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Chemainus River Emergency Sediment Removal

Construction Completion Report

Final Report
February 1, 2023
KWL Project No. 3427.021

Prepared for:
BC Ministry of Environment and Climate Change



Ministry of
Environment and
Climate Change Strategy



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Executive Summary

Accumulation of sediment and debris on the left bank point bar and side channel of the Chemainus River downstream of the Trans-Canada Highway Bridge has reduced river capacity and increased the potential for bank erosion on the right bank and a partial avulsion of the mainstem channel into relic side channels on the right bank floodplain. Due to gravel sources upstream and the highly erodible material on the right bank, the incremental risk to river capacity was considered high such that emergency sediment removal was recommended.

Sediment deposits were removed from two locations on the Chemainus River, one point bar along the natural mainstem channel south of the Trans-Canada Highway Bridge and the other located along the dry side channel on the left bank floodplain of the Chemainus River. In addition, several hazard trees on the right bank of the Chemainus River were topped and delimbed to reduce wind loading and potential for windfall into the river resulting in disturbance to root systems and the river bank material.

The majority of the work was completed by Stone Pacific Contracting from November 8 to 24, 2022. Approximately 2,960 m³ of sediment was removed from the point bar and side channel and hauled to seven locations offsite within Halalt First Nation (Halalt 2), Penelakut First Nation (Tsussie 6) and District of North Cowichan lands where gravel material was desired for various flood protection measures. The total construction cost was \$137,666.95 (excluding GST) and was completed under the contract value.

Recommendations for further assessment at this site and other short term flood mitigation measures are included along with completion of long term wholistic solutions as part of the Chemainus River Integrated Watershed Management Plan.



1. Introduction

PricewaterhouseCoopers (PwC) is working with the Ministry of Environment and Climate Change Strategy (MECCS) to assess and address the impacts of sediment introduced during the 2021 atmospheric river (AR) event. Recent funding by the Province of British Columbia (BC) was approved to help remove deposited sediment in the waterways of the Chemainus River. Kerr Wood Leidal Associates Ltd. (KWL) has been retained by MECCS through PwC to manage the removal of sediment from high impact areas.

The scope of the works includes sediment removal at the following locations as shown in Figure 1-1:

- Removal of gravel accumulated at the point bar on the left bank of the Chemainus River mainstem channel, as well as re-sloping the riverbank.
- Removal of sediment accumulated in the dry side channel located on the left bank floodplain.

In addition, topping and delimbing of several hazard trees on the right bank of the mainstem channel of the Chemainus river to reduce potential for windfall into the river resulting in disturbance to root systems and the river bank material was also completed.

1.1 Background

The Chemainus River is a salmon-bearing stream found on the east coast of Vancouver Island with its estuary located approximately 10 km north of the City of Duncan. The watershed has an area of approximately 360 km² and the mainstem of the river is approximately 64 km long (Wightman et al. 1998).

Two extreme rainfall events on February 1, 2020, and on November 15, 2021, resulted in the second highest (500 m³/s) and third highest (468 m³/s) daily peak flows on record for the Chemainus River since 1953 (Chemainus River near Westholm WSC 08HA001). The highest peak daily flow record, 537 m³/s, was recorded on February 11, 1983. It should be noted that during high flow events, overbank flow occurs into the floodplain upstream of the 08HA001 hydrometric gauge and as such the gauge under reports the total flow coming into the upstream end of the Chemainus River floodplain upstream of Highway 1. Further details on the flow split upstream is discussed by Northwest Hydraulic Consultants in the Chemainus River Floodplain Mapping Program Part 1, Appendix B – Hydrology, May 2022.

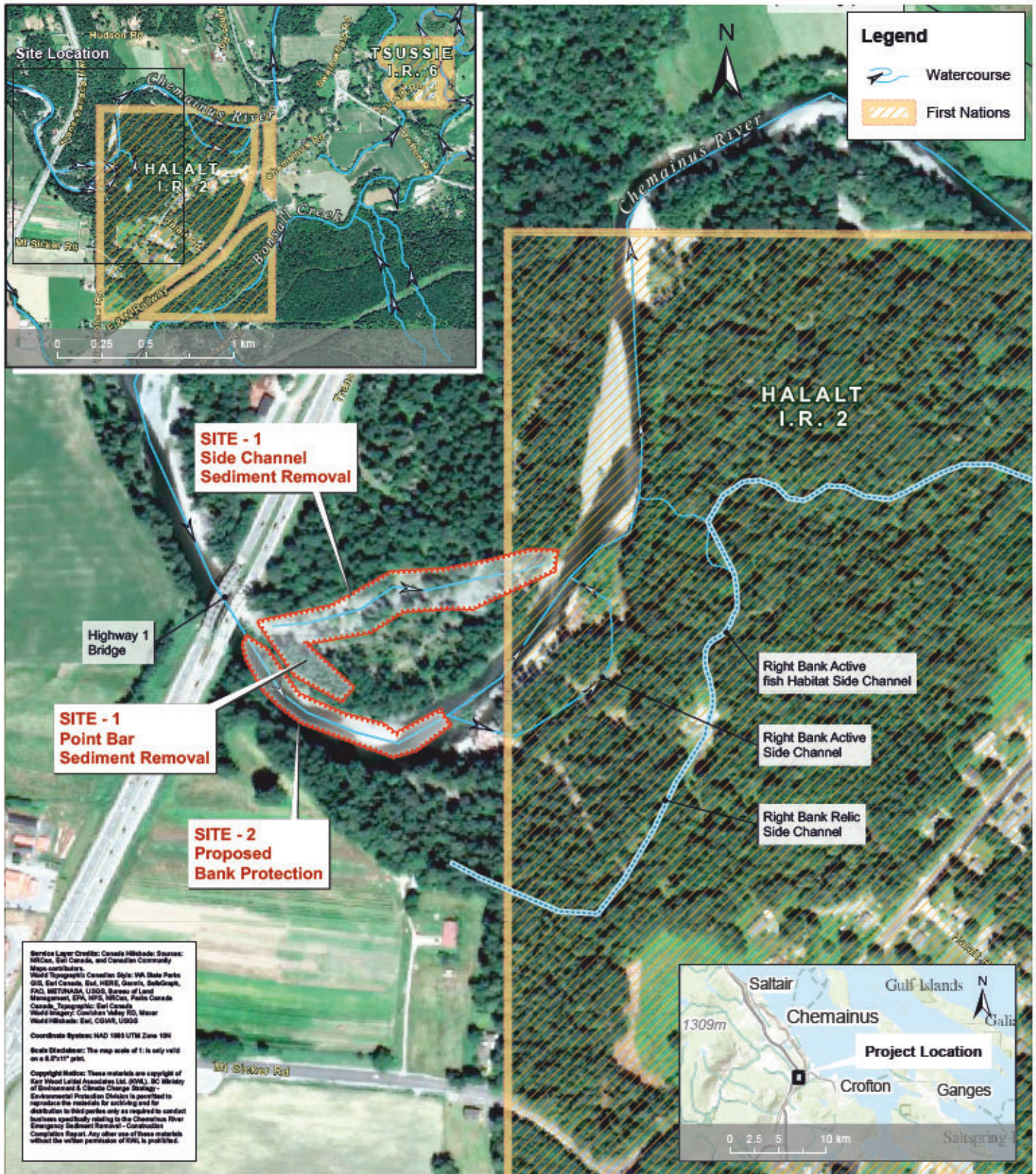
As a result of these extreme rainfall events, Halalt First Nation, Penelakut First Nation (Tsussie) and surrounding land within the District of North Cowichan experienced flooding as the Chemainus River overtopped its banks.

A preliminary site assessment was performed by KWL on September 7, 2022 and is included as Appendix A. The field reconnaissance of the Chemainus River focused on the channel between the Trans-Canada Highway (TCH) Bridge and the Chemainus River bridge as well as additional areas of flooding concern within Halalt IR2 and surrounding areas in the District of North Cowichan.

The site assessment was also attended by Chief Thomas and Joe Seward of Halalt First Nation; Derek Masselink, Cody Anderson, and Amanda Swift of Emergency Management BC (EMBC); Cheri Ayers of BioAyers Consultants; and Kalena Chang of Price Waterhouse Coopers (PwC).

The preliminary risk assessment was carried out considering the incremental change in risk to public health and safety, river channel capacity, environment, and infrastructure because of accumulation of sediment and debris from the November 2021 flood.

**BC Ministry of Environment & Climate Change Strategy -
Environmental Protection Division**
Chemainus River Emergency Sediment Removal - Construction Completion Report



Project No. 3427.021

Date February 2023

Scale 1:5,000

0 50 100 200 m

**Chemainus River Emergency
Sediment Removal - Site Location**

Figure 1-1



During the site visit four primary areas of concern for sediment and debris accumulation introduced by the November 2021 flood event along the Chemainus River between the TCH Bridge and Chemainus Road were identified (as shown in Appendix A – Figure 1):

- Site 1 – Left bank point bar and dry side channels downstream of TCH Bridge.
- Site 2 – Right bank erosion downstream of TCH 1 Bridge.
- Site 3 – Right bank side channels downstream of TCH Bridge.
- Site 4 – Gravel bar between the E&N Railway Bridge (Black Bridge) and Chemainus River Bridge.

Of these four sites, Site 1 was determined as high priority for sediment removal in fall 2022 and Site 2 was identified as a priority for design and construction in 2023. Two sediment deposition areas at Site 1 were identified as emergency work which include the main channel left bank point bar and the Chemainus River side channel. These two Site 1 areas as well as Site 2 are shown in **Figure 1-1** and described below.

The assessment of flood risks was beyond the scope of the preliminary site assessment due to the complex nature of overland flooding across the Chemainus River floodplain near the Halalt FN community. Mitigating long term flood risks within the Chemainus River floodplain requires an integrated approach involving strategies across the floodplain and is the focus of the Lower Chemainus River Integrated Flood Management Plan (IFMP) which is being led by the Cowichan Valley Regional District in partnership with Halalt FN, the District of North Cowichan and the local community with technical consulting support from Northwest Hydraulic Consultants (NHC). The IFMP is intended to provide long term actions to address flooding as well as on going debris and sediment accumulation along the lower Chemainus River and Bonsall Creek. The IFMP process is currently underway, and the partners are currently developing long term flood and sediment/debris management options to evaluate. In addition, Indigenous Services Canada (ISC) is also carrying out a separate coastal flood risk assessment which considers flood risks along the Chemainus River.

Therefore, the focus of this emergency sediment removal work is to create more channel capacity and provide some immediate relief during the next few high flow events. The sediment removal will also provide an opportunity to assess the rate of sediment and debris accumulation in this reach of Chemainus River, which will inform future long term sediment management measures to reduce bank erosion and channel avulsion and the resulting risk to communities in the floodplain.

1.2 Location

The project location is the mainstem of the Chemainus River between Trans-Canada Highway (TCH) Bridge and the Chemainus River Bridge. Over time, sediment has accumulated at a point bar and in a dry side channel of the left bank of the river downstream of the TCH Bridge, resulting in increased erosion on the right bank of the channel and reduced channel capacity. The point bar consists of gravel/cobble material, while the side channel consists of mixed cobble, finer gravel, and sand.

Table 1-1: Project Site Information

Site ID	S-CM-1
Site Description	Chemainus River @ HWY1 near Halalt IR 2
Location	UTM Zone 10 U N 5,435,217 m, E 489,484 m
Local Government Agency	Halalt First Nation, District of North Cowichan
Waterbody	Chemainus River



1.3 Scope

The main objective of this emergency sediment removal project was to remove an estimated volume 300 m³ of gravel and sediment from the point bar and an estimated volume of 2,700 m³ from the dry side channel on the Chemainus River left bank downstream of the TCH Bridge.

1.4 Project Team

The KWL project team includes:

- Craig Sutherland, MSc., P.Eng., Senior Water Resources Engineer/Qualified Professional
- Stephen Bridger, P.Eng., Senior Civil Engineer/Project Manager/Contract Administrator
- Dave Murray, P.Eng., Senior Technical Specialist
- Liam Mackle, P.Eng., Water Resources Engineer
- Andrea Kerr, EIT, Junior Civil Engineer

KWL gratefully acknowledges the assistance and input of the following individuals, particularly the following:

Halalt First Nation

- Chief James Thomas
- Caroline Gladstone, Director
- Tony George Sr., Archaeological Monitor

District of North Cowichan

- David Conway, P.Eng., Director Engineering Projects

PwC

- Mike Wise, P.Eng., Project Manager
- Fred Bjork
- David McKenna
- Kalena Chang

Contractors – Stone Pacific Contracting

- Greg Stone, Project Manager/Superintendent
- Thomas Smith, Foreman/Operator
- Mike Greenwood, Operator
- John Haynes, Operator
- Curtis Butler, Labourer, First Aid
- Jerry Janik, Surveyor

Subcontractors

- Cheri Ayers, BioAyers Consulting, Environmental Consultant to Halalt First Nation
- Cowichan Engineering Services
- Jamie Godfrey and Jeremiah Bain, Current Environmental, Environmental Monitors
- AEL/EMCON Traffic Control
- Onsite Tree Services

2. Design

2.1 Site Conditions

The works took place on two parcels of land adjacent to Halalt IR 2 that the Chemainus River flows through downstream of the TCH Bridge. Prior to commencing the work, Land Access agreements were sent to DNC, Russell Farms, and Halalt IR 2 to gain access to the site locations. Further details on these agreements are covered in Section 3 of this report.

Table 2-1: Land Ownership of Project Locations

District of North Cowichan (municipal)	PID 017-760-933 Plan Number VIP 54048 Lot 1
Private Land owned by Russell Farms (private)	PID 004-023-838 Plan Number VIP 9254 REM Lot A

Air photo review in the Geomorphic Atlas indicates that the point bar and side channel area has become more vegetated since 1975 (see Figure 2-1) indicating the bar is becoming more stable and at higher elevation over time.



Figure 2-1: Changes in Vegetation Cover on Point Bar Downstream of Highway 1 Bridge
(Source: NHC, 2022)

Accumulation of sediment on the point bar and within the side channel on the left bank concentrates flow in the Chemainus River mainstem channel along the opposite right bank which tends to increase potential for erosion of the right bank. Some of the trees growing on the point bar have eroded and were partially spanning the channel in the 2021 photo.

Well heads for the District of North Cowichan (DNC) water supply system are located adjacent to the side channel and are protected by riprap (Photos 1 and 2). The elevation of the riprap beneath the newly constructed channel is roughly 7.2m (above CGVD28 Datum), and the elevation of the bottom of the channel at this location is roughly 7.9m. A test pit was dug at the downstream well head to confirm the location of the riprap. Additional riprap armouring was determined as unnecessary based on the test pit and the record drawings for the well head protection provided by DNC.



Photo 1: DNC Water Supply Well Head Protected by Riprap Adjacent to Side Channel



Photo 2: DNC Water Supply Well Head Protected by Riprap Adjacent to Side Channel

2.2 Chemainus River Design Objective

Site 1 – Sediment Removal – Left Bank Point Bar and Side Channels D/S of TCH Bridge

Site 1 consists of a gravel/cobble point bar on the mainstem and a relic side channel consisting of finer gravel and sand. Over time, sediment has built up in the side channel such that the elevation is about 1 to 2 m higher than the mainstem channel elevation and is only activated during high flow events. Photos 3 and 4 below show the point bar and side channel.



Photo 3: Gravel Accumulation at U/S End of Point Bar on Right Bank of Chemainus River



Photo 4: Sediment Accumulated Inside Channel on Right Bank of Chemainus River
Note TCH Bridge in background



Due to the urgent nature of the work to reduce the potential for flooding and erosion of Halalt IR2 and the surrounding areas under the District of North Cowichan jurisdiction, the project was pursued in fall prior to the onset of high river flows. The gravel removal was focused on the side channel excavation and the point bar at Site 1 so the work could be performed outside of the wetted channel under dry conditions.

2.3 Design Details

The project timeline did not allow for the development of typical engineering design drawings. In such case, a design sketch (as shown in Figure 2-2) was prepared showing the desired sediment removal areas and typical channel cross-sections that was to be confirmed in the field with topographic survey prior to beginning any excavation works.

The design sketch was prepared on October 20, 2022 and included sufficient detail to support the review by Halalt FN and District of North Cowichan staff as well as the regulatory review for permitting and approvals. The design sketch was also used to determine the approximate level of effort for construction purposed and provide information for contract procurement.

A critical component of the design was to determine the elevations for the sediment removal depth to ensure the side channel would function as intended. Several of the key requirements were as follows:

- Ensure the upstream elevation of the side channel was at least 0.3 m to 0.5 m below the top bank elevation of the right bank of the mainstem of the Chemainus River and above the baseflow flow level in the main channel such that the side channel is only engaged during high flows.
- Ensure the side channel has positive grade to enable it to drain out after the river mainstem water recedes.
- Construct the side channel with an approximate base width of 4 m and 3H:1V side slopes using existing materials.
- Maintain a minimum setback from the North Cowichan municipal water supply well heads and the existing rip rap protection.
- Ensure the point bar sediment removal was at least 0.3 m above the wetted area of the channel mainstem.
- Maintain existing trees and vegetation where possible to reduce the overall impact of the works.

In addition to the side channel and point bar sediment removal the works also included topping and delimbing of several hazard trees on the right bank of the river. This was recommended to reduce wind loading and potential for windfall into the river resulting in disturbance to root systems and the riverbank material.

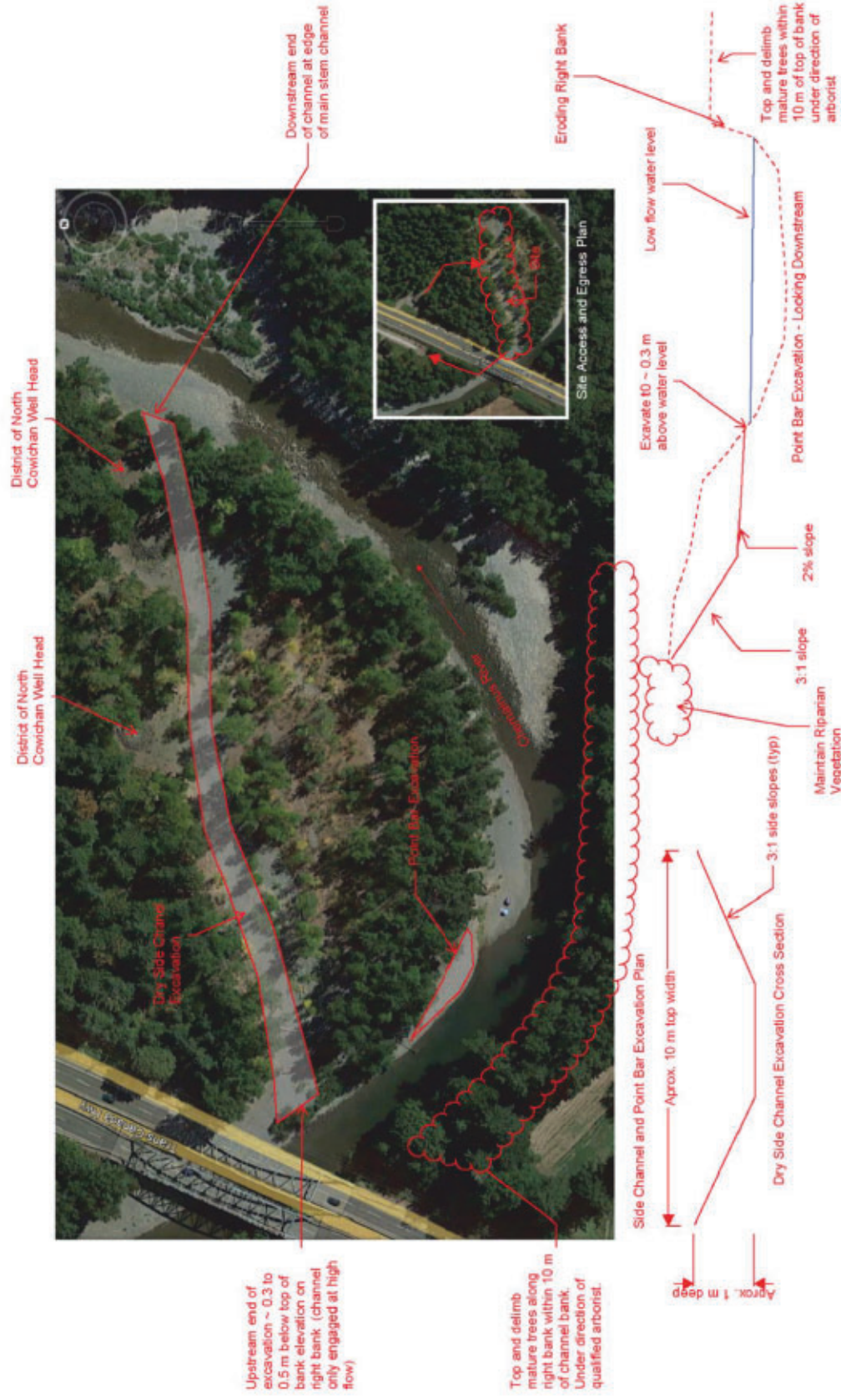


Figure 2-2: Chemainus River Sediment and Debris Removal (October 20, 2022)



3. Permitting and Approvals

The sediment removal at the side channel and point bar involved works in and around a stream and as such required permits and approvals prior to commencing works. The work was determined to be low risk even though it was performed outside of the least-risk work window.

An Environmental Management Plan (EMP) was developed for project that set out the requirements and measures to avoid, minimize, and mitigate any potential adverse environmental impacts. The EMP provided overarching guidance for how environmental considerations were implemented and monitored during the construction phase of the Project. A copy of the EMP is attached in Appendix B.

3.1 Water Sustainability Act – Change Approval

As all institutional projects are not subject to the Riparian Areas Protection Regulation (RAPR), an RAPR assessment was not required for the Project. Work within a regulatory riparian setback cannot be avoided as the sediment to be removed was within the stream bed. This Project was submitted to the Ministry of Forest (Water Sustainability Act Change Approval for Works In and About a Stream) for review. The Ministry of Forests issued a WSA Change Approval on November 2, 2022, (file: 2009983) for this emergency works Project and a copy is attached in Appendix C.

The Ministry of Environment and Climate Change Strategy was authorized to make changes in and about a stream as follows:

- Site Isolation: Excavation of a siltation pit and construction of cobble/gravel berms for the purposes of side channel isolation.
- Side Channel Excavation: Removal of 3,000-5,000 cubic meters of cobble, gravel, and sediment material.
- Point Bar Excavation: Removal and/or re-contouring of the cobble/gravel point bar located between the side channel and the mainstem of the Chemainus River.
- Tree Topping: Delimbing and topping of undermined trees along the right bank that are at high-risk of toppling into the river. Tree work must be overseen by a qualified arborist.

3.2 Fisheries Act - Request for Review

A Request for Review was not submitted to Fisheries and Oceans Canada (DFO) for this project as it was determined that the project can avoid prohibited effects to fish and fish habitats and species at risk by not working within the wetted river channel. It is understood from DFO that work can be completed without a review if construction works “can be designed to avoid prohibited effects on fish and/or fish habitat or species at risk, their habitat or residences”. KWL worked closely with Current Environmental to monitor construction works to mitigate risk to aquatic species and habitats.

3.3 Species at Risk Act

A Species at Risk Act permit was not required as no critical habitat for listed species is found on site.



3.4 Land Access

Halalt First Nation, Russell Farms, and the District of North Cowichan were contacted to provide consent for the Ministry of Environment and Climate Change Strategy to access their land for the purpose of completing Works In and About a Stream for the Chemainus River Emergency Sediment Removal project. Consent was provided for both site access and to complete the works as shown in Appendix D.

3.5 MoTI

Stone Pacific hired AEL Traffic Control to complete a works permit and the required traffic management plan for access and egress from the construction site onto Highway 1. The approved works permit from Ministry of Transportation and Infrastructure (MoTI) is attached in Appendix E.

3.6 First Nation Consultation

KWL met with Chief Thomas and Joe Seward of Halalt First Nation, on September 7, 2022 during the initial field reconnaissance of the Chemainus River. During this meeting the initial concepts for the sediment removal works were discussed and further input was received from Halalt First Nation in the subsequent Task Force Meetings facilitated by PwC. Halalt First Nation confirmed that they supported the project and understood the urgency in removing the sediment from the two locations, as per the attached letter in Appendix F dated October 19, 2022.



4. Construction

Halalt First Nation Chief and consultants contacted four contractors to discuss the proposed works, their capabilities and availability. The contractors included:

- EMCON
- Stone Pacific
- HG Excavating
- Matt T Excavating

Stone Pacific was recommended as the most suited for the work as they have a large fleet of equipment such that they can accommodate the short notice and urgency of the works.

District of North Cowichan have previously worked with Stone Pacific on other projects and were confident in their ability to address sensitivity instream, works. Stone Pacific provided a quote on September 21, 2022 of \$158,585.99 (exclusive of GST), met the technical requirements for the project, and was awarded the construction contract. The CCDC4 contract and the supporting construction documents are found in Appendix G.

4.1 Construction Team

Stone Pacific

The construction team was led by Greg Stone of Stone Pacific as the Project Manager along with the Site Superintendent Thomas Smith and equipment operators and laborers. AEL provided traffic control services as a sub-contractor. Onsite Tree Services provided qualified arborist, tree topping and removal services as a sub-contractor.

KWL

KWL provided the technical support for the emergency works at Site 1. Stephen Bridger served as the Project Manager and Contract Administrator, Liam Mackle and Andrea Kerr completed the field inspections, and Craig Sutherland is the Qualified Professional/Engineer of Record for the works. KWL was responsible for performing site inspections and Contract Administration duties.

KWL Subconsultants

Current Environmental was retained to perform full-time environmental monitoring on site and be the qualified environmental professional.

Cowichan Engineering Services was retained to perform pre and post construction topographic surveying as well as assist with estimating the volume of sediment removed.

Archeological monitoring services were provided by Tony George Sr of Halalt First Nation.

4.2 Construction Methodology

Site Access

Access to the site was off the Trans-Canada Highway and at the District of North Cowichan Chemainus Pumphouse waterworks station. The access route is used by the District of North Cowichan and Halalt First Nation. There are two access roads at the pumphouse, one provides access to two well heads owned and operated by the District, and the other provides access to the side channel.

The existing access road to the channel required some additional material to improve access for dump trucks, as well as reduce the amount of mud and dirt carried offsite during trucking. Stone Pacific supplied approximately 24 m³ of road base material (150 mm minus) to improve the access road for the purpose of trucking material offsite. Upon completion of the works, North Cowichan provided approval for the additional road base to remain in place and did not require the access road to be reinstated as it served pre-construction. The access to the site it is shown in Figure 4-1.

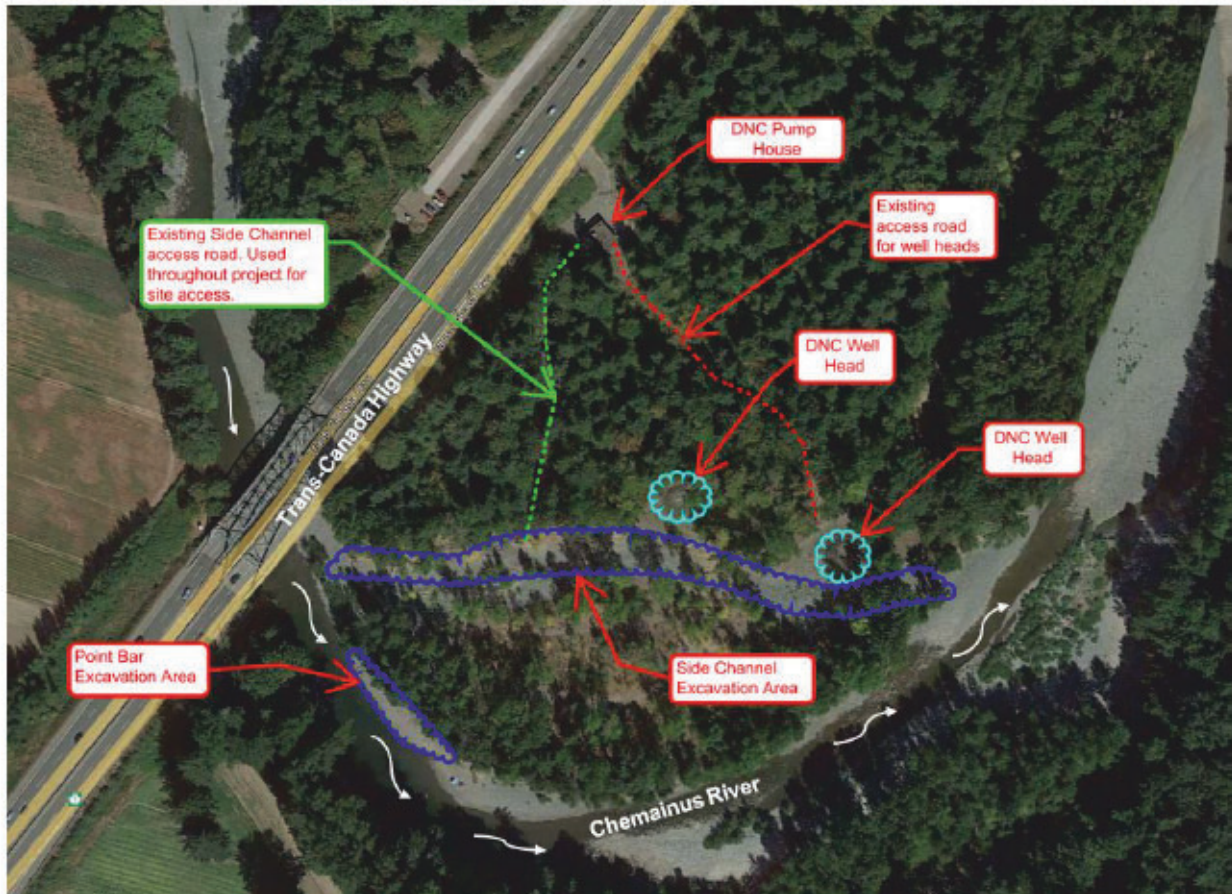


Figure 4-1: Site Access

Side Channel Excavation

An estimated 2,700 cubic meters of material was proposed to be excavated from the dry side channel. The excavation depth ranged from 0.4 m to 2 m. The channel excavation was designed with a 3:1 slope resulting in a top width of 10 m and a bottom width of 4 m. To maintain the 3:1 design slope throughout the channel was constructed with a varying top width such that some areas of the excavated channel resulted in a top width of approximately 20 m.

Benchmarks along the alignment were established starting at the upstream end of the excavated channel. The centerline and side slope offsets were marked out at each station along the alignment. A berm was left at the downstream end of the channel to act as a barrier from the river and for sediment management during construction. In the event of heavy rainfall or a rise in water level the downstream



berm was in place as a safety measure to help prevent premature flooding of the channel during the works. The excavation followed the existing channel morphology and where possible avoided the removal of riparian vegetation and mature trees. Some existing scour holes adjacent to tree along the side channel were infilled as directed by Environmental Monitor to reduce potential for fish stranding. Material excavated from the channel was hauled off site to various location in Halalt IR 2 and the surrounding District of North Cowichan areas where this type of fill material could either be used immediately or stockpiled for future use.

Point Bar Removal

The point bar at Site 1 was removed by excavating material from the waters edge back to the existing bank. The excavation maintained a vertical distance of at least 300 to 450 mm from the river water level. The slope of the bank was tailored to the surrounding area. Further construction activities at the point bar included removal of a small cottonwood tree that had fallen into the mainstem of the channel. After consideration from KWL and Current Environmental, it was determined that the fallen tree should be removed to prevent log jams in the narrow section of the river. The root ball remained intact on the side of the bank as a potential future fish habitat. The material excavated from this area was hauled away without any tree removal or expansion of the corridor between the side channel and the mainstem. The material removed from the point bar was hauled off site to the adjacent private property owned by Russell Farms.

Tree Topping and Delimbing

Tree topping and removal was identified as part of the emergency works at Site 1. During construction, eight trees were identified as hazard trees and flagged for topping. The trees marked for topping were significantly undermined and at risk of falling in the river and potentially causing a debris blockage and/or further bank erosion. The objective was to reduce windthrow of the trees which could have significant impacts to erosion on the already at-risk right bank of the river. The trees were topped by a qualified arborist from Onsite Tree Service. Seven of the eight marked trees were topped, as well as one additional cottonwood tree which was topped as a safety measure for the arborists. The tops of trees and limbs were left of site as dead down wood.

Site Clean Up

Once the excavation was complete at the side channel, it was left in as natural a state as possible. The berm at the downstream end of the channel was removed and graded as part of the channel outlet. The access road was tidied up by Stone Pacific prior to their demobilization. During their demobilization from the site Stone Pacific cleaned up the staging area located at the DNC pumphouse. A water control curb that directs storm water into a catch basin that was in poor condition prior to the works was further damaged during trucking. The curb was subsequently replaced under a change order with Stone Pacific at the request of DNC.

4.3 Schedule and Sequence

Table 4-1 shows the construction schedule for the project with works beginning at the point bar and side channel simultaneously. Once the sediment was removed at the point bar, Stone Pacific focused their efforts to bulk excavating and grading of the side channel. A total of two days were spent excavating the point bar while eight days were spent excavating the side channel.



Table 4-1: Construction Schedule

Work Component	Nov 7	Nov 8	Nov 9	Nov 10	Nov 11	Nov 14	Nov 15	Nov 16	Nov 17	Nov 18	Nov 21	Nov 24
Construction Activities												
Pre-Construction Meeting												
Stone Pacific Mobilization												
Point Bar Excavation												
Channel Excavation												
Quality Assurance												
Demobilization												
Tree Delimbing and Topping												

4.4 Construction Quantities

The initial estimate for the quantity of sediment to be removed was based on engineering judgement and validated by the pre-construction survey information. Sediment quantities were also estimated using the typical design cross section (as per Figure 2-2) applied to the length of channel to obtain a volume. The volume estimates are summarized in Table 4-2 below and includes a comparison with the actual quantities removed based on the pre and post construction survey information.

Table 4-2: Sediment Removal Quantities

Sediment Location ID	Pre-Construction Volume Estimate (m³)	Post Construction Volume Removed (m³)
Point Bar	300	108
Side Channel	2,700	2,850
Total Volume Removed (m³)		2,958

During construction the sediment removal progress at the point bar and the side channel was estimated using the number of truck loads hauled off site per day. It was assumed that each truck had a carrying capacity of 7.5 m³ based on conversations with Stone Pacific and the maximum payload for the trucks in use. Material at both the point bar and side channel was hauled off site to multiple sites in the surrounding area. provides the estimated sediment volume deposited at each site.



Table 4-3: Trucking Volumes and Deposition Locations

Sediment Location ID	2587 Mt. Sicker Road	Tsussie Road	7893 Westholme Road	8129 Chemainus Road	8228 Chemainus Road	Chemainus Cemetery	7971 Chemainus Road
Jurisdiction	DNC	Tsussie 6	Halalt 2	Halalt 2	Halalt 2	Halalt 2	Halalt 2
Point Bar (m³)	142.5	-	-	-	-	-	-
Side Channel (m³)	-	645	30	780	120	765	495

A comparison of the estimated sediment removal volume can be made using the number of trucks that hauled material offsite and the post-construction survey is presented in Table 4-4. As shown below, the relative difference in volume estimate methods is very low at 0.7%.

Table 4-4: Sediment Removal Volume Comparison

Sediment Location ID	Number of Trucks	Volume Estimate (m³) Using 7.5 m³ per Truck	Estimated Volume from Pre and Post Construction Survey (m³)
Point Bar	19	142.5	108
Side Channel	378	2,835	2,850
Total Volume Removed (m³)		2,977.5	2,958
% Difference in Estimated Excavation Volume			0.7%

4.5 Environmental Monitoring

Environmental monitoring was conducted by Current Environmental as the Qualified Environmental Professional onsite. Responsibilities of the environmental monitor included, but were not limited to, the following:

- Inspect all mitigation measures and erosion and sediment control measures to ensure they are appropriate and working properly and recommend modifications and repairs when necessary.
- Have written authority to halt any construction activity if it is deemed necessary to protect fish, wildlife, and their habitat.
- Identify, monitor, and promptly report any situations of ongoing or potential damage to the environment.
- Ensure the EMP was implemented by the Contractor for the duration of the construction phase of the project.

A summary of the work completed for the project is provided in Appendix H.

4.6 Engineering Field Inspection

A field inspector was on site every day during construction. A summary is presented below in Table 4-5.



Table 4-5: Inspection Summary

Date	Field Inspector	Summary of Construction Works
2022-11-07	N/A	Pre-construction kickoff meeting.
2022-11-08	N/A	Stone Pacific mobilized to site.
2022-11-09	Liam Mackle	- Excavation began at Point Bar. Most of point bar material was removed by the end of day. Some further clean up required. - Center line of channel surveyed and staked out - Channel excavation began at downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction. - Approximately 120 m³ excavated from point bar and 98 m³ excavated from the downstream end of the channel.
2022-11-10	Andrea Kerr	- Stone Pacific trucked in 4 loads of clean road base material that was placed along the access road to provide better traction for trucks and reduce mud transfer offsite and onto HWY 1. - Channel excavation continued from the downstream end. Rough material removal continued past the first well head. Grading at end of channel started. - Approximately 22.5 m³ of material removed from Point Bar and 645 m³ of material removed from the downstream end of the channel. - Point Bar excavation complete with roughly 300 mm clearance from the water level at the river. - Representatives from District of North Cowichan and Cowichan Engineering Services visit site.
2022-11-11	Liam Mackle	- Channel excavation continued from the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction. - Some issues at the unloading area – trucks got stuck and caused some early delays that resolved through the day. - Discussions on grading around well head, and potential placement of riprap. - Approximately 500 m³ of material removed from the Channel.
2022-11-14	Andrea Kerr	- Channel grading continued at the at the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction. - Excavation started at upstream end. - Some over-excavation found when grading downstream end. Material filled from channel side. - Approximately 443 m³ of material removed from the Channel.



Date	Field Inspector	Summary of Construction Works
2022-11-15	Liam Mackle	- Channel was initially cut at a consistent top width of 10 m; the contractor was instructed to have a varying top width with consistent 3:1 side slope. This was marked out at the downstream end and additional side slope excavation began. - Small groups of trees were measured and marked for removal along the right bank of the channel to accommodate the full channel width excavation. This was discussed and approved by the Environmental Monitor. - As-builts were received for the well heads indicating that the riprap extends further and lower than expected, and additional riprap armouring is likely not needed. - Approximately 533 m³ of material removed from the Channel.
2022-11-16	Andrea Kerr	- Site work was delayed for a short period due to safety concerns from dense fog and traffic control at HWY 1 that resulted in trucks not being able to safely enter or exit the site for approximately 15 minutes. - Channel excavation continued and is within the last ~50 m of the haul road before completion. - Additional material removed downstream at the instruction of KWL the day before. Slope re-checked and will need a small amount of material removed to achieve 3:1 slope as desired. - Small groups of trees were removed to achieve desired 3:1 slope. - Approximately 510 m³ of material removed from the Channel.
2022-11-17	Liam Mackle	- Channel excavation was effectively completed, the fill at the downstream end was removed, most of the downstream reach has been shaped to 3:1 side slope or shallower. - The overbank areas with low spots were filled and shaped into a flood terrace to prevent fish stranding at the request of the Environmental Monitors. - No more trucking of material offsite, the remaining material removed as part of final grading and shaping will be left on site. - Approximately 338 m³ of material removed from the Channel. - Trees were flagged for topping on the right bank, planned to happen next week.



Date	Field Inspector	Summary of Construction Works
2022-11-18	Andrea Kerr Craig Sutherland	- No traffic control in place. Not needed as there were no trucks hauling material. - Final grading of channel bed to 0.4% slope. - Grade checked along entire alignment. - Channel side slopes tidied up. - Road touched up and smoothed by operator. - All signs and stakes removed. - Stone Pacific to tidy up pump house yard during demob. - Asphalt water control curb to be reinstated at pump house. <u>Final QP Inspection by Craig Sutherland</u> - Final channel grading and control was underway while on-site. - Reviewed conditions of access road, point bar gravel removal area, dry side channel gravel removal area, and mainstem channel downstream of work site.
2022-11-21	N/A	Stone Pacific demobilized from site.
2022-11-24	Andrea Kerr	- Inspected Stone Pacific's demobilization from the District of North Cowichan pump house. - Tree topping started with the topping of an unmarked cottonwood tree. Arborist explained it was a potential safety issue and could interfere with topping of marked trees. This was approved by KWL. - One tree that was marked was not topped because it had already been topped in the past. - Some trees were fallen leaving taller stumps, this was again due to climber safety. The trees were too tightly grouped too safely top. - One additional cottonwood was broken during falling. It became hung up on another tree. This was a safety concern for all parties. Greg and Martin discussed options on how to safely fall this tree as it could not be left as is. - France the property owner was contacted to discuss the issue. She gave permission to fall additional cottonwoods if necessary. - This option was not preferable as it would require lengthy clean up. The trees would have to fall in her field and would require clean up crews from both Onsite and Stone Pacific. - Arborist Martin Bilina assessed the situation further and decided he could safely fall it using a "fence-post" method combined with rope rigged to a vehicle to pull the tree away from the base/ground. - The tree was successfully and safely removed.

Detailed field reports with photos can be found in Appendix I.



4.7 Site Completion

Point Bar

Stone Pacific completed the sediment removal at the Chemainus River point bar on November 11, 2022. Demobilization from the point bar was not necessary as the two sites are connected. Once the work at the point bar was completed, operators focused their efforts on the excavation of the side channel.

Chemainus River Side Channel

Stone Pacific completed the sediment removal from Chemainus River side channel on November 18, 2022 and demobilized from the site on November 21, 2022.

Tree Topping and Delimbing

Tree topping and delimbing was completed by Onsite Tree Services, a sub contractor for Stone Pacific Ltd., on November 24, 2022.

The record drawings for the project are included in Appendix J.

4.8 Operations and Maintenance

Regular monitoring of sediment and debris at known locations of accumulation at Site 1 on the Chemainus River is recommended to reduce risk to important transportation links and maintain channel conveyance.

An additional topographic survey of the side channel and point bar areas should be completed in the spring or early summer months to enable an approximation of the sediment accumulation over the winter months.



7. Closure and Recommendations

Sediment removal at the Chemainus River side channel and point bar just downstream of the TCH Bridge was completed prior to the rainfall season. Approximately 2,850 m³ of sediment was removed at the side channel and 108 m³ at the point bar by Stone Pacific Contracting. The sediment was removed and deposited at seven locations within Halalt IR2, Tsussie IR6 and District of North Cowichan where material was desired for flood protection means.

There is significant potential that additional sediment will get deposited in the Chemainus River at this location during future rainfall events, such that an ongoing monitoring is needed to review the effectiveness of the project works.

In addition, the following recommendations should be considered for the Chemainus River watershed:

- Further temporary flood mitigation works could be implemented to reduce flood risks in the Halalt FN community while long term solutions are planned, designed and permitted.
- As part of the ongoing Lower Chemainus River Integrated Flood Management Plan process, flood improvement and sediment/debris management options should be identified and tested using the available hydraulic model.
- A Chemainus River Watershed Management Plan process should be implemented with Halalt and Penelakut First Nations, local government (CVRD and DNC), private forestry landowners (Mosaic) and other private landowners along the Chemainus River with support of senior governments. The goal would be to develop a community led plan which can provide guidance on management of watershed scale processes which impact sediment, flood, and debris risks in the lower watershed. The planning process should at a minimum address the sediment, debris and flood risk concerns but may also include broader and related concerns such as drought flows, ground water, etc.



8. Report Submission

Prepared by:

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Reviewed by:



EGBC Permit to Practice:
1000696
2023-02-01

Craig Sutherland, P.Eng.
Technical Review



Statement of Limitations

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This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

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Revision History

Revision #	Date	Status	Revision	Author
0	February 1, 2023	FINAL		ACK
A	January 20, 2023	DRAFT	Draft report for internal review	ACK



KERR WOOD LEIDAL
consulting engineers

Appendix A

Technical Memorandum Preliminary Site Assessment of Potential Area of Concern



Technical Memorandum

DATE: October 20, 2022

TO: Mike Wise, Fred Bjork, Kalena Chang
Price Waterhouse Coopers

FROM: Craig Sutherland, M.Sc., P.Eng.

CC: Derek Masselink, EMBC

RE: PRELIMINARY SITE ASSESSMENT OF POTENTIAL AREA OF CONCERN
Site S-CR-1 Chemainus River, Halalt First Nation
Our File 3427.014-300

1. Introduction

The purpose of this high level and preliminary assessment of identified Area of Concern is to allow the Province of BC to review and consider risks, potential consequences, and to prioritize urgent repair and mitigation measures to existing damaged waterway systems, including removal of sediments, introduced by the 2021 Atmospheric River Event (ARE).

The assessment, as summarized in this memorandum for the noted Area of Concern, follows the following general methodology and approach:

1. High level senior engineering experience and judgement, review of available relevant reference information, site visits and visual inspections, and communication with relevant stakeholders.
2. Risk assessment.
3. Identification and advice on prioritized and appropriate mitigation measures (if any), their required timing, and further work required to validate such advice.

Table 1: Site Information

Site ID	S-CM-1
Site Description	Chemainus River @ Halalt IR 2
Location	UTM Zone 10 U N 5,435,217 m, E 489,484 m
Local Government Agency	Halalt First Nation, District of North Cowichan
Waterbody	Chemainus River



2. Background

2.1 Scope of Assessment

The focus of this high level and preliminary assessment is on review of sediment and debris accumulation in the Chemainus River between Highway 1 Bridge and Chemainus Road Bridge as a result of the November 2021. The focus of this assessment is on potential impact on channel erosion and channel avulsion risk in the Halalt First Nation (Halalt FN) community located within Halalt IR 2 and the neighbouring properties within the District of North Cowichan.

In addition to sediment and debris accumulation locations in the Chemainus River, other locations of flooding concerns within Halalt IR 2 and Penelakut FN communities (Tsussie IR 6) were observed in the field and documented here as a record.

Assessment of flood risks is beyond the scope of this preliminary assessment due to the complex nature of overland flooding across the Chemainus River floodplain near the Halalt FN community. Mitigating long term flood risks within the Chemainus River floodplain will require an integrated approach involving strategies across the floodplain beyond that which can be assessed within the scope of this preliminary assessment. Reducing of flood risk within the floodplain is the focus of the Lower Chemainus River Integrated Flood Management Plan (IFMP) which is being led by the Cowichan Valley Regional District in partnership with Halalt FN, the District of North Cowichan and the local community with technical consulting support from Northwest Hydraulic Consultants (NHC). The IFMP is intended to provide long term actions to address flooding as well as on going debris and sediment accumulation along the lower Chemainus River and Bonsall Creek. The IFMP process is currently underway, and the partners are currently developing long term flood and sediment/debris management options to evaluate. In addition, Indigenous Services Canada (ISC) is also carrying out a separate coastal flood risk assessment which considers flood risks along the Chemainus River.

Therefore, the focus of this preliminary assessment is to assess how sediment and debris accumulation in the Chemainus River from the November 2021 flood event could lead to bank erosion/channel avulsion and the risks associated with the communities on the floodplain and to develop short term actions to address any identified areas of concern.

2.2 Recent Flood Events

Two extreme rainfall events on February 1, 2020 and on November 15, 2021 resulted in the second highest (500 m³/s) and third highest (468 m³/s) daily peak flows on record for the Chemainus River since 1953. The highest peak daily flow record, 537 m³/s, was recorded on February 11, 1983.

Estimated Peak Instantaneous Flows in the Chemainus River for the February 2020 and November 2021 flood are approximately 950 m³/s and 850 m³/s, respectively. These estimates include a 30% increase to the peak instantaneous flow recorded at the Chemainus River near Westholm (08HA001) to account for overbank flow observed upstream of the gauge that is not recorded at the gauge.¹

As part of the recently completed Lower Chemainus Floodplain Mapping Project prepared by Northwest Hydraulic Consultants (NHC) for the Cowichan Valley Regional District (CVRD), a flood frequency analysis (FFA) was carried out using the peak flows recorded at the Chemainus River Bridge. The results of the FFA indicate that the February 2020 flood was between a 100-year return period (1% Annual Exceedance Probability) and 200-year year return period (0.5% Annual Exceedance Probability)

¹ Northwest Hydraulic Consultants, Chemainus River Flood Mapping Program Part 1 – Floodplain Mapping Report, Appendix B – Hydrology, Prepared for Cowichan Valley Regional District, May 2022.



event. The November 2021 was approximately a 50-year return period (2% annual exceedance probability) flood event.

It is difficult to distinguish what debris and sediment accumulation was the result of a particular flood event. However, the large flood event in February 2020 likely resulted in additional debris and sediment being carried and deposited in the river channel during the November 2021 flood event.

2.3 Geomorphological Context

The Chemainus River Geomorphic Atlas (Geomorphic Atlas) prepared by NHC for CVRD in May 2022 was reviewed to provide background on historical river processes and to provide context for this preliminary assessment. For consistency, reach numbering and references presented in this preliminary assessment are based on those presented in the Geomorphic Atlas.

The Geomorphic Atlas provides an overview of the watershed scale and reach scale geomorphic processes for the first seven reaches identified along the lower ~8 km of the Chemainus River. Only Reaches 3 to 5 are located within or adjacent to Halalt FN and are the focus of this assessment. However, an understanding of the geomorphic conditions and processes upstream and downstream is important in assessing sediment, debris, and erosion hazards within the study area.

For instance, the Geomorphic Atlas identified 17 log jams within the upstream reaches (Reach 6 and Reach 7), with 13 of the log jams and about 18,000 m² of surface area of unvegetated gravel bar located in the channel within Reach 6 which extends upstream of the Highway 1 bridge by about 1.4 km. The Geomorphic Atlas identified 13 log jams and about 17,000 m² of surface area of unvegetated gravel bar within Reach 5. This provides an indication of the potential upstream debris and sediment that could be mobilized in future events and could be deposited along the Chemainus River near the Halalt FN in the future.

The Geomorphic Atlas is based on field reconnaissance prior to the November 2021 event, therefore the amount of debris and gravel upstream likely would have changed and a new reconnaissance should be carried out to assess current conditions upstream. Assessment of debris and gravel deposits upstream could help identify areas where debris or gravel could be removed as a proactive measure to reduce future accumulation of debris within Halalt FN as well as providing additional conveyance upstream to limit potential for bank erosion and avulsion.

2.4 Site Visit

On September 7, 2022, Craig Sutherland, P.Eng. of Kerr Wood Leidal Associates Ltd. (KWL) carried out field reconnaissance of the Chemainus River channel between the Highway 1 Bridge and Chemainus River Bridge (named the Highway 1A Bridge in the Geomorphic Assessment) and areas where flooding is a concern on Halalt FN lands. The reconnaissance was also attended by Chief Thomas and Joe Seward of Halalt FN, Derek Masselink, Cody Anderson, and Amanda Swift of Emergency Management BC (EMBC), Cheri Ayers of BioAyers Consultants, and Kalena Chang of Price Waterhouse Coopers (PwC). Ms. Ayers and Ms. Chang had to leave early for other engagements and were only in attendance for the first half of the inspections at the upstream sites near the Highway 1 Bridge.

As shown in Figure 1, the site visit focused on four primary areas of sediment and debris accumulation introduced by the November 2021 flood event along the Chemainus River between Highway 1 and Chemainus Road:

Site 1 – Left bank point bar and side channels downstream of Highway 1 Bridge – Reach 5.

Site 2 – Right bank erosion downstream of Highway 1 Bridge – Reach 5.



Site 3 – Right bank side channels – Reach 5.

Site 4 – Gravel bar between the E&N Railway Bridge (locally known as the Black Bridge) and Chemainus River bridge – Reach 3.

The sites roughly align with sites identified in the Chemainus River Geomorphic Atlas. However, due to the proximity of Sites 1, 2, and 3 they are interrelated and will be assessed together. The naming of sites on the left and right bank follows standard naming conventions based on a viewer looking downstream along the channel.

Four additional sites where flooding is a concern were observed including:

Site A – Butcher Slough at Tsussie Road Bridge.

Site B – Butcher Slough at Swallowfield Road/Ducks Unlimited Access Road culverts.

Site C – Bonsall Creek at Tsussie Road.

Site D – Drainage relief culverts at E&N railway near Halalt FN community.

As these sites are not related to sediment and debris accumulation from the November 2021, they have not been evaluated. However, they are recorded here as a record on flood concerns in the area.

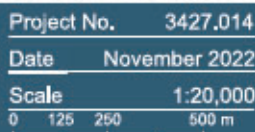


Figure 1



3. Land Ownership

Land ownership along the Chemainus River between the Highway 1 Bridge and the Chemainus Road Bridge includes Halalt IR 2, private property and property owned by the District of North Cowichan. Land ownership/jurisdiction of the additional sites A-D includes Halalt IR 2, Tsussie IR 6, and property owned/managed by Catalyst Paper and Ducks Unlimited Canada (See Table 2).

Table 2: Land Ownership/Jurisdictions

Site #	Site Description	Land Ownership/Jurisdiction
1	Chemainus River Left Bank Side Channel/Point Bar	District of North Cowichan
2	Chemainus River Right Bank Erosion	Private
3	Chemainus River Right Bank Side Channels	Private/Halalt I.R. 2
4	Chemainus River gravel bar E&N Railway/ Chemainus Road Bridge	Private
A	Butcher Slough at Tsussie Road Bridge	Tsussie I.R. 6
B	Butcher Slough at Swallowfield Access Road	Private (Catalyst Paper/Ducks Unlimited)
C	Bonsall Creek at Tsussie Road	Tsussie I.R. 6
D	E&N Railway Drainage Relief Culverts	Halalt I.R. 2

A map of the property and jurisdictional boundaries is shown in Figure 2.

Transportation infrastructure in the area is also owned and maintained by various jurisdictions including:

- Highway 1 Bridge & Highway 1 Island Highway – Ministry of Transportation and Infrastructure (MoTI)
- E&N Railway Bridge – Island Corridor Foundation/Southern Railway of Vancouver Island
- Chemainus River Bridge and Chemainus Road (north of Crofton Road) – District of North Cowichan
- Mt Sicker Road (west of Highway 1)/Chemainus Road (within Halalt FN 2)/Crofton Road – MoTI

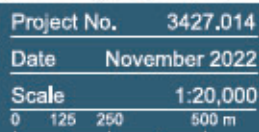


Figure 2



4. Site Hazards

4.1 Inter-Related Sites 1, 2, 3

Sites 1, 2, and 3 are adjacent to each other and are interrelated. They will be assessed together.

Site1 – Left Bank Point Bar/Side Channel d/s of Hwy 1 Bridge (Reach 5)

The point bar and side channel on the left bank of the Chemainus River downstream of the Highway 1 bridge consists of gravel/cobble material on the point bar in the mainstem of the river and finer gravel and sand in the side channel. Over time, sediment appears to have built up in the side channel such that now the side channel elevation is about 1 to 2 m higher than the mainstem channel elevation and is only activated during high flow events. Photos 1 and 2 below show the point bar and side channel.



Photo 1: Gravel Accumulation at U/S End of Point Bar on Right Bank of Chemainus River



Photo 2: Sediment Accumulated Inside Channel on Right Bank of Chemainus River
Note Highway 1 Bridge in background

Some of the trees growing on the point bar have eroded and are now partially spanning the channel (Photo 1).



Well heads for the District of North Cowichan (DNC) water supply system are located adjacent to the side channel and are protected by riprap (Photos 3 and 4). The depth of riprap below the channel is unknown.



Photo 3: DNC Water Supply Well Head Protected by Riprap Adjacent to Side Channel



Photo 4: DNC Water Supply Well Head Protected by Riprap Adjacent to Side Channel

Air photo review in the Geomorphic Atlas indicates that the point bar and side channel area has become more vegetated since 1975 (see Photo 5) indicating the bar is becoming more stable and at higher elevation over time.



Photo 5: Changes in Vegetation Cover on Point Bar d/s of Highway 1 Bridge
(Source: NHC, 2022)

Accumulation of sediment on the point bar and within the side channel on the left bank concentrates flow in the Chemainus River channel along the opposite right bank which tends to increase potential for erosion of the right bank and increase potential for channel avulsion across the right bank floodplain. This erosion is discussed further in Site 2 and Site 3.

Site 2 – Eroding Right Bank (Reach 5)

The second site along the Chemainus River is immediately across the main channel from Site 1 and consists of an eroding right bank on the outside of long sweeping bend downstream of the Highway 1 bridge. The bank is approximately 200 m long and consists of unconsolidated sand and gravel layers over cobble/gravel layer near the channel bed (see Photo 6). The upstream 40 m of the bank is protected by concrete slabs placed downstream of the Highway 1 bridge while the remainder is unprotected with varying degrees of root strength from riparian vegetation. The bank is well vegetated with mature cottonwood trees and undergrowth.

Air photo interpretation in the Geomorphic Atlas indicates that the bank has been eroding at an average rate of about 0.9 m/year but with variations on year-to-year basis with changes in peak flow magnitude since 1950. For instance, the November 2021 flood event resulted in between 2.5 m to 6.3 m in lateral bank erosion based on pre and post flood event survey carried out by NHC. Large woody debris and willow wattles installed along the bank in this location in late summer of 2021 failed during the November 2021 flood.



**Photo 6: Right Bank of Chemainus River
Downstream of Highway 1 Bridge Showing
Mature Riparian Trees and Exposed Roots**

Ongoing erosion of the right bank could result in reduced width of the natural berm/high ground along the river channel in this location leading to:

1. Increased potential for overbank flow into floodplain on right bank downstream of the Highway 1 bridge.
2. Increased potential for avulsion of the main channel into the right bank side channel (discussed further in Site 3 below).

Both an increase potential for overbank flow and potential channel avulsion could increase risk to the Halalt FN lands, to the neighbouring community and to important off channel fish habitat discussed further in Site 3.

Site 3 – Right Bank Side Channels

Two side channels are located on the right bank floodplain of the Chemainus River. The first side channel is about 10 m wide and runs from the downstream end of the long eroding bend on the right bank (Site 2) to approximately 100 m downstream (into Reach 4). The upstream end of the first side channel is partially blocked by a significant log jam located on the right bank as well as a constructed riprap/log groin which crosses the open portion of the side channel (Photo 7).



Photo 7: Entrance to Right Bank Side Channel Showing Eroding Bank, Riprap/Log Groin, Log Jam

Both the logjam and the groin limit the amount of water that flows into the side channel in this location. However, on-going erosion upstream (Site 2) could outflank the groin structure and result in additional water flowing into the side channel during large flood events.

A second smaller relic side channel about 6 m to 8 m wide flows through the right bank floodplain is set back from the mainstem by about 100 m. This side channel meanders through the right bank floodplain for approximately 1.6 km before flowing back into the mainstem channel upstream of the E&N railway bridge at the downstream end of Reach 4.

Two gravel berms have been constructed across the floodplain within Halalt FN reserve lands between the two side channels. A trapezoidal channel has been left in the berm at the location of the relic side channel (see Photo 8). These were constructed as emergency measures during the 2021 flood. They limit flow across the floodplain and concentrating flow in the two side channels.



Photo 8: Opening Through the Berm for Smaller Right Bank Side Channel

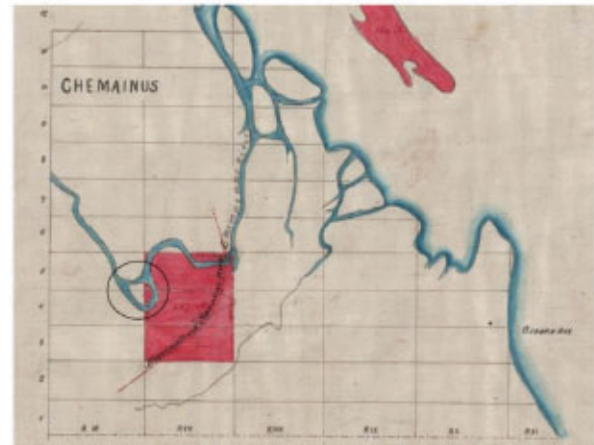


Photo 9: Map From 1877 Showing Two Active River Channels Near the Location of the Observed Side Channels
(Source: NHC, 2022)

The downstream end of the side channel was excavated approximately 30 years ago to provide groundwater fed off channel habitat for juvenile salmon. The excavation starts about 500 m downstream of the mainstem channel.

This relic side channel is a preferential pathway for potential channel avulsion. The potential for avulsion would be exacerbated by accumulation of LWD and bank erosion near the entrance of this channel at Site 2. The geomorphic hazard maps produced by NHC in 2022 show this area to be an avulsion hazard zone. In addition, maps prepared in 1877 (Indian Affairs Survey Records No. BC 220) suggest that the mainstem river was historically two channels in this location (Photo 9).

Preliminary Risk Evaluation

The preliminary risk assessment has been carried out considering the incremental change in risk to public health and safety, river channel capacity, environment, and infrastructure as a result of accumulation of sediment and debris from the November 2021 flood. In other words, how much has the risk of flooding or erosion to community changed because of the accumulation of sediment and debris or what level of reduction in risk could be expected if the sediment or debris was removed.

As the communities on the Chemainus River floodplain experience flooding regularly, they should be considered to be at high risk. However, the high level of risk due to flooding is a result of a combination of many different processes across the watershed and the entire floodplain. Therefore, the assessment of incremental risk is focused on the incremental change in risk for specific sites and based on professional opinion supported by the recent flood management studies. For instance, Figure 3 shows results of NHC flood modelling which shows the extent and multiple flow paths across the floodplain during flood events which has been used to understand potential for flooding at the different sites. In addition, an animation of flooding across the Chemainus River floodplain was prepared for the IFMP and is available at <https://www.planyourcowichan.ca/flood-mapping/widgets/119195/videos/9101>.

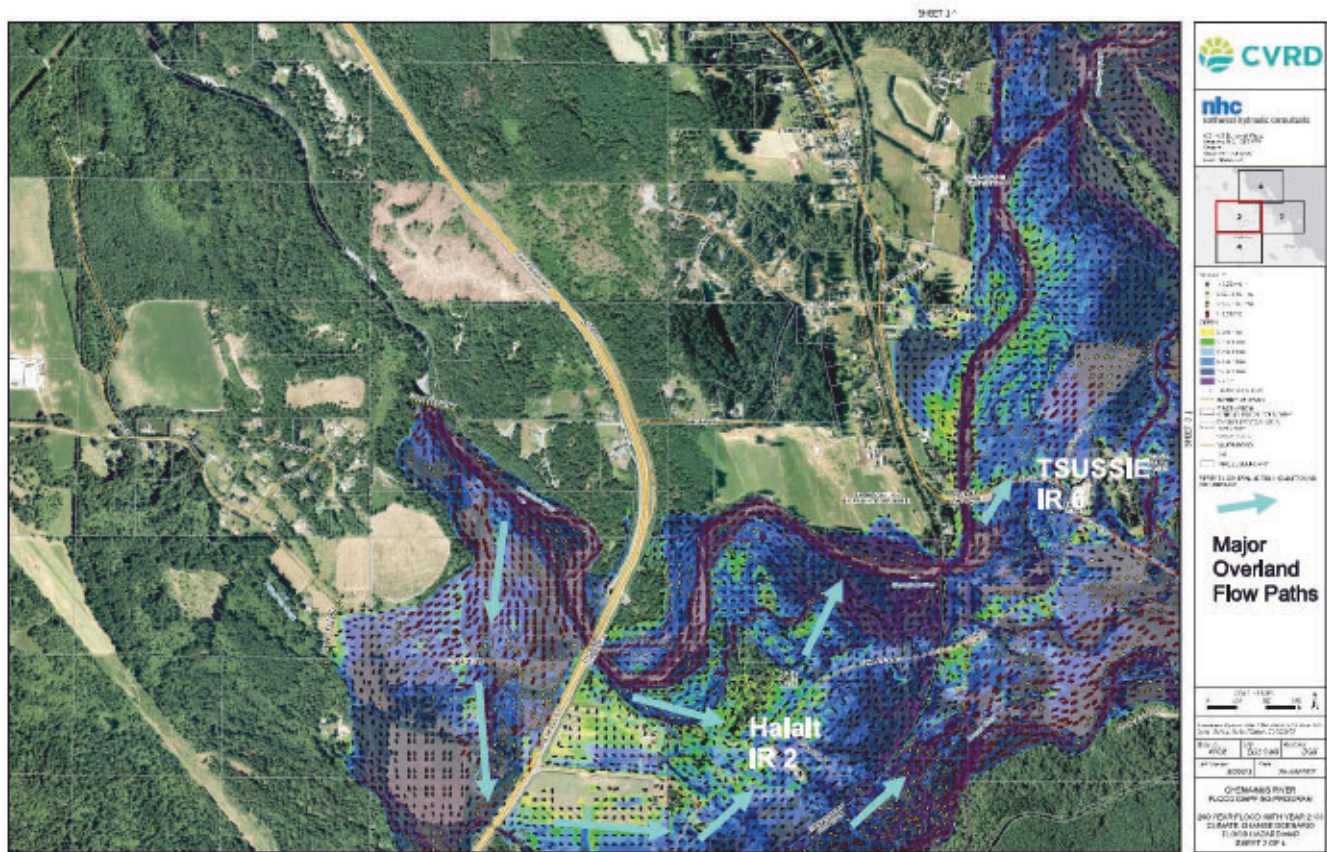


Figure 3: Flow Depth-Velocity Map for 200-year Flood on Chemainus River near Halalt FN and Tsussie FN
(Source: NHC, 2022)

Preliminary Risk Evaluation – Site 1, Site 2, and Site 3

As the geomorphic processes at Site 1, Site 2, and Site 3 work together to increase risk they have been evaluated together. Evaluating the risk at these sites is complicated due to the series of events that would need occur to change the risk to communities in the floodplain.

1. What is the impact of sediment and debris at Site 1 on potential to increase flood levels or bank erosion in the channel?
2. What is the likelihood that increased flood levels or bank erosion could lead to increased overbank flow at Site 2 or avulsion of the main channel into the relic side channels at Site 3 on the right bank floodplain?
3. How could overbank flow at Site 2 or avulsion at Site 3 change flood levels or erosion at the communities within the floodplain?
4. What impact would increased water levels or erosion have on the community, on infrastructure or on the environment on the floodplain?

The Preliminary Qualitative Risk Evaluation for Site 1, Site 2 and Site 3 is shown in Table 3. The risk key which describes how levels of incremental risk were evaluated is included in Enclosure A for ease of reference.



Table 3: Preliminary Risk Evaluation (Site 1, Site 2, and Site 3)

Category	Preliminary Incremental Risk Evaluation	Consequence
Public Health and Safety	Medium	Ongoing accumulation of sediment on the left bank point bar/side channel (Site 1) and erosion of the right bank (Site 2) is likely and increases the potential for additional overbank flows onto the right bank floodplain. The upstream end of the relic side channel is set back from the mainstem (about 100 m) which limits the potential for a partial or full avulsion. However, the berm construction across the floodplain between the mainstem channel and the relic side channel could concentrate flow in the relic side channel increasing the potential for avulsion. Therefore, avulsion is moderately likely. An avulsion into the relic side channel may moderately increase potential for flooding in comparison to the overall flood risk within the Halalt Community resulting in moderate, long-term disruption to the community. Therefore, the incremental risk to public health and safety because of debris accumulation at Site 1 is considered medium in comparison to the overall flood risk the community faces which is high.
River Capacity	High	Accumulation of gravel/debris on the left bank point bar and side channel (Site 1) has reduced river capacity at Site 1 location and increases potential for bank erosion on right bank (Site 2) and partial avulsion to side channels (Site 3). Due to gravel sources upstream and the highly erodible material on the right bank, the incremental risk to river capacity is considered to be high.
Environmental	Medium	Avulsion of the mainstem flow into the relic side channel (Site 2) could result in loss of the existing 1.6 km of rearing side channel habitat which provides unique rearing habitat along this reach of the river. The upstream end of the relic side channel is set back from the mainstem (about 100 m) which limits the potential for a partial or full avulsion. However, the berm construction across the floodplain between the mainstem channel and the relic side channel could concentrate flow in the relic side channel increasing the potential for avulsion. Therefore, avulsion is moderately likely and the incremental risk to environment is considered medium.
Infrastructure	Low	As discussed above, the potential for erosion of the right bank is high with moderate likelihood of avulsion into relic side channel. However, infrastructure (homes, roads, water system) within Halalt FN are set back (300 m to 500 m) from both the mainstem and relic side channel. Therefore, the potential for impact to infrastructure as a result of bank erosion or channel avulsion is considered to be low within Halalt FN.
Note: The preliminary risk assessment was carried out considering the incremental change in risk to public health and safety, river channel capacity, environment, and infrastructure because of accumulation of sediment and debris from the November 2021 flood. In other words, how much has the risk of flooding or erosion to community changed because of the accumulation of sediment and debris or what level of reduction in risk could be expected if the sediment and/or debris was removed.		

4.2 Site 4 – Debris and Gravel Accumulation (Reach 2)

Site 4 is located between the E&N Railway Bridge and the Chemainus River Bridge (Reach 2 in the NHC Geomorphic Atlas). This area is a depositional zone with a 10,000 m³ (approximate) gravel bar. The right bank of the channel is protected by riprap between the E&N bridge and a bedrock outcrop upstream of the Chemainus Road bridge. Since 1992, the channel has migrated from the right bank to the left bank (Photo 10).



Photo 10: Air photos from 1992 (left) and 2021 (right) showing how channel morphology has changed in the depositional area over time

(Source: NHC 2022)

In November 2021, a large amount of wood debris accumulated on the right abutment of the Chemainus Road Bridge (Photo 11). This debris has since been removed. However, it remains a location where debris accumulates and may require removal at this location again in future.

The combination of debris and sediment accumulation in this location along with the relatively low right bank of the river in this location, can result in increased overbank flow. However, the potential for channel avulsion is limited as the entire reach between the two bridges is protected from erosion by either riprap or bedrock outcrops.



Photo 11: Large woody debris on right abutment of Chemainus Road Bridge after November 2021 flood which has since been removed

(Source: NHC 2022)



Preliminary Risk Evaluation – Site 1, Site 2, and Site 3

Table 4: Preliminary Risk Evaluation (Site 4)

Category	Preliminary Incremental Risk Evaluation	Consequence
Public Health and Safety	Medium	Accumulation of sediment within the reach between the E&N Railway Bridge and Chemainus River Bridge (Reach 3) reduces conveyance in the mainstem of the channel which could result in additional overbank flow in the Butcher Slough and across the right bank floodplain. This additional flow could lead to some moderate degree of increased flood levels across Chemainus Road, along and within the Tsussie FN community. The riverbanks of the river are protected from erosion by bedrock outcrops and riprap, sediment accumulation has limited potential for triggering bank erosion. Therefore, there is moderate incremental risk to public health and safety.
River Capacity	Medium	Ongoing accumulation of sediment within the reach between the E&N Railway Bridge and Chemainus River Bridge (Reach 3) will continue to reduce conveyance in the mainstem of the channel which could result in additional flow in the Butcher Slough and across the right bank floodplain. However, as the riverbanks along this reach of the river are protected from erosion by bedrock outcrops and riprap, sediment accumulation has limited potential for triggering further bank erosion or channel avulsion.
Environmental	Low	Accumulation of sediment in this reach of the river has promoted growth of bar top vegetation and collection of wood debris which provides additional complexity to habitat in this area. Therefore, the incremental risk to environment is considered to be low.
Infrastructure	Low	Past accumulation of wood debris on the E&N bridge and Chemainus River bridge indicate that these structures are susceptible to debris accumulation. However, recent removal of debris from these bridges has reduced the incremental risk of impacting infrastructure. Ongoing monitoring will be required to assess accumulation of debris at these bridges.
Note: The preliminary risk assessment was carried out considering the incremental change in risk to public health and safety, river channel capacity, environment, and infrastructure because of accumulation of sediment and debris from the November 2021 flood. In other words, how much has the risk of flooding or erosion to community changed because of the accumulation of sediment and debris or what level of reduction in risk could be expected if the sediment and/or debris was removed.		

4.3 Additional Sites

Four additional drainage related sites were observed during the site visit; however, these are not related to sediment or debris. They are recorded here for completeness but are outside the scope of the sediment and debris project.

A - Butcher Slough at Tsussie Road

During the November 2021 flood, a temporary floodwall was installed at this location to direct flood water along Butcher Slough away from the Tsussie Road community (Photo 12). At the time of the site visit, the floodwall was removed, however, there are plans to re-install a temporary floodwall in the event of high flows in winter of 2022/23.



Photo 12: Alignment of Temporary Flood Wall Partially Protecting Tsussie Road

B - Butcher Slough at Swallowfield Access Road

There are two 1,200 diameter steel culverts at the Swallowfield Access Road where it crosses the Swallowfield Access Road (Photo 13). These may be undersized for the flow in Butcher Slough and could be contributing to higher peak flood water levels upstream, near Tsussie Road.



Photo 13: Swallowfield Access Road Culverts

C- Bonsall Creek at Tsussie Road

Two 600 mm culverts with flap gates were installed under Tsussie Road approximately 10 years ago. The intent of these culverts is to drain the fields to the west of Tsussie Road. However, the flap gates on the outlet into Bonsall Creek are corroded and no longer close/seal properly. This allows water from Bonsall Creek to flow into the fields during periods of high flow and high tide in Bonsall Creek. The drainage path and the culverts are shown in Photo 14.



Photo 14: Location of Tsussie Road Culverts and Flap Gates

The effectiveness of the flap gates should be assessed as part of on-going hydraulic modelling work and the flap gates should be replaced if the analysis indicates that the culverts/flap gates provide a drainage benefit.

D – E&N Railway Embankment Drainage Relief Culverts

During large flood events in the Chemainus River, water flowing across the right bank floodplain flows through the Halalt FN Community. The E&N Railway embankment traverses the floodplain and cuts off floodplain flow resulting in pooling of water within the Halalt FN community. In order to assist with drainage of the ponded areas, three sets of three 900 mm diameter CSP culverts have been installed through the E&N railway embankment.

During flood events, water flowing through these culverts is directed towards Bonsall Creek along relic floodplain channels which flow through Halalt IR 2 to the southeast of the E&N railway right of way. Although the magnitude of flow through the culverts is likely relatively small in comparison to flow in Bonsall Creek, the redirection of flow into Bonsall Creek could have impacts on flood levels downstream within Tsussie IR 6. Assessment of these impacts is beyond the scope of this preliminary assessment and should be carried out as part of the Lower Chemainus River Integrated Flood Management Plan.



5. Short-term Mitigation Options for Sites 1, 2, 3

The results of the preliminary risk assessment for Sites 1 to Site 3 results in moderate to high risks therefore short-term mitigation options were explored.

Site1 – Left Bank Point Bar/Side Channel D/S of Hwy. 1 Bridge (Reach 5)

A short-term option to reduce concentration of flow on the right bank is to trim sediment from the left bank point bar within the mainstem channel and remove any wood debris that has accumulated with the sediment in this area. Given the historical evidence of sediment accumulation in this area, this would be considered a short-term solution. However, it may provide time to implement more permanent erosion protection on the right bank in future.

An alternative option to excavate sediment from the left bank side channel with the aim to reduce concentration of flow on the right bank was discussed on-site. Improving side channel conveyance would involve excavating the sediment accumulation in the side channel such that the inlet elevation would be below the floodplain on the right bank but above baseflow level in the main channel. This would split flood flows between the mainstem channel and the side channel to reduce potential for erosion on right bank but maintain baseflows in the main channel to protect summer fish habitat.

Given the historical evidence of sediment accumulation and stabilization of the left bank side channel observed in aerial photography, future deposition of sediment is likely to fully or partially refill any proposed excavated channel. Therefore, the length of time that this option might be effective may be limited.

As indicated above, there are uncertainties with the option to excavate sediment from the right bank side channel that would have to be evaluated further to assess the effectiveness of this option that is beyond the scope of this preliminary assessment including:

1. A hydraulic assessment of the effectiveness of reducing erosion on the right by splitting flood flows between the mainstem and the left bank side channel.
2. A review of increased potential of erosion and risk of damage to the DNC well heads located along the left bank side channel as well as any potential of negatively impacting water availability.
3. An estimation of how quickly the left bank side channel could refill with sediment which would provide an indication of the long-term maintenance requirements for this channel.

Given the potential for on-going sediment accumulation in the left bank side channel leading to limited effectiveness over time, we consider the option of improving conveyance in the left bank side channel (Site 1) to be a lower priority option compared to protecting the right bank from further erosion as discussed in more detailed in Site 2 below. However, further assessment of the hydraulics, the potential risk to DNC well-heads and the long-term effectiveness of excavating accumulated sediment from the left bank side channel may be warranted if a longer time frame is required to implement bank erosion protection measures at Site 2.

Site 2 – Eroding Right Bank (Reach 5)

Given the risks associated with ongoing erosion of the right bank downstream of Highway 1 Bridge (Site 2), permanent protection of this highly erodible bank from further erosion is top priority. Permanent protection could include both hard points (riprap spurs or bendway weirs) to direct flow away from the bank as well as riparian and aquatic habitat features to protect and promote healthy fish habitat in the reach. An example of a site combining hard points with riparian habitat is shown in Photo 15.



Photo 15: Example of Combination of Riparian Habitat with Rock Hard Points for Erosion

Site 3 – Right Bank Side Channels

The berms should be removed, and alternative alignments or locations of temporary berms or permanent dykes should be assessed for short term and long-term flood mitigation for Halalt FN. This could be undertaken as part of the Lower Cowichan Integrated Flood Management Plan.



6. Site Opinion and Advice

Based on the hazard and risk assessment, Site 1, Site 2, and Site 3 along the Cowichan River is an Area of Concern (AC), requiring further assessment, emergency work, and potential mitigation measures to be implemented as soon as possible.

Emergency Sediment and Debris Removal Works (ASAP)

- **Design and Construct Right Bank Erosion Protection (Design Winter 2022/23 and Construction Summer 2023):** given the risk of avulsion and increase in floodplain flows associated with ongoing erosion of the right bank of the Chemainus River downstream of Highway 1 bridge (Site 2), it is recommended that bank protection measures be designed and constructed. These measures can include riparian and habitat features but may have to also rely on hard points (such as riprap spurs or bendway weirs) due to the higher flow velocities and scour associated with this location. This option will require detailed engineering design, environmental permitting, and negotiations with the private property owner to allow for construction access and future maintenance access along the right bank of the Chemainus River. This work will require planning and design over winter of 2022/23 and construction during low flow/low risk fish window in summer of 2023. This work is located within private property and as such will require permission from property owner for access, construction as well as consideration for agreement on permanent access for future maintenance.
- **Remove Sediment and Debris (Fall 2023*)** on left bank dry side channel downstream of Highway 1 Bridge (Site 1) involving excavating a channel through the gravel along the relic side channel to act as a high flow channel. Removal of sediment and debris from the point bar on the left bank is also included in this proposed work. This work will require conceptual design of channel, regulatory permitting, confirmation of the potential impact to DNC well heads and pre-/post-construction topographic survey to measure quantity of sediment removed and on going topographic surveys in spring 2023 to monitor how quickly sediment is depositing in the channel. This work should be done under direction of a Professional Engineer. The entire length of the side channel is located within property owned by the District of North Cowichan. However, the point bar on channel right bank is located within the same property as the channel right bank and will require property owner approval for the work.

* As the side channel is outside the normal flow path of the Chemainus River, excavation could be carried out in the dry over fall 2023. However, this will be dependant on timelines for planning/design and will have to be carefully risk managed should rainy weather and higher flows arrive.
- **Top and Delimb Mature Trees (Fall/Winter 2023)** on the eroding right bank (Site 2) to reduce wind loading and potential for windfall resulting in disturbance to root systems. Mature trees within 10 m of the top of bank should be considered for topping and delimbing. A Qualified Arborist should be consulted during this work to recommend the amount of tree trimming. As these trees are located on private property, permission to enter and top/delimb trees will be required from the owner.



7. Additional Recommendations to be Undertaken Outside the November 2021 AREA Sediment Program

Short Term Recommendations

- **Remove Temporary Berms (ASAP)** immediately on the right bank floodplain between the Chemainus River and the small side channel to prevent redirection of overbank flows into neighbouring properties, concentration of flow in the side channels and increased risk of avulsion. The berms should be removed down to floodplain level. Erosion protection should be installed on banks of the smaller relic side channel where the berm crosses the side channel. This work should be done under direction of a Professional Engineer. After removal of the berm, alternative short- and long-term flood mitigation measures should be investigated as part of the Lower Chemainus Integrated Flood Management Plan.
- **Monitor Debris Accumulation (On going):** Regular monitoring of debris at known locations of accumulation (downstream of the Highway 1 Bridge, E&N bridge and Chemainus Road bridge, etc.) is required to reduce risk to these important transportation links and maintain channel conveyance.
- **Undertake an Aerial Surveillance of River Wide Sediment and Debris.** Based on Cowichan Watershed Board Twinned Watershed Study (2021) information, several log jams (17) and gravel bars were identified in reaches (Reach 6 and Reach 7) upstream of the Highway 1 Bridge and Halalt FN Reserve Lands. The findings in the preliminary site assessment carried out by KWL are based solely on ground reconnaissance for a limited section of the river. It would be prudent to undertake an aerial reconnaissance by a qualified professional of the Chemainus River from tidewater to the lower Canyon to identify the current channel conditions including locations of wood debris or significant sediment accumulation that could be mobilized in future floods. This information could then be used to carry out comprehensive assessment of the entire lower river to any identify critical debris or gravel bars that could be managed as part of a broader sediment/debris management program for the Chemainus River.

Long Term Recommendations

- **Assess and Implement Flood Protection Improvements and Ongoing Sediment Management Options:** As part of the ongoing Lower Chemainus River Integrated Flood Management Plan process, flood improvement and sediment/debris management options should be identified and tested using the available hydraulic model. Some of the additional sites identified as part of this reconnaissance can be used to help guide options for improvements. In particular, the impacts of the E&N flood relief culverts (Site D) on flows and water levels in Bonasall Creek should also be reviewed as part of the assessment of flood management options.
- **Develop a Watershed Management Plan:** A Chemainus River Watershed Management Plan process should be implemented with Halalt FN, local government (CVRD and DNC), private forestry landowners (Mosaic) and other private landowners along the Chemainus River with support of senior governments. The goal would be to develop a community led plan which can provide guidance on management of watershed scale processes which impact sediment, flood, and debris risks in the lower watershed. The planning process should at a minimum address the sediment, debris and flood risk concerns but may also include broader and related concerns such as drought flows, ground water, etc.



8. Closure

Please contact Craig Sutherland at 250-889-2155 if there are any questions or concerns.

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Encl.: Enclosure A: Risk Evaluation Matrix

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Revision History

Revision #	Date	Status	Revision Description	Author
0	October 20, 2022	Final		CS/DNM

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Enclosure A

Risk Evaluation Matrix

Table A-1: Risk Evaluation Matrix

		Risk Evaluation and Response				
Indices	Consequence Rating	Very Low	Low	Medium	High	Very High
	Public Health and Safety	Minor disruption to flow.	Minor, short term disruption to local community or moderate disruption to few.	Moderate disruption to local community, or substantial disruption to few.	Moderate, long term disruption to local community.	Substantial, long term disruption to region.
	River Capacity	Flow contained within the channel	Flow temporarily floods adjacent land	Flow floods adjacent lands resulting in prolonged flooding	Partial avulsion of flow resulting in flooding, erosion and scour damage to adjacent land and infrastructure	Full avulsion of flow resulting in flooding, erosion and scour damage to adjacent land and infrastructure
	Environmental	No noticeable loss or deterioration of habitat, species, unique landscapes, or culturally valued sites.	Small, short term loss or deterioration of important, unique, rare, or endangered habitat, species, landscapes, or culturally valued sites. Moderate, recoverable loss or damage of less valued habitat, species, landscapes, or sites.	Moderate temporary or small permanent loss or deterioration of important, unique, rare, or endangered habitat, species, landscapes, or culturally valued sites. Moderate loss or damage of less valued habitat, species, landscapes, or sites.	Moderate permanent loss or deterioration of important, unique, rare, or endangered habitat, species, landscapes, or culturally valued sites.	Major permanent loss or deterioration of important, unique, rare, or endangered habitat, species, landscapes, or culturally valued sites.
	Infrastructure	No infrastructure impacted	Impacts to infrastructure (minor erosion or scour, some debris accumulation, partial infilling, etc.) are not expected to have an impact on the operation of the infrastructure	Impacts to infrastructure (erosion or scour, debris accumulation, infilling, etc.) leave infrastructure vulnerable	Impacts to infrastructure (erosion or scour, debris accumulation, infilling, etc.) should be repaired post-freshet	Impacts to infrastructure (erosion or scour, debris accumulation, infilling, etc.) will likely result in failure or irreparable damage to the infrastructure - repairs should commence pre-freshet
	Annual Exceedance Probability	Very Low	Low	Medium	High	Very High
Very Likely	>0.2	M	H	H	VH	VH
Likely	0.2-0.1	L	M	H	H	VH
Moderate	0.1-0.02	L	L	M	H	H
Unlikely	0.02-0.005	VL	L	L	M	H
Very unlikely	<0.005	VL	VL	L	L	M

Risk Key		Very High	High	Medium	Low	Very Low
VH		Risk is unacceptable short-term (before next flood season); Risk reduction required				
H		Risk is unacceptable medium term; Risk reduction plan must be developed and implemented in a reasonable time frame				
M		Risk may be tolerable; more detailed review required				
L		Risk is tolerable; monitor				
VL		Risk is broadly acceptable; no further review needed				



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Appendix B

Environmental Management Plan



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Chemainus River Sediment Debris Removal

Environmental Management Plan

Final Report
November 2, 2022
KWL Project No. 3427.014

Prepared for:
BC Ministry of Environment and Climate Change Strategy



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1. Introduction

1.1 Project Description

The Ministry of Environment and Climate Change Strategy (ENV) is working to review and consider risks, potential consequences, and to prioritize urgent repair and mitigation measures to existing damaged waterway systems, including removal of sediments introduced by the 2021 Atmospheric River Event. This project is intended to address sediment and debris accumulation in the Chemainus River between Trans-Canada Highway (TCH) Bridge and Chemainus Road Bridge. The accumulated material has the potential to create channel erosion and channel avulsion risk in the Halalt First Nation (Halalt FN) community located within Halalt IR 2 and the neighbouring properties within the District of North Cowichan.

The immediate proposed Project includes the following works:

- Sediment removal from the entire side channel on river left just downstream from the TCH bridge (~3000 m³);
- Bar top removal of a point bar that is directing flow at the eroding mainstem river right bank downstream of the Trans-Canada Highway (TCH) bridge; and
- Topping large cottonwood trees that are currently undermined and threatening to fall into the river, further destabilizing the eroded right bank.

Kerr Wood Leidal Associates Ltd. (KWL) was retained to prepare an Environmental Management Plan (EMP) for the Project. The EMP includes general guidance on the following topics:

- Environmental monitoring;
- Timing of works;
- Protection of fish and fish habitat;
- Vegetation management;
- Erosion and sediment control;
- Deleterious substance control and spill management; and
- Site clean up and restoration.

1.2 Purpose of the Environmental Management Plan

This Environmental Management Plan (EMP) sets out the requirements and measures that will be adopted to avoid, minimize, and mitigate the potential adverse environmental impacts of the Project. This plan is to be implemented by the Contractor throughout the duration of the Project and applies to the construction phase. The EMP intends to provide overarching guidance for how environmental considerations will be implemented and monitored during the construction phase of the Project.

The EMP is a living document and will be updated over the course of the construction phase of the Project as planning for work activities is finalized and as findings from the monitoring program warrant changes in environmental management.



1.3 Roles and Responsibilities

The parties involved in the Project have the following roles and responsibilities with respect to environmental management:

1. The Contract Administrator shall:
 - a. ensure that the appropriate resources are available to establish, implement, maintain, and improve environmentally responsible construction practices; and
 - b. liaise with the EM about potential impacts to environmental components during construction;
 - c. liaise with all QPs involved with the Project as needed; and
 - d. provide the resources required for environmental awareness and protection training, contract Qualified Professionals¹ (QPs) with specific expertise as needed, environmental documents specific to the Project, and financial resources.
2. The Environmental Monitor (EM) shall:
 - a. advise the Contractor on environmental protection and monitor environmental protection measures;
 - b. identify deficiencies of the Contractor and communicate with the Contractor on how to address deficiencies;
 - c. have written authority to halt or modify any construction activity if it is deemed necessary to protect fish and wildlife populations or their habitats; and
 - d. report to the Contract Administrator.
3. The Contractor includes any company and its field staff retained by the Contract Administrator to construct a component of the Project. The Contractor shall:
 - a. plan and conduct activities in compliance with the EMP and all applicable legislation, approvals, and best management practices;
 - b. report directly to the Contract Administrator regarding all site activities;
 - c. ensure that there is no release of deleterious substances into Chemainus River or any other nearby water sources;
 - d. ensure all staff, including subcontractors, are familiar with the EMP, and know their responsibilities in meeting the outcomes of the plan;
 - e. communicate changes in construction plans or activities that could impact the implementation of the EMP to the Contract Administrator, the EM, and KWL as quickly as possible; and
 - f. keep a copy of the EMP on-site at all times.

¹ QPs will have the expertise or knowledge needed to advise and/or support the Contract Administrator, the EM, the Contractor, and KWL with respect to environmental (i.e., biologist) or other (i.e., engineering) concerns.



1.4 Guiding Documents

The following guidance documents were used to develop the EMP:

- *Requirements and Best Management Practices for Making Changes In and About a Stream* (Government of British Columbia 2022);
- *Guidelines for Reduced Risk Instream Work Windows* (MOE 2006)
- *Measures to Protect Fish and Fish Habitat* (DFO 2019);
- *Standards and Best Practices for Instream Works* (WLAP 2004);
- *A Field Guide to Fuel Handling, Transportation and Storage* (WLAP 2002);
- *B.C. Approved Water Quality Guidelines: Aquatic Life, Wildlife, and Agriculture* (MOE 2021);
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (MOE 2014); and
- *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993).



2. Project Location and Scope of Work

2.1 Project Location and Physical Setting

The Chemainus River is a salmon-bearing stream found on the east coast of Vancouver Island with its estuary located approximately 10 km north of the City of Duncan. The watershed has an area of approximately 360 km² and the mainstem of the river is approximately 64 km long (Wightman et al. 1998).

Two extreme rainfall events on February 1, 2020, and on November 15, 2021, resulted in the second highest (500 m³/s) and third highest (468 m³/s) daily peak flows on record for the Chemainus River since 1953. The highest peak daily flow record, 537 m³/s, was recorded on February 11, 1983.

The project location is the mainstem of Chemainus River between Trans-Canada Highway (TCH) Bridge and Chemainus Road Bridge. Over time, sediment has accumulated at a point bar and in a side channel on the left bank of the river downstream of the TCH bridge, increasing erosion on the right bank of the channel (figures 2-1 and 2-2). The point bar consists of gravel/cobble material, while the side channel consists of finer gravel and sand.

The works will take place on two parcels of land adjacent to the Chemainus River downstream of the TCH bridge:

District of North Cowichan lands (municipal):
PID 017-760-933
Plan Number VIP 54048
Lot 1

Private land owned by Russell Farms (private):
PID 004-023-838
Plan Number VIP9254
REM Lot A

Chemainus River has been identified as an Area of Concern (AC) requiring immediate attention based on a high level, preliminary hazard, and risk assessment.

Table 2-1: Site Information

Site ID	S-CM-1
Site Description	Chemainus River at Halalt IR 2
Location	UTM Zone 10U 448438E 5414132N
Local Government Agency	Halalt First Nation, District of North Cowichan
Waterbody	Chemainus River





2.2 Scope of Proposed Works

The work is expected to be undertaken as follows:

Table 2-2: Proposed Construction Methods

Stage	Activity	Description of Activity
Site Preparation	Access Established and Existing Road Top Dressed	A paved exit road exists for access off the TCH at the District of North Cowichan's pumping station. A small access road from the pump station to the side channel already exists but needs to be prepped for truck traffic including top dressing with suitable gravel where needed. Gravel from the excavation site will be used. Truck hauling in and away from the site will use either the eastern temporary road past the pumping station or the western temporary road under the TCH bridges depending on mainstem water levels. In wet conditions and when mainstem flows prevent egress the eastern route will serve as both the exit and entrance to and from the site. A haul road within the side channel will also be levelled to allow excavation to happen from a downstream to upstream direction.
	Site Isolation	The side channel currently is a dry channel that is perched well above the current water level. The machine on site will dig a siltation pit leaving a berm of materials between the side channel and the river at the downstream end of the side-channel that will be used to collect any rainwater or groundwater that is generated on site during construction. A pump will be installed to pump dirty water, if necessary, away from the river as a precaution but it expected that the gravel berm that is left will provide filtration. A berm of material will also be left at the top of the side channel to prevent water from entering the site directly from the river. River water levels will fluctuate if rain arrives however, it is expected that the side channel excavation invert will be above typical October/early November flood levels.



Stage	Activity	Description of Activity
Construction	Side Channel Excavation	Approximately 3000 cubic meters of materials is proposed to be excavated from the channel. The channel excavation will be approximately 1m deep by 10 m wide and 300 m long. Benchmarks will be established at the inlet, mid-way and outlet to guide the excavation. The excavation will follow the current channel morphology and avoid as much as possible removal of riparian vegetation and mature trees. Material excavated from the channel will be end hauled to a site on the Halalt Reserve that has been used in the past to store gravel.
Construction (cont'd)	Point Bar Removal	A small point bar will be removed by scalping the bar from the water's edge back to the existing bank. The slope of the remaining bar will be tailored to be similar to the adjacent bank. Material excavated will be either trucked away if trucking access is possible without tree removal or spread out on the island between the side channel and the mainstem. No trees will be buried if point bar sediment is to remain on site.
	Tree Topping	Undermined trees that are in danger of toppling into the river will be identified and topped by a qualified arborist. The objective is to reduce windthrow of these trees which when toppled could create significant sites of erosion on the already eroding right bank of the Chemainus River. Tops of trees and limbs will be left on site as dead down wood.
	Site Clean Up	Once the sediment is removed from the side channel the channel will be left in as natural state as possible. The berm at the inlet and the outlet of the side channel will be left in place to allow a natural process of water entering the site.

2.3 Construction Timeline

The target date for start of works is October 24, 2022. Works will end on or before November 30, 2022.



3. Environmental Setting

The Chemainus River supports runs of Coho, Chinook, and Chum Salmon as well as Steelhead Trout; Pink and Sockeye Salmon are infrequently reported. Other recorded salmonid species include Atlantic Salmon and Dolly Varden.

Due to the urgent nature of the work to reduce the potential for flooding and erosion of Halalt First Nation lands, the project is being pursued this fall prior to the onset of higher river flows. Gravel removal will focus on side channel excavation and existing point bar removal only at this time and occur outside the wetted channel under dry conditions. As a result, we propose that the work is relatively low risk and can proceed with appropriate mitigation measures and Qualified Environmental Professional oversight outside of the least-risk work window.



4. Regulatory Requirements

4.1 Permits and Approvals

As all institutional projects are not subject to the Riparian Areas Protection Regulation (RAPR), an RAPR assessment is not required for the Project. Work within a regulatory riparian setback cannot be avoided as the sediment to be removed is within the creek bed. Therefore, this Project was submitted to the Ministry of Forests (*Water Sustainability Act* Change Approval for Works In and About a Stream) for review.

- *Water Sustainability Act* Notification for Changes in and About a Stream (WSA Change Approval #: 2009983)

A DFO Request for Review has not been submitted for this project as it has been determined that the project can avoid prohibited effects to fish and fish habitats and species at risk by not working within the wetted river channel.

A *Species at Risk Act* permit is not required as no critical habitat for listed species is found on site.



5. Environmental Management Plan

The following measures will be used to avoid, minimize, and mitigate potential environmental impacts of the Project and to ensure compliance with all environmental legislation, permits, and approvals.

5.1 Environmental Monitoring

Environmental monitoring will be conducted to ensure appropriate measures are being taken to protect the environment. The Environmental Monitor (EM) must be an appropriately Qualified Environmental Professional (QEP). The EM will regularly inspect the work site for compliance with the environmental requirements of the Project. Findings will be recorded and reported to the Contract Administrator and the Contractor. The EM must be familiar with the regulatory requirements of the Project and has the responsibility to report all non-compliance events and stop work if necessary. The EM will be on-site at project start-up and during any instream works or sensitive activity. A copy of this document, including the EM's contact information, will be kept on-site for the duration of the Project. Responsibilities of the EM will include, but are not limited to, the following:

- Review all permits, best management practices, and the EMP.
- Be on-site for Project start-up and critical works (i.e., works adjacent to sensitive areas).
- Meet with the contractor before construction to explain all mitigation and environmental protection measures.
- Monitor project compliance with the EMP, address changes to the Contractor, and Contract Administrator to ensure EMP is continuously updated, as needed.
- Inspect all mitigation and ESC measures to ensure they are appropriate and working properly and recommend modifications and repairs when necessary.
- Have written authority to halt any construction activity if it is deemed necessary to protect fish, wildlife, and their habitat.
- Identify, monitor, and promptly report any situations of ongoing or potential damage to the environment.
- Report to the Contract Administrator and relevant regulatory agencies on environmental issues encountered during construction.
- Prepare a monitoring report within 60 days of the Project's completion and submit to any agencies if required.

5.2 Timing of Works

- Project activities will be scheduled for dry weather conditions whenever possible.
- As works will occur outside of the timing window, necessary mitigation measures will be implemented. A QP will provide environmental monitoring during the work to provide advice on work timing and additional mitigation measures that may be required.
- Vegetation clearing and tree removal will occur outside the general bird timing window for the region (March 1 to August 31), which will protect breeding birds and bats in the assessment area.



5.3 Protection of Fish and Fish Habitat

- If water pumping is required, pump intakes, will be equipped with fish screens (mesh width < 2.54 mm) to prevent entrainment and impingement of fish, in accordance with the DFO Interim Code of Practice for End-of-pipe fish protection screens.
- In-water work is not anticipated. If any in-water work occurs, the duration of this work will be minimized so that it does not diminish the ability of fish to carry out one or more of their life processes.
- Minimize disturbance will occur to natural materials (e.g., embedded logs) and vegetation that contributes to habitat or stream channel stability.
- Minimize disturbance will occur to existing vegetation on and adjacent to the stream banks.

5.4 Vegetation Management

- Vegetation clearing and tree removal will occur outside the general bird timing window for the region (March 1 to August 31), which will protect breeding birds and bats in the assessment area.
- Professional arborists and biologists will be consulted throughout the site clearing and construction phases to minimize impacts to vegetation communities.
- Clearing will be limited to areas necessary for the works. Existing roads, trails, and other access points will be used where possible.
- A tree or other structure containing a nest of eagles, peregrine falcons, gyrfalcons, ospreys, and herons must not be felled, even outside of the breeding season for these species. This is in accordance with Section 34(b) of the *Wildlife Act*.
- Wildlife trees will be retained if possible. They provide essential habitats to birds and other wildlife.
- Where topping or removing dead limbs of danger trees will remove the hazard, this option is preferred over removing the entire tree.
- Vegetation should be replanted, where temporary clearing is needed to accommodate the works.

5.5 Invasive Plant Management

- All machinery will be inspected and cleaned before entering or leaving the construction site to remove any invasive plant propagules.
- All invasive vegetation removed will be disposed of off site at an appropriate facility.
- All material used on site (e.g., straw, hydroseeding, etc.) must be certified weed-free.

If patches of knotweed or hogweed are encountered during site clearing or other works in the Project area, they will be flagged off and reported to the QEP immediately. Knotweed must be managed carefully as it is able to reproduce from rhizomes and stem fragments. The following procedures should be adhered to:

- All plant and soil material must be removed from site in a way as to minimize transfer of plant parts to other areas;
- All plant parts must be removed, potentially by hand with appropriate personal protective equipment, sealed in plastic bags, and disposed of appropriately off site; and



- Topsoil within 10 m of the extent of the knotweed patch may not be used as backfill. The soil should be disposed off site at an appropriate waste management facility experienced in dealing with knotweed-contaminated soils.

5.6 Erosion and Sediment Control Plan

The purpose of erosion and sediment control (ESC) is to prevent the introduction of sediments (e.g., silts, clays, and sand) into watercourses. The ESC Plan prescribes methods to prevent the erosion and mobilization of sediment of exposed areas by rainfall or water flow through the work site, to intercept and manage sediment-laden runoff from works prior to leaving the work site and entering the watercourse, and/or manage the risk of a sediment discharge.

The ESC measures can be adapted or added to before, during, and after construction as required based on the recommendations of the EM. ESC measures will be set up prior to starting work. Measures will be monitored regularly and maintained until all disturbed ground has been stabilized.

ESC measures include the following:

1. Undertake works during dry weather where possible.
2. Deposit all spoil materials above the high-water mark, ensuring sediment re-entry into watercourses or waterbodies is prevented.
3. Cover all disturbed areas and spoil piles with poly sheeting or a reasonable alternative if inclement weather is expected.
4. Minimize vegetation disturbance on banks to the furthest extent possible.
5. Deploy perimeter ESC measures such as silt fences, berms, and check dams as necessary.
6. All ESC measures will be monitored regularly by both the Contractor and the EM and maintained until all disturbed ground has been stabilized.
7. Any other measures needed to prevent erosion of a watercourse and work site, or sediment from entering any watercourse, as determined by the EM or Engineer.

5.7 Deleterious Substance Control and Spill Management

- All fueling of vehicles and equipment will be done off-site or onsite in a designated fueling area over a spill containment tray at least 50 m from any watercourse.
- All equipment washing must be done off-site or onsite in a designated area at least 50 m from any watercourse or in a manner that will prevent wash from reaching any waterway.
- Generators, pumps, and other stationary equipment will be placed on spill trays or equipped with other secondary containment. Where possible, generators will be located at least 50 m from any waterway.
- All machinery will be clean, in good working condition and free of excess oil and grease. Equipment will be inspected daily and documented.
- Containers will be labelled according to the *Transportation of Dangerous Goods Act* and *Workplace Hazardous Materials Information Systems* (WHMIS) regulations.
- Oil waste, filters, absorbent pads, and cartridges will be collected and disposed of off-site at an appropriate facility in accordance with federal, provincial, and municipal regulatory requirements.



- To prevent the release of substances toxic to fish, there will be no use of treated wood products within a watercourse.
- A spill response plan and spill kit will be on site and suitable for all substances on-site, and staff trained in its use.

Spill Response

- The contractor will prepare a spill management plan which includes notification procedures, contact telephone numbers and spill report forms.
- A spill kit will remain on site during construction. The kit will be stocked with appropriate supplies for the site size and conditions (e.g., absorbent pads, booms, granular absorbent). Staff will be trained in the proper use of the kit.
- Any spill of a toxic or deleterious substance over the reportable limits as outlined in the Ministry of Environment and Climate Change Strategy Spill Reporting Factsheet (MOE, 2021)² will be reported immediately to the BC Provincial Emergency Program 24-hour phone line at 1-800-663-3456.
- If a spill of toxic or deleterious substances occurs within a watercourse or waterbody both MOF and DFO will be notified immediately. All spills will be reported to the EM immediately.

5.8 Site Clean Up and Restoration

- All construction materials and garbage will be removed from site after the Project is complete.
- Erosion and sediment control devices and measures will be removed following the stabilization of all disturbed areas.
- The contractor will be responsible for leaving the site in compliance with all Permits, Approvals, and Authorizations.

² https://www2.gov.bc.ca/assets/gov/environment/air-land-water/spills-and-environmental-emergencies/docs/materials/fact_sheet_spill_reporting.pdf



Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Andrew Baylis, M.Sc.
Project Biologist

Reviewed by:



Patrick Lilley, MSc, RPBio, BC-CESCL
Senior Biologist



Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of BC Ministry of Environment and Climate Change Strategy for the Environmental Management Plan for the Chemainus River Sediment-Debris Removal Project. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

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Revision History

Revision #	Date	Status	Revision	Author
0	November 2, 2022	Final		AJB/PL

Proudly certified as a leader in quality management under Engineers and Geoscientists BC's OQM Program from 2013 to 2021.



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Appendix C

Water Sustainability Act Change Approval



November 2, 2022

Job Number: 123646
vFCBC Tracking Number: 100400518

Ministry of Environment and Climate Change Strategy
PO Box 9047 Stn Prov Gov
Victoria BC V8W 9E2

Dear Ministry of Environment and Climate Change Strategy,

Change Approval - Changes In and About a Stream (File 1005623)

A Change Approval for the above application has been granted and a *Water Sustainability Act* Section 11(1) Changes In and About a Stream Approval document verifying this is attached.

This Change Approval does not authorize occupation of private or Crown owned land. Permission of the affected landowner, or a permission to occupy Crown land, must be obtained and should be in writing for your protection.

The holder of this approval shall ensure that any proposed development and/or changes do not impact traditional or special sites in accordance with the *Heritage Conservation Act* and the ability of First Nation community members to participate in traditional activities on the land and water.

This approval does not constitute authority of any other agency. The holder of this approval shall have the necessary permits from other agencies concerned prior to the commencement of the works authorized herein. The permit holder is required to adhere to all other applicable Provincial and Federal Regulations.

Archeological sites (both recorded and unrecorded) are protected under the *Heritage Conservation Act* and must not be altered or damaged without a permit from the Archeology Branch. The holder of this approval must advise everyone who will be involved in ground-disturbance and construction that if archeological materials are encountered, activities must be halted and the Archeology Branch contacted at 250 953-3334 for direction.

We wish to inform you that the water bodies may serve as spawning and rearing areas for fish. The protective requirement of the federal *Fisheries Act* must be met. Accordingly, it is necessary for you to screen your water intake to protect against entry of small fish as per Freshwater Intake End-of-Pipe Fish Screen Guidelines (Department of Fisheries and Oceans, 1995). Please refer to the Fisheries and Oceans Canada website (<https://publications.gc.ca/collections/Collection/Fs23-270-2004E.pdf>) for this publication.

Section 105 of the *Water Sustainability Act* gives the recipient of this notice the right to appeal my decision. You may file an appeal within 30 days of the date indicated on this letter. Information on filing an appeal can be found on the Environmental Appeal Board website at <http://www.eab.gov.bc.ca/>.

If you have any questions or concerns regarding the document issued or this letter, please contact Randy Reid, Water Officer, by email at randy.reid@gov.bc.ca or by phone at 250 736-6981.

Sincerely,



Jim Proteau
Assistant Water Manager

Enclosure(s)



November 2, 2022

Job Number: 123646
vFCBC Tracking Number: 100400518

Ministry of Environment and Climate Change Strategy
PO Box 9047 Stn Prov Gov
Victoria BC V8W 9E2

Dear Ministry of Environment and Climate Change Strategy,

Change Approval - Changes In and About a Stream (File 1005623)

Ministry of Environment and Climate Change Strategy, PO Box 9047 Stn Prov Gov, Victoria, BC, V8W 9E2 is hereby authorized to make changes in and about a stream as follows:

1. The name of the stream is Chemainus River.
2. The changes to be made in and about the stream are:
 - **Site Isolation:** Excavation of a siltation pit and the construction of cobble/gravel berms for the purposes of side channel site isolation.
 - **Side Channel Excavation:** Removal of 3,000-5,000 cubic meters of cobble, gravel and sediment material.
 - **Point Bar Excavation:** Removal and/or re-contouring of the cobble/gravel point bar located between the side channel and the mainstem of Chemainus River.
 - **Tree Topping:** Delimbing and topping of undermined trees along the right bank that are at high-risk of toppling into the river. Tree work must be overseen by a qualified arborist.
3. The location of the works is on the following land parcels, as provided by the applicant: LOT 1, SECTION 5, RANGE 6, CHEMAINUS DISTRICT, PLAN VIP54048 and LOT A, SECTION 4, RANGE 6, CHEMAINUS DISTRICT, PLAN 9254 EXCEPT PART IN PLAN 2793RW
4. All works shall be completed in accordance with:
 - “Chemainus River Sediment Debris Removal – Environmental Management Plan” prepared by Kerr Wood Leidal (KWL)

5. All works shall take place between November 2, 2022 to December 2, 2022, and June 15, 2023 to September 15, 2023 during favorable weather conditions.
6. Upon completion of work provide Randy Reid (Randy.Reid@gov.bc.ca), Water Officer, FOR, with a summary as-built report including photographs of the side channel excavation and point-bar removal works.
7. A Qualified Environmental Professional/Monitor with the authority to halt work shall be on site during all phases of construction, including consideration of project shutdown in the event of heavy rains or increased stream flows.
8. All machinery and equipment operating within the stream shall be clean, free of external grease, oil or fluid leaks and shall use biodegradable grease, oil and fluids.
9. Fuelling and servicing of vehicles and equipment must occur a minimum of 30 metres away from all streams, lakes and waterbodies. Keep a spill containment kit on site and train onsite staff in its use. Immediately report any spill of a substance that is toxic, polluting, or deleterious to aquatic life of reportable quantities to the Dangerous Goods Incident Report 24-hour phone line at 1 800 663-3456.
10. The works shall not result in depressions that have the ability to trap fish and other aquatic life.
11. The holder of this approval shall take reasonable care to avoid damaging any land, works, trees, or other property and shall make full compensation to the owners for any damage or loss resulting from the exercise of the rights granted with this approval.
12. Riparian areas which are disturbed by the works shall be restored to their original condition and protected from erosion.
13. All material utilized during construction shall be contoured and placed in a stable area such that it is not able to mobilize and managed to avoid entry into any stream or watercourse.
14. Measures must be taken to ensure that no harmful material (e.g. fuel and other hydrocarbons, soil, road fill, or sediment) which could adversely impact water quality, fish and other aquatic life, and/or fish habitat, be allowed to enter the wetted perimeter as a result of the project activities.
15. All work shall be carried out in accordance with the Provincial "*Requirements and Best Management Practices for Making Changes In and About A Stream in British Columbia (2022)*" <https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-requirements-bmps.pdf?msclkid=295e67c4c1ae11ecadd4ff4606dd7f6e> and

"A Users' Guide for Changes In and About A Stream in British Columbia (2022)"
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-users_guide.pdf?msclkid=92f2e4dbc1b011ec95c005b94d9b874d.

16. All changes in an about the stream shall be completed to the satisfaction of a Water Manager, as defined by the *Water Sustainability Act*.
17. Where there is a potential for silt runoff in the proximity of existing watercourses, control devices will be installed prior to construction activities commencing;
 - a) Filter fabric dams, rock check dams, and silt fencing will be used as needed on a site-specific basis to control erosion. Filtration should be accomplished using filter fabric keyed into substrates and banks, and elevated using stakes. Silt fencing is not an acceptable mitigation technique to control erosion in flowing ditches; however it is useful for containing slumping areas and for use as baffles to slow water velocities.
 - b) Excavation will be stopped during intense rainfall events or whenever surface erosion occurs affecting the watercourse.
 - c) Watercourses are not to be traversed by machinery at any time.
 - d) Soil stockpiles will be placed a minimum of 30 metres from any watercourse and in a location where erosion back into the watercourse cannot occur and will not impede any drainage.
 - e) Soil stockpiles with the potential to erode into watercourses are to be covered with poly sheeting or mulch. Other techniques, such as terracing or surface roughening can greatly reduce surface erosion on steeper slopes.
 - f) Site re-vegetation measures may be required to stabilize soils and stream banks and reduce erosion. The measures, including planting native vegetation, are to be implemented as directed by the biologist as construction is completed.

Sincerely,



Jim Proteau
Assistant Water Manager

Enclosure(s)



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Appendix D

Access Agreements



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Appendix H

Final Environmental Report

CHEMAINUS RIVER - FLOOD MITIGATION GRAVEL REMOVAL (2022)

Final Environmental Report

December 8, 2022



Before and during photos of the downstream end of the left bank side channel excavation.

Prepared for:

Halalt First Nation &
Kerr Wood Leidal

Prepared by:

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INTRODUCTION

The Chemainus River is a locally important salmon bearing river in southeastern Vancouver Island between the communities of Chemainus and Duncan. Its watershed drains approximately 360 km² with a 64 km long mainstem. The lower reaches of the river contain notable development within its historic floodplain including farms, commercial and residential developments, the Trans-Canada highway (Highway 1), and Reserve lands of the Halalt, Stz'uminus, and Penelakut first nations.

The second and third highest peak daily flows ever recorded on the Chemainus River were recorded in February of 2020 and November of 2021 respectively, and resulted in closure of Highway 1, flooding of farms and businesses of the area, and evacuation of residents of the Halalt I.R. 2 in the lower floodplain. The damage caused by these events and projections of the increase in similar events due to climate change has instigated an Integrated Flood Management Plan on the Lower Chemainus River led by the Cowichan Valley Regional District and the Halalt First Nation to create a long-term flood mitigation strategy. In conjunction with this process, the BC Ministry of Environment and Climate Change and the Halalt First Nation have developed a multi-stage plan for the short-term mitigation of known risks in key areas of the lower watershed. This report summarizes gravel extraction activities that occurred at Site 1 of this plan.

STUDY AREA

Site 1 covers approximately 2 ha and is located on the left bank of the Chemainus river immediately downstream of the Highway 1 bridge crossing (Figure 1). At this location, the river makes a sharp bend to river left, and direction of flow changes from southeast to northeast.

Site 1 consists of two features of interest: a side channel at river left that cuts through the inside of the bend in the mainstem of the Chemainus River (Photo 1) and a point bar in the mainstem channel that extends from the left bank towards the right bank (Photos 2 and 3). The side channel has historically been activated at high flows in the Chemainus River; however, it has infilled with sediments to a depth of up to 2 m over time. The combination of extreme high flows during recent flood events and the blockage of this side channel have resulted in damage to downstream areas of the floodplain by forcing flows towards and, in the case of the 2021 flood, over the right bank. These issues are exacerbated by the point bar feature at Site 1.

The Chemainus river adjacent to Site 1 is a known migration corridor and spawning ground for chum and chinook salmon.

SUMMARY OF WORK COMPLETED

Onsite works were conducted from November 7 – 18, 2022 inclusive of pre-work meetings and demobilization from site. Works consisted primarily of removal of sediments with excavators and hauling off site with dump trucks (Photo 4). Additionally, one downed tree was removed from the mainstem channel immediately upstream of the point bar (Photo 5, Figure 1).

Machinery on site consisted of two excavators which remained on site for the duration of the project, and between 3-5 trucks per day. The removal of sediment to reopen the left bank side channel and remove the point bar at Site 1 was completed according to design specifications by Kerr Wood Leidal (KWL; Oct. 21, 2022), and final volumes of sediment removed were slightly under forecasted amounts (See Results and Discussion below). Due to the location of two wellheads owned and maintained by the District of North Cowichan (DNC) within the work site (Figure 1), initial planning discussions included the potential of riprap installation in the excavated channel; however, the existing riprap protection was deemed to be sufficient. No new riprap was installed over the course of the project.

Works were conducted under the full-time supervision of an environmental monitor, and turbidity downstream of the worksite was measured regularly while machines were operating on site. Background turbidity measurements were taken upstream of the worksite daily.

Mitigation measures put in place to prevent any harmful alterations, disruptions, or destructions to fish habitat in the Chemainus River included:

- 1) A large spill kit on site at all times while work was ongoing (Photo 6) as well as smaller spill kits onboard both excavators.
- 2) Use of biodegradable oils and lubricants in machinery on site.
- 3) Fueling of machinery further than 30 m from the river.
- 4) Pressure washing all machinery prior to arrival onsite (Photo 7).
- 5) Retention of a sediment dams at both ends of the side channel excavation to maintain site isolation from the mainstem channel (Photos 8 and 9).
- 6) Compaction sealing of walls of the excavated channel to prevent release of sediment (Photo 10).
- 7) Completing all excavation outside of wetted areas of the Chemainus River in dry conditions.

GOALS AND OBJECTIVES

Environmental monitoring was required to ensure that construction-related risks to the Chemainus River were minimized through appropriate management practices, communications, and operational protocols and to maintain compliance with federal and provincial regulations specific to environmental protection. This report is intended to provide a summary of monitoring and reporting measures and standards implemented during work to avoid causing a HADD to fish and fish habitat pursuant to Section 35 of the federal *Fisheries Act*.

SITE CONDITIONS AND FIELD METHODS

Environmental monitoring (EM) methodologies followed specifications listed in the project EMP (KWL, 2022), as well as measures described in the BC Ministry of Environment and Climate Change Strategy (MOECCS) *Change Approval - Changes In and About a Stream (File 1005623)* and documents referenced therein.

Works were conducted during a period of dry weather and low flow conditions which dropped throughout the work period (Figure 2), meaning that flows in the Chemainus river were contained entirely within the mainstem and all works were completed in the dry. Site isolation was accomplished by leaving berms of existing sediment in place at each end of the excavation (Photos 7 and 8); however, the lack of rain and low discharge ensured that there was no risk of inundation of the work site.

Adult salmon were periodically observed rising from deep pools on the outside of the sharp bend in the river across from Site 1. Additionally, there were two observations of individual salmon in a riffle approximately 100 m downstream of these pools. There was no evidence of spawning activity in any part of the river adjacent to the work area.

Works were conducted almost entirely on dry land with the closest proximity excavation to the river being the excavation of the point bar. This was completed with oversight provided by the project EM, and gravels were excavated to a height of no less than 12" from the wetted portion of the river (Photo 11). Bulk excavation work consisted of gravel trucks using accreted sediments within the historic side channel as an access road and was completed entirely under the supervision of a cultural monitor from the Halalt First Nation as well as the designated EM. Trucks were then loaded with excavators and exited the site via the same route. This ensured that the project footprint was not extended for the creation of roads, as all disturbance was contained within the final footprint of the engineered side channel. Due to the flood history of the side channel, the project footprint was largely unvegetated, and shrub and tree removal was minimal.

Instream works consisted of the removal of a single cottonwood (*Populus trichocarpa*) that had fallen into the river. The stem was cut free from its root ball, which was left in place to retain habitat complexity, and then the tree was lifted out of the river by an excavator from the shore (Photo 5). A small pulse of sediment was visible as the tree was removed; however, it cleared quickly and did not create a noticeable change in downstream turbidity (Figure 3).

Turbidity was measured throughout the entire project duration with a LaMotte 2020i Turbidity meter. Daily background measurements were taken approximately 100 m upstream of the worksite, and downstream measurements were taken every 2-3 hours, or at increased frequency during works deemed sensitive. No pumping or fish salvage efforts were required to facilitate gravel excavation.

RESULTS AND DISCUSSION

Pre-work gravel volumes had filled the historic left bank side channel to a depth of up to 2 m and had effectively obstructed flow during flood conditions. The geomorphology of the river at Site 1 results in the blockage of the left bank side channel having significant negative impacts of downstream areas in the floodplain, which were exacerbated by the creation of the point bar at Site 1. Over the course of the project, an estimated volume of 2,958 – 2,977.5 m³ sediments was removed from these two problem areas.

The works resulted in the removal of the point bar to within approximately 12" above the wetted elevation of the Chemainus River, and the re-establishment of a continuous side channel with a

bottom width of 4 m and a 3:1 slope. Top of Bank widths varied from 9.9 m to 20.35 m and the channel was approximately 280 m long.

The excavation footprint was compacted using excavators to walk over it and bucket pack it to limit erosion as well as to ensure that no depressions were left which could pose an entrapment risk to fish as water levels drop after engagement of the side channel. Furthermore, natural depressions in the floodplain adjacent to the work area such as scouring behind embedded coarse woody debris (CWD) were filled where possible while avoiding harm to riparian areas outside of the immediate project footprint.

Background turbidity measurements were taken upstream of the worksite each day to establish the 24-hour maximum turbidity according to BC Water Quality Guideline (BCWQG)¹ for turbidity of 8 ntu above background. At no point over the course of the project did turbidity measurements downstream of the worksite exceed the BCWQG limit (Figure 3). The only observed increase in turbidity as a result from works over the course of the project was during the removal of the downed cottonwood from the mainstem of the Chemainus river adjacent to the point bar (Photo 5). The removal of this tree created a localized sediment plume; however, it cleared within 30 minutes and did not create a measurable increase of turbidity downstream. This tree was removed due to its potential to entrain woody debris transported downriver during high flow events and become a log jam causing additional flooding concerns.

Vegetation within the project footprint was minimal due to historic flooding and recent infill with sediments; however, some vegetation removal was necessary to reconstruct the channel. A total of 15 trees were removed, with a maximum diameter at breast height (DBH) of 40 cm (Table 1). Additionally, a total area of approximately 60 m² of shrubs, primarily young cottonwood, were removed. All trees removed were pushed over with an excavator and left in the floodplain to retain ecosystem function. All shrubs removed were growing directly within the excavation footprint.

¹ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

Table 1: Summary of tree species and sizes removed from the work footprint.

Species	Diameter at Breast Height (cm)
Cottonwood	37.5
Cottonwood	30
Douglas fir	9
Grand fir	5
Douglas fir	2
Cottonwood	22
Cottonwood	12
Cottonwood	14
Cottonwood	27.5
Cottonwood	30
Cottonwood	40
Cottonwood	9
Cottonwood	20
Cottonwood	15
Cottonwood	6

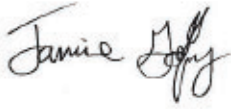
CONCLUSIONS

Based on the observations and conclusions provided in this report it is our assertion that works were carried out in accordance with the requirements outlined in the Change Approval - Changes In and About a Stream (File 1005623), and that there were no Harmful Alterations, Disruptions, and Destructions (HADDs) to fish habitat as defined under Section 35 of the *Fisheries Act*.

Expected outcomes of this project include the short-term mitigation of flood risk in the lower watershed. These works are not meant to be a final solution to expected future significant rain events in the Chemainus River; however, they are expected to provide sufficient mitigation to prevent large scale flood damage until a finalized long-term solution is developed. Due to the acknowledged short-term nature of this mitigation measure, the channel should be re-assessed in fall 2023 and beyond, to determine whether flood mitigation at Site 1 continues to meet target criteria. Sediment management at Site 1 is expected to be an ongoing issue that will require longterm resources for the effective management of flood mitigation in the Chemainus River.

CLOSURE

We trust this report provides a satisfactory overview of environmental mitigation and procedures



Created by Jamie Godfrey, Tech. on December 14, 2022



Reviewed by Dusty Silvester, R.P.Bio. on December 14, 2022

DISCLAIMER

This report was prepared for Kerr Wood Leidal and the CVRD by Current Environmental Ltd. The quality of information, conclusions and estimates contained herein is consistent with the level of effort expended and is based on: i) information available at the time of preparation; ii) data collected by the author, technical personnel and/or supplied by outside sources; and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Kerr Wood Leidal and the CVRD only, subject to the terms and conditions of the respective Contribution Agreements or understanding with Current Environmental Ltd. Other use or reliance on this report by any third party is at that party's sole risk.

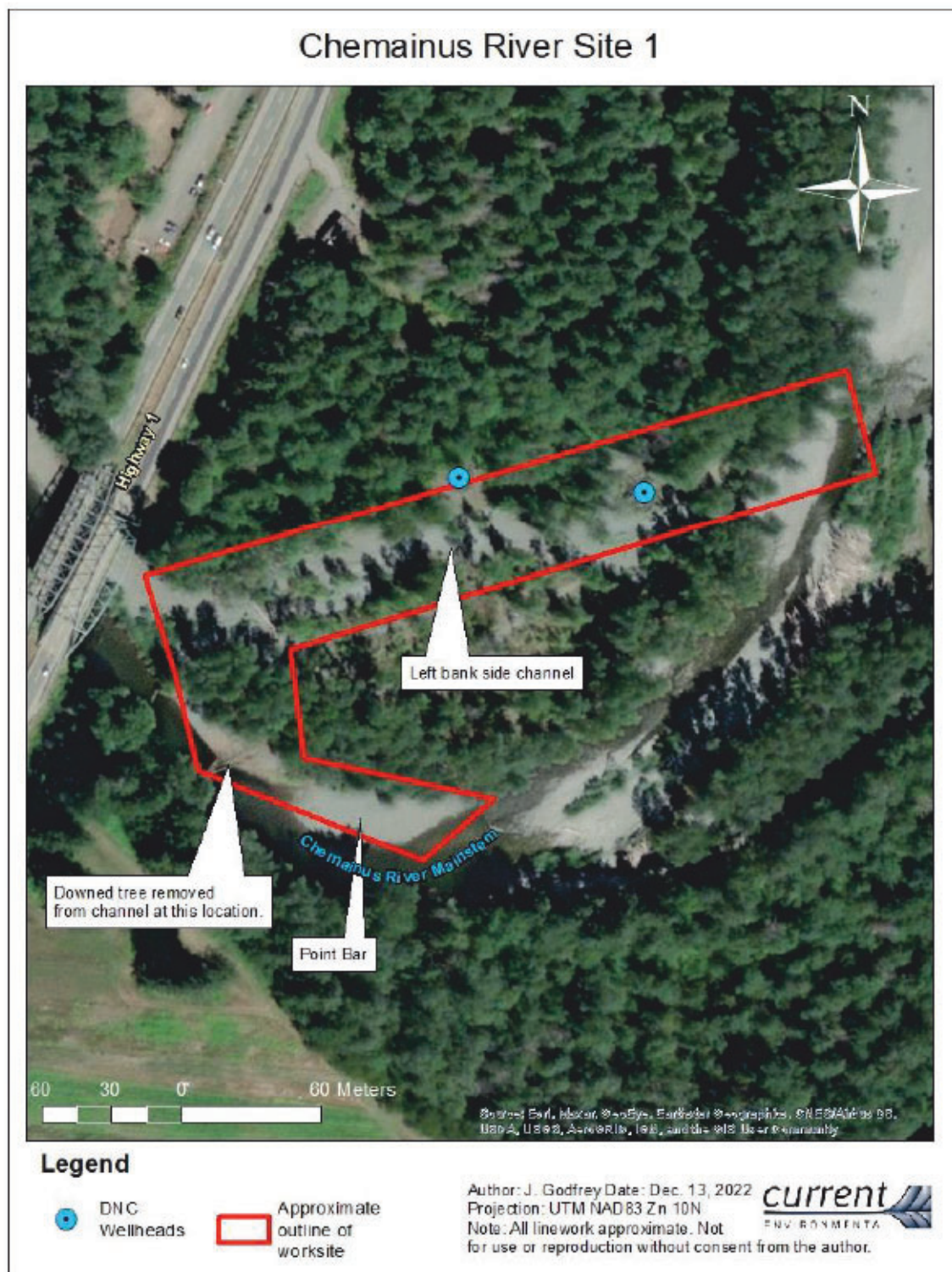


Figure 1: Overview of work area at Site 1 on the Chemainus River.

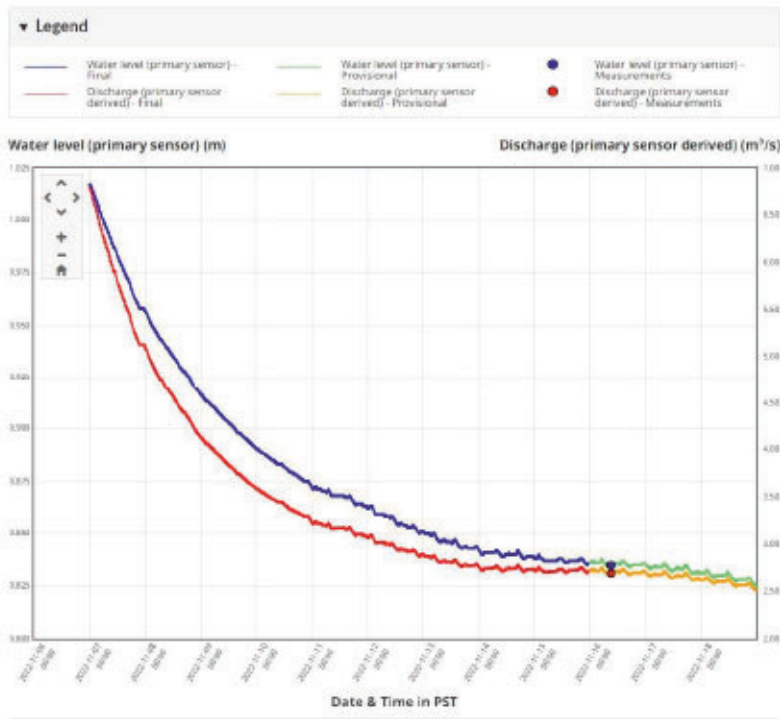


Figure 2. Water level (blue line (m)) and discharge (red (m³/s)) from the Chemainus River near Westholme (Stn. 08HA001) during the Nov. 7 – 18, 2022 work period at Site 1.

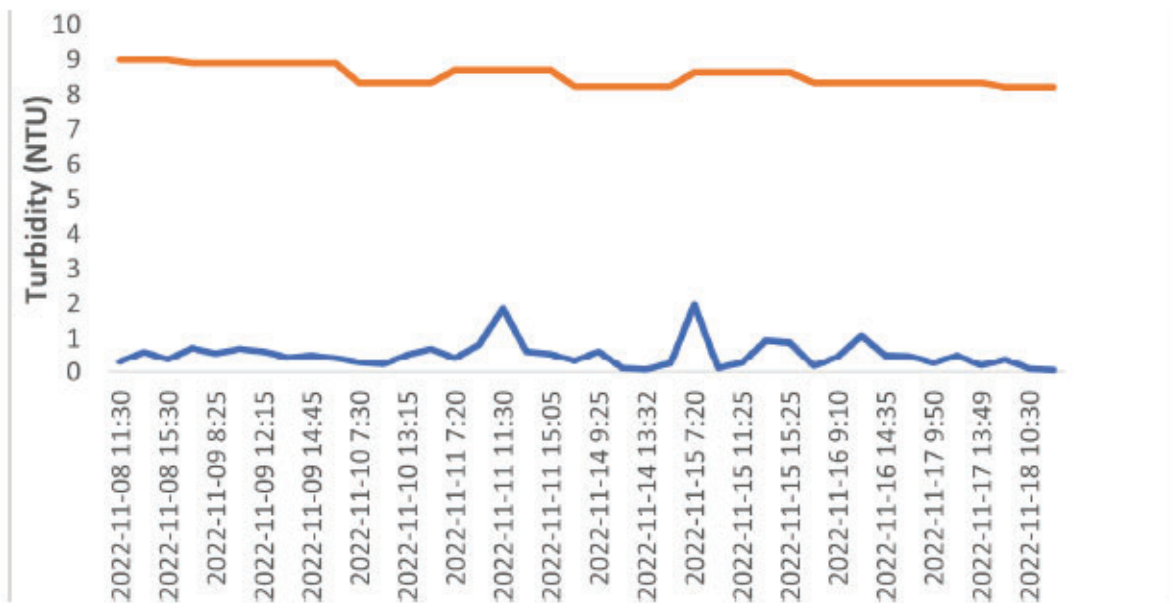


Figure 3. Turbidity (ntu) curve showing measurements taken downstream of the work area over the course of the project. Measured downstream turbidity levels (blue) are shown relative to the upper limit of allowable change in turbidity based on daily background measurements (orange).

PHOTOS



Photo 1: View downstream at the historic side channel at Site 1 that has been infilled with accreted sediment over time.



Photos 2 and 3: Looking upstream at the point bar of Site 1 before (left) and after (right) removal. The point bar lies at the inside of a sharp bend in the river and forces flow towards the opposite bank and causing erosion during high flows.



Photo 4: A dump truck being loaded by an excavator on accreted sediments of the historic side channel on Nov. 9, 2022.



Photo 5: Excavator removing downed cottonwood from the mainstem channel immediately upstream of the point bar.

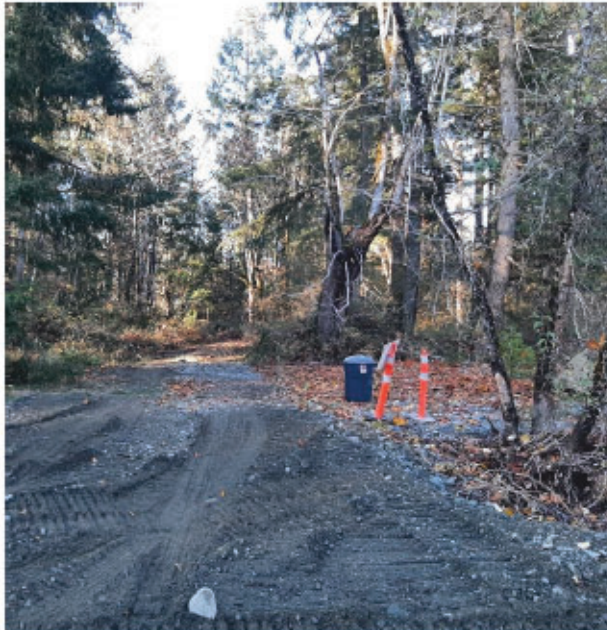


Photo 6: View of the access road to the worksite with the spill kit visible (blue garbage bin).



Photo 7: Excavator arriving on site pressure washed clean to avoid introduction of invasive species.



Photos 8 and 9: Sediment berms at the downstream (left) and upstream (right) end of the side channel excavation.



Photo 10: Walls of newly excavated left bank side channel after compaction with excavators.



Photo 11: Point bar after bulk excavation was complete, while shaping and compacting was ongoing. No sediments were introduced to the river, and turbidity levels remained well within acceptable ranges.



KERR WOOD LEIDAL
consulting engineers

Appendix I

Field Review Reports



Project Name:	Cheminus River Emergency Sediment Removal	Date:	November 9, 2022
KWL Project Number:	3427.021	Report No.:	001
Contractor:	Stone Pacific	Prepared By:	Liam Mackle On-Site @ 08:00 Depart Site @ 15:30

Weather: Clear, 4 degrees C

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures:

1. Attend Stone Pacific morning toolbox safety meeting @ 08:00.

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Mike, Operator

Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor

Halalt FN:

Archaeological Monitor

Equipment Observed on-site:

- 2 excavators
- Dump trucks to haul material

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place and maintained throughout the day
- Removal of fallen tree in the river while maintaining the rootball as per environmental permits
- Bar topping nearly completed as directed by KWL, some material remaining to be hauled away
- Overflow channel centreline was surveyed and staked out
- Stone Pacific measured and marked channel offsets and top of bank locations
- Channel excavation began at the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction

Quality Control:

- Channel bottom elevations were checked by Stone Pacific and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Bar topping nearing completion with removed tree



Photo 2: Overflow channel excavation beginning



Photo 3: Unexcavated "berm" at downstream end of channel.



Liam Mackle
Observer Name

Signature

2022/11/09
Date



Project Name:	Chemainus River Emergency Sediment Removal	Date:	November 10, 2022
KWL Project Number:	3427.021	Report No.:	002
Contractor:	Stone Pacific	Prepared By:	Andrea Kerr
			On-Site @ 07:15
			Depart Site @ 16:00

Weather: Cloudy, 6 degrees C

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Brief site Visitors:

Greg, Project Manager, Stone Pacific

David Conway, District of North Cowichan

John Carter, and Cam from Cowichan Engineering

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Mike, Operator

Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

CAT 290G

CAT 320C

Trucks

NL0285 – 9 loads

NL0279 – 8 loads

NR1044 – 10 loads

NL0280 – 9 loads

Plus, one load I did not get which vehicle hauled.

47 loads total

Each truck hauls approximately 12-14 tonnes.

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place and maintained throughout the day
- Bar topping complete as directed by KWL, remaining material has been hauled away
- Stone Pacific measured and marked channel offsets and top of bank locations. Stone Pacific finished marking out upstream end, centerline and offsets are marked in BLUE towards the beginning of the alignment.

- Stone Pacific trucked in 4 loads of clean material. 3 1-inch clean gravel, and 1 stone. This was placed along the access road to provide better traction for trucks and reduce mud transfer offsite and onto HWY 1.
- Channel excavation began at the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction.
- Area of concern discussed with John and Cam from Cowichan Engineering. The concern is the upstream/right side of the channel will be lower than the newly excavated channel. This may result in localized flooding in this area. It is clear this pattern has occurred in the past as the root wads are highly exposed on the bank.
 - One potential risk of these trees falling is the close proximity to the monitoring well-head downstream.
- Channel excavation continued from the downstream end. Rough material removal continued past the first well head. Grading at end of channel started.
- Discussions on grading around well head, and placement of riprap. Still to be decided and communicated by KWL.

Quality Control:

- Channel bottom elevations were checked by Stone Pacific and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Area of concern, looking upstream, the left bank is lower in elevation than the new channel alignment. Possible over-topping point of new channel.



Photo 2: Material trucked in for access road.



Photo 3: Point bar at completion mid-day.



Photo 4: Looking downstream, right channel extents may impact tree nearest to top of bank.



Photo 5: Looking upstream, one operator performing bulk material removal while grading commences at the downstream wedge.



Photo 6: End of day progress downstream.



Photo 7: Looking upstream, end of day progress.

Andrea Kerr
Observer Name

Andrea Kerr
Signature

2022/11/10
Date



Project Name:	Chemainus River Emergency Sediment Removal	Date:	November 11, 2022
KWL Project Number:	3427.021	Report No.:	003
Contractor:	Stone Pacific	Prepared By:	Liam Mackle On-Site @ 07:00 Depart Site @ 16:00

Weather: Cloudy, 6 degrees C

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

Deere 290G

Trucks

4: 3 Stone Pacific and 1 subcontractor

Approximately 59 loads total

Each truck hauls approximately 12-14 tonnes.

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place and maintained throughout the day
- Channel excavation continued from the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction.
- Some issues at the unloading area – trucks got stuck and caused some early delays that resolved through the day
- Discussions on grading around well head, and placement of riprap. Still to be decided and communicated by KWL. Riprap is not currently included in approvals
- Rough channel excavation nearly reached the access road by end of day

Quality Control:

- Channel bottom elevations were checked by Stone Pacific and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Area in front of downstream well head that will require riprap



Photo 2: Current channel geometry, looking upstream



Photo 3: End of day channel extents, looking downstream



Photo 4: End of day progress – excavation has nearly reach the access road

Liam Mackle
Observer Name

Liam Mackle

Signature

2022/11/11
Date

Project Name:	Cherninus River Emergency Sediment Removal	Date:	November 14, 2022
KWL Project Number:	3427.021	Report No.:	004
Contractor:	Stone Pacific	Prepared By:	Andrea Kerr
			On-Site @ 07:15
			Depart Site @ 16:00

Weather: Sun/Cloud mix, 6 degrees C

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Brief site Visitors:

Greg, Project Manager, Stone Pacific

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Mike, Operator

Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

CAT 290G

CAT 320C

Trucks

NR 1044 (Apex): 16

RE 7969 (BT05): 16

SK 7698 (BT09): 16

PH 3398 (Cougar): 11

59 loads total

Each truck hauls approximately 12-14 tonnes.

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place and maintained throughout the day
- Channel grading continued at the at the downstream end, leaving a wedge of unexcavated material to act as a temporary berm during construction.
- Channel excavation stopped at station 0+115 to maintain access for trucks.
- Excavation started at upstream end.
- Station 0+068 to 0+115 remaining to excavate.
- Discussion with Greg from SP about whether the surveyors have been out. Surveyors haven't been on site since Nov. 10 for a brief visit. No shots taken that day.

- Some over-excavation found when grading downstream end. Material filled from channel side. See photo 4, on the right bank.

Quality Control:

- Channel bottom elevations were checked by Stone Pacific and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Excavation starting at upstream end.



Photo 2:



Photo 3: Grading continued towards upstream end.



Photo 4:

Andrea Kerr
Observer Name

Andrea Kerr
Signature

2022/11/14
Date

Project Name:	Chemainus River Emergency Sediment Removal	Date:	November 15, 2022
KWL Project Number:	3427.021	Report No.:	005
Contractor:	Stone Pacific	Prepared By:	Liam Mackle On-Site @ 07:00 Depart Site @ 16:00

Weather: Fog, 1 degree C to cloudy and 8 degrees

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Mike, Operator

Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

Deere 290G

Deere 320C

Trucks

3 Stone Pacific

No truck count, much of the day was spent on grade adjustments down stream so the removal of channel excavations upstream was not thoroughly observed

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place and maintained throughout the day
- Channel excavation continued and is within the last ~100 m of the haul road before completion.
- Channel was initially cut at a consistent top width of 10 m, the contractor was instructed to have a varying top width with consistent 3:1 side slopes. This was marked out at the downstream end and additional side slope excavation began.
- Small groups of trees were measured and marked for removal along the right bank of the channel to accommodate the full channel width excavation. This was discussed and approved within the biology team.
- As-builts were received for the well heads indicating that the riprap extends further and lower than expected, and additional riprap armouring is likely not needed

Quality Control:

- Channel bottom elevations were checked by Stone Pacific and Cowichan Engineering, and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Initial shaping of 3:1 side slopes at the downstream end



Photo 2: A copse of trees flagged for removal



Photo 3: End of day progress at downstream end, looking downstream



Photo 4: End of day progress at upstream end, some excavation remains at the access road

Liam Mackle
Observer Name

Liam Mackle

Signature

2022/11/15
Date



Project Name:	Chemainus River Emergency Sediment Removal	Date:	November 16, 2022
KWL Project Number:	3427.021	Report No.:	006
Contractor:	Stone Pacific	Prepared By:	Andrea Kerr
		On-Site @	07:15
		Depart Site @	16:00

Weather: Fog, 1 degree C to cloudy and 8 degrees

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

- Near misses reported by Traffic Control. Vehicles could not see the taper in time and multiple near misses were witnessed.

Site Safety Mitigation Measures: First aid station

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator
John, Operator
Curt, Laborer

Current Environmental:

Jamie Godfrey, Environmental Monitor
Jeremiah, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

Deere 290G
Deere 320C

Trucks

NL 0285 – 20
PD 4223 – 20
SK 7968 – 18
SG 6245 – 20
Total Count = 78

Site Activities Observed and Discussions with Client/Contractor:

- Traffic control along HWY 1 was put in place. Due to safety concerns from the dense fog traffic controller had to open both lanes of traffic at our work site until the fog lifts. Vehicles could not see the taper in time and multiple near misses were witnessed. Trucks will stage until the fog lifts and the lane closure can be reinstated. Closure lasted about 15 minutes until the fog lightened.
- Channel excavation continued and is within the last ~50 m of the haul road before completion.
- Additional material removed downstream at the instruction of KWL the day before. Slope re-checked and will need a small amount of material removed to achieve 3:1 slope as desired.
- Small groups of trees were removed to achieve desired 3:1 slope.
- As-builts were received for the well heads indicating that the riprap extends further and lower than expected, and additional riprap armouring is likely not needed

Quality Control:

- Channel bottom elevations were checked by Stone Pacific, and adjustments were marked for the excavator.
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: End of day, excavation remaining



Photo 2: End of day progress looking downstream.



Photo 3: Remainder of bulk removal at end of day.

Andrea Kerr

Andrea Kerr
Observer Name

Signature

2022/11/16
Date



Project Name:	Cheminus River Emergency Sediment Removal	Date:	November 17, 2022
KWL Project Number:	3427.021	Report No.:	007
Contractor:	Stone Pacific	Prepared By:	Liam Mackle On-Site @ 07:15 Depart Site @ 15:30

Weather: Partly cloudy, 7 degrees

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator
John, Operator
Curt, Laborer

Current Environmental:

Jeremiah, Environmental Monitor

Halalt FN:

Tony, Archaeological Monitor

Equipment Observed on-site:

Excavators

Deere 290G
Deere 320C

Trucks

Stone Pacific x4

Total Count = unknown

Site Activities Observed and Discussions with Client/Contractor:

- Channel excavation was effectively completed, the fill at the downstream end was removed, most of the downstream reach has been shaped to 3:1 side slopes or shallower.
- The overbank areas with low spots were filled and shaped into a flood terrace in an attempt to prevent fish stranding.
- No more trucking will occur, the remaining material removed as part of final grading and shaping will be lost on site.
- Trees were flagged for topping on the right bank, planned to happen next week

Quality Control:

- John from Cowichan Engineering came by, anticipates they will assist in final grade checks tomorrow
- No other issues this day.

Archaeology:

- Halalt representative on-site to monitor construction activities this day.
- No other issues reported this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Overbank on right bank near downstream end filled to prevent fish stranding



Photo 2: Channel excavation complete



Photo 3: Downstream fill berm removed



Photo 4: Some shaping and cleaning up still required

Liam Mackle
Observer Name

Liam Mackle
Signature

2022/11/17
Date



Project Name:	Cherninus River Emergency Sediment Removal	Date:	November 18, 2022
KWL Project Number:	3427.021	Report No.:	008
Contractor:	Stone Pacific	Prepared By:	Andrea Kerr
			On-Site @ 07:15
			Depart Site @ 16:00

Weather: 1 degree C to cloudy and 8 degrees

Remarks:

First Aid Attendant: Curt (Stone Pacific)

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Site Safety Mitigation Measures: First aid station

Personnel Onsite:

Stone Pacific:

Thomas, Site Foreman, Operator

Curt, Laborer

Current Environmental:

Jeremiah, Environmental Monitor

Equipment Observed on-site:

Excavators

Deere 290G

Deere 320C

Site Activities Observed and Discussions with Client/Contractor:

- No traffic control in place. Not needed as no trucks coming and going.
- Final grading of channel bed to 0.4% slope.
- Grade checked along entire alignment.
- Channel slopes tidied up, left side of channel looking downstream.
- Road touched up and smoothed by operator.
- All signs and stakes removed.

Quality Control:

- Channel bottom elevations were checked by Stone Pacific, and adjustments were marked for the excavator.
- Stone Pacific to tidy up pump house yard during demob.
- Asphalt rain curb to be reinstated at pump house. TBD for who performs and pays (DNC requests project pay for it).
- No issues this day.

Archaeology:

- No issues this day.

Environmental:

- No issues this day.

Site Photos:



Photo 1: Drainage curb, destroyed by dump trucks, to be reinstated.



Photo 2: Drainage curb from another angle.



Photo 3: Stone Pacific to tidy pump house lot during demob.

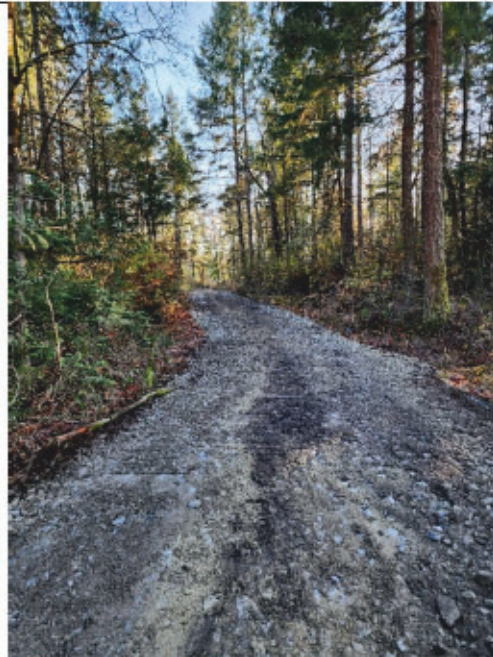


Photo 4: Road after tidying and resurfacing.



Photo 5: End of day, construction wrapped up.

Andrea Kerr
Observer Name

Signature

2022/11/18
Date

Project Name:	Cherninus River Emergency Sediment Removal	Date:	November 24, 2022
KWL Project Number:	3427.021	Report No.:	009
Contractor:	Stone Pacific	Prepared By:	Andrea Kerr
Subcontractor:	Onsight Tree Service	On-Site @ 08:00	
		Depart Site @ 14:30	

Weather: Fog, 5 degree C to sunny, 10 degrees

Remarks:

First

Site Safety Incidents: No safety or near-miss incidents observed or reported on-site this day.

Personnel Onsite:

Martin Bilina. arborist
2 arborist/laborers

Stone Pacific:

Greg Stone

Equipment Observed on-site:

Two trucks belonging to arborists.

Site Activities Observed and Discussions with Client/Contractor:

- Tree topping started with the topping of an unmarked cottonwood tree. Arborist explained it was a potential safety issue and could interfere with topping of marked trees. This was approved by KWL.
- One tree that was marked was not topped because it had already been topped in the past.
- Some trees were fallen leaving taller stumps, this was again due to climber safety. The trees were too tightly grouped to safely top.
- One additional cottonwood was broken during falling. It became hung up on another tree. This was a safety concern for all parties. Greg and Martin discussed options on how to safely fall this tree as it could not be left as is.
- France the property owner was contacted to discuss the issue. She gave permission to fall additional cottonwoods if necessary.
 - This option was not preferable as it would require lengthy clean up. The trees would have to fall in her field and would require clean up crews from both Onsight and Stone Pacific.
- Martin Bilina assessed the situation further and decided he could safely fall it using a "fence-post" method combined with rope rigged to a vehicle to pull the tree away from the base/ground.
- The tree was successfully and safely removed.

Quality Control:

- Arborists bucked up fallen trees and tree-tops to smaller pieces which would lay flat on the ground. This practice helps with decomposition.
- Reviewed Stone Pacific's demob location to check it was left as requested. See photos.
- No issues this day.

Archaeology:

- No issues this day.

Environmental:

- No issues this day.
- Arborists used BIO oil for equipment.

Site Photos:



Photo 1: Deep scouring just below asphalt curb. Not sure if it is from a vehicle tire or water.



Photo 2: Pump house lot after demob.



Photo 3: Asphalt drainage curb after demob.



Photo 4: Broken tree caught in large group of cottonwoods.



Photo 5: View from Point Bar



Photo 6: Previously topped marked tree that was left as is.

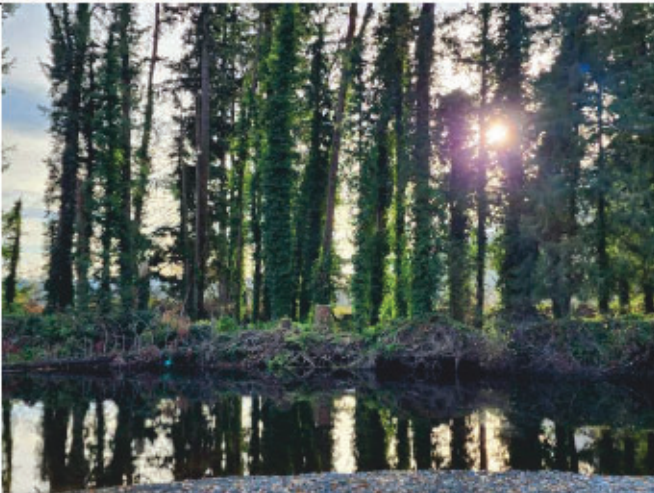


Photo 7: The leaning cedar was successfully removed.

Andrea Kerr
Observer Name

Andrea Kerr

Signature

2022/11/24
Date



KERR WOOD LEIDAL
consulting engineers

Appendix J

Record Drawing

