

# Stream Mapping Results Report

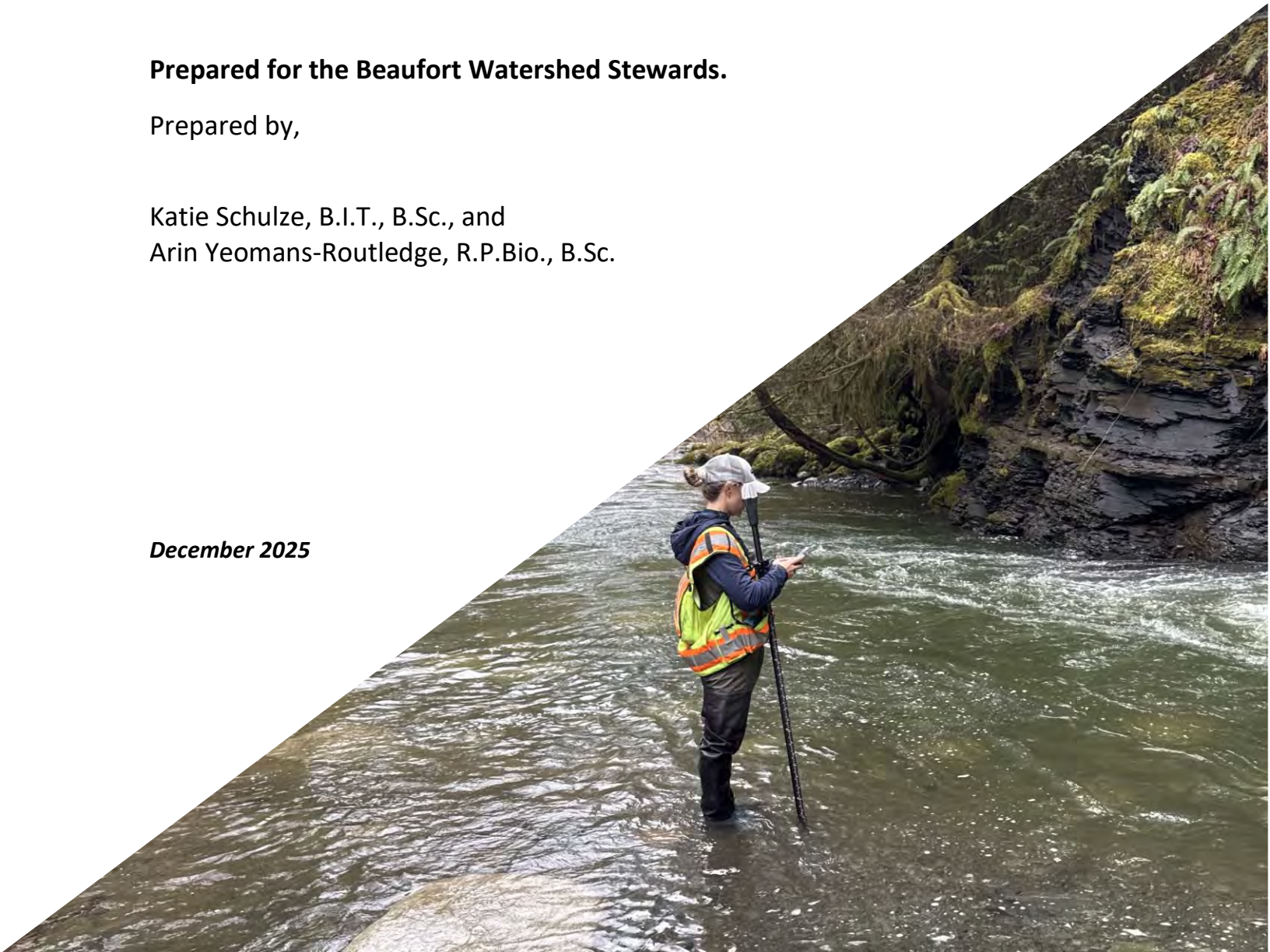
## Trent River 2025

Prepared for the Beaufort Watershed Stewards.

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## **Executive Summary**

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Between February and August 2025, Astraea Environmental Consulting (Astraea), in collaboration with the Beaufort Watershed Stewards (BWS) and K'ómoks First Nation (KFN) Guardians, completed comprehensive stream-mapping and habitat assessment work for the Trent River system in Royston, BC. This project focused on ground-truthing and updating streamlines for the Trent River watershed, identifying key aquatic habitat features, and assessing summer low-flow refuge conditions under ongoing climate-change pressures.

The Trent River supports populations of cutthroat trout and multiple Pacific salmon species (coho, chinook, pink, and chum). Prior to this project, most mapped streamlines were derived from photogrammetric interpretation, with limited Sensitive Habitat Inventory Mapping available (SHIM). Updated field surveys using high-accuracy GPS equipment identified previously unmapped tributaries, off-channel habitats, wetlands, barriers to fish passage, and important juvenile rearing areas—including deep pools, side channels, and beaver ponds. Updated spatial data were compiled into revised streamlines submitted to the Comox Valley Regional District (CVRD) and the Province of BC for integration into iMap BC and CVRD iMap.

Key findings include:

- Identification of numerous complex habitat features (side channels, large woody debris jams, mid-channel islands, beaver ponds) that contribute to hydraulic, thermal, and structural diversity essential for salmonid life stages.
- Documentation of natural barriers (waterfalls and bedrock chutes) that define the upper extent of anadromous fish access in the Trent River.
- Correction of significant spatial inaccuracies in previously mapped streamlines for Maple Creek, including a ~200 m offset at the Trent River confluence and incorrect routing near a major beaver pond.
- Evidence of degraded water quality conditions below Maple Creek due to its function as the Village of Cumberland's sewage outfall, including brown turbidity, elevated temperatures, and extensive algal growth.
- Heavy infestation of reed canary grass within Maple Creek, reducing riparian function and fish habitat suitability.
- Identification of deep pools within the mainstem, several of which function as important summer refuges for juvenile salmonids.

These results provide an updated, high-accuracy habitat inventory and form a strong technical basis for future restoration planning, regulatory decision-making, and long-term watershed stewardship.

**The Beaufort Watershed Stewards would like to thank the Pacific Salmon Foundation and the Comox Valley Regional District for providing funding assistance for this project.**

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## Glossary

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Term	Definition
<b>Alluvium</b>	Unconsolidated mineral sediment (e.g., gravel, cobble, sand, silt) transported and deposited by flowing water, forming channel bed material and influencing spawning and rearing habitat quality.
<b>Anadromous Fish</b>	Fish species that migrate from the ocean to freshwater to spawn. (e.g., Pacific salmon - coho, chinook, pink, chum - and sea-run cutthroat trout accessing reaches below natural barriers).
<b>Bedrock Chute</b>	A steep, confined section of exposed bedrock where high-velocity flow may create a partial or complete barrier to upstream fish migration.
<b>Cascade</b>	A short, steep series of small drops characterized by turbulent flow over coarse substrate or bedrock; generally limited rearing habitat and may influence upstream fish distribution.
<b>Floodplain</b>	The low-lying area adjacent to the main channel that is periodically inundated during high-flow events and may contain side channels, off-channels, and wetland habitats.
<b>Freshwater Atlas (FWA)</b>	The Province of BC's official GIS database of freshwater features - including streams, lakes, and wetlands - used to support fisheries management, environmental assessment, and land-use planning (available via iMap BC).
<b>Gravel Bars</b>	Depositional accumulations of gravel and cobble within or adjacent to the channel that may provide spawning habitat for salmonids where suitable interstitial flow and oxygenation occur.
<b>Ground-Truthing</b>	Field verification of mapped streamlines and habitat features using GPS equipment to ensure accurate delineation of reaches and habitat conditions.
<b>Intermittent Channel</b>	A channel that conveys surface flow seasonally or during precipitation events but is dry during summer low-flow conditions; may still contribute to fish habitat if connected to fish-bearing waters.
<b>Large woody debris (LWD)</b>	A functional habitat feature wherein woody debris falls within the wetted width and contributes structural complexity to the stream (i.e., creating pools and slowing down water).
<b>Off-Channel Habitat</b>	Aquatic habitat connected to the main channel during high flows (e.g., backwaters, beaver ponds, floodplain channels) that often provide critical rearing or refuge habitat for juvenile salmonids.
<b>Pool</b>	A deeper, low-velocity section of channel formed by scour or channel morphology; important for fish holding and summer thermal refuge.
<b>Reach</b>	A discrete segment of a stream defined by relatively uniform channel morphology, gradient, confinement, substrate characteristics, and habitat unit composition. During habitat assessments, reaches are delineated to organize field surveys, describe habitat conditions systematically, and identify limiting habitats or restoration priorities at an appropriate spatial scale.
<b>Resident Fish</b>	Fish species that complete their entire life cycle in freshwater and do not migrate to the ocean (e.g., resident cutthroat trout upstream of migration barriers).

Term	Definition
<b>Riparian Zone</b>	The vegetated interface between aquatic and terrestrial ecosystems that influences water temperature, shading, in-stream cover, bank stability, nutrient input, and overall habitat function.
<b>River-Left</b>	The left bank of a stream when facing downstream.
<b>River-Right</b>	The right bank of a stream when facing downstream.
<b>Sensitive Habitat Inventory Mapping (SHIM)</b>	A standardized methodology developed in BC to map and inventory watercourses, riparian habitats, and aquatic habitat features using GPS-based field survey techniques and GIS integration to support habitat protection, restoration, and land-use planning
<b>Side-Channel</b>	A secondary channel that branches from and later rejoins the mainstem, typically providing lower-velocity habitat and increased hydraulic diversity.
<b>Stream</b>	As defined under provincial legislation (WSA and RAPR), a natural or modified watercourse or body of water that contains water permanently or seasonally and provides, or contributes to, fish habitat.
<b>Streamline</b>	The mapped centerline of a stream channel representing the flow path as delineated during ground-truthed field survey and GIS compilation.
<b>Thermal Refuge</b>	Localized habitat areas (e.g., deep pools, groundwater-influenced zone, off-channel habitat) that provide cooler, thermally stable conditions during periods of elevated water temperature.
<b>Thalweg</b>	The deepest, lowest-elevation line within a channel, typically representing the zone of maximum flow and used for GPS-based channel delineation.
<b>Vegetated Mid-Channel Islands</b>	Stable sediment accumulations within the active channel supporting established vegetation and influencing channel hydraulics and habitat complexity.
<b>Watercourse</b>	A natural or constructed channel that conveys surface water either permanently or seasonally and exhibits a defined bed and banks or evidence of flow (e.g., scour or alluvial deposition). In this report, “watercourse” is used as a general geomorphic term, whereas “stream” reflects the regulatory definition applied under WSA and RAPR.
<b>Waterfall</b>	A vertical or near-vertical drop in channel elevation that may function as a permanent barrier to upstream fish migration and define the upstream extent of anadromous fish access.
<b>Wetland</b>	A saturated or seasonally inundated area supporting hydrophytic vegetation and hydric soils; may be connected to a stream and included under regulatory stream definitions (i.e., under RAPR).

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## Introduction

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Astraea Environmental Consulting (Astraea) is pleased to provide the Beaufort Watershed Stewards (BWS) with a summary of stream mapping work completed between February and August 2025 in the Royston area. The target local stream of interest, identified by BWS, is the Trent River (Figure 1).

Prior to our work, the Trent River system (WSC: 920-545800) was mapped in the Provincial Freshwater Atlas (FWA) primarily using photogrammetric interpretation of aerial imagery. Only a very small portion that is available on the Comox Valley Regional District (CVRD) iMap has been mapped using Sensitive Habitat Inventory Mapping (SHIM) methodology (chain and compass/ground-truth mapping); this work was completed by Comox Valley Project Watershed in the late 1990s and early 2000s. The Trent River is known to support cutthroat trout and salmon populations, including coho, chinook, pink, and chum.

This project, in collaboration with BWS and the K'ómoks First Nation (KFN) Guardians, aimed to provide detailed habitat mapping of the lower ~10 km reaches of the Trent River system, between the Inland Island highway (Hwy 19) and Baynes Sound. In addition, an assessment of summer low-flow refuges in the lower reaches was completed in the summer to identify, protect, and/or enhance these important habitat features in the face of climate change.

Works completed include:

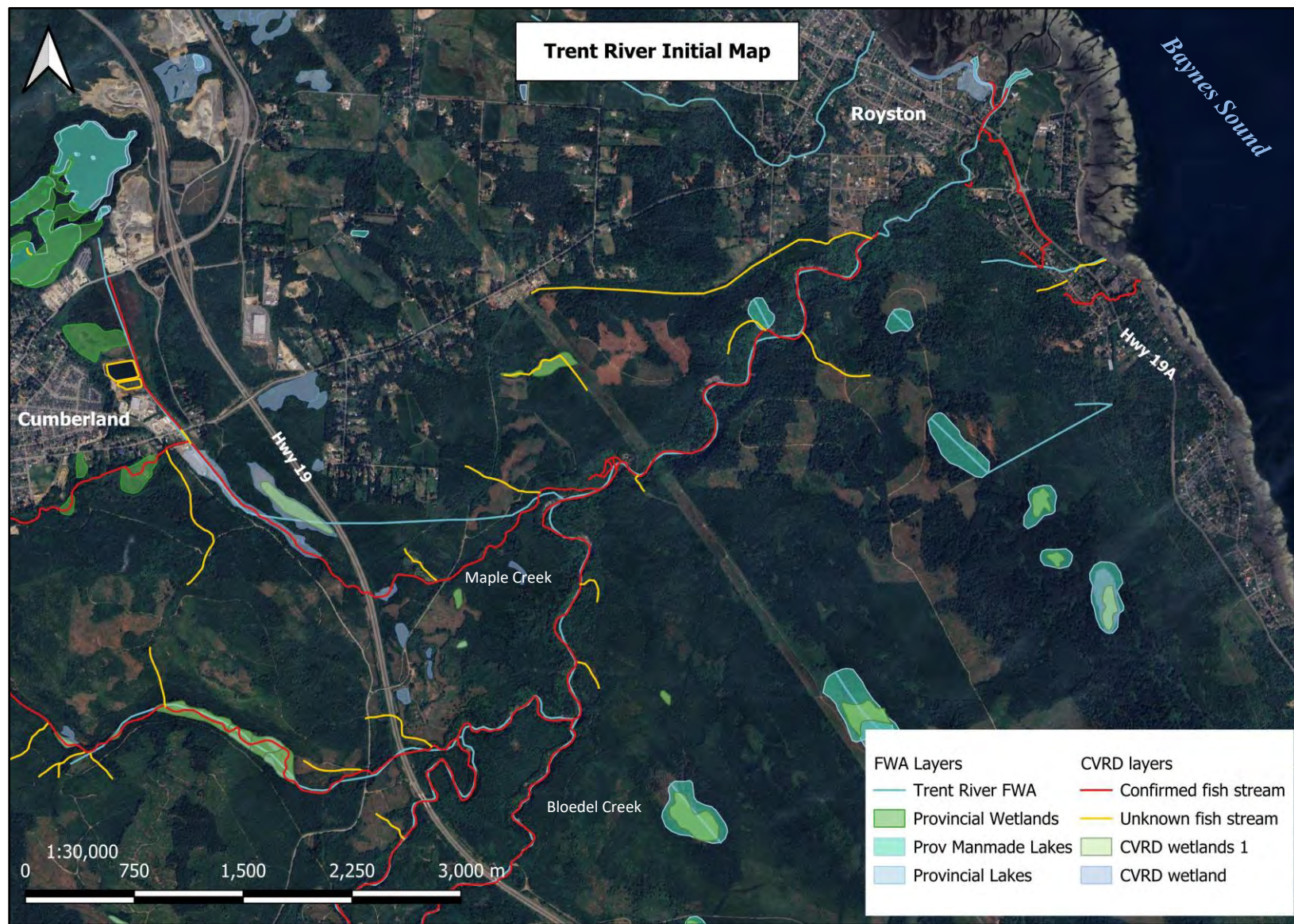
- Identifying previously unidentified tributaries and ditches that flow into the streams.
- Observing impacted or underperforming riparian habitats.
- Assessing low summer flow refuge habitat (i.e., deep pools).
- Assessing existing habitat values (spawning habitat, cover, and other instream features).
- Identifying barriers to fish access (culverts, falls, and other obstacles to migration).
- Identifying opportunities for future enhancement projects.
- Providing GIS data to the Province (i.e., FWA) and Municipality (i.e., CVRD iMap), thereby enhancing local knowledge of aquatic habitats and making the information accessible to the public. This is a vital tool for planners, landowners, and other decision-makers.

Work was conducted jointly by Astraea Biologists, K'ómoks First Nation Guardians, and BWS volunteers and included ground truth mapping of the river and any previously unmapped tributaries or ditches using high-accuracy GPS tools. Stream segments were defined following the provincial guidelines, as outlined in the Definitions Section below. Key habitat features outlined above were identified, described, and documented with photographs and GPS waypoints. The GPS data collected were then analyzed in the office using GIS software and compiled into updated streamlines and community-facing annotated maps. Updated streamlines were distributed to the CVRD and the Province of British Columbia's geomatics

departments for integration into publicly accessible online mapping resources (i.e., iMap BC and CVRD iMap; currently in progress). See the Mapping Methods section for more details.

The figure below contains the current mapped extent of the Trent River available online via iMap BC and via the CVRD iMap.

Figure 1. Initial Mapped Extent of the Trent River, Royston, BC. (FWA & CVRD iMap, 1996-2001).



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## Definitions

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### STREAM

As per the Water Sustainability Act (WSA)<sup>1</sup>, "**stream**" means

- a) a natural watercourse, including a natural glacier course, or a natural body of water, whether or not the stream channel of the stream has been modified, or
- b) a natural source of water supply,

*including, without limitation, a lake, pond, river, creek, spring, ravine, gulch, wetland or glacier, whether or not usually containing water, including ice, but does not include an aquifer;"*

As per the Riparian Area Protection Regulation (RAPR)<sup>2</sup>, "**stream**" means

- a) a watercourse or body of water, whether or not usually containing water, and
- b) any of the following that is connected by surface flow to a watercourse or body of water referred to in paragraph (a):
  - i. a ditch, whether or not usually containing water;
  - ii. a spring, whether or not usually containing water;
  - iii. a wetland;"

Accordingly, a "**stream**" is any watercourse (natural or man-made) that 1) provides fish habitat, 2) contains water permanently or seasonally, and 3) is scoured by water or contains observable deposits of alluvium. A "**stream**" may not be currently inhabited by fish, but may provide water, food, and nutrients to a fish-bearing stream. Thus, side channels, off-channels, and tributaries are included within the definition of a "**stream**" under WSA and RAPR.

### DITCH

As per the Water Sustainability Act (WSA), a "**ditch**" is defined as "*a long, narrow, excavated channel for carrying water, often for drainage*".

A "**ditch**" can still be considered a "**stream**" if it was or still is a natural watercourse or if it is a source of water supply to downstream fish-bearing watercourses, even if it has been modified.

Generally, a "**ditch**" is not considered a "**stream**" under the WSA if

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<sup>1</sup> Government of British Columbia. (2014). *Water Sustainability Act* (SBC 2014, c. 15). Retrieved from <https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/14015>

<sup>2</sup> Government of British Columbia. (2019). *Riparian Areas Protection Regulation*, B.C. Reg. 178/2019. Retrieved from [https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/178\\_2019/](https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/178_2019/)

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- a) it only carries overland flow or surface runoff (i.e., it has no headwaters or springs),
  - b) it was constructed as a 'work' under a WSA water licence or use authorization, or
  - c) it is operated in a manner consistent with a drainage 'exemption' under Sections 31-34.1 of the *Water Sustainability Regulation* (e.g., corridor drainage, local government drainage work, agricultural drainage, etc.)<sup>3</sup>
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## Mapping Methods

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The watercourses were ground-truthed by K'ómoks First Nation Guardians (total of 5 guardians trained) and BWS volunteers (total of 8 volunteers), and one to two *Astraea* biologists. Mapping was completed to review the existing habitat conditions between the estuary and the Inland Island Highway (Hwy 19). The recent mapping used the SHIM methodology to delineate the stream centerline and aquatic habitats. The thalweg (deepest point of the stream channel) was surveyed to collect geospatial and elevation data. For wetlands, perimeter points were collected, and vegetation types were recorded to aid in habitat delineation.

To define the different sections of the channel (i.e., natural stream, channelized stream, ditch, and wetlands) that were surveyed, provincial regulatory definitions were applied as outlined above in the Definitions Section. Both the WSA and RAPR define a stream as any watercourse providing fish habitat, natural or human-made, that contains water on a perennial or seasonal basis and is scoured by water or contains observable deposits of mineral alluvium; or has a continuous channel bed including a watercourse that is obscured by overhanging or bridging vegetation or soil mats. A stream may not be currently inhabited by fish, but may provide water, food and nutrients to other streams that do support fish. Side channels, intermittent streams, and seasonally wetted contiguous areas are included in the definition of a stream, which includes active floodplains and wetlands connected to streams. In general, the only watercourses excluded from the definition of stream under the WSA and RAPR are those that do not support fish or drain into a watercourse that supports fish; for example, an isolated wetland that is not connected to a stream system, or a roadside ditch that is not directly connected to a downstream fish-bearing watercourse.

The streamlines were surveyed using either an Emlid Reach RX unit or an iPhone 15 Pro Plus running Avenza Maps. The Emlid Reach RX is a commercial survey unit used for urban and remote land surveying. The Emlid Reach RX utilizes the Real Time Kinematic (RTK) technique to improve the accuracy of standalone Global Navigation Satellite System (GNSS) receivers. The

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<sup>3</sup> Government of British Columbia. (2021, December 9). *A User's Guide for Changes In and About a Stream in British Columbia* (Version 2022.01). Ministry of Environment and Climate Change Strategy.

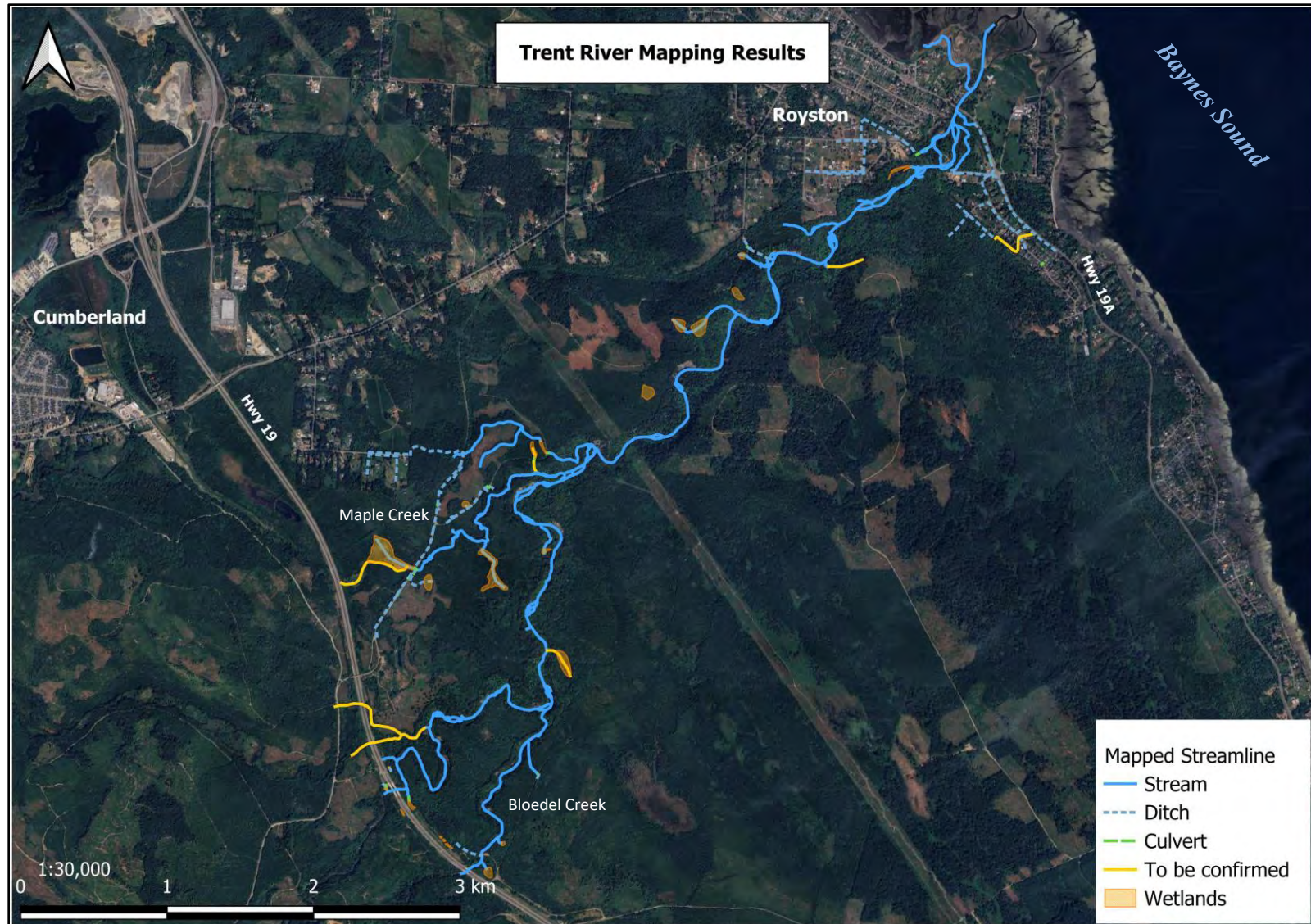
[https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-users\\_guide.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-users_guide.pdf)

Emlid Reach RX provides accurate points to within one meter. By comparison, traditional GNSS receivers, like those in smartphones, can determine the position with 2–4 meters accuracy. As such, the Emlid was predominantly used unless two teams were working at the same time, with one using the Emlid and one using Avenza Maps on an iPhone.

Collected GPS data was then reviewed using Quantum Geographic Information System (QGIS) software by a GIS technician. Differences in the watercourses mapped by Astraea and those available from previous mapping efforts were reviewed. Notable additions to the available Fresh Water Atlas (FWA) streamlines include (1) previously unmapped channels, tributaries, braided channels, and off-channel habitats, including side channels and backwatered channels that provide key refuge habitat during high flow events, (2) wetlands, and (3) road crossings and culverts (sizing and length data were recorded).

The updated streamline map for the Trent River (Figure 2), which has been submitted to the Comox Valley Regional District and to the Province of BC, is presented below.

Figure 2. Ground-truthed stream mapping results of the Trent River, Royston, BC. (August 31, 2025).



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## Features-of-Interest

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Key features of interest that were identified during the survey are outlined here and presented below in mapped form (Figure 3) for the Trent River. Photographs of these features are included in Appendix A. Sections of the stream channel have been broken down based on their location within the geographic areas and discussed in this manner below. In addition, the locations of deep pools surveyed during the summer low-flow assessment are included in Appendix B.

### Trent River Mainstem

#### Gravel bars, vegetated islands, side channels, beaver ponds

Complex in-stream features are essential for supporting the full freshwater life cycle of Pacific salmon, including spawning, incubation, and juvenile rearing. These features increase hydraulic, thermal, and structural diversity within the river, enabling salmon to access the range of habitats required throughout different flow conditions and life stages.

Within the mainstem of the Trent River, several complex in-stream features were identified and incorporated into the streamline dataset (see numbered photos in Figure 3):

- Side-channels and off-channels
- Gravel bars and vegetated mid-channel islands
- Active beaver ponds
- Large woody debris (LWD) jams

This increased channel complexity is important for the diverse habitat mosaic present within the Trent River ravine and floodplain, supporting Pacific salmon populations, resident trout, and other sensitive wildlife (e.g., amphibians, migratory birds, and predators).

Key ecological functions provided by these features include:

- **Thermal Refuge Creation:** Off-channel habitats, beaver ponds, and LWD-associated pools often interact with groundwater or hyporheic flow, producing cooler, well-oxygenated micro-habitats that serve as thermal refuges during summer low-flow and high-temperature periods.
- **Spawning Habitat Formation:** Gravel bars and depositional zones provide suitable spawning substrate with appropriate interstitial flow and oxygenation for egg incubation.
- **Juvenile Rearing Habitat:** Side-channels, floodplain pools, and LWD structures generate slower-velocity areas, complex cover, and enhanced invertebrate drift, offering high-quality foraging and refuge opportunities for juvenile salmon.

The mapping and documentation of these in-stream features during the Trent River assessment provide essential baseline information for ongoing habitat evaluation and future restoration planning. Integrating these data with hydrologic, thermal, and biological observations will support evidence-based management strategies aimed at protecting and enhancing salmon habitat throughout the Trent River system. Example photographs of these habitat features are included in Appendix A.

### **Waterfalls and bedrock chutes**

Natural geomorphic features—including waterfalls, bedrock chutes, and cascades—can function as permanent barriers to anadromous fish migration by creating hydraulic conditions that exceed the swimming or leaping capabilities of adult Pacific salmon. These features can completely obstruct upstream passage and therefore shape the distribution of anadromous versus resident fish populations within a watershed.

Within the Trent River watershed, several such features were documented (Figure 3):

- Trent River Falls: A steep falls section beginning approximately 1 km east from Hwy 19 (see Photo 31, Appendix A);
- Bloedel Creek Falls: An extended bedrock chute followed by a steep falls section, beginning ~200 m east from Hwy 19 and extending for ~600 m downstream (see Photos 40-44, Appendix A);
- Maple Creek Falls: A short bedrock chute and steep falls section ~400 m upstream from the confluence with the Trent River mainstem (see Photos 47-48, Appendix A).

Together, these waterfalls and bedrock chutes define the natural limit of anadromous fish (i.e., Pacific salmon) access in the Trent River watershed. As a result, reaches upstream of these locations support resident fish populations only (i.e., resident cutthroat trout). Accurate identification and mapping of these barriers provide essential information for fisheries management, habitat classification, and assessments of salmon distribution within the system. See Appendix A for representative photos of the falls.

### **Deep pools**

Juvenile Pacific salmon rely on summer refuge habitats to survive periods of low flow, drought, and elevated water temperatures. Deep pools are particularly important, as their greater depth and reduced velocities typically provide cooler, more thermally stable conditions that allow juvenile salmon to conserve energy, avoid predators, and maintain physiological function during periods of thermal stress (i.e., the summer months). With projected increases in summer temperatures due to climate change, monitoring and conserving these refuge habitats is increasingly critical. Mapping and restoring thermal refuges—such as through the introduction

of large woody debris or the protection of groundwater inputs—can enhance habitat complexity and support salmon resilience in warming river systems.

During the assessment survey, the locations of deep pools were recorded and are represented in Figure 4.

## **Maple Creek**

### **Corrections to Maple Creek Streamline**

During the assessment, the mapped location of the Maple Creek streamline was corrected in several places (Figure 3):

- The historically mapped location of the confluence with the Trent River mainstem was off by ~200 m (see Photo 46, Appendix A).
- In addition, the recorded course of the creek in the vicinity of the large beaver pond was found to be inaccurate.

These updates improve the spatial accuracy of the streamline of Maple Creek and will support future habitat assessments and restoration planning, where precise mapping is essential for understanding flow paths, floodplain connectivity, and overall habitat function. See Appendix A for representative photos.

### **Sewage outfall and water quality concerns**

Maple Creek currently serves as the sewage outfall for the Village of Cumberland. During the survey, increased algae growth and brown, turbid water was observed within Maple Creek and the Trent River mainstem downstream of the Maple Creek confluence —conditions consistent with nutrient enrichment or effluent discharge impacts. However, Coho fry were still observed in the lower reaches below the Maple Creek Falls (April 22, 2025). The combination of sewage effluent, reduced water clarity, and potential eutrophication poses concerns for overall water quality and the suitability of Maple Creek as habitat for Pacific salmon. See the Summer Low-Flow Assessment Section below for further discussion.

### **Riparian vegetation invasion: Reed Canary Grass**

Between the service road crossing and the Maple Creek falls, the stream channel becomes heavily impacted by a dense infestation of reed canary grass (*Phalaris arundinacea*). This invasive grass forms dense monocultures that outcompetes native riparian vegetation, reduces plant diversity, alters stream-bank stability, restricts water flow, and degrades fish habitat. In this context, the reed canary grass infestation reduces habitat quality for native fish species (i.e., resident cutthroat trout), by increasing water temperatures due to loss of shading vegetation, disrupting natural channel processes, promoting sedimentation, and reducing the quality of spawning gravel and rearing habitat. See Appendix A (Photos 51-52) for representative photos.

## Summer Low-Flow Assessment

The summer low-flow assessment was conducted August 21, 2025, between the Highway 19A bridge and the Royston–Cumberland Rail Trailhead at the end of Trent Road (Figure 5). During the assessment, the locations and physical attributes of deep pools within the mainstem were documented, including substrate type, incidental fish observations, pool depth, dimensions, and water temperature. These deep pools were also selected for installation of temperature data loggers (Tidbits™). These loggers will provide continuous, year-round thermal data, enabling an assessment of how effectively these deep-pool habitats buffer juvenile salmon from temperature extremes. See Appendix B for summary table of the pool locations and attributes.

During the low-flow assessment, water quality conditions within the Trent River mainstem downstream of the Maple Creek confluence were observed to be brown, turbid, and warm (>15 °C). Substantial algal growth was present on the streambed and floating within pools. Fish (i.e., coho fry, three spined sticklebacks) were observed in this reach; however, incidental observations of coho fry ceased approximately 2.6 km downstream of the Maple Creek confluence, while incidental observations of three spined stickleback continued. In comparison to coho salmon, three spined sticklebacks are more tolerant to increased water temperature and decreased dissolved oxygen concentrations. In contrast, water clarity improved and algal abundance decreased to negligible levels upstream of the Maple Creek confluence (See Photos 53-54, Appendix A).

Integrating these field observations with forthcoming long-term thermal records will improve understanding of how deep pools within the Trent River function as summer thermal refuges and will help inform management strategies aimed at protecting and maintaining these critical juvenile rearing habitats.

Figure 3. Annotated features-of-interest map for Trent River, Royston, BC. (See Appendix A for corresponding site photographs).  
(August 31, 2025)

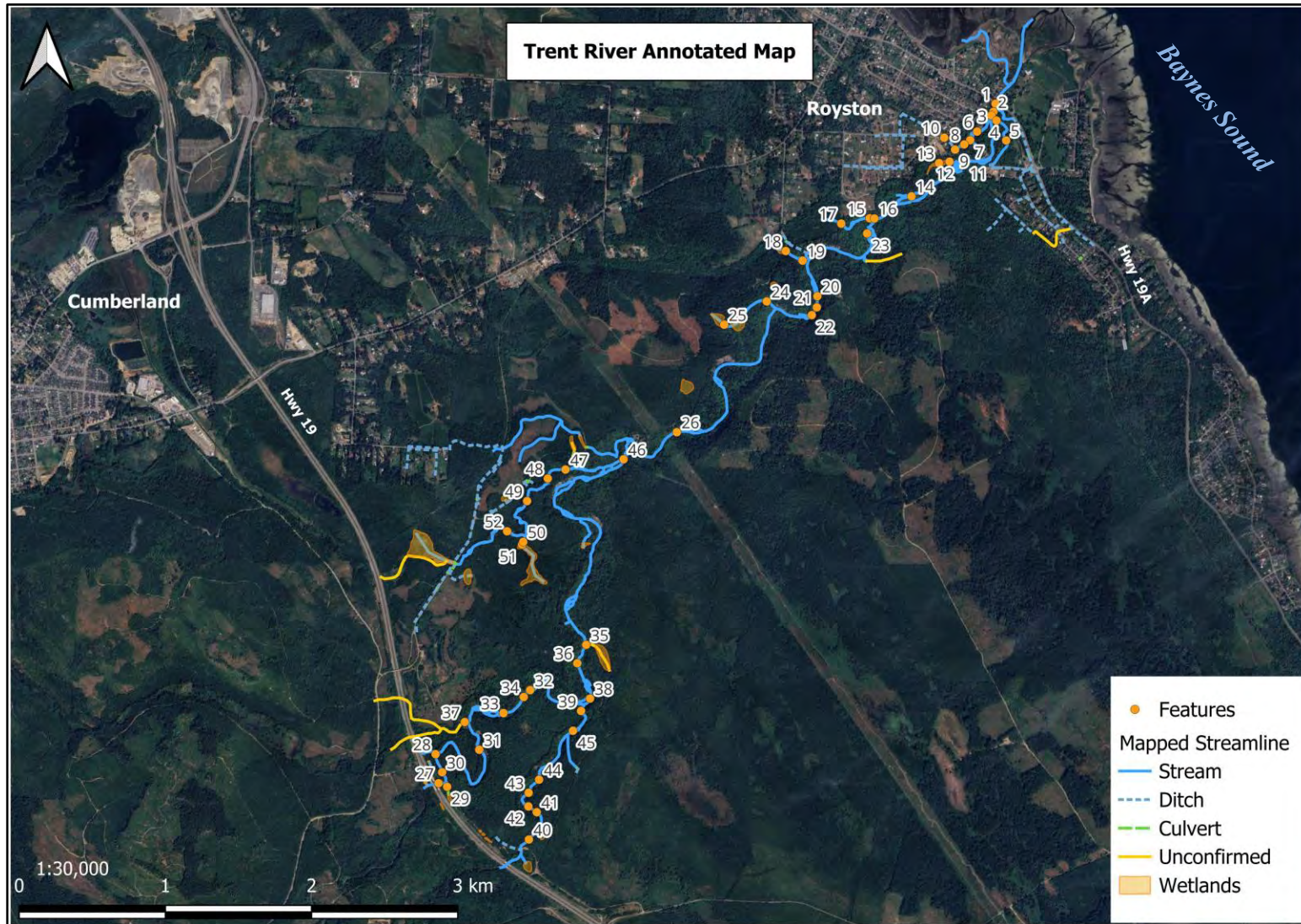


Figure 4. Identified deep pools as assessed during the initial survey and during the summer low-flow survey for the Trent River, Royston, BC. (August 26, 2025)

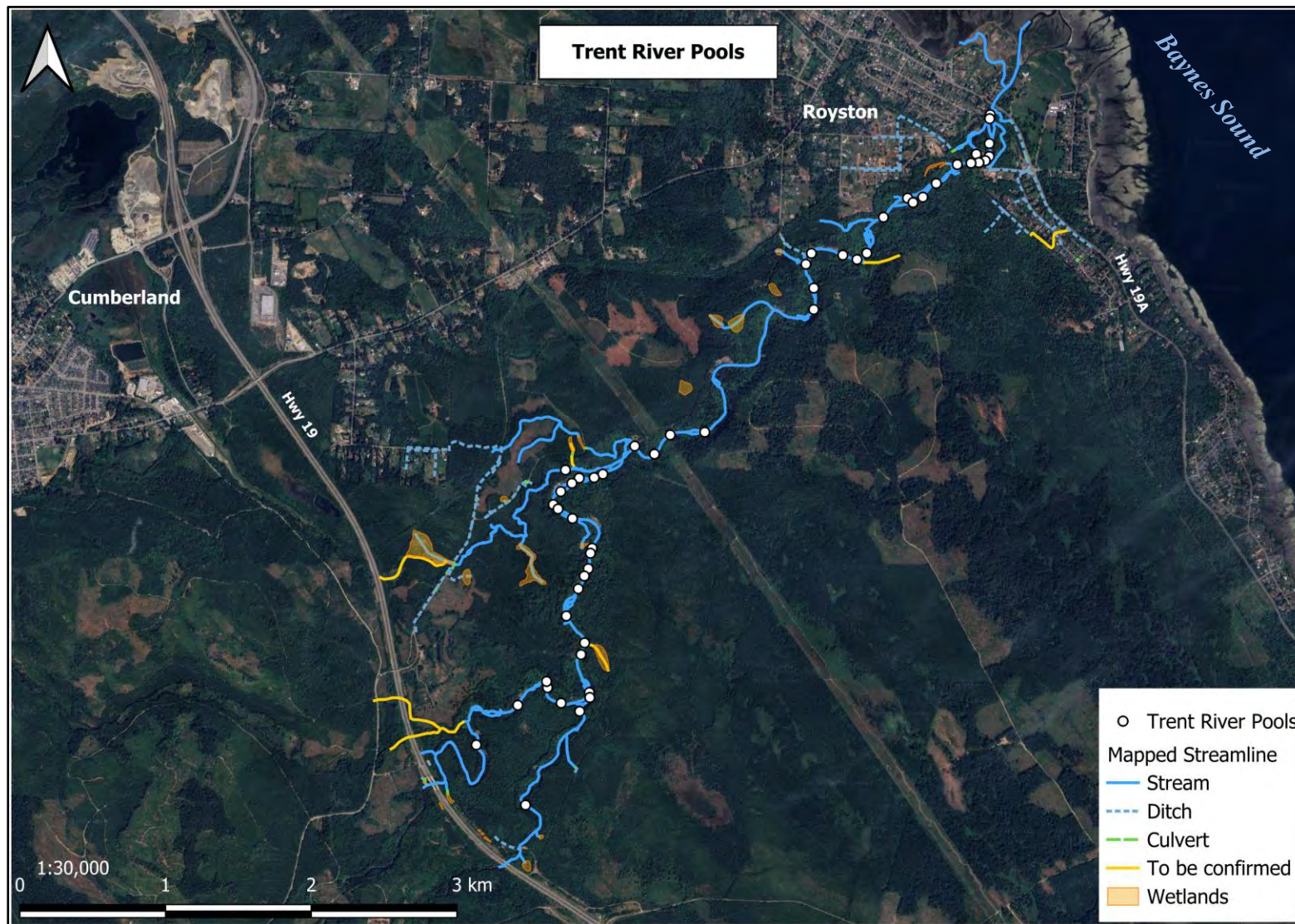
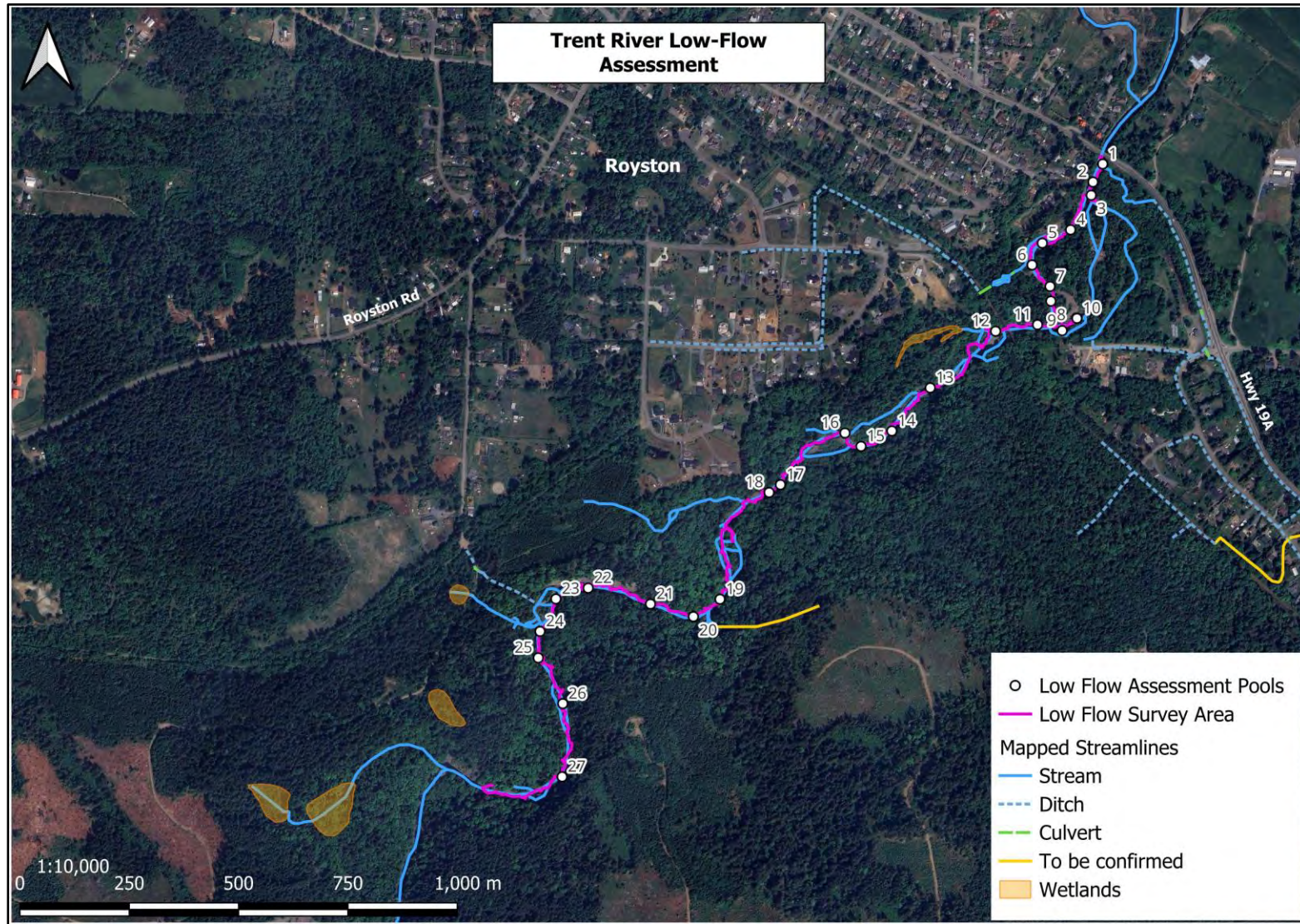


Figure 5. Low-flow survey effort and locations of identified deep pools in the Trent River mainstem, Royston, BC. (See Appendix B for summary table with pool features). (August 26, 2025).



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## Recommendations

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Based on the results of the 2025 Trent River Stream Mapping project, the following actions are recommended to support long-term protection, restoration, and management of the Trent River watershed:

### Relevance Under Changing Environmental Conditions

With increasing frequency of drought, declining summer baseflows, and elevated water temperatures associated with climate change, the protection and enhancement of complex in-stream habitats are becoming increasingly important. Restoration actions that increase channel complexity—such as LWD additions, riparian planting, deep pool habitat enhancement, and supporting beaver activity—can help sustain thermal refuges, maintain hydrologic connectivity, and improve habitat quality for multiple salmon life stages.

### Maple Creek Effect

The combination of effluent discharge, poor water quality (e.g., turbidity, abundant algal growth), invasive riparian vegetation, and previously mis-mapped streamlines indicates that Maple Creek currently functions as degraded habitat for salmonids and other aquatic species. Although coho fry were observed in the lower reaches—demonstrating some residual rearing potential—the long-term habitat quality remains compromised without targeted restoration and improved water management. Recommendations for Maple Creek include:

- **Engagement with the Village of Cumberland:** Engage with the Village of Cumberland to ensure that regular water quality monitoring occurs at the sewage outfall. With upgrades underway at the Village’s wastewater treatment facility, ongoing monitoring will be essential to confirm that effluent meets ecological standards and that improvements translate into measurable benefits for water quality and fish habitat.
- **Water Quality Monitoring and Fish Sampling:** Collection of water samples for fecal coliform, nitrogen, and phosphorus testing is encouraged, as these parameters are key indicators of eutrophication. In addition, fish inventory sampling (e.g., minnow trapping or electrofishing) above the Maple Creek Falls is recommended to assess fish habitat quality for resident fish (i.e., cutthroat trout).
- **Riparian Restoration and Reed Canary Grass Management:** Prioritize removal or control of reed canary grass and the re-establishment of native riparian vegetation. Restoring native plants will improve bank stability, provide shading to reduce stream temperatures, enhance in-stream habitat complexity, and restore ecological function.

## Ongoing Community and KFN Guardian Involvement

Continue training and field participation of KFN Guardians and BWS volunteers in stream mapping, water-quality sampling, and fish habitat assessment techniques to build long-term community-based watershed stewardship capacity.

Strengthening local expertise will support consistent monitoring of habitat conditions, enable rapid identification of emerging concerns (e.g., erosion, invasive species, thermal stress), and ensure that updated spatial and ecological information is regularly incorporated into watershed management decisions.

Expanding the technical skillsets of the KFN Guardians will also enhance the quality and quantity of data available for long-term trend analysis. Additionally, continued trilateral partnerships between environmental consultants, Guardians, and volunteer community groups provide an important cultural, educational, and stewardship benefit, helping connect community members to the watershed and supporting collaborative management between Indigenous and non-Indigenous partners.

Ultimately, maintaining and expanding this collaborative monitoring network will create a sustainable, locally driven foundation for continued habitat protection, restoration planning, and adaptive management across the Trent River watershed.

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## Conclusion

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The Trent River stream mapping and habitat assessment project conducted by Astraea Environmental Consulting in partnership with the Beaufort Watershed Stewards and the K'ómoks First Nation Guardians has greatly improved the understanding of aquatic habitat for the Trent River. Through ground-truthed, GPS-based habitat mapping techniques, the project identified and documented critical rearing habitats, corrected long-standing mapping inaccuracies, identified barriers to fish passage, and revealed important water-quality concerns associated with Maple Creek. The Trent River supports diverse and sensitive salmonid populations that rely on a mosaic of complex habitats—deep pools, side channels, beaver ponds, gravel bars, and shaded riparian zones—to complete their freshwater life cycles. Climate-driven changes, including higher summer temperatures and reduced flows, underscore the importance of protecting and enhancing these features.

The resulting data, integrated into the Provincial and Comox Valley Regional District's online mapping platforms, will support informed decision-making and conservation planning. Looking ahead, continued water-quality monitoring, riparian restoration (particularly in Maple Creek), protection of thermal refuges, and efficient integration of updated mapping into regional planning tools will be essential in supporting the long-term ecological resilience of the Trent River watershed.

Sincerely,

Katie Schulze, B.I.T., B.Sc., and  
Arin Yeomans-Routledge, R.P.Bio., B.Sc.,



Arin Yeomans-Routledge, R.P.Bio. (2645), B.Sc., QEP.

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## **Appendices**

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**Appendix A – Trent River: Photo Appendices**

**Appendix B – Trent River: Low-flow Refuge Pool Locations**

## **Appendix A**

### **Trent River: Photo Appendices**

**Photo 1. Bridge at Hwy 19A. Arrow indicates flow direction. Photograph collected March 6, 2024.**



**Photo 2. Concrete footings of historic railway bridge. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 3. Start of vegetated gravel bars upstream of old island highway (HWY 19A) bridge. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 4. Downstream outlet of a constructed river-right side channel (constructed by DFO). Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 5. Downstream view from bridge over the constructed river-right side channel (constructed by DFO). Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 6. Placed riprap along the river-left side channel. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 7. Identified river-left tributary upstream of the placed riprap. A pedestrian bridge and walkway has been constructed over the channel. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 8. Identified river-left tributary culvert upstream of the walkway. The top of the culvert originates at the railway. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 9. Identified river-left tributary culvert inflow. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 10. Identified river-left tributary ditch along the railway. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 11. View upstream at the railway trestle bridge over the Trent River mainstem. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 12. Looking upstream at an active beaver dam creating river-left off-channel habitat above the trestle bridge. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 13. View of the pond created by the beaver dam. Excellent off-channel habitat for juvenile salmonid rearing. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 14. View of a large LWD jam at the top of a river-left side channel. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 15. View looking upstream at an identified river-left tributary. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 16. View of the river-left tributary bedrock chute near the confluence with the mainstem. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 17. View from the top of the river-left tributary falls. Arrow indicates flow direction. Photograph collected March 6, 2025.**



**Photo 18. View of the primary culvert under the start of the Royston to Cumberland Railway Trails. Arrow indicates flow direction. Photograph collected March 7, 2025.**



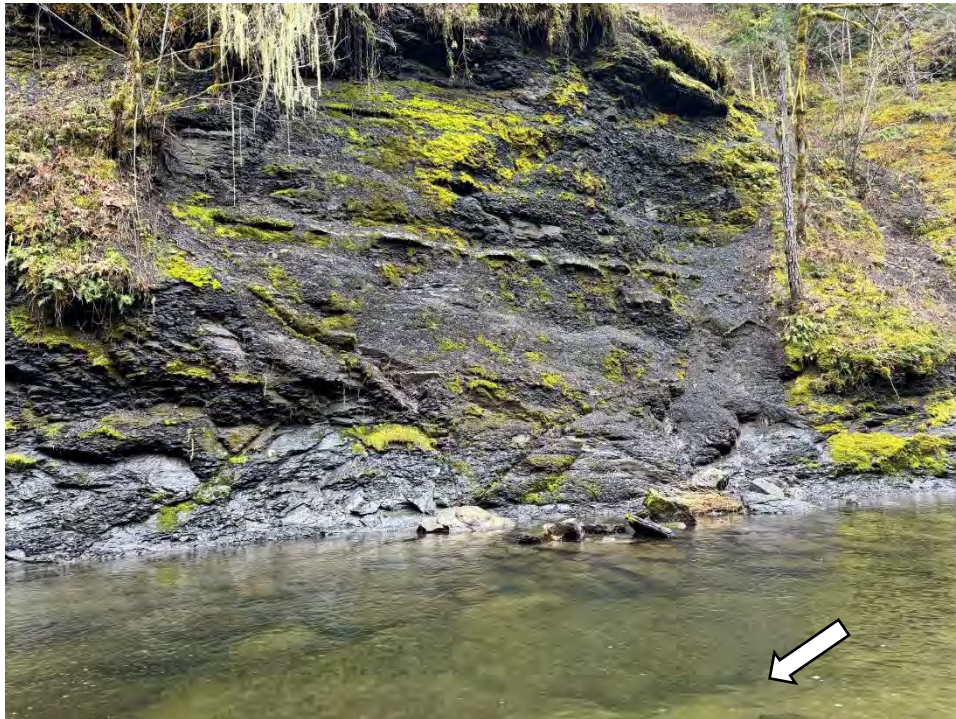
**Photo 19. View of the river-left tributary sourced from the above culvert. Evidence of a high-flow blowout. Arrows indicate flow direction. Photograph collected March 7, 2025.**



**Photo 20. Representative view of mainstem habitat. BWS volunteers traversing the river to the river-left bank. Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 21. Representative view of seepage point from steep shale cliffs (river-right). Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 22. Representative view of eroding shale cliffs (river-right) that define the Trent river above the trestle bridge. Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 23. Representative view of side channel habitat (river-left). Many coho fry and smolts were observed here. Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 24. River-left tributary sourced from beaver pond. Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 25. River-left tributary (multiple channels) sourced from wetland flowing towards the beaver pond. Arrows indicate flow direction. Photograph collected March 7, 2025.**



**Photo 26. View of a deep pool below large woody debris in the mainstem below the Hydro lines. Arrow indicates flow direction. Photograph collected March 7, 2025.**



**Photo 27. Representative view of the mainstem below Hwy 19. Arrow indicates flow direction.  
Photograph collected March 10, 2025.**



**Photo 28. View of the river-left tributary falls near Hwy 19. Arrows indicate flow direction.  
Photograph collected March 10, 2025.**



**Photo 29. River-right tributary below Hwy 19. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 30. Representative view of mainstem habitat above the Trent River falls. The KFN Guardians and BWS volunteers are assessing the river-right shale cliff. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 31. Representative view of Trent River Falls. Resident trout were documented above the falls. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 32. KFN Guardians and BWS volunteer traversing the mainstem. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 33. Channels braiding around vegetated islands in the mainstem, creating side channel habitat. Arrows indicate flow direction. Photograph collected March 10, 2025.**



**Photo 34. Representative view of the mainstem below the Trent River Falls. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 35. River-right tributary seep sourced from Provincially mapped wetland (to be further assessed). Arrow indicates flow direction. Photograph collected April 24, 2025.**



**Photo 36. Recreational use of the river-right bank along the mainstem, including a shack (circled) and ATV trail. Arrow indicates flow direction. Photograph collected April 24, 2025.**



**Photo 37. River left tributary falls (~10 m high) downstream of the Trent River falls. Arrows indicate flow direction. Photograph collected March 10, 2025.**



**Photo 38. Confluence of Bloedel Creek (river-right) and the Trent River mainstem (river-left). Arrows indicate flow direction. Photograph collected March 10, 2025.**



**Photo 39. View upstream of Bloedel Creek near the confluence with the Trent River mainstem. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 40. View of the bedrock chute upstream of the Bloedel Creek Falls. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 41. View of a second bedrock chute upstream of the Bloedel Creek Falls. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 42. Bloedel Creek Falls 1. There is a second set of falls ~50 m downstream. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 43. Bloedel Creek Falls 2. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 44. View of a third bedrock chute downstream of the Bloedel Creek Falls. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 45. Representative view of Bloedel Creek habitat downstream of falls/chutes. Arrow indicates flow direction. Photograph collected March 10, 2025.**



**Photo 46. Maple Creek confluence with the Trent River mainstem. Arrow indicates flow direction. Photograph collected April 22, 2025.**



**Photo 47. Maple Creek falls. Arrow indicates flow direction. Photograph collected April 22, 2025.**



**Photo 48. Start of bedrock chute above Maple Creek falls. Arrow indicates flow direction. Photograph collected April 23, 2025.**



**Photo 49. Representative view of Maple Creek above falls. Note the abundance of algae and moss on the boulders. Arrow indicates flow direction. Photograph collected April 23, 2025.**



**Photo 50. View of the beaver dam sourcing the river-right tributary of Maple Creek. Arrow indicates flow direction. Photograph collected April 23, 2025.**



**Photo 51. View of the beaver pond sourcing the river-right tributary of Maple Creek. Photograph collected April 23, 2025.**



**Photo 52. Representative view of Maple Creek near the forest service road. Note the abundance of reed canary grass in the channel. Arrow indicates flow direction. Photograph collected April 23, 2025.**



**Photo 53. Representative view of the Trent River mainstem below the Maple Creek confluence observed during the summer low-flow assessment. Arrow indicates flow direction. Photograph collected August 21, 2025.**



**Photo 54. Representative view of the Trent River mainstem upstream of the Maple Creek confluence. Arrow indicates flow direction. Photograph collected August 25, 2025.**



## **Appendix B**

### **Trent River: Low-Flow Refuge Pool Locations**

**Table 1. Low-Flow Refuge Assessment Pool Data, collected August 21, 2025.**

#	Feature	Observations	Lat	Long	Elevation (m)	Fish observations	Pool depth (cm)	Substrate	Temperature (°C)
1	Shallow pool river-right 6x2m	-	49.641	-124.932	14.452	Coho fry	30	Gravel	16
2	Pool by old bridge footing 10x50m	-	49.641	-124.933	15.241	Coho fry	65	Gravel, cobble	18
3	River-right pool 6x25m	-	49.640	-124.933	16.723	Coho fry	42	Gravel, cobble	16
4	Shallow pool 60x6m	Nice overhanging vegetation	49.640	-124.933	15.037	Coho fry	40	Gravel, cobble	15
5	Stagnant pool 60x4m	High abundance of stickleback, some larger, Coho concentrated towards upstream end of pool	49.639	-124.934	17.109	Stickleback and coho	50	Cobble	17
-	Tributary channel stagnant	Hydrophilic plants and grasses, water striders, no fish observed isolated from mainstem downstream	49.640	-124.934	16.283	None	50	Cobble	-
6	Shallow pool 55x4m	Flow upstream through dense reed canary grass - isolated from upstream migration	49.639	-124.934	16.783	Stickleback and coho	41	Gravel	17
7	Very shallow pool lots of fish and filamentous algae	-	49.639	-124.934	18.652	Stickleback and coho	-	-	19
8	Deep pool by root wad 30x6m	Lots of overhanging vegetation and roots	49.638	-124.934	20.460	Stickleback and coho	73	Bedrock, shale gravel	17
-	Beaver dam (new)	Abundance of reed canary grass upstream and downstream, stickleback	49.638	-124.933	18.538	Stickleback			17
9	Deep pool river-right	-	49.638	-124.933	19.126	Stickleback	82	Gravel, cobble	16
10	Deep pool river-right 2 10x20m	-	49.638	-124.933	18.059	Stickleback	80	Gravel, cobble	16
11	Deep run 8x40m	-	49.638	-124.934	21.888	Stickleback and coho	100	Gravel	16
12	Deep pool 20x15m	-	49.638	-124.936	23.673	Stickleback and coho	100	Bedrock, cobble	16
13	Deep long pool	-	49.636	-124.938	26.619	Stickleback and coho	130	Gravel	16

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14	Pool 30x6m	-	49.636	-124.939	25.239	Stickleback and coho	58	Gravel	16
15	Pool 40x8m	-	49.635	-124.941	25.280	Stickleback and coho	60	Bedrock, cobble	17
16	Pool at large log jam	-	49.635	-124.941	20.485	None	>150	Gravel, cobble	20
17	Deep pool below large undercut Cottonwood 10x15m	-	49.634	-124.942	27.161	Coho fry	77	Gravel, cobble	15
18	Deep pool 16x35m	Deep pool at bottom of bedrock section lots of gravel a metre deep at least connects into secondary pool downstream at Cottonwood	49.634	-124.943	29.294	Stickleback and coho	100	Gravel, cobble	15
19	Deep pool river right bank	Long deep pool on river right pool becomes deep halfway across channel	49.632	-124.944	45.285	Coho fry	120	Gravel	15
20	Moderate pool 10x18m	-	49.632	-124.945	42.470	Coho fry	70	Boulder, cobble	16
21	Moderate pool 8x35m	Pool at base of Riffle	49.632	-124.946	39.839	Stickleback and coho	70	Gravel, cobble	16
22	Small pool 6x8m	-	49.632	-124.948	45.050	Coho fry	40	Gravel, cobble	16
23	Bedrock pool 10x20m	-	49.632	-124.949	45.397	Stickleback	70	Bedrock	18
24	Deep pool 12x80m	Water is very green due to high abundance of algae likely due to inputs from Maple Creek	49.631	-124.950	39.495	Stickleback	80	Gravel, cobble, boulder	18
25	Bottom of the previous pool	-	49.631	-124.951	44.656	Stickleback	60	Gravel, cobble, boulder	18
26	Pool 6x18m	Have not seen Coho Fry since the small 6 x 8 m pool	49.630	-124.949	47.956	Stickleback	70	Gravel, cobble	19
27	Pool 70x8m	-	49.628	-124.949	55.932	Stickleback	70	Gravel	18