

Squamish Estuary Fish Passage Improvement Project

COA-F23-F-3643

APRIL 1 TO NOVEMBER 1, 2022

FINAL REPORT



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Executive Summary

The Central Estuary Restoration Project is the culmination of over forty years of planning and development between Squamish Nation, Fisheries and Oceans Canada, the provincial government, and the Squamish River Watershed Society to restore salmon habitat and tidal connectivity between the Squamish River and the central estuary. In the early 1970s a Training Berm road was constructed from the Mamquam River down to Howe Sound in order to confine the Squamish River to allow the construction of a deep sea coal port in the estuary. The 5 km road was completed in 1972. At the same time regulatory agencies back in the day determined the Squamish estuary was not a good location for a coal port and then spent the ensuing years studying the biological diversity within the estuary.

In the early 2000s DFO, and then the SRWS, embarked on installing nine culvert crossings across the Training Berm to re-establish tidal/river exchange. In addition to this work, in early 2001 the SRWS secured funding through the former Bridge Coastal Restoration Program (File #01LM18) to remove the 15-hectare dredge spoils site associated with the construction of the Training Berm/Coal Port and construct salmon habitat and tidal channels throughout the site.

The ensuing years resulted in numerous projects that were supported by Squamish Nation and government agencies to restore salmon habitat throughout the estuary. Studies and on-going research over the decades allowed for greater insights into the effectiveness of these restoration efforts and whether juvenile salmonids were able to access the estuary from the river and the benefits to salmon stocks and increased biodiversity. The results were observations that salmon were not able to move across the nine culvert openings which likely resulted in undue mortality in the outmigrating juvenile Chinook salmon.

In 2018 the SRWS was able to develop an ambitious project to improve fish passage between the river and the estuary through a three phased approach. The first phase was to replace culverts at key locations with fish-friendly passageways. This resulted in the replacement of two culverts respectively in 2019 and 2020 at Culvert #3 and Culvert #4. Phase 2 of the project was to modify the lower Spit portion of the Berm that all but shot juvenile salmonids out into Howe Sound before giving them an opportunity to enter into the brackish waters of the estuary. This resulted in 2021 with the initial stage 1 of the project to open 300m of the 850m portion of the Spit structure. This phase of the work was completed in May 2022. The next stage 2 is proposed for the coming year to remove the remaining 550m to complete the 850m opening. The third phase of the project is for the future to restore additional connectivity through the Cattermole Slough and Bridge Pond, an important overwintering and rearing site for coho salmon and juvenile Chinook salmon.

This current report focuses on the work completed as part of this year's project (COA-F23-F-3643) which was in continuation of the restoration initiated in the previous fiscal year as part of File #COA-F22-F-3475. Much of the results and observations are the same as provided in the previous years report. However, fisheries and biophysical monitoring for the 2022 season commenced in early April and continued until late September 2022. The results of the monitoring program will be synthesized and compared with monitoring completed in previous years. As well, following the completion of the 300m opening the site was surveyed using drone video overflights taken at low tide combined with lidar/bathymetry surveys of the site from the former Spit to the west berth of the Squamish Terminals. These two surveys were then duplicated in early October towards the end of the summer freshet period in order to determine if there was any movement of bedload or sedimentation.

The current status of the project is preparing for the final stage of removing the remaining 550m of the Spit/Berm. In May of 2022 applications were once again submitted to Transport Canada to obtain authorization under the Navigable Waters Act, as well as to the Provincial Government to secure authorization under the Water Sustainability Act and Wildlife Act. The hope is that all permits will be secured by December 2022 to allow the remaining work to commence in early January 2023.

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Abbreviations:

CERP – Central Estuary Restoration Project

CSEB – Canadian Society for Environmental Biologists

CVGD28 – Canadian Vertical Geodetic Datum 28 (defined by mean sea level)

DFO – Fisheries and Oceans Canada

DOS – District of Squamish

FWCP – Fish and Wildlife Compensation Program

IFR – InStream Fisheries Research

MOE – Ministry of Forests, Lands, and Natural Resources, Development and Operations

PIT – Passive Integrated Transponder

SN – Squamish Nation

SNC-L – SNC Lavalin

SRWS – Squamish River Watershed Society

SWS – Squamish Windsports Society

TC – Transport Canada

WMA – Wildlife Management Area

1.0 Introduction and Project Description

The Central Estuary Restoration Project (CERP) is a multi-year project focused on improving fish access for salmonids between the Squamish River and the central estuary. The focus is to restore declining Chinook salmon populations by improving rearing habitat within the estuary. To achieve this objective, the scope of the project includes three phases (Figure 1):

- Phase 1 – Culvert Upgrades: replace culverts at key locations along Training Berm with fish passage friendly culverts (completed in 2019 & 2020).
- Phase 2 – Spit Modification: modification of the southern end of the Training Berm, also referred to as the Spit, to restore access to over 300 hectares of salmon rearing habitat (initiated in 2021 and 2022 with the opening of 300m and plans are underway to secure permits to continue work in 2023 to remove the remaining 550m to be completed by 2023 with the full 850m opening).
- Phase 3 – Bridge Pond Rewatering: install flow control structures across CN Spur Line to improve water quality between the Bridge Pond/Cattermole Slough and Pretty Slough in the central estuary (in the area managed by Squamish Nation referred to as Site “A”) – this phase will be explored in future years.

1.1 Project Site Location

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 km². 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 (WMA) which is Crown land managed by the provincial government (MOE 2007). Access along the Training Berm is maintained by the District of Squamish (DOS) through a lease agreement with the provincial government in order to provide access at the south end for wind sports activities between May and September annually. The entire CERP project site is within the territorial lands of Squamish Nation.

1.2 History of the Training Berm

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 to facilitate the construction of a coal port in the estuary. The federal government of the day shut the port development down, but the 5 km road remained in place limiting fish access and river flow from the Squamish River to the central estuary.

In 1994, twin corrugated steel pipe (CSP) culverts were installed by Fisheries and Oceans Canada (DFO) at the site referred to as Location #3 (Figure 2). From 2001 until 2013 the

SRWS, in partnership with DFO, installed an additional eight more culvert crossings to improve tidal exchange 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, which were all sized 1.2 m in diameter or smaller and were poorly positioned to be effective at allowing fish passage as they were either submerged or elevated above the river depending upon the tidal cycle. The lack of access to the estuary for the juvenile salmonids may have resulted in the loss of a certain percentage of the juvenile Chinook population as they were forced directly into Howe Sound (Lingard et al., 2018a).

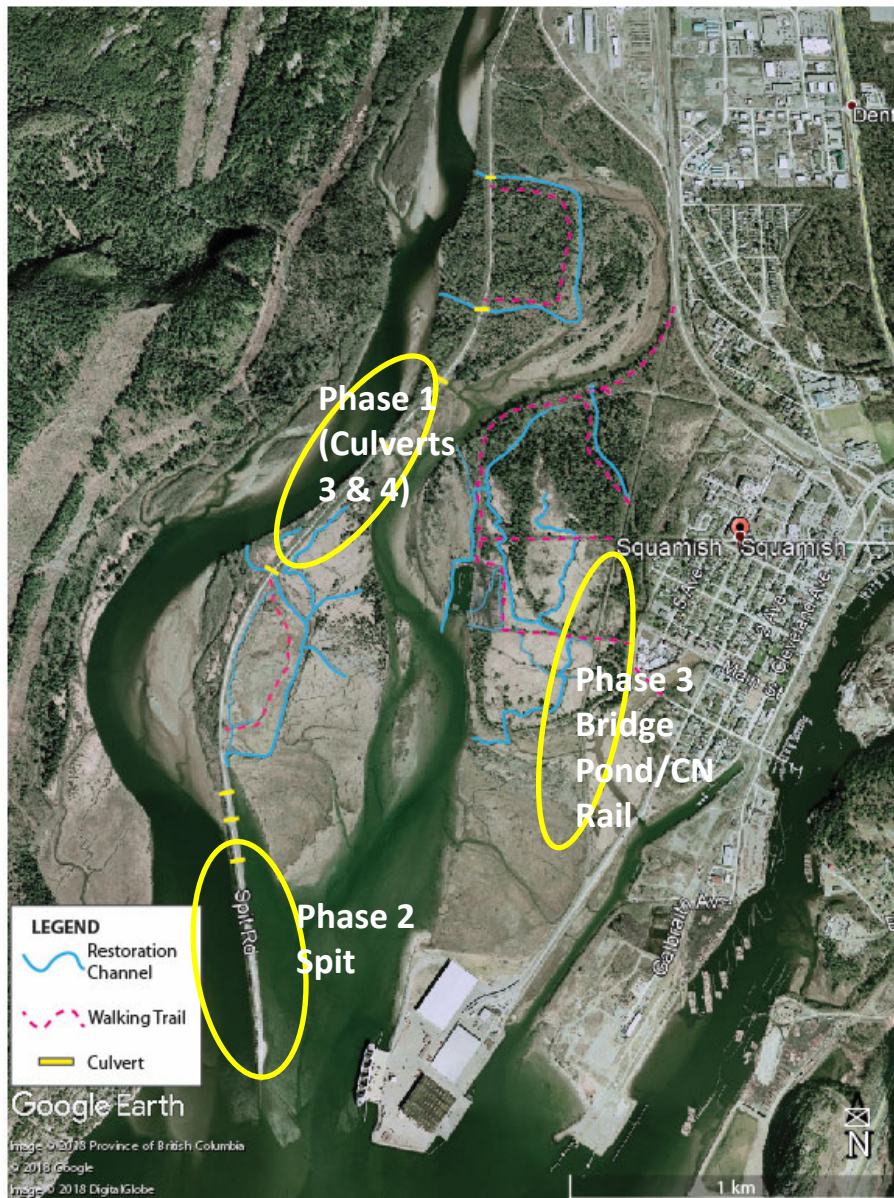


Figure 1: Central Estuary Restoration Project Phases

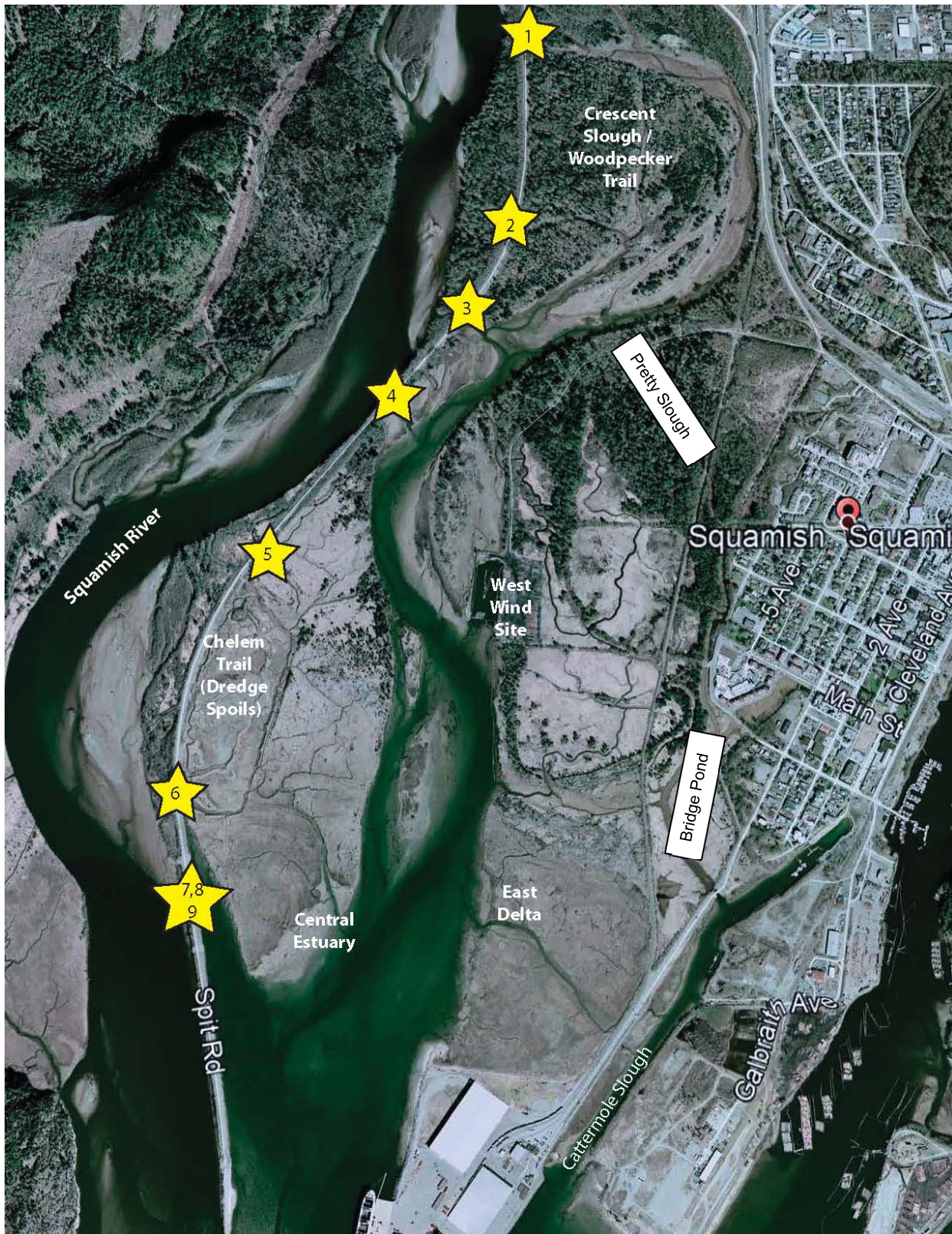


Figure 2: Location map of culvert crossings (1 to 9 in yellow stars) Squamish estuary

1.3 Alignment with Cheakamus River Watershed Action Plan

The CERP project is consistent with the main priority areas identified in the Cheakamus River Watershed Action Plan (FWCP 2017) including:

- CMS.RLR.HB.14.05: high priority item to implement habitat restoration in the Squamish estuary.
- CMS.RLR.HB.17.01: high priority to conduct restoration activities in the Squamish estuary to benefit Chinook salmon and other salmonids.
- CMS.RLR.HB.18.01: high priority to improve fish passage between the Squamish River and the Central Estuary across the Training Berm.

Key factors the CERP project addresses are:

- I.* Restore access to estuary for juvenile salmonids, focus on providing rearing habitat for Chinook salmon. Estuary channels provide excellent rearing habitat for Chinook fry. Over 95% of the juvenile Chinook salmon captured migrating out of the Cheakamus River were first year fry (Lingard et al., 2018b). These Chinook fry require a period of residency in estuarine waters during their first spring prior to entry into saltwater. The Squamish River estuary and its tidal channels provide this critical Chinook salmon rearing habitat for the Cheakamus River Chinook salmon populations. Without adequate connections between the Squamish River and the estuary delta, fish passage is severely limited, and studies have indicated the habitat is underutilized (Lingard 2018).
- II.* The loss of fundamental estuarine flow processes where fresh water moves in diverse patterns and mixes with marine waters is another factor that is addressed in all three phases of the project.
- III.* Another limiting factor addressed is the potential to improve the growth and survival of Chinook salmon fry. A large component of the Chinook salmon fry produced from spawning grounds on the Cheakamus River leave the river soon after emergence and rear and feed in the mainstem Squamish River and the estuary channels for some months prior to their migration into Howe Sound. By improving Cheakamus River Chinook fry and smolt access to and use of the warm, nutrient rich waters of the Squamish River estuary their overall productivity and survival would be expected to increase (Mangusson and Hillborn 2003).
- IV.* Incidental benefits are also expected for other species of interest including steelhead and cutthroat trout, and pink, coho and chum salmon. As well, bull trout and coho salmon from the Cheakamus River watershed may spend varying periods of time in the Squamish River estuary during their life cycle. Herring and other marine species will also benefit from this project.

1.4 Project Urgency

The importance to restore fish passage between the Squamish River and the central estuary cannot be overstated. This project is recognized as being of high importance to Squamish Nation, the Provincial government, and Federal Fisheries who all recognize that coastal Chinook salmon populations are in decline and that access to the estuary is critical for their survival. Chinook salmon are recognized for their importance as a source of food and cultural significance to Squamish Nation, a source of revenue for sports and recreation fishing enthusiasts, and as a vital link to the health of the south coast resident Killer Whale (SRKW) populations. In addition, Chinook salmon are considered to be of cultural and ecological importance in British Columbia and of federal conservation concern (COSEWIC 2019). There is also a need to restore access between the Squamish River and the central estuary to all life stages of salmonids as it is not fully understood how the Training Berm has impacted the overall ecosystem of the watershed and health of the salmon populations. What is known is that following the construction of the Training Berm in the early 1970s many stocks, including pink salmon and Chinook salmon runs all but plummeted, as illustrated in Figure 3 below (SDU, 2021).

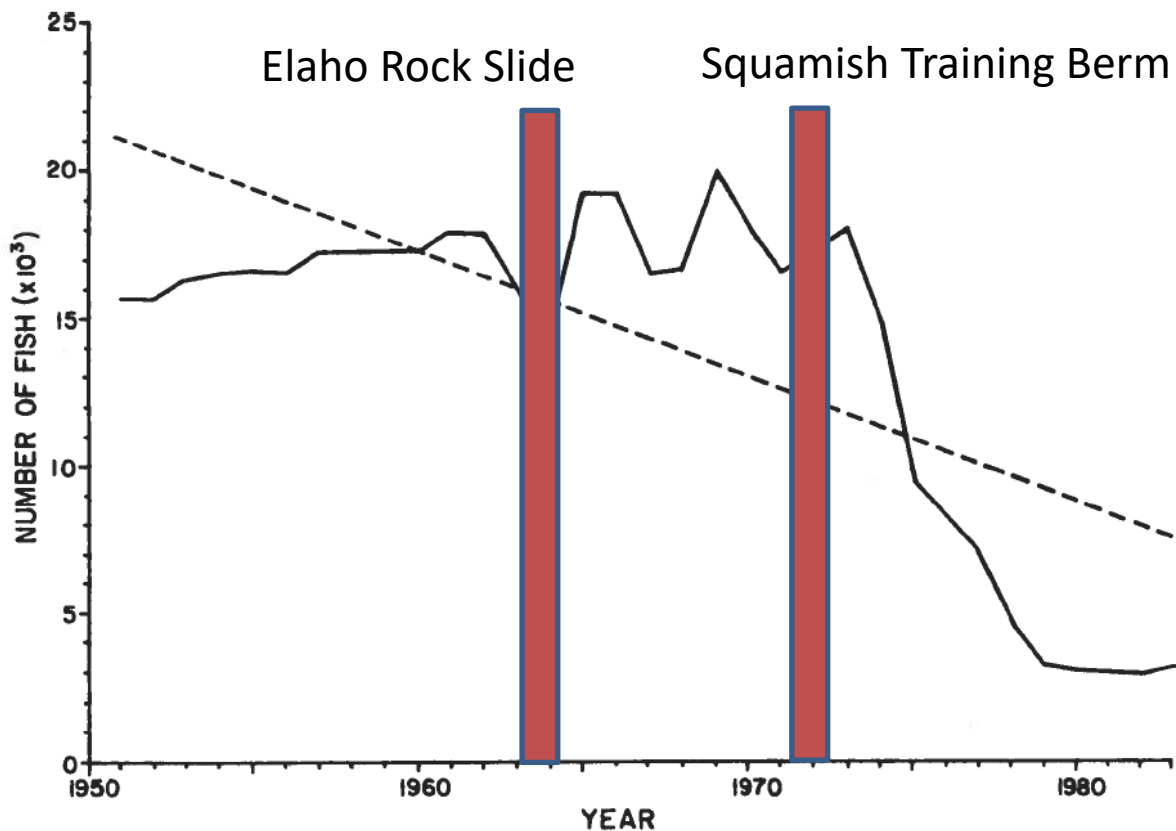


Figure 3 Graph of Chinook Salmon collapse (graph taken from Salmon Data Unit – New Salmon Escapement Database System)

1.5 Benefit to Salmon

The focus of the CERP multi-year project is to improve Chinook salmon (*Oncorhynchus tshawytscha*) populations and overall health. However, the project will also benefit coho salmon (*O. kisutch*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), steelhead (*O. mykiss*), as well as other salmonids, char, herring, and marine habitat in general.

2.0 Goals and Objectives

The focus of this project was to modify the lower section of the Training Berm, referred to as the Spit, to restore fish accessibility between the Squamish River and the estuary for outmigrating salmonids, in particular Chinook salmon. Many steps were necessary to achieve this goal which included undertaking a series of engineering design, models, and simulations. Furthermore, fisheries and biophysical monitoring played an important role in establishing base-line data by which the success of the restoration activities will be determined.

Table 1. Summary of Project Phases & Monitoring Programs

Goal	Objective	Details	Date Achieved
Fisheries & Biophysical Monitoring	Establish baseline data followed by consistent monitoring design following physical works associated with Phases 1, 2, and 3	Fisheries monitoring using various techniques including PIT tags, acoustic tags, Gee trapping & seine netting at various locations in the Squamish River and Estuary. Biophysical monitoring for water quality, sediment transport, vegetation colonization at various locations in the Squamish River and estuary	2018 2019 2020 2021 2022 (update provided in this reporting year) 2023 – 2024 (wrap up and summary of overall effectiveness of restoration activities)
Phase 1: improve fish accessibility across Training Berm	Replace fish passage obstructing culverts across Squamish Training Berm	Culvert replacement at Location #3	May 2019
		Culvert replacement at Location #4	September 2020
		Additional culvert replacements (Locations #1 & #2)	For the future once the DOS installs the downtown flood control diking

Phase 2: modification of lower Spit to reopen lower 300 hectares of habitat	Modification of Spit	Wave modelling	June 2020
		Spit Modification modelling	March 2021
		Meetings & consultation	2018 - present
		Construction	February 1 – May 15, 2022: partial 300m removal; September 15, 2022 – May 15, 2023 for removal of remaining 550m
Phase 3: Bridge Pond re-watering	Install a flow control structure across the CN Spur line to provide controlled flows into the Bridge Pond	Fisheries monitoring & Biophysical monitoring	Summer 2018, 2019, 2020, 2021
		Design & Approval	On hold until the DOS upgrades the Third Avenue flood dike

3.0 Study Area

The Squamish Training Berm is a 5 km structure that extends from the confluence of the Mamquam River downstream to Howe Sound and confines the Squamish River to its western bank. The focus of this phase of the project was to modify the lower 300m of the Spit (Figure 4).



Figure 4 Phase 2 Partial Opening

4.0 Methods

The methodology for the removal/modification of the lower 300m of the Training Berm structure included leaving the southern tip as a stand-alone island, now referred to as Spit Island. In advance of any work the soil was sampled to determine composition and ensure the material was clean and suitable for removing off-site. Soil physical and chemical

characterization was undertaken over two dates, on March 23, 2021 and June 4, 2021 by WSP (WSP, April and July 2021).

Once the soil characterization had been completed the next stage was to secure all the permits and authorizations, which were all obtained by January 27, 2022. The next stage was to confirm where the material would be removed to and the Squamish Oceanfront, having reviewed the soil characterization reports, determined the upper soil/gravel material would be of use to their development site. As well, the underlying layer of armour / rip rap rock was transported to the Cheekye gravel pit for use by Squamish Nation on dike stabilization and other future projects.

Construction activities commenced January 28, 2022 and most of the work was undertaken during the low-tide periods of the day to excavate the berm down to the -1 CGVD28 (Canadian Geodetic Vertical Datum) elevation and methodically place large (1m+) armour rock from the base at a slope of 1.5:1 to the top to ensure erosion protection along the northern edge of the Spit Island. Once the northern end of the Spit Island was completed (right side of Figure 4 illustration below) the berm material was then excavated down to the -1 CGVD28 elevation for 300m and the new temporary revetment at the new southern end of the Berm was armoured to prevent erosion until the next phase of the project commences in the fall (left side of Figure 5 illustration below).

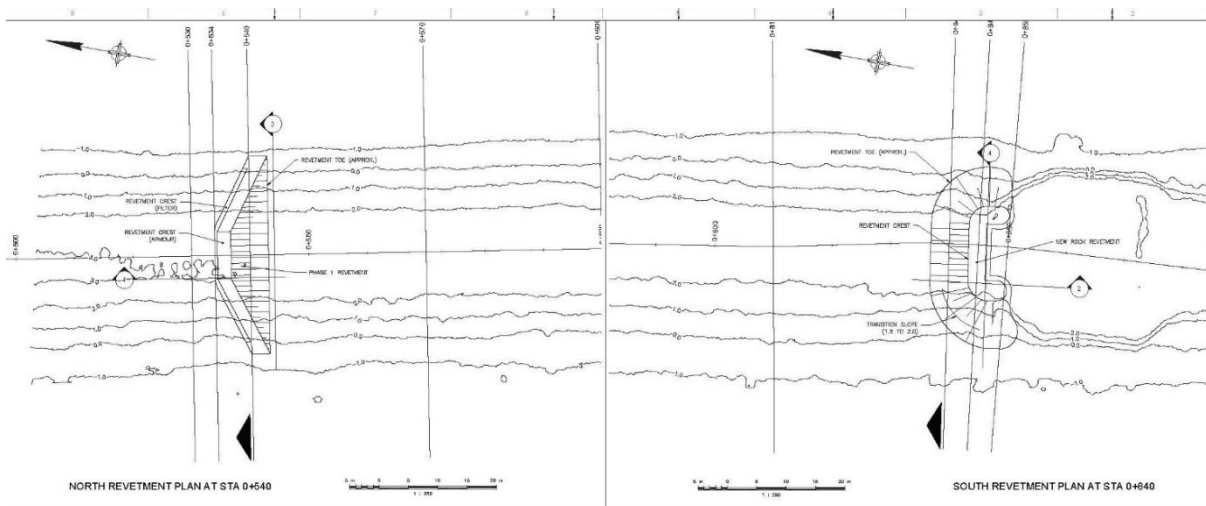


Figure 5 Plan view of 300m Berm Modification

Due to the complexity of working during the low tide periods, which often coincided with late night hours, safety lights were set up at the work site. Furthermore, safety precautions were undertaken by the excavator and truck operators who ensured the machinery was equipped with vegetable hydraulics and that an emergency spill kit was on the site at all times.

Once work commenced the large armour rock and aggregate were stockpiled at an appropriate location off-site (to the north of the work site). The first 10 days were spent in stabilizing the new north end of what was to become “Spit Island” through the placement of large armour rock to provide stabilization for the future. The rock was underlain by geotextile fabric to secure it in place. This was followed by the excavation of the berm, peeling back the upper 3m – 4m soil / gravel surface material along with the lower armour / rip rap material. The soil / gravel material was stockpiled at an approved location further north along the Berm and transported to the Squamish Oceanfront lands and the armour rock was stockpiled and then transported to the Squamish Nation Cheekye gravel pit. Two excavators operated at the southern end of the project to safely excavate the site and load material onto rock trucks. The rock trucks moved the site to the off-site location to stockpile for removal off-site during the subsequent day with a tandem dump-truck.

Due to the project not getting underway until February, a concern about potential herring spawning during the work window arose. As it turned out, the safety lights did, in fact, attract a very small herring spawn during the construction period so all excavation was halted until the herring eggs hatched. This resulted in a delay of a few weeks. Physical works were completed by May 15, 2022.

4.1 Construction and Environmental Monitoring:

In preparation of the construction an environmental and management plan was completed (SRWS, November 2021). This document laid out the communications protocol, the responsibilities of the Environmental Monitor, along with the construction schedule and operations plan. Fisheries and Oceans Canada staff provided the Environmental Monitor and the Squamish River Watershed Society, assisted by DFO and WSP, provided construction supervision and oversight.

Other than the need to shut down during the herring spawning period, no outstanding issues occurred, and the project proceeded as planned.

As well, a post-construction and monitoring plan was prepared in partnership between SRWS and DFO to outline the protocol by which the site would be monitored immediately following construction in order to observe any potential changes to the movement of sedimentation or large woody debris (SRWS, December 2021). This monitoring program included the various site surveys to be conducted following construction including physical site survey (with the use of a total station) along with Lidar overflight and sonar depth soundings for a bathymetric survey. These surveys will be repeated on the site following the spring freshet period to determine if there was any change to the structure or the inner estuary.

4.2 Fisheries Monitoring

Fisheries monitoring was once again undertaken under the guidance and leadership of Stephanie Lingard who is also completing a MSc thesis with the UBC Pacific Salmon Ecology and Conservation Laboratory on this work and project. The fisheries technical team was provided by InStream Fisheries Research and the excerpt below was taken from the draft final report prepared by Stephanie Lingard “Central Estuary Fisheries Monitoring Program Summary; 2020 – 2021” (March 2022):

The 2021 CERP fisheries monitoring program was successfully implemented and found the new culvert to function at passing juvenile Chinook salmon. Box culvert usage increased to 10% from the 2% estimated in 2020, and 3 out of 4 fish passing through culverts used the newly installed box culvert at “Culvert 4”. However, the proportion of the total sample entering the estuary only increased by 4% compared to 2020. It could be that ~30% of juveniles are all that survive the downriver migration to enter the estuary, or it could be that many fish are migrating on the other side of the river and are unable to find the estuary. Continued monitoring of the new breach will be helpful to resolve some of this uncertainty as there are plans to test receivers in the Squamish River and Howe Sound to try and gather some data from fish that do not enter the estuary.

The acoustic telemetry data indicates juvenile Chinook salmon are migrating into the estuary day and night, suggesting tide conditions play a role in cueing movement. Chinook salmon appear to be moving into the estuary when the tide is over 2.0 m either during the day or at night. This pattern may occur because the culverts and the channels near the terminus of the spit are not passable or attractive at lower tides. The new breach in the berm will slow water at mouth of the river and will potentially allow juvenile salmon to hold and explore the environment in search of the estuary more than is possible now.

Total Chinook salmon captures in the estuary between February and September were low (n= 282) compared to Chum and Coho salmon. Low catches of Chinook salmon in the estuary further support the results of the acoustic telemetry program that indicate most fish are not entering the estuary. The lower encounter rates may also indicate that the population continues to be severely depressed. It is difficult to disentangle confounding factors in the catch results from the fishing program because little monitoring of salmon populations has been conducted in the watershed in the past three decades.

Coho salmon were the most abundant species in the estuary and are present over the greatest period compared to other salmonids. The oligohaline environment of the Squamish Estuary may favor the sub-yearling Coho salmon life-history compared to other watersheds

with more saline estuaries. It is unknown whether these fish spend the winter in the estuary, migrate to sea, or move up into the watershed. (Lingard, 2022)

4.3 Biophysical Monitoring

Biophysical monitoring was once more undertaken under the oversight of Lake Trail Environmental Consulting. The summary below was taken from the document “Central Estuary Monitoring Program: Interim Report for Biophysical Monitoring of the Squamish Estuary” prepared by Lake Trail Environmental, March 13, 2022:

The 2021 Central Estuary Monitoring Program Interim Report provides interim results of the biophysical restoration monitoring component and recommendations on further monitoring and data analysis that will contribute to evaluation of the effectiveness of restoration objectives. Baseline biophysical information for the years 2018 to 2020 is presented. Previous CERP interim biophysical monitoring reports include those by McAuley & Togado (2019) and Tryon & Togado (2020).

Biophysical monitoring involved establishing several permanent stations along the length of the Central Estuary for data collection. These permanent stations provide opportunities for repeated measures of water quality, water levels, vegetation transects, soils, sediment and channel morphology measures. A large data component involves automatic loggers that collect water level, temperature and conductivity. Elevation surveys provide vertical changes in water level, sediment, and estuarine marsh, mudflat and tidal channel habitats. Water profile sampling in the river and the estuary provide information on the location of the salinity wedge in the river and oxygen concentrations in the estuary. Vegetation surveys provide baseline information for comparison to future post-restoration conditions. Soil sampling measured organic carbon content and soil compaction in two areas of the estuary. Photo-point monitoring ensures a visual record of changes at different locations in the estuary.

Preliminary analysis of baseline information revealed the following key items of interest:

- *Improved water temperatures for Chinook salmon migration were found in 2020 near the Culvert 3 upgrade project location compared with 2019 temperatures measured prior to the culvert upgrade*
- *The Culvert 3 culvert upgrade also coincided with the largest recorded accretion of sediment near the culvert compared to baseline measurements and other sediment stations in the estuary. There were also large changes in channel morphology at the Culvert 3 outlet tidal channel.*
- *Soil carbon and bulk densities indicated a low organic carbon concentrations and relatively high compaction, likely due to sediment deposition from the river.*

- *Opportunities to assess the effects of the current (2022) and future berm removal were identified; these include monitoring the lower Estuary site for an increased duration in the spring/summer low-salinity regime during the Chinook salmon migration period and changes in channel morphology.*

Opportunities to increase robustness of a Before/After design approach to assessment are also considered and include the use of historical as well as baseline data for comparison and the use of a reference site. (Tryon, 2022)

4.4 Engagement with the Public, Stakeholders, and Community

Ongoing meetings and discussion throughout the year have been undertaken to update the project team, including Squamish Nation, Fisheries and Oceans Canada, the Province of BC, District of Squamish, Squamish Terminals, and Transport Canada on the work completed to date and the plans for the next stage of the project to remove the remaining 550m planned for January 2023.

5.0 Results and Outcomes

As previously reported in last year's report (COA-F22-F-3475) several initial studies, simulations, and memos were completed to summarize the movement of sedimentation, large woody debris, and determine the long-term monitoring program to determine the effectiveness of the project. The project was undertaken in a two staged approach with an initial 300m opening completed in 2022 (January to April) and the next 550m modification planned for 2023 (January to May)

Summary of reports and studies completed in advance of the project construction:

- Squamish Training Berm Realignment – Wave Impact Assessment (SNC Lavalin, February 26, 2020)
- Squamish Training Berm Removal – Phase 2 (SNC Lavalin, February 11, 2021)
- Assessment of Change of River Outflow Patterns on Vessel Manoeuvrability (Lantec Marine, October 12, 2021)
- Central Estuary Restoration Plan Stage 1: 300m Spit Deactivation Construction and Environmental Management Plan. (SRWS, November 4, 2021)
- Assessment of Sediment Risk (following CERP) (SNC Lavalin, November 23, 2021)
- Potential Changes to Large Woody Debris Prevalence in the Lower Squamish River Estuary following the Central Estuary Restoration Project (WSP, November 24, 2021)
- Central Estuary Restoration Plan Stage 1: 300m Spit Deactivation Post-Construction and Monitoring Plan. (SRWS, December 15, 2021)

- Squamish River Central Estuary Restoration Project Training Wall Removal Final Engineering Design for 300m partial removal (WSP, December 13, 2021)
- Central Estuary Monitoring Program: Interim Report for Biophysical Monitoring of the Squamish Estuary. (Lake Trail, March 13, 2022)
- Central Estuary Fisheries Monitoring Program Summary 2020 – 2021 Funding Year. (S. Lingard and InStream Fisheries, March 3, 2022)
- Post-construction pre-freshet survey of 300m opening. Completed May 2022 WSP
- Post-freshet survey of 300m opening. Completed October 5, 2022 WSP
- Engineering design of next stage of 550m opening
- Application for authorizations: Transport Canada Navigable Waters Act, Provincial Water Sustainability Act, Provincial Wildlife Act.

Summary of Permits and Approvals for 300m opening:

- November 9, 2021: Motion in Council from District of Squamish in support of the partial restoration
- December 10, 2021: Approval under Canadian Navigable Waters Act
- January 19, 2022: Section 4(4) B.C. Wildlife Act Authorization to conduct construction works within the Skwelwil'em Squamish Estuary Wildlife Management Area
- January 24, 2022: Water Sustainability Act, Section 11(1) Change Approval In and About a Stream Authorization
- January 28, 2022: District of Squamish Noise Exemption Permit

6.0 Discussion

The Central Estuary Restoration Project is an ambitious project that involved years of development and the direction and leadership of a strong project team consisting of the Squamish River Watershed Society, Squamish Nation, and Fisheries and Oceans Canada.

A summary of the previous years' accomplishments can be found in reports COA-F19-F-2603 (May 2019), COA-F20-3067 (June 2020), and COA-F21-F-3308 (March 2021) that resulted in the replacement of two undersized culverts with fish friendly 3m x 3m concrete box culverts as part of Phase 1. The past two fiscal years focused on the a partial modification of the 850m resulting in initial removal of 300m of the Spit. The challenges for moving this phase of the project forward were not insubstantial. The main concerns around this phase of the project were regarding potential impacts to the operations of the west berth of the Squamish Terminals. Furthermore, the wind sport recreation user group, spearheaded by the Squamish Windsports Society (SWS), was concerned about the loss of vehicular access to the south end of the Spit which has been a launch site for their sport.

Over the course of the two years numerous meetings were held with the respective groups and organizations. As well, numerous studies, including the wave modelling, spit removal modelling, navigation simulation, sedimentation transport, and woody debris transport were all undertaken to help inform the decision-making process. These studies helped to establish that the Spit provided no flood protection, was minimal in creating or protecting against sedimentation accumulation or movement and had very little impact on the movement of woody debris between the river and central estuary (the movement of woody debris was determined to predominantly be the result of in-flow wind activity, not river flows).

In order to address the restricted access to the southern end of the Spit the District of Squamish and Squamish Nation created a sub-committee to meet and discuss with wind sport recreation users short-term and long-term solutions. The SRWS provided support to these discussions by making the engineering team with WSP available to answer any specific questions the SWS had regarding the restoration activities and potential access of Spit Island for their usage. As well, the District of Squamish engaged the services of their community planner consultant, Sandra Bicego, to facilitate discussion with the SWS.

This project has been developed in partnership with Fisheries and Oceans Canada and Squamish Nation and is of importance to improve the overall health of Chinook salmon stocks and restore the estuary to previous pre-development conditions. Support has also been recognized from the local sports fish advisory board, recreational fishing groups, Ministry of Forests, Lands, and Natural Resource Operations, and other community stewards. The results of the restoration efforts to restore Chinook salmon access to the estuary is an important program for the Salish Sea. Closer to home it allows Squamish Nation's ability to harvest local salmonids, as well as provide educational programming. The project allows for engagement with local universities, technical institutes, and local schools in hands-on experiential learning opportunities including tree planting, mapping, monitoring, and the development of long-term post-graduate research studies. In addition to allowing community and student engagement, the SRWS has been able to sponsor a University of British Columbia Master's student to study Chinook salmon behaviour associated with the restoration efforts. Students from School District #48 regularly participate in special events, programs, and activities directly associated to this project including studying wildlife and fish movement, planting native riparian vegetation, undertaking tree and bird surveys, and learning about the natural habitat and environment (for more on these programs check our website: <https://www.squamishwatershed.com/outreach-program.html>).

7.0 Recommendations

The work undertaken over the past two fiscal years was to allow the partial 300m opening of the Training Berm and the next steps will be to secure the permits and approvals to remove the remaining 550m of the Berm for this fall for the full 850m opening. The next steps include

extensive monitoring and surveying of the excavated portion of the structure to track any changes in sedimentation, movement of large woody debris, or changes in biophysical habitat. Further fisheries monitoring will help to determine the effectiveness of these restoration efforts to restoring Chinook salmon stocks and allow juvenile salmon to enter into the estuary as they are leaving the Squamish River.

The engagement from the stakeholders and the community have been an important measure of the success of the project and is reflective the interest this project has on the community from the spectrum of industry, recreation, and being part of First Nations reconciliation.

8.0 Acknowledgement

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- WSP Team: Jordan Matthieu, Kevin Henshaw, and Justin Murray
- SNC Lavalin Team: Gabriela Maciel-Jobb, Nora Asadollahi, and John Readshaw
- Stephanie Lingard, MITACS Masters student
- Lora Tryon, Lake Trail Environmental Consulting
- InStream Fisheries

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- As well, special thank you to retired DFO biologists Dave Nanson and Matt Foy

9.0 Photo Log



January 28, 2022. Construction commences



January 31, 2022. No construction during high tide. Note placement of geofabric beneath newly placed armour rock



February 3, 2022. Armour placement at north end of Spit Island completed. Facing south.



February 6, 2022. Excavation of Berm underway. Facing south towards "Spit Island".



February 8, 2022. Work continues. Facing south towards “Spit Island”.



February 10, 2022. High tide. Facing south towards “Spit Island”.

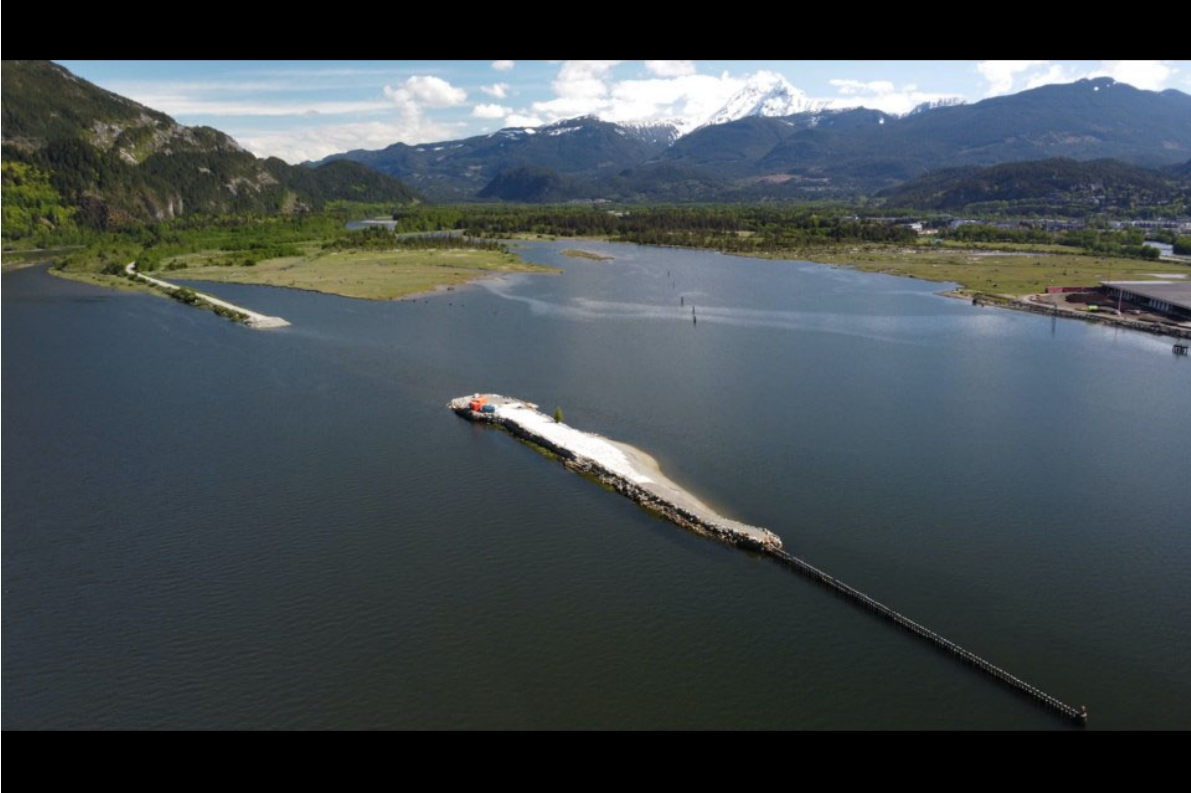


March 9, 2022. Facing south towards "Spit Island"



August 9, 2022. View from Sea to Sky Gondola.

Aerial photos May 23, 2022 (courtesy J Buchanan)



Aerial photo July 15, 2022 during freshet (courtesy of J. Buchanan)



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