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Chemainus River Right Bank Recovery below Highway #1 Bridge

2024 Construction Completion

Final Report
December 30, 2025
KWL Project No. 3427.025

Prepared for:
BC Ministry of Environment and Climate Change



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1. Introduction

1.1 Purpose of Report

This report documents the completion of recovery works on the right bank of the Chemainus River downstream of the Trans Canada (Highway 1) Bridge crossing. This work was completed in response to the November 2021 Atmospheric River Event (ARE).

Kerr Wood Leidal Associates Ltd. (KWL) was retained by the BC Ministry of Environment and Climate Change Strategy (ENV) to lead the technical aspects of this project including project management, coordination of the Chemainus River Task Force, design, tendering and procurement, and construction services including site reviews and contract administration.

1.2 Background

This is the third year of flood recovery work on the Chemainus River, building upon previous work completed by KWL on behalf of ENV. A preliminary site assessment was performed by KWL on September 7, 2022 that established project and design objectives. This assessment was updated on September 25, 2023 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 Road Bridge as well as additional areas of flooding concern within Halalt IR2 and surrounding areas in the Municipality of North Cowichan. 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.

As shown in Figure 1-1, 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 the Chemainus Road bridge.

Since the preliminary site assessment on September 7, 2022, KWL and ENV have worked together on recovery projects to address the areas of concern as listed in Table 1-1. A brief description of the works completed and status is also provided.

Table 1-1: Summary of Works Completed at Areas of Concern

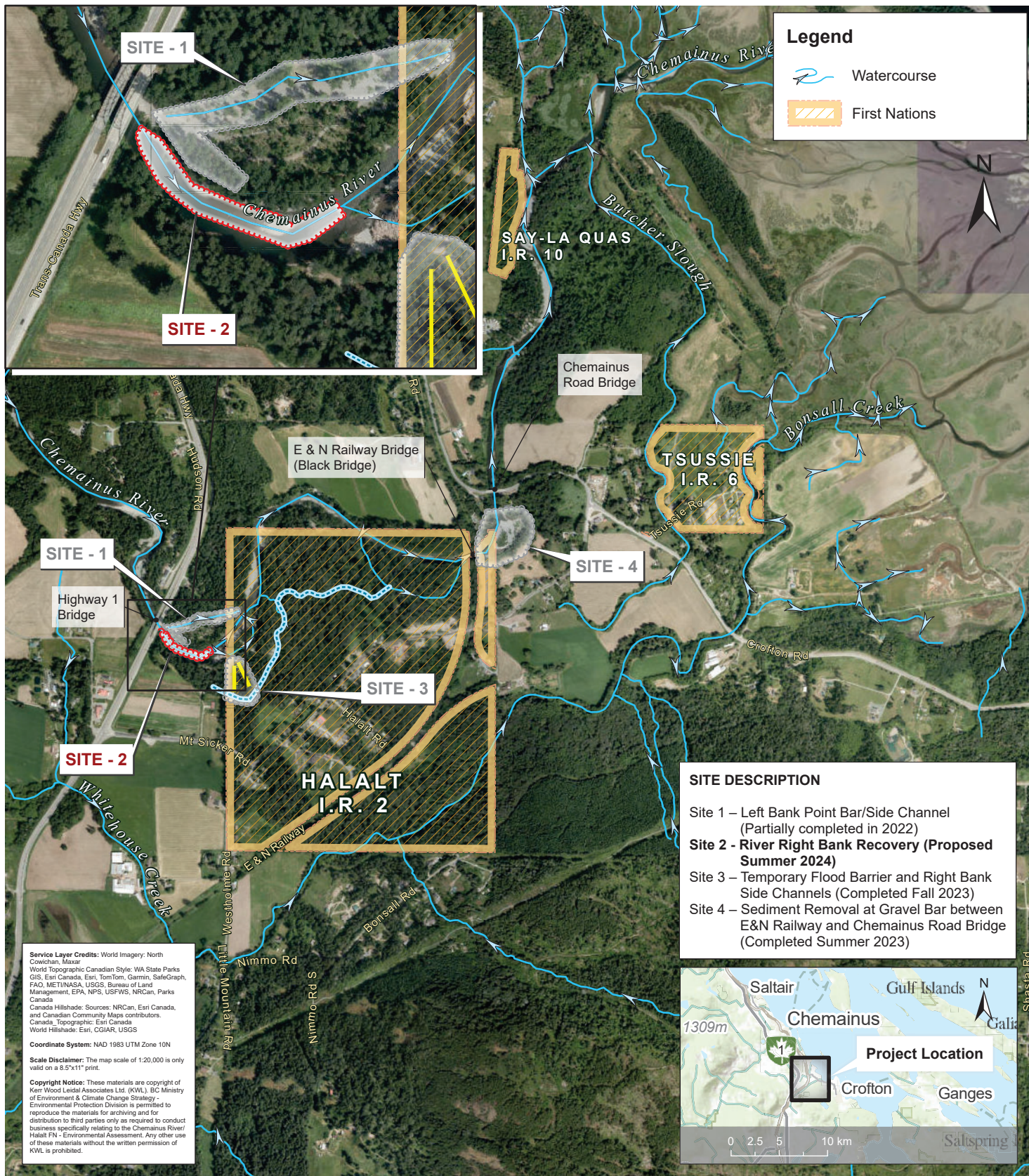
Location	Name	Description of Work	Status
Site 1	Left Bank Side Channel	Sediment removal at the left bank dry side channel and point bar downstream of the Highway 1 Bridge	Completed November 2022 (See 2022 KWL completion report)
Site 2	Right Bank Downstream of TCH Bridge	Recovery of the right bank downstream of Highway 1 Bridge and construction of bendway weirs	Completed in September 2024 (this report)
Site 3	Right Bank Side Channels	Temporary flood protection from the right bank side channels (Hesco flood barrier)	Completed November 2023 (see 2023 KWL completion report)
Site 4	Gravel Bar Between E&N Railway Bridge and Chemainus Road Bridge	Sediment removal at the gravel bar	Completed September 2023 (see 2023 KWL completion report)

BC Ministry of Environment & Climate Change Strategy

Chemainus River Right Bank Recovery – Environmental Assessment and Offsetting Plan



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Project No. 3427.025

Date February 2024

Scale 1:20,000

0 125 250 500 m

Project Location

Figure 1-1



At Site 2, the location of the right bank recovery works, the November 2021 ARE resulted in between 2.5 m to 6.3 m of lateral bank erosion along the section of unprotected bank based on available pre-flood and post-flood survey data. This erosion resulted in loss of approximately 100 linear metres of an unregulated riverside berm which extended upstream from the unregulated berm within Halalt IR 2. Loss of a portion of the unregulated riverside berm has resulted in:

1. Increased overbank flow into floodplain and the relic side channels adjacent to the right bank downstream of the Highway 1 bridge.
2. Increased potential for avulsion of the main channel into side channels on the right bank floodplain.

Both an increase potential for overbank flow and channel avulsion could increase risk to the Halalt First Nation lands and the neighbouring community within the Municipality of North Cowichan as well as important off channel fish habitat. The design and implementation of the works described herein are in response to these concerns.

1.3 Location

The project site is located on the south (or right) bank of the Chemainus River immediately downstream of the Trans Canada Highway (Highway #1) Bridge about 12 km north of Duncan, BC. The site is located on privately owned land (2587 Mount Sicker Road) within the District of North Cowichan and upstream and adjacent to Halalt IR 2 as shown in Figure 1-1.

Site ID	S-CM-1
Site Description	Chemainus River @ HWY1 downstream of TCH Bridge
Location	UTM Zone 10 U N 5,414,050 m, E 448,432m
Local Government Agency	Halalt First Nation, District of North Cowichan
Waterbody	Chemainus River

1.4 Scope

The design intent of the works was to provide an innovative solution for recovery of the right riverbank of the Chemainus River by means of the construction of a series of bendway weirs. The construction scope of work for this project is generally described as follows:

- Establish access to the work area by removing a section of Hesco basket wall to facilitate machine access and clearing and grubbing the vehicular access road as well as individual access points to the river's edge at the location of each bendway weir.
- Isolate the instream work area for each bendway weir separately using floating turbidity curtains to allow for construction in the wet without releasing plumes of sediment during rock placement. Once each curtain section is fully installed, the isolated area is cleared of any trapped fish through the use of seine netting and/or electrofishing.
- Install six rock bendway weirs into the riverbed and along the right bank and extending into the river at an upstream angle using MoTI Class 1,000 kg riprap. The works also include Class 250 kg riprap as bank armouring and to key each bendway weir into the bank. An upstream riprap key extends the rock into the bank to reduce the risk of erosion causing outflanking of the works during a major flood event.



- Install two trees with rootballs into the bank and extending into the river to form a large woody debris structure for fish habitat on the downstream side of each bendway weir.
- Remove invasive species within the footprint of the works as indicated by the professional biologist, primarily English Ivy.
- Restore and plant disturbed areas with a blend of native grasses, forbs, trees, and shrubs. Sections of riprap are also joint planted with willow stakes to provide overhanging cover. The restoration and planting work includes a maintenance period of 1 year following construction completion.
- Decommission site access and reconstruct the section of Hesco wall that was removed to facilitate access to the site.

1.5 Project Team

The KWL project team included:

- Project Director – Crystal Campbell, P.Eng.
- Senior Technical Advisor/Qualified Professional – Craig Sutherland, P.Eng.
- Project Manager – Stephen Bridger, P.Eng.
- Engineer of Record, Field Reviews, Contract Administrator – Liam Mackle, P.Eng.
- Project Biologist – Chad Davey, RPB
- CAD and Field Reviews – Peter Collins, ASCT

The following subconsultant support was engaged:

- Environmental Monitoring – Madrone Environmental Services Ltd.
- Site Survey – Turner and Associates Land Surveying
- Hydraulic Modelling – Northwest Hydraulics (nhc)

Halalt First Nation representatives:

- Chief – James Thomas
- Director – Caroline Gladstone
- Finance Director – Annie Cossey
- Archaeological Monitor – Tony George Sr.
- Waters Edge Biological Consultants – Cheri Ayers

The general contractor for the work was Ts'uubaa Pacific Civil Projects LP, with the following key staff:

- Project Manager – Greg Stone
- Site Foreman – Jerry Janik
- Equipment Operator – Todd Fredrickson
- Subcontractors:
 - Landscaping – Blue Pine Enterprises
 - Fencing – Tower Fence

On behalf of the client, project direction was provided by the following:

Ministry of Environment and Climate Change Strategy – Flood Debris Management Secretariat

- Senior Project Manager – Amy Vallarino
- Operations Manager – Thyren Garde-Jacobs



District of North Cowichan

- Director Engineering Projects – David Conway
- Senior Environmental Specialist – Dave Preikshot

Cowichan Valley Regional District

- Environmental Services Division Manager – Jeff Moore



2. Design

2.1 Pre-Construction Site Condition

The project site is located on the outside of a long sweeping bend on the south (or right) bank of the Chemainus River downstream of the Highway 1 Bridge. Existing materials along the 240 m long section of the south riverbank downstream of Highway 1 bridge consisted of exposed unconsolidated gravel layers over a cobble/gravel layer near the channel bed. The riparian area on the floodplain adjacent to the south riverbank consists of mature cottonwood trees and shrubs. Immediately downstream of the Highway 1 bridge for approximately 40 m, there are randomly placed concrete slabs that are not engineered and remnants of the old highway bridge deck materials. Aside from some concrete slabs at the riverbank, essentially the entire 240 m section consisted of an unprotected natural riverbank with varying degrees of root strength from the riparian vegetation. The downstream end of the unprotected bank is located near the reserve boundary of Halalt IR 2, which is located about 280 m downstream of the Highway 1 bridge.

At this location, the right riverbank was actively eroding resulting in increasing loss of private land and increased sediment input to the river. Additionally, several mature riparian trees had been undermined or fallen into the river channel as a result of the observed erosion.

2.2 Design Objective and Description

The design objective was to recover the integrity of the right bank through installation of bendway weirs in lieu of traditional bank armoring to reduce the construction footprint and maintain as much natural riverbank and riparian area as possible. The bendway weir river training method includes use of a series of low level rock structures angled slightly upstream to direct channel flow away from the eroding bank. Induced scour at the tip of the weirs and on the downstream sides of the weirs results in formation of pools which is beneficial for fish habitat complexity. Further fish habitat design considerations include large woody debris structures downstream of each weir with attached rootballs to promote local scour and provide further naturalization and fish refuge.

The bank recovery works extend approximately 200 m along the south (right) bank of the river, tying into a series of existing randomly placed concrete slabs and extending downstream. The upstream end of the works consist of a shorter bendway used to transition flow away from the bank and a rock cut off trench extending approximately 12 m into the river bank perpendicular to the flow. The remaining five bendway weirs consist of Class 1,000 kg riprap and extend approximately 7 to 12 m into the river channel. Each bendway weir has a rock cutoff trench and bank armoring consisting of 250 kg class riprap extending approximately 7 m upstream and downstream of the centerline of the weir. Rootwads were embedded into the bank armoring on the downstream side of each bendway weir crest for fish habitat. The angular riprap material was top dressed in rounded alluvium to naturalize the weirs.

The bendway weir concept and alignment was built into the 2-D HEC RAS hydraulic model for the Chemainus River developed by NHC as part of the Integrated Flood Management Plan for the Cowichan Valley Regional District in 2022 to assess the impacts and effectiveness under several flood scenarios. The results of the hydraulic modelling included estimates of the water surface elevation and velocities with and without the bendway weirs to assist with finalizing the detailed design and are included in Appendix B.



After construction of the weirs, vegetation restoration of the site consisted of intensive bank and riparian planting of native plants, shrubs, and trees. Upper sections of the bank riprap were staked with willow cuttings to provide long term overhanging cover to the river. In addition, removal of invasive species within the project footprint was undertaken.

Record drawings for the works are included in Appendix C.



3. Permitting and Approvals

3.1 First Nations Consultation

KWL first met with Chief Thomas and Joe Seward of Halalt First Nation on September 7, 2022 during the initial field reconnaissance of the Chemainus River. Halalt First Nation confirmed that they supported the project and understood the urgency for recovery of the right bank downstream of the Highway 1 Bridge.

Penelakut First Nation staff also supported the project and participated in the Chemainus Task Force and associated meetings.

On December 4, 2023, an open house was hosted by Halalt First Nation in collaboration with the Cowichan Valley Regional District and Municipality of North Cowichan. There were approximately 107 community members from North Cowichan, Penelakut First Nation and Halalt First Nation in attendance. Information on the Chemainus Right Bank Recovery project was shared along with the sediment removal and temporary flood barrier works completed in 2023. In addition, there was information presented by Halalt First Nation on the Chemainus River Watershed Initiative project, and by the CVRD on the Chemainus River Flood Mapping (NHC 2022), as well as MNC on general flood emergency preparedness measures.

Halalt First Nation staff were involved in the design review and construction phases of the project through ongoing site visits and meetings with ENV staff and the design team.

3.2 Environmental

An Environmental Assessment and Offsetting Plan was developed to provide details on the proposed construction activities, existing environmental attributes present at the site, potential impacts to environmental attributes, measures to mitigate adverse impacts, a habitat balance and offsetting plan, and recommended monitoring.

The Environmental Assessment and Offsetting Plan report was submitted in support of a *Fisheries Act* Authorization application to Fisheries and Oceans Canada (DFO) and a *Water Sustainability Act* (WSA) Change Approval application submitted to the BC Ministry of Water, Lands, and Resource Stewardship (WLRS). A copy of the Environmental Assessment and Offsetting Plan is provided in Appendix D along with the WSA Change Approval and DFO Letter of Advice.

The Water Sustainability Act Change Approval for Works In and About a Stream authorization letter was issued on July 12, 2024 (file: 1006026). Correspondingly, a Request for Review was submitted to Fisheries and Oceans Canada (DFO) for the project and a Letter of Advice (24-HPAC-00149) was received from DFO dated May 22, 2024. Implementation measures to avoid and mitigate the potential for prohibited effects to fish and fish habitat were provided and copies of approval letters are attached in Appendix D.

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

Full-time environmental monitoring services were provided by Madrone Environmental Services Ltd and representatives were on site during the construction works to mitigate risk to aquatic species and habitats.



3.3 Archaeological

Archaeological permitting was undertaken by ENV under HCA permit 2021-0453 for the Chemainus River Right Bank Recovery project. The permitting required that an archaeological monitor from Halalt First Nation was onsite during the construction works.

3.4 Land Access

Halalt First Nation, a private landowner (2587 Mount Sicker Road), 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 Right Bank Recovery project.

In addition, a Licence of Occupation agreement was created and executed by both the landowner at 2587 Mount Sicker Road and ENV. A copy of the agreement is attached in Appendix F.

It is noted that Clause 18 of the agreement refers to Transfer of the Property which occurred in March 2025 and ENV is awaiting a signed Assignment and Assumption Agreement with the new property owners.

Furthermore, the agreement as written expires on December 31, 2028 and is also in reference to the temporary flood barrier (Hesco basket wall) that was constructed in fall of 2023.



The upper bank sections were top dressed in soils sourced on site once each weir was finished, then the instream isolation was removed under direction of the environmental monitor. This process was followed for the installation of all six bendway weirs.

Site cleanup and restoration began with a “rough and loose” surface treatment of the disturbed areas that included uneven ground finishing with little to no compaction, incorporation of alluvium into the soil, and placement of logs and other wood debris. After the heavy equipment had been demobilized from the site, the landscape restoration took place and included seeding and planting all disturbed areas per the approved restoration and planting plan. When vehicular access was no longer required, the removed section of Hesco basket wall was also reinstated.

4.3 Engineering Field Review and Contract Administration

Engineering field reviews were completed by Peter Collins and Liam Mackle, and contract administration was completed by Liam Mackle and Stephen Bridger. Construction progress reviews and field inspections occurred several times a week for the duration of the project and at critical points in the construction process. Weekly field inspection reports have been included in Appendix H.

4.4 Changes During Construction

The following changes from the tendered contract were implemented during construction and were included in four approved change orders:

- Several existing concrete slabs at the upstream end of the site were moved for construction access and broken up for removal from the site. This work also included testing the concrete for asbestos which came back with a negative result.
- A unit price change for the Class 1,000 kg and 250 kg riprap and gravel filter material based on a quantity variance exceeding 15% and per the CCDC contract.
- Removal of an undercut tree along the right bank.
- Bucking of several trees deposited during high flows on the left bank at the site of the 2022 side channel excavation work across the river from the right bank recovery works.
- A unit price change for the property fence due to a quantity variation.
- Chimney inspection and repair work at 2587 Mt Sicker Road in follow up to issues identified during the 2023 flood recovery work.
- Additional bank restoration work and seeding at the property (8282 Chemainus Road) used to access the river for the 2023 Sediment Removal Project.

Further details for the change orders are included in the contract payment documentation discussed in Section 5.



4.5 Construction Monitoring

4.5.1 Environmental Monitoring

Environmental monitoring was conducted by Madrone Environmental Services Ltd. (MESL) as the Qualified Environmental Professional onsite. Responsibilities of the environmental monitor included, but were not limited to, the following:

- Pre-construction bird survey and breeding bird nest sweep, and daily site sweeps for terrestrial wildlife and Species at Risk.
- Oversee and inspect the installation and function of instream isolations, including fish salvage (seine netting and minnow traps), and ongoing turbidity and water quality monitoring during active instream construction.
- Implementation monitoring for habitat features such as LWD, plantings, watering, and site cleanliness.
- 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 environmental monitoring for the project is provided in the Post-Construction Environmental Monitoring Report by MESL in Appendix I.

4.5.2 Archaeological Monitoring

Archaeological monitoring services were provided by Tony George Sr. of Halalt First Nation to oversee all excavation activities during construction.

4.6 Project Completion

Ts'uubaa Pacific achieved Substantial Performance of the construction works including site restoration, planting, and temporary irrigation installation effective September 20, 2024 with the 55 day lien holdback period ending November 14, 2024.

Some minor works were completed following these dates including:

- Fence and gate installation completed on November 12, 2024.
- Chimney repair work at 2587 Mount Sicker Road completed November 25, 2024 (resulting from damage to the chimney from vibration during the 2023 construction works).

A record survey based on ground truthed drone photogrammetry was received October 10, 2024 and the record drawings are included in Appendix C.

The contract included 1-year of plant maintenance was completed in November 2025. Quality assurance work, inspection, and monitoring was provided by KWL and MESL. An Effectiveness Monitoring Report (MESL 2025) for the plant maintenance is provided in Appendix I.



4.7 Summary of Key Dates

Table 4-1 shows a summary of key project dates for the right bank works.

Table 4-1: Summary of Key Dates

Work Component	Date(s)
Ts'uubaa Pacific Mobilization	August 5, 2024
Site Access	August 5 - 9, 2024
Clearing and Grubbing	August 5 - 9, 2024
Bendway Weir Construction	August 12 - September 6, 2024
Site Restoration and Planting	August 26 - September 23, 2024
Ts'uubaa Pacific Demobilization	September 6, 2024
All Site Works Completed (i.e., fence)	November 12, 2024
Completion of Plant Maintenance Period	November 2025



6. Future Considerations

6.1 Operation, Maintenance, and Monitoring

Beyond the first year maintenance period in the construction contract, operation and maintenance considerations for the project works are anticipated to be minimal. Regular monitoring of the performance of the bendway weirs should occur during and following any high flow events. Maintenance or repairs may be required if any excessive material deposition or shifting of the weir or bank riprap occurs during major floods as determined by a qualified professional.

Monitoring and maintenance of the riparian vegetation may be required including removal of invasive species to protect and promote growth of planted riparian vegetation.

Long term monitoring shall be undertaken by the Municipality of North Cowichan and Halalt First Nation.

6.2 Other Considerations

As part of the ongoing Lower Chemainus River Integrated Flood Management Plan process, additional flood improvement options could be identified and tested using the available hydraulic model. This may include additional sediment removal that could be identified following a detailed sediment assessment and transportation study.

Further development of the Chemainus Watershed Initiative and management planning process led by Halalt First Nation with support from the CVRD and MNC will aid in providing guidance for additional flood management along the Chemainus River. The goal is to develop a community led plan to provide guidance on management of watershed scale processes that impact sediment, flood, and debris risks in the watershed.



7. Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.



Permit to Practice #1000696
2025-12-31

Liam Mackle, P. Eng.
Water Resources Engineer

Reviewed by:

Stephen Bridger, P. Eng.
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Senior Engineer



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	December 30, 2025	FINAL	Final issued for Use	LTM



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Appendix A

Preliminary Site Assessment of Potential Area of Concern – Revised

Kerr Wood Leidal

September 25, 2023

Technical Memorandum

DATE: September 25, 2023

TO: Amy Vallarino
Flood Debris Management Secretariat

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

RE: PRELIMINARY SITE ASSESSMENT OF POTENTIAL AREAS OF CONCERN – REVISED
Site S-CR-1 Chemainus River, Halat First Nation
Our File 3427.020-300

1. Introduction

The purpose of this high level and preliminary assessment of identified Areas 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 @ Halat IR 2
Location	UTM Zone 10 U N 5,435,217 m, E 489,484 m
Local Government Agency	Halat First Nation, District of North Cowichan
Waterbody	Chemainus River

This revised technical memorandum provides an update to the original preliminary site assessment for the Chemainus River (Site S-CM-1) dated October 20, 2022. This revised memo includes additional field information collected as well as improved understanding of Chemainus River channel and flood conditions based on further field visits and discussions with Halat First Nation (Halat FN), Municipality of North Cowichan (MNC) staff and other community that have occurred since the original memo was issued. In addition, the memo provides revised recommendation for remedial actions based on the work carried out since preparation of the original preliminary assessment completed in September 2022.



2. Background

Recent Flood Events

Two extreme rainfall events on February 1, 2020 and on November 15, 2021 resulted in the third highest (468 m³/s) and second highest (500 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.

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 and the November 2021 flood correspond to a 15-year return period flood and a 10-year return period flood, respectively¹.

Community Flood and Erosion Risks

The Halalt FN community and neighbouring properties within the MNC are located within the Chemainus River, Bonsall Creek and Whitehouse Creek floodplains. Past flood events and recently completed hydraulic modelling carried out by NHC indicate that flow frequently spills over the riverbanks and across the floodplain of Chemainus River, Bonsall Creek and Whitehouse. These floods can have substantial long-term impacts to the local community in terms of life safety, impacts to infrastructure, and negative impacts to health. In addition, flooding can result in closure of Highway 1 and other local roads across the floodplain. As all the transportation corridors connecting Vancouver Island communities cross the Chemainus River floodplain and there are no alternative detour routes available, flooding can result in significant disruption to regional transportation system. Therefore, the underlying flood risks to the Halalt FN community, MNC community and the broader Cowichan Valley and Vancouver Island region are considered to be high to very high.

Mitigating these 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. Reduction 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 (CVRD) in partnership with Halat FN, the MNC and the local community.

As stated earlier, the purpose of this preliminary assessment is to consider risks and potential consequences resulting from accumulation of sediment and debris during recent flood events. Therefore, the assessment of risk in this high level and preliminary assessment considers:

1. How accumulation of sediment and debris during the recent 2020 and 2021 flood events in the Chemainus River between Highway 1 Bridge and Chemainus Road Bridge has changed the likelihood of flooding, channel erosion and channel avulsion across the floodplain.
2. What are the incremental changes in flooding and erosion impacts to the community resulting from sediment and debris accumulation that are beyond the underlying risks to communities in the floodplain.

Any measures to mitigate increased risks resulting from the recent 2020 and 2021 flood events are intended to help reduce risk in the interim while long term solutions to address underlying risks are developed and implemented.

¹ Northwest Hydraulic Consultants, Chemainus River Flood Mapping Program Part 1 – Floodplain Mapping Report, Prepared for Cowichan Valley Regional District, Draft Report – Rev 0. May 2022.



Geomorphological Context

The Chemainus River Geomorphic Atlas (Geomorphic Atlas) prepared by NHC for CVRD in May 2022² 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 ~8km of the Chemainus River. Only reaches 3 to 5 are located within or adjacent to Halat 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 Halat FN in 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 Halat FN as well as providing additional conveyance upstream to limit potential for bank erosion and avulsion.

2.1 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 Halat First Nation (Halat FN) lands. The reconnaissance was also attended by Chief Thomas and Joe Seward of Halat FN, Derek Masselink, Cody Anderson and Amanda Swift of Ministry of Emergency Management and Climate Readiness (EMCR), 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 along the Chemainus River between Highway 1 and Chemainus Road:

1. Left bank point bar and side channels downstream of Highway 1 Bridge – Reach 5.
2. Right bank erosion downstream of Highway 1 Bridge – Reach 5.
3. Right bank side channels – Reach 5.
4. Gravel bar between the E&N Railway Bridge (locally known as the Black Bridge) and Chemainus River bridge – Reach 3.

² Northwest Hydraulic Consultants, Chemainus River Flood Mapping Program Part 1 – Floodplain Mapping Report, Appendix C-Chemainus River Geomorphic Atlas, Prepared for Cowichan Valley Regional District, Draft Report – Rev 0. May 2022.



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.

Halat FN also showed KWL/PwC/EMBC four additional sites where flooding is a concern including:

- A. Butcher Slough at Tsussie Road Bridge.
- B. Butcher Slough at Swallowfield Road/Ducks Unlimited Access Road culverts.
- C. Bonsall Creek at Tsussie Road.
- D. Drainage relief culverts at E&N railway near Halat FN community.

The naming of sites on the left and right bank follows standard naming conventions based on a viewer looking downstream along the channel.

Following the original site visit in September 2022, KWL has attended several additional field visits which have allowed for additional information to be collected and to provide an improved understanding of the impacts of the 2020 and 2021 flood events. A summary of these site visits is included in Table 2.

Table 2: List of Chemainus River Site Visits

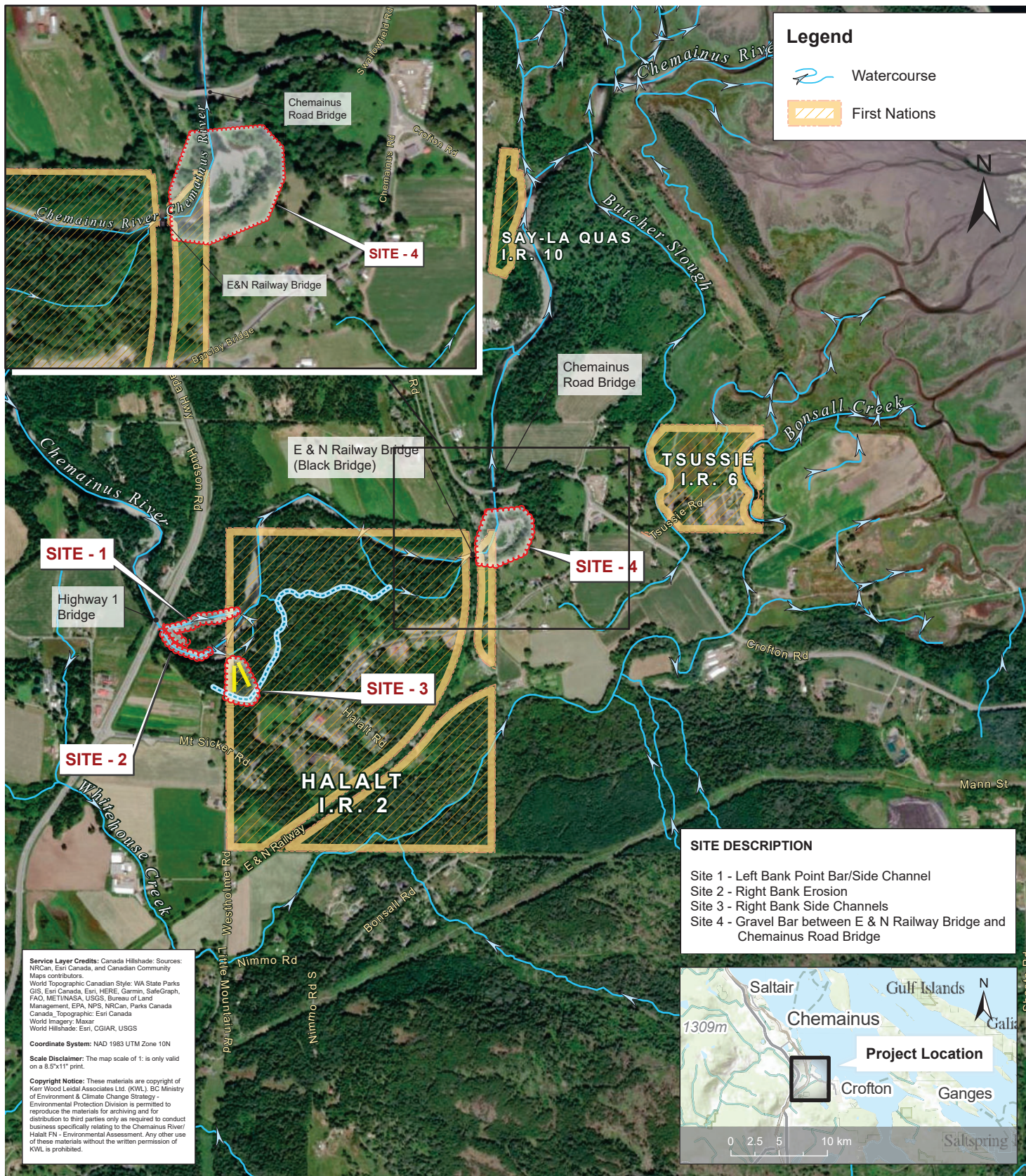
	Purpose/Location	Attended by
September 7, 2022	Initial site reconnaissance to review channel conditions and discuss flood implications. Site visit was limited to access across Halalt FN lands and MNC lands.	Chief Thomas, Halalt FN Joe Seward, Penelakut FN Cheri Ayers, Halalt FN (Consultant) Josh James, Penelakut FN Derek Masselink, EMCR Cody Anderson, EMCR Amanda Swift, EMCR Kalena Chang, PWC Craig Sutherland, KWL
December 15, 2022	Review Site 4 conditions and Discussion with adjacent landowners.	Craig Sutherland, KWL Liam Mackle, KWL Dave Conway, MNC Colin James, Property Owner Don Allingham, Property Owner
January 5, 2023	Review alignments for interim flood protection works and discussion of broader floodplain management issues.	Chief Thomas, Halalt FN Cheri Ayers, Halalt FN (Consultant) Josh James, Penelakut FN David Conway, MNC Jeff Morre, CVRD Corey Anderson, EMCR Hanah Swift, EMCR Craig Sutherland, KWL Shamsul Chowdhury, Parsons
January 19, 2023	Review of Chemainus River Right Bank (Site 2 and Site 3)	Chief Thomas, Halalt FN Cheri Ayers, Halalt FN Craig Sutherland, KWL David Conway, MNC France Bournazel, Property Owner

Additional site visits not listed above have occurred to address specific issues related to gravel/debris management planning as well as the design of interim flood protection work and Chemainus River right bank works have also taken place. However, these visits do not relate specifically to preliminary site assessment and so have not been included.

BC Ministry of Environment & Climate Change Strategy - Environmental Protection Division Chemainus River/Halalt FN - Environmental Assessment



KERR WOOD LEIDAL
consulting engineers



Project No. 3427.021

Date July 2023

Scale 1:20,000

0 125 250 500 m

Project Location

Figure 1



3. Land Ownership

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

Table 3: Land Ownership/Jurisdictions

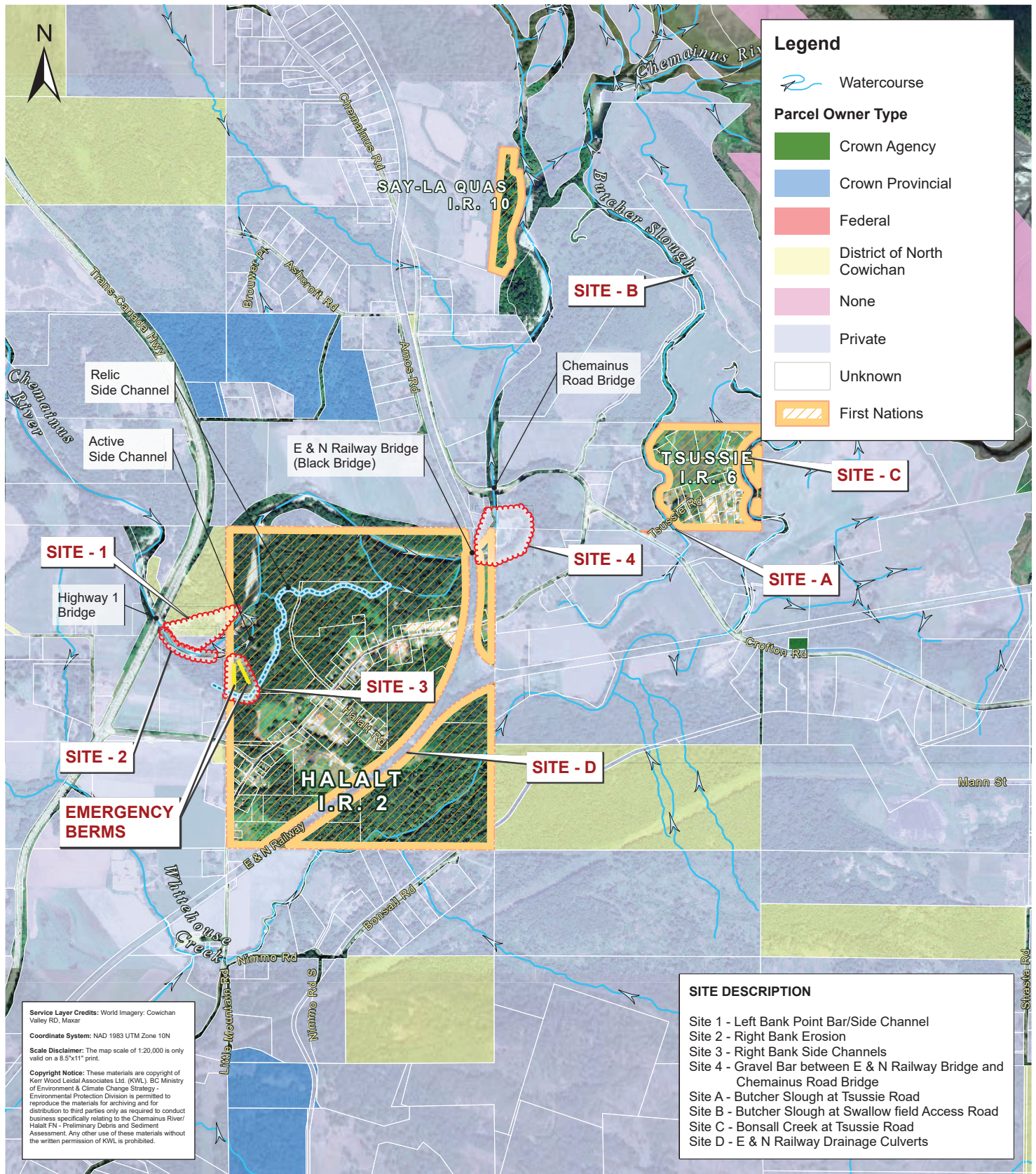
Site #	Site Description	Land Ownership/Jurisdiction
1	Chemainus River Left Bank Side Channel/Point Bar	District of North Cowichan
2	Chemainus River Right Bank Erosion	Private
3	Chemainus River Right Bank Side Channels	Private/Halat I.R. 2
4	Chemainus River gravel bar E&N Railway/ Chemainus Road Bridge	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	Halat 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 Halat FN 2)/Crofton Road – MOTI

BC Ministry of Environment & Climate Change Strategy - Environmental Protection Division Chemainus River/Halalt FN - Preliminary Debris & Sediment Assessment



Project No. 3427.014
 Date November 2022
 Scale 1:20,000
 0 125 250 500 m

Study Area - Land Ownership

Figure 2



4. Site Hazards

4.1 Inter-related Sites 1, 2, 3

Sites 1, 2, and 3 are adjacent to each other, are interrelated and will be assessed together. A plan showing Sites 1, 2 and 3 is included in Figure 3.

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 consist 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

Airphoto 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, 2002)

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**

Based on conversations on site with the owner of the property on which the erosion is occurring and Chief Thomas of Halalt FN, we understand that erosion of the right bank of the Chemainus River has result in loss of approximately 200 m of a berm which ran parallel to the river channel. This riverside berm connected from the end of the access road/berm from Halalt Land to the Highway 1 road embankment downstream of the highway bridge crossing (see Photo 7).



**Photo 7: Right Bank of Chemainus River
Downstream of Highway 1 Bridge Showing
Approximate Alignment of Original Berm**

No records of construction of the riverside berm have been provided to KWL but it is likely the riverside berm was constructed as part of the fisheries side channel work carried out on Halalt I.R. 2. Based on remaining evidence of the riverside berm observed on site, the crest of the original berm was at elevation approximately equal to the agricultural field elevation to the south of the site. According to floodplain mapping and recently completed hydraulic modelling studies, the original riverside berm would have been overtopped during extreme floods (200-year return period flood). However, the original riverside berm would have prevented overbank flow during more frequent flood events into the relic side channels located between the main river channel and the agricultural fields to the south.

Ongoing erosion of the right bank could result in additional loss of the original berm along the river channel in this location and further changes to the upstream end of the relic side channels on the right bank floodplain leading to:

1. Increased overbank flow into floodplain and relic side channels on right bank downstream of the Highway 1 bridge, this overbank flow follows side channels through the right bank floodplain across Halat FN IR 2 towards the Halalt FN community and a portion of the overbank flow passes through a culvert under the E&N railway embankment to the north of Chemainus Road leading to increased flooding to properties to the east of the E&N railway embankment during more frequent flood events.
2. Increased frequent flooding of floodplain and side channels leading to potential for avulsion of the main channel across the right bank floodplain and into the relic side channels (discussed further in Site 3 below).

Both an increased potential for overbank flow and channel avulsion increase risk to the Halat FN community and neighbouring communities as well as important off channel fish habitat discussed further in Site 3.

Site 3 – Right Bank Side Channels

Description

Two side channels are located on the right bank floodplain of the Chemainus River. The first side channel, which is an active side channel that 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 active right bank 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 8).



Photo 8: Entrance to Right Bank Side Channel Showing Eroding Bank, Riprap/Log Groin, and Log Jam

Both the logjam and the groin limit the amount of water that flows into the active side channel in this location. However, ongoing erosion upstream (Site 2) could outflank the groin structure and result in additional water flowing into the active right bank 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. The relic 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. It flows through mature riparian vegetation and is at an elevation that is high enough not to be activated during all high flow events.

Two temporary gravel berms were constructed across the relic side channels in the floodplain within Halat FN reserve lands (see Photo 9). A trapezoidal channel has been left in the berm at the location of the relic side channel (see Photo 10). These were constructed as emergency measures during the 2021 flood. They limited flow across the floodplain and concentrated flow in the two side channels.

As a precaution, these temporary berms have now been removed on recommendation from KWL (see Photo 12). It should be noted that wood debris was observed along the alignment of the temporary berms. It is not clear if this wood debris was placed as part of construction of the berms or was in place before construction (see Photo 13). It is recommended that this material be removed and incorporated into future rehabilitation work.



Photo 9: Berm constructed within Halat FN across the relic floodplain side channels on right bank of Chemainus River



Photo 10: Opening Through the Berm for Smaller Right Bank Side Channel

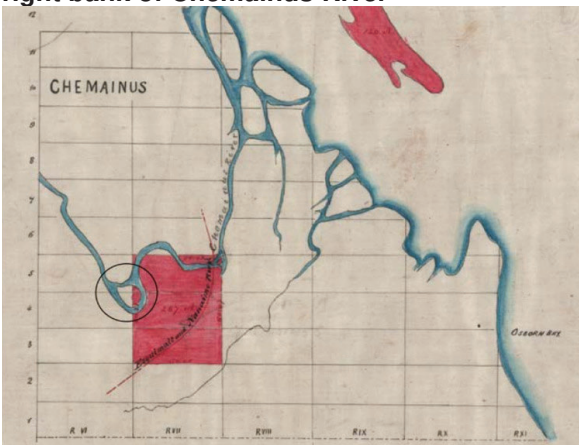


Photo 11: Map From 1877 Showing Two Active River Channels Near the Location of the Observed Side Channels
 (Source: NHC, 2022)

The downstream portion of the right bank relic side channel was excavated approximately 30 years ago to provide ground water rearing habitat for juvenile salmon. This habitat channel is approximately 1.6 km long. The habitat channel 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 11).



Photo 12: Temporary berm across floodplain within Halalt FN now removed.



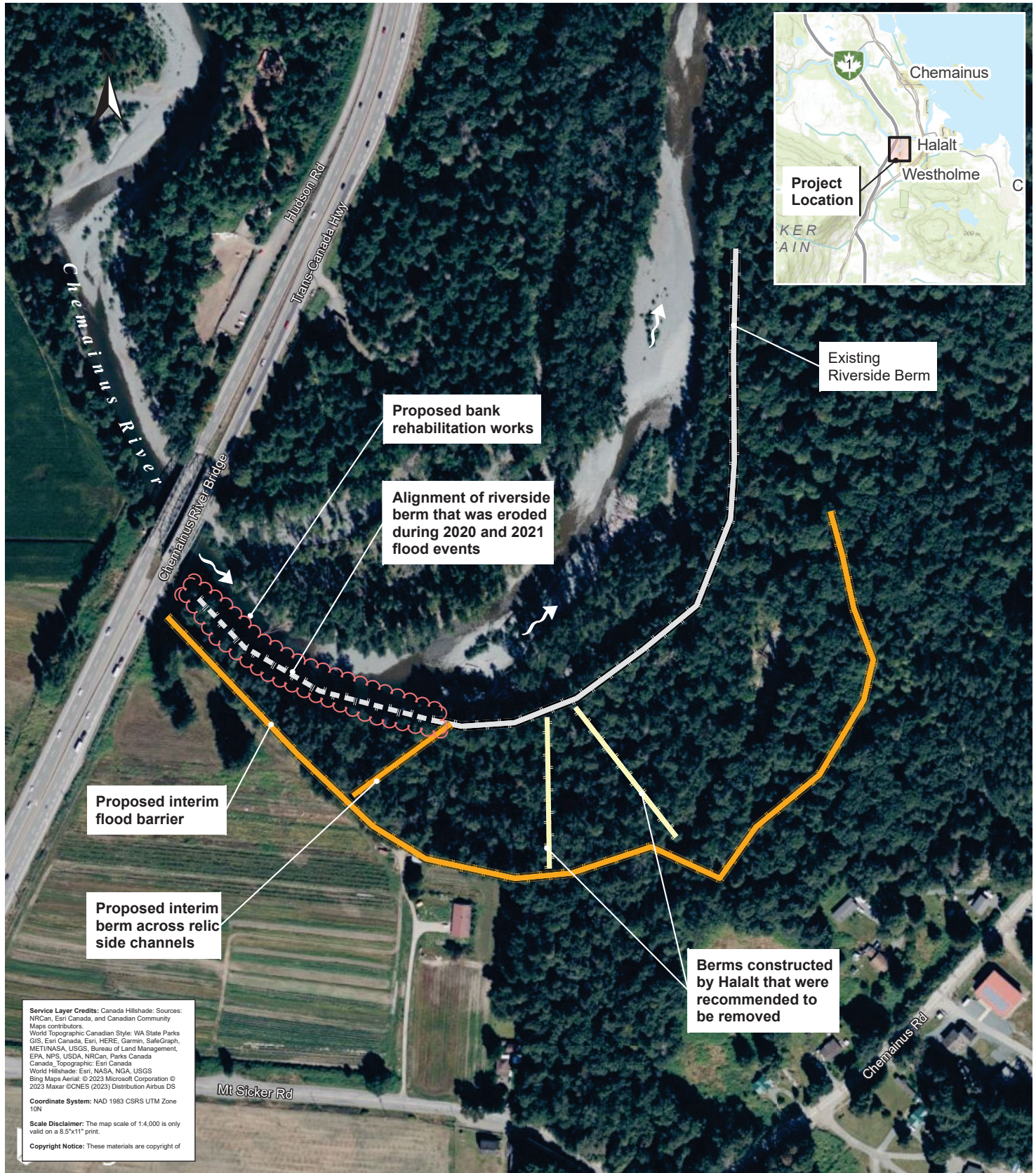
Photo 13: Wood debris observed adjacent to alignment of temporary berm.

BC Ministry of Environment and Climate Change Strategy

Chemainus River Right Bank Protection below Highway#1 Bridge



KERR WOOD LEIDAL
consulting engineers



Project No. 3427.025

Date September 2023

Scale 1:4,000

25 50 100 m

Site 1, Site 2 and Site 3
Plan

Figure 3



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

The Preliminary Qualitative Risk Evaluation is shown in Table 3. As the geomorphic processes at Sites 1, 2, and 3 work together to increase risk they have been evaluated together. The risk key is included in Enclosure A for ease of reference.

Table 3: Preliminary Risk Evaluation (Site1, Site 2, and Site 3)

Category	Preliminary Risk Evaluation	Consequence
Public Health and Safety	High	Ongoing accumulation of sediment on the left bank point bar (Site 1) and erosion of the right bank (Site 2) increases the potential for additional overbank flows onto the right bank floodplain during larger/less frequent flood events. This ongoing erosion has resulted in loss of approximately 200 m of a riverside berm that runs adjacent to the right bank of the Chemainus River mainstem channel. Loss of the riverside berm has resulted in increased overbank flow from the river into the upstream end of the relic side channels on the right bank. The loss of the berm has resulted in an increased likelihood of overbank flow and potential for avulsion. Given the increased frequency of overbank flow into the relic side channel, the potential of flooding within the Halalt Community and neighbouring community during relatively small flood events has increased. In addition, the increased potential for an avulsion of the main channel into the relic side channel results in further increase risk for potential for flooding within the Halat Community. Flooding results in significant long-term disruption to the Halat FN and neighbouring communities. Therefore, the incremental risk to public health and safety resulting from ongoing erosion of the right bank is considered to be High.
River Capacity	High	Ongoing accumulation of gravel/debris in the left bank point bar and side channel (Site 1) reduces river capacity and increases potential for bank erosion on right bank (Site 2) and avulsion into the relic side channel (Site 3). Due to gravel sources upstream and the highly erodible material on the right bank, the potential for deposition on left bank and continued erosion of the right bank is likely. Therefore, the risk of reduced river capacity is considered to be high.
Environmental	Medium	Potential avulsion of the mainstem flow into the relic side channel would result in significant impacts to the existing 1.6 km of rearing side channel habitat within Halalt FN which provides unique rearing and refuge habitat along this reach of the river. As the increased potential for avulsion is considered to be moderately likely the impact to environmental values is considered to be moderate.



Category	Preliminary Risk Evaluation	Consequence
Infrastructure	Medium	Due to gravel sources upstream and the highly erodible material on the right bank, the potential for further deposition on left bank and erosion of the right bank is likely. Given the increased frequency of overbank flow into the relic side channel, the potential of flooding within the Halalt Community and neighbouring community during relatively small flood events has increased. In addition, the increased potential for an avulsion of the main channel into the relic side channel results in further increase in risk for potential for flooding within the Halat Community. As, infrastructure (homes, roads, water system) within Halat FN are set back (300 m to 500 m) from both the mainstem and relic side channel the direct impact from bank erosion and potential channel avulsion is limited. However, increased potential for flooding due to loss of the riverside berm could result in increased likelihood of negative impacts to infrastructure within Halalt FN and neighbouring community. Given the limited potential for increased impacts to infrastructure due to bank erosion and potential channel avulsion and high potential for increased impacts due to increased likelihood of flooding, it is considered that increased risks to infrastructure are moderate within Halat FN and neighbouring community.

4.3 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 14).



Photo 14– 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 15). This debris has since been removed. However, it remains a location where debris accumulates and may require removal at this location again in future.



Photo 15: Large woody debris on right abutment of Chemainus Road Bridge after November 2021 flood which has since been removed (Source: NHC 2022)



Table 4: Preliminary Risk Evaluation (Site 4)

Category	Preliminary Risk Evaluation	Consequence
Public Health and Safety	High	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 private properties on the right bank floodplain. Increased overbank flow in Butcher Slough and across private properties on the right bank can lead to increase flood flows across Chemainus Road and into the Tussie I.R. 6. Although the peak water levels are not likely to change significantly as a result of sediment accumulation in the river channel at this location, the frequency of overbank flow is likely to increase which increases risk of flooding within these communities. The riverbanks along this reach of the river are protected from erosion by bedrock outcrops and riprap, sediment accumulation has limited potential for triggering bank erosion resulting in either further increased flows or potential for channel avulsion (such as at Site 2 which is not protected by riprap). However, the risk to public health and safety is still considered to be High due to the frequency of overbank flows.
River Capacity	High	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. Therefore, the risk to river capacity is considered to be High.
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.
Infrastructure	Medium	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 risk of impacting infrastructure. Ongoing monitoring will be required to assess accumulation of debris at these bridges.



5. Short-term Mitigation Options

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

Removal of sediment in the left bank side channel (Site 1) as outlined in the original preliminary assessment in September 2022 was completed during a period of unusually low water in November of 2022. Due to the risk of rainfall and potential for flooding of the construction site, the time window to carry out the work was limited. Therefore, only about 2,850 m³ of the original design amount of 5,000 m³ for sediment removal was carried out.

Comparison of topographic surveys carried out immediately after sediment removal including supplementary LiDAR from pre-2020 and in summer of 2022 indicates that a net volume of 560 m³ was transported out of the left bank side channel over the winter of 2022/23 (see Appendix B). The comparison of topographic surveys indicates that conveyance of the left bank side channel appears to have been maintained with left bank side channel invert elevations and channel widths measured in 2023 being approximately the same as those measured immediately after channel excavation in 2022. The only significant difference appears to be:

- Deposition in the upstream 70m of the excavated left bank side channel (between Stn 0+40 to Stn 0+110 as shown in Appendix B).
- Scour around tree trunks and tree roots (Section at Stn 0+080 and Stn 0+200 in Appendix B) that were not removed as part of the sediment removal program in 2022 due to time constraints for construction.

To maintain and improve conveyance through the left bank side channel (Site 1) and limit potential for ongoing erosion along the right bank (Site 2) over the winter of 2023/24, it is recommended that additional sediment removal be carried out along the left bank side channel to approximately match the surveyed post construction channel invert profile. It is also recommended to remove a small number of trees to limit the potential for scour holes to develop which appear to be the main source of sediment migrating from the left bank side channel.

Given the potential for ongoing sediment accumulation in the left bank side channel leading to limit 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.

5.2 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), reinstatement of a riverside berm and permanent protection of this highly erodible bank from further erosion is top priority. As the river channel has now moved into the alignment of the original riverside berm, reconstruction of the riverside berm at its original location is now not possible.

The proposed bank reinstatement work would be intended to reduce potential of overbank flows into the relic side channels on the right bank floodplain using a nature-based approach. The proposed bank reinstatement works would consist of a naturalized berm running parallel to the river channel that would be designed to be replanted with riparian vegetation. The proposed reinstated riverside berm would be set back from the river channel to maintain integrity of the existing riparian area.

To protect the natural berm from erosion, the proposed bank reinstatement works would also include hard points (spurs or bendway weirs) in the river channel to direct flow away from the erodible bank to allow the bank to restabilize over time 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 16).

The intent of the right bank reinstatement is to limit overbank flow into the relic side channel for smaller/relatively frequent flood events. Rehabilitating the right bank will reinstate a level of flood protection for the fish habitat side channel and the Halalt FN community similar to what was provided prior to erosion and loss of the original riverside berm. However, the proposed reinstatement will not protect the Halalt FN community and neighbouring properties within MNC during more extreme flood events. Therefore, an interim flood barrier has also been proposed to be installed shown in Figure 3. The proposed interim flood barrier is intended to provide a level of reduced flood risk for the Halalt FN community while the community carries out floodproofing measures in the community. The interim flood barrier is being constructed separately from the sediment and debris program but is provided here for context.

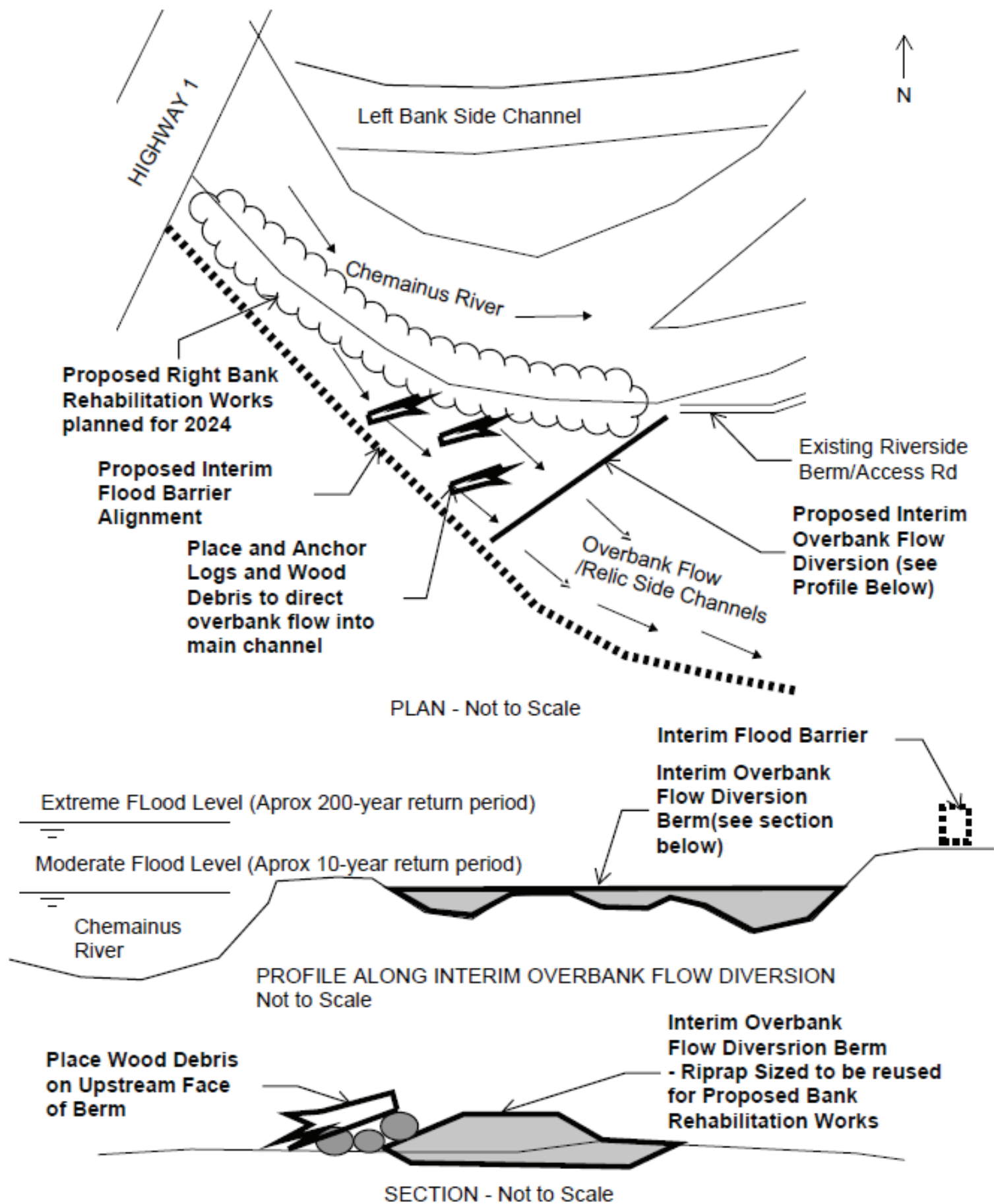


Photo 16: Example of Combination of Riparian Habitat with Rock Hard Points for Erosion

5.3 Site 3 – Right Bank Side Channels (Reach 5)

As work has not yet progressed on rehabilitation of the right bank (Site 2), the risk of overbank flow into the relic side channels on the right bank floodplain remains for the winter high flow season of 2023/24. In order to limit flow into the right bank relic side channels during lower/more frequent flood events, it is recommended that interim measures be carried out to partially block flow into the relic channels. The proposed interim overbank flow diversion would involve placement of riprap berms across the relic side channels (see Figure 4). Riprap should be sized such that it could be reused for construction of the hard points included in the design of the right bank rehabilitation works (Site 2).

In addition to the riprap berms, the work should also include rearrangement of the existing wood debris on and in the relic side channels to help direct flow away from the relic side channels and back into the main river channel during periods of high flow. The rearranged wood debris should be anchored (either to buried rock or mature riparian trees). Additional wood salvaged from the temporary berm alignment within Halalt FN and/or the sediment and debris removal projects (Site 1 and Site 4) could also be used to supplement the current wood debris in the floodplain.





5.4 Site 4 - Debris and Gravel Accumulation (Reach 2)

Given the risks associated with increased frequency of flooding resulting from sediment and debris accumulation in the Chemainus River Channel between the E&N Railway Bridge and Chemainus River Bridge, removal of sediment and debris on the gravel bar to help reestablish a portion of the river channel capacity at this location should be carried out during the low-risk fish window. The gravel removal should be designed as a gravel bar “trimming: to limit disturbance to the bar and limit potential for channel instability resulting from removal of the bar. The bar trimming should include removal of gravel above the low water level on the downstream two-thirds of the bar length. Any gravel, existing vegetation and wood debris located at the upstream third of the bar should also be left in place to help stabilize the bar. The gravel bar trimming should be graded to prevent formation of small pools which could lead to fish entrapment. Vegetation along the channel that has formed along the right bank riprap should also be protected.

It should be noted that this is a short-term solution and that further gravel removal should be planned in future until such time as long term solutions can be implemented (see Section 6). There should be a channel morphology monitoring program set up to measure effectiveness of gravel removal program. This should consist of a set of channel cross sections surveyed along the channel mainstem from upstream of the Highway 1 Bridge to downstream of the Chemainus Road bridge as well as sampling of riverbed sediment gradation (Wolman Sample). These could be located at transect locations established as part of the habitat assessment work carried out for Halat.

6. Site Opinion and Advice

Based on the hazard and risk assessment, Site 1, Site 2, Site 3 and Site 4 along the Chemainus River are Areas of Concerns, requiring further assessment, emergency work, and potential mitigation measures to be implemented as soon as possible.

Emergency Sediment and Debris Removal Works (2023/24):

- **Additional Sediment and Debris Removal (Site 1)** on left bank side channel downstream of Highway 1 Bridge involving trimming of sediment accumulation and removal of a small number of trees. This work should be completed based on regulatory permitting requirements and under direction of a Professional Engineer.
- **Design and Construct Right Bank Erosion Protection (Site 2):** given the risk of avulsion and increase in overbank flows into the floodplain associated with ongoing erosion of the right bank of the Chemainus River downstream of Highway 1 bridge, it is recommended that rehabilitation of the floodplain berm and bank restoration measures be designed and constructed. These measures can include riparian and habitat features but may have to also rely on hard points (such as spurs or bendway weirs) due to the higher flow velocities and scour associated with this location. This option will require detailed engineering design, negotiations with the private property owner to allow for construction access along the right bank of the Chemainus River as well as environmental regulatory approvals for working instream. Design and construction field review of this work should be completed under direction of a professional engineer and be carried out in accordance with regulatory permitting requirements and landowner permissions.
- **Remove Sediment and Debris (Site 4)** on Chemainus River between E&N Railway Bridge and Chemainus Road Bridge (Site 4) involving trimming of sediment accumulation and removal of minor wood debris to the low water level. This work should be completed based on regulatory permitting requirements and under direction of a Professional Engineer.



Long-term Holistic Solutions

- **Assess Flood Protection Improvements:** As part of the ongoing Lower Chemainus River IFMP process, flood improvement 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.
- **Develop a Watershed Management Plan:** A Chemainus River Watershed Management Plan process should be implemented with Halat 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.

Additional Recommendations to be Undertaken Outside this Sediment Program

- **Install Interim Overbank Flow Diversion** across the relic side channels on the right bank of the Chemainus River including riprap berms and wood debris. Wood debris adjacent to the alignment of the temporary berm (now removed) on Halalt FN and from sediment/debris removal projects (Site 1 and Site 4) could be reused at this site. This work should be completed based on regulatory permitting requirements, landowner permissions and under direction of a Professional Engineer.
- **Monitor Debris Accumulation:** 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. This should be carried out by repeated channel cross section surveys at defined locations prior to and a year after sediment removal.
- **Install Interim Flood Protection Barrier:** The proposed interim flood barrier should be designed and installed to help reduce flood risk for the Halalt FN community while planned flood proofing measures are carried out.



Closure

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

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:



Craig Sutherland, MSc., P.Eng.
Senior Water Resources Engineer

Reviewed by:

Stephen Bridger, M.A.Sc., P.Eng.
Project Manager

CS/SB/aah

Encl.: Enclosure A: Risk Evaluation Matrix
Enclosure B: Pre/Post Construction Ground Surface Comparison - Left Bank Side Channel Gravel Removal

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 Description	Author
0	October 20, 2022	FINAL		CS/DNM
1	September 25, 2023	REVISED	Revised based on additional information and field reconnaissance	CS/SB



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Enclosure A

Risk Evaluation Matrix

Table A-1: Risk Evaluation Matrix

		Risk Evaluation and Response				
	Consequence Rating	Very Low	Low	Medium	High	Very High
Indices	Public Health and Safety	Minor disruption to few.	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
Likelihood						
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		VH	Very High	Risk is unacceptable short-term (before next flood season); Risk reduction required		
		H	High	Risk is unacceptable medium-term; Risk reduction plan must be developed and implemented in a reasonable time frame		
		M	Medium	Risk may be tolerable; more detailed review required		
		L	Low	Risk is tolerable; monitor		
		VL	Very Low	Risk is broadly acceptable; no further review needed		



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Enclosure B

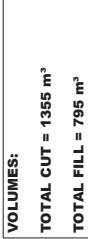
Sediment Monitoring Survey - Left Bank Side Channel Gravel Removal



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5

NOTE: AB = AS BUILT AFTER 2022 GRAVEL REMOVAL WORKS



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SEDIMENT MONITORING 2022 TO 2023 LEFT BANK SIDE CHANNEL

NOTE: AB = AS BUILT AFTER 2022 GRAVEL REMOVAL WORKS



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Appendix B

NHC Hydraulic Modelling Support Northwest Hydraulics June 11, 2024

Northwest Hydraulic Consultants Ltd.

495 Dunsmuir Street, #405
Nanaimo, BC V9R 6B9
Tel: 250.754.6425
www.nhcwater.com



NHC Reference No. 3008939
June 11, 2024

Kerr Wood Leidal

844 Courtney Street
Victoria, BC V8W 1C4

Attention: Stephen Bridger, PEng

Via email: SBridger@kwl.ca

Re: Chemainus River Ph. 2 Bank Protection Works
Hydraulic Modelling Support - Final Report, Rev. 0

1 INTRODUCTION

Kerr Wood Leidal (KWL) is designing bendway weirs downstream of Highway 1 on the Chemainus River. To support their design, KWL has requested Northwest Hydraulic Consultants Ltd. (NHC) to provide hydraulic modelling support. NHC developed the 2D HEC-RAS model for the Chemainus River floodplain as part of the Integrated Flood Management Plan (IFMP) study for the Cowichan Valley Regional District (CVRD) from 2021-2023 (NHC, 2022).

NHC's scope includes updating the IFMP model in the project reach (Figure 1) to reflect current conditions as of spring 2024, and modifying the model geometry to reflect the addition of the bendway weirs. The bendway weirs were not modelled individually, but were instead modelled as a blocked area over their total footprint at the design elevations provided by KWL. These two geometry scenarios were modelled under 5 different flow conditions for a total of 10 sets of results. The modelled scenarios are summarized in Table 1. NHC provided hydraulic model results (water level and velocity) to KWL via email for each scenario. The scope and modelling approach was confirmed with KWL in the project scoping meeting on February 21, 2024.

Elevations and model results are in Canadian Geodetic Vertical Datum 2013 (CGVD2013) for consistency with the datum used in the IFMP. Elevations provided by KWL in CGVD28 were converted to CGVD2013 by adding 0.15 m.

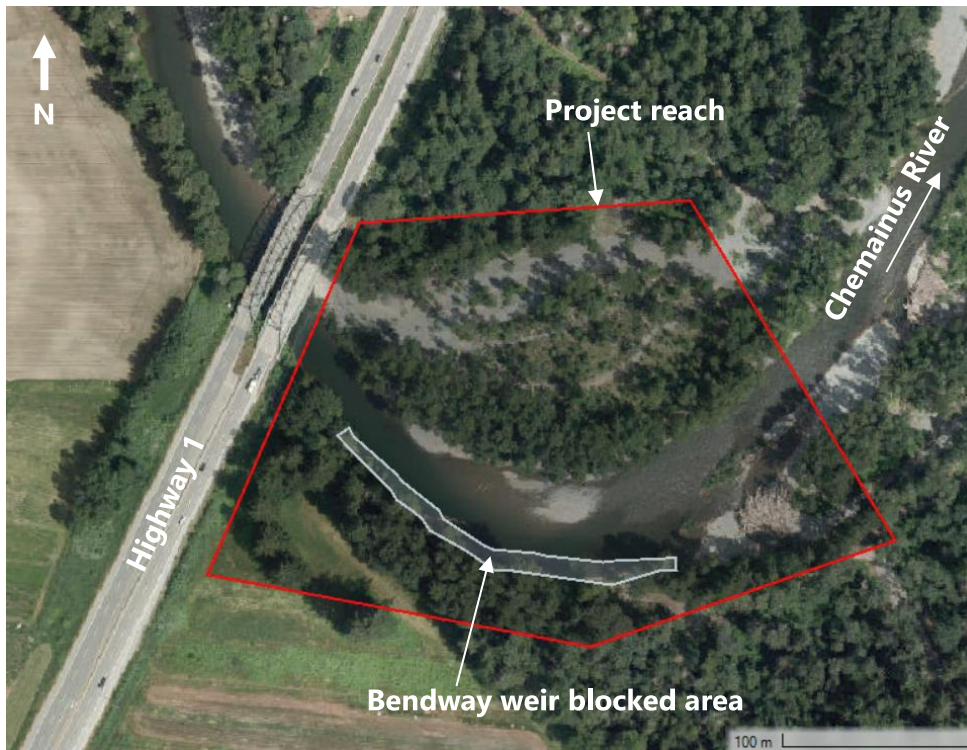


Figure 1 Project reach and location of blocked area used to simulate bendway weir design.

Table 1 Summary of Hydraulic Model Simulations.

Simulation No.	Scenario	Event	Downstream Boundary Condition
1	Existing, 2024 geometry through project reach	200-year + CC	20-year + 1 m SLR
2	Design, bendway weir blocked area	200-year + CC	20-year + 1 m SLR
3	Existing, 2024 geometry through project reach	50-year	20-year
4	Design, bendway weir blocked area	50-year	20-year
5	Existing, 2024 geometry through project reach	20-year	5-year
6	Design, bendway weir blocked area	20-year	5-year
7	Existing, 2024 geometry through project reach	10-year	5-year
8	Design, bendway weir blocked area	10-year	5-year
9	Existing, 2024 geometry through project reach	Mean annual discharge	HHWLT
10	Design, bendway weir blocked area	Mean annual discharge	HHWLT

Notes:

1. CC = climate change allowance; SLR = sea level rise; HHWLT = higher high water large tide

2 HYDROLOGY

The Water Survey of Canada (WSC) gauge *Chemainus River near Westholme* (ID: 08HA001) was used to estimate the mean annual discharge (MAD). Discharge for other design runs were taken from the IFMP study by NHC (2022). Model inflows and boundary conditions are summarized in Table 2.

Table 2 Model inflow and boundary conditions.

Return period	Peak Chemainus River discharge (m ³ /s)	Ocean boundary condition	Ocean boundary water level (El. m, CGVD2013)
200-year + CC	1197	20-year + 1 m SLR	3.35
50-year	848	20-year	2.34
20-year	741	5-year	2.23
10-year	656	5-year	2.23
Mean annual discharge	13.3	HHWLT	1.7

Notes:

1. Refer to IFMP NHC (2022) for detail on flood frequency analysis.
2. CC = climate change allowance; SLR = sea level rise; HHWLT = higher high water large tide

3 HYDRAULIC MODELLING

The 2D HEC-RAS model developed for the IFMP was updated within the project reach to provide the output requested by KWL.

3.1 Existing Model Assessment

The initial IFMP model was developed for flood events, and was calibrated and validated against high flows. At lower flows, water levels in the model become sensitive to natural hydraulic controls in the channel (e.g., gravel bars, log jams). Initial model runs showed the IFMP model underpredicting water levels by up to 0.3 m in the project reach at the mean annual discharge, despite the model producing a good match to observed water levels at higher discharge.

NHC visited the project reach on April 4, 2024 to assess the presence of controls and inform model geometry adjustments. The following observations were made during the site assessment:

- At low flows, water levels in this reach are controlled by a gravel bar, riffle, and log jam that were not captured in the hydraulic model (Photo 1).
- Near the project area, erosion and scour in the channel occurred after the IFMP hydraulic model was developed, so was not accurately represented. The bankline had receded up to 10 m relative to the conditions when the IFMP model was developed.
- A large gravel bar and log jam prevents lower flows from entering the right bank side channel just downstream of the project area (Photo 2). The elevation of this observed control is higher than represented in the IFMP hydraulic model. The IFMP model geometry caused flows to split at lower flows than they were under observed 2024 site conditions.

Based on these observations, the following adjustments to the IFMP model were made to develop the baseline model geometry for this project:

- Adjusted the right bank within the project reach to reflect the approximate bankline as of April 2024.
- Deepened the channel thalweg along the right side of the channel through the project reach.
- Raised the channel elevation downstream of the project area to approximate the hydraulic control caused by the gravel bars and log jams immediately downstream of the project area.

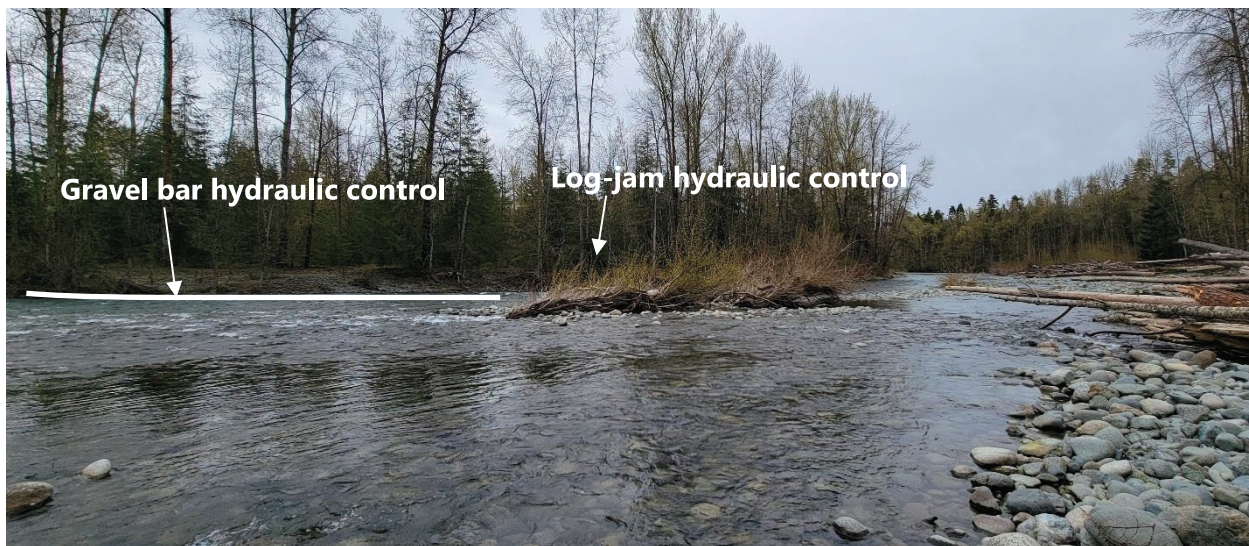


Photo 1 Gravel bar and log jam downstream of the project area.



Photo 2 Gravel bar preventing low-flow from entering right bank side channel.

3.2 Model Validation with Lower Flows

Following the updates to the baseline model geometry described in Section 3.1, NHC validated the model against lower flows. Available data was limited. Additionally, due to the active nature of the bed and temporary features such as log jams creating the hydraulic control, the low flow model is only valid for this time; future local changes may alter water levels. The following data were used:

1. Water surface elevation (WSE) points collected October 7, 2021 for the IFMP project (NHC, 2022) during an estimated discharge of $9 \text{ m}^3/\text{s}$
2. Provisional WSE measured by WSC January 16, 2024 during a measured discharge of $10.7 \text{ m}^3/\text{s}$.
3. WSE provided by KWL November 2022 during an estimated discharge of $3 \text{ m}^3/\text{s}$.

Results for the conditions above are presented in Figure 2.

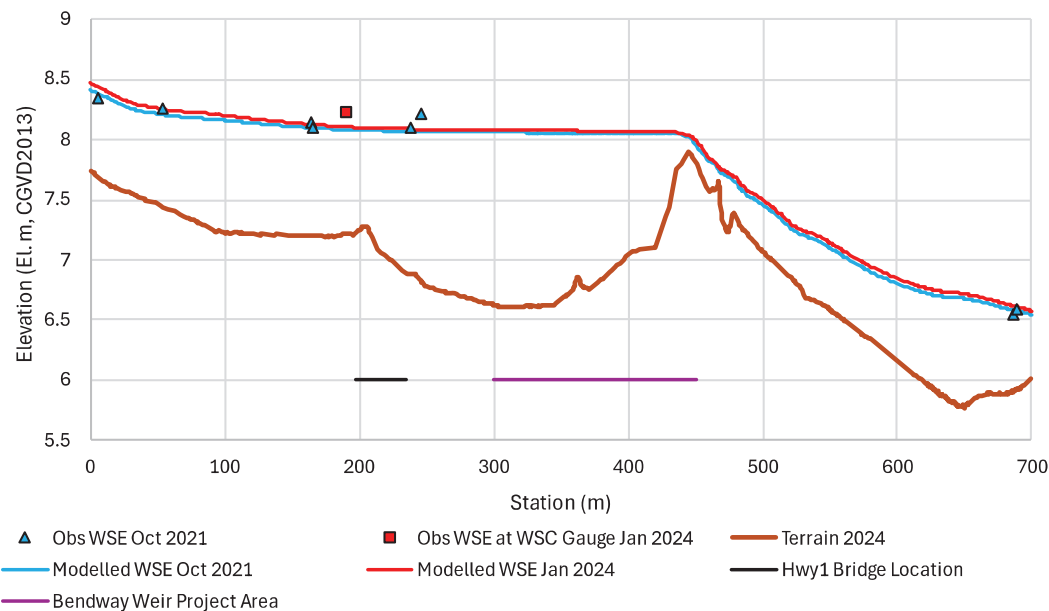


Figure 2 Comparison of modelled WSE with observed (obs) WSE following model geometry updates.

3.3 Model Results

As described in Section 1, the bendway weirs were modelled as a blocked area based on the design footprint and crest heights provided by KWL. The ground topography was raised to the crest level of the bendway weirs, allowing them to overtop, and assuming minimal conveyance between the structures. This approach was taken in agreement with KWL to provide information on the general influence of the weirs on water levels and velocities, while allowing flexibility in the number and placement of weirs in KWL's design. The model roughness (Manning's n) was maintained at 0.035 for the project reach, including the blocked area.

NHC reviewed results from each simulation, plotted WSE profiles and velocities, qualitatively compared results for different scenarios, and checked for general reasonableness of results and model errors. Model results for water surface elevation and velocity for the baseline geometry and the addition of the bendway weirs have been provided to KWL in LandXML format for the scenarios listed in Table 1. All interpretation of results is the responsibility of KWL.

3.4 Assumptions and Limitations

The basic model limitations described in the Chemainus River flood mapping program (NHC, 2022) apply for this study. Additionally, no comprehensive bathymetric survey was available for the project reach reflecting current conditions as of spring 2024. The geometry adjustments described in this report are based on site observations and approximate spot elevations taken by NHC.

Validation of the model performance was done to the degree possible, as described in Section 3.2; however, the results should be taken and interpreted in the context of their development and limitations. Due to the active nature of the bed and temporary features such as log jams creating the hydraulic control, the low flow model is only valid for this time; future local changes may alter water levels.

By representing the bendway weirs simply as a blockage, this analysis does not indicate the local hydraulic effect of the structures along the bank or indicate whether the structures will be effective in reducing erosion or scour in the reach. All interpretation of results is the responsibility of KWL.

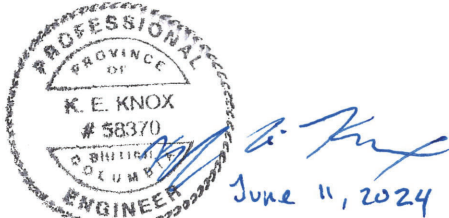
CLOSURE

We trust this report meets your needs. If you have any questions or requests, please feel free to contact the undersigned.

Sincerely,

Northwest Hydraulic Consultants Ltd.

Report prepared by:



Kylie Knox, PEng
Hydrotechnical Engineer

Report reviewed by:



Jason Kindrachuk, PEng
Hydrotechnical Engineer



Dave McLean, PhD, PEng
Principal

EGBC Permit to Practice Number: 1003221

REFERENCES

NHC (2022). *Chemainus River Flood Mapping Program: Part 1 - Floodplain Mapping (0)*. Final Report. Prepared by Northwest Hydraulic Consultants for Cowichan Valley Regional District. 23 pp.

DISCLAIMER

This report has been prepared by **Northwest Hydraulic Consultants Ltd.** for the benefit of Kerr Wood Leidal for specific application to the Chemainus River Ph. 2 Bank Protection Works Hydraulic Modelling Support. The information and data contained herein represent **Northwest Hydraulic Consultants Ltd.'s** best professional judgment in light of the knowledge and information available to **Northwest Hydraulic Consultants Ltd.** at the time of preparation and were prepared in accordance with generally accepted engineering and geoscience practices.

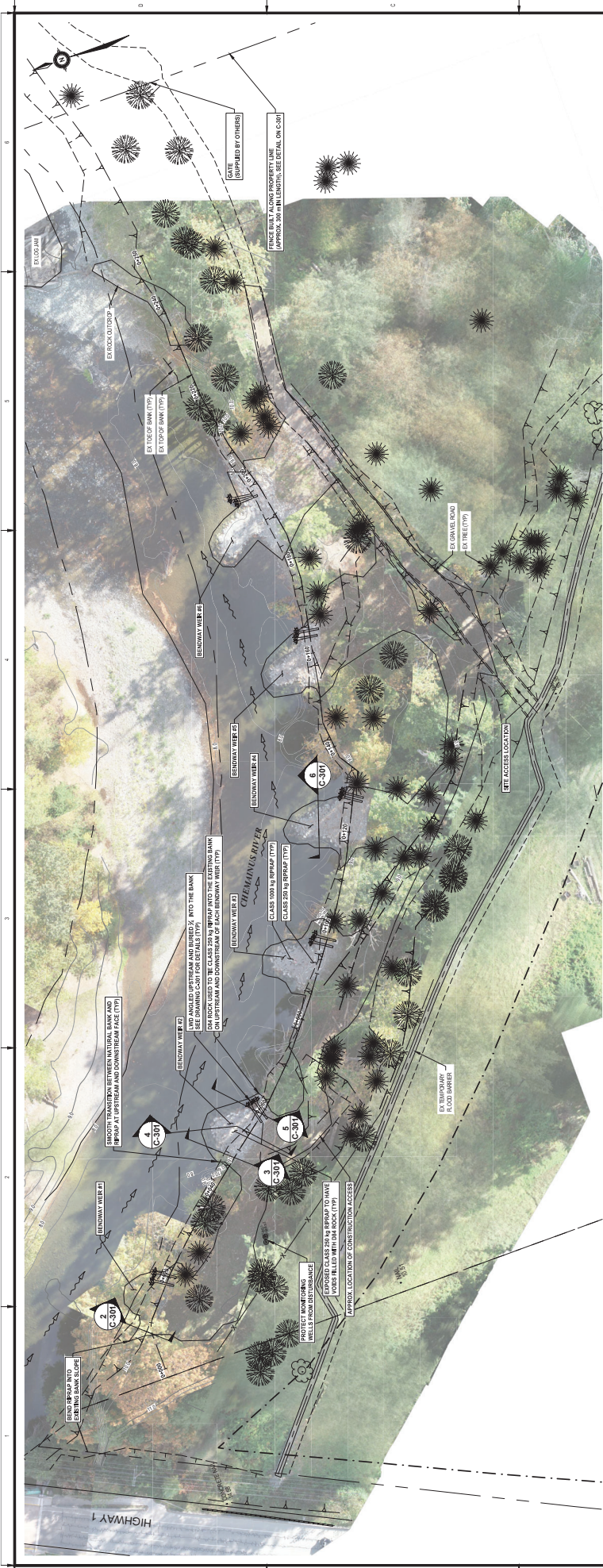
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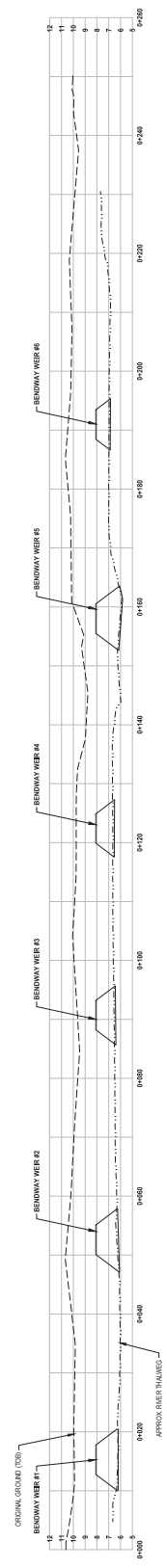
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Appendix C

Record Drawings

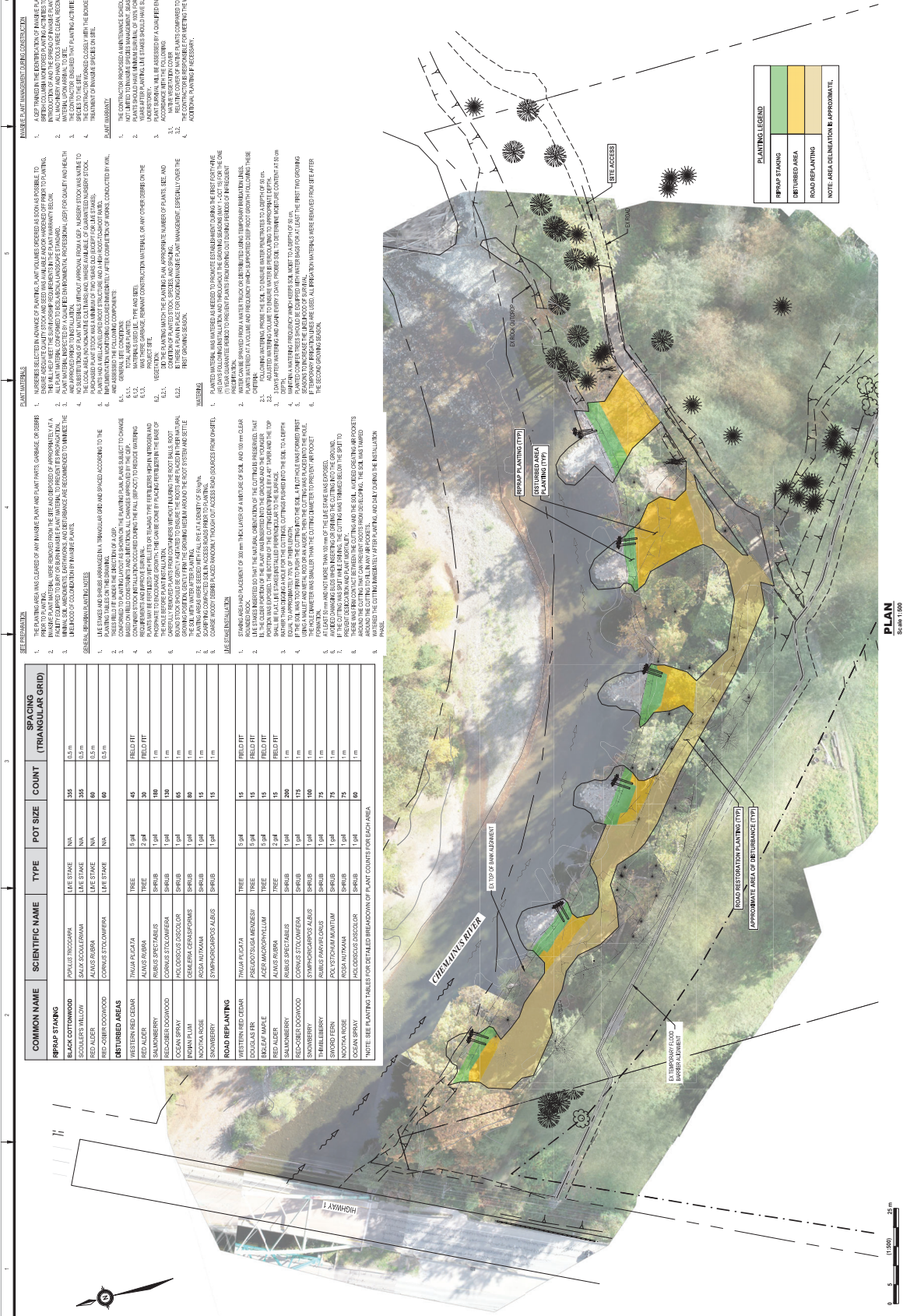


PLAN
Scale 1:400



TOP OF BANK - PROFILE
Scale 1:400

 KERR WOOD LEIDAL Consulting Engineers Accountability • Collaboration • Excellence • Innovation										REVISIONS <table><thead><tr><th>Rev</th><th>Date</th><th>Des</th><th>Chk</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>2024-04-15</td><td>LM</td><td>PAC</td><td>ISSUED FOR TENDER</td></tr><tr><td>1</td><td>2024-04-29</td><td>LM</td><td>PAC</td><td>ISSUED FOR CONSTRUCTION</td></tr><tr><td>2</td><td>2024-05-09</td><td>LM</td><td>PAC</td><td>ISSUED FOR RECORD</td></tr></tbody></table>										Rev	Date	Des	Chk	Description	0	2024-04-15	LM	PAC	ISSUED FOR TENDER	1	2024-04-29	LM	PAC	ISSUED FOR CONSTRUCTION	2	2024-05-09	LM	PAC	ISSUED FOR RECORD	THE TOTAL AND JOINT LIABILITY OF THE UNDERSIGNED ENGINEERS IS LIMITED TO THE AMOUNT OF THE FEE RECEIVED FOR THE SERVICES PROVIDED. THE UNDERSIGNED ENGINEERS SHALL NOT BE RESPONSIBLE FOR THE CONSTRUCTION OF THE PROJECT OR THE PERFORMANCE OF THE PROJECT. THE UNDERSIGNED ENGINEERS SHALL NOT BE RESPONSIBLE FOR THE CONSTRUCTION OF THE PROJECT OR THE PERFORMANCE OF THE PROJECT. THE UNDERSIGNED ENGINEERS SHALL NOT BE RESPONSIBLE FOR THE CONSTRUCTION OF THE PROJECT OR THE PERFORMANCE OF THE PROJECT. REVISIONS <table><thead><tr><th>Rev</th><th>Date</th><th>Des</th><th>Chk</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>2024-04-15</td><td>LM</td><td>PAC</td><td>ISSUED FOR TENDER</td></tr><tr><td>1</td><td>2024-04-29</td><td>LM</td><td>PAC</td><td>ISSUED FOR CONSTRUCTION</td></tr><tr><td>2</td><td>2024-05-09</td><td>LM</td><td>PAC</td><td>ISSUED FOR RECORD</td></tr></tbody></table>										Rev	Date	Des	Chk	Description	0	2024-04-15	LM	PAC	ISSUED FOR TENDER	1	2024-04-29	LM	PAC	ISSUED FOR CONSTRUCTION	2	2024-05-09	LM	PAC	ISSUED FOR RECORD	HALALT FIRST NATION CHEQUAMEGON RIVER BANK STABILIZATION RIGHT BANK STABILIZATION OVERALL PLAN & PROFILE										Project No. 3427-2025 Drawn By: CIVIL										Sheet No. C-101 2									
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Appendix D

Environmental Assessment and Approval Documents



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Appendix D-1

Environmental Assessment and Offsetting Plan

Kerr Wood Leidal

February 15, 2024



KERR WOOD LEIDAL
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Chemainus River Right Bank Recovery

Environmental Assessment and Offsetting Plan

Final Report
February 15, 2024
KWL Project No. 3427.025

Prepared for:
BC Ministry of Environment and Climate Change Strategy



Ministry of
Environment and
Climate Change Strategy



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Report Submission



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Appendix

Appendix A: Engineering Drawings



1. Introduction

Ministry of Environment and Climate Change Strategy (ENV) is working to address continued erosion of the right bank of the Chemainus River downstream of the Highway 1 bridge. Continued erosion of this bank during significant rain events in recent years has led to failure of the original unregulated riverside berm and subsequently has resulted in an increased prevalence of flood waters entering Halalt First Nation IR 2 Lands (Halalt) and neighbouring properties within the Municipality of North Cowichan (MNC). The Chemainus River Right Bank Recovery (the Project) proposes to construct seven (7) bendway weir structures along to the right bank in hopes of providing a long-term solution to the ongoing erosion of this bank and mitigate future impacts on community, infrastructure, and fish habitat.

This Environmental Assessment and Offsetting Plan provides details on the proposed construction activities, existing environmental attributes present at the site, potential impacts to environmental attributes, measures to mitigate adverse impacts, a habitat balance and offsetting plan, and recommended monitoring. This report is intended to support a *Fisheries Act* Authorization application to Fisheries and Oceans Canada (DFO) and a *Water Sustainability Act* Change Approval application submitted to the BC Ministry of Water, Lands, and Resource Stewardship (WLRs).

1.1 Project Background

The November 2021 Atmospheric River Event (ARE) caused substantial sediment movement, flooding and changes through BC's river and creek systems, including on the Chemainus River.

Flooding can have substantial long-term impacts to the local community in terms of life safety, impacts to infrastructure, and negative impacts to health. Therefore, the underlying flood risks to Halalt and MNC community are considered to be high to very high.

In September 2022, a preliminary risk assessment¹ was carried out due to 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.

During the preliminary risk assessment, four sites were identified for multi-phased recovery works on the Chemainus River (Figure 1-1). This Project focuses on Site 2.

1. Site 1 – Left Bank Side Channel/Point Bar Sediment Removal (Partially completed in 2022).
- 2. Site 2 – River Right Bank Recovery (The Project).**
3. Site 3 – Temporary Flood Barrier and Right Bank Side Channels (Completed Fall 2023).
4. Site 4 – Sediment Removal at Gravel Bar between E&N Railway and Chemainus Road Bridge (Completed Summer 2023).

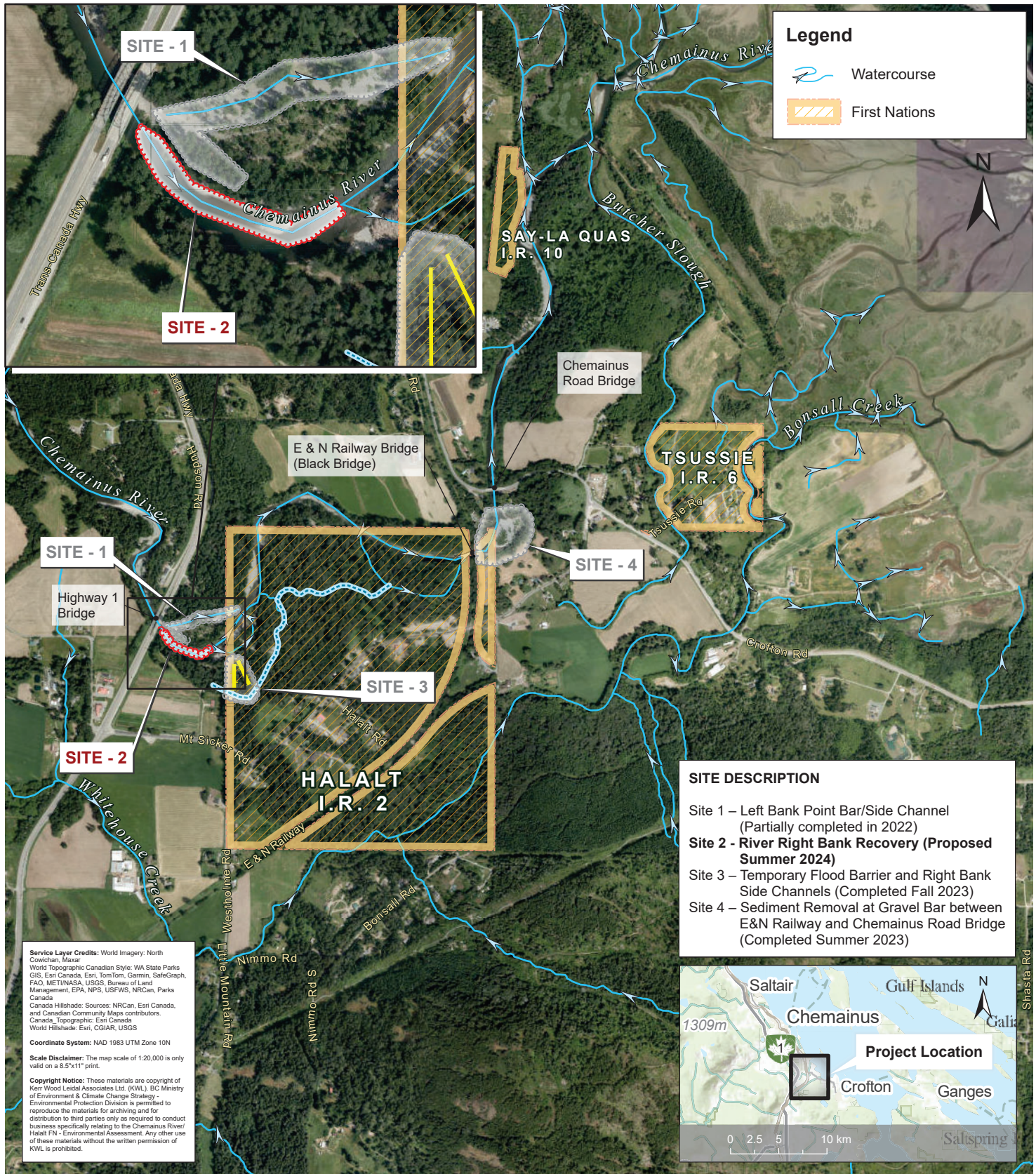
¹ KWL, 2022. Preliminary Site Assessment of Potential Area of Concern: Site S-CR-1 Chemainus River, Halalt First Nation. Prepared for Halalt First Nation. Project 3427.014.

BC Ministry of Environment & Climate Change Strategy

Chemainus River Right Bank Recovery – Environmental Assessment and Offsetting Plan



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Project No. 3427.025

Date February 2024

Scale 1:20,000

0 125 250 500 m

Project Location

Figure 1-1



1.2 Regulatory Context and Requirements

All Project construction related works must be completed in compliance with applicable legislation, guidelines, and commitments outlined below in Table 1-1.

Based on the current scope of the proposed works, the following environmental legislation does not apply to the Project:

- Federal *Impact Assessment Act* [S.C. 2019, c. 28, s. 1]: The Project does not meet the criteria for a designated project described in the Schedule describing physical activities in the Regulations Designating Physical Activities (SOR/2012-147); and
- Provincial *Environmental Assessment Act* [SBC 2018, c. 51]: This Project does not meet the criteria for a reviewable project described in the Reviewable Projects Regulation (BC Reg. 243/2019).

Table 1-1: Environmental Legislation and Regulations Applicable to the Project

Legislation	Agency	Area of Regulation	Permits/Actions Required
Federal			
<i>Fisheries Act</i> [R.S.C., 1985, c. F-14]	Fisheries and Oceans Canada	Protection of fish and fish habitat.	• Submit an Authorization application to the Fish and Fish Habitat Protection Program to identify potential risks to the conservation and protection of fish and fish habitat. • Submit a Scientific Fish Licence application to salvage fish from the Project area.
<i>Migratory Birds Convention Act</i> [SC 1994, c. 22]	Environment and Climate Change Canada	Prohibiting injury, molestations, and destruction of migratory birds and their nests.	• A bird nest survey by a Qualified Environmental Professional (QEP) will be performed prior to any vegetation clearing that occurs between March 1 to August 31 to ensure there are no active migratory bird nests in the disturbance area. • Nests of birds in Schedule 1 of the Migratory Birds Regulations (2022) will be reported as required by the regulations and will be protected for the duration of time required by the regulations (e.g., 36 months for Pileated Woodpecker (<i>Dryocopus pileatus</i>)).
<i>Species at Risk Act</i> [SC 2002, c. 29]	Aquatic Species - Fisheries and Oceans Canada (DFO) (aquatic species); Terrestrial Species - Environment and Climate Change Canada (ECCC)	Protection of species designated on Schedule 1 of the Act and their critical habitat.	• Known critical habitat present for Oregon Forestsnail (<i>Allogona townsendiana</i>) within 1 km of the Project. Since the Project is occurring on non-federal land away from critical habitat, no permitting to ECCC is required. • No known aquatic SARA listed species or habitats are present at the site or within 1 km. No permitting to DFO is required.



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Legislation	Agency	Area of Regulation	Permits/Actions Required
<i>Canadian Navigable Waters Act (RSC 1985) – Approval</i>	Transport Canada	Requires approval for works that may impact navigation on waters in Canada.	The Project is located on a non-scheduled waterway and is not considered major work; however, the work may interfere with navigation. A Notification of Work on a Non-Scheduled Waterway will be produced and posted to invite public comments.
Provincial			
<i>Water Sustainability Act</i> [SBC 2014, c. 15]	Ministry of Water, Land and Resource Stewardship	Regulates activities being carried out in and about a stream.	- Submit a Section 11 Change Approval for works in and about a stream. - Ensure all works adhere to the conditions of the Change Approval.
<i>Wildlife Act</i> [RSBC 1996, c. 488, S. 34]		Regulates works that impact wildlife species in BC.	- Submit a Scientific Fish Collection permit application to salvage fish from the Project area. - Wildlife Permit may be required to remove small mammals and herptiles which may be present in the Project area prior to construction.
<i>Weed Control Act</i> [RSBC 1996, c. 487]		Requires all land occupiers to control the spread of provincial and/or regional noxious weeds on their land.	Ensure proper identification and management of invasive plants throughout Project works.
<i>Integrated Pest Management Act</i> [RSBC 2003, c. 58]	Ministry of Environment & Climate Change Strategy	Regulates pesticide use and treatment of noxious weeds in BC.	Ensure pesticide permit is obtained, if required, for treatment of noxious weeds.
<i>Heritage Conservation Act (RSBC 1996)</i>	Ministry of Forests	Protects and conserves heritage property in British Columbia.	Ensure archaeology Permits are obtained, if required. The project approach to archaeological investigation and permitting is currently evolving and further information will be provided as the archaeological work proceeds.
Municipal			
<i>Local Government Act – Municipality of North Cowichan Official Plan Bylaws</i> And in part provincially mandated: <i>Riparian Areas Protection Regulation (RAPR)</i>	North Cowichan	Regulates development within 30 m of watercourses and within other environmentally sensitive areas.	The Project may be eligible for an exemption from the Development Permit requirement as the works are required to prevent, control, or reduce flooding (Clause 2.2c).

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2. Project Description

2.1 Project Setting

The Chemainus River is located on southeastern Vancouver Island; its headwaters begin roughly north of the Cowichan River. This fish-bearing river travels southeast to outflow in the Strait of Georgia, passing through the town of Chemainus approximately 10 km north of the City of Duncan. Chemainus River is susceptible to sediment accumulation, which reduces the habitat quality for spawning salmonids and other aquatic species. The watershed has an area of approximately 360 km² and the mainstem of the river is approximately 64 km long. Land use within the upper watershed is dominated by forestry operations while the lower watershed is comprised of agricultural, residential, and commercial zones.²

The project will occur directly downstream (east) of the Highway 1 Bridge (Figure 2-1). Table 2-1 presents the geographical location of the site.

Table 2-1: Project Location Description

Site ID	Site 2
Site Description	Chemainus River @ Highway 1 near Halalt IR 2
Location	UTM Zone 10U 448411E 5414087N
Local Government Agency	Halalt First Nation, Municipality of North Cowichan
Waterbody	Chemainus River

2.2 Engineering Design

The preliminary risk assessment carried out for Site 2 indicates that accumulation of sediment and debris in the channel, as well as erosion of the right bank, is considered to be high risk to the community due to:

- more frequent overbank flow across the right bank floodplain and right bank side channels leading to increased risk of flooding for the community; and
- increased potential for avulsion of the mainstem river channel into the relic side channels which would move the main river channel closer to the community, thereby increasing the risk of flooding and erosion.

² Kennen Consulting. 2022. Twinned Watersheds Project: Riparian Vegetation Assessment in the Chemainus and Koksilah Watersheds. Prepared for: Cowichan Watershed Board.



In addition to the preliminary risk assessment³, the engineering design has been developed based on input from existing fish and fish habitat conditions at Site 2⁴, hydraulic modelling, and discussions from the Chemainus River Task Force⁵. Given the risk of avulsion and increase in overbank flows, recovery work is focusing on bank erosion protection measures. These measures were designed to include riparian planting and aquatic habitat complexing but will have to also rely on hard points such as bendway weirs due to the higher flow velocities and scour associated with this location.

Engineering design drawings of proposed works can be found in Appendix A. A total of four figures are included in Appendix A:

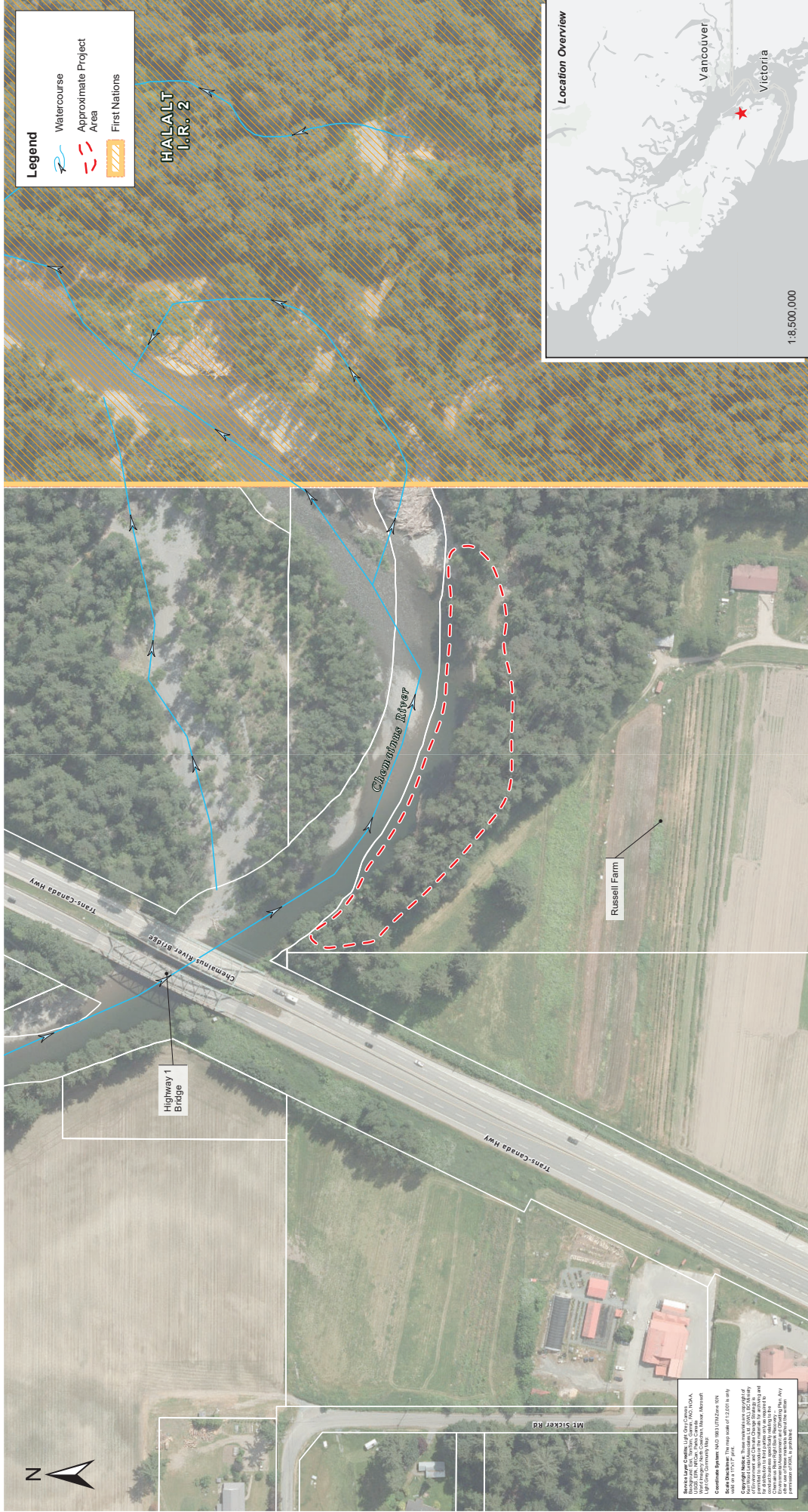
- Figure A-1 shows the general project area, construction access and laydown area;
- Figure A-2 is the construction plan;
- Figure A-3 is the planting plan; and
- Figure A-4 is the typical cross-sections for the weirs and planting area.

³ KWL, 2022. Preliminary Site Assessment of Potential Area of Concern: Site S-CR-1 Chemainus River, Halalt First Nation. Prepared for Halalt First Nation. Project 3427.014.

⁴ M.C. Wright and Associates Ltd. 2024. Habitat Atlas Mapping. [Twinned Watershed Working Habitat Atlas \(arcgis.com\)](https://arcgis.com). Accessed February 2, 2024.

⁵ A recurring meeting between ENV, KWL, MNC, Halalt First Nation, Penalakut First Nation, and BC Ministry of Water, Lands, and Resource Stewardship (WLRS)

BC Ministry of Environment and Climate Change Strategy
Chemainus River Right Bank Recovery – Environmental Assessment and Offsetting Plan



Project No. 3427.025

Date February 2024

Scale 1:2,000

0 25 50 100 Metres

Project Area

Figure 2-1



2.3 Work Sequence

The anticipated sequence for the Project is outlined below. It is assumed that Tasks 2-7 will be repeated multiple times to build all seven (7) weirs.

1. Vegetation grubbing and removal of ground cover to allow for site access.
2. Install and secure an isolation measure within the Chemainus River such as floating silt curtain.
3. Salvage fish from within the isolated area using minnow traps, dip netting, electrofishing.
4. Excavate and grade to design parameters where needed.
5. Place riprap where prescribed.
6. Build weir structure using angular rock covered with rounded river cobble/gravel.
7. Place large woody debris.
8. Remove instream isolation measures.
9. Plant shrubs, trees, and live stakes where prescribed.
10. Demobilize site.

2.4 Construction Timeline

Construction will be aligned with the 2024 reduced risk window for fish in the Chemainus River (August 1 to September 15). In the event of schedule disruptions or delays, works may extend past September 15. In the event of such delays, KWL will contact designated representatives from relevant governing bodies (i.e., DFO and WLRS) to discuss possible mitigations and determine a path forward.

Out-of-water works (e.g., riparian restoration planting) may extend later into the year and possibly into early 2025. All works will be overseen by an Environmental Monitor who is a Qualified Environmental Professional (QEP) with experience in fish and fish habitat protection.

2.5 Construction Access and Laydown Area

Access for construction will occur along an existing road off Chemainus Road (see Figure A-1 in Appendix A). The construction laydown area will occur along an existing cleared area adjacent to the access road (see Figure A-1 in Appendix A).



3. Existing Biophysical Conditions

3.1 Methods

An assessment of existing conditions in the Project area was conducted using desktop and field reviews. The Project area is composed of the right bank of the Chemainus River downstream of the Highway 1 Bridge (Figure 2-1). The remainder of Section 3 includes a summary of the information collected during this assessment.

3.2 Desktop Review

An assessment of existing environmental values within 1 km of the Project area was conducted using the following online sources:

- BC HabitatWizard;
- BC Fish Information Data Query (FIDQ);
- BC Conservation Data Centre (BC CDC) Species and Ecosystems Explorer Database;
- BC CDC iMap;
- BC Ecological Reports Catalogue (EcoCat); and
- M.C. Wright and Associates Ltd. Habitat Atlas Mapping.

3.3 Field Investigation

On September 6, and December 12, 2023, KWL biologist Chad Davey (RPBio) visited the Project area to assess the existing environmental conditions, features, and values present at the site and to provide context for the potential ecological impacts of the proposed works.

3.4 Fish Communities

The Chemainus River supports runs of Coho (*Oncorhynchus kisutch*), Chinook (*Oncorhynchus tshawytscha*), and Chum Salmon (*Oncorhynchus keta*) as well as Cutthroat (*Oncorhynchus clarkii*) and Steelhead/Rainbow Trout (*Oncorhynchus mykiss*). Pink (*Oncorhynchus gorbuscha*) and Sockeye Salmon (*Oncorhynchus nerka*) have historically been reported. Other observed salmonid species include Dolly Varden (*Salvelinus malma*) although this observation is more than thirty years old and there is no record of the Chemainus River supporting a population of Dolly Varden.

The Project area does not contain critical habitat for any aquatic species under Schedule 1 of Canada's *Species at Risk Act*. No fish monitoring was conducted by KWL, but juvenile salmonids were observed near the E&N Railway bridge just downstream of the project area. Table 3-1 highlights all fish species documented in the Chemainus River since 1985.

**Table 3-1: Fish Species Documented in the Chemainus River**

Common Name	Scientific Name
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>
Chum Salmon	<i>Oncorhynchus keta</i>
Coho Salmon	<i>Oncorhynchus kisutch</i>
Cutthroat Trout	<i>Oncorhynchus clarkii</i>
Dolly Varden	<i>Salvelinus malma</i>
Lamprey	<i>Lampetra sp.</i>
Pink Salmon	<i>Oncorhynchus gorbuscha</i>
Prickly Sculpin	<i>Cottus asper</i>
Rainbow Trout	<i>Oncorhynchus mykiss</i>
Sculpin (General)	<i>Cottoidea sp.</i>
Sockeye Salmon	<i>Oncorhynchus nerka</i>
Steelhead	<i>Oncorhynchus mykiss</i>
Stickleback (General)	<i>Gasterosteidae sp.</i>
Unidentifiable trout fry	<i>Oncorhynchus sp.</i>

3.5 Aquatic Habitat

Results from the desktop review indicated that within the confines of the Project area, the river's aquatic habitat can be described as a glide⁶. The reach also faces challenges in terms of low habitat complexity (<30%) and little instream cover (<10%)⁷. The riverbed is composed of cobble-gravel substrates and prevalence of spawning gravels is relatively low. Aquatic habitat units within and surrounding the Project area are illustrated on Figure 3-1.

The field investigation confirmed that instream cover is limited to undercut banks with some overhanging vegetation (Photo 1). Instream habitat complexity is generally low, but some areas exist that provide hiding places or refuge for aquatic life (Photo 2).

⁶ M.C. Wright and Associates Ltd. 2024. Habitat Atlas Mapping. [Twinned Watershed Working Habitat Atlas \(arcgis.com\)](https://arcgis.com). Accessed February 2, 2024.

⁷ Ibid



Photo 1: Chemainus River looking upstream towards Highway 1 Bridge. Undercut banks visible to the left (river right when looking downstream).

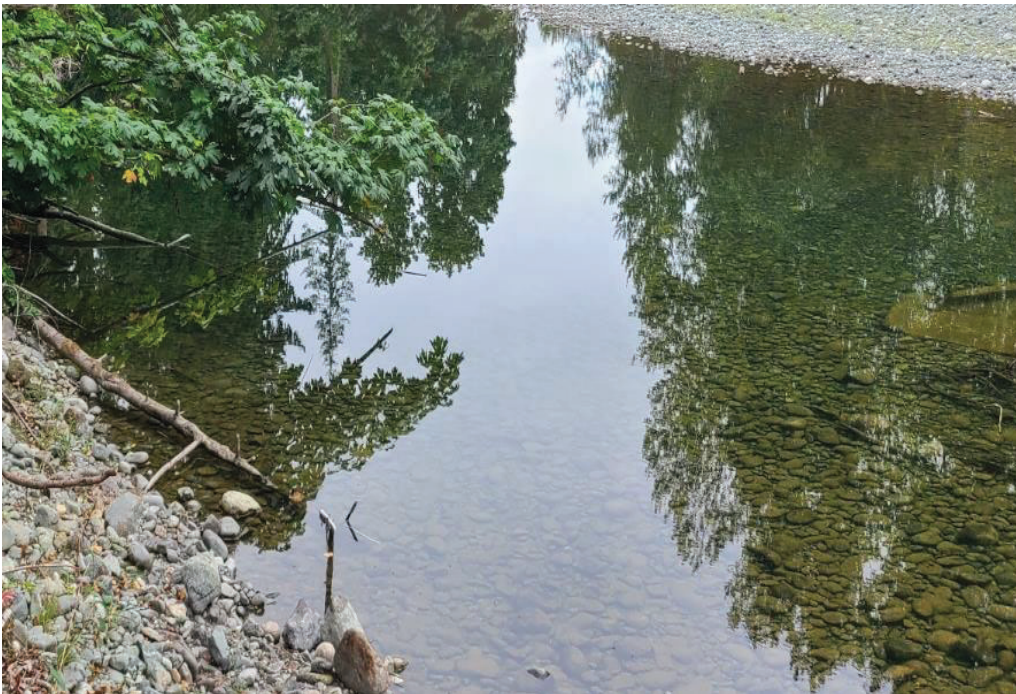


Photo 2: Overhanging vegetation, instream complexity and substrate within the Project area.

3.6 Riparian Habitat

Riparian habitat within the Project area is indicative of a deciduous-mixed floodplain forest and is comprised of Bigleaf maple (*Acer macrophyllum*), Black cottonwood (*Populus trichocarpa*), Douglas Fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), and Red alder (*Alnus rubra*) (Photo 3). Invasive herbaceous vegetation was pervasive within the Project area. Ground cover and trunks of trees were almost entirely covered with English Ivy (*Hedera helix*) as seen in Photo 4. Other sub-canopy and herbaceous vegetation present consisted of Himalayan blackberry (*Rubus armeniacus*), Common holly (*Ilex aquifolium*), Bigleaf maple saplings, Salal (*Gaultheria shallon*), Scotch broom (*Cytisus scoparius*), and wood fern (*Dryopteris sp.*) The entirety of Chemainus River floodplain from Highway 1 to the mouth is mapped as Red alder / Salmonberry / Common horsetail Ecological Community⁸. However, this occurrence is based entirely on aerial imagery analysis⁹. Based on the field investigation performed by KWL, this ecological community is not present within the Project area. Existing riparian habitat characterization from M.C. Wright and Associates Ltd. for the Project area and surrounding area is presented on Figure 3-1.



Photo 3: Deciduous-Mixed Floodplain Forest within the Project area.

⁸ Government of British Columbia. 2024. Habitat Wizard. Endangered Species and Ecosystems.

⁹ Ibid



Photo 4: Extensive invasive English Ivy herbaceous cover.

3.7 Terrestrial Wildlife and Species at Risk

Many terrestrial wildlife species utilize the Chemainus River to perform their life processes. Based on incidental observations during the field investigations, species such as American Black Bear (*Ursus americanus*), Bald Eagle (*Haliaeetus leucocephalus*), Turkey Vulture (*Cathartes aura*), Mule Deer (*Odocoileus hemionus*), Northwestern Garter Snake (*Thamnophis ordinoides*) and Yellow-bellied Sapsucker (*Sphyrapicus varius*) may be present within the Project area during construction.

Based on data from the BC Conservation Data Centre and federal Species at Risk Critical Habitat mapping, designated critical habitat for Oregon Forestsnail (*Allogona townsendiana*) is present within 1 km of the Project area (Figure 3-1). In addition, several occurrences of Oregon Forestsnail have occurred within 1 km of the Project area. However, it is KWL's opinion that there is a low likelihood to encounter Oregon Forestsnail within the Project area due to the extensive cover of invasive English Ivy and minimal presence of Stinging Nettle (*Urtica dioica*), which is known to be the preferred grazing plant of the species.¹⁰

No other terrestrial species at risk were identified during the desktop review or field investigation. Potential impacts to Oregon Forestsnail and other terrestrial wildlife are provided in Section 4, while avoidance and mitigation measures are outlined in Section 5.

¹⁰ South Coast Conservation Program. 2024. Oregon Forestsnail. Accessed on February 5, 2024: <https://www.sccp.ca/species-habitat/oregon-forestsnail>



Existing Habitat



4. Potential Impacts

The Project is anticipated to result in temporary and permanent effects on the environmental values identified in Section 3. All potential impacts to fish communities and aquatic resources that may result from the Project are outlined in Table 4-1. Potential impacts to riparian habitat are summarized in Table 4-2 and potential impacts to Oregon Forestsnail and other terrestrial wildlife are summarized in Table 4-3. Mitigation measures to avoid potential adverse impacts are outlined in Section 5.

Table 4-1: Potential Impacts to Fish Communities and Aquatic Habitat

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact
Use of Industrial Equipment – Contaminant Release	Temporary	Introduction of deleterious substances into the Chemainus River could negatively impact fish health.	Low	Moderate
Use of Industrial Equipment – Sediment Release	Temporary	Increased turbidity from instream works could negatively impact fish health.	Moderate	Moderate
Instream Isolation	Temporary	Installation of fish isolation areas within the Chemainus River will temporarily alter fish habitat within the work area. Fish and aquatic life will be salvaged under the direction of a QEP.	High	Low
Bendway weir and large woody debris installation	Permanent	Will permanently remove aquatic habitat, alter the profile of the right bank and alter river morphology within the immediate area.	High	Low
Use of Industrial Equipment	Permanent	There is potential for injury or mortality of fish/eggs/ova during construction.	Low	High

Table 4-2: Potential Impacts to Riparian Habitat

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact
Clearing of Riparian Vegetation	Temporary	Removal of trees and understory vegetation (native and invasive) for construction access and laydown. Temporary loss of riparian buffer and canopy cover.	High	Moderate
Clearing of Riparian Vegetation	Temporary	Introduction of additional invasive plant species.	Low	Moderate



Table 4-3: Potential Impacts to Terrestrial Wildlife and Species at Risk

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact
Oregon Forestsnail				
Clearing of Riparian Vegetation	Temporary	Potential to encounter Oregon Forestsnail while clearing vegetation for site access. Temporary loss of habitat to perform life processes.	Low	Moderate
Clearing of Riparian Vegetation	Temporary	Site vegetation clearing and equipment use may introduce additional invasive plant species.	Low	Moderate
Site Isolation	Temporary	Installation of security fencing, sediment fencing, and other barriers may inhibit movement of Oregon Forestsnail.	Low	Moderate
Use of Industrial Equipment	Permanent	There is potential for injury or mortality of Oregon Forestsnail during construction.	Low	High
Other Terrestrial Species				
Clearing of Riparian Vegetation	Temporary	Removal of dead trees and understory vegetation may impact tree-nesting birds and mammals due to temporary loss of habitat.	High	Moderate
Disturbance, noise, barriers, and increased traffic	Temporary	Terrestrial species may be temporarily impacted during construction from changes in light, noise, and vibration. Wildlife habitat connectivity through the Project area may be temporarily disrupted.	High	Low



5. Avoidance and Mitigation Measures

5.1 Avoidance Measures

Avoidance measures implemented into the Project design include the following:

- The Project will avoid removing large cottonwood or coniferous trees wherever possible. In circumstances where a tree obstructs access, avoiding tree removal will be prioritized and shifting the access routes will be preferred; and
- As mentioned in Section 3.5, undercut banks currently provide some instream cover in the Project area. Through the installation of the bendway weirs and associated riprap, a portion of the undercut bank will be affected. However, naturalized bank between the bendway weirs will be avoided and left untouched (Appendix A).

5.2 Mitigation Measures

The following guidance documents were used to develop mitigation measures for this project:

- *Requirements and Best Management Practices for Making Changes In and About a Stream in British Columbia*. Version 2022.01. Government of British Columbia, 2022;
- *Measures to Protect Fish and Fish Habitat*, Fisheries and Oceans Canada, 2019;
- *A Field Guide to Fuel Handling, Transportation and Storage*, Ministry of Water, Land and Air Protection, 3rd Edition, 2002;
- *B.C. Approved Water Quality Guidelines*, Ministry of Environment and Climate Change Strategy Updated 2018;
- *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia*, Ministry of Water, Land and Air Protection, 2004;
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia*, Ministry of Environment and Climate Change Strategy, 2014;
- *Land Development Guidelines for the Protection of Aquatic Habitat, Fisheries and Oceans*, 2nd Edition, 1993; and
- *New Migratory Birds Regulations*, Environment and Climate Change Canada, 2022.

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 appropriate Qualified Environmental Professional (QEP). The EM will regularly inspect the work site for compliance with the environmental requirements of the Project. Observations will be recorded and reported to the Consultant 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 the project start-up and during any sensitive activity.



Use of Reduced Risk Instream Work Window

Instream works will be completed in the reduced risk instream work window for the area (August 1-September 15). Conducting works at this time should reduce the potential for fish to be present in the work area. Proposed works are expected to last through the entire work window (until September 15), with a potential to extend beyond if necessary (e.g., weather delays). Any extension will be done with the direction of the QEP for the project and in consultation with regulatory agencies.

Fish Salvage

Instream isolation will be the primary mitigation measure for fish (e.g., silt curtain). Noise deterrents and handheld sonar devices may be used to detect fish within the silt curtain. Salvage from within the silt curtain where be performed where it is safe and practicable using minnow traps, seine netting and dip netting. Isolation measures will be continually monitored each day for the duration of the project. A QEP will be on site during all in-water works.

Terrestrial Wildlife

The QEP will perform a wildlife sweep of the work area each day before construction begins to ensure no wildlife is present. If present, removal of terrestrial wildlife from the construction area will be completed under the direction of the QEP and with all required permits.

Species at Risk

A QEP that is trained in the identification of regionally relevant species at risk will be on-site at all times during construction. If any species at risk individuals or evidence of individuals is observed, the QEP will stop work and contact necessary governing bodies to determine the path forward.

Water Quality Considerations

In-situ turbidity and pH monitoring will be performed throughout the entirety of instream works. If required, laboratory analysis for total suspended sediments (TSS) may be completed for the purposes of documenting defensible sediment load concentrations during background and elevated flow conditions.

The following criteria for in situ will apply to water around the project area, especially during construction, under the discretion of the EM:

- Induced downstream turbidity/total suspended sediment should not exceed background levels by more than 8 Nephelometric Turbidity Unit (NTU) (average) in 24 hours;
- For sediment inputs that last between 24 hours and 30 days the mean turbidity should not exceed background by more than 2 NTU;
- Induced turbidity should not exceed background levels by more than 5 NTU at any time when background turbidity is between 8 and 50 NTU. When background exceeds 50 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time; and
- Induced downstream pH should remain between pH6.5 and pH9.0, and not more than 10% of background if less than pH6.



Additional in situ or ex situ laboratory analysis for other water quality parameters including, but not limited to, the following list will be sampled as required over the course of project works on an as-needed basis as determined by the EM and will be subject to current working and approved BC Water Quality Guidelines for the Protection of Aquatic Life¹¹ (BCWQG-AL):

- Temperature (°C);
- Dissolved Oxygen (%);
- Extractable Petroleum Hydrocarbons (LEPH/HEPH);
- Organics (Oil & Grease); and
- Conductivity (µS/cm).

Erosion and Sediment Control

The Contractor will produce an Erosion and Sediment Control Plan for review by the QEP before construction begins.

ESC measures will 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 and/or haul spoil to an appropriate location for disposal;
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 and applicable;
6. All ESC measures will be monitored regularly by both the Contractor and the EM and maintained until all disturbed ground has been stabilized; and
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.

Habitat Protection

A QEP will oversee tree removal and provide input to minimize deleterious effects during construction. Where topping or removing dead limbs of danger trees will remove the hazard, this option is preferred over removing the entire tree.

Breeding Bird Nest Surveys

Unless absolutely necessary to proceed with project works, tree removal, and vegetation clearing is to take place outside the regional bird nesting period (March 1 to August 31) to avoid impacts to migratory birds. A bird nest search will be required if vegetation is to be removed within the regional bird nesting period.

¹¹ MOE. 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture.



The following will apply:

- If an active nest is identified, a no-work zone buffer will be established and maintained around the active nest to minimize access and sensory disturbance;
- The buffer distance will vary depending on the species of bird. Therefore, the buffer distance will be determined based on best management practices and the professional judgement of the QEP;
- Nests will be monitored to assess nest activity and effectiveness of the buffer. Clearing (disturbance) can continue once the EM has determined that the nest is no longer active;
- If no active nests are found in surveyed areas, vegetation clearing (disturbance) can commence, but must be complete within 36 hours of the pre-disturbance nest survey being conducted; and
- Nests of birds in Schedule 1 of the Migratory Birds Regulations (2022) will be reported as required by the regulations and will be protected for the duration of time required by the regulations (e.g., 36 months for pileated woodpecker).

Spill Prevention and 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 30 m from any storm drain and watercourses.
- All equipment washing must be done off-site or in a designated area at least 30 m from storm drains and watercourses in a manner that will prevent wash from reaching any waterway.
- Generators, pumps, and other stationary equipment will be placed on spill trays. Where possible, generators will be located at least 30 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.
- A spill kit will be on each site, and staff trained in their use. Spill kits will contain appropriate materials for each site including spill booms capable of spanning creek widths where applicable.
- Any spill of a listed substance according to the *Spill Reporting Regulation* will be immediately reported to the Provincial Emergency Program 24-hour phone line at 1-800-663-3456. The BC Ministry of Environment and Climate Change Strategy, CVRD, and all project team members will be notified of the spill.

Site Restoration and Replanting

- Areas where aquatic and riparian vegetation is disturbed or removed will be replanted with native plant species as required, including construction laydown areas and machine access routes.
- Riprap within weirs will be infilled and top dressed in local bed material and topsoil mix (~ 0.5 m depth). Banks will be planted with black cottonwood and willow live stakes; red alder and red-osier dogwood plugs or pots.



5.3 Summary of Residual Impacts

After mitigation measures are implemented, residual impacts resulting from the Project are likely to result in serious harm to fish and fish habitat, including:

- The alteration of **474 m²** of aquatic habitat in the Chemainus River from the installation of seven (7) bendway weir structures and associated riprap protection; and
- The removal of approximately **1,345 m²** of riparian vegetation through placement of riprap and road access construction.

Other impacts identified in Section 4 are not anticipated to cause residual effects after mitigation measures have been implemented. These impacts to fish habitat will be mitigated by procedures outlined Section 7.2 and in the forthcoming Construction Environmental Monitoring Plan (CEMP).



6. Offsetting Plan

An offsetting plan is required to offset the impacts to aquatic and riparian fish habitat associated with the Project. Avoidance of all impacts is not possible as repairs are necessary to address bank erosion and to mitigate future flood risk. The offsetting plan is guided by existing literature on habitat conditions¹², Chemainus River Task Force discussions, and field observations.

The following section outlines the offsetting objectives, offsetting measures to be implemented, and the resultant habitat balance from the proposed offsetting measures.

6.1 Offsetting Objectives

Proposed offsetting measures were designed to enhance local fish productivity that would benefit a variety of fish species that are present in the Chemainus River (Table 3-1). The reach of the Chemainus River within the Project area generally lacks instream cover and aquatic habitat complexity¹³, which is supported by field observations (see Sections 3.5 and 3.6).

As such, the goals of the proposed offsetting measures aim to increase aquatic habitat complexity and instream cover. This will be achieved through the installation of large woody debris (LWD) structures, planting of local, non-invasive plant species in the disturbed riparian area and over buried riprap, where possible.

6.2 Offsetting Measures

Large Woody Debris (LWD)

Large woody debris will be incorporated into the bendway weir structure to increase instream cover and aquatic habitat complexity for fish (Appendix A).

Riprap Enhancement

Riprap used in the bendway weir installation will be filled with native bed materials (sand and gravel) and planted with Black cottonwood and willow live stakes. Red Osier Dogwood and Red alder will be planted in the areas closer to the high-water mark.

The goal of this offsetting measure is to increase the prevalence of riparian vegetation, vegetation cover and shade within the Project area which was identified as being Poor in Section 3. Riparian vegetation shades waterways from typical summer temperatures, providing nutrients as leaf litter or bug drop, and preventing the establishment of invasive species. Riparian vegetation, hydric soils and leaf litter may act as a sponge, soaking up stormwater during high flow events and allowing water to be slowly released back into the stream. The increase in organic matter and reduction in soil compaction associated with riparian vegetation also allows for greater water infiltration and drainage.

Implementation monitoring and effectiveness monitoring protocols are in place to ensure the native vegetation successfully establishes and creates functional riparian habitat over the following five (5) years post construction.

¹² M.C. Wright and Associates Ltd. 2024. Habitat Atlas Mapping. [Twinned Watershed Working Habitat Atlas \(arcgis.com\)](https://www.arcgis.com). Accessed February 2, 2024.

¹³ Ibid.



Riparian Planting

All disturbed areas as a result of construction will be amended with topsoil where necessary and planted with native vegetation. Any invasive species will be removed. The list of plants to be used in restoration planting are summarized in Table 6-1. Tree removal will be limited to imminent risk (danger trees) and where required for site access. In circumstances where a tree obstructs access, avoiding tree removal will be prioritized and alternative access routes will be considered. Any trees that must be removed will be replaced based using a 3:1 ratio based on the BC Tree Replacement Criteria¹⁴. A detailed planting plan with prescribed quantities and densities will be prepared prior to construction.

Table 6-1: Plant Species for Restoration Planting

Common Name	Scientific Name	Type
Over buried Riprap		
Red alder	<i>Alnus rubra</i>	Plug
Black cottonwood	<i>Populus trichocarpa</i>	Live stake
Red osier dogwood	<i>Cornus sericea</i>	1-gallon pot
Willow species	<i>Salix sp.</i>	Live stake
Riparian Planting		
Red alder	<i>Alnus rubra</i>	2-gallon pot
Black cottonwood	<i>Populus trichocarpa</i>	2-gallon pot
Western Red Cedar	<i>Thuja plicata</i>	2-gallon pot
Douglas Fir	<i>Pseudotsuga menziesii</i>	2-gallon pot
Grand Fir	<i>Abies grandis</i>	2-gallon pot
Big Leaf Maple	<i>Acer macrophyllum</i>	2-gallon pot
Sword fern	<i>Polystichum munitum</i>	1-gallon pot
Stinging nettle	<i>Urtica dioica</i>	1-gallon pot
Salmonberry	<i>Rubus spectabilis</i>	1-gallon pot
Snowberry	<i>Symphoricarpos albus</i>	1-gallon pot
False Azalea	<i>Menziesia ferruginea</i>	1-gallon pot
Nootka rose	<i>Rosa nutkana</i>	1-gallon pot
Thimbleberry	<i>Rubus parviflorus</i>	1-gallon pot

¹⁴ Government of British Columbia. 1996. Tree Replacement Criteria. [TreeReplCrit \(gov.bc.ca\)](http://gov.bc.ca). Accessed February 2, 2024



6.3 Habitat Balance

This section outlines the habitat balance for the amount impacted fish habitat and the amount of offsetting habitat created or enhanced. Table 6-2 summarizes the residual impacts to fish habitat and proposed aquatic offsetting measures, while Table 6-3 summarizes residual impacts to riparian habitat and proposed riparian offsetting measures.

Table 6-2: Summary of Residual Aquatic Habitat Impacts and Proposed Offsetting Areas

Proposed Works	Habitat Description	Area (m ²)
Residual Impacts – Aquatic Habitat		
Bendway weir installation	Glide habitat with low channel complexity and limited instream cover.	474
Total Aquatic Area Impacted		-474 m²
Proposed Offsetting – Aquatic Habitat		
Channel Complexing	Large woody debris	140
Total Aquatic Offsetting		+140 m²
Net Aquatic Habitat		-334 m²

Table 6-3: Summary of Residual Riparian Habitat Impacts and Proposed Offsetting Areas

Proposed Works	Habitat Description	Area (m ²)
Residual Impacts – Riparian Habitat		
Loss of Riparian Habitat	Riparian vegetation is mixed-deciduous lowland forest, understory is dominated by English Ivy.	1,345
Total Riparian Area Impacted		-1,345 m²
Proposed Offsetting – Riparian Habitat		
Planting over Riprap	Riprap along the bank will be buried with growing medium and planted and staked.	1195
Riparian Planting	All disturbed areas will be amended with topsoil where necessary and planted with local, non-invasive vegetation.	150
Total Riparian Offsetting		+1,345 m²
Net Riparian Habitat		+0 m²

Overall, there will no net loss of riparian vegetation (Table 6-3) within the project area. In contrast, the habitat balance presented here (Table 6-2) shows the impacts to the aquatic habitat to be negative, and only partially mitigated by the proposed offsetting measures.

There are two elements of the habitat balance that are not quantified in Table 6-2: the removal of invasive species of vegetation to be replaced by native vegetation, and the improvement of the aquatic habitat that is expected from the buried riprap plantings once fully grown. The project area is dominated by invasive species and lacks riparian cover along the bank, both of which are being addressed, at least in part, by the proposed works.



7. Recommended Monitoring and Maintenance Protocols

Consistent monitoring and maintenance during and after construction will ensure that recommended avoidance and mitigation measures are proving effective at minimizing risk of potential adverse impacts. The following section outlines a combination of construction, implementation, effectiveness monitoring and maintenance recommendations to successfully execute the Project and sustain minimal impacts to surrounding environmental values during and after construction.

7.1 Monitoring Approach

The monitoring approach proposed is based on the advice and guidance found in the following documents:

- *Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act, Fisheries and Oceans Canada, 2019;*
- *Requirements and Best Management Practices for Making Changes In and About A Stream in British Columbia, Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2022;*
- *Guidelines for In-Stream and Off-Channel Routine Effectiveness Evaluation, Ministry of Water, Land, and Air Protection, 2003; and*
- *Monitoring and Assessment of Fish Habitat Compensation and Stewardship Projects: Study Design, methodology, and Example Case Studies, Mike Pearson (et al.), 2005.*

7.2 Construction Monitoring for Mitigation Measures

Construction Environmental Management Plan (CEMP) for Project Works

A CEMP will be developed for the construction of project works and supplemented by requirements and recommendations listed in regulatory permits. The CEMP will:

- set out the requirements and measures that will be adopted to avoid, minimize, and mitigate the potential impacts to fish and fish habitat as a result of the Project;
- be implemented by the Contractor throughout the project and applies to the construction phase; and
- provide overarching guidance for how environmental considerations will be implemented and monitored during the construction phase of the project.

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



Construction Environmental Monitoring

Construction monitoring will be carried out by a QEP or a team working under the direction of a QEP. The responsibilities of the Environmental Monitor (EM) will be:

- to monitor and provide recommendations to ensure compliance with all applicable permits (i.e., *Fisheries Act* Authorization and *Water Sustainability Act* Change Approval), best management practices, and the Construction Environmental Management Plan; and
- to provide additional recommendations to avoid and mitigate impacts to fish and fish habitat to the greatest extent possible.

Reporting

The EM will prepare daily environmental monitoring reports detailing the activities conducted, issues of non-compliance with the CEMPs and mitigation measures implemented to address deficiencies, as well as a representative photo log.

Upon completion of construction, the EM will prepare a brief memo summarizing key incidents; the daily reports will be included in the appendix of the CEMP. The memo will be submitted to DFO and WLRS within 60 days of completion of construction.

7.3 Implementation Monitoring

This stage of monitoring will occur immediately after completion of works and ensure the works were carried out as planned.

Monitoring Objectives

The purpose of implementation monitoring is to ensure offsetting works are functioning as designed. The objectives of the offsetting will be used to identify metrics of success for the proposed works. The objectives include:

- Increase habitat complexity and instream cover within this reach of the Chemainus River; and
- Increase riparian plant biodiversity.

These components will be used to frame metrics of success for the implementation monitoring, as described below.

Monitoring Protocol

Implementation monitoring of offsetting measures will be conducted by appropriate QEP or team of QEPs. Generally, it is expected that monitoring will be completed by (or under supervision of) a Registered Professional Biologist (RPBio).

Implementation monitoring will evaluate the project's offsetting components through examining the following questions:

- **Large Woody Debris**
 - Does the LWD match the specifications indicated on the design drawings (i.e., size, species, installed elevation)?



- **Riprap Enhancement**

- Do the materials used match the design drawings?
- Do plant materials appear in good condition (i.e., healthy and free of pests)?
- Are stakes and plugs installed in the correct manner?

- **Riparian Planting**

- Does the planting match the planting plan? Appropriate number of plants, type of plant (i.e., live stakes versus potted plants), size and condition of planted stock, species, and spacing?
- Is there sufficient coverage of seed mix in areas with exposed soil?
- Have plants been installed in the appropriate location and in an appropriate manner to facilitate establishment (i.e., planting depth, stem vertical, no air pockets around root ball)?
- Is there a watering plan in place with adequate frequency for site moisture conditions?
- Has all the garbage and any other unnecessary debris been removed from the planting areas?

Any deficiencies identified on site by the QEP during the implementation monitoring will be communicated to the contractor and via email. A follow-up implementation monitoring site visit by the QEP(s) will be conducted to ensure all deficiencies have been addressed.

7.4 Effectiveness Monitoring

Effectiveness monitoring will be conducted annually for five years following construction. This will allow sufficient time to ensure the vegetation has become established, and that all Project components are functioning as intended. Monitoring will occur once a year in late summer (July/August) when plants are leafed out and water levels are lowest. This will facilitate accurate assessment of plant growth and survival and assessment of low-flow stream conditions.

Annual effectiveness monitoring site visit will include collection of a comprehensive set of photos of key site features in each zone.

General Site Conditions

Monitoring of general site conditions will include, but is not limited to, documentation of:

- presence of garbage, erosion, and sediment control (ESC) materials, or any other debris in the channel or planting areas; and
- evidence of site disturbance (e.g., erosion, exposed soil, vandalism, unauthorized trails).

Aquatic Habitat

Effectiveness monitoring is needed to demonstrate that the aquatic habitat is functioning as intended for the targeted aquatic species as outlined in the Monitoring Objectives. The functionality and success of the aquatic habitat will be based on the following:

- **Instream Cover** – Qualitative assessment of the condition of LWD;
 - Does the LWD appear stable and or at risk of being dislodged?
 - Is LWD providing instream cover for aquatic species?

Table 7-1 details the specific criteria to be used to assess aquatic habitat.



Riparian Planting Areas

The functionality and success of the planted areas will be determined based on:

- **Planted Stock** – Quantitative and qualitative assessment of the success of plantings based on the proportion of plant survivorship and qualitative assessment of plant health. This includes evidence of yellowing, grazing (i.e., uniform height reduction, widespread absence of leaf tips, waterfowl observed grazing on site), and/or other physical damage (e.g., smothering by logs or garbage); and
- **Invasive Plants** – Quantitative assessment of the mean percent cover of invasive plants. English Ivy has been identified as a considerable threat to this area. These species tend towards forming monotypic stands, degrading habitat quality and function, and once established, are very challenging to manage for reestablishment of native species.

Table 7-1 details specific criteria to assess the condition of each planting area. Plant survivorship will be assessed using the number of plants planted based on numbers obtained during implementation monitoring. Replacement planting, when deemed necessary, should be tracked to ensure appropriate adjustments to plant numbers and species for future years of monitoring of plant stock health and survivorship.



Table 7-1: Effectiveness Monitoring Assessment Protocol

Components	Score			
	4	3	2	1
Fish Habitat				
Instream Cover	LWD in excellent condition; all components are solid and submerged.	LWD in sufficient condition and is providing instream cover; minimal evidence of potential dislodging.	LWD in poor condition and is not providing much instream cover; some LWD already dislodged or close to dislodging.	LWD in poor condition or have been dislodged. Structures will not last another high flow season.
Planting Areas				
Planted Stock	Plant survival > 90%. Planted stock in excellent condition; all plants are in good health with no evidence of stress or damage.	Plant survival 80% - 90%. Planted stock in adequate condition; most plants are in good health with no evidence of stress or damage.	Plant survival 60% - 79%. Planted stock partially failed; some plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.	Plant survival < 60%. Planted stock in very poor condition; many plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.
Invasive Plants	No evidence of invasive plants present in the planted area.	Few small patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Many patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Abundant cover of invasive plants throughout the planted area and/or invasive plants present include noxious weeds (i.e., knotweed).
Scoring 4 = Exceeds expectations and objectives. 3 = Meets expectations and objectives. 2 = Fails to meet either expectations or objectives; maintenance needed. 1 = Fails to meet expectations and objectives; site diagnostic and adaptive management needed.				

7.5 Routine Maintenance and Adaptive Management

Routine maintenance is likely to be needed in the years following construction to ensure native vegetation are well established and functioning as intended. Maintenance activities may include:

- watering of planted stock, especially in the first growing season;
- replacement planting;
- invasive plant management (especially in the first few growing seasons); and
- removal of trash.

Further assessment and maintenance may be needed depending on the results of the effectiveness monitoring assessment. All components that receive a score of 2 or lower (based on the assessment in Table 7-1) will require maintenance to bring the component up to target conditions. However, if multiple components receive a score of 2 or lower, a site diagnostic may be warranted. A site diagnostic can be used to determine the potential underlying causes of poor performance of the restoration prescription and recommend potential solutions.

An adaptive management approach will be used to propose solutions to address the failed components based on greater understanding of localized conditions gained from the site diagnostic. In the case that a novel stressor is identified and/or considerable changes are needed to address an issue on site, additional monitoring frequency and duration may be recommended to ensure the site meets expectations and objectives of the approved design.



Reporting

Implementation Monitoring Report

An implementation monitoring report will be prepared and submitted to DFO and WLRS within 60 days of completion of construction and/or once all deficiencies have been addressed. The report will include:

- an executive summary;
- an as-built survey;
- detailed documentation of the field fit implementation of planting, habitat complexing structures, and other relevant components;
- an outline of any deficiencies on site and how they were addressed to ensure the works meet the approved design; and
- a representative photo log using standardized viewpoints and bearings (where applicable).

Effectiveness Monitoring Reports

A monitoring memo will be prepared following the last site visit of each monitoring year. The memo will include:

- an executive summary;
- an overview of general site conditions;
- assessment scores for each component listed in Table 7-1;
- an overall assessment of site conditions relative to the project objectives and intended function;
- a representative photo log using standardized viewpoints and bearings (where applicable);
- an overview of maintenance needed with revised monitoring schedule, if deemed necessary; and
- findings of the site diagnostic and adaptive management recommendations, if deemed necessary.

The monitoring memo will be submitted to DFO and WLRS within 60 days of the last site visit of each monitoring year.



8. Contingency Measures

8.1 Construction Contingency Measures

If the avoidance and mitigation measures outlined are found, over the course of the monitoring, to be insufficient to prevent harmful impacts to fish and fish habitat, the following contingency measures will be implemented:

- The Environmental Monitor will require works to stop until a suitable strategy to address the issues is implemented by the contractor; and
- Works may be completed during different conditions or with different construction techniques if issues are identified by the Environmental Monitor.

8.2 Offsetting Contingency Measures

Effectiveness monitoring will be conducted to assess the success of the offsetting plan. In the event that the offsetting plan does not meet the criteria outlined, the following contingency measures will be implemented:

- Identify which criteria the offsetting plan has not successfully met;
- Determine the cause of the deficiency;
- Determine how to resolve the cause of the deficiency (e.g. altering the design, addition of new plants, identify additional maintenance needs); and
- Implement and monitor the contingency measures.

In the unlikely event that these contingency steps are unsuccessful in remedying the deficiencies, alternate sites in the region will be identified for additional restoration.



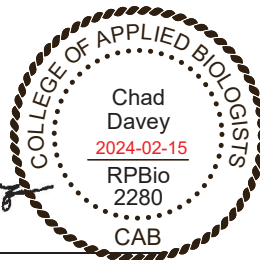
Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Sherri Jonkman, RBTech
Environmental Technologist

Reviewed by:



Chad Davey, M.Sc., RPBio
Technical Reviewer

Statement of Limitations

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Revision History

Revision #	Date	Status	Revision	Author
0	February 15, 2024	Final	For client submission	JMD



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Appendix A

Engineering Drawings



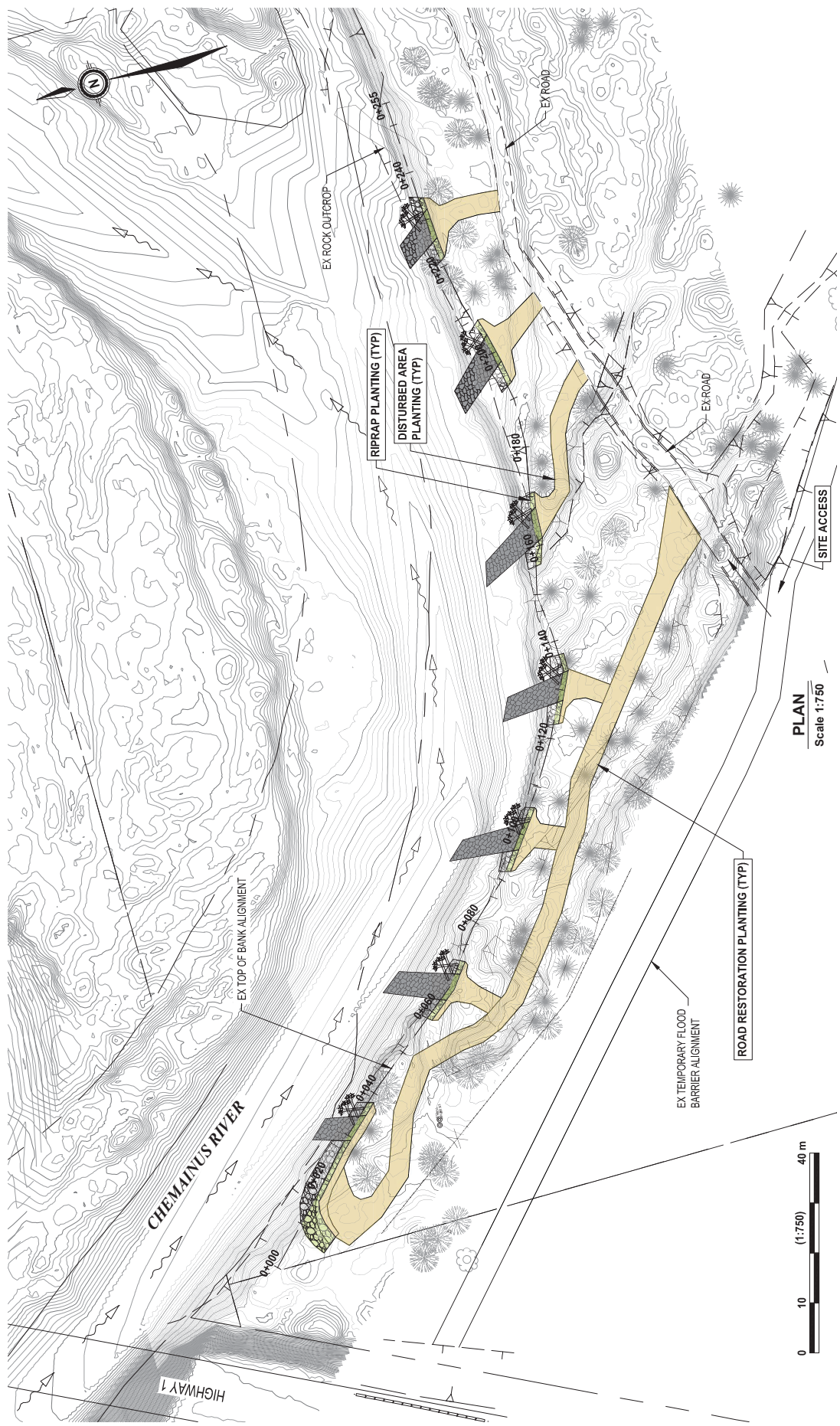
PLAN	N.T.S
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SHEET 20/20 TOTAL 4/20

Plot Size: A3 (300mm x 420mm)
Plot Scale: 1:750
Drawing Scale: 1:750
Drawing Date: 20/07/2018
Drawing Title: BENDWAY WEIR STRUCTURES CONSTRUCTION PLAN



FIGURE A-2
BENDWAY WEIR STRUCTURES
CONSTRUCTION PLAN







KERR WOOD LEIDAL
consulting engineers

Appendix D-2

Change Approval for Works In and About a Stream File 1006026

**Ministry of Water, Land and Resource
Stewardship**

July 12, 2024



July 12, 2024

Job Number: 128595

vFCBC Tracking Number: 100436018

BC Ministry of Environment and Climate Change Strategy
PO Box 9337 Stn Prov Govt
Victoria, BC V8W 9M1

Dear BC Ministry of Environment and Climate Change Strategy:

Change Approval - Changes In and About a Stream (File 1006026)

Ministry of Environment and Climate Change Strategy, PO Box 9337 Stn Prov Govt, Victoria, BC V8W 9M1 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:
 - Riparian vegetation grubbing and ground cover removal for site access;
 - Construction of seven bendway weirs using riprap, angular rock, rounded cobble and gravel;
 - Installation of large woody debris habitat structures; and
 - Riparian planting of the bendway weirs and disturbed riparian areas.
- 3) The location of the works are at the following coordinates, as provided by the applicant:
 - 48.8769700, -123.7027420;
- 4) All works shall be completed in accordance with the:
 - Change Approval application, submitted February 16, 2024;
 - 'Chemainus River Right Bank Recovery – Environmental Assessment and Offsetting Plan' prepared by Kerr Wood Leidal – dated February 15, 2024; and
 - 'Halalt First Nation Chemainus River Bank Stabilization' Engineered drawings, prepared by Kerr Wood Leidal.

Page 1 of 3

**Ministry of Water, Land and
Resource Stewardship**

Water Authorizations

Mailing Address:
103 2100 Labieux Road
Nanaimo, BC V9T
6E9

Location:
2nd Floor 2100 Labieux Rd
Nanaimo, BC

Tel: 250-751-7220
Fax: 250 751-7192
Web: [www2.gov.bc.ca/gov/
content/environment/air-land-
water/water](http://www2.gov.bc.ca/gov/content/environment/air-land-water/water)

July 12, 2024
Job Number: 128595
File Number: 1006026

- 5) All works shall take place between August 1, 2024 - September 15, 2024, and/or August 1, 2025 - September 15, 2025.
- 6) A Qualified Environmental Professional/Monitor with the authority to halt work shall be on site during all phases of construction.
- 7) 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.
- 8) 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**.
- 9) The works shall not result in depressions that have the ability to trap fish and other aquatic life.
- 10) 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.
- 11) Riparian areas which are disturbed by the works shall be restored to their original condition and protected from erosion.
- 12) 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.
- 13) 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.
- 14) All rock used in the works shall be clean and free of sediment producing material, durable, non-acid generating and suitably graded.
- 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.

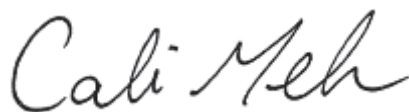
July 12, 2024
Job Number: 128595
File Number: 1006026

16) Where there is a potential for silt runoff in the proximity of existing watercourses, control devices will be installed prior to construction activities commencing;

- 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;
- Excavation will be stopped during intense rainfall events or whenever surface erosion occurs affecting the watercourse;
- Watercourses are not to be traversed by machinery at any time;
- Soil stockpiles will be placed a minimum of 15 metres from any watercourse and in a location where erosion back into the watercourse cannot occur and will not impede any drainage;
- 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;
- Permanent exposed soil areas and erosion-prone slopes that may potentially erode into the watercourse are to be seeded immediately, or covered with geotextile; and
- Clearing will take place immediately prior to excavation and earthworks to minimize the length of time that soils are exposed.

17) Complete site re-vegetation, including planting native vegetation per developed planting plan and as directed by the biologist as construction is completed.

Sincerely,

A handwritten signature in cursive script, reading "Cali Melh".

Cali Melnechenko
Water Manager



KERR WOOD LEIDAL
consulting engineers

Appendix D-3

Fisheries and Oceans Canada Letter of Advice (24-HPAC-00149)

**Fisheries and Oceans Canada
May 22, 2024**



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Pacific Region
Ecosystem Management Branch
3190 Hammond Bay Road
Nanaimo, BC
V9T 6N7

Région du Pacifique
Direction de la gestion des écosystèmes
3190, rue Hammond Bay
Nanaimo, (C.-B.)
V9T 6N7

May 22, 2024

Our file Notre référence
24-HPAC-00149

Ministry of Environment and Climate Change Strategy
ATTENTION: Amy Vallarino
PO Box 9337 Stn Provincial Government
Victoria BC V8W 9M1

Via email: Amy.Vallarino@gov.bc.ca

Dear Amy Vallarino:

Subject: Bank Recovery, Chemainus River, Halalt IR 2 – Implementation of Measures to Avoid and Mitigate the Potential for Prohibited Effects to Fish and Fish Habitat

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your proposal on February 16, 2024. We understand that you are proposing to install erosion protection measures along the right bank of the Chemainus River. The proposed project includes:

- Construction of an equipment access route for the installation of bank protection;
- Installation of seven riprap bendway weirs; and
- Riparian planting of the bendway weirs and access route.

Our review considered the following information:

- *Application for Authorization* form submitted by email on February 16, 2024;
- *Chemainus River Right Bank Recovery Environmental Assessment and Offsetting Plan*, dated February 15, 2024, submitted by email on February 16, 2024; and
- Additional information describing site isolation measures provided by Amy Vallarino (Ministry of Environment and Climate Change Strategy) via email on March 28, 2024.

Your proposal has been reviewed to determine whether it is likely to result in:

- The death of fish by means other than fishing and the harmful alteration, disruption or destruction of fish habitat which are prohibited under subsections 34.4(1) and 35(1) of the *Fisheries Act*; and
- Effects to listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the *Species at Risk Act*.

The aforementioned outcomes are prohibited unless authorized under their respective legislation and regulations. As of the date of this letter, no individuals of any aquatic species listed under the *Species at Risk Act* were identified in the vicinity of the proposed works.

To avoid and mitigate the potential for prohibited effects to fish and fish habitat (as listed above), we recommend implementing the measures listed below:

- Conduct environmental monitoring, including water quality monitoring, during all project activities that may result in potential negative effects to fish and fish habitat.
- Carry out instream works between August 1 – September 15, within the reduced risk work window for fish.
- Conduct in-water undertakings and activities during periods of low flow and during favourable weather conditions with minimal precipitation.
- Limit the duration of in-water works, undertakings and activities so that it does not diminish the ability of fish to carry out one or more of their life processes (spawning, rearing, feeding, migrating).
- Maintain fish passage during all phases of the project.
- Isolate the work areas and implement the applicable measures from DFO's *Interim standard: In-water site isolation*.
- Maintain an appropriate depth and flow for the protection of fish and fish habitat downstream of the worksite at all times.
- Conduct fish salvages to ensure that no fish are present in the isolated area. Capture, relocate, and monitor for fish trapped with isolated, enclosed, or dewatered areas.
- During warm weather conditions, conduct salvages in the coolest part of the day.
- Monitor water quality parameters (temperature and dissolved oxygen) and flow to ensure conditions are suitable for fish salvage and relocation.
- Ensure that all pump intakes used in fish bearing waters have an appropriately designed fish screen to prevent the impingement or entrainment of fish as per DFO's *Interim Code of Practice: End-of-pipe fish protection screens for small water intakes in freshwater*.
- Use only clean, non-acid generating and non-metal leaching rock below the ordinary high water mark and where rock placement is required.
- Limit vegetation removal, pruning and grubbing to the area required for accessing the project site. Re-vegetate the affected riparian zone with native species suitable for the project site.
- Develop and implement an Erosion and Sediment Control Plan to reduce the risk of sedimentation of fish habitat.
- Develop and implement a Spill Response Plan to reduce the risk of a deleterious substance discharge into fish habitat.
- Ensure equipment is in good working condition and free of leaks prior to conducting works in or near fish habitat.

Provided that you incorporate these measures into your plans, the Program is of the view that your proposal is not likely to result in the contravention of the above mentioned prohibitions and requirements.

Should your plans change or if you have omitted some information in your proposal, further review by the Program may be required. Consult our website (<http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html>) or consult with a qualified environmental consultant to determine if further review may be necessary. It remains your responsibility to remain in compliance with the *Fisheries Act*, the *Species at Risk Act* and the *Aquatic Invasive Species Regulations*.

It is also your Duty to Notify DFO if you have caused, or are about to cause, the death of fish by means other than fishing and/or the harmful alteration, disruption or destruction of fish habitat. Such notifications should be directed to the DFO-Pacific Observe, Record and Report phone line at 1-800-465-4336 or by email at DFO.ORR-ONS.MPO@dfo-mpo.gc.ca.

Please notify the Program by email at michelle.spani@dfo-mpo.gc.ca at least 10 days before starting your project, ensuring your file number and appropriate on-site contact information is included. We recommend that a copy of this letter be kept on site while the work is in progress. It remains your responsibility to meet all other federal, provincial and municipal requirements that apply to your proposal.

Please note that the advice provided in this letter will remain valid for a period of one year from the date of issuance. If you plan to execute your proposal after the expiry of this letter, we recommend that you contact the Program to ensure that the advice remains up-to-date and accurate. Furthermore, the validity of the advice is also subject to there being no change in the relevant aquatic environment, including any legal protection orders or designations, during the one year period.

If you have any questions with the content of this letter, please contact Michelle Spani at our Nanaimo office at 778-268-3859 or by email. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Andrew MacInnis
Senior Biologist, Coastal Watershed Regulatory Operations
Fish and Fish Habitat Protection Program

c.c.: Chad Davey, Kerr Wood Leidal Associates Ltd., cdavey@kwl.ca



KERR WOOD LEIDAL
consulting engineers

Appendix E

Construction Environmental Management Plan

Kerr Wood Leidal

August 9, 2024



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Chemainus River Right Bank Recovery

Construction Environmental Management Plan

Draft Report
August 9, 2024
KWL Project No. 3427.025

Prepared for:
BC Ministry of Environment and Climate Change Strategy



Ministry of
Environment and
Climate Change Strategy



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Report Submission

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BC MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY

Chemainus River Right Bank Recovery
Construction Environmental Management Plan
DRAFT Report
August 9, 2024

List of Acronyms

Acronym	Full Phrase
AR	Atmospheric River
BCWQG-AL	BC Water Quality Guidelines for the Protection of Aquatic Life
BMP	Best Management Practices
CEMP	Construction Environmental Management Plan
CNWA	Canadian Navigable Waters Act
DFO	Fisheries and Oceans Canada
ECCC	Environment Climate Change Canada
EEP	Provincial Environmental Emergency Program
EM	Environmental Monitor
ESC	Erosion and Sediment Control
KWL	Kerr Wood Leidal Associates Ltd.
ENV	Ministry of Environment and Climate Change Strategy
FOR	Ministry of Forests
MSDS	Materials Safety Data Sheet
NTU	Nephelometric Turbidity Units
QP	Qualified Professional
QEP	Qualified Environmental Professional
RAPR	Riparian Areas Protection Regulations
SAR	Species at Risk
SARA	Species at Risk Act
TC	Transport Canada
TSS	Total Suspended Sediments
WHMIS	Workplace Hazardous Materials Information Systems
WLRS	Ministry of Water, Land and Resource Stewardship



1. Introduction

Ministry of Environment and Climate Change Strategy (ENV) is working to address continued erosion of the right bank of the Chemainus River downstream of the Highway 1 bridge. Continued erosion of this bank during significant rain events in recent years has led to failure of the original unregulated riverside berm and subsequently has resulted in an increased prevalence of flood waters entering Halalt First Nation IR 2 Lands (Halalt) and neighbouring properties within the Municipality of North Cowichan (MNC). The Chemainus River Right Bank Recovery (the Project) proposes to construct six (6) bendway weir structures along to the right bank in hopes of providing a long-term solution to the ongoing erosion of this bank and mitigate future impacts on community, infrastructure and fish habitat.

Kerr Wood Leidal Associates Ltd. (KWL) was retained by ENV to prepare a Construction Environmental Management Plan (CEMP) for the Project. The CEMP includes general guidance on the following topics:

1. Environmental Monitoring
2. Timing of Works
3. Protection of Fish and Fish Habitat
4. Vegetation Management
5. Invasive Plant Management
6. Erosion and Sediment Control (ESC)
7. Deleterious Substance Control and Spill Management
8. Waste Management
9. Vehicle and Site Maintenance
10. Wildlife Management
11. Clean up and Restoration
12. DFO Letter of Advice Recommendations

1.1 Purpose of the Construction Environmental Management Plan

The CEMP sets out the requirements and measures that should 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 CEMP intends to provide overarching guidance for how environmental considerations will be implemented and monitored during the construction phase of the Project.

The CEMP 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.



1.2 Roles and Responsibilities

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

1. The Consultant (KWL) shall:
 - a. ensure that the appropriate resources are available to establish, implement, maintain, and improve environmentally responsible construction practices;
 - b. liaise with the Environmental Monitor (EM) about potential impacts to environmental components during construction;
 - c. liaise with all Qualified Professionals (QP) involved with the Project as needed; and
 - d. provide the resources required for environmental awareness and protection training, contract QP with specific expertise as needed, provide environmental documents specific to the Project, and ensure resources are made available to parties involved in construction.¹
2. The Environmental Monitor (Madrone Environmental Services), shall:
 - a. be on-site full time during start up, instream works or during any activities which pose an elevated risk to the environment;
 - b. perform necessary targeted environmental surveys or salvages, including but not limited to fish salvage, bird nesting surveys, incidental wildlife removal or water quality monitoring;
 - c. advise Ts'uubaa Pacific on environmental protection and monitor environmental protection measures;
 - d. identify deficiencies of the Project or works and communicate with the Contractor on how to address deficiencies;
 - e. 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
 - f. report to the Consultant.
3. The Contractor (Ts'uubaa Pacific) and any subcontractors shall:
 - a. plan and conduct activities in compliance with the CEMP and all applicable legislation, approvals, and best management practices;
 - b. report directly to the Consultant regarding all site activities;
 - c. ensure that there is no release of deleterious substances into the Chemainus River or any other nearby water sources;
 - d. ensure all staff, including subcontractors, are familiar with the CEMP, 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 CEMP to the Consultant, the EM as quickly as possible; and
 - f. keep a copy of the CEMP on-site at all times.

¹ QPs will have the expertise or knowledge needed to advise and/or support the ENV, KWL, Madrone and Ts'uubaa Pacific 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 CEMP:

- *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).
- *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993).



2. Project Location and Scope of Work

2.1 Project Setting

The Chemainus River is located on southeastern Vancouver Island; Its headwaters begin roughly north of the Cowichan River. This fish-bearing river travels southeast to outflow in the Strait of Georgia, passing through the town of Chemainus approximately 10 km north of the City of Duncan. Chemainus River is susceptible to sediment accumulation, which reduces the habitat quality for spawning salmonids and other aquatic species. The watershed has an area of approximately 360 km² and the mainstem of the river is approximately 64 km long. Land use within the upper watershed is dominated by forestry operations while the lower watershed is comprised of agricultural, residential and commercial zones.²

The project will occur directly downstream (east) of the Highway 1 Bridge (Figure 2-1). Table 2-1 presents the geographical location of the site.

Table 2-1: Project Location Description

Site ID	Site 2
Site Description	Chemainus River @ Highway 1 near Halalt IR 2
Location	UTM Zone 10U 448411E 5414087N
Local Government Agency	Halalt First Nation, Municipality of North Cowichan
Waterbody	Chemainus River

² Kennen Consulting. 2022. Twinned Watersheds Project: Riparian Vegetation Assessment in the Chemainus and Koksilah Watersheds. Prepared for: Cowichan Watershed Board.

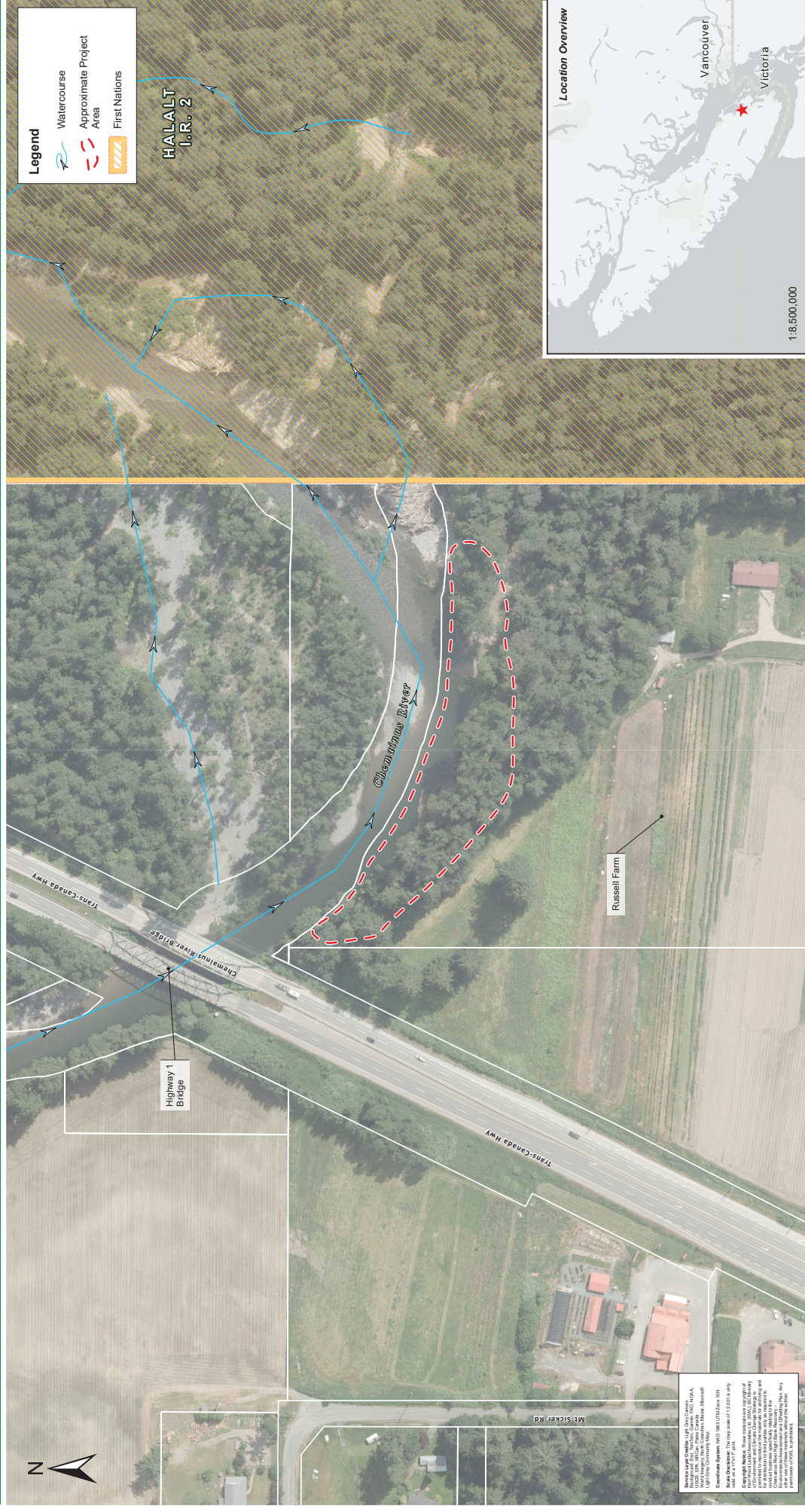


Figure 2-1



2.2 Work Sequence

The anticipated sequence for the Project is outlined below. It is assumed that Tasks 2-7 will be repeated multiple times to build all six (6) weirs.

1. Vegetation grubbing and removal of ground cover to allow for site access.
2. Install and secure an isolation measure within the Chemainus River such as floating silt curtain.
3. Salvage fish from within the isolated area using minnow traps, dip netting, electrofishing.
4. Excavate and grade to design parameters where needed.
5. Place riprap where prescribed.
6. Build weir structure using angular rock covered with rounded river cobble/gravel.
7. Place large woody debris.
8. Remove instream isolation measures.
9. Plant shrubs, trees, and live stakes where prescribed.
10. Demobilize site.

2.3 Construction Timeline

Construction will be aligned with the 2024 reduced risk window for fish in the Chemainus River (August 1 to September 15). In the event of schedule disruptions or delays, works may extend past September 15. In the event of such delays, KWL will contact designated representatives from relevant governing bodies (i.e., DFO and WLRS) to discuss possible mitigations and determine a path forward.

Out-of-water works (e.g., riparian restoration planting) may extend later into the year and possibly into early 2025. All works will be overseen by an Environmental Monitor who is a Qualified Environmental Professional (QEP) with experience in fish and fish habitat protection.



3. Environmental Setting

3.1 Aquatic Habitat

The river's aquatic habitat within the project area can be described as a glide³. The reach also faces challenges in terms of habitat complexity(<30%) and instream cover (<10%)⁴. The riverbed is composed of cobble-gravel substrates and prevalence of spawning gravels is relatively low.

3.2 Fish Communities

The Chemainus River supports runs of Coho (*Oncorhynchus kisutch*), Chinook (*Oncorhynchus tshawytscha*), and Chum Salmon (*Oncorhynchus keta*) as well as Cutthroat (*Oncorhynchus clarkii*) and Steelhead/Rainbow Trout (*Oncorhynchus mykiss*). Pink (*Oncorhynchus gorbuscha*) and Sockeye Salmon (*Oncorhynchus nerka*) have historically been reported. Other observed salmonid species include Dolly Varden (*Salvelinus malma*) although this observation is more than thirty years old and there is no record of the Chemainus River supporting a population of Dolly Varden. The Project area does not contain critical habitat for any aquatic species under Schedule 1 of Canada's Species at Risk Act. No fish monitoring was conducted by KWL, but juvenile salmonids were observed near the E&N Railway bridge just downstream of the project area.

3.3 Riparian Vegetation

Riparian habitat within the Project area is indicative of a deciduous-mixed floodplain forest and is comprised of Bigleaf maple (*Acer macrophyllum*), Black cottonwood (*Populus trichocarpa*), Douglas Fir (*Pseudotsuga menziesii*), Western red cedar (*Thuja plicata*), and Red alder (*Alnus rubra*). Invasive herbaceous vegetation was pervasive within the Project area. Ground cover and trunks of trees were almost entirely covered with English Ivy (*Hedera helix*). Other sub-canopy and herbaceous vegetation present consisted of Himalayan blackberry (*Rubus armeniacus*), Common holly (*Ilex aquifolium*), Bigleaf maple saplings, Salal (*Gaultheria shallon*), Scotch broom (*Cytisus scoparius*), and wood fern (*Dryopteris sp.*).

3.4 Species at Risk

Based on data from the BC Conservation Data Centre and federal Species at Risk Critical Habitat mapping, designated critical habitat for Oregon Forestsnail (*Allogona townsendiana*) is present within 1 km of the Project area. In addition, several occurrences of Oregon Forestsnail have occurred within 1 km of the Project area. However, it is KWL's opinion that there is a low likelihood to encounter Oregon Forestsnail within the Project area due to the extensive cover of invasive English Ivy and minimal presence of Stinging Nettle (*Urtica dioica*), which is known to be the preferred grazing plant of the species.

³ M.C. Wright and Associates Ltd. 2024. Habitat Atlas Mapping. [Twinned Watershed Working Habitat Atlas \(arcgis.com\)](https://arcgis.com). Accessed February 2, 2024.

⁴ Ibid



4. Regulatory Requirements

4.1 Permits and Approvals

As all institutional projects are not subject to the Riparian Areas Protection Regulation (RAPR), a 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. Table 4-1 summarizes all relevant environmental permits for this Project, **copies of these documents must be kept on site at all times during construction.**

Table 4-1: Received Environmental Permits/Approvals

Legislation	Permit/Approval Received	File/Permit No.
Federal <i>Fisheries Act</i>	Letter of Advice (Received May 23, 2024)	24-HPAC-00149
BC <i>Water Sustainability Act</i>	Change Approval (Received July 16, 2024)	1006026
Federal <i>Fisheries Act</i>	Scientific Fish Licence (Received August 6, 2024)	XHAB 454 2024
BC <i>Wildlife Act</i>	Fish Collection Permit (Received July 5, 2024)	NA24-856939



5. Construction 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. Throughout the duration of the project, any changes made to the CEMP must be approved by the Consultant and the Environmental Monitor. All personnel, including the Environmental Monitor (EM), Ts'uubaa Pacific, and all QEPs, must be notified before the commencement of any relevant construction activities. The ENV, Consultant and Environmental Monitor may request changes to the CEMP at their discretion. An updated copy of the CEMP must be kept on-site at all times.

5.1 Environmental Monitoring

Environmental monitoring will be conducted to ensure appropriate measures are being taken to protect the environment. The EM must be an appropriately 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 Consultant and Ts'uubaa Pacific. 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 CEMP.
- Be on-site for Project start-up and critical works (i.e., works adjacent to sensitive areas).
- Meet with Ts'uubaa Pacific before construction to explain all mitigation and environmental protection measures.
- Monitor project compliance with the CEMP, address changes to Ts'uubaa Pacific, and Consultant to ensure CEMP 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 Consultant 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.

Monitoring Frequency

An EM will be required full time during all in water works and part time after in water works have been completed. An ESC monitor will visit the site weekly and following rain events over 25 mm in 24 hours.



Environmental Monitoring Reporting Procedure

EM report, which includes ESC updates, will be submitted to the Project Manager on a weekly basis. An overall summary report will be submitted within 60 days of project completion.

- Construction activities undertaken during the reporting period.
- Environmental conditions.
- Tracking of emerging and outstanding environmental issues.
- Summary of monitoring data collected.
- Summary of fish and wildlife sightings.
- Description of mitigation measures implemented, their effectiveness, obstacles/ issues that arose during construction and adaptive strategies applied to correct those issues.
- ESC report.
- Photographs.

Contingency

If over the course of the monitoring, mitigation measures outlined within the CEMP are found to be insufficient to prevent harmful impacts to the surrounding environmental values, the environmental monitor will require works to stop until a suitable strategy to address the issue is implemented by Ts'uubaa Pacific.

5.2 Timing of Works

- Project activities will be scheduled for dry weather conditions whenever possible.
- If possible, work should occur during the regional timing window of lowest risk to salmonids (Aug 1 to Sept 15) as recommended by DFO.
- Vegetation clearing and tree removal should be scheduled outside the regional bird nesting window (March 16 to August 17) to avoid impacts to migratory birds.
 - a bird nest search will be required prior to the removal of any trees. The following will apply:
 - if an active nest is identified, a no-work zone buffer will be established and maintained around the active nest to minimize access and sensory disturbance;
 - the buffer distance will vary depending on the species of bird. Therefore, the buffer distance will be determined based on best management practices and the professional judgement of the QEP;
 - nests will be monitored to assess nest activity and effectiveness of the buffer. Clearing (disturbance) can continue once the QEP has determined that the nest is no longer active;
 - Vegetation clearing can continue in the surveyed area for up to seven days after the survey so long as the works do not stop. If work stops, the survey must be re-done; and



- nests of birds in Schedule 1 of the Migratory Birds Regulations (2022) will be reported as required by the regulations and will be protected for the duration of time required by the regulations (e.g., 36 months for pileated woodpecker).

5.3 Protection of Fish and Fish Habitat

- The proposed work area will be isolated bulk bags, silt curtains or suitable alternative. Suitable measures must be employed to reduce the amount of sediment laden water from entering the channel.
- Sound deterrents (i.e., plungers) may be used to disperse fish out of the work area before isolation is installed.
- If fish or amphibians are detected in the isolated area prior to the beginning of works, a QEP will salvage any fish and amphibians present, where it is safe and practicable and with all applicable permits, prior to commencement of work.
- Slow commencement of in-water activities is recommended to encourage mobile aquatic species to leave the construction area.
- The duration of in-water work, and activity 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 to natural materials and vegetation that contributes to habitat or stream channel stability wherever possible.
- Minimize disturbance to existing native vegetation on and adjacent to the stream banks wherever possible.
- Following the commencement of work, daily environmental monitoring visits will take place for the duration of in water project operations. The environmental monitor will perform the following tasks while onsite:
 - perform an environmental kick-off meeting with Ts'uubaa Pacific to clarify procedures and requirements under the *Water Sustainability Act* and *Fisheries Act*;
 - assess mitigation measures and ensure Best Management Practices (BMP) are used to reduce the risk of harm to fish and fish habitat; and
 - measure water quality parameters (i.e., turbidity) during work to evaluate potential impacts to fish and fish habitat from repair works. Water quality measurements will be collected upstream and downstream of the work zone under the direction of a QEP.

Guidelines and Water Quality Parameters

In-situ turbidity and pH monitoring will be performed throughout the entirety of instream works. If required, laboratory analysis for total suspended sediments (TSS) may be completed for the purposes of documenting defensible sediment load concentrations during background and elevated flow conditions.

The following criteria for in situ will apply to water around the project area, especially during construction, under the discretion of the EM:

- Induced downstream turbidity/total suspended sediment should not exceed background levels by more than 8 Nephelometric Turbidity Unit (NTU) (average) in 24 hours;



- For sediment inputs that last between 24 hours and 30 days the mean turbidity should not exceed background by more than 2 NTU;
- Induced turbidity should not exceed background levels by more than 5 NTU at any time when background turbidity is between 8 and 50 NTU. When background exceeds 50 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time; and
- Induced downstream pH should remain between pH6.5 and pH9.0, and not more than 10% of background if less than pH6.

Additional in situ or ex situ laboratory analysis for other water quality parameters including, but not limited to, the following list will be sampled as required over the course of project works on an as-needed basis as determined by the EM and will be subject to current working and approved BC Water Quality Guidelines for the Protection of Aquatic Life⁵ (BCWQG-AL):

- Temperature (°C)
- Dissolved Oxygen (%)
- Extractable Petroleum Hydrocarbons (LEPH/HEPH)
- Organics (Oil & Grease)
- Conductivity (µS/cm)

5.4 Vegetation Management

- Vegetation clearing should be scheduled outside of the regional bird nesting window (March 16 to August 17) which will protect breeding birds in the Project area. If vegetation clearing or tree removal is needed during this window, a bird nest survey should be conducted by a QEP familiar with bird habitat prior to vegetation removal, in accordance with the Canadian Wildlife Service recommendations for compliance with the *Migratory Bird Convention Act*.
- 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.
- Areas cleared to facilitate access will be replanted with local, non-invasive species.

⁵ MOE. 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture.



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, fill, etc.) must be certified weed-free.
- Upon Project completion, native shrubs and trees will be planted in disturbed areas within the footprint to maintain soil stability and to minimize the potential for invasive species colonization.
- 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 of appropriately off site at an appropriate waste management facility experiences in dealing with knotweed-contaminated soils.

5.6 Erosion and Sediment Control Plan

Ts'uubaa Pacific is responsible for developing an erosion and sediment control plan (ESC) which will then be assessed by the QEP. The purpose of 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 Ts'uubaa Pacific 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.

General Mitigation Measures

All work performed during construction will be undertaken in such a manner as to avoid or minimize potential surface erosion to and discharge of sediment laden water to the Chemainus River. The following measures will be implemented to minimize soil erosion and control sediment run-off from construction areas:

- Restrict construction activities, storage of materials and access to designated temporary workspaces.
- Minimize clear/grub and excavation work to reduce exposure of erodible soils to precipitation as practicable.
- Site access/egress route(s) should be off of paved areas. Wheel wash or rumble pads should be installed such that sediment tracking from vehicle and machinery traffic remains within Project boundaries.
- Excavated soil/rock should be disposed of or placed in such a manner, so as to prevent its entry into any environmentally sensitive areas.
- Construction activities should be stopped in areas of erodible soils during heavy precipitation (>25 mm / 24 hrs.) if increased turbidity of discharge water cannot be mitigated.

Site Access and Laydown Areas

The site will be accessed from the existing road surface. Vehicles used will be working in and around paved park access road surfaces and have the potential to cause sediment track-out to public road surfaces. Ts'uubaa Pacific will implement road sweeping along paved park access road surfaces to prevent sediment track-out, as required. Site access and laydown areas will be clearly marked with signage, fencing, hi-visibility tape or alternative to ensure equipment enters and exits at approved locations, to reduce potential interactions with the public, and to ensure storage of materials in appropriate locations.

Air Quality and Dust Suppression

The project is adjacent to regularly utilized roads and farmland. The proposed works have the potential to generate dust and must be performed such that fugitive dust generation is minimized. Construction activities that have the potential to generate dust include excavation, backfilling, and machine/passenger vehicle access/egress. These works should be performed in accordance with the following:

- Speed limits (less than 30 km/hr) will be enforced on all unpaved roads used by construction crews and vehicles.
- Idling of machinery or passenger vehicles will be limited to the furthest extent possible; machinery will be turned off when not in use.
- Exposed erodible surfaces and material stockpiles in construction areas will be kept to a minimum and or covered to prevent air borne mobilization.
- Dust suppression will be conducted as required under the discretion of the EM.
- Exposed areas will be vegetated as soon as practicable to limit sources of airborne particulate.



Site Preparation

As part of site preparation, Ts'uubaa Pacific will excavate as needed. The following best management practices will be adhered to during excavation works:

- All excavation will be during periods of favorable weather conditions.
- Any temporarily stockpiled erodible materials should be centralized to consolidated stockpiles and covered with polyethylene sheeting prior to rain events to prevent erosion to waterways.

Worksite Isolation

Prior to clearing, grubbing and site preparation outlined above, Ts'uubaa Pacific will isolate the instream work area by bulkbags or other isolation devices.

The EM will salvage aquatic life from the isolated area prior to and during dewatering. The EM will have all applicable salvage permits on hand.

5.7 Deleterious Substance Control and Spill Management

The purpose of this section is to minimize the potential for a spill or release of hydrocarbons or other hazardous materials to sensitive environments. This section also describes procedures to be followed if a spill occurs during the project. Due to the nature of the Project, potential for spilled substances include, but may not be limited to the following:

- Fuels (gasoline and/or diesel);
- Hydraulic fluid;
- Other hydrocarbon-based lubricants (grease, motor oil, transmission oil, gear oil, form oil, etc.); and
- Glycol-based coolants.

Potential Causes of Spills

There are numerous construction activities that can lead to spills of the above-listed materials. Potential causes of spills may include but not be limited to the following:

- Hydrocarbon lubricant, hydraulic fluid, and/or glycol coolant spillage from onsite machinery during maintenance.
- Fuel spills during re-fueling or over filling of tanks.
- Hydraulic line rupture from active machine works.
- Coolant spillage from overheating and/or cooling system malfunction.
- Vehicle/machinery accidents, tipping, roll-over, and/or collision with local topographical features or woody vegetation.
- Vehicle/machinery collisions with fuel/lubricant storage facilities, rupturing tanks, drums, pails, etc.
- Heavy rainfall/storm event in excess can mobilize spilled hydrocarbons or overtop containment trays.



Spill Prevention Measures & Contingency

All spills associated with the Project, regardless of quantity and location, are reportable to the Project Owner and EM. In an attempt to prevent spills from the anticipated causes above, the following measures should be put in place by Ts'uubaa Pacific over the course of works:

- Fuel should not be stored on site wherever possible. If fuel is stored on site, it will be contained within a locked, clearly marked container with secondary spill containment and in a pre-determined designated area.
- In order to ensure compliance with applicable federal and provincial legislation, including national/provincial Fire Code, all short-term storage (i.e., <24hr) will be conducted as per the latest edition of BC Fuel Guidelines.
- All fuel transportation to and from site will be conducted as per the Canada Transportation of Dangerous Goods Regulation.
- Ts'uubaa Pacific will conduct daily visual inspections on all equipment such as containment receptacles, pumps, hoses, and staging gear. No equipment will be operated onsite if it does not pass inspection.
- 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 30 m from any watercourse.
- Fueling of small (e.g., pumps, generators) will be conducted on level ground over a portable flexible spill tray in good condition.
- 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.
- All machinery will be clean, in good working condition and free of excess oil and grease. All hydraulic machinery used in the channel of the stream will use environmentally sensitive hydraulic fluids which are non-toxic to aquatic life, and which are readily or inherently biodegradable. 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.
- All equipment on site will be equipped with portable spill kits.
- 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.
- If maintenance of onsite equipment is required, it will be conducted by an appropriate service technician from a reputable organization. Any/all fluid changes will be conducted on level ground over portable flexible spill tray(s), and all waste fluids will be removed from site by Ts'uubaa Pacific.
- Contaminated materials (e.g., rags, oil filters etc.) will be stored in sealed container(s), in absence of precipitation, and routinely removed from site for disposal at an appropriate facility.
- Storage of unused maintenance fluids and/or fuels will be conducted in a dedicated and marked area, in absence of potential precipitation, with secondary containment, and with barriers to machinery collision.
- A spill response plan and spill kit(s) will be on site and suitable for all substances on-site, and staff trained in its use.



Emergency Spill Response Plan

In the event of a spill, Ts'uubaa Pacific should immediately cease all works at the spill location and power down the affected equipment. If safe to do so, Ts'uubaa Pacific should immediately tend to the spill with applicable spill response material. Once the source is determined and stopped, the operator of the equipment must notify the site supervisor who must report the spill to the Project Owner and EM. Small spills of 1 L to less than 100 L to ground require notification to the Project Owner and EM within 24 hours.

Large spills greater than 100 L to ground, or any amount conveyed to water constitute an environmental incident, and require immediate notification to applicable agencies (FOR, BC EEP & DFO).

Large spills should be immediately communicated to the Project Owner and EM, who will coordinate agency notification and incident reporting.

For spill reporting requirements breakdown by substance spilled and volume, refer to Table 5-1. A list of Project emergency contacts can be found in Table 5-2, below. This list will be updated as contact information becomes available throughout the Project.

Spill Reporting/Investigation

In the event of a spill, Ts'uubaa Pacific shall immediately take the necessary steps to resolve the incident. Ts'uubaa Pacific must:

- Prepare a spill management plan which includes notification procedures, contact telephone numbers and spill report forms.
- Have a spill kit that 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.
- Provide the necessary labour, equipment, and materials to contain and remove the spill.
- Report any spill of a toxic or deleterious substance over the reportable limits as outlined in the ENV Spill Reporting Factsheet (MOE, 2021) will be reported immediately to the BC Provincial Emergency Program 24-hour phone line at 1-800-663-3456⁶.
- If a spill of toxic or deleterious substances occurs within a watercourse or waterbody both FOR and DFO will be notified immediately. All spills will be reported to the EM immediately. Clean up the affected area.
- Dispose of waste materials at an approved disposal site.
- Restore the area to the satisfaction of the EM.

Spills should be reported utilizing a standard Spill Report Form, Ts'uubaa Pacific will provide this form to the ENV and KWL prior to the onset of the project for review. Written notification of the spill must follow within two weeks of this verbal report.

⁶ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/spills-and-environmental-emergencies/docs/materials/fact_sheet_spill_reporting.pdf



**Table 5-1: Emergency Spill Action Plan Spill Reporting Requirements
Breakdown by Substance as per the BC Spill Reporting Regulation**

Substance Spilled	Specified Amount
Class 1, Explosives as defined in section 2.9 of the Federal Regulations.	Any quantity that could pose a danger to public safety, 50 kg, or any quantity in watercourse.
Class 3, Flammable Liquids as defined in section 2.18 of the Federal Regulations.	100 L to land or any quantity in or near watercourse.
Class 8, Corrosives as defined in section 2.40 of the Federal Regulations.	5 kg or 5 L or any quantity in or near watercourse.
Waste oil as defined in section 1 of the Hazardous Waste Regulation.	100 L or any quantity in or near watercourse.

Table 5-2: Project Emergency Response Contact List

Agency/Person	Telephone Number
Fire, Police, Ambulance	911
Provincial Environmental Emergency Program (EOP) – 24 hr Hotline	1-800-663-3456
DFO – 24 hr Hotline	1-800-465-4336
Province of BC	
Amy Vallarino	250-804-5438
Consultant: KWL	
Project Manager: Stephen Bridger	604-367-6335
Technical Lead: Craig Sutherland	250-889-2155
Qualified Environmental Professional: Chad Davey	250-686-7411
Engineering Field Inspector #1: Liam Mackle	236-464-0094
Engineering Field Inspector #2: Peter Collins	250-857-7466
Project Manager: Stephen Bridger	604-367-6335
Environmental: Madrone Environmental Services Ltd.	
Senior Aquatic/Terrestrial Scientist: Trystan Willmott	250-737-4155
Senior Biologist/ Environmental Monitor #1: Justin Lange	250-737-4309
Environmental Monitor #2: Alicia Mildner	250-737-3827
Contractor: Ts'uubaa Pacific	
Project Manager: Greg Stone	250-715-8510
Safety Manager/Project Coordinator: Tiffaney Daniels	250-466-4283
Superintendent: Jerry Janik	250-797-4269
Foreman:	TBD
Billing Administrator: Melissa Clark	250-715-5924
Halalt First Nation	
Annie Cossey	250-246-4736
North Cowichan	
Director, Subdivision and Environmental Services: David Conway	250-746-3136



Post-Spill Reporting

After spill cleanup, the EM, with support from Ts'uubaa Pacific will prepare a detailed report outlining the environmental emergency, including:

- The circumstances leading to the environmental emergency or accident, including date, time, location, staff involved, construction activities, and weather conditions.
- Details of the material spilled including the quantity and the surface conditions and area impacted by the spill:
 - a summary of the chain of communication or notification including EM actions and communications;
 - the Proponent and all subcontractor staff actions and communications; and
 - agencies notified, and their actions.
- Due diligence actions taken by Ts'uubaa Pacific and ENV to prevent recurrence.
- If samples were collected, the methodology used and the analytical results.
- Environmental features that were impacted or of concern.
- Actions undertaken to clean up the emergency and the Site.
- A photo synopsis (date and time stamped photos) during the emergency and after cleanup.

5.8 Waste Management

The objective of this section is to assist in the management of solid, liquid, and hazardous wastes during construction of the Project. This will mitigate potential impacts to human health and the environment, to ensure compliance with the BC *Environmental Management Act* and associated regulations. It is intended to serve as an approachable reference to applicable guidelines for Ts'uubaa Pacific.

All anticipated construction activities have the potential to generate waste (e.g., solid, liquid, or hazardous) requiring management. The following procedures are presented to assist Ts'uubaa Pacific to meet requirements during construction.

For the purposes of the Project, potential construction wastes have been classified into the following two categories:

1. Hazardous waste
2. Non-hazardous solid and liquid waste



Hazardous Waste

No hazardous waste is expected to be stored on site. Any hazardous materials and/or waste used and/or generated on site must be removed daily by Ts'uubaa Pacific upon completion of daily activities. Potentially hazardous waste for the Project may include but not be limited to the following:

- Waste petroleum fuels and glycol coolants
- Waste petroleum oil and lubricants

If hazardous materials are present on site, the following measures should be implemented to ensure hazardous waste is properly managed:

- Material Safety Data Sheets (MSDS's) for all on-site controlled products will be maintained by Ts'uubaa Pacific, whoever is responsible for the products.
- No hazardous waste will be disposed of onsite. All the above listed hazardous wastes will be stored onsite for daily export and proper offsite disposal in appropriate containment to prevent unsafe human exposure or release to local terrestrial, aquatic, or atmospheric receiving environments. Storage will be conducted in compliance with WHMIS, MSDS, WorkSafe BC, and BC Hazardous Waste Regulation requirements, and transport will be conducted as per BC Transport of *Dangerous Goods Act*.
- Hazardous waste storage will be conducted in isolation of precipitation and within secondary containment (e.g., impermeable spill catchment pans with sufficient volume) to prevent release to ground and leaching of toxic materials to local terrestrial and aquatic receiving environments and/or groundwater contamination. Storage facilities should also be clearly marked and be protected from machinery movement to prevent vehicle/container collisions and accidental spills, as much as possible.
- Absorbent materials or soils contaminated with oil, or any quantity of hydrocarbon fuels must be handled and transported as hazardous waste. Any contaminated soil will be excavated and hauled off-site to an authorized treatment/disposal area in accordance with the BC Hazardous Waste Regulations.
- Soils suspected of containing contaminants will be managed according to the appropriate Health and Safety Plan developed by Ts'uubaa Pacific and reviewed by a QEP.
- In the event that material believed to be contaminated or hazardous is discovered during excavation at the site, the EM must be notified immediately. If the hazardous material is stable and does not pose an immediate threat, operations should be ceased until the EM or appropriately qualified professional determines the appropriate course of action for removal of the hazardous material. If the hazardous material poses an immediate threat and is unstable, then spill response procedures should be immediately followed to contain the hazardous material.



Non-Hazardous

The following is a list of common, non-hazardous wastes that are typical on a construction site of this nature and are anticipated to be present over the course of construction:

- Food waste
- Recyclables (e.g., food containers, pop cans etc.)
- Non-hazardous domestic refuse
- Overburden
- Mineral soils
- Cardboard
- Scrap metal

All non-hazardous waste is to be stored in designated bins or cans and removed from site following the cessation of each workday. No waste is to be left on site overnight. Ts'uubaa Pacific will not dump, burn, garbage, or other non-organic construction wastes associated with the work at any time.

5.9 Vehicle and Site Maintenance

In order to mitigate environmental issues arising from Ts'uubaa Pacific vehicle and machinery maintenance issues, Ts'uubaa Pacific is responsible for implementing the following:

- Vehicles and equipment, including their hydraulic fittings, shall be inspected daily to ensure that they are in good condition and free of leaks.
- Routine maintenance of passenger vehicles or highway-legal trucks will not be conducted onsite.
- All machinery will be in clean, operational condition, with documented factory-required servicing records made available to the EM, or other identified representative(s) upon request.
- Site spill kits and vehicle spill kits should be checked regularly for adequate supplies.
- All fluid replacement (e.g., oil, hydraulic fluid, glycol coolants etc.), greasing, and/or refueling will be conducted above temporary secondary containment pads (i.e., spill trays) of sufficient volume on level ground.

5.10 Wildlife Management

This section outlines the project-specific mitigation for wildlife that has been developed for the project. Mitigation measures are listed below and should be implemented on an ongoing basis and through consultation with the EM.

General Wildlife Mitigation Measures

- Wildlife must not be harassed or fed.
- All project personnel are responsible for reporting observations of wildlife impacts and incidents to the Owner and the EM. If immediate action is required, project personnel will contact the EM.
- Food waste will be stored and properly disposed of, to prevent attracting wildlife and having wildlife become habituated to the construction site and activities.



Birds

Measures to mitigate impacts to birds, including raptors, include the following:

- Vegetation clearing will occur outside the migratory bird nesting window (March 16 to August 17), where possible.
- If vegetation clearing must occur outside of the nesting window a QEP will conduct a pre-clearing nest survey.
- If an active nest is identified, a buffer (i.e., no-work zone) will be established around the active nest, and nest activity will be monitored to ensure nest occupants are not being disturbed by surrounding works. The QEP will determine the appropriate buffer based on the species of bird:
 - once the QEP has determined that the occupants of the nest have fledged, clearing within the no-work zone will continue; and
 - if no active nests are found in surveyed areas, vegetation clearing can commence, but must begin within 24–48 hours of the active bird nest survey.
- Prior to construction activities, a QEP should complete a raptor nest survey to identify, if present, any new eagle nests (or other species protected under the BC Wildlife Act) that may be impacted by construction activities. If an eagle nest is identified, further mitigation (determined by a QEP) will be implemented to avoid impacts to the nests. If impacts are not avoidable, the appropriate regulatory authority will be consulted.
- If no active nests are found in surveyed areas, vegetation clearing can commence.

Human-Wildlife Conflict Management

Human-wildlife conflict management specifications are provided to protect both project personnel and wildlife that may be encountered onsite. Human-wildlife conflicts can result in human injury or death and/or the destruction of wildlife that pose a continued threat to humans. The listed specifications are intended to reduce conflict with those wildlife species that could become a safety concern to project personnel, including coyotes. The strategy for reducing human-wildlife conflict during this project will be through education and implementation of avoidance measures.

Education

It is recommended that project personnel receive wildlife awareness and safety orientation. Wildlife encounter orientation material and programs such as the WildSafeBC program should be used to educate project personnel on reducing human-wildlife conflict. Onsite orientation topics should also include species identification, avoidance measures, and how to respond if potentially dangerous wildlife are encountered.



Avoidance

Avoiding human-wildlife encounters is the first step towards creating a safe work environment for both humans and wildlife. Proper handling, storage, and use of potential wildlife attractants is a key measure in avoiding human-wildlife conflict. The following measures must be implemented to control potential wildlife attractants:

- Animal-proof containers should be used to store daily garbage. Other locations secure from wildlife may also be used for storing other potential attractants (e.g., fuel).
- Food items should be kept in animal-proof locations, such as indoors or in storage containers (which must be kept clean when not in use).

If coyotes or other wildlife are found to be entering active construction sites, then aversive conditioning techniques are strongly encouraged to deter wildlife. These might include creating loud noises using a bear banger or air horn. If wildlife is not deterred and frequent the Site, Ts'uubaa Pacific should notify the EM, who will notify a Conservation Service Officer (1-877-952-7277).

Species at Risk

The project has the potential to interact with unidentified wildlife and/or plant species at risk (SAR) during the construction phase. If SAR or important habitat features related to SAR are discovered during the construction works, and are in potential danger from being disturbed, the Discovery Protocol for SAR must be implemented. The following outlines the step-by-step discovery response procedure.

Step 1:

Stop construction activities in the immediate vicinity of the discovery. During works, the EM will most likely be the one identifying SAR or important habitat features; however, construction personnel may also note wildlife they suspect could be at risk or features that may be important for wildlife.

Step 2:

The EM should be notified of the discovery and should assess the situation. Based on the EM's assessment:

- Construction can resume if no danger of disturbance to the discovery is identified.
- The EM should contact the QEP to discuss the discovery and develop appropriate mitigation. The QEP may deem it necessary to visit the Site to develop an appropriate mitigation plan in consultation with the EM.
- If appropriate, a no-work zone (i.e., buffer) should be established around the discovery, and construction can resume outside of the buffer area.

Step 3:

The EM should document the discovery in the weekly Inspection Summary Report, noting the following:

- The date of discovery.
- A general description of the onsite location and specific location.
- Photographs and a general description of the discovery.
- Photographs and a general description of the surrounding environment.
- Response mitigation measures implemented, if any.



5.11 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.
- All disturbed areas of the banks of the stream shall be restored to their original condition. Vegetation removed for the purposes of temporary access must be replanted using native species that are suitable for the site conditions.
- Ts'uubaa Pacific will be responsible for leaving the site in compliance with all Permits, Approvals, and Authorizations.

5.12 DFO Letter of Advice Recommended Measures

- Conduct environmental monitoring, including water quality monitoring, during all project activities that may result in potential negative effects to fish and fish habitat.
- Carry out instream works between August 1 – September 15, within the reduced risk work window for fish.
- Conduct in-water undertakings and activities during periods of low flow and during favourable weather conditions with minimal precipitation.
- Limit the duration of in-water works, undertakings and activities so that it does not diminish the ability of fish to carry out one or more of their life processes (spawning, rearing, feeding, migrating).
- Maintain fish passage during all phases of the project.
- Isolate the work areas and implement the applicable measures from DFO's *Interim standard: In-water site isolation*.
- Maintain an appropriate depth and flow for the protection of fish and fish habitat downstream of the worksite at all times.
- Conduct fish salvages to ensure that no fish are present in the isolated area. Capture, relocate, and monitor for fish trapped with isolated, enclosed, or dewatered areas.
- During warm weather conditions, conduct salvages in the coolest part of the day.
- Monitor water quality parameters (temperature and dissolved oxygen) and flow to ensure conditions are suitable for fish salvage and relocation.
- Ensure that all pump intakes used in fish bearing waters have an appropriately designed fish screen to prevent the impingement or entrainment of fish as per DFO's *Interim Code of Practice: End-of-pipe fish protection screens for small water intakes in freshwater*.
- Use only clean, non-acid generating and non-metal leaching rock below the ordinary high-water mark and where rock placement is required.
- Limit vegetation removal, pruning and grubbing to the area required for accessing the project site. Re-vegetate the affected riparian zone with native species suitable for the project site.
- Develop and implement an Erosion and Sediment Control Plan to reduce the risk of sedimentation of fish habitat.



- Develop and implement a Spill Response Plan to reduce the risk of a deleterious substance discharge into fish habitat.
- Ensure equipment is in good working condition.

5.13 Change Approval Conditions

- All works shall take place between August 1, 2024 - September 15, 2024, and/or August 1, 2025 - September 15, 2024.
- A Qualified Environmental Professional/Monitor with the authority to halt work shall be on site during all phases of construction.
- 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.
- 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**.
- The works shall not result in depressions that have the ability to trap fish and other aquatic life.
- 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.
- Riparian areas which are disturbed by the works shall be restored to their original condition and protected from erosion.
- 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.
- 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.
- All rock used in the works shall be clean and free of sediment producing material, durable, non-acid generating and suitably graded.
- 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)*" and "*A Users' Guide for Changes In and About A Stream in British Columbia (2022)*"
- Where there is a potential for silt runoff in the proximity of existing watercourses, control devices will be installed prior to construction activities commencing;
 - 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;



- excavation will be stopped during intense rainfall events or whenever surface erosion occurs affecting the watercourse;
 - watercourses are not to be traversed by machinery at any time;
 - soil stockpiles will be placed a minimum of 15 metres from any watercourse and in a location where erosion back into the watercourse cannot occur and will not impede any drainage;
 - 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;
 - permanent exposed soil areas and erosion-prone slopes that may potentially erode into the watercourse are to be seeded immediately, or covered with geotextile; and
 - clearing will take place immediately prior to excavation and earthworks to minimize the length of time that soils are exposed.
- Complete site re-vegetation, including planting native vegetation per developed planting plan and as directed by the biologist as construction is completed



6. Limitations

Findings presented in this CEMP are based upon reviews of available documentation and discussions with available personnel and regulatory representatives, review of available records and the terms and conditions for the planned construction, and observations of the Project Site and surrounding lands. Consequently, while conclusions and recommendations documented in this report have been prepared in a manner consistent with that level of care and skill normally exercised by other members of the environmental science and engineering profession, practicing under similar circumstances in the area at the time of the performance of the work, this CEMP is intended to provide information and to suggest mitigative strategies to reduce, but not necessarily eliminate, the potential for environmental impacts to occur as a result of planned construction activities at the Project Site.

This CEMP is meant to be a living and flexible document that can be used to provide guidance in environmental protection measures that can be implemented during routine construction activities, as well as unanticipated events or requirements that may arise during construction.



Report Submission

Prepared by:

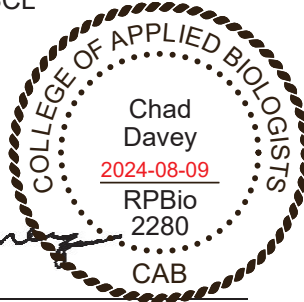
KERR WOOD LEIDAL ASSOCIATES LTD.

A handwritten signature in black ink, reading 'Jaime Dimillo', is positioned above a horizontal line.

Jaime Dimillo, BIT, BC-CESCL
Junior Biologist

Reviewed by:

A handwritten signature in black ink, reading 'Chad Davey', is positioned above a horizontal line.



Chad Davey, M.Sc., RPBio
Technical Reviewer



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	Comments	Author
A	August 9, 2024	Draft	Issued for Construction	JMD



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KERR WOOD LEIDAL
consulting engineers

Appendix F

License of Occupation Agreement



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Appendix H

Engineering Field Reviews



Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	August 5 to 9, 2024
KWL Project Number:	3427.025	Report No.:	001
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Mainly sunny, 25+ degrees		

Remarks:

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

Personnel Onsite:

Liam Mackle
Tony George
Justin Lange

Ts'uubaa Pacific:

Jerry Janik
Todd Fredrickson
Steve Danesin
Jeff Raymond

Equipment Observed on-site:

Hitachi 350 Excavator
John Deere 290 Excavator
CAT D6 Dozer
CAT 730 Rock Truck

Construction Progress and Discussions:

- Onsite construction kickoff meeting
- Access achieved by removing a section of Hesco wall and improving an existing access road through Halalt land
- Site clearing and grubbing completed to achieve access to each bendway weir location
- Tree removal completed, fir and cedar saved for LWD, maple and cottonwoods disposed of on site
- Site meeting to discuss upstream riprap key extents and locations of the furthest upstream two weirs
- Class 250 kg riprap stockpiled
- D84 screening underway at Maple Mountain stockpile
- Project signage placed at access points and on river left bank

Quality Control / Action Items:

- Set up weekly meetings with Russell Farms for progress updates
- Halalt funeral planned for August 14, so no trucking or vehicle traffic is allowed on Chemainus Road from 8 am until noon
- Potential changes to the property fence alignment, to be discussed further with Russell Farms

Archaeology:

- No issues this week

Environmental:

- Bird sweep completed
- Instream isolation to begin next week



Site Photos:			
Photo 1: Access clearing		Photo 2: Site signage	
Photo 3: Access road		Photo 4: Tree removal	

Liam Mackle
Observer Name



Signature

2024/08/09
Date

Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	August 12 to 16, 2024
KWL Project Number:	3427.025	Report No.:	002
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Mainly sunny, 20+ degrees		

Remarks:

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

Personnel Onsite:

Liam Mackle
Tony George
Justin Lange

Ts'uubaa Pacific:

Jerry Janik
Todd Fredrickson
Steve Danesin
Jeff Raymond

Equipment Observed on-site:

Hitachi 350 Excavator
John Deere 290 Excavator
CAT D6 Dozer
CAT 730 Rock Truck

Construction Progress and Discussions:

- Visit to Tsu Quarry to inspect and approve Class 1000 kg riprap and trees flagged for removal to be used as LWD
- Upstream area isolation completed, key and first bendway weir completed, with D84 rock placed on bank and large woody debris secured
- Second isolation placed and fished, bendway weir #2 construction underway
- Ongoing stockpiling of materials on site
- Weekly update meetings with Russell Farms underway
- DFO site inspection completed
- Rain forecast for the weekend, river conditions to be monitored

Quality Control / Action Items:

- Small diesel spill reported (<50 mL). Affected material was removed from site and leak was fixed per the submitted spill response plan
- Additional D84 rock to be placed on the top of bendway weir #1

Archaeology:

- No issues this week

Environmental:

- Instream isolations and minnow traps as required
- Ongoing turbidity monitoring

Site Photos:

Photo 1:
Weir #1
isolation and
excavation



Photo 2:
Weir #1
nearing
completion



Photo 3:
LWD install



Photo 4:
D84
material
install



Photo 5:
Weir #2
under
construction



Liam Mackle
Observer Name

Liam Mackle

Signature

2024/08/16
Date



Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	August 19 to 23, 2024
KWL Project Number:	3427.025	Report No.:	003
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Partly cloudy and periods of rain, 18+ degrees		

Remarks:

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

Personnel Onsite:

Liam Mackle
Tony George
Justin Lange

Ts'uubaa Pacific:

Jerry Janik
Todd Fredrickson
Steve Danesin
Jeff Raymond

Equipment Observed on-site:

Hitachi 350 Excavator
John Deere 290 Excavator
CAT D6 Dozer
CAT 730 Rock Truck

Construction Progress and Discussions:

- Periods of heavy rain had minimal impacts to river levels and did not affect isolations or construction
- First three bendway weirs completed, including D84 rock on banks and top of weir, and LWD installed
- D84 material added to the top of bendway weir #1
- Additional rock added to an exposed bank at bendway weir #2 resulting from bank excavation
- Concrete slabs moved for construction to be tested for asbestos then removed from site
- Onsite discussions about future bank erosion potential, undercut trees with exposed roots, and post-construction flow paths
- Modification to the proposed fence alignment discussed

Quality Control / Action Items:

- Discussions on potential ESC measures for stockpiles during heavy rain
- Ts'uubaa to get an estimate for fireplace repairs at Russell Farms
- Ts'uubaa to provide a fence sample for Russell Farms to approve prior to installation

Archaeology:

- No issues this week

Environmental:

- Instream isolations and minnow traps as required
- Ongoing turbidity monitoring



Site Photos:

Photo 1:
Weir #3
underway



Photo 2:
D84 on top
of Weir #2



Photo 3:
Upstream
key
completed
and buried



Photo 4:
Weir #3
completed
with D84
and LWD,
isolation
being
removed



Liam Mackle
Observer Name

Liam Mackle

Signature

2024/08/23
Date



Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	August 26 to 30, 2024
KWL Project Number:	3427.025	Report No.:	004
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Partly cloudy, 20+ degrees		

Remarks:

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

Personnel Onsite:

Liam Mackle
Tony George
Justin Lange

Ts'uubaa Pacific:

Jerry Janik
Todd Fredrickson
Steve Danesin
Jeff Raymond

Equipment Observed on-site:

Hitachi 350 Excavator
John Deere 290 Excavator
CAT D6 Dozer
CAT 730 Rock Truck

Construction Progress and Discussions:

- Weirs 4 and 5 completed, except for LWD install
- Weir 6 isolation in place
- Concrete asbestos testing completed
- Concrete bridge deck slabs broken up and removed from site
- Access road reclamation completed up to weir 3, including rough and loose finish
- Gate installation next week

Quality Control / Action Items:

- Discussions on temporary water licensing for landscaping irrigation
- Additional site work at Colin James' property following last year's sediment removal project
- Existing Hesco wall was damaged near the access point and will need to be replaced

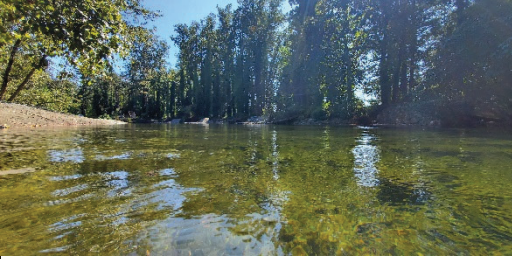
Archaeology:

- No issues this week

Environmental:

- Instream isolations and minnow traps as required
- Ongoing turbidity monitoring



Site Photos:			
Photo 1: First four completed weirs		Photo 2: Final two instream isolations	
Photo 3: Access road reclamation underway		Photo 4: Damaged Hesco baskets	
Photo 5: Progress at end of week (looking downstream)			



Liam Mackle
Observer Name

Signature

2024/08/30
Date



Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	September 3 to 6, 2024
KWL Project Number:	3427.025	Report No.:	005
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Sun and cloud, 17+ degrees		

Remarks:

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

Personnel Onsite:

Liam Mackle
Tony George
Justin Lange

Ts'uubaa Pacific:

Jerry Janik
Todd Fredrickson
Steve Danesin
Jeff Raymond

Equipment Observed on-site:

Hitachi 350 Excavator
John Deere 290 Excavator
CAT D6 Dozer
CAT 730 Rock Truck

Construction Progress and Discussions:

- Partial week due to statutory holiday and completion of site work
- All bendway weirs completed including D84 and LWD
- All isolations removed
- Access road rehabilitation completed with rough and loose finish and random placement of wood and debris
- Partial demobilization
- Gate installation
- Fence material and alignment finalized
- Existing floodplain berm will not be lowered to provide a preferential overflow point

Quality Control / Action Items:

- Plant substitutions made to the landscaping plan

Archaeology:

- No issues this week

Environmental:

- Turbidity monitoring as required



Site Photos:

Photo 1:
All weirs
completed
and
isolations
removed



Photo 2:
Access road
rehabilitation
complete

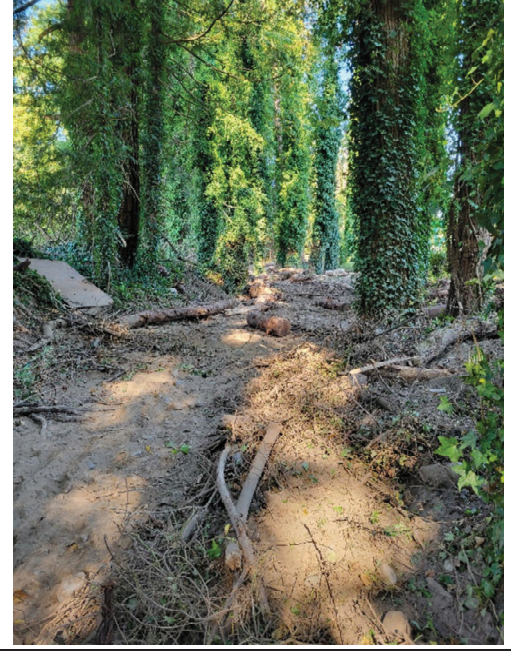


Photo 3:
Completed
weirs looking
upstream



Photo 4:
Wood debris
for floodplain
restoration



Liam Mackle
Observer Name

Liam Mackle

Signature

2024/09/06
Date



Project Name:	Chemainus River Right Bank Recovery below Highway #1 Bridge	Date:	September 23 to 27, 2024
KWL Project Number:	3427.025	Report No.:	006
Contractor:	Ts'uubaa Pacific Civil Projects LP	Prepared By:	Liam Mackle
Subcontractor:	N/A		
Weather:	Sun and cloud, 15+ degrees		

Remarks:

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

Personnel Onsite:

Blue Pine Enterprises (Landscaping)
Ts'uubaa Pacific
Onsight Tree Services

Equipment Observed on-site:

-

Construction Progress and Discussions:

- Planting completed and temporary irrigation system installed
- Property fence alignment surveyed and marked
- Two gates installed along Russell Farms property east side
- Undercut cottonwood tree on right bank felled, bucked, and left on site
- Two trees removed for fence install
- Trees in the left bank side channel bucked in to 6 to 8 foot lengths

Quality Control / Action Items:

- Fireplace and chimney repairs booked for November 25 with follow up to occur to come earlier if possible

Archaeology:

- N/A

Environmental:

- N/A

Site Photos:

Photo 1:
Installed gate and tree removal for fence install



Photo 2:
Undercut cottonwood tree removed

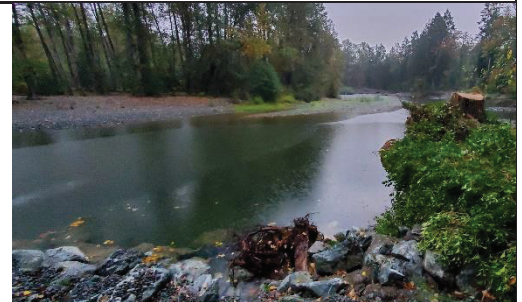




Photo 3:
Cottonwood
felled and
bucked



Photo 4:
Bucked
trees in left
bank side
channel



Liam Mackle
Observer Name

Signature

2024/09/30
Date



KERR WOOD LEIDAL
consulting engineers

Appendix I

Post-Construction Environmental Monitoring Reports



KERR WOOD LEIDAL
consulting engineers

Appendix I-1

Post-Construction Environmental Monitoring Report

Madrone Environmental Services

December 16, 2024



POST-CONSTRUCTION ENVIRONMENTAL MONITORING REPORT: Chemainus River Right Bank Restoration

FOR:

Kerr Wood Leidal Associates Ltd.
200-4185A Still Creek Drive
Burnaby, BC V8W 1R7

BY:

Justin Lange, B.Sc., R.P.Bio.,
Trystan Willmott, B.Sc., R.B.Tech., and
Danielle Lacasse, B.Sc., B.I.T.

December 16, 2024

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1 Background and Introduction

In November 2021, an Atmospheric River Event (ARE) caused significant changes to many of British Columbia's fluvial systems, including Chemainus River. After the ARE, the Ministry of Environment and Climate Change Strategy (MOECCS) began working to address erosion concerns along Chemainus River, particularly the section immediately downstream of the Highway 1 bridge (the Project Area). Continual erosion of the right bank of the Chemainus River in the Project Area, in addition to a reduction in channel capacity caused by accumulation of sediment and debris from the ARE, led to flooding concerns. A higher incidence of flood water entering Halalt First Nation IR2 Lands (Halalt) and neighbouring properties in the Municipality of North Cowichan (MNC) has increased risks to human safety, the natural environment, and infrastructure.

Based on results of a preliminary risk assessment completed by Kerr Wood Leidal Associates Ltd. (KWL), four sites were identified for recovery works on Chemainus River. This led to the inception of The Chemainus River Right Bank Recovery Project, which addresses one of the identified sites. This project, designed by KWL on behalf of MOECCS, involved construction of six bendway weirs situated along the right riverbank in the area subject to active erosion. **Figure 1** provides an overview of the general construction footprint included in the Project Area. The main project objective is long-term erosion control that will decrease potential for avulsion, help prevent channel migration into areas closer to the local community and reduce the frequency of overbank flows. Successful implementation of these objectives will help mitigate future impacts to the community, infrastructure, and natural environment. Additional objectives of the project are to increase aquatic fish habitat through placement of Large Woody Debris (LWD), planting riprap used to construct the bendway weirs, and improving the function of riparian habitat by planting native species.

To complete the project in compliance with applicable environmental legislation, regulations, and Best Management Practices (BMPs), KWL completed an Environmental Assessment (EA) and Offsetting Plan¹ in February 2024. This assessment identified multiple ecological attributes in the Project Area that required direction from a Qualified Environmental Professional (QEP) to ensure application of appropriate mitigation. Madrone Environmental Services Ltd. (Madrone) followed up with an Environmental Support proposal² related to implementation of requirements of the EA and Offsetting Plan; this proposal was provided to KWL.

Review and subsequent approval of the project, which included evaluation of KWL's EA and Offsetting Plan, was provided by the federal Department of Fisheries and Oceans (DFO) and provincial Ministry of Water, Land, and Resource Stewardship (MWLRS). The DFO issued an Avoid and Mitigate letter (File No. 24-HPAC-00149) and MWLRS provided a Change Approval (File No. 1006026). Conditions in these provincial and federal responses were included as required mitigation to be applied during completion of the project.

Mitigation measures that were outlined in the EA and Offsetting Plan and government approvals were to be addressed by a contracted QEP. Therefore, Madrone was retained by KWL to conduct third party Environmental Monitoring. Monitoring occurred between August 2024 and September 2024, with a final construction-phase site visit taking place on September 19th, 2024.

¹Environmental Assessment and Offsetting Plan - Chemainus River Right Bank Recovery. Kerr Wood Leidal (Project No. 3427.025). February 15, 2024. Prepared for BC Ministry of Environment and Climate Change Strategy.

² Chemainus River Right Bank Recovery – Environmental Support. Madrone environmental Services Ltd. (Project No. P24.1123). May 28th, 2024. Prepared for Kerr Wood Leidal.

The impacted area and work zone encompassed an area of approximately 1,820 m² (excluding offset restoration). The main development activities in the Project Area included:

- Vegetation removal for the purpose of constructing temporary access roads.
- Construction of temporary access roads.
- Construction of six bendway weirs along the right bank of Chemainus River.
- Ecological restoration of the riverbank at each weir location.
- Ecological restoration of temporary access road footprints upon completion of weir construction.

Stone Pacific Contracting Ltd. (Stone Pacific) were contracted to complete the construction phase of the project. Engineers from KWL supervised the work to ensure that project objectives were met. Stone Pacific were provided with a copy of KWL's EA and Offsetting Plan, Madrone's Environmental Support proposal, and government approval documents.

2 Mitigation Measures

The main mitigation measures that were implemented as part of the project included the following:

- Fish salvages and worksite isolation to avoid construction-related impacts to fish.
- Avoidance of impacts to breeding birds.
- Erosion and Sediment Control (ESC).
- Control of deleterious substances (e.g., hydrocarbons from working machinery).
- Restoration of riparian vegetation.

To help ensure that project requirements were fully understood by all parties involved in the project, a pre-construction meeting was held on August 6th, 2024. This meeting included representatives from Halalt, Municipality of North Cowichan, Stone Pacific, KWL, and Madrone. This pre-construction meeting was valuable as it allowed for input from multiple organizations and ensured proper communication and understanding of project objectives and mitigation measures.

3 Monitoring Summary

3.1 Project Timing

Construction activities were planned accordingly to coincide with the required least-risk window for instream works established by regulatory agencies. This general mitigation measure helped reduce risks to sensitive ecological resources by ensuring that construction activities were conducted during typical low river flows and avoided the most sensitive life stages of fish and wildlife.

3.2 Site Monitoring Visits

As construction activities commenced, Madrone completed monitoring visits during the more sensitive stages of development, such as instream work associated with installation of the bendway weirs. Site isolation and fish salvages were conducted as part of these focused visits. Several other field visits were conducted when no instream work was occurring to ensure that appropriate mitigation measures were being employed for all project aspects. Where possible, site visits were completed to coincide with rainfall events to ensure that mitigation measures were performing properly. In several cases, modifications to mitigation measures were made to improve aspects of environmental management.

Over the course of construction (August-September 2024), 22 site visits were completed by Madrone for monitoring purposes (**Table 1**). Justin Lange, B.Sc., R.P.Bio., was the lead Environmental Monitor (EM) for the duration of the project. Photographs were taken during the monitoring process, which are included in **Appendix A**. All photos are annotated, which provides supplemental information to the chronological summary of monitoring activities included in Section 4.

TABLE 1. MONITORING ACTIVITY DURING CHEMAINUS RIVER RIGHT BANK RECOVERY

Month and Year	Number of Site Visits	Site Visit Dates
August 2024	17	6,8,12,13,14,15,16,19,20,21,22,23,26,27,28,29,30
September 2024	4	3,11,13,19
October 2024	1	21

3.3 Application of Mitigation Measures

3.3.1 Fish Salvage and Construction Site Isolation

During project planning and at the pre-construction meeting, members of Halalt advised the project team that early running chinook salmon (*Oncorhynchus tshawytscha*) were staging in pool habitat units downstream of the Project Area. Based on typical late summer flow conditions and occurrence of a very shallow riffle immediately downstream of the Project Area, movement of these fish into the work area was considered unlikely. Reasoning for this was that during low flows, the riffle created a barrier to upstream movement of adult salmon due to insufficient water depth. Should flows have increased to allow for movement of adult salmon, risk from the work site was considered low, as movement of fish would not be obstructed, and each bendway weir construction area would be subject to fish salvage and isolation from the mainstem. No signs of adult salmon of any species were noted in the Project Area for the duration of the project.

Fish salvage occurred prior to any instream work being initiated in the Project Area. The primary method of mitigation involved setting up isolation units around each proposed instream work area. The Project Area was isolated into 6 individual units and was sequentially salvaged as construction progressed. Bendway weir site 1 (upstream site) was first isolated using seine nets, then had silt curtains installed after the area had been salvaged. In addition to containing sediment, silt curtains were used for effective fish isolation and were installed from the bank outwards to exclude fish from the isolation area as they were pulled out into the river.

Based on learnings from salvaging and isolating site 1, seine nets were not used during the salvage and isolation process for weir sites 2-6. Instead, silt curtains were used as the primary method to establish isolation zones to be salvaged. Once the silt curtain was secured in a given area, each isolation unit was extensively fished using minnow traps. Traps were baited with smoked oysters and salmon roe and left to soak for 17-20 hours. Even during low summer flows, each isolation area was too deep for electrofishing to be conducted safely. A combination of strategic silt curtain placement and intensive use of minnow traps was effective in removing fish from each isolation area.

Captured fish and crustaceans were identified, counted, and released downstream of the construction area in suitable habitat. Adult and juvenile Rainbow Trout (*Oncorhynchus mykiss*) and juvenile Coho Salmon (*Oncorhynchus kisutch*) were the only salmonid species encountered. Prickly Sculpin (*Cottus aster*) and Threespine Stickleback (*Gasterosteus aculeatus*) were other fish species encountered. Several Signal Crayfish (*Pacifastacus leniusculus*) were also salvaged from each work area (**Table 2**). Collection data were submitted to the Department of Fisheries and Oceans as well as the Province, as per conditions of the project's Scientific Fish Collection permits.

TABLE 2. SUMMARY OF SALVAGES FROM ISOLATION UNITS DURING CHEMAINUS RIVER RIGHT BANK RECOVERY

Isolation Unit	Rainbow Trout	Coho Salmon (juveniles)	Prickly Sculpin	Threespine Stickleback	Signal Crayfish
1	2	0	8	0	8
2	1	2	0	6	2
3	0	0	0	2	2
4	2	20	4	0	2
5	7	22	15	0	10
6	0	28	9	0	9
Totals	12	72	36	8	33

3.3.2 Breeding Bird Surveys

Initial site preparation activities associated with vegetation removal and construction of temporary access roads coincided with the end of the breeding bird period. This was beneficial, as breeding activity decreases markedly through late summer. Potential impacts to breeding birds were, therefore, decreased significantly by commencing the project in early August. Despite low risks, required mitigation to address potential impacts to breeding birds involved completion of pre-clearing nest surveys for any vegetation removal occurring prior to August 17th.

3.3.3 Erosion and Sediment Control

Over the course of the construction process, an adaptive approach was taken when implementing ESC measures. The primary focus was to ensure that no sediment was mobilized and transported into any aquatic habitat. In order to control sediment that was produced when conducting instream work at each bendway weir site, silt curtains were deployed during the construction process. The curtains were generally effective in isolating sediment and allowing it to settle out of suspension. Some seepage of sediment from underneath the silt curtains was noted, but turbidity levels remained well within required ranges considering water quality downstream of the work site.

Near the end of the construction process, exposed soil persisted throughout the area, including adjacent to the reconstructed bank. As a primary, expedient measure to stabilize exposed soil and prevent erosion, grass seed was spread as soon as the project was complete. A mix of native tree and shrub species were also planted, which will help provide long-term erosion control. An irrigation system was installed and a watering schedule implemented to ensure that seed and planted stock could establish.

3.3.4 Management of Deleterious Substances

During the monitoring site visits, brief inspections were carried out by the EM on machinery being used as part of the construction process. Apart from one small leak that occurred during the project that was addressed promptly, the machines were noted to be in good working order and appeared to be free of any leaks and excess grease. Biodegradable, non-toxic hydraulic oil and lubricants were used in machinery as a precautionary measure. During inspection of the machinery, suitable portable spill kits were observed on each machine. Throughout the construction process, a “first response” spill kit (80-litre sorbent capacity) was positioned on site in an accessible location.

Fuel management/refueling was satisfactory as all fueling occurred a safe distance (more than 30 m) from the edge of Chemainus River. Furthermore, when heavy machinery was parked at the end of a shift or not being used as part of construction, it was positioned in a laydown area removed from the main work site. By doing so, all machinery was positioned away from any aquatic habitat. If a leak did occur while parked, there would be no concern of any substance being transported to any aquatic habitat.

3.3.5 Water Quality

During the pre-construction meeting on August 6th, 2024, Madrone personnel established two water quality monitoring sites (**Figure 2**). The upstream sampling site was located above the area of influence of the project (48.878367, -123.704061) and the downstream site was positioned approximately 25 m downstream of where active construction was taking place (48.877750, -123.701474). The upper sampling site was located in a deep pool close to the HWY 1 Bridge and the lower sampling site was located in a shallow riffle.

Water quality sampling using a *Professional Plus YSI* meter included dissolved oxygen, pH, temperature, and conductivity. Turbidity was measured separately with a *LaMotte 2020e* turbidity meter.

Pre-construction water quality sampling was conducted on August 6th, 2024, to establish baseline conditions. Water quality was measured at the start of each construction day and additionally as the EM deemed necessary. If any sediment was observed outside the isolated work areas, the EM took downstream measurements immediately.

Pre-established criteria for turbidity were as follows:

- Background levels were not to be altered by more than an average of 8 Nephelometric Turbidity Units (NTUs)/24 hours.
- Sediment inputs lasting more than 24 hours and less than 30 days were not to exceed an average turbidity of more than 2 NTUs.

The pre-established criterion for pH was:

- pH should remain between 6.5 and 9.0.



Figure 2. Water quality monitoring sites relative to project area.

No specific criteria or thresholds were formulated for dissolved oxygen, temperature, or conductivity. These parameters were still collected to help provide a general overview of water quality. All water quality parameters remained within specified limits for the duration of the project. It should be noted that pH levels were relatively high, especially at the upstream water quality site, prior to initiation of project activities. Reasoning for these high background pH levels are unknown, but pH decreased to more neutral levels for the duration of the project. **Appendix B** provides results of water quality sampling.

3.3.6 Riparian Vegetation Management

During the Chemainus River Right Bank Recovery project, most of the vegetation that was removed was associated with the establishment of temporary machine access roads along the right bank of Chemainus River. Upon completion of construction, the services of Blue Pine Enterprises Ltd. were retained, and the impacted riparian area was replanted with native vegetation. A watering plan was implemented, and the site was left free of construction related garbage and debris.

4 Chronological Summary of Site Monitoring

4.1 August 2024

August 6, 2024

On August 6, 2024, breeding bird surveys were conducted by two teams of two in areas to be disturbed in the Project Area. Surveys were conducted within the time frame of sunrise to 11 am to ensure that the optimal bird activity period was captured. Weather conditions were acceptable for this type of survey with overcast skies, calm winds, and no precipitation. One team began surveying at the southwest corner of the Project Area while the other team began in the northeast corner. Teams worked towards each other, passed in the middle of the survey area and continued towards the end of the Project Area. This overlap ensured that the area received two passes with views from different directions.

No evidence (i.e., active nests) of breeding birds was observed. A Western Flycatcher (*Empidonax difficilis*) was observed feeding a fledged Brown-headed Cowbird (*Molothrus ater*) chick. The chick was mobile, and the birds were moving in and out of the survey area. A list of all bird species observed throughout the survey is included in **Appendix C**. Following the survey, Stone Pacific followed Madrone's requirements for vegetation removal to meet clearing deadlines. By adhering to Madrone's guidelines, repeat surveys were not required.

August 12, 2024

On August 12, 2024, which was the first day of site isolation and fish salvage operations, flow conditions were extremely low, and the river was clear with no visible turbidity. The site closest to the Highway 1 bridge (bendway weir 1) was isolated with nets – to enable the entire isolation area to be enclosed, nets were zip-tied together. Once the isolation zone was established, ten minnow traps were baited with salmon roe and smoked oysters and left to soak overnight.

August 13, 2024

During onsite activities on August 13, 2024, minnow traps were pulled, and all captured individuals were documented and released downstream of the construction area. A silt curtain was set up around the proposed work area for bendway weir 1 and the excavator began instream work. A trench was dug into the bank down to the waterline, which was to be filled with riprap. It was noted that all sediment generated during instream work was contained within the area enclosed by the silt curtain.

August 14, 2024

On August 14, 2024, sediment from the previous day's activity had settled and the water within the isolation zone was clear. The excavator placed medium (3 foot) riprap inside the trench that had been constructed the previous day. During this time, water within the isolation unit was turbid, as expected. A small sediment

plume occurred downstream of the isolated area, which appeared to be associated with the silt curtain lifting while working in the trench. Sediment was contained locally and did not reach the second weir site or the downstream water quality monitoring site.

August 15, 2024

On the morning of August 15, 2024, no visible turbidity was noted beyond the silt curtain and sediment continued to settle inside the containment zone. In preparation for work on bendway weir 2, the silt curtain was installed in that area. Ten baited minnow traps were then placed in the weir 2 work area. During set up, no salmonids were observed in the isolated area.

A small leak from the excavator was noted while working in the weir 1 isolation area, which resulted in staining of riprap material. The affected area was in a dry zone outside the wetted area of the river. Immediately upon discovering the leak, which was associated with a leaking fuel primer, the leak was wrapped in absorbent spill kit pads. The affected riprap was then removed and disposed of properly, and the machine taken out of service.

August 16, 2024

Minnow traps were removed from the isolated weir 2 work area on August 16, 2024, before construction crews arrived. No salmonids were caught in any of the ten deployed traps, and none were observed within the isolation area. The leaking fuel primer on the machine was fixed by installing a new part and the crew started work on weir 2 by constructing the riprap trench. The silt curtain held up well during all instream work.

August 19, 2024

Heavy rain in the form of thunderstorms occurred over the weekend and by August 19, 2024, the river had risen slightly. The silt curtains appeared to be in working order and unaffected by changing conditions. All sediment that had been generated from previous work had settled out. The site looked stable at the beginning of the day and work continued in the isolation area for weir 2. The weir 3 work area was isolated with silt curtain and ten baited minnow traps were set.

August 20, 2024

On the morning of August 20, 2024, minnow traps were pulled from the weir 3 isolation zone. All captured species were recorded and released. Work crews then started clearing the access way for the weir 3 work area. The silt curtain around weir 3 needed to be readjusted as a small plume of sediment was leaking out from a hole near shore. At first, it was noted that sediment outside of the curtain did not travel far downstream and was contained to the local area. As work progressed, however, sediment continued to leak out around the curtain, which resulted in work being shut down for the day. Sediment did not move far downstream and continued to be isolated to the immediate area surrounding the silt curtain. Measured turbidity on the downstream side of the silt curtain did not exceed 11 NTU. Coincidentally, a loose hydraulic hose was noted - the early shut down allowed crews to fix this before it became a concern.

August 21, 2024

On the morning of August 21, 2024, all sediment had settled out overnight and water on either side of the silt curtain in the active weir 3 work area was clear. Additionally, there was no visible turbidity downstream of the worksite. When work started, some sediment began seeping out from under the curtain. An attempt was

made to rectify this by using rocks to try and improve anchoring of the curtain to the substrate. Turbid water outside the isolation zone appeared to be settling within 20 m of the site and was not reaching the downstream water quality sampling station.

August 22, 2024

Monitoring personnel began the day by placing rocks on the downside corner of the silt curtain in the weir 3 work area. A small sediment plume occurred when the silt curtain was moved. There were no significant sediment concerns throughout the day, as most work was completed outside the wetted area of the river. The third weir was finished, and crews set up the silt curtains around weir site 4. Following isolation of the work area, ten baited minnow traps were set.

August 23, 2024

In the morning, minnow traps were pulled from the isolation zone of the weir 4 work area. Of the 12 minnow traps set, 6 were empty. All captured species from occupied traps were recorded and released. Excavations began to build the base for the weir, which resulted in a small plume of sediment escaping around the downstream end of the silt curtain. Sediment remained isolated to the immediate area, but efforts were made to close the outer silt curtain edge by strategically placing rocks.

August 26, 2024

Based on wet weather, a slight increase in river flow was noted on August 26, 2024, but no erosion on the previously constructed weirs was noted. The crew constructed a containment berm with river rock to act as a barrier for any turbid runoff from the work site. Crews also capped weir 4 with river rock and any sediment generated was contained in this placed material. Sediment began to slowly seep under the silt curtain but remained in the immediate area.

August 27, 2024

On August 27, 2024, the river rose in response to heavy rain. Based on weather conditions, no construction work occurred. Instead, silt curtains were moved to the weir 5 isolation area. Ten baited minnow traps were set once the site had been isolated.

August 28, 2024

Minnow traps were pulled, and all captured species were recorded and released on the morning of August 28, 2024. Work then began on weir 5, which resulted in some sediment seeping out underneath the silt curtain. The bottom of the curtain was lined with rocks to help minimize sediment release. Turbidity was originally 0.84 NTU at the downstream sample site before work began. It increased to 5.6 NTU about 15 m down from the curtain when the plume occurred. An hour after the rocks were added, turbidity went back down to 0.14 NTU within 15 m of the curtain. In preparation for work on weir 6, the site 6 area was isolated using silt curtains and 12 minnow traps were set in the isolated area.

August 29, 2024

The minnow traps were pulled from the weir 6 isolation area during the morning of August 29, 2024. All captured species were recorded and released. Minnow traps were set back for a second night in the weir 6 isolation area. Instream work then recommenced in the site 5 work area. Rehabilitation of the temporary access roads also began, with placement of woody debris.

August 30, 2024

On the morning of August 30, 2024, minnow traps were pulled from the weir 6 isolation zone and all captured species recorded and released. The river was clear adjacent to the work site, with no visible turbidity. Large rocks were being placed at the end of weir 5 and primary excavations began in the weir 6 isolation area. It was noted that when rocks were dropped, waves generated from the impact appeared to cause sediment to seep out from underneath the silt curtain. This temporary generation of turbid water outside of the silt curtain remained in the immediate area and did not migrate downstream of the work site.

4.2 September 2024

September 3, 2024

Crews completed weir 6 by the end of the workday on September 3, 2024. The silt curtain was working well, with only a minimal amount of sediment seeping under the curtain.

September 11 and 13, 2024

On September 11, 2024, replanting of disturbed riparian areas and temporary access roads was underway. Plants were on 1-metre centres and willow stakes had been planted over riprap on each weir. By September 13, 2024, a watering system had been installed, planting had been finished, and seed mix was spread over disturbed areas.

5 Implementation Monitoring

5.1 Condition of Restored Riparian Areas

A site visit occurred on September 19, 2024, to check on the quality of riparian planting. Based on lists provided by the planting contractor (Blue Pine Enterprises Ltd.), it is apparent that an adequate number and mix of species was used (**Appendix D**). The size and condition of planted stock was very good, plants had been spaced accordingly, and all plants had been planted using appropriate methods. All areas had been left clean with no evidence of garbage or construction-related debris.

Site disturbance that occurred during the project effectively removed significant areas of invasive plant coverage (mainly English ivy – *Hedera helix*). By planting disturbed areas with native plants, it is hoped that invasive plants will be suppressed. It will be important to monitor any establishment of invasive plants and to ensure survival of planted stock over the long-term to ensure that native vegetation is helping to prevent growth of invasive plants.

An irrigation system had been set up to water planted areas during the late summer period. As a result, soil moisture was adequate to allow establishment of planted stock. It was recommended to remove this system before the anticipated return of high river flows to prevent it from being damaged or washed away. The system should be reinstalled next summer (2025) to ensure that planted areas receive adequate irrigation during the drier months.

It was noted that some deciduous plant species such as thimbleberry (*Rubus parviflorum*), red osier dogwood (*Cornus stolonifera*), and snowberry (*Symphoricarpos albus*) had been browsed by deer. Depending on the degree of browse that occurs during future years, it may be necessary to implement measures to address this damage to planted stock. Some browse is expected, and the good condition and size of planted stock will help reduce browsing impacts.

The seed mix that had been spread was sprouting by September 19, 2024. This will provide adequate ground cover that will help reduce erosion and transportation of sediment over the winter months. Woody debris that had been spread throughout disturbed areas will also help reduce erosion of disturbed areas. This material will add habitat complexity to the Project Area by providing habitat for amphibians, small mammals, and birds.

5.2 LWD Specifications

The KWL EA and Offsetting Plan accurately identified that instream cover for fish was generally limited in the Project Area. In addition to planting native vegetation in disturbed riparian areas and placing live stakes over riprap, LWD was prescribed as a component of each bendway weir in terms of improving instream cover for fish and increasing pre-existing aquatic habitat complexity.

During instream works, we can confirm that LWD was incorporated into each weir. As per design plans developed by KWL, LWD was keyed into the bank immediately downstream of each weir, with the root wad and part of the stem protruding out into the river at the specified elevation. Other than weir 1 (one root wad was installed), two pieces of LWD were used for each weir and consisted of adequate material (coniferous species). It is expected that fish will use the LWD for cover during all but the lowest flow regimes. Being placed on the downstream side of each weir, the LWD is located in preferential velocity shadows, where benefits from LWD in terms of providing cover will be maximized.

It should be noted that KWL design drawings appear to indicate 3 pieces of LWD for each weir - see **Figure 3** (excerpt from KWL's EA and Offsetting Plan). Having 2 pieces of LWD instead of 3 is not expected to significantly reduce instream cover for fish or aquatic habitat complexity. Post-project instream cover and aquatic habitat complexity values are still expected to be higher compared to pre-existing conditions, when also considering benefits of cover and provision of velocity shadows created by the weirs.

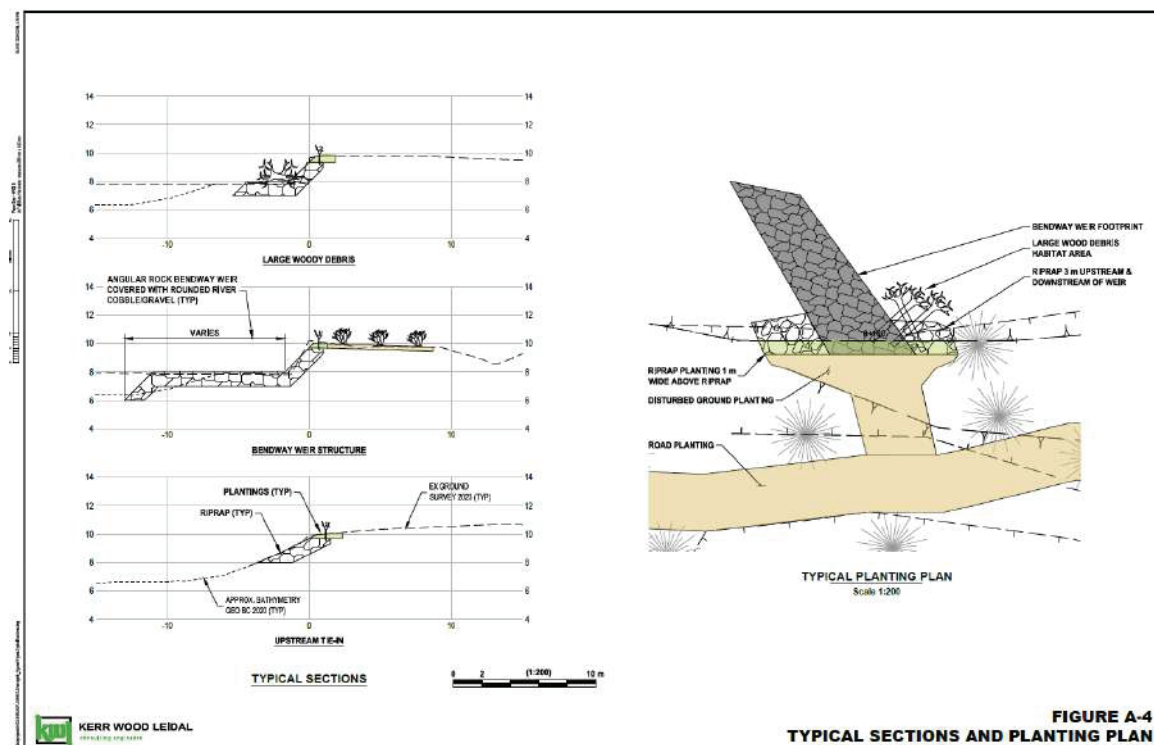


Figure 3. Excerpt from KWL's EA and Offsetting Plan showing LWD specifications.

5.3 Condition of Planted Riprap

As shown in **Figure 3**, strips approximately 1 m wide were to be planted with live stakes along the upper edge of each weir. The objective of such planting is to increase the features, functions, and conditions of riparian habitat in terms of providing benefits to adjacent aquatic habitat.

During the site visit conducted on September 19, 2024, it was noted that required planting medium had been placed over riprap in appropriate areas and live stakes had been inserted. Live stakes appeared to be a mix of Scouler's willow (*Salix scouleriana*), red alder (*Alnus rubra*), red-osier dogwood (*Cornus sericea*), and black cottonwood (*Populus balsamifera trichocarpa*). All these species are considered pioneer species that are well suited to the live staking method. The planting area extended beyond the 1 m strip covered with planting medium to include exposed riprap on each weir.

Based on observations during the field assessment, it is possible that many of the live stakes may not have been inserted deep enough to withstand desiccation during the summer months prior to becoming established. Some stakes were also relatively thin and may not contain sufficient energy reserves to remain viable. Initial green up next spring (2025) is expected to be successful for most stakes, but it will be important to determine survival of live stakes at the end of the first two summers and over the longer-term to gauge whether stakes have established successfully.

It is likely that survival will be very low for stakes inserted into exposed riprap, as stakes may become washed away during high flows. In addition, many of the stakes inserted into the riprap will likely become desiccated based on a lack of growing medium between interstitial spaces in the riprap. It should be noted, however, that any live stakes placed beyond the upper strips that were covered with planting medium are considered to exceed the planting area requirements. Any live stakes that do survive in the exposed riprap would, therefore, be considered a bonus.

6 Future Monitoring Requirements

KWL's EA and Offsetting Plan provides requirements for Effectiveness Monitoring over the longer-term. Monitoring is required each year for 5 years following project completion to ensure that project objectives are being met. Monitoring site visits should be conducted during late summer (late August or early September), as this will allow for an accurate assessment of the survival of planted vegetation (including live stakes). Low flows, typical of late summer will also allow for qualitative inspections of placed LWD to determine whether it is stable and providing intended functions.

Effectiveness Monitoring will involve a quantitative assessment of the survival percentage of planted stock. A qualitative assessment will also be conducted to determine general condition of planted areas to identify any physical damage, excessive browsing evidence, or signs of poor plant health. A quantitative assessment of invasive species cover will also be conducted to describe the percent cover of invasive species (particularly English ivy).

General site conditions will also be assessed as part of Effectiveness Monitoring to identify any concerns related to aspects such as garbage, erosion, vandalism (e.g., unauthorized trails), and presence of exposed soils. Site photographs will be an important component of long-term monitoring to allow comparisons to be made from year to year to help determine conditions of project components and conformance to project objectives.

To help provide a metric for assessing long-term project success, KWL developed an Effectiveness Monitoring Assessment Protocol (Table 7-1 in KWL's EA and Offsetting Plan). This protocol is shown in **Figure 4**, which is a copy of KWL's Table 7-1. This scoring protocol will be used during Effectiveness Monitoring over the next 5 years.

Maintenance of offsetting project components is expected over the long-term. This will include aspects such as irrigation of planted stock, which will likely be required over at least the first two summers (2025 and 2026), additional planting to meet survival thresholds, invasive plant removal, removal of any accumulated garbage, and addressing any vandalism concerns. As per KWL's EA and Offsetting Plan, any project offsetting components that receive a score of 2 or lower using the Effectiveness Monitoring Assessment Protocol (**Figure 4**) will need to be addressed to ensure expected targets are met.

KWL's Effectiveness Monitoring requirements also recommend initiation of a "Site Diagnostic" should multiple components score less than 2. The Site Diagnostic would be used as a means to identify reasons for low success rates and to provide solutions. Adaptive management may be required to ensure that project objectives are met – this may involve implementing changes to site offsetting plans and increased monitoring requirements to ensure that project components are performing as expected over the long-term.

Components	Score			
	4	3	2	1
Fish Habitat				
Instream Cover	LWD in excellent condition; all components are solid and submerged.	LWD in sufficient condition and is providing instream cover; minimal evidence of potential dislodging.	LWD in poor condition and is not providing much instream cover; some LWD already dislodged or close to dislodging.	LWD in poor condition or have been dislodged. Structures will not last another high flow season.
Planting Areas				
Planted Stock	Plant survival > 90%. Planted stock in excellent condition; all plants are in good health with no evidence of stress or damage.	Plant survival 80% - 90%. Planted stock in adequate condition; most plants are in good health with no evidence of stress or damage.	Plant survival 60% - 79%. Planted stock partially failed; some plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.	Plant survival < 60%. Planted stock in very poor condition; many plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.
Invasive Plants	No evidence of invasive plants present in the planted area.	Few small patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Many patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Abundant cover of invasive plants throughout the planted area and/or invasive plants present include noxious weeds (i.e., knotweed).
Scoring 4 = Exceeds expectations and objectives. 3 = Meets expectations and objectives. 2 = Fails to meet either expectations or objectives; maintenance needed. 1 = Fails to meet expectations and objectives; site diagnostic and adaptive management needed.				

Figure 4. Excerpt from KWL's EA and Offsetting Plan showing Effectiveness Monitoring Assessment Protocol.

As part of Effectiveness Monitoring, a brief report will be provided after the final site visit of the year. Based on KWL's EA and Offsetting Plan, these reports will include the following information:

- Executive summary.
- Description of general site conditions.
- Results of the Effectiveness Monitoring Assessment (using KWL's scoring protocol shown in **Figure 4**).
- Review of general site conditions in terms of adherence to project objectives and intended functions.
- Representative photos using standard photo points that can be repeated each year.
- Description of any required maintenance and revision of monitoring schedule, if applicable.
- Account of Site Diagnostic results and adaptive management requirements, if necessary.

Annual Effectiveness Monitoring reports will be provided to KWL for submission to DFO and MWLRS within 60 days of the final site visit of the year. These reports will be required for 5 years (2025-2029), assuming that no adjustments are required to monitoring duration.

7 Closure

If there are any questions regarding the contents of this report, please contact the undersigned author.

The image shows a handwritten signature in blue ink that reads "Justin Lange". To the right of the signature is a circular blue ink stamp. The stamp contains the text "COLLEGE OF APPLIED BIOLOGY" around the top edge, "Justin Lange" in the center, "R.P. Bio" below the name, "2406" below that, and "CAB" at the bottom.

MADRONE ENVIRONMENTAL SERVICES LTD.

Reviewed by:

Justin Lange, B.Sc., R.P.Bio.

Senior Aquatic and Terrestrial Biologist

APPENDIX A

MONITORING PHOTOS



SPILL KIT LOCATED IN A CENTRAL PROJECT AREA LOCATION FOR DURATION OF THE PROJECT.



WARNING SIGNAGE POSTED ON THE LEFT BANK OF THE CHEMAINUS RIVER OPPOSITE THE MAIN WORK AREA. SIGNS WERE PLACED AT THE MOST COMMON PEDESTRIAN ACCESS POINTS.

WEIR 1



ISOLATED WORK ZONE OF WEIR 1. THE SEINE NETS WERE PUT IN PLACE TO ENSURE FISH DID NOT ENTER THE WORK ZONE DURING SALVAGE OPERATIONS.



LOOKING DOWN AT THE WORK ZONE OF WEIR 1. NOTE THE SILT CURTAIN (YELLOW BOOMS), WHICH WAS PUT IN PLACE TO CONTAIN SEDIMENT. IT WAS NECESSARY TO EXCAVATE BACK FROM THE EDGE OF THE RIVER TO PROPERLY KEY IN RIPRAP.



PLACEMENT OF RIPRAP IN THE EXCAVATED TRENCH.



EXCAVATOR ATOP THE RIPRAP OF WEIR 1. THE KEYED IN RIPRAP WAS USED TO PROVIDE A STABLE WORKING PLATFORM DURING THE EXCAVATION PROCESS.



EXCAVATIONS AS PART OF WEIR CONSTRUCTION. A TRENCH WAS DUG OUT TO ALLOW FOR THE BASE LAYER OF RIPRAP TO BE PLACED AND CREATE STABILITY FOR THE WEIR.



A SMALL LEAK WAS DETECTED IN THE EXCAVATOR'S FUEL SYSTEM AND RESULTED IN SEVERAL BOULDERS BEING COATED IN DIESEL FUEL. ALL THESE ROCKS (EXAMPLE SHOWN) WERE REMOVED AND PROPERLY DISPOSED OF.



THE FACE OF WEIR 1 PRIOR TO BEING CAPPED WITH D95 COBBLES.



LOOKING DOWN AT THE LWD THAT WAS PLACED IMMEDIATELY DOWNSTREAM OF THE WEIR TO INCREASE AQUATIC HABITAT COMPLEXITY.



LOOKING DOWN AT WEIR 1 AFTER CONSTRUCTION WAS COMPLETED.

WEIR 2



THE ENCLOSED WORK AREA FOR WEIR 2. TO ENSURE ADEQUATE WORKING AREA, A THIRD SILT CURTAIN WAS ATTACHED. NOTE THE SILT CURTAIN WAS EFFECTIVE IN CONTAINING TURBID WATER THAT WAS GENERATED DURING EXCAVATIONS.



PREPARATION OF THE BANK FOR CONSTRUCTION OF WEIR 2. EXCAVATIONS WERE REQUIRED TO ACHIEVE THE REQUIRED SLOPE PRIOR TO PLACEMENT OF RIPRAP.



LOOKING DOWNSTREAM IMMEDIATELY BELOW THE ENCLOSED WORK ZONE. THE WATER OUTSIDE THE ISOLATED AREA REMAINED CLEAR FOR THE DURATION OF WEIR 2 CONSTRUCTION.



ABOVE AND BELOW: PHOTOS OF THE BANK AFTER DRAIN ROCK HAD BEEN SPREAD AND PRIOR TO PLACEMENT OF RIPRAP.





INSTREAM EXCAVATIONS THAT WERE REQUIRED TO CONSTRUCT THE BASE LAYER OF WEIR 2. NOTE THAT THE ROCK PLACED ALONG THE BANK WAS USED AS A PLATFORM FOR THE EXCAVATOR.



LOOKING DOWN AT WEIR 2 AFTER CONSTRUCTION WAS COMPLETED.

WEIR 3



THE ENCLOSED WORK AREA FOR WEIR 3.



EXAMPLE OF DEPTH OF BANK EXCAVATION FOR WEIR 3. THE PURPOSE OF THE EXCAVATION WAS TO KEY RIPRAP INTO THE RIVERBANK.



ABOVE AND BELOW: WEIR 3 RIPRAP PLACEMENT AND WEIR CAPPING USING D95 COBBLES.





DRAIN ROCK PLACEMENT. RIPRAP WAS PLACED OVER THE BANK, LEADING DOWN TO THE WEIR.



LOOKING DOWN AT THE COMPLETED WEIR 3 STRUCTURE.

WEIR 4



ABOVE AND BELOW: THE ISOLATED WORK ZONE OF WEIR 4. THE LENGTH OF THIS WEIR REQUIRED A LARGER ISOLATION ZONE.





ABOVE AND BELOW: BANK EXCAVATION FOR WEIR 4 AND PLACEMENT OF RIPRAP IN THE CHANNEL.





SILT CURTAIN DURING CONSTRUCTION OF WEIR 4. NOTE THAT THE DIRTY WATER WAS CONTAINED BY THE CURTAIN.



LOOKING TOWARDS WEIR 4 DURING THE CONSTRUCTION PROCESS.



PLACEMENT OF RIPRAP AT THE OUTER EXTENT OF WEIR 4. THE PORTION OF THE WEIR CLOSEST TO THE RIVERBANK WAS USED AS A PLATFORM FOR THE EXCAVATOR TO ENSURE ADEQUATE REACH.

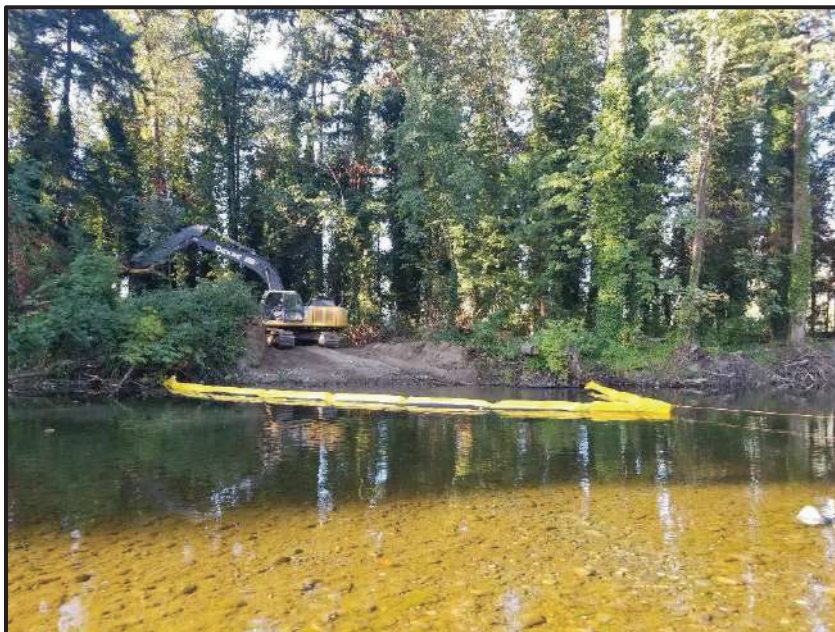


WEIR 4 UPON COMPLETION.

WEIR 5



ABOVE AND BELOW: LOOKING FROM THE LEFT BANK OF THE RIVER AT THE WEIR 5 ENCLOSURE AND INITIAL BANK EXCAVATIONS.





THE EXTENT OF WEIR 5.



TURBID WATER THAT SEEPED OUT OF THE ISOLATED AREA FROM UNDER THE SILT CURTAIN. TURBID WATER WAS CONTAINED IN THE IMMEDIATE AREA AND DID NOT REACH THE LOWER WATER QUALITY SITE.



WEIR 5 UPON COMPLETION OF RIPRAP PLACEMENT AND LWD.



LOOKING UPSTREAM AT COMPLETED WEIRS 3, 4 AND 5.

WEIR 6



THE WEIR 6 ENCLOSURE PRIOR TO INITIATION OF BANK EXCAVATIONS.



LOOKING DOWN THROUGH THE BANK EXCAVATION OF WEIR 6.



ABOVE AND BELOW: WEIR 6 DURING CONSTRUCTION. THE SILT CURTAIN WAS GENERALLY EFFECTIVE DURING CONSTRUCTION OF WEIR 6.





LOOKING DOWN AT WEIR 6 AFTER RIPRAP WAS CAPPED WITH D95 COBBLES.

WATER QUALITY STATIONS



A PHOTO OF THE UPSTREAM WATER QUALITY SAMPLING STATION. THIS SITE WAS POSITIONED IMMEDIATELY BELOW THE HIGHWAY 1 BRIDGE IN A DEEP POOL, APPROXIMATELY 50 M ABOVE WEIR 1.



LOOKING DOWN AT THE DOWNSTREAM SAMPLING STATION, ABOUT 25 M BELOW WEIR 6.

FISH SALVAGE



EXAMPLE OF A RAINBOW TROUT CAPTURED FROM THE WEIR 1 ISOLATION AREA. FISH THAT WERE CAUGHT WERE TRANSPORTED DOWNSTREAM BEYOND ANY CONSTRUCTION INFLUENCE.



A RAINBOW TROUT FROM THE WEIR 4 ISOLATION AREA.



A PRICKLY SCULPIN CAPTURED DURING THE SALVAGE PROCESS.



SIGNAL CRAYFISH, WHICH WERE CAUGHT IN SEVERAL ISOLATION AREAS.



JUVENILE COHO SALMON CAUGHT IN THE WEIR 5 ISOLATION AREA. THIS PHOTO IS REPRESENTATIVE OF THE COHO THAT WERE CAUGHT THROUGHOUT THE FISH SALVAGE.



COHO SALMON, RAINBOW TROUT, CRAYFISH, AND PRICKLY SCULPINS CAPTURED IN THE MINNOW TRAPS THAT WERE DEPLOYED TO SALVAGE WEIR 6.

RIPARIAN RESTORATION



THE STAGING SITE FOR ORGANIZATION OF PLANTS, WHICH WAS ADJACENT TO WEIR 5. NOTE THE PLANTS ORGANIZED BY SPECIES PRIOR TO DISTRIBUTION.



A PORTION OF THE TEMPORARY ACCESS ROAD CORRIDOR DURING THE REPLANTING PROCESS. NOTE THAT THE CREW DISTRIBUTED AND POSITIONED THE PLANTS IN APPROXIMATE LOCATIONS PRIOR TO PLANTING. THE WHITE PIPE IS PART OF THE TEMPORARY IRRIGATION SYSTEM THAT WAS INSTALLED.



LOOKING WEST ALONG A FULLY REPLANTED SECTION OF THE ROAD. AFTER THE PLANTS WERE PUT IN, GRASS SEED WAS APPLIED OVER THE SOIL TO REDUCE EROSION.



LIVE WILLOW LIVE STAKES THAT WERE INSTALLED ALONG THE UPPER EDGE OF WEIR 1.



A FULLY RESTORED SECTION OF THE TEMPORARY ACCESS ROAD AREA ABOVE WEIR 2. NOTE THAT COARSE WOODY DEBRIS WAS ALSO DISTRIBUTED IN THE PLANTING AREA.



ABOVE AND BELOW: AREAS ADJACENT TO WEIR 3 AND WEIR 4 AFTER BEING REPLANTED. NOTE THAT COURSE WOODY DEBRIS WAS ALSO DISTRIBUTED THROUGHOUT THESE AREAS.





WEIR 5 AFTER UPON COMPLETION OF REPLANTING.



THE AREA IMMEDIATELY ABOVE WEIR 6 AFTER BEING REPLANTED.

APPENDIX B

WATER QUALITY SAMPLING RESULTS

SUMMARY OF WATER QUALITY SAMPLING CONDUCTED DURING CHEMAINUS RIVER RIGHT BANK RECOVERY

Sampling Date	Sampling Time	Site	Turbidity (NTU)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Temperature (°C)	Comments
August 6 th , 2024 (pre-construction)	10:38	Upstream	0.05	9.72	9.0	76.5	21.1	
	10:18	Downstream	0	9.14	7.8	77.0	21.0	
August 8 th , 2024	10:43	Upstream	0	9.92	8.23	Not measured	21.0	
	10:30	Downstream	0	8.93	8.06	Not measured	20.7	
August 13 th , 2024	08:30	Upstream	0	8.63	7.62	78.0	18.4	
	08:15	Downstream	0	8.85	7.79	78.0	18.5	
August 14 th , 2024	08:00	Upstream	0	8.63	7.73	78.2	18.0	Overcast; 18-20°C.
	07:45	Downstream	0	8.96	7.74	78.7	18.0	
August 14 th , 2024	13:45	Upstream	0	8.6	7.74	78.6	18.8	Sunny and clear; 24°C.
	13:30	Downstream	0	8.8	7.75	7.75	19.0	
August 15 th , 2024	08:45	Upstream	0	9.0	7.75	78.5	18.2	Clear, sunny; 18°C.
	08:30	Downstream	0	8.96	7.77	78.7	18.4	
August 16 th , 2024	07:45	Upstream	0	8.61	7.79	78.3	18.1	No sediment reaching lower sample site.
	07:30	Downstream	0	8.98	7.76	78.5	18.0	
August 19 th , 2024	08:45	Upstream	0	8.98	7.72	79.8	17.8	River clear but flowing higher.
	08:30	Downstream	0	9.0	7.81	79.6	18.0	

Sampling Date	Sampling Time	Site	Turbidity (NTU)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Temperature (°C)	Comments
August 20 th , 2024	08:45	Upstream	0	8.95	7.74	79.6	17.7	River flowing clear, and did not come up overnight.
	09:00	Downstream	0	9.01	7.79	79.8	17.9	
August 21 st , 2024	08:00	Upstream	0	9.15	7.74	79.3	17.2	Sediment in immediate area around silt curtain.
	07:45	Downstream	0	9.23	7.72	79.2	17.0	
August 21 st , 2024	15:15	Upstream	0	9.05	7.74	79.4	17.3	
	15:00	Downstream	0	9.08	7.76	79.5	17.1	
August 22 nd , 2024	09:45	Upstream	0	9.4	7.67	74.0	17.1	River slowly receding.
	09:30	Downstream	0	9.21	7.7	73.6	17.2	
August 23 rd , 2024	07:30	Upstream	0	9.18	7.7	75.3	17.2	Cloudy with showers; 16°C at time of sample.
	07:15	Downstream	0	9.25	7.72	75.0	17.0	
August 26 th , 2024	08:00	Upstream	0	9.35	7.74	75.2	17.0	Working on 4th weir.
	07:45	Downstream	0	9.28	7.69	75.8	16.8	
August 27 th , 2024	13:00	Upstream	0	10.51	7.87	78.4	16.8	No instream work today.
	12:45	Downstream	0	9.0	7.83	76.8	16.6	

Sampling Date	Sampling Time	Site	Turbidity (NTU)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Temperature (°C)	Comments
August 28 th , 2024	07:45	Upstream	0	10.4	7.84	78.1	16.6	Sunny; 15°C. Sediment holding between silt curtains.
	07:30	Downstream	0	10.18	7.85	77.7	16.5	
August 28 th , 2024	12:45	Upstream	0	10	7.88	78	16.8	
	12:30	Downstream	0.84	9.75	7.86	78.9	16.7	5.6 NTU measured right below silt curtain.
August 29 th , 2024	10:16	Upstream	0	10.53	7.61	71.3	14.5	No instream work today.
	09:15	Downstream	0	10.35	7.6	71.3	14.7	
August 30 th , 2024	08:40	Upstream	0	10.26	7.61	71.9	14.8	No instream work today.
	08:30	Downstream	0	10.15	7.64	72.2	15.0	
August 30 th , 2024	14:30	Upstream	0	10.05	7.61	72.3	14.9	
	14:20	Downstream	0.96	9.98	7.63	74.6	15.2	Sediment seeping out from under silt curtain.
September 3 rd , 2024	08:45	Upstream	0	9.76	7.72	72.9	17.6	
	08:30	Downstream	0	9.45	7.74	73.7	17.3	Water flowing clear.

APPENDIX C

BIRD SPECIES LIST – BREEDING BIRD SURVEY CONDUCTED ON AUGUST 6TH, 2024

CHEMAINUS RIVER RIGHT BANK RECOVERY PRE-CONSTRUCTION BREEDING BIRD SURVEY OBSERVATIONS

Bird Species	Latin Name	Number of Observations
Canada Goose	<i>Branta canadensis</i>	18
Killdeer	<i>Charadrius vociferus</i>	4
Turkey Vulture	<i>Cathartes aura</i>	1
Bald Eagle	<i>Haliaeetus leucocephalus</i>	1
Belted Kingfisher	<i>Megaceryle alcyon</i>	3
Hairy Woodpecker	<i>Leuconotopicus villosus</i>	1
Northern Flicker	<i>Colaptes auratus</i>	1
Western Flycatcher	<i>Empidonax difficilis</i>	4
Common Raven	<i>Corvus corax</i>	2
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	7
Red-breasted Nuthatch	<i>Sitta canadensis</i>	2
Brown Creeper	<i>Certhia americana</i>	6
Pacific Wren	<i>Troglodytes pacificus</i>	1
Bewick's Wren	<i>Thryomanes bewickii</i>	1
European Starling	<i>Sturnus vulgaris</i>	5
Swainson's Thrush	<i>Catharus ustulatus</i>	1
American Robin	<i>Turdus migratorius</i>	4
Cedar Waxwing	<i>Bombycilla cedrorum</i>	11
Pine Siskin	<i>Spinus pinus</i>	33
Spotted Towhee	<i>Pipilo maculatus</i>	3
Orange-crowned Warbler	<i>Leiothlypis celata</i>	1

APPENDIX D

LIST OF PLANTS USED FOR RIPARIAN RESTORATION

NATIVE PLANT SPECIES USED FOR RIPARIAN RESTORATION DURING CHEMAINUS RIVER RIGHT BANK RECOVERY

Plant Species	Latin Name	Quantity of Plants
Riprap Staking		
Black Cottonwood	<i>Populus trichocarpa</i>	355
Scouler's Willow	<i>Salix scouleriana</i>	355
Red Alder	<i>Alnus rubra</i>	60
Red-osier Dogwood	<i>Cornus sericea</i>	60
Disturbed Area Around Weirs		
Western Redcedar	<i>Thuja plicata</i>	45
Red Alder	<i>Alnus rubra</i>	30
Salmonberry	<i>Rubus Spectabilis</i>	180
Red-osier Dogwood	<i>Cornus sericea</i>	130
Ocean Spray	<i>Holodiscus discolor</i>	65
Indian Plum	<i>Oemleria cerasiformis</i>	80
Nootka Rose	<i>Rosa nutkana</i>	15
Snowberry	<i>Symphoricarpos albus</i>	15
Road Replanting		
Western Redcedar	<i>Thuja plicata</i>	15
Douglas-fir	<i>Pseudotsuga menziesii</i>	15
Big-leaf Maple	<i>Acer macrophyllum</i>	15
Red Alder	<i>Alnus rubra</i>	15
Salmonberry	<i>Rubus spectabilis</i>	200
Red-osier Dogwood	<i>Cornus sericea</i>	175
Snowberry	<i>Symphoricarpos albus</i>	100
Thimbleberry	<i>Rubus parviflorus</i>	75
Sword Fern	<i>Polystichum munitum</i>	75
Nootka Rose	<i>Rosa nutkana</i>	75
Ocean Spray	<i>Holodiscus discolor</i>	60



KERR WOOD LEIDAL
consulting engineers

Appendix I-2

Effectiveness Monitoring Report Madrone Environmental Services December 8, 2025



EFFECTIVENESS MONITORING REPORT

Chemainus River Right Bank Restoration

FOR:

Kerr Wood Leidal Associates Ltd.
200-4185A Still Creek Drive
Burnaby, BC V8W 1R7

BY:

Alicia Mildner, B.Sc., R.B.Tech., and
Justin Lange, B.Sc., R.P. Bio.

December 8, 2025

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1 Introduction

In November 2021, an Atmospheric River Event (ARE) caused significant changes to many of British Columbia's fluvial systems, including Chemainus River. After the ARE, the Ministry of Environment and Climate Change Strategy (MOECCS) began working to address erosion concerns along Chemainus River, particularly the section immediately downstream of the Highway 1 bridge (the Project Area). Continual erosion of the right bank of the Chemainus River in the Project Area, in addition to a reduction in channel capacity caused by accumulation of sediment and debris from the ARE, led to flooding concerns. A higher incidence of flood water entering Halalt First Nation IR2 Lands (Halalt) and neighbouring properties in the Municipality of North Cowichan (MNC) increased risks to human safety, the natural environment, and infrastructure.

Based on results of a preliminary risk assessment completed by Kerr Wood Leidal Associates Ltd. (KWL), four sites were identified for recovery works on Chemainus River. This led to the inception of The Chemainus River Right Bank Recovery Project, which addressed one of the identified sites. This project, designed by KWL on behalf of MOECCS, involved construction of six bendway weirs situated along the right riverbank in the area subject to active erosion. **Figure 1** provides an overview of the general construction footprint included in the Project Area. The main project objective is long-term erosion control that will decrease potential for avulsion, help prevent channel migration into areas closer to the local community, and reduce the frequency of overbank flows. Successful implementation of these objectives will help mitigate future impacts to the community, infrastructure, and natural environment. Additional objectives of the project are to increase aquatic fish habitat through placement of Large Woody Debris (LWD), planting riprap used to construct the bendway weirs, and improving the function of riparian habitat by planting native species. Construction of the bendway weirs was completed in early September 2024, and replanting was done by Blue Pine Enterprises Ltd. in early October 2024.

As part of KWL's Environmental Assessment and Offsetting Plan, requirements were presented for Effectiveness Monitoring. It was determined that following project completion, one year of Effectiveness Monitoring would be suitable to ensure that project objectives are being met. Madrone Environmental Services Ltd. (Madrone) was retained by KWL as the Qualified Environmental Professional (QEP) to ensure all Effectiveness Monitoring requirements have been met.

2 Effectiveness Monitoring Objectives

The main objectives of the project's Effectiveness Monitoring include the following:

- Assessment of general site conditions to identify any concerns related to aspects such as garbage, erosion, vandalism (e.g., unauthorized trails), and presence of exposed soils.
- Assessment of the survival of planted stock and percentage of living plants. This also includes general condition of planted areas to identify any physical damage, excessive browsing, or signs of poor health.

- Assessment of invasive species cover to determine the percent cover, with particular focus being given to English ivy (*Hedera helix*)

FIGURE 1. PLANTING OVERVIEW

3 Monitoring Summary and Site Observations

To fulfill the required one year of Effectiveness Monitoring, a site visit was conducted by Justin Lange (B.Sc., R.P.Bio.) and Alicia Mildner (B.Sc., R.B.Tech.) on October 22, 2025. Representative site photographs were taken to provide a baseline of site conditions and allow for comparisons to be made from year to year (Appendix A). During the site assessment, Effectiveness Monitoring Assessment Protocol Scores were assigned to each category by applying **Table 7-1** from the Environmental Assessment and Offsetting Plan prepared by Kerr Wood Leidal (**Table 1**). The scoring matrix identifies a score of 4 as exceeding expectations and objectives; a score of 3 meets expectations and objectives, whereas a score less than 2 fails to meet expectations.

TABLE 1. PROTOCOL FOR EFFECTIVENESS MONITORING

Table 7-1: Effectiveness Monitoring Assessment Protocol

Components	Score			
	4	3	2	1
Fish Habitat				
Instream Cover	LWD in excellent condition; all components are solid and submerged.	LWD in sufficient condition and is providing instream cover; minimal evidence of potential dislodging.	LWD in poor condition and is not providing much instream cover; some LWD already dislodged or close to dislodging.	LWD in poor condition or have been dislodged. Structures will not last another high flow season.
Planting Areas				
Planted Stock	Plant survival > 90%. Planted stock in excellent condition; all plants are in good health with no evidence of stress or damage.	Plant survival 80% - 90%. Planted stock in adequate condition; most plants are in good health with no evidence of stress or damage.	Plant survival 60% - 79%. Planted stock partially failed; some plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.	Plant survival < 60%. Planted stock in very poor condition; many plants with evidence of yellowing, grazing or physical damage, and/or other factors that compromise the health of the plant.
Invasive Plants	No evidence of invasive plants present in the planted area.	Few small patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Many patches of invasive plants present in disturbed areas (i.e., exposed soil). No noxious weeds present (i.e., knotweed).	Abundant cover of invasive plants throughout the planted area and/or invasive plants present include noxious weeds (i.e., knotweed).
Scoring 4 = Exceeds expectations and objectives. 3 = Meets expectations and objectives. 2 = Fails to meet either expectations or objectives; maintenance needed. 1 = Fails to meet expectations and objectives; site diagnostic and adaptive management needed.				

3.1 General Site Characteristics

During the site visit, observations were made with regards to general site conditions. Overall, it appeared that the Project Area was in good condition and appeared to be relatively undisturbed. No garbage or debris was noted in the river, on the bendway weirs or in replanted areas. There was also no evidence of vandalism or erosion. Several small trails were noted adjacent to Weir #6, as evidenced by areas of trampled grasses. These trails could be the result of wildlife movement through the area and were not noted as being a significant concern with regard to project success.

3.2 Aquatic Habitat

Effectiveness Monitoring Assessment Protocol Score: 4

Aquatic habitat conditions were assessed during the site visit, and consideration was given to the functionality and success of constructed aquatic habitat. Instream cover was installed in the form of Large Woody Debris (LWD) keyed into the weirs. The LWD appeared stable and not at risk of being dislodged. While conditions at the time of the assessment were poor (low light and high water), the LWD appeared to be sufficiently placed to provide suitable instream cover for aquatic species, particularly juvenile salmonids.

3.3 Riparian Planting Areas

Planted Stock - Effectiveness Monitoring Assessment Protocol Score: 3 (overall score for combined planting areas)

Invasive Plants - Effectiveness Monitoring Assessment Protocol Score: 3

As part of the Project, three areas were replanted with native vegetation. The goal of planting was to restore and increase the features, functions, and conditions of riparian habitat in terms of providing benefits to Chemainus River. The replanting zones included the riprap staking zones along the top of each bendway weir, disturbed zones leading up to each weir, and the road corridor used to access the weirs.

3.3.1 Riprap Staking Zone

Replanting of areas immediately above the riprap bendway weirs was completed using the live stake planting method. Table 2 outlines the species and number of stakes that were planted. Based on observations during the Effectiveness Monitoring site visit, it was noted that many of the live stakes (at least 80-85%) did not survive. When the live stakes were planted, adequate planting depths were not achieved and there was a lack of growing medium between interstitial spaces in the riprap. Therefore, the result was that the live stakes could not become established and died due to desiccation. Also, many of the stakes could easily be pulled out from between the rocks. The live stakes that did survive are located above the weirs in areas where adequate growing medium is present. It should be noted that natural re-vegetation is occurring along the top of the bendway weirs. Plants will continue to naturally establish over the long-term where adequate growing medium occurs.

TABLE 2. RIPRAP STAKING ZONES SPECIES LIST

Plant Species	Latin Name	Quantity of Plants
Black Cottonwood	<i>Populus trichocarpa</i>	355
Scouler's Willow	<i>Salix scouleriana</i>	355
Red Alder	<i>Alnus rubra</i>	60
Red-osier Dogwood	<i>Cornus sericea</i>	60

3.3.2 Disturbed and Road Corridor Planting Zones

To replant the Disturbed and Road Corridor Planting Zones, 1-gallon, 2-gallon, and 5-gallon potted plants were used. It was apparent that the mix of species and number of plants was adequate for the site (Tables 3 and 4). Generally, the potted plants that were planted appear to be healthy. Based on observations, it appeared that the survival rate exceeded 80%.

Although the general survival rate of the plants is considered acceptable, it should be noted that several Douglas-fir (*Pseudotsuga menziesii*) did not survive the first year. It appeared that those trees did not receive adequate water and became stressed. Plants also exhibited damage (i.e., broken branches or missing leaves) due to deer browse. Red osier dogwood (*Cornus sericea*), thimbleberry (*Rubus parviflorus*), and red alder (*Alnus rubra*) appeared to be the plant species that were most affected by deer browse. In contrast, coniferous tree species such as western redcedar (*Thuja plicata*) and Douglas fir were not impacted by wildlife. Shrub species such as snowberry (*Symphoricarpos albus*) and salmonberry (*Rubus spectabilis*) also seemed to be avoided in terms of deer browse. The grass seed mix that was spread throughout the Project Area has also successfully established. A thick layer of grass was observed at the time of the Effectiveness Monitoring site visit.

TABLE 3. DISTURBED PLANTING ZONES SPECIES LIST

Plant Species	Latin Name	Quantity of Plants
Western Redcedar	<i>Thuja plicata</i>	45
Red Alder	<i>Alnus rubra</i>	30
Salmonberry	<i>Rubus spectabilis</i>	180
Red-osier Dogwood	<i>Cornus sericea</i>	130
Ocean Spray	<i>Holodiscus discolor</i>	65
Indian Plum	<i>Oemleria cerasiformis</i>	80
Nootka Rose	<i>Rosa nutkana</i>	15
Snowberry	<i>Symphoricarpos albus</i>	15

TABLE 4. ROAD CORRIDOR SPECIES LIST

Plant Species	Latin Name	Quantity of Plants
Western Redcedar	<i>Thuja plicata</i>	15
Douglas-fir	<i>Pseudotsuga menziesii</i>	15
Big-leaf Maple	<i>Acer macrophyllum</i>	15
Red Alder	<i>Alnus rubra</i>	15
Salmonberry	<i>Rubus spectabilis</i>	200
Red-osier Dogwood	<i>Cornus sericea</i>	175
Snowberry	<i>Symphoricarpos albus</i>	100
Thimbleberry	<i>Rubus parviflorus</i>	75
Sword Fern	<i>Polystichum munitum</i>	75
Nootka Rose	<i>Rosa nutkana</i>	75
Ocean Spray	<i>Holodiscus discolor</i>	60

At the time of the October 2025 monitoring visit, invasive plant growth in the replanted zones was minimal. Several small patches of Canada thistle (*Cirsium arvense* - noxious weed in Schedule A of the BC Weed Control Regulation¹) and an abundance of English ivy (*Hedera helix*) were noted growing adjacent to the road corridor. English ivy is of particular importance and was identified as a considerable threat to the replanted zones as extensive growth occurred throughout the Project Area prior to work beginning. At the time the Effectiveness Monitoring site visit, however, there was no evidence of English ivy growth in restored zones. It appears the grass that has established throughout the planting zones has provided adequate ground cover and may be assisting in preventing establishment of invasive plants.

4 Maintenance Requirements

Currently, there is no requirement to conduct further maintenance of planted stock or invasive plant removal activities. The requirement for one year of Effectiveness Monitoring has been satisfied and it appears that the native herbs, shrubs, trees, and grass that have established are healthy. The plants are also helping to suppress invasive plant growth.

5 Closure

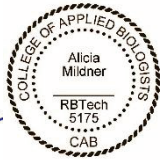
Madrone conducted one year of Effectiveness Monitoring, with the goal being to assess success of restoration activities. The aquatic habitat was assessed to exceed expectations. The riparian planting areas

¹ [Weed Control Regulation](#)

were assessed to meet the expectations set out in the Effectiveness Monitoring Assessment Protocol, despite poor survival of live stakes. Replanting live stakes is not recommended in areas where survival was low, based on continued poor growing conditions for live stakes, especially in terms of desiccation. Natural regeneration, which was noted during the site assessment, will lead to continued establishment of vegetation in areas subject to live staking.

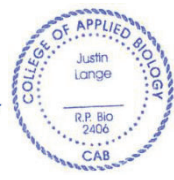
If you have any questions or concerns regarding environmental monitoring of this project, please do not hesitate to contact the undersigned.

Prepared by:



Alicia Mildner, B.Sc., R.B.Tech.

Reviewed by:



Justin Lange, B.Sc., P.R. Bio.

APPENDIX A

PHOTOGRAPH SUMMARY: MONITORING PHOTOS



Looking downstream along the top of bendway weir #6. Note that live stakes were inserted into the riprap and successful growth is limited.



Looking down at one of the bendway weirs. As can be seen in the photo, herb species have naturally established, and this was noted on several of the weirs.



Most of the live stakes placed in the riprap did not survive; however, this is an example of a surviving live stake, with new growth.



A healthy snowberry plant located in the disturbed planting zone. Note the abundance of grass, which has successfully established after seed was spread throughout the Project Area.



Looking upstream at one of the disturbed zones adjacent to the river and weirs. Several planted western redcedar and red alder are growing amongst the grass and appeared to be in good health.



An example of a healthy western redcedar in a disturbed zone adjacent to the river and bendway weirs.



A healthy planted red osier dogwood in a disturbed planting zone.



A planted thimbleberry plant exhibiting some signs of browsing. Some plants had been browsed, but it did not appear to be a significant concern throughout the Project area.



Above and below: a disturbed planting zone, showing Coarse Woody Debris placement and success of grass establishment. Several deciduous trees have been subjected to browsing pressure, but at the time of the assessment it was noted that the level of browse does not warrant additional planting measures.





Example of a planted Douglas-fir tree within the road corridor planting zone that did not survive.



Looking in a southeasterly direction at the transition of a disturbed planting zone and road corridor planting zone. Note that the sword ferns appear healthy and the lack of invasive plant growth (particularly English ivy) in the replanted zones.



Looking downstream at the tree stems/root balls that were put in as LWD adjacent to bendway weir #1. This feature remains intact and is contributing to instream cover, particularly for juvenile salmonids.