, etc.)
2 – SWD = small woody debris, LWD = large woody debris, OV = overhanging vegetation, IV = instream vegetation, B = boulder, U = undercut banks, DP = deep pool

6.0 Discussion and Recommendations for *RAR* Implementation

Note that when the word stream is used in the following discussion, it is intended to represent all features defined as “streams” under *Riparian Areas Regulation* (*RAR)*, including natural streams, ditches, ponds, lakes and wetlands.

This project has provided the remaining data required to complete detailed mapping of streams (as defined under *RAR*) present within 26 “*RAR* designated watersheds” on Salt Spring Island. Through this mapping initiative, the local Islands Trust has developed an accurate representation of the drainage networks within these watersheds (with some limitations), along with a detailed database of habitat information and preliminary riparian protection areas (Streamside Protection and Enhancement Areas, or SPEAs). This activity represents a positive and significant step in integrating the requirements of the *RAR* into proposed future developments included under this regulation.

Throughout the development of the *RAR* implementation strategy to be adopted by the Salt Spring Island Local Trust Committee (LTC), it is important to consider that the objective of the *RAR* is to protect local fish and fish habitat. Keeping this perspective will help direct the determination of the most effective way to achieve this goal while considering the specific characteristics of the watersheds on the island along with the local development priorities.

Mapping conducted for this project was focused on the centre line for all streams, and the Top of Bank (TOB) or High Water Mark (HWM) of linear features (streams and ditches) were not determined. However, given that the average width of most drainages within the 19 watersheds was less than 3 m, this small amount of locational uncertainty related to the extent of the 30 m Riparian Assessment Area (RAA) for the mapped features is unlikely to result in a significant impacts to the riparian areas of these streams. The final determination of the RAA is made by a QEP in the field and will provide the accurate assessment of whether or not proposed development is occurring in a RAA. Continuing to develop public awareness of the requirements of RAR and when it is to be applied is a challenging but critical component of creating a development environment where the protection of riparian areas becomes a routine part of development planning.

The Salt Spring Island LTC is considering three approaches to implementing the *RAR*, which are briefly reviewed below:

1. **Establish a 30 m Development Permit Area (DPA) for the larger creeks (or portions of those creeks) along with all wetlands and lakes on Salt Spring Island** – A 30 m DPA will result in a detailed and accurate assessment of the drainages that are affected by the proposed development, the potential impacts to riparian areas and the required SPEAs, but could result in landowner frustration in already developed areas. This approach also increases the probability that unmapped drainages are located prior to any disturbance. Involvement of a QEP will ensure proper delineation of HWM or TOB and identification of *RAR* streams. Measures to protect the determined SPEA will be developed and provide the best protection of riparian habitat.

2. **Establish a 15 m Development Permit Area for all other streams, within which a SPEA will be determined according to the *RAR* assessment methodology** - A 15 m DPA will reduce the number of times an assessment will be triggered but may not adequately cover development next to a ravine. Several of the streams that we mapped were in a ravine where 15 m would not even extend to the top of the ravine bank. Island Trust may want to implement a different DPA for ravine reaches where they have been adequately highlighted by existing mapping. This would ensure that bank stability is not compromised reducing the risk of slope failure and impacts to fish habitat. A site visit by a QEP would be necessary to determine the TOB in the reaches of these ravine DP areas.

3. **Establish a 15 m SPEA for all areas not identified in approach no. 1 using landscaping regulation amendments to the Land Use bylaw -** This option may result in a SPEA that is larger than required by *RAR* in many smaller streams yet not adequately protect riparian habitat in areas that are within a ravine. In the 19 watersheds mapped by MBC in November 2013 only two reaches in the Cable Creek watershed and two reaches in the McLemnan Creek watershed were assigned preliminary SPEAs greater than the minimum of 10 m for a stream out of a total of 102 stream reaches where a preliminary SPEA was determined. The preliminary SPEAs for these reaches ranged from 10.8 m to 13.2 m. As mentioned above 15 m wouldn't adequately account for areas within ravines and could result in slope stability concerns if adequate vegetation protection is not prescribed as would typically done through a detailed *RAR* assessment. This option may also be difficult to justify around ditches and marginal habitat.

Recommendations relating to the development of the *RAR* bylaw for Salt Spring Island have been provided by Madrone Environmental Services following the mapping of five watersheds in early 2013 (Willmott et al., 2013). These include various recommendations for the extent of the development area associated with the mapped streams while noting the requirement of the regulation that local bylaws meet or beat the protection offered under *RAR*. These recommendations will not be repeated in this document. Instead, recommendations and items for consideration are provided that will hopefully serve to drive the development of a bylaw that can be successfully integrated into future development on the island.

RAR Implementation Recommendations:

I. Once the development permit areas (DPAs) have been established (either based on the 30 m RAA or based on the preliminary SPEA determinations), ensure that local staff reviewing development plans (including subdivision plans or building permit applications) are familiar with the watershed mapping and the process to be followed if development is proposed within the DP areas. Front counter staff and bylaw enforcement personnel (including building inspectors) often represent the first or most consistent point of contact for residents and developers, and must be able to direct them into the required DP process.

II. Continue to develop the public education process with respect to the requirements of *RAR*. In general, the public tends to be less aware of the significance of small drainages and constructed ditches and will inadvertently end up out of compliance with the regulation by removing vegetation or undertaking development activities within the RAA. When this occurs in the City of Campbell River, property owners are typically required to go through a retroactive development permit process that requires an assessment by a QEP to determine the appropriate SPEA for the activity and a riparian restoration or compensation plan for any areas that have been impacted. This retroactive process can result in delays to the development process as well as additional unexpected cost to the developer/landowner.

III. Property owners should be encouraged to consult with the Salt Spring Island LTC planning staff and / or a QEP when they are proposing development in properties within the mapped drainage networks to verify when development activities could be subject to *RAR*. This also provides an opportunity to identify other drainages that would be considered a stream under *RAR* that may not have been identified through the initial mapping process or to identify areas of marginal habitat where adequate protection for downstream resources can be achieved through a modified process.

IV. It is important to note that even if a drainage does not appear on the local stream mapping developed for the Salt Spring Island LTC but does meet the definition of a stream under *RAR*, it is still protected under *RAR*. Therefore, it is recommended that wording be incorporated into any *RAR* bylaw that accounts for potentially unmapped *RAR* drainages and the responsibility of the property owners or developer to provide the required riparian protection under the regulation. Some local governments have not included this type of wording in their bylaws, which has led to confusion and frustration for property owners when additional drainages are located by QEPs during the evaluation of drainages identified under the bylaw.

V. The application of the *RAR* to ditches can cause significant reductions in the usable area of a development property, especially when multiple ditches are associated with a property. For example there are two roadside ditches present in the property on the corner of Grantville Street and Fort Street in the Walker Hook Creek watershed (Appendix 3, Map 17). Tributary 1 has an average bankfull width of 0.6 m and Tributary 1B has an average bankfull width of 0.4 m. Both ditches would require a 5 m SPEA unless fish sampling was completed to confirm the absence of fish within these ditches. Non-fish bearing ditches require a minimum SPEA of 2 m while fish bearing ditches are assigned a minimum SPEA of 5 m. According to *RAR*, any variance to the SPEA determined through a detailed assessment or established by local government bylaw would require review by Provincial and Federal regulators. This results in a potentially complicated, lengthy and expensive process for the developer that is often hard to justify when compared to the nature of the habitat or the proposed development activities near ditches. Roadside ditches conveying local drainage require protection to ensure that water quality and quantity are maintained but they may or may not contain fish or fish habitat. Assessment by a QEP is required to evaluate the type of habitat offered by the ditch, fish presence or absence and the position of the drainage within the watershed, i.e. the distance of the ditch from fish bearing water. We recommend that wording be included within the *RAR* implementation bylaw to allow QEPs to follow a non-*RAR* process if application of the *RAR* will not result in additional protection of fish and fish habitat and the proposed development activities are small in scope (i.e. construction of a single family residence). The alternate process should require the QEP to provide justification for the non-*RAR* process (including the process for determining non-fish bearing status as described in the *RAR* assessment methods), along with the anticipated potential impacts of the proposed development and recommended measures to protect water quality in the ditch during and after development in order to protect downstream fish habitat.

VI. Similarly, portions of streams within the mapped drainage network were found to lack productive fish habitat and it is expected that many of these areas do not support a population of fish, particularly in the headwaters of smaller watersheds or in heavily modified areas that are unlikely candidate areas for future restoration. However, due to their connection to known or potential fish habitat downstream, these areas are also regulated under *RAR* and by definition would require that a SPEA be established that functions to protect the form and functions of the riparian areas. These small streams would require a minimum SPEA of 10 m through application of the *RAR* process. For example Reach 3 of Walker Hook Creek has an average bankfull width of 1.5 m and is located 600 m to 1300 m upstream from fish bearing portions of Walker Hook Creek. The required SPEA for this entire reach would be 10 m within which no development could occur. In these particular areas, a reduced SPEA can often be justified as the main objective for that area will be the protection of water quality. Allowing developers to engage a QEP to follow a non-*RAR* process that still achieves the goal of protecting water quality, as described above, can simplify the development permit process, potentially reduce the cost to the developer and avoid the requirement to involve other regulators. This non-*RAR* process can specify that a minimum distance of stream that must exist between the proposed development area and confirmed fish habitat, as well as the types of development where this process can be applied, in order to lay out clear direction to Salt Spring Island LTC staff and landowners or developers.

VII. In addition to defining DPAs or default SPEAs by stream size, the Salt Spring Island LTC may also want to consider a trigger based on the size, density or type of the development. For instance a single property owner proposing to construct a shed on their residential property may default to a 15 m DPA or even preliminary SPEA. But if a large scale residential subdivision or commercial development is proposed adjacent to an *RAR* stream, perhaps a 30 m RAA DPA should be applied to ensure protection of fish and fish habitat.

VIII. The Salt Spring Island LTC should also consider how they will approach situations where unapproved development occurs within a DP area, and include wording in the bylaw that outlines the potential consequences of this. Since the *RAR* has been adopted, one of the primary challenges associated with the regulation is ensuring that the required SPEAs and measures to protect the SPEAs (as determined by a QEP) are actually implemented. Audits completed by provincial regulators on properties where *RAR* assessments have been completed have indicated that accurate delineation of SPEAs by a QEP prior to development is frequently not completed and can lead to inadvertent or sometimes intentional encroachment into the protected areas. The *RAR* Implementation Guidebook includes a discussion of compliance monitoring and enforcement, including enforcement tools available to local governments to ensure compliance with the requirements of *RAR* assessments. Including wording in the *RAR* bylaw to address non-compliance with measures prescribed by QEPs through *RAR* assessments will clarify the actions that may be taken by the Salt Spring Island LTC in the event this does occur. These actions could include the use of stop work orders to address situations during construction that are contrary to the requirements of the *RAR* assessment report.

IX. A post-development assessment completed by a QEP is one strategy recommended by the Province for evaluating compliance where an *RAR* assessment has been completed and filed with the provincial notification system. The report is required to verify that the requirements stated in the *RAR* report have been met during the development project. These reports are often not completed due to lack of follow up by developers and / or regulators, but if this requirement is included with the development permit for the site and linked to a performance bond that is refunded upon the submission of a post-development assessment the report is much more likely to be completed and any non-conformance issues can be identified and resolved.

The recommendations provided are based primarily on previous experiences with the *RAR* as it is applied in several cities and regional districts on Vancouver Island. These have not been considered in relation to other regulations that are relevant to bylaw development, including the *Local Government Act*. Therefore, while these recommendations may be reasonable from the perspective of a QEP, their integration into the final *RAR* bylaw adopted by the Salt Sprign Island LTC must be considered in context with all other relevant regulations.

In closing, the integration of the *RAR* into local planning processes for new and redevelopment projects has proven to have a significant learning curve in the early stages for all parties, including local government staff, QEPs, property owners and developers. Fully considering the implications of wording integrated into *RAR* bylaws can help anticipate situations where a more simplified process is justifiable, as long as the objective of protection for fish and fish habitat is still being achieved. Clearly defining terms and requirements of the bylaws will also reduce the potential for confusion, frustration and excessive costs to property owners, particularly when small scale projects are being undertaken by private landowners.

7.0 References

BC WLAP. 2006. Riparian Areas Regulation Implementation Guidebook. s.l. : Environmental Stewardship Division, 2006.

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Reimer, Kathleen. 2013. Riparian Areas Regulation Assessment Report for 1611 Musgrave Road and 344 Anna's Drive, Salt Spring Island. Completed for Skywater Capitol Corporation.

Reimer, Kathleen. 2012. Fish Bearing Streams and Potential Fish Habitat Mapping Report - Duck Creek - St. Mary Lake Watershed and Cusheon Creek - Cusheon Lake Watershed. Salt Spring Island, BC : Island Stream and Salmon Enhancement Society (ISSES), 2012.

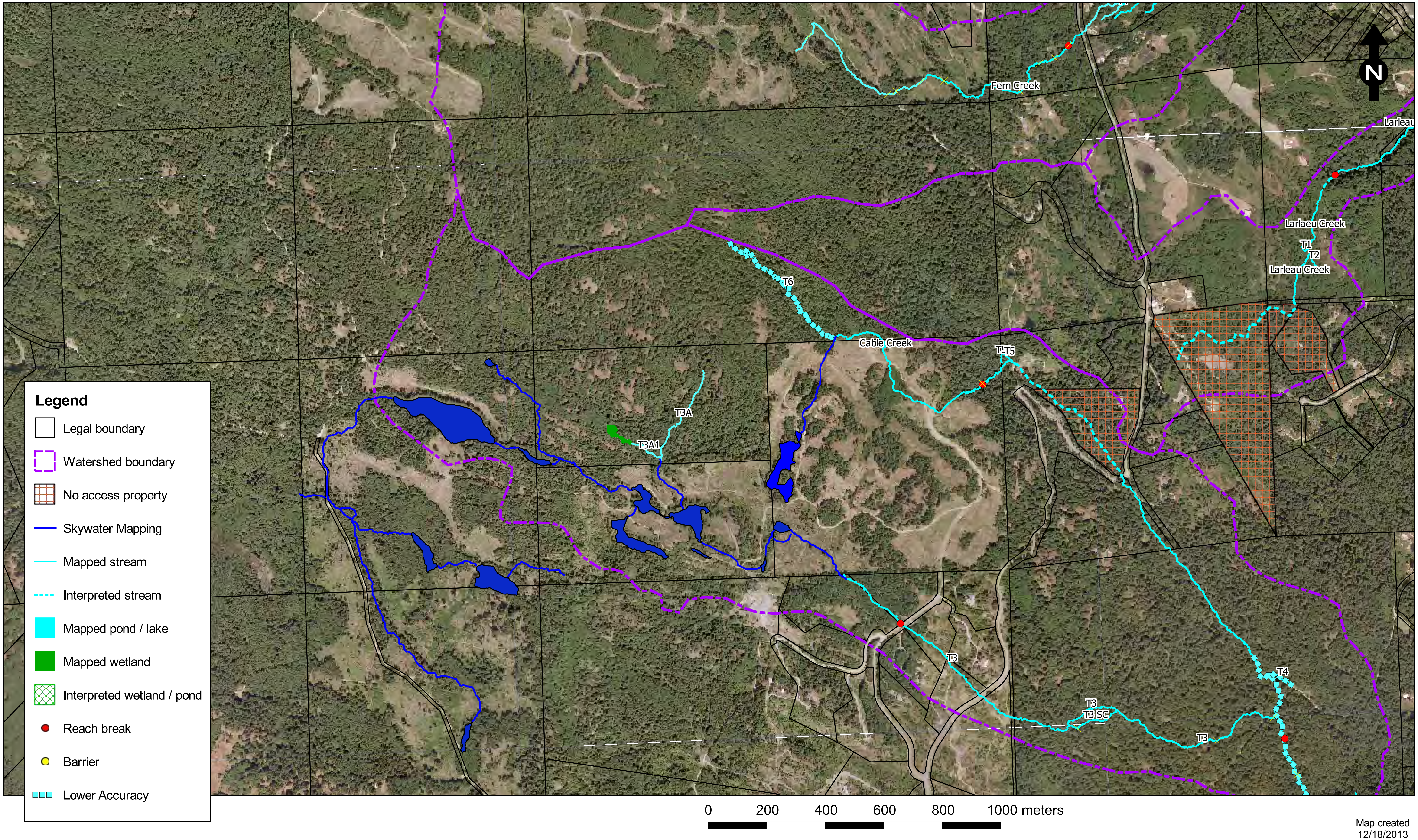
Trystan Willmott, Justin Lange, Jennifer Morgen. 2013. Salt Sring Island Riparian Area Regulation Stream Identification - Bullock, Fulford, Maxwell, Stowell and Weston Watersheds. Duncan, BC : Madron Environmental Services Ltd., 2013.

Appendix 1 – Global Positioning System (GPS) Data Limitations

Watershed	Drainage	Data Limitations	Corrections
Acland Brook	Acland Brook	GPS settings were adjusted to HDOP 8, SNR 20. Poor satellite geometry.	All points with greater than 20 m accuracy were removed.
Burgoyne Bay	Burgoyne Bay South	Nearby mountain may be causing poor satellite reception.	Used filters during post-processing to remove low accuracy positions.
Cable Creek	T4, T6	Poor satellite reception noted.	Deleted low accuracy positions.
Cable Creek	Cable Creek	Portions of section with poor accuracy are in a ravine (Reach 2). Attempted to re-map but no improvements in accuracy.	Deleted low accuracy positions.
Cupples Creek	Cupples Creek	Sections with 5-10 m accuracy.	Removed positions greater than 5 m accuracy.
Madrona Creek	T1	Most positions with an accuracy of 5-6 m.	Deleted low accuracy positions.
Madrona Creek	T6 Pond	Accuracy of 5-10 m.	Deleted low accuracy positions.
Sharpe Creek	Tributary 2	Decreased accuracy for this tributary.	Deleted low accuracy positions.
Sharpe Creek	Sharpe Creek	Section with 5-10 m accuracy in a ravine.	Deleted positions with 7-10 m accuracy.

Appendix 2 – Cable Creek Headwaters Mapping

Mapping completed by Polaris Land Surveying under the direction of Kathy Reimer was completed for a residential subdivision on Musgrave Road and Anna's Drive for Skywater Capital Corporation.



Map created
12/18/2013

Skywater Subdivision Mapping - Cable Creek Watershed

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape
Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

Appendix 3 – Watershed Maps

The final mapping showing the mapped or interpreted stream centre lines (streams and ditches), wetlands and ponds located during the surveys of 19 watersheds on Salt Spring Island are presented in this appendix. The maps are presented in alphabetical order. Tributary map labels have been abbreviated to “T” in order to accommodate labels on small streams or ditches within the map scale.

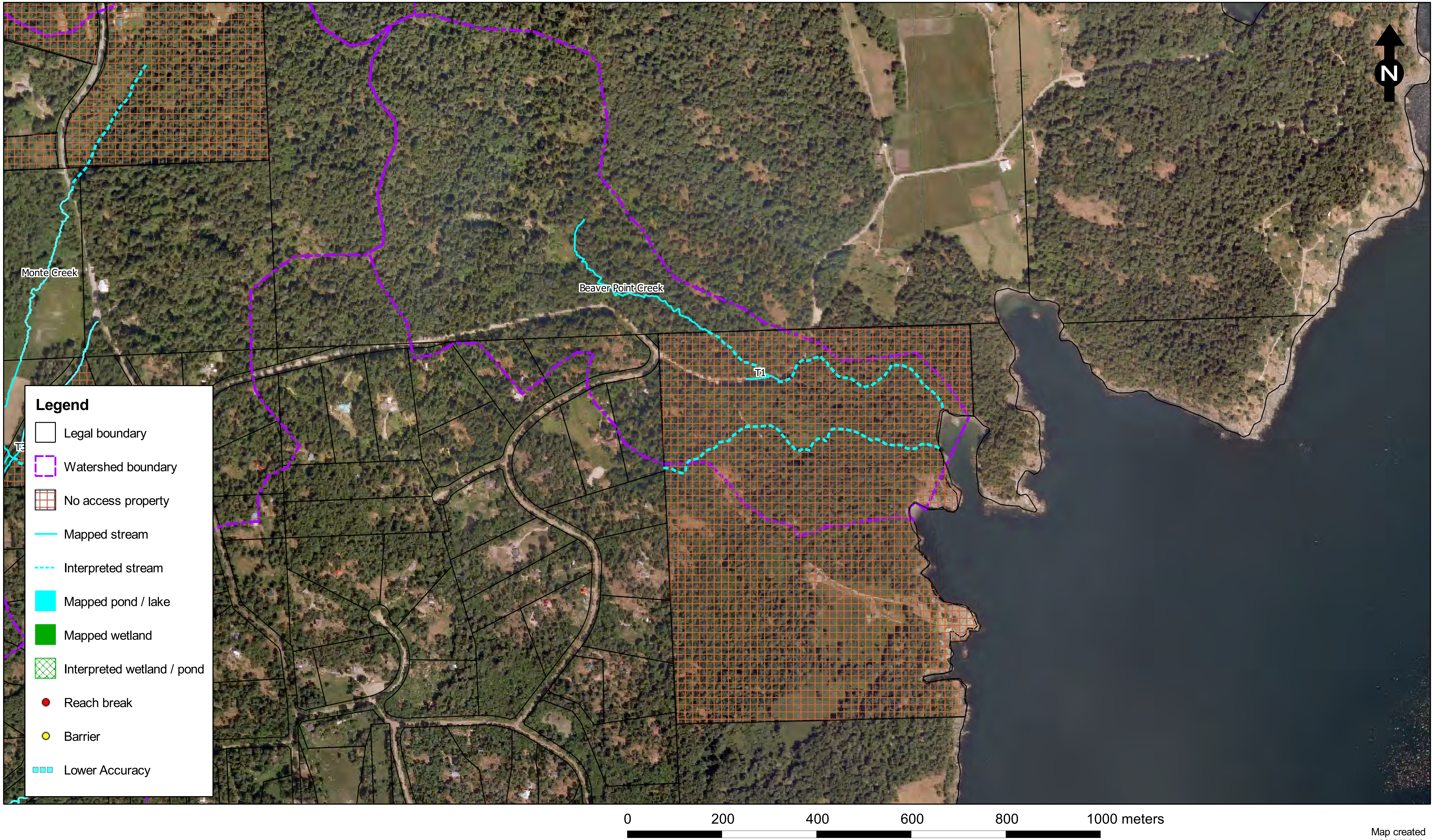
Map No.	Watershed(s)
1	Acland Brook
2	Beaver Point Creek
3	Burgoyne Creek
4	Cable Creek
5	Cupples Creek and Cupples East Creek
6	Fern Creek
7	Ganges Creek and Swanson Creek
8	Larleau Creek
9	Madrona Creek
10	Mansell Creek
11	McFadden Creek
12	McLemnan Creek
13	Monte Creek
14	Okano Creek
15	Sharpe Creek
16	Soule Creek
17	Walker Hook Creek

Map created
12/18/2013

Map 1 - Acland Brook

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

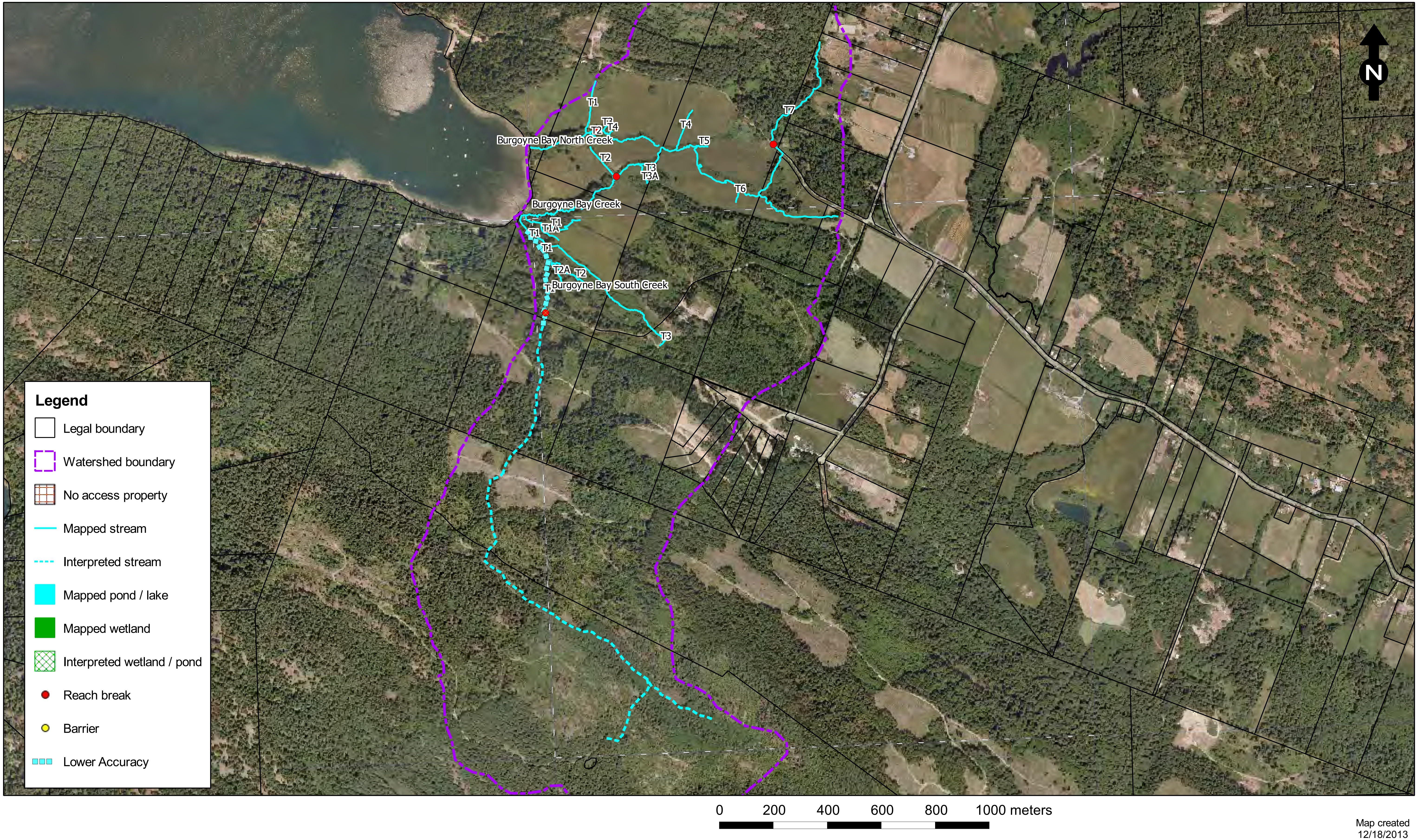


Map created
12/18/2013

Map 2 - Beaver Point Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

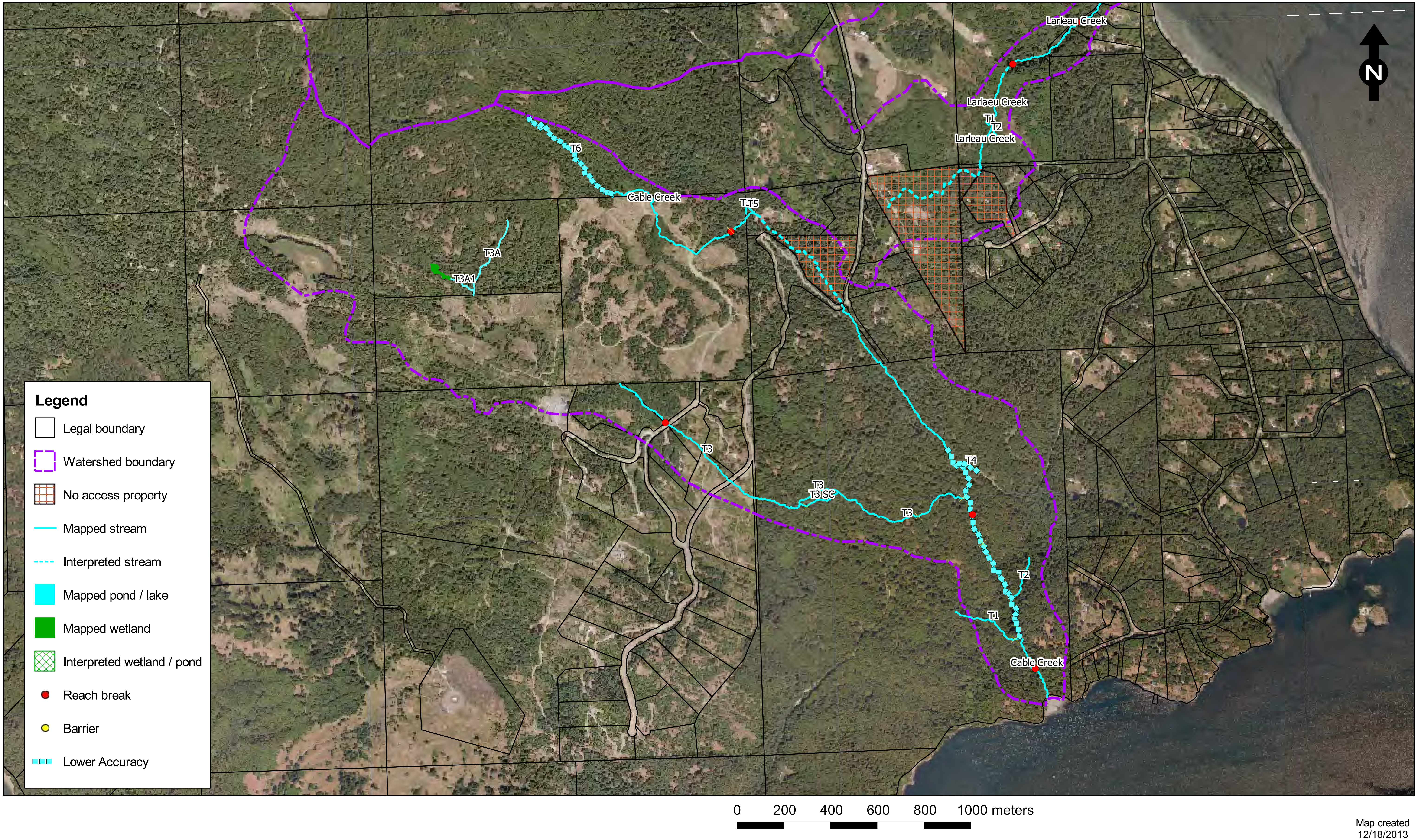


Map 3 - Burgoyne Bay Watershed

Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

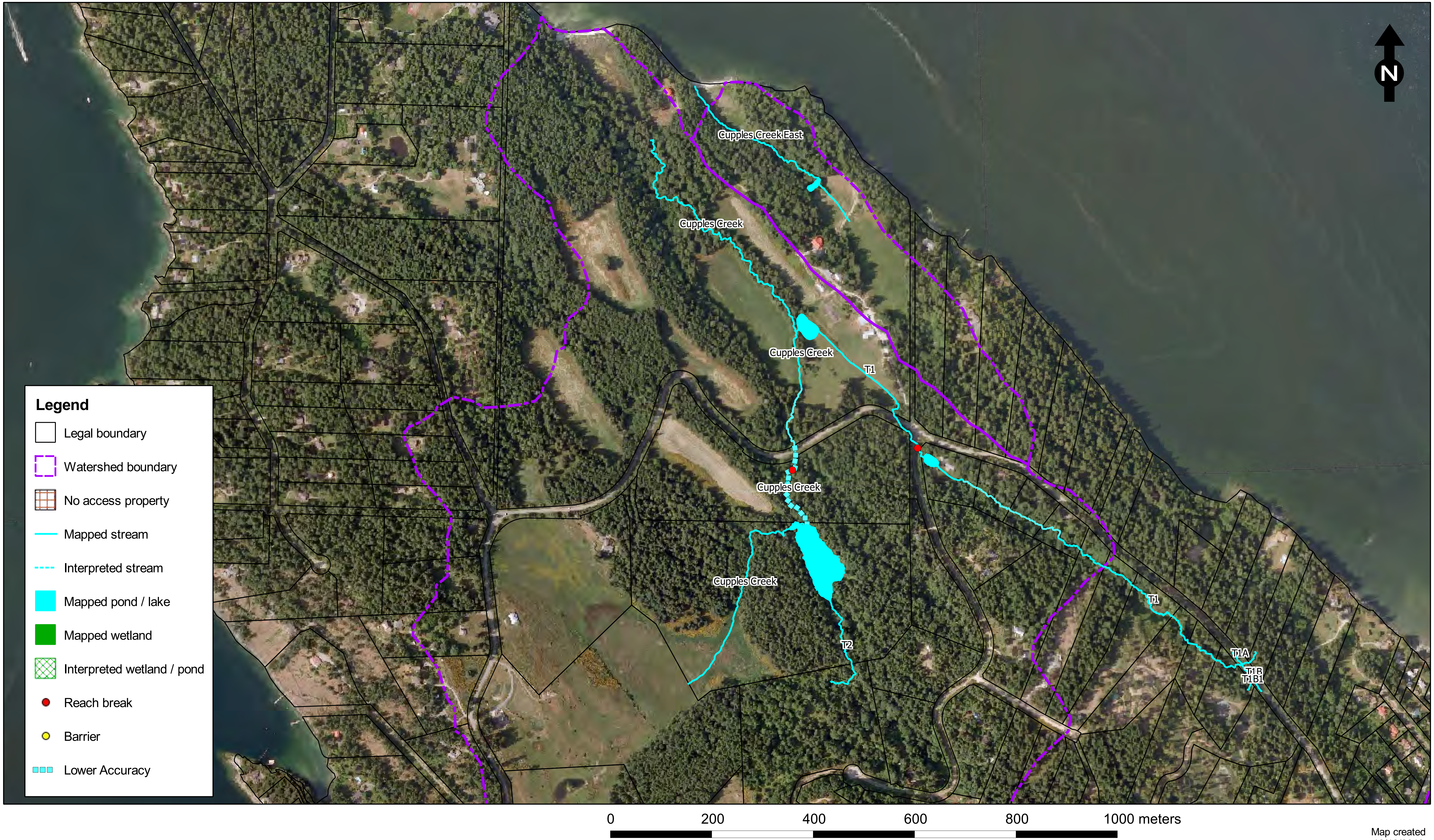


Map 4 - Cable Creek

Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

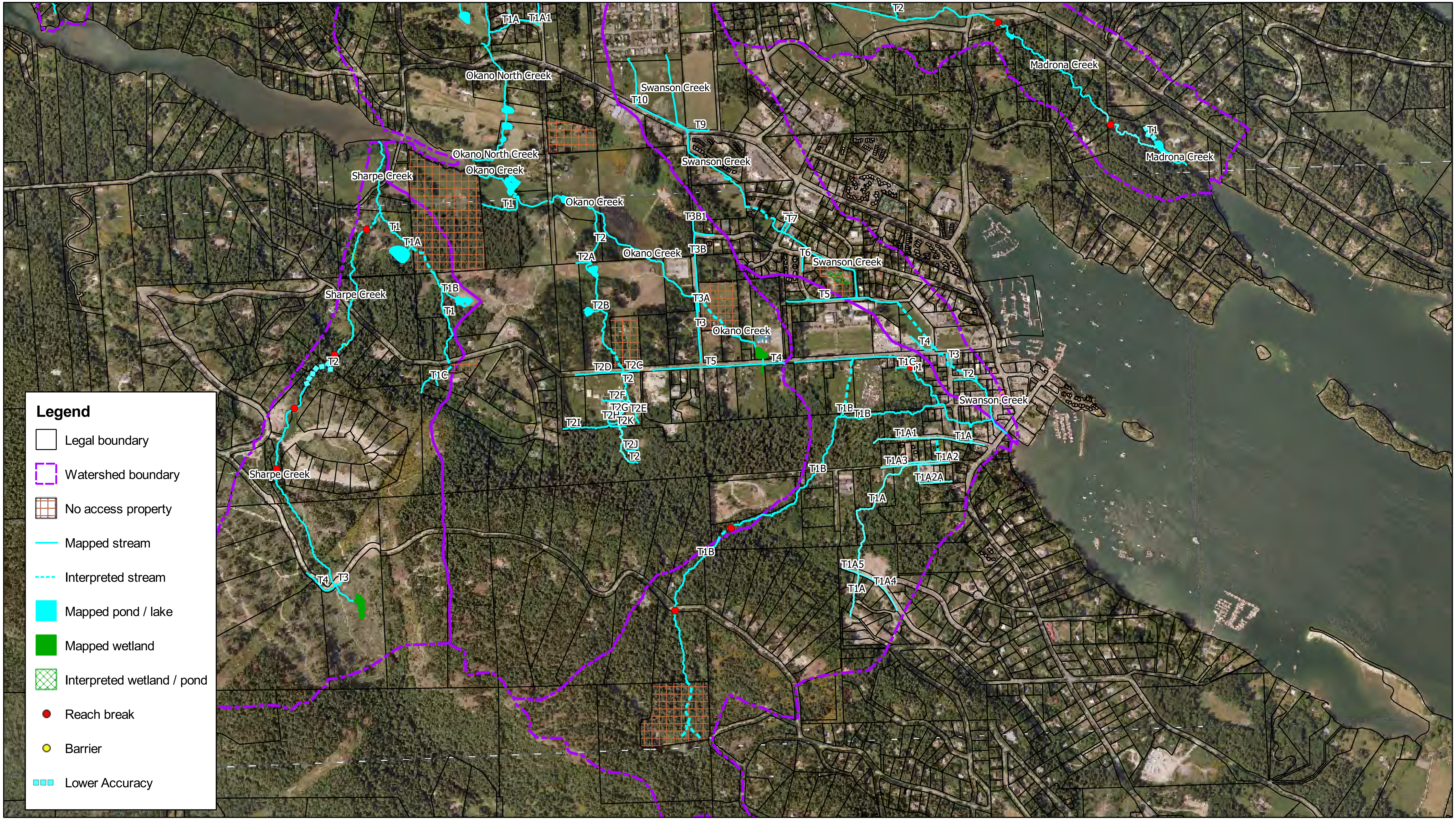


Map 5 - Cupples and Cupples East Creek

Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



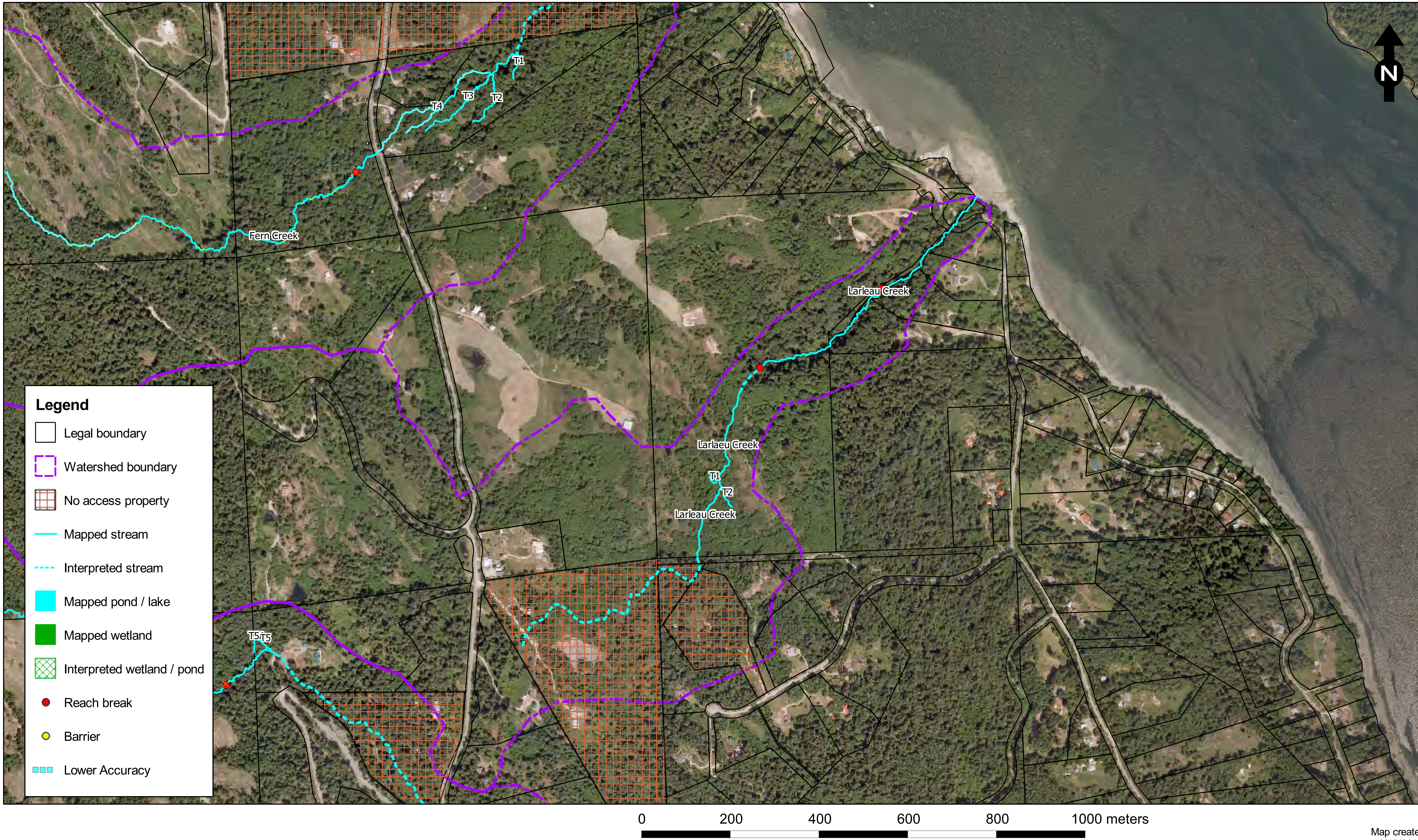
0 200 400 600 800 1000 meters

Map created
02/25/2014

Map 7 - Ganges Creek (T1A) and Swanson Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

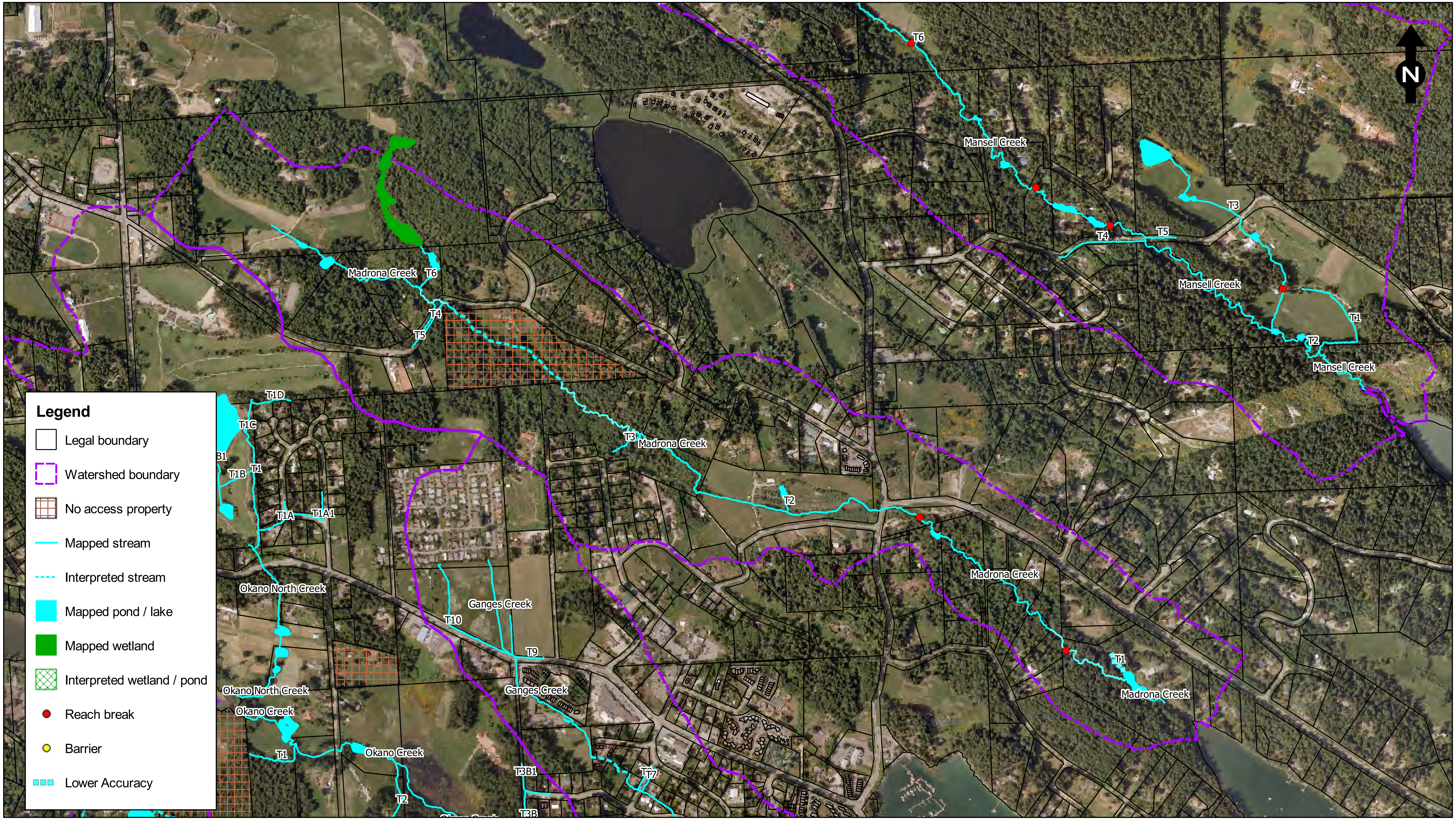


Map 8 - Larleau Creek

Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape
Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



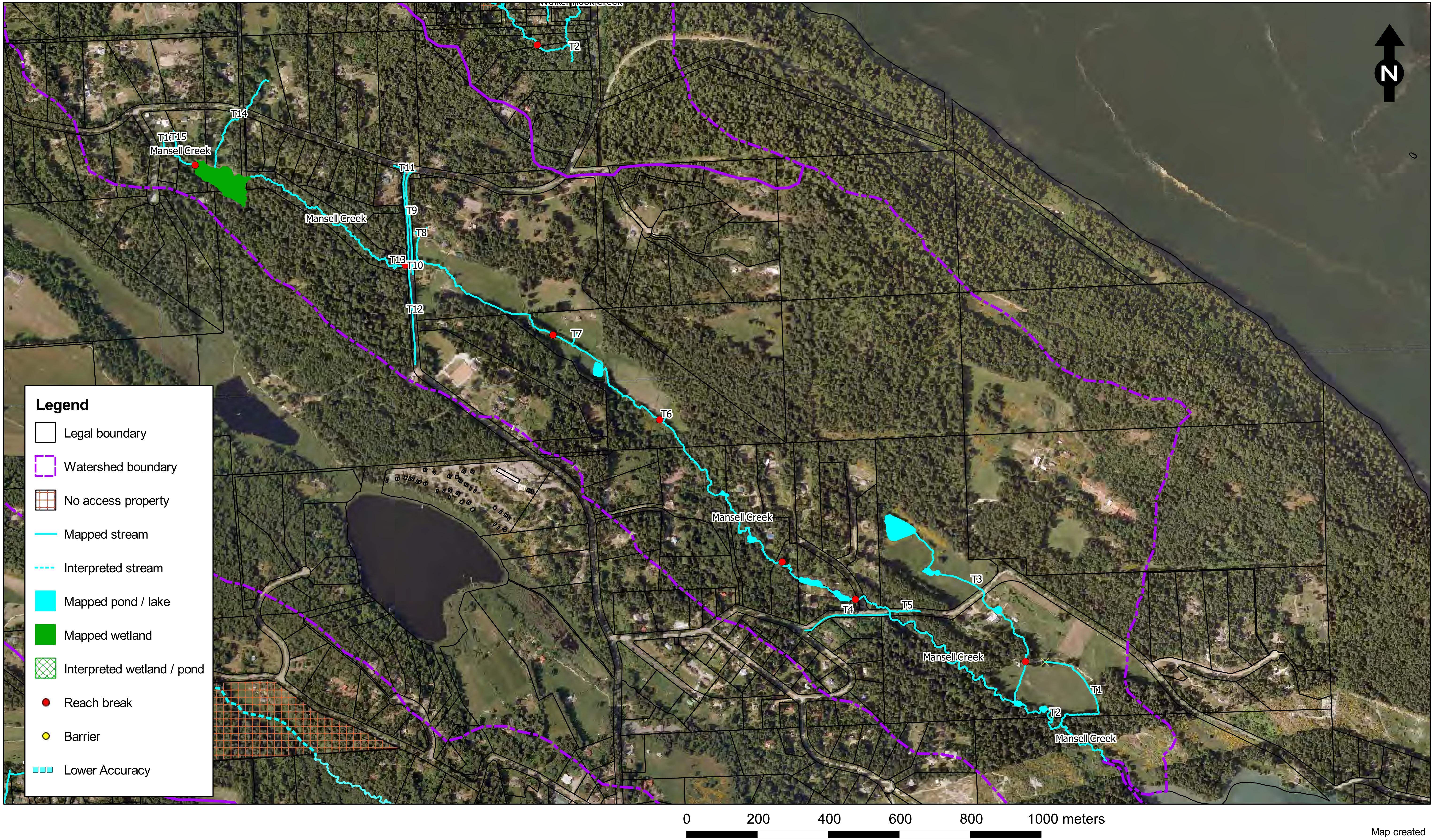
0 200 400 600 800 1000 meters

Map created
12/18/2013

Map 9 - Madrona Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



Map created
12/18/2013

Map 10 - Mansell Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting

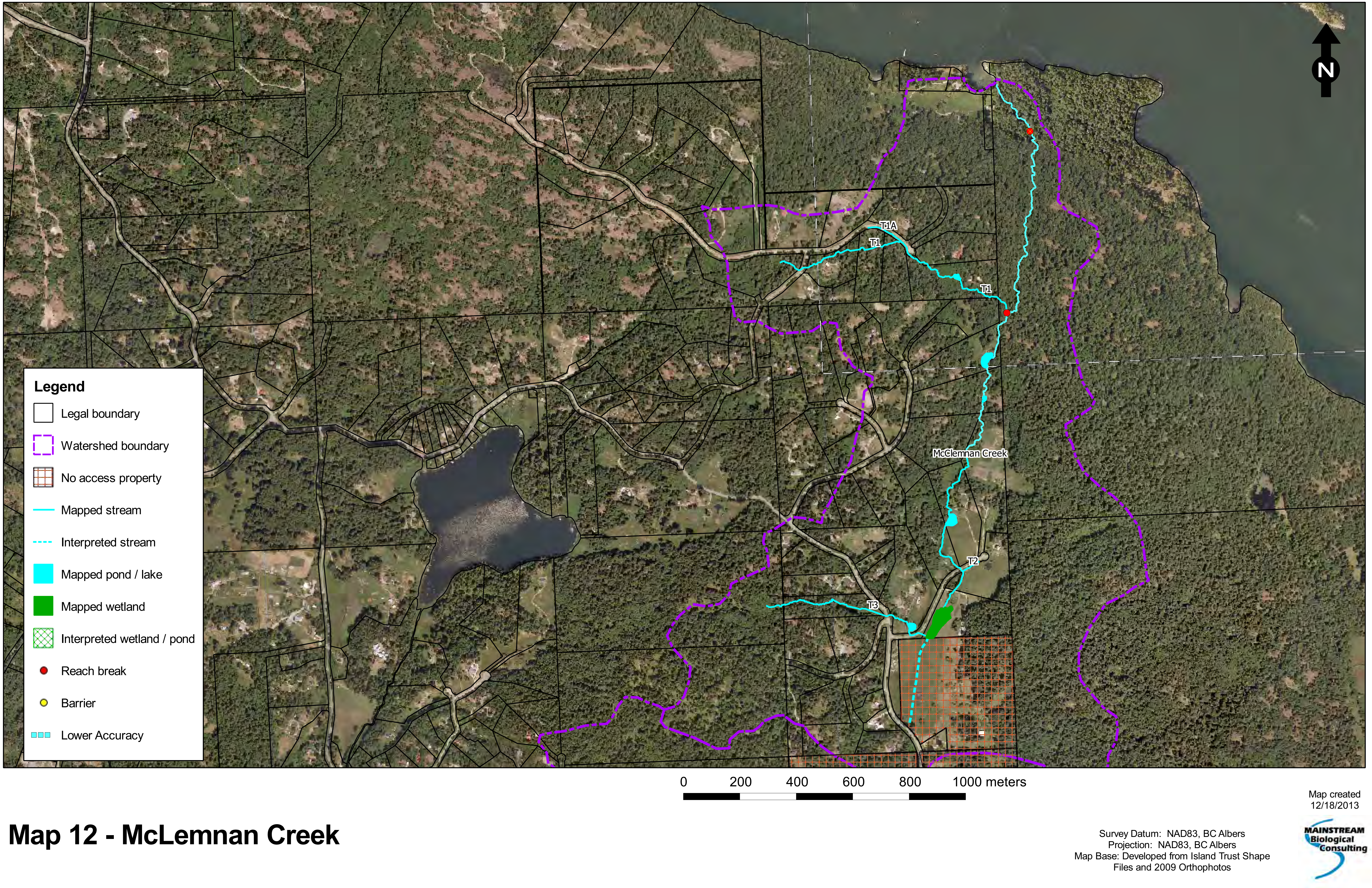
0 200 400 600 800 1000 meters

Map 11 - McFadden Creek

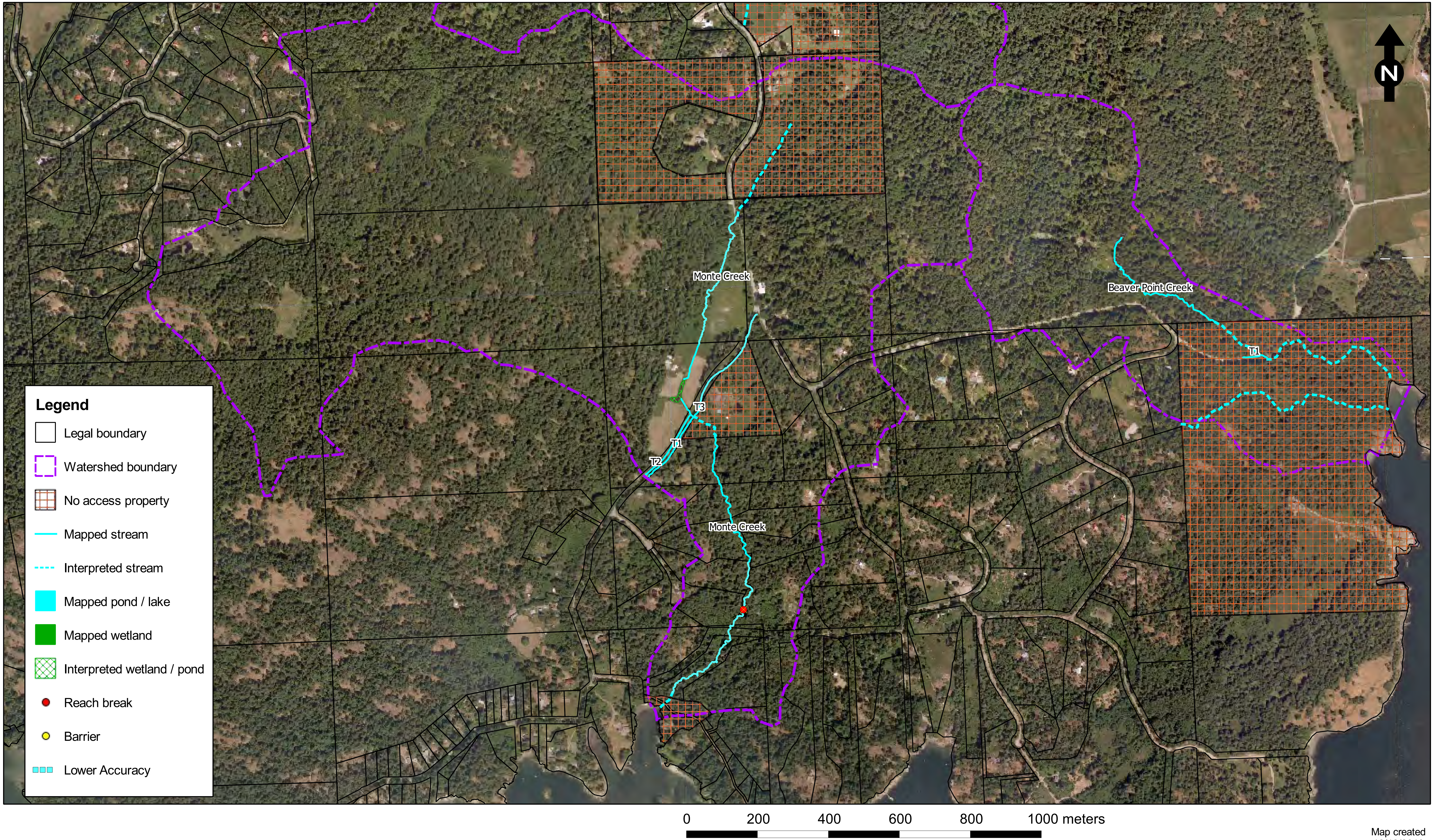
Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape
Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



Map 12 - McLemnan Creek

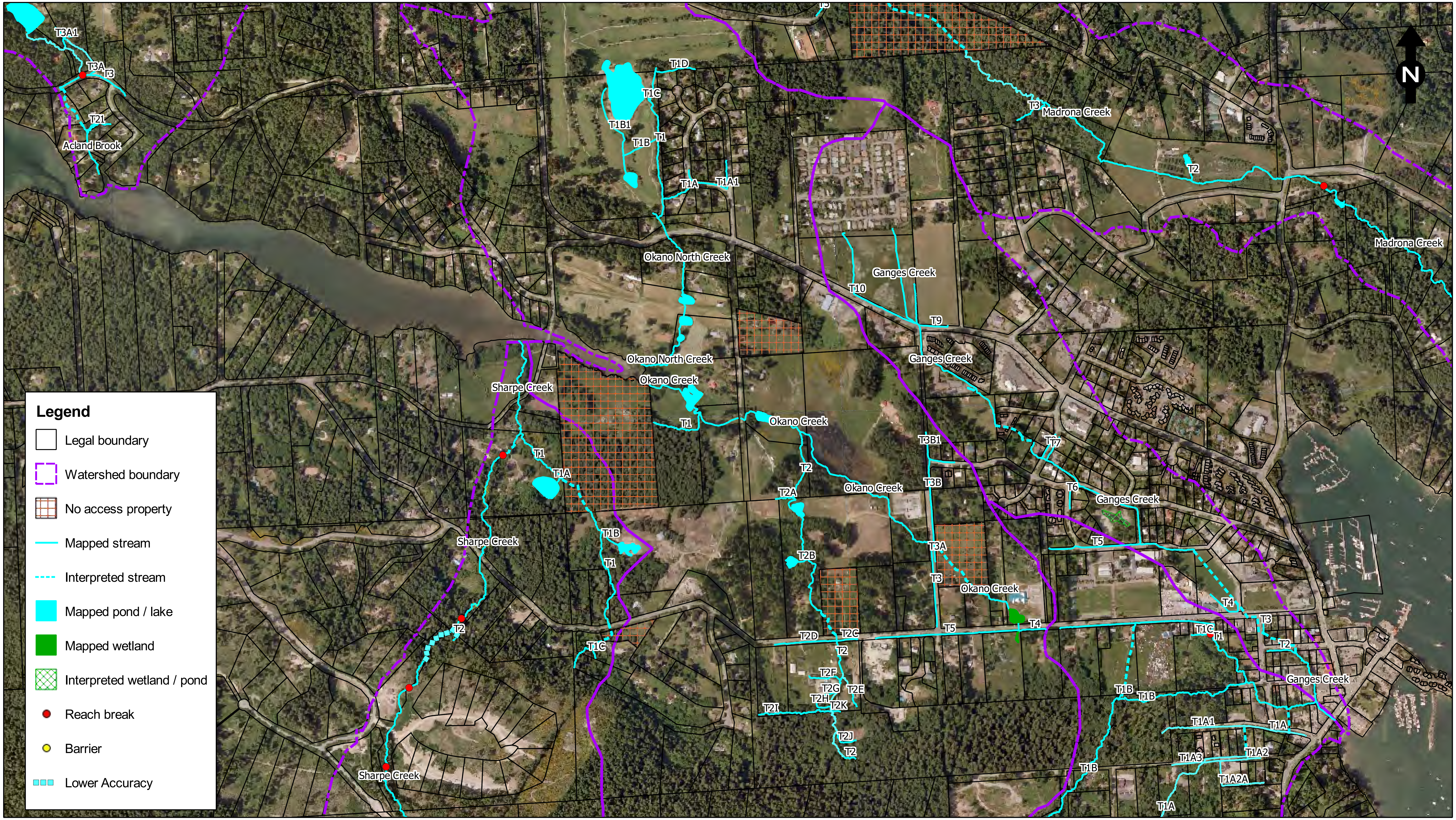


Map created
12/18/2013

Map 13 - Monte Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



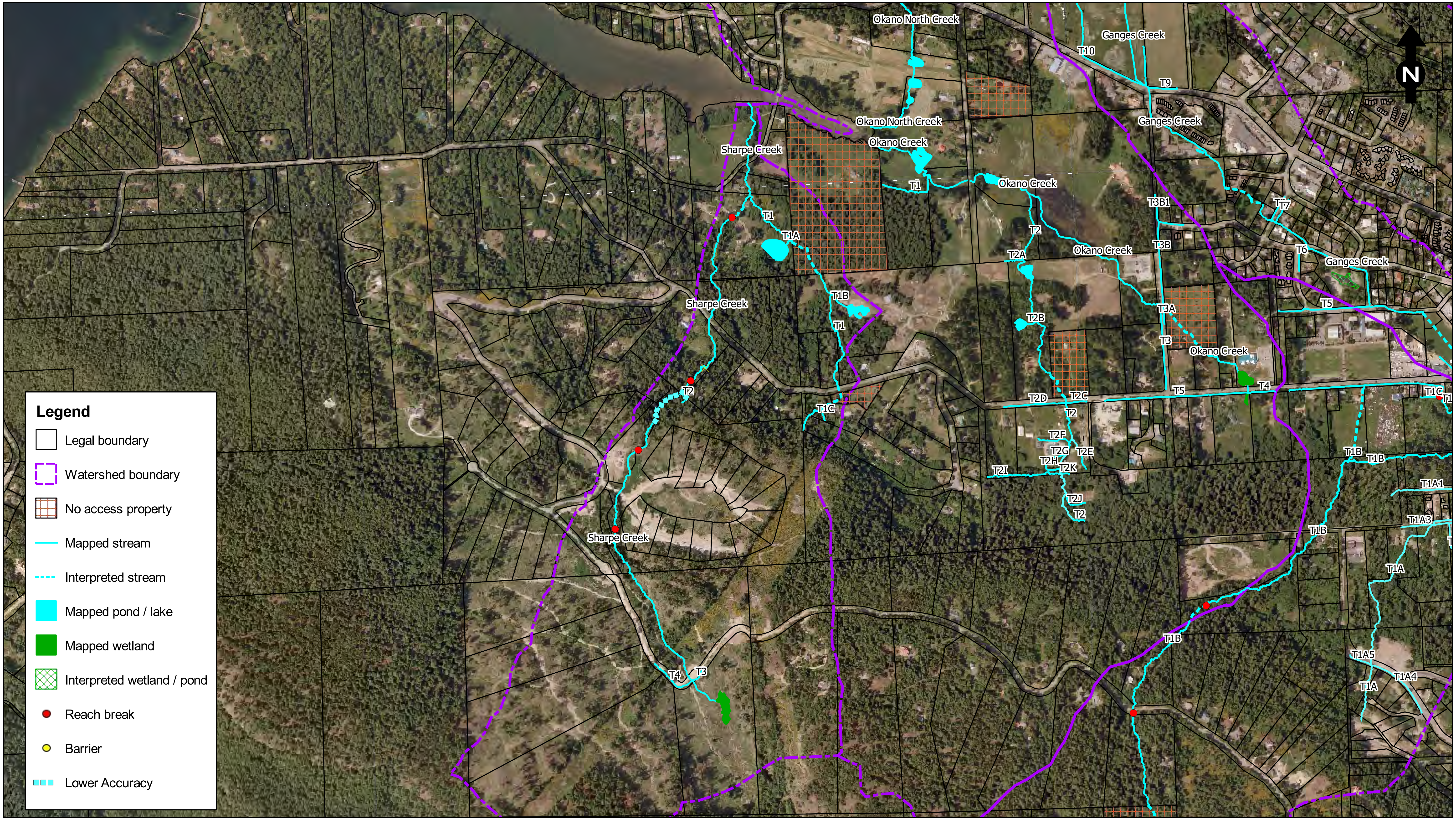
0 200 400 600 800 1000 meters

Map created
12/18/2013

Map 14 - Okano Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

Mainstream Biological Consulting



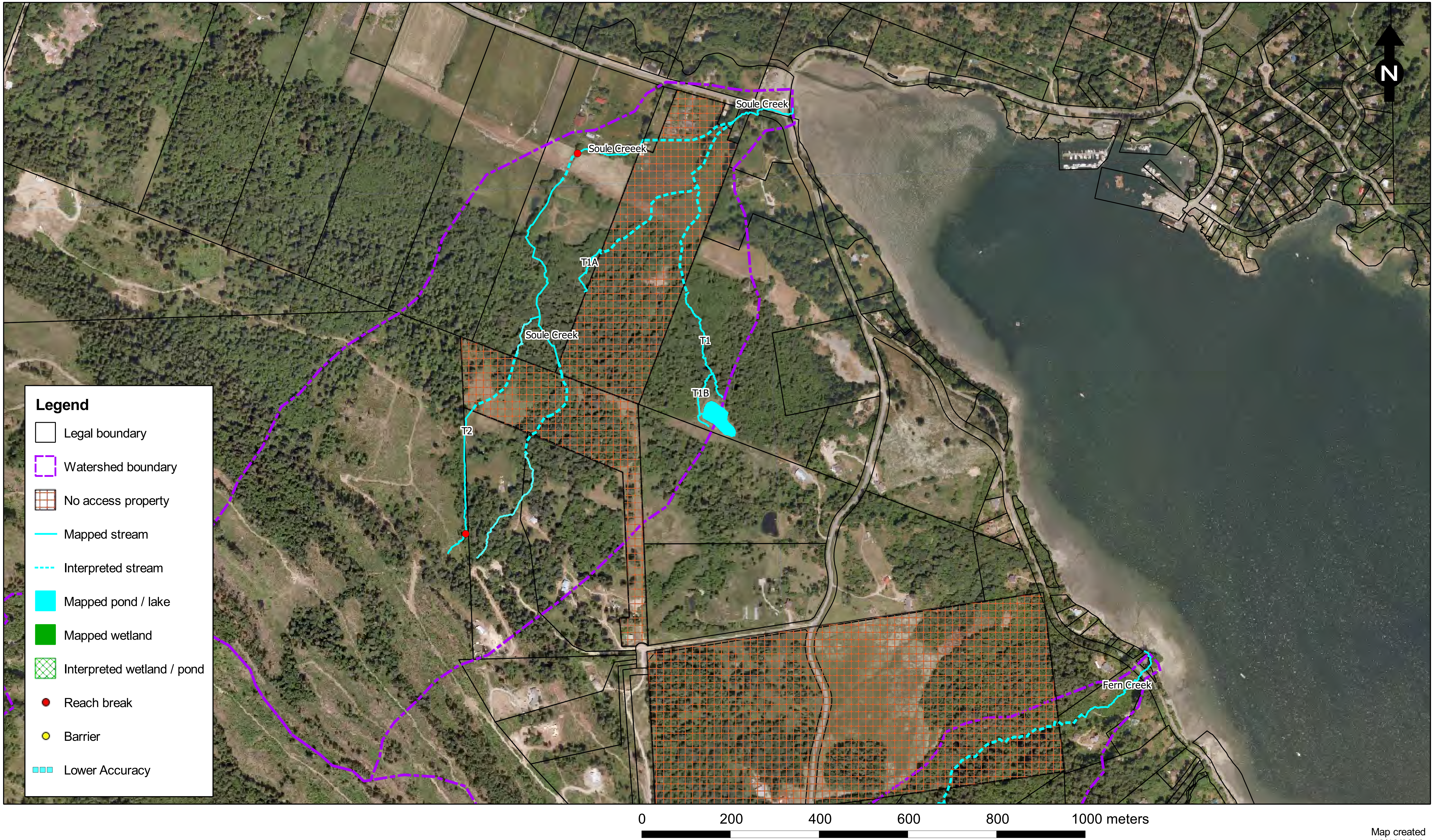
0 200 400 600 800 1000 meters

Map created
12/18/2013

Map 15 - Sharpe Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

MAINSTREAM Biological Consulting



Map 16 - Soule Creek

Map created
12/18/2013

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

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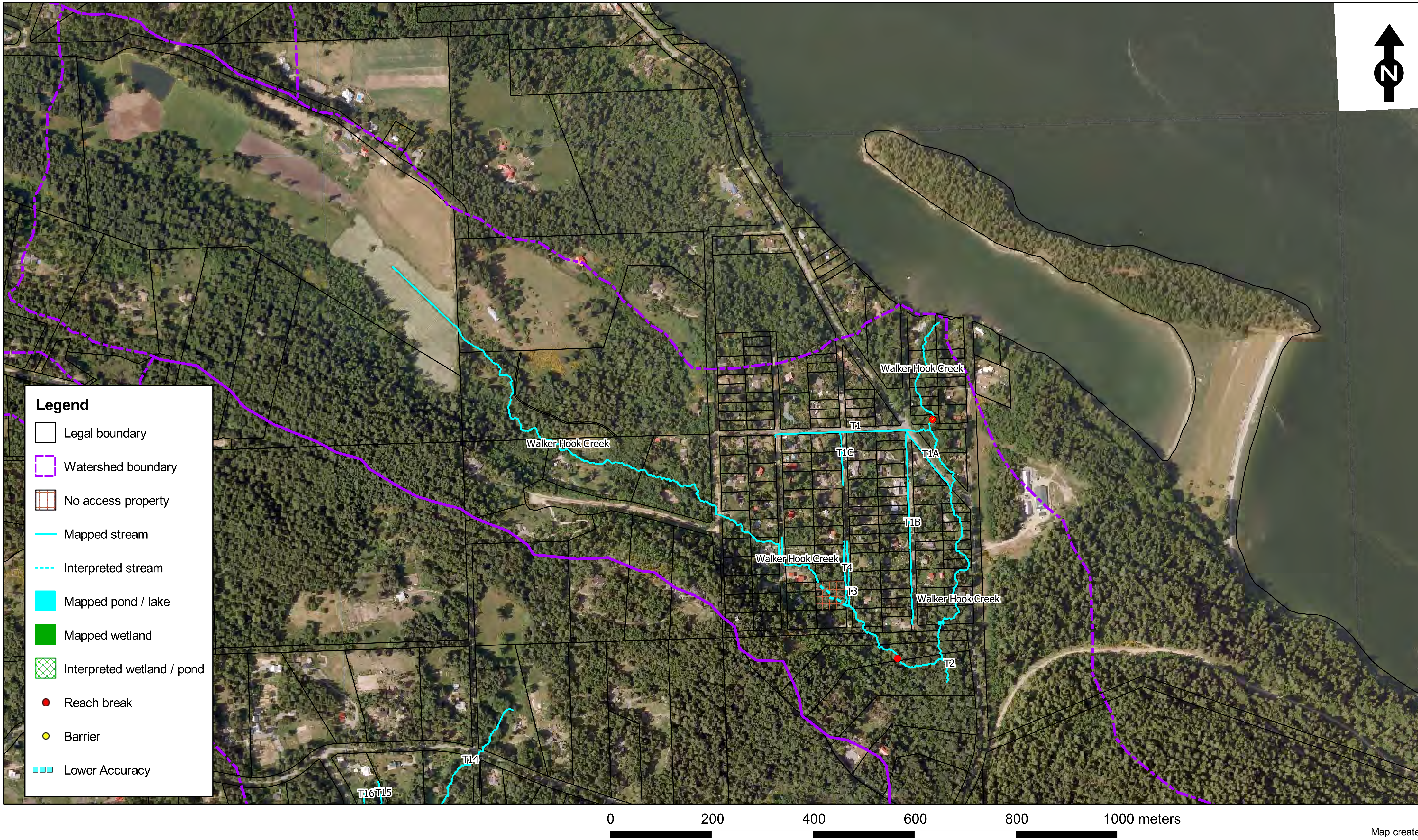

Map created
12/18/2013

Map 17 - Walker Hook Creek

Survey Datum: NAD83, BC Albers
Projection: NAD83, BC Albers
Map Base: Developed from Island Trust Shape Files and 2009 Orthophotos

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