Squamish Estuary Salmon Habitat Recovery Project

C1-PAC-02-A2 (17-HPAC-01341-A2)

2018/2019 – YEAR 2

FINAL REPORT

Prepared for:
Coastal Restoration Fund

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Executive Summary

The 2018/2019 fiscal year was year 2 of a five-year project funded by the Coastal Restoration Fund program to improve fish habitat, in particular Chinook Salmon, within the Squamish Estuary. This second year was focused on Phase 1 of the project to replace a culvert along the Training Berm to improve fish passage between the Squamish River and the Central Estuary. The Central Estuary Restoration Project, a multi-year, multi-phased project, is the culmination of decades of discussion with Fisheries and Oceans Canada staff and Squamish Nation staff and Council to improve salmon habitat within the estuary. The CRF funded project includes three main areas: Phase 1 – replacement of a culvert (or culverts) at key locations along the Training Berm to improve fish access from the river to the central estuary for outmigrating juvenile salmonids; Phase 2 – realignment of the Spit to open up 77 hectares of estuarine habitat to salmonids; and Phase 3 – installation of a flow control structure across the CN Spur Line to improve base flows into the upper end of Bridge Pond / Cattermole Slough to improve water quality for salmonid habitat.

The 2018/2019 year was full of challenges, accomplishments, setbacks, and ultimately, the replacement of the former 1.2 metre diameter corrugated twin culverts located at Culvert #3 with a new 35m length 3m x 3m diameter concrete box culvert to span the berm. This achievement was the result of numerous discussions, engagement with the community, and input from the regulators and was based on flood and sediment transport models prepared by Kerr Wood Leidal. Discussions between DFO RRU staff with District of Squamish and Provincial staff were also the corner stone of a successful outcome from the year.

The completion of Year 2 also included a robust fishery monitoring program developed and implemented by InStream Fisheries Research Inc (IFR), a water quality monitoring program developed and implemented by Lake-Trail Consulting (LTC), and emerging scientific techniques for the coming year by which to monitor the movement of juvenile Chinook fry as they access the new culvert. Mid-way through the year additional staff support was brought on to address the large-scale project goals and Kimberly Armour, Assistant Project Manager, started work full-time on the project in August 2018.

Contents

Abbreviations

CSP – corrugated steel pipe
DFO – Fisheries and Oceans Canada
DOS – District of Squamish
IFR – InStream Fisheries Research Inc
LTC – Lake Trail Environmental Consulting
MFLNRO – Ministry of Forests, Lands, Natural Resource Operations and Rural Development
PIT – passive integrated transponder
RFID – radio- frequency identification telemetry
SRWS – Squamish River Watershed Society
ST – Squamish Terminals
SWS – Squamish Windsports Society
TNT – The Nature Trust of BC

1.0 Introduction and Project Description

Year 2 of this five-year project focused on the replacement and upgrade of one of the culverts along the Squamish Training Berm to improve fish access for salmonids, particularly outmigrating juvenile Chinook salmon, from the Squamish River into the Central Estuary. To achieve this goal several engineering models had to be undertaken to determine the sediment transport along the Squamish River, the wave attenuation created by the Squamish Training Berm, and flood modelling. As well, in continuation of the first year, fisheries and water quality monitoring was undertaken.

The Squamish Estuary, located approximately 52 km north of Vancouver, is situated at the head of Howe Sound where the Squamish River discharges a drainage area of over 3,650 square km. The Squamish estuary encompasses the tidal waters of upper Howe Sound, from the confluence of the Squamish River upstream to the Mamquam River, the Mamquam Blind Channel, and Stawamus River. The project site is located within the Skwelwil'em Squamish Estuary Wildlife Management Area which is owned and managed by the provincial government. Access along the Training Berm Road is maintained by the District of Squamish in agreement with the provincial government in order to provide access at the south end for wind sports activities between May and September annually. The Training Berm, an antiquated structure which was constructed in the early 1970s by BC Rail, was originally intended to "train" the Squamish River along the western edge in order to facilitate the construction of a coal port in the estuary. However, the federal government of the day shut this operation down, which resulted in the 5 km road that effectively cut all access from the Squamish River to the Central Estuary from flows and fish access. In 1994 a twin CSP culvert was installed by Fisheries and Oceans Canada (Culvert #3). From 2001 until 2013 the Squamish River Watershed Society (SRWS) installed an additional 8 more culvert crossings in partnership with DFO to improve tidal exchange and provide fish access between the river and estuary. From 2013 until 2017 the SRWS commissioned a study to determine how the juvenile salmonids were utilizing the culverts. The result of the study determined that salmonids were not able to access the culverts for various reasons, which was likely resulting in the loss of a certain percentage of survival of salmonids as they were flushed down into Howe Sound (InStream 2017).

2.0 Goals and Objectives

The project objectives for Year 2 were as follows:

- Improve juvenile Chinook salmon access between the Squamish River and the estuary by upgrading passage structures through the Training Berm by replacing the culvert located mid-way down the berm (Culvert #3) to allow increased flow and tidal exchange;
- Work with water quality and salmon fisheries monitoring crews to establish baseline data on the characteristics of the Squamish River and Central Estuary, study the movement of juvenile Chinook (and other salmonids) as they outmigrate down the Squamish River, including the use of radio telemetry and state of the art acoustic monitoring techniques.

Furthermore, a major component of the Year 2 phase of the project was to engage with the community, project partners, and land managers to secure approvals for the culvert upgrades and initiate discussions around Phase 2 and Phase 3 of the project, respectively the realignment of the Spit and the installation of an intake structure across the CN Spur Line in subsequent years.

Year 2 (2018/2019):

i. Milestone 1: Project Planning and Capacity Building: A key component of the second year, was continued engagement with the stakeholders and community partners. This project is a partnership between the Squamish River Watershed Society (SRWS), Fisheries and Oceans Canada (DFO), and Squamish Nation. The stakeholders include District of Squamish (DOS), Squamish Terminals (ST), Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO), Squamish Windsports Society (SWS), Nature Trust of BC (TNT), and local conservation groups. Several meetings were held throughout the year between the project partners, DOS, ST, and SWS to discuss the overarching goals of the project. A larger forum was held in March 2019 to update the partners, funders, and general public on the status of the project.

Meetings, Workshops, and Presentations:
Throughout the year ongoing discussions were held with the project partners (Fisheries and Oceans Canada RRU staff and Squamish Nation staff) as well as the project supporters and stakeholder. Below is a list of some of the specific meetings that were held:

- July 6, 2018: Meeting with Provincial representatives (Jennifer McGuire, Environmental Sustainability and Strategic Planning Division, Ministry of Environment & Climate Change Strategy)

- July 10, 2018: Presentation sent to Minister Douglas Donaldson, Minister of Forests, Lands, Natural Resource Operations and Rural Development
- July 31, 2018: Meeting with Squamish Windsports Society
- August 2, 2018: Meeting with Kerr Wood Leidal regarding update on flood modelling and sediment transport studies
- August 24, 2018: Meeting with Scott Barrett, Director, Resource Management, Ministry of Forests, Lands, and Natural Resource Operations and Rural Development (minutes attached)
- October 2, 2018: Presentation to District of Squamish Council
- October 16, 2018: Presentation to Squamish Windsports Society
- October 30, 2018: Meeting with District of Squamish staff
- November 1, 2018: Presentation and meeting with Squamish Terminals
- November 27, 2018: Meeting with District of Squamish to discuss Bridge Design
- November 27, 2018: Engaging WSP to discuss detailed bridge design and engineering
- December 4, 2018: Follow-up presentation to District of Squamish Council
- February 7, 2019: Meeting with Squamish Terminals to provide project update
- February 7, 2019: Meeting with Mayor Elliott (DOS) to provide project update
- February 13, 2019: Conference call with KWL & DFO to discuss bridge requirements for seismic conditions and scour
- March 14, 2019: Stakeholder Meeting

Media Coverage and Press Releases:

- May 15, 2018, Squamish Chief
- December 6, 2018, Squamish Chief
- March 28, 2019, Squamish Chief

ii. Milestone 2: Engineering and Hydrologic Survey and Design: Three main areas of engineering studies were undertaken in the second year including sediment transport along the Squamish River and into the Central Estuary, Flood Modelling, and the initiation of realignment of the Spit and the impacts of the Training Berm for wave attenuation. Each of the report and drawings listed below are appended to this report.

Reports:

- Squamish River Training Dike Culvert Elevation. Survey Design. Bunbury & Associates. August 9, 2018
- Training Berm Bridge Opening Hydraulic Modelling. Kerr Wood Leidal. November 26, 2018
- Squamish Estuary Qualitative Sediment Transport Assessment. Kerr Wood Leidal,

December 21, 2018

- Squamish Training Berm Realignment – Wave Impact Assessment proposal. SNC Lavalin. February 25, 2019
- Culvert #3 Land Surveyor's Plan with Reference Points for Excavations. Bunbury and Associates. March 15, 2019
- Squamish River Spit Culvert Replacement – Hydrotechnical Memo. WSP. March 18, 2019
- Detailed Culvert Design. Langley Concrete Group. March 19, 2019

iii. Milestone 3: Construction Works: The focus of the year was to replace a culvert at a key location with either a clear-span bridge or a significantly large culvert to allow access for outmigrating juvenile salmonids between the Squamish River and the Central Estuary. The initial part of the year was to determine which culvert would be most suitable for replacement (as per the sediment model and the flood modelling studies). The result was that Culvert #3 was selected. Initially a clear-span bridge was proposed and WSP Engineering was commissioned to develop a bridge design to accommodate the flood events as modelled by KWL. However, with the absence of any meaningful provincial staff at this early stage, the District of Squamish (DOS) required the bridge be designed for a highways standard that had not been anticipated within the budget. Furthermore, the DOS required that any new bridge structures be able to withstand seismic events. As a result of increased costs and unrealistic deliverables for a structure that is neither a flood dike nor with any seismic integrity, the fallback plan was to explore the replacement of the 1.2 CSP diameter culvert with a 3m x 3m diameter concrete box culvert. A new design was developed by WSP and was given approval both by the DOS and, ultimately, by the Provincial Government.

Reports:

- Construction Safety Plan. Squamish River Watershed Society. March 1, 2019

iv. Milestone 4: Monitoring, Field Sampling, and Training: Several studies were initiated as part of Year 1 to establish baseline data along the Squamish Training Berm including studying the fish movement in the estuary, collecting data on water quality including dissolved oxygen, conductivity / salinity, pH, temperature, turbidity, and sediment transport. Training included teaching basic fish collection and fish identification techniques, the use of survey equipment, and how to collect water quality data using field equipment and data loggers. The reports listed below are appended to this report.

Reports:

- Baseline Monitoring Report for the Squamish Estuary Restoration Project. Squamish River Watershed Society. June 2018
- Squamish River Estuary Culvert (fisheries) Monitoring. InStream Fisheries Research Inc. October 18, 2018
- Interim Restoration (water quality) Monitoring Report for 2018. Lake Trail Environmental Consulting. March 29, 2019
- Squamish River Central Estuary Restoration Effectiveness (fish) Monitoring Draft Proposal. InStream Fisheries Research Inc. March 1, 2019

3.0 Study Area

The Squamish Training Dike is a 5 km structure that extends from the confluence of the Mamquam River downstream to Howe Sound and confines the Squamish River to the western bank. The focus of this phase of the project was to improve fish passage across Culvert #3 located at latitude 49.707275 longitude -123.170656 (Figure 1).

4.0 Methods

The groundwork laid in the 2017/2018 fiscal year (Year 1) provided the background information on what was required to improve fish passage across the Training Berm by replacement or upgrades to the culvert crossings at key locations. To this end, the project partners (Squamish Nation and Fisheries and Oceans Canada) engaged in detailed discussions to determine the best location for the culvert improvements. Based on the engineering modelling and with input from the province and District of Squamish, the most suitable location was determined to be Culvert #3.

With the site location identified the focus of the summer was to continue monitoring for fish presence and distribution through the estuary as well as to collect water quality monitoring data. Respectively InStream Fisheries Research Inc was hired to continue the fisheries monitoring they had commenced the previous year and Lake Trail Environmental Consulting developed a detailed water quality monitoring plan which was implemented over the course of the year, including the placement of data loggers at key locations. Both consultants worked closely with one another to ensure the data being collected was consistent for both their studies.

October 2018 – February 2019:
Once the location for the culvert upgrade was determined to be Culvert #3 the project team met with District of Squamish staff to discuss the design of a bridge structure. The initial intent was to hire an engineering consultant to design a bridge similar to the new bridge replacement on the Ashlu River (which had blown out the previous winter). However, early on in the discussions with the DOS staff they specified their requirements

for a bridge design would need to meet both highway and seismic standards. This was well outside of the scope of the project budget (as it would be well in excess of $1M) and not consistent with the wildlife berm structure in which the crossing was to be undertaken at Culvert #3. The engineering firm, WSP, who was initially engaged in November 2018 to develop the bridge design, was then able in the spring to develop alternative options which ultimately resulted in the decision to go with a box culvert design..

February – March 2019:
Once the decision to construct a box culvert was agreed upon the engineering firm, WSP, worked closely with DFO RRU staff and Langley Concrete to develop a detailed design, survey the site around Culvert #3, complete a detailed survey, and then prepare the site for construction.

The 3m x 3m diameter concrete box culvert design consisted of 11 individual pieces that would make up the 35m length culvert and two headwalls that would be placed at either end. The order for the culvert was placed with Langley Concrete in early February with some modifications around installing baffles. The engineering design for the box culvert took into consideration the KWL flood modelling and concrete baffles were determined to be the best means by which to reduce flood velocities as predicted in the flood model.

The site preparation included the removal of the vegetation in March prior to any bird nesting activity and a report was submitted for approval to the provincial government in advance of any tree clearing (Memo – CERP Tree Survey, March 2019). The access to the road was closed off to the public and a coffer dam on the river side of the culvert was installed to act as a plug. Due to the location of the site being within tidal estuary where there is an average of 4.6m tidal exchanges daily, working in the “dry” was not an option and the estuary side of the work site remained open to tidal flow. The site was excavated over a 4-day period and the old twin 1.2m CSP culverts were removed (and discarded). The bedding for the site was prepared during low-tide periods and over the course of two days the culvert and headwalls were installed. The channels leading from the river and into the estuary on either side of the headwalls were shored up with a minimum of 1.5m of large armour rock to be level with the invert of the headwall/culvert. Additional armour and riprap were extended along the river intake channel to prevent scour.

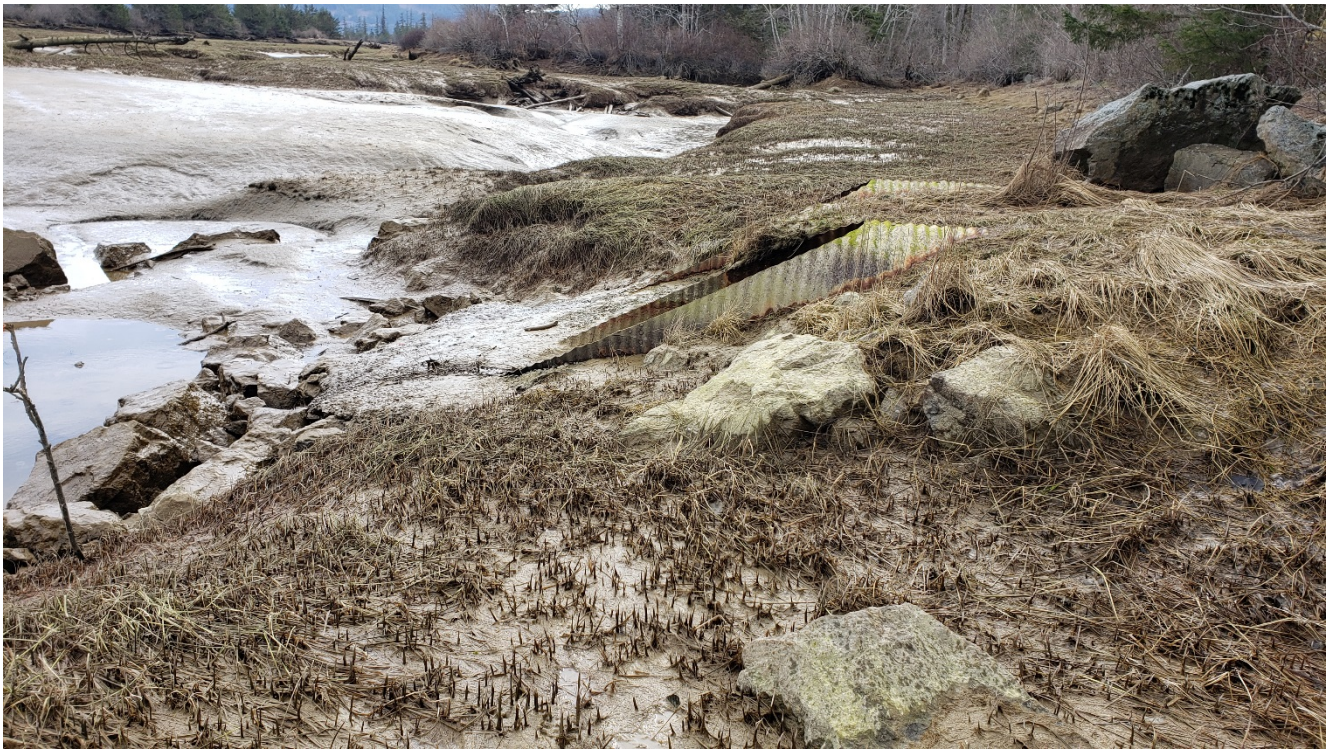


Photo 1. Original twin CSP (on estuary side) facing south

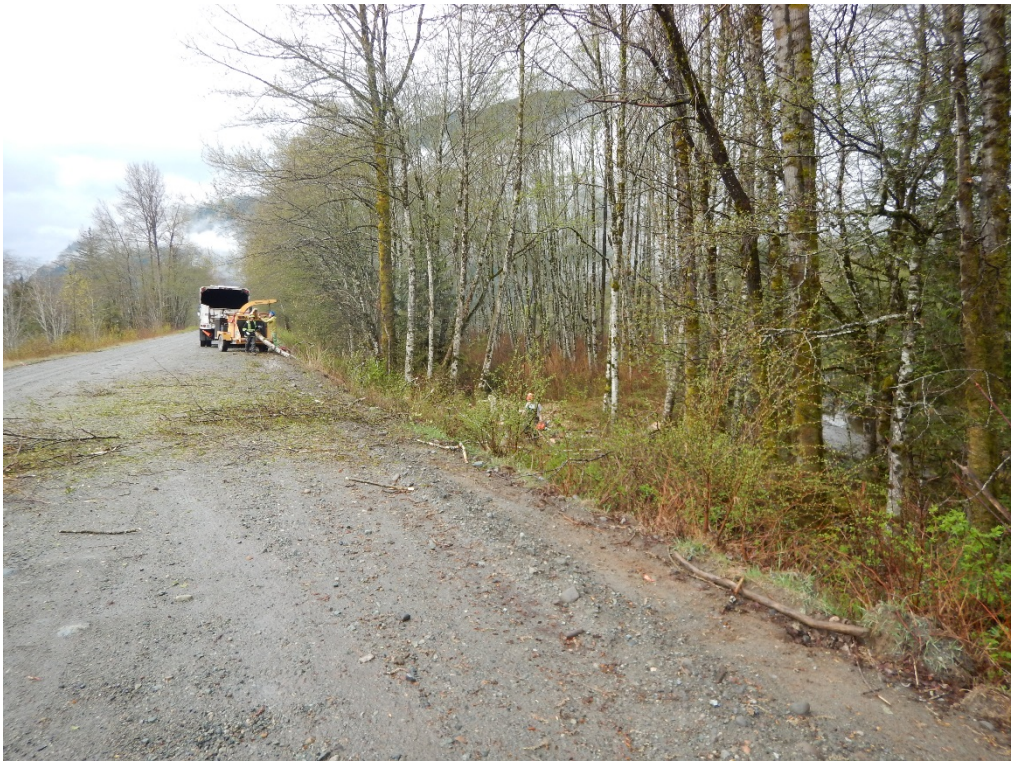


Photo 2. Clearing vegetation in preparation of site excavation

Photo 3. Preparing the opening

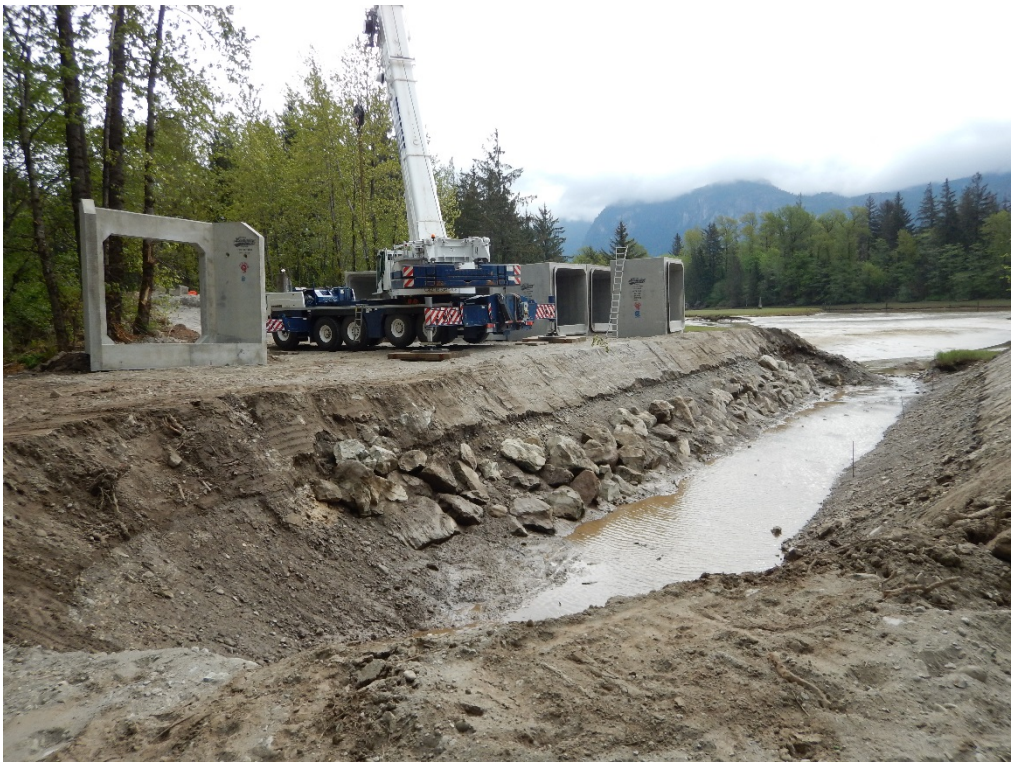


Photo 4. Crane set up to commence culvert install the following day during low tide

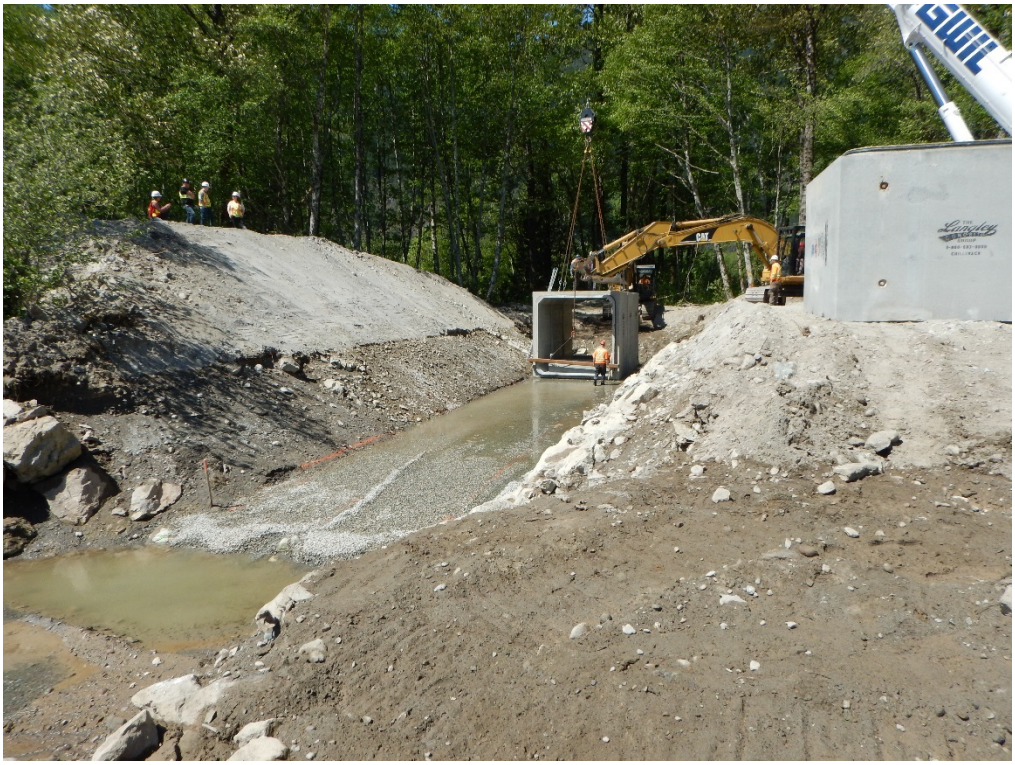


Photo 5. Channel ready for culvert installation

Photo 6. Culvert installation almost complete

Photo 7. Culvert and headwalls installed (facing east from river side)

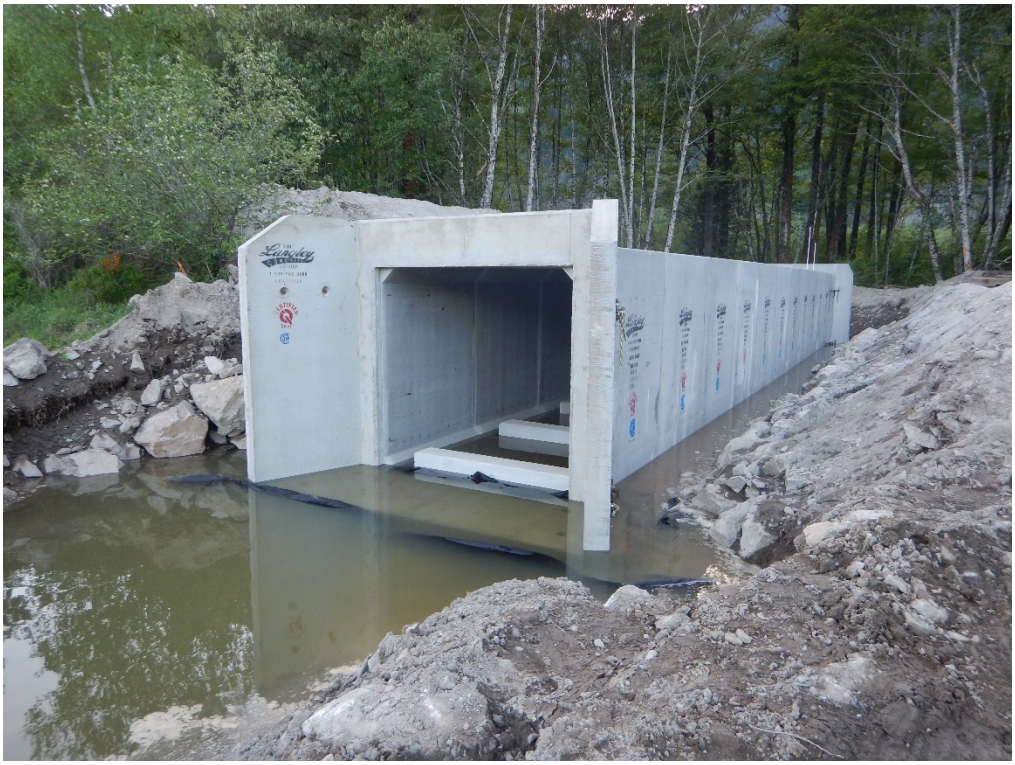


Photo 8. Tide starting to enter from estuary side (facing west)

Photo 9. Backfilling over culvert (river side facing east)

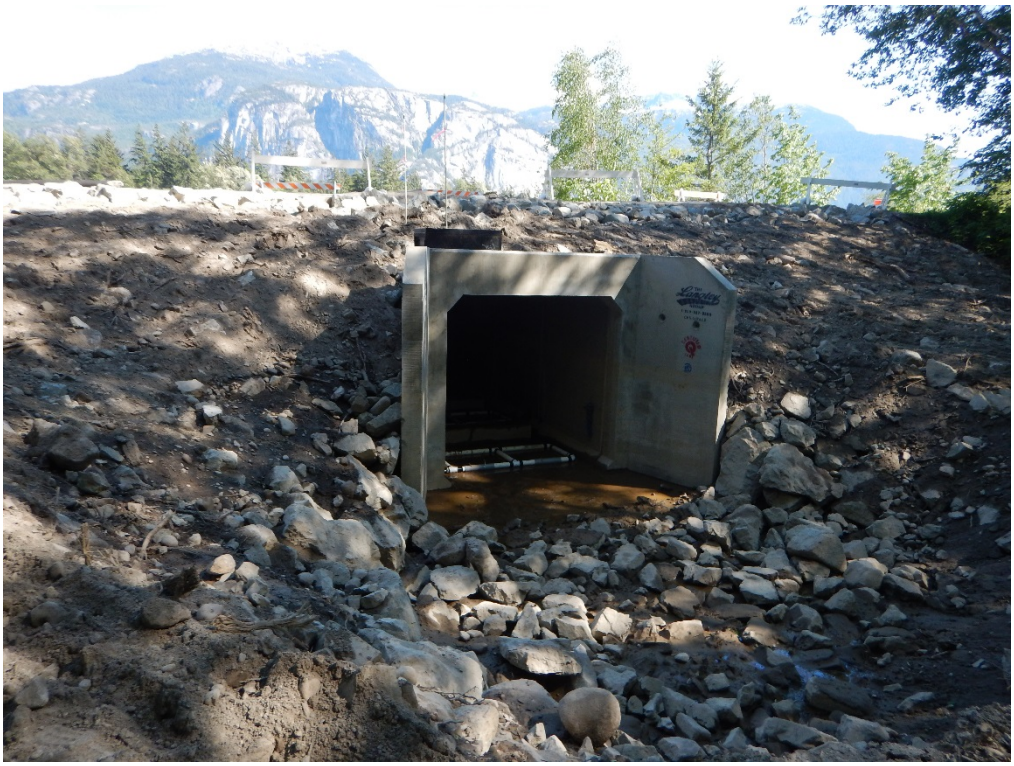


Photo 10. Backfilled and cleaning up site (facing east)

4.1 Fisheries Monitoring:

The monitoring that was initiated in the previous year was continued under the direction of InStream Fisheries Research Inc with the objective to determine whether the culverts in the Squamish River berm were allowing or hindering the passage of juvenile Chinook salmon during their out migration into Howe Sound. The Training Berm is considered to be a potential barrier to juvenile fish migration from the Squamish River into the estuary rearing environment (IFR 2018). Through the use of radio-frequency identification (RFID) telemetry, passive integrated transponder (PIT) tags, fish were captured using seine netting at various locations around the river and estuary. A total of 454 PIT tagged salmon were released and none of them were observed or detected on the antenna in the two culverts studies (Culverts #3 and #4). In addition, 49 tagged fish were released in the vicinity of the two culverts of which only 22 were observed to make use of Culvert #3, and only during a very limited tidal period in which the water flowed directly through the culvert. The results of the study indicated Chinook salmon were not using Culverts #3 or #4 to access the estuary.

For a full review of the fisheries monitoring please refer to “Squamish River Estuary Culvert Monitoring” by InStream Fisheries Research, October 2018.

4.2 Water Quality Monitoring:

Water quality monitoring is another layer of baseline data that was collected as part of this project in order to determine the ultimate impacts of the culvert upgrades and overall changes proposed to the Squamish Estuary. A detailed water quality monitoring protocol was developed by Lake Trail Environmental Consulting specific for the Squamish estuary and this project by which the project success could be measured based on the capacity of habitat improvements to benefit the early life history of Chinook salmon. Activities in 2018 included establishing stations in the estuary and river for long-term monitoring of the restoration efforts and included establishing control sites as well as the collection of baseline data prior to restoration. The monitoring metrics included:

- Water quality;
- Physical habitat;
- Hydrology;
- Sediment dynamics;
- Vegetation communities; and
- Invertebrate communities.

Water quality measurements included collecting data on tidal water levels, temperature, conductivity, dissolved oxygen levels, surveying tidal channel dimensions, installation of

sediment accretion stations, and installation of invertebrate settling plate arrays (Hester Dendy's). Photo-point monitoring was used as a visual baseline for post-construction conditions.

The 2018 Water Quality Monitoring program resulted in the successful installation of seven permanent stations and the collection of baseline data prior to the culvert upgrades. A detailed summary of the monitoring program can be found in the "Interim Restoration Monitoring Report for 2018 Squamish Estuary Restoration Project" prepared by Lake Trail Environmental, March 2019.

5.0 Results and Outcomes

The second year of this five-year project was extremely busy and ambitious. The focus was to concentrate on Phase 1 of the project, to upgrade or improve fish passage along the Training Berm by replacement one or more culverts. Through detailed engineering and hydrologic modelling, and in discussions with the provincial and municipal staff, the decision was made to focus on replacing Culvert #3.

The original intention of Phase 1 of the project, in discussion with DFO and Squamish Nation staff, was to install a bridge crossing consistent with other provincial crown land areas, such as along forest service roads (with a usual life span of around 45 years). However, due to requirements by the DOS and provincial government staff that the bridge be designed to highways standards, be at a minimum design for 75 years, and be built to seismic standards, the costs became prohibitive as the design team (WSP engineering) estimated to the total costs to be in excess of one million dollars.

The discussion then turned towards more reasonably priced options such as replacing the 1.2m twin CSP culverts with a 3m x 3m concrete box culvert. The engineering firm commenced designing for this structure and it was approved by all parties. In early March authorizations from the province were received for works under the Wildlife Act section 4(4) and Change Approval and Notification (changes in and about a stream under the Water Sustainability Act). The District of Squamish engineering department approved a Memorandum of Understanding for the culvert replacement and all works were undertaken under the supervision and direction of Fisheries and Oceans Canada RRU staff.

6.0 Discussion

The Central Estuary Restoration Project is a multi-phased, multi-year project that includes three main areas of focus: Phase 1 – replacement of culverts at key locations along the Training Berm to improve fish access between the Squamish River and the Central Estuary; Phase 2 – realignment of the Spit; and Phase 3 – installation of a flow control structure across the CN Spur Line to improve base flows into the top end of the Bridge Pond / Cattermole Slough. Discussions around the three phases commenced in Year 1 (2017/2018) of the project and resulted in the initiation of Phase 1 of the project for Year 2 (2018/2019) to improve fish access across the Training Berm at an agreed upon location, which was determined to be Culvert #3. Throughout the second year of the project the discussion has continued with the stakeholders, community, and project partners around Phases 2 and 3 which culminated in a stakeholder meeting held on March 14, 2019 to provide an update on the overall project scope and timelines. A summary of the discussion held on March 14, 2019 has been appended to this report (Central Estuary Restoration Project Meeting Minutes March 14, 2019).

Some of the challenges faced in Year 2 included the change in design from a bridge to a box culvert crossing, working with the engineering flood modelling firm to obtain detailed reporting in a timely manner, and addressing the needs of the community and recreation user groups as the access to the lower end of the Training Berm was closed off to the public as the site was prepared for the culvert installation. Some specific challenges around the culvert installation included the challenges in transporting such large box culvert structures to the site and the delivery of the product in a timely manner. One of the biggest challenges in the first part of the year was engaging with provincial staff and due to their shortage in staffing (which resulted in the province deferring the project decision making to the District of Squamish). Some of the lessons learned, that will be applied as we move forward into the third year, include the division of labour amongst SRWS and DFO staff, improved communications planning, and improve lines of communications with provincial staff. The project team was expanded mid-way through Year 2 to include an assistant project manager, Kimberly Armour, due to the large work load the project created and it has been a huge asset to have a dedicated staff person overseeing all aspects of the project on behalf of the SRWS. The input from DFO RRU staff remain central to the decision making process of Phase 1 and will continue to be integral to the success of Phases 2 and 3. As well, the need to secure additional funding in each subsequent year to cover the total project costs, above and beyond what has been approved by Coastal Restoration Fund, remain an important component to achieving the overall project scope.

7.0 Recommendations

The second year of this five-year project was extremely ambitious and included the completion of flood modelling, sediment transport modelling, initiation of a wave model of the estuary without a berm. As well, the second year including on-going water quality and fisheries monitoring to establish baseline data in advance of physical works. The culmination of the year was the replacement of the culvert at site #3 with a 3m x 3m box culvert and the improvements of inflows from the Squamish River through a deeper and erosion protected channel leading from the river to the new culvert. Some of the focus for Year 3 will include the clean-up and replanting around Culvert #3, ongoing community communications and signage, full scale fisheries monitoring that will use state of the art scientific methodology including PIT tagging and acoustic telemetry to monitor fish passage across the culverts and determine the overall success of the culvert replacement. As well, ongoing efforts to engage with the stakeholders and project partners will be a high priority as the discussions move to Phases 2 and 3 and efforts move ahead to realign the Spit and improve water flows into the upper Bridge Pond / Cattermole Slough.

8.0 Acknowledgement

We would like to thank Coastal Restoration Fund for the contribution of seed funding for this project as well as our partners, Fisheries and Oceans Canada and Squamish Nation.

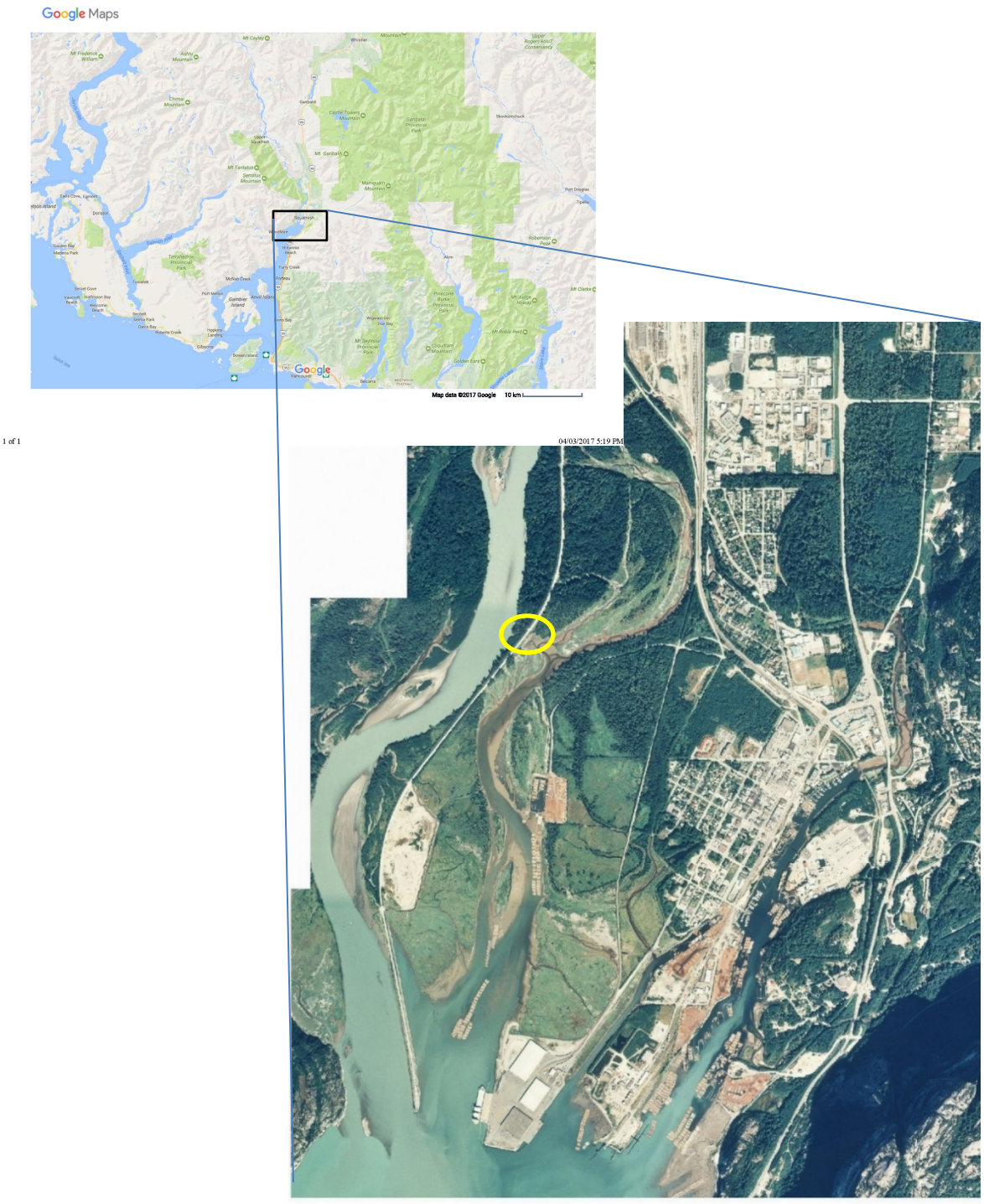
Project Team:
Edith Tobe, Project Manager, Squamish River Watershed Society
Kimberly Armour, Assistant Project Manager, Squamish River Watershed Society
Randall Lewis, Project Negotiation and Development, Squamish Nation
Dave Nanson, Restoration Biologist, Fisheries and Oceans Canada
Al Jonsson, Habitat Engineer, Fisheries and Oceans Canada
Murray Manson, Fisheries Protection Biologist, Fisheries and Oceans Canada

We would also like to take this time to thank:

- Scott Barrett, Nicola Bickerton, and Eric Balke, Ministry of Forests, Lands, and Natural Resource Operations
- Mayor Karen Elliot & Councillor Doug Race, District of Squamish
- Kim Stegman, Paul Morris, Emma Jarret, Squamish Terminals
- DOS engineering department
- Squamish Windsports Society
- Squamish Environment Society, and
- Squamish Streamkeepers

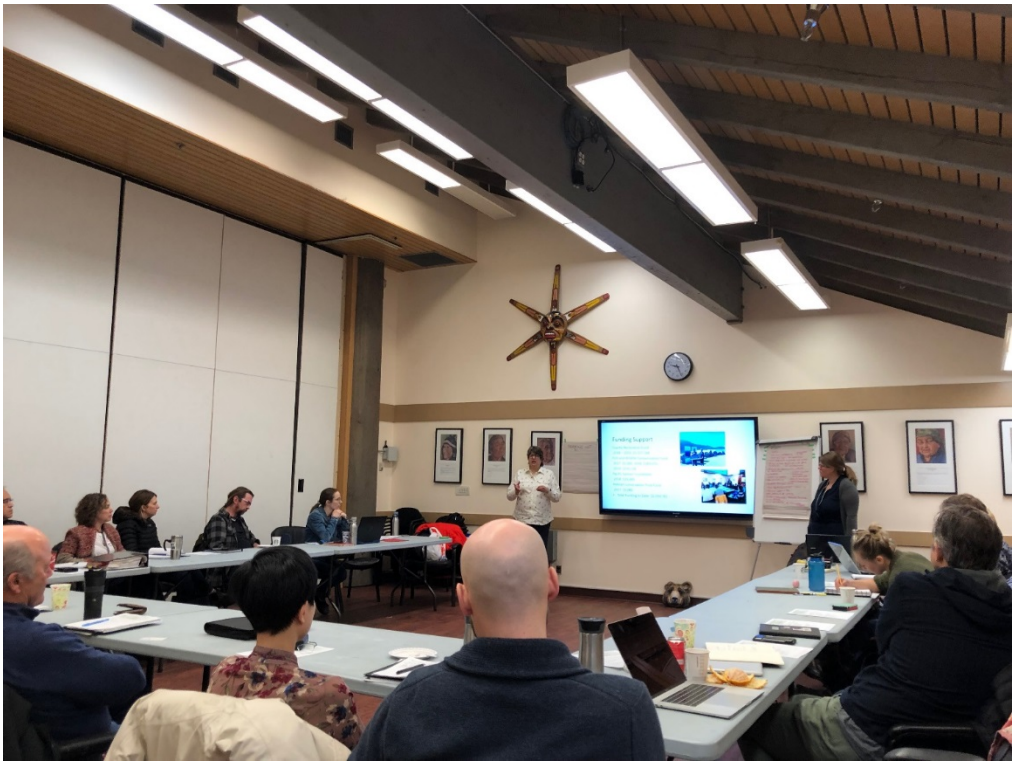
9.0 Site Map

Figure 1. Site Map and Project Location (yellow circle at Culvert #3)



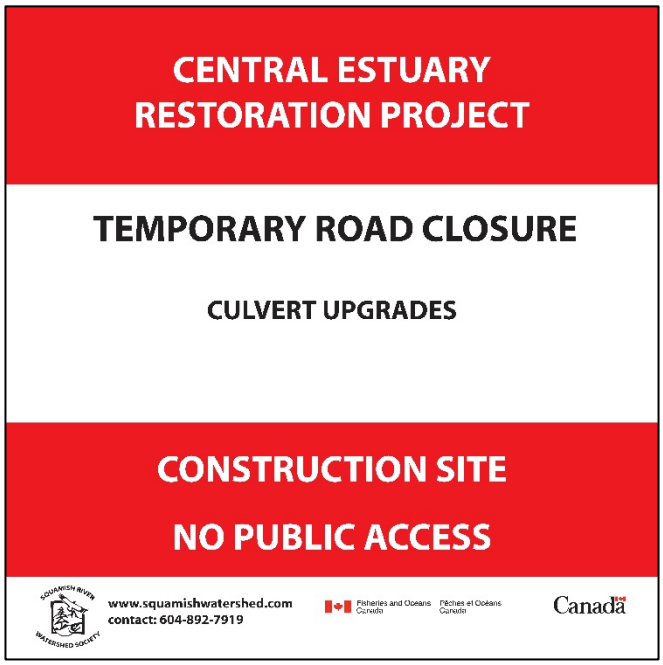
10.0 Photos

March 14, 2019 – Stakeholder Meeting

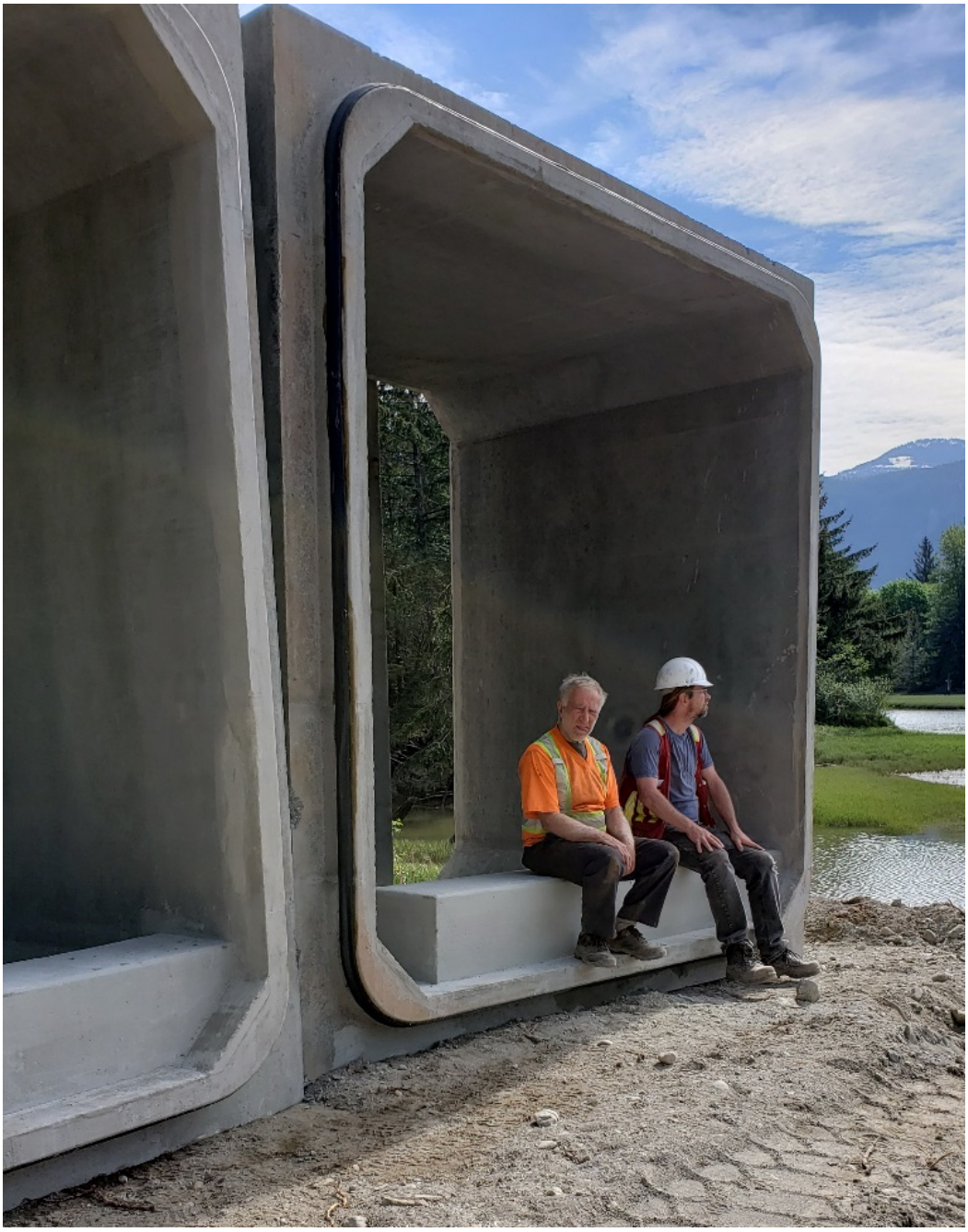


Signage:

Sign installed on access trail beside new culvert



Temporary construction signage



Al Jonsson (DFO engineer on right) taking a break with Rick Hunter (John Hunter & Company owner and operator)