Proposed 2022 Vedder River Sediment Removal Project

Nova Pacific Environmental

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Nova Pacific Environmental

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1.0: INTRODUCTION

The Vedder River Area Management Committee (VRMAC) manages the floodway capacity of the Vedder River in part, through periodic sediment removals. This ongoing effort has reduced the risk of flooding while maintaining habitat values for regionally significant fish along the Vedder River for over 25 years. The Vedder River exhibits ongoing accumulation of sediments such that the capacity of the channel diminishes over time. To meet provincial flood protection standards to maintain 1 in 200-year flow capacity (Q200), sediment accumulation and dyke freeboard are assessed and, based on this assessment, excavations are planned. These excavations are then implemented in even numbered, non-pink salmon spawning years.

For the 2022 cycle VRMAC retained Kerr Wood Leidal Associates, Ltd. (KWL) to conduct hydraulic modeling of the Vedder River to determine where the excavations should occur to address the flood potential. VRMAC retained Nova Pacific Environmental, Ltd. (NPE) to develop specific plans for removals that would meet flood risk objectives while ensuring that fish habitat and other environmental and regulatory concerns were met. The purpose of this document is to provide information required by Fisheries and Oceans Canada (DFO) and the BC Ministry of Forests (MoF) to support the applications for required permits under the *Fisheries Act (Section 35)* and *Water Sustainability Act (Section 11)* respectively.

Three accompanying documents are being submitted separately as part of the application package to the DFO and MoF. These documents are referenced in this report and are identified as follows:

1. 2022 Vedder River Hydraulic Assessment (KWL - Apr 2022)
2. 2016 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts (NPE - Jan 2018)
3. 2016 Vedder River Sediment Removal - Monitor's Report (NPE - Dec 2016)

Until 2016, biennial excavations had been required to meet the freeboard requirements for the Vedder River, however lower rates of sediment accumulation have resulted in this activity being deferred since 2016. The atmospheric river event of November 2021 resulted in significant flows in the Chilliwack/Vedder River that resulted in the addition of 440,000 cubic meters of sediment into the Vedder River between Vedder Crossing and the Highway 1 Bridge. The hydraulic modelling performed by KWL determined that the sediment deposition increased the 1 in 200-year flood profile and several sections of dike along the Vedder River and Canal do not have the required freeboard. Following this event, the long-term average sediment deposition rate is 55,000 cubic meters per year or 110,000 cubic meters biennially.

The following sections provide details for up to 11 proposed excavations for 2022 including, excavation strategies, habitat conditions, mitigation and enhancement provisions, and project

logistics. The full program is outlined with the addition of appendices that address, methodology, hydraulic profile, endangered species (SARA) concerns and reference materials.

1.1: 2022 Vedder River Sediment Removal Program

Based on the results of the hydraulic assessment eleven excavation sites were identified for the fisheries work window of 2022, with a total potential volume of 151,000 cubic meters.

Terms of reference provided by the updated Vedder River Management Area Plan (EBA Tetratech, 2015) recommends removing the long-term average biennial sediment accumulation volume. The average biennial sediment accumulation in the Vedder River has been calculated to be 110,000m^3.

Final decisions to reduce or drop specific sites will be based on results of agency reviews, freshet changes, site specific effectiveness, habitat protection and enhancement considerations, and logistics. This could lead to significant variation of the volume for any specific site; however, the total removal will not exceed 110,000 m^3. Thus, although this application includes 11 sites totalling 151,000 m^3, approval to remove a total of 110,000 m^3 is requested.

The 2018 and 2020 sediment removal programs were cancelled due to relatively low sediment aggradation, due in part to smaller freshets during the previous few years. The hydraulic model showed an improvement in freeboard within the freeboard limited section of the dyke from 2016 to 2018 (see KWL 2020 report - Appendix A-1). Additionally, sediment input to the Vedder River may have been reduced due to an avulsion upstream of Vedder Crossing. The avulsion happened in December 2015 and directed the flow into a substantial off channel pond which has been observed to fill over the past few years. The area where filling occurred was estimated from Google Earth to be approximately 50,000 square meters.

The survey data provided by McElhanney and analysed by KWL indicates that 440,000 cubic meters of sediment in the Vedder River and Canal since 2020 and hydraulic modeling shows the 1:200 year flood profile has increased (KWL 2022). Areas in the lower reach of the river and upper end of the canal do not meet the provincial dike freeboard requirement of 0.75m. The 2022 proposed excavations are located in the lower reach and the canal section to improve flow conveyance and dyke freeboard as well as in the upper and middle sections of the river to limit the amount of sediment moving into the freeboard limited areas. This is of particular concern since much of the material upstream shows signs of continuing shifting as evidenced by localized steeper bar edges.

The eleven (11) potential sediment removal locations for 2022 (shown in Figure 1) have been selected to:

- Lower water levels where dyke freeboard is limited.

- Trap sediment upstream of the freeboard limited area.
- Reduce future excessive excavation requirement in the Lower Reach when a large flood occurs and limit sediment movement into this reach during a flood to bolster the freeboard in limited areas.
- Increase capacity in the canal section of the river to lower the backwater curve to lower water levels in the freeboard limited area.
- Provide optimum habitat outcomes while meeting flood protection objectives for sediment removal; and/or
- Provide additional habitat in the immediate vicinity of the excavations where suitable habitat enhancement opportunities exist.

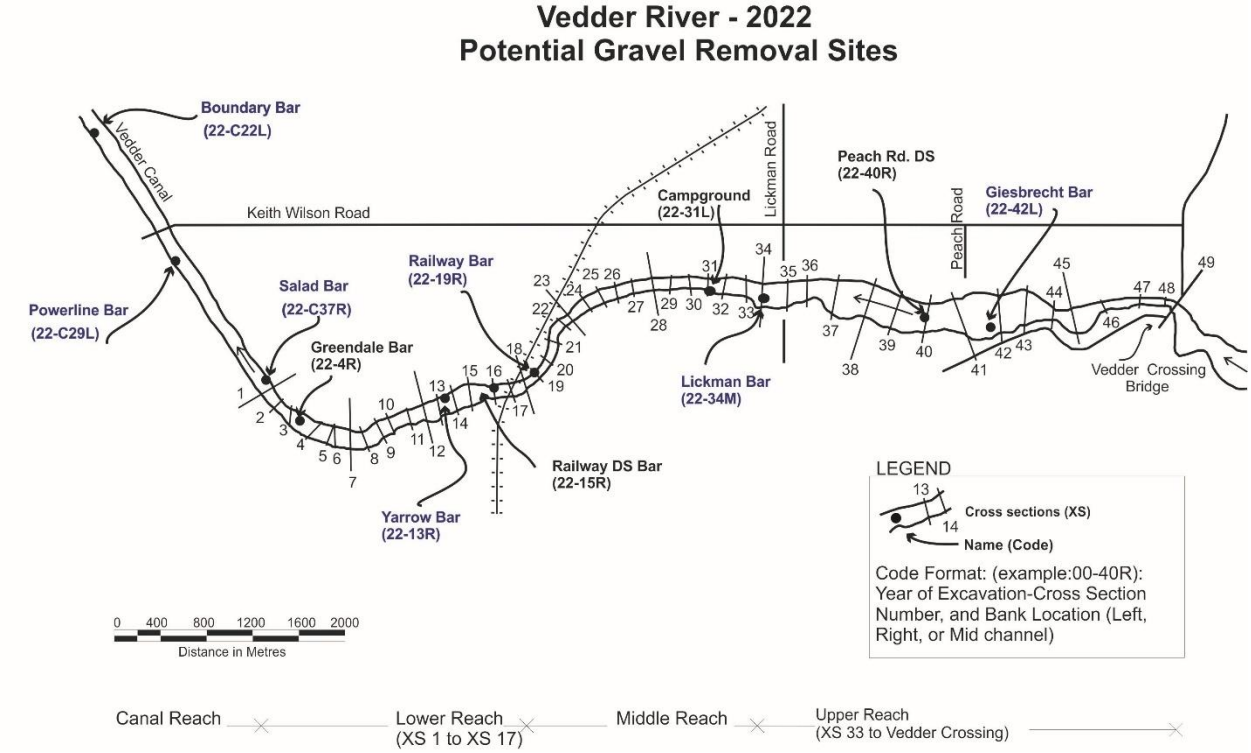

Figure 1: Locations of proposed excavations for the 2022 Vedder River Sediment Removal Program.

Each of the eleven excavations proposed for 2022 is adjacent to actively used fish habitat for spawning, rearing, and/or migration. This report will provide details of each proposed excavation, the adjacent fish habitats, expected fish utilization, potential impacts, and mitigating measures to be implemented during excavation.

1.2: General Habitat Assessment and Monitoring Post-Excavation

The assessment protocol includes detailed evaluation of habitat types both before and after the excavation. In addition, spawning locations for pink and chum salmon have been tracked on the

entire Vedder River for the years, 1994 to 2014, as part of the excavation assessment activities. As of 2014, this spawning tracking looks at habitat and spawning only at and around the individual excavation sites.

A detailed review of the fish habitat and excavation work conducted as part of the 2016 program, has been attached to this submission (Appendix A-2). A similar approach to program assessment will be followed in 2022. Current habitat conditions are noted for each proposed excavation in Section 7 of this document and more detailed habitat mapping will be conducted post-2022 freshet and prior to excavation and will be provided to the permitting agencies and stakeholders once available.

Assessments of previous excavations similar to the ones proposed for 2022 has allowed for the development of sediment removal procedures that focus on providing optimal outcomes for fish and fish habitat. However, it is important to remember that the Vedder River is subject to significant natural changes arising from the deposition and erosion of the bed material. For details on the hydrological rationale for the removals, the reader is referred to the Vedder River Hydraulic Profile 2022 Report (KWL 2022).

1.3: Applicant Information

Land ownership along the Vedder River includes the cities of Abbotsford and Chilliwack as well as Provincial Crown Lands and these three entities are members of VRMAC. The City of Chilliwack has taken the lead administrative role on behalf of VRMAC for the sediment removal planning process and is therefore the applicant for the purposes of permitting applications. A summary of the applicant's information associated with the proposed work is provided in Table 1. The proponent has provided a letter to allow NPE to work on their behalf regarding all permitting activities for the proposed project.

Table 1: Applicant information for the proposed Vedder River Sediment Removal Program.

Name:	City of Chilliwack
Contact Name:	Frank Van Nynatten
Email:	vanny@chilliwack.com
Mailing Address:	City of Chilliwack 8550 Young Road Chilliwack, BC V2P 8A4

2.0: EXCAVATION SITE SELECTION

2.1: Planning and Implementation Process Overview

Annual sediment accumulations are currently approximately 55,000 cubic meters per year on average with more sediment moving in years of major flow events and less sediment in years with lower flow. The estimate of material required for removal in each cycle is based on the results of surveys conducted at the start of each cycle and the hydraulic modeling as discussed below.

Each excavation cycle on the Vedder River begins with an updated survey of more than 70 previously determined cross sections. This information is used for hydraulic modeling that identifies areas of accumulation and degradation of substrate, determines quantities of sediment in various sections of the river, and predicts the water level and dyke freeboard in a 1 in 200-year flood (KWL 2022).

Aerial photographs of the river are taken prior to the spring freshet of an excavation year to help identify potential excavation locations. The candidate bars are then assessed in the field to identify key habitat features, identify potential habitat enhancement opportunities, and to devise a site-specific excavation plan based on the established guidelines in the Vedder River Area Management Plan, to ensure optimal habitat outcomes. The guidelines are applied to ensure the protection of existing features and optimization of anticipated post excavation conditions. Logistic issues are also evaluated at this stage, including access, stockpile locations, and potential effects on other resource users. For the 2022 sediment management cycle, the field assessment was undertaken jointly by NPE and a geomorphologist (Stirling Geoscience).

Once a set of feasible and environmentally sound excavations are identified they are compared to the identified freeboard deficiencies and calculated volumes of material required to meet channel capacity objectives. Additional hydraulic modeling is completed using this information to determine the effect of the removals on flood water levels and freeboard. A final set of target excavations is then selected to meet the flood reduction objectives while minimizing disruption to fish habitat. Once the program plan is established, permitting is initiated.

In the implementation stage, the suite of excavation sites that have been selected are tendered. Immediately prior to removal, NPE will layout a field fit excavation plan to ensure that the habitat outcome objectives are met. During removal, a qualified environmental professional (QEP) monitors the activities to ensure that the excavations proceed in environmentally sound manner and in accordance with the plans and program objectives. A survey is undertaken after the removal to determine the actual removal volume. One year after removal, a biological assessment by a registered professional biologist (R.P.Bio.) is completed to assess habitat

changes along the river and canal and a report of this assessment is submitted to VRMAC, DFO, and the Ministry of Forests (MLWRS).

2.2: Timing Considerations

Planning and implementation of this biennial sediment removal program requires that planning be completed following the fall freshet but preceding the spring freshet due to the need to complete the works during the reduced risk fisheries window. Cross sectional surveys are usually completed in February with hydraulic modeling, and site selection and design following in March and April. Coordination of the new information and optimization of the program is targeted for the beginning of May to allow as much time as possible for permitting and to allow removal contracts to be let. The start of excavations is dependent on dropping water levels as well as the July 15 to September 15 fishery window. Accordingly, the excavations usually begin around August 1 and continue to September 15. Detailed assessment of excavations and related habitat conditions is usually completed in the late summer and fall and incorporates additional aerial photography and groundtruthing linked to water levels and observations of spawning around the excavations.

2.3: Candidate Bars and Final Bar Selection for 2022

To ensure that the best possible suite of sediment removal sites were selected, a preliminary overview of the whole of the Vedder River was conducted. From this overview, eleven sites were selected that best meet the VRMAC objectives to maintain floodway capacity while optimizing fish habitat value (Table 2).

Table 2: List of Candidate Bars Considered for 2022 Sediment Removals (identified from upstream to downstream).

#	Bar Name	Plan Developed	Yield (m^3)	Comments
1	Giesbrecht	Y	18,600	Upstream gravel trap. Expected to refill without significantly affecting habitat
2	Peach Road Downstream	Y	12,700	Excavation expected to refill in similar configuration
2b	Peach Road Scalp	Y	3,450	Scalp in combination with deep pit excavation may help limit erosion downstream.

3	Lickman	Y	16,500	Expected to refill in similar configuration. Similar potential to limit erosion as with Peach Road
3b	Lickman Scalp	Y	5,000	Scalp should help increase riffle habitat
4	Campground	Y	23,400	New bar configuration. Has covered intake to off-**channel habitat enhancements**
5	Railway Bar	Y	7,500	Relatively small but accessible. Frequent previous excavations. Sediment trap potential.
6	D/S Rail Bridge Bar	Y	8,150	Good candidate, but access is very challenging. High habitat enhancement potential.
7 a	Yarrow A	Y	9,250	Established access. Proximal to freeboard limited zone. Several previous excavations.
7b	Yarrow B	Y	6,973	
8	Greendale Bar	Y	6,000	Access is feasible but challenging. Proximal to freeboard limited zone. Several previous successful excavations.
8b	Greendale Scalp	Y	3,600	
9	Salad Bar	Y	8,400	Small volume. Accessible. Several successful past excavations.
10	Powerline Bar	Y	7,500	Similar profile and size to KWB. Next in line for canal D/S to U/S strategy initiated in 2014.
11	Boundary Bar	Y	14,000	Excavated twice previously. Has reformed since 2014 excavation.
	Total		**151,000**	

3.0 FISH HABITAT IN THE VEDDER AND EXCAVATION DESIGN

3.1: General Considerations for Fish Habitat

Salmonids known to occur within the Vedder River include all five Pacific salmon species; Chinook *(Oncorhynchus tshawytscha)*, chum (*Oncorhynchus keta)*, coho *(Oncorhynchus kisutch)*, pink *(Oncorhynchus gorbuscha*) and sockeye *(Oncorhynchus nerka)* salmon, as well as steelhead trout *(Oncorhynchus mykiss)*. The life stages of salmonids which have been documented within the Vedder River include spawning, rearing, and migration. All excavation planning and implementation decisions consider these species and their utilization of habitats within the Vedder River. Excavations take place within the window where fish utilization is at its lowest, after most juvenile salmonids have migrated out of the area and before spawning. In addition, excavations are conducted in non-pink salmon spawning (even) years.

Protecting spawning habitat for salmonids is of critical concern for sediment removal efforts on the Vedder River including preserving known spawning habitat areas and identifying opportunities to enhance or create new spawning habitat opportunities for these species. Typically, only chum and pink salmon spawn in the river reaches where the excavations take place. Generally, pink salmon have been noted to spawn in channel tail-out areas above riffles and excavations are designed to ensure that these riffle areas are not bypassed by the excavation footprint. Chum salmon most often spawn below riffles and within side channels where sub-sediment flows are emerging and all excavations are designed to avoid disruption to these sub-sediment flows and, where possible, include opportunities to enhance flows in these habitat channels. Sockeye and coho salmon along with steelhead travel through the Vedder River on route to their preferred spawning areas in smaller tributaries or upstream in the Chilliwack River. Very occasionally, spawning Chinook salmon or their redds have been observed in the Vedder River. The excavations are planned to minimize changes that could detrimentally impact redds placed post excavation.

Salmonids are known to rear in many locations along the river including around the excavations. Concentrations of juvenile salmonids have been noted in pools, downstream of riffles in glide tails, along channel edges where cover is available, and within microchannels that are frequently found along the inside edge of sediment bars. Each sediment removal site is designed to avoid changes that would result in detrimental impacts to these habitat features and frequently incorporate measures to enhance these habitat features. The guidelines provided in the next section address the key approaches that are used.

Both adult and juvenile salmonid migration can be affected by the proposed excavations and mitigation steps will be undertaken to minimize any of these potential impacts. These consist

primarily of deep wide openings to the excavations and avoiding leaving pits that could become isolated pools.

Habitat mapping is typically conducted annually during low flows and comparisons are made before and approximately one year after for each excavation site. Detailed habitat mapping has not been completed since the post excavation assessment conducted in 2017, for the 2016 removal program as there has been a six-year deferral for the sediment removal program. However, aerial photography of the river was obtained in the fall of 2018 and again in March 2020. The current aerial imagery, used in this report was captured by the City of Chilliwack on March 24, 2022. This imagery, in conjunction with prior habitat mapping, data from spawning surveys, and recent physical assessments of the candidate bars is used to develop an update of the habitat conditions along the river to support excavation design. Additional imagery and a detailed inventory of habitat conditions will be collected before excavations begin to allow an accurate characterization of the effects of the impacts and to ensure that the work is completed in a way that optimizes the habitat objectives.

3.2: Environmental Inputs to Excavation Design

Each excavation has been prepared in accordance with best management practices developed specifically for the Vedder River Sediment Removal Program. These were developed in cooperation with the Vedder River Technical Committee (VRTC) and VRMAC with significant contribution and collaboration with DFO and provincial agency staff in the years between 1994 and 2012. Designs incorporate inputs from professional biologists and hydrologists and rely on the documented experience from 90 individual excavations since 1994, to predict what will happen post construction and to fine tune the designs to ensure neutral or beneficial outcomes. Amendments have been made to the design guidelines to expand the range of removal options and improve fish habitat outcomes. The guidelines underwent a comprehensive review as part of the 2015 Vedder River Management Area Plan update. The latest version of the guidelines is presented in Table 4.

Table 4: Guidelines and Constraints Followed During Excavations.

No.	Guidelines
1	No excavations in pink spawning years in the reach where most pink salmon spawn.
2	Avoid excavating in areas of sub-gravel percolation as this may impact chum salmon spawning and water levels in enhanced off-channel habitat.
3	Work only in isolation from flowing water.
4	Leave the upstream third of bars.
5	Adherence to the fisheries work windows.
6	Avoid digging consecutive bars because of potential interaction between them.
7	Excavate channels to replicate natural streambed shape to minimize post-excavation changes.
8	Protect areas adjacent to points where secondary channels branch off from the main flow.
9	Avoid excavating in areas adjacent to sensitive habitat.
10	Avoid digging long pits associated with elevation drops or which can affect long sections of the river.
11	Leave gently sloped inside edges on the upper end of cuts to prevent head cutting and to leave stable habitat for chum salmon spawners.
12	Open the upstream end of deep sediment pits so that headcutting can occur, and to encourage sediment flow into the pits.
13	Construct internal, cross channel berms in long pits or where there is a significant elevation drop.
14	Leave the downstream ends of bars since this will preserve tailouts which provide rearing and spawning opportunities.
15	Ensure riffles are not bypassed by excavation.
16	Adjacent dry channels should be deepened and stabilized with flow control structures such as LWD complexes.
17	Leave pits with large head differences closed to prevent chum spawning within them or fish trapping.
18	Open excavations thoroughly to avoid creating fish traps. Two deep openings adjacent to the main channel should prevent this problem.
19	Use caution when designing excavation where the thalweg approaches the pit at an angle of more than a few degrees. Design mitigation may include options to reduce the opening or move the excavation or the opening downstream when this condition is encountered.

Potential sediment removal sites are evaluated, based on their potential to provide an effective removal while avoiding harm to fish and fish habitat. The guidelines (Table 4) were developed through adaptive management to provide optimal habitat outcomes from the sediment removal program and inform the design, monitoring, and assessment of the excavations over several

iterations of sediment removal. Several guidelines, such as adhering to the fisheries window and working in isolation of flowing water, are typically requirements of the authorization and are intended to avoid detrimental impacts during the excavation. Not all guidelines are followed for each pit and some guidelines apply only to relatively rare circumstances.

Each excavation site is designed to yield optimal habitat in its post excavation condition. Gentle slopes, strategic flow inlets and outlets, and careful placement and delineation of the excavation footprint are employed to ensure habitat impacts are minimal. Large channel changes and post excavation effects such as head-cutting are avoided by not bypassing riffles, leaving the upstream ends of bars and avoiding sequential sediment bars. Habitat mitigation and enhancements are incorporated where appropriate and include placement of large woody debris (LWD), enhancement of secondary or micro-channels, and occasionally other initiatives such as constructing channels or riparian planting.

The habitat mapping exercise provides an evaluation of the changes or effects for each excavation site. The assessment area for each site is intended to capture all of the changes related to each excavation. However, the effects of natural changes are difficult to extricate from effects caused by the sediment removal operations. In effect, we are looking for the impact of the changes due to the excavations on a dynamic and constantly changing system.

The habitat methodology and most recent assessments have been attached to the application (Appendix A-2). Given the similarity of the excavation forms and locations over the years and the consistent application of guidelines per our described methodology, outputs from past habitat mapping provide the best predictor for possible impacts from the currently proposed excavations. This includes a vast amount of data that has already been collected, analyzed in depth and shows that the program generally yields a net gain of fish habitat on average. Section 7 of this document includes a discussion of the anticipated outcome for each proposed excavation.

3.2.1 LWD Placement Strategy

Large Woody Debris (LWD) placement within the excavations are a key element of habitat enhancement at each excavation. LWD placement at each site is dependent on the local availability of suitable logs and root wads as well as suitable locations. As LWD placement is frequent and repeated with each excavation cycle, a percentage of washouts and other natural modifications are expected.

No anchors are employed due to the changing nature of the target placement locations and concerns that anchoring materials such as cable and ballast would detrimentally affect river conditions, fish habitat and constitute a safety hazard to recreational users of the river.

GPS coordinates are recorded for each of the major LWD placements, and a photographic record is created. Additional single or paired LWD pieces will be keyed in on occasion, but these may not be tracked. This aspect of LWD placement is considered mitigation and not generally considered in determining net impacts to habitat.

4.0 CONSTRUCTION MITIGATION MEASURES AND MONITORING

Once the final set of sediment removal sites is approved, removals are monitored to ensure that the excavations follow the design, and that Best Management Practices (BMPs) are followed. Several of the key BMPs that are universal to all work on the Vedder are discussed here and in more detail for specific bars in Section 7 of this document.

All works are to be completed with adherence to the following Best Management Practices (BMPs):

- Standards and Best Practices for Instream Works. BC Ministry of Water, Land and Air, March 2004;
- Measures to Avoid Causing Harm to Fish and Fish Habitat. Fisheries and Oceans Canada, 2013;
- A User's Guide to Working in and Around Water; Understanding the Regulation under British Columbia's Water Act. BC Ministry of Environment, May 2005; revised 2009; and
- A Field Guide to Fuel Handling, Transportation and Storage. BC Ministry of Water, Land and Air Protection, 2002.

Excavations for maintaining the capacity of the Vedder River will be conducted "in the dry" or outside the flowing waters of the Vedder River. This means that a perimeter buffer zone or berm will be maintained throughout the excavation process to ensure no deleterious materials from the excavation enter the Vedder River. Bar access is selected to limit disruptions from any culvert crossings and to minimize destruction of riparian habitat. Most locations have existing access that requires only minimal clearing of small-scale vegetation and construction of a ramp down to the bar surface. All machines will be cleaned and inspected before commencing work at any of the Vedder River sites. Machines will use environmentally friendly hydraulic fluid and be free of any leaks, soil, or contaminants.

4.1: Hauling and Stockpiling Activities

During hauling, water can flow out of the loaded gravel trucks, and there is more potential for spillage, particularly on access ramps, if the water content of the excavated material is high. Generally, the monitor will direct the operators to briefly stockpile the material adjacent to the

pit so it can drain before being loaded into the trucks. Where conditions warrant, the monitor will allow material to be loaded directly from the pit to the trucks however, if excess water is apparent on the bar surface, ramps, or roads, this will be halted. Water runoff will be limited to areas that are still to be excavated or the footprint of the access route that is to be restored. Any runoff will be directed to the excavation footprint or to a temporary settling pond using grading or silt fencing as required. Small amounts of water dripping along the haul routes during dry weather periods is effective at limiting dust generation. Runoff from excavated material, once it is transported to the stockpile site also has the potential to enter sensitive habitats if the stockpiles are near any of these habitats or watercourse or drainages that connect to these habitats. All stockpile areas will be monitored carefully during active use to ensure that all sediment and runoff water remains within the footprint. Depending on footprint and expected height, material destined for any particular stockpile site should be excavated using the two-step approach, first moving the material out of the pit and onto the bar and then after time to drain into the trucks

Silt fencing will be available on site for use at the discretion of the environmental monitor, particularly when there is insufficient unexcavated area or berm elevation to ensure that silt laden water will not enter the flowing channel of the river.

4.2: Excavation Openings

Once each excavation is complete, it will be necessary to open the excavation to the main flow of the river to ensure that the completed excavation interacts with the main channel as intended and to ensure that fish, including salmon fry and adult spawners, do not get trapped within an isolated pond. The “opening” of the gravel bar will produce a one-time localized turbidity event as the turbid water contained within the enclosed area is flushed out. Although dependent on the size of the excavation and the relative size of openings, the period of turbidity will be short in duration.

To minimize the impact of this one-time turbidity event, the environmental monitor will be on site and will direct the pit opening. Typically, this would involve opening the downstream end first so disturbed sediments moving into the active channel can be minimized. When the upstream end is subsequently opened, the disturbed sediments naturally flow into the pit as the river flow enters. The excavation acts as a settling pond for the larger sediments. The openings will be excavated to the maximum extent possible before breaking containment to keep the turbidity in the excavation footprint as low as possible. Turbidity monitoring and plume tracking during previous excavations shows that the turbidity is within acceptable limits except for a short distance downstream, typically across a narrow part of the channel adjacent to the bank below the downstream opening. Previous experience has shown that the plume dissipates quickly as

the water contained in the pit is flushed out and diluted. Turbidity data collected during previous higher flow periods will be provided for comparison purposes.

4.3: High Water Considerations

Occasionally, during the work window for this project, high water conditions may require the need to repair or build up sections of the berm to maintain containment. To ensure that this is done safely, clean excavators may be allowed to briefly enter the wetted channel but only in areas that were recently dry. This approach to berm repair is preferable to allowing river flows to enter the excavation area as that could result in erosion and related sediment deposition and stranding of fish within an excavation that is temporarily open to the flowing channel.

4.4: Access to Sites

Access to the sites is managed according to well established practices. Generally, all of the selected bars are accessible via existing routes. Bars with a lack of suitable access usually results in exclusion from the sediment removal program. Access routes include the tops of dykes and existing armoured banks with access roads already in place and other existing access roads and trails. The access routes may require some trimming of branches to assure safe conditions on the haul roads, but clearing is not normally required. If vegetation removal is required, it will only be to the extent necessary to access the bar. Any trees noted in the area will be protected where possible. Access to the bar surface usually requires a ramp down from the bank and often the crossing of small secondary channels or microchannels near the toe of the bank. Traffic on the sediment bars will be confined to the footprint and a single access track with pullouts if required. Details of access for each bar are provided in Section 7.

Culverts will be sized to ensure that flow to affected channels is maintained. An environmental monitor will supervise their installation. The culverts will be carefully placed, and flow directed through them before ramp construction begins. Typically, a single wet crossing by an excavator is allowed to access material for ramps and cover for the culverts. This material is usually obtained from the excavation footprint but on occasion it is necessary to use a borrow pit that is refilled once access to the footprint area is completed. If appropriate, the borrow pit will be situated to function as a settling pond for any runoff from trucks accessing the ramp. Culvert length will be such that spillage from haul trucks does not enter the flowing water. This is particularly critical where a channel is adjacent to the bank and culverts are required for the ramp. Where appropriate, isolation of the work area and fish salvage will be conducted before ramp installation.

4.5: Turbidity Monitoring

Previous field studies will be used to develop a turbidity monitoring system that would be adaptable to sediment removal sites and to collect turbidity data during construction works. Turbidity measurements will be taken prior to the start of excavations and daily (upstream and downstream from excavation area) during the sediment extraction works.

Prior to opening each excavation, turbidity readings from the enclosed pit will also be collected. Additional readings will be taken downstream as the plume of turbid water exits the excavation site. The turbidity readings will be obtained using a LaMotte 2020we Turbidimeter. The 2020we meter meets or exceeds EPA (Environmental Protection Agency) design specifications for NPDWR (National Primary Drinking Water Regulations) and NPDES (National Pollutant Discharge Elimination System) turbidity monitoring programs as specified by the USEPA method 180.1.

5.0 POST-EXCAVATION ASSESSMENT

Assessment of the excavation includes follow up surveys to ensure that objectives are being met, and detailed habitat mapping to ensure that habitat changes are in balance with expectations and to demonstrate that there is no net loss of habitat arising from the sediment removal program. Habitat mapping provides an objective method for tracking and rating habitat conditions before and one year after each sediment removal activity.

The habitat mapping is conducted through analysis of aerial photos of the excavation locations taken at the same flow levels as the pre-construction in conjunction with ground-truthing at each bar. Habitat elements are mapped out to attain an overall habitat ranking value for the excavation location both before and after the excavation. Each habitat element (i.e. pool, riffle, glide) is given a habitat rating based on a methodology developed specifically for the Vedder River to compare pre and post habitat values in the vicinity of the excavation sites. Spawning surveys are also conducted for chum salmon each year and for pink salmon during non-excavation years.

More detail on this can be found in the assessment report for the 2016 excavations that has been included as Appendix A-2. Note that this report is the latest in a series of reports that describe monitoring and assessment works completed on the river. A full list of reports on the Vedder River prepared by NPE is found in Appendix B.

Habitat mapping provides an evaluation of the changes at each individual excavation. Until 2014, habitat conditions were evaluated along the entire river. Recently, it was determined that virtually all of the changes linked to the excavation activity could be evaluated by looking at a smaller area. Typically extending one XS up and one XS down will capture substantially all of the

changes related to each excavation. However, the effects of natural changes are difficult to extricate from effects caused by the sediment removal operations. In effect, we are looking for the impact of our changes on a dynamic and constantly changing system. Given the similarity of the excavation forms and locations over the years and the consistent application of guidelines per the described methodology, the results of this assessment provide an excellent predictor of anticipated outcomes. A vast amount of data has already been collected, analyzed in depth and shows that the program generally yields a net gain on average to fish habitat. This is not a surprising outcome given that optimization of fish habitat is a key driver of the program and is paramount at the tactical (specific excavation detail planning) level.

6.0: ANTICIPATED EFFECTS FROM THE EXCAVATIONS

Once the excavations are completed, they are opened to the flowing water of the river. The downstream end is opened first to ensure that water levels do not increase in the pit and to limit sediment outflow when the downstream opening is excavated. When the upstream end is opened, sediments are washed into the pit where they settle. The water in the pit, however, retains high turbidity and this creates a temporary increase in turbidity downstream as it is displaced, usually within a few hours.

With the onset of the fall freshet, higher flows will tend to modify the shape of the excavation. Filling begins immediately as openings widen and outer berms are eroded. In some cases, the erosion of the berm is encouraged by excavating to a steeper slope. Some head cutting is possible which can affect adjacent riffles near the upstream end of the excavation, but this is normally avoided by leaving gentle slopes and a substantial upstream buffer from areas of head differences.

There are usually more wetted habitats present when the detailed follow up assessment is completed one year later. Habitat diversity is often increased as a result of the excavations and the habitat ratings calculated provide a mix of increases and decreases to habitat value. These changes occur in an environment that is changing with each freshet and separating the effects of the excavation from the natural changes is challenging. Each excavation is designed so that the changes related to the excavations are similar to natural changes and no net loss in habitat is anticipated. Where larger changes occur, this often recapitulates the effects of a natural avulsion even though the river is generally confined.

One apparent long-term trend is that after excavation and some time for channel adjustment, that habitat is improved or similar in the majority of cases. Later, as sediment fills in the various aquatic habitats, habitat ratings tend to drop.

The long-term strategy of removing annual expected targets led to some degradation of the channel bed over the last few cycles when peak flows were relatively lower. This was exacerbated by the 2018 avulsion to, and subsequent accumulation of sediment in, an old habitat pond near the Soowahlie First Nation Reserve, just upstream of Vedder Crossing. However, with the fall freshet of 2021 sediment has moved through the system resulting in freeboard limitations in the lower reach. The upper sections of the river previously showed some degradation as material has continued to move through the system despite lower inputs from above Vedder Crossing. However, the recent addition of 440,000 cubic meters since 2020 has resulted in aggradation in all reaches (KWL 2020).

Both channel aggradation and degradation influence fish habitat values, whether or not this is an impact of anthropogenic sediment removal programs.

Fish habitat values could be negatively affected if the channel were deepening leading to a loss, for example, of riffle areas and a net loss of habitat. Riffles are a very high value habitat due to their contribution to primary productivity and associated larval insect grazers as well as the feeding niche they provide for juvenile salmonids. In other river systems, serious negative habitat outcomes have been noted where sediment depletion has occurred from uncontrolled sediment removal (Kondfolf et al 2002) but removals from the Vedder, limited to long term average inflows have not shown any evidence of systemic effects from lowering of the channel (NPE 1994 -2016) at rates established by the Vedder River Management Area Plan Update (EBA Tetratech 2015). The type and distribution of habitats remains similar with increases in shallower wetted habitats and habitat complexity, providing for a positive outcome. Arguably, there is more habitat complexity from braiding and changes in the areas where degradation has occurred.

The detailed habitat mapping that has been done provides good evidence that riverbed degradation is not of concern within the sustainable long-term strategy in effect for the Vedder River. Where the sediment removal program results in lowering of the bed there appears to be a corresponding lowering of the water level as the geomorphology of the river remains similar. There are also natural changes occurring in the river, such as bank erosion, natural channel shifts and the continuous downstream movement of sediment. Periodic erosion which tends to widen the active channel also contributes to channel capacity without lowering the riverbed.

To ensure that this remains the case and to ensure that longer term changes do not arise annual mapping of habitats is an ongoing component of the Vedder River Sediment Management Program. The most recent completed assessment is provided in Appendix A-2. In addition to providing the results from the 2016 excavation, this report provides a detailed description of the habitats in the Vedder River as well as the methodology used for the assessment.

7.0: INDIVIDUAL EXCAVATION DETAILS

Plans for each of the eleven proposed excavations are provided in the following pages along with a brief description of location, access, stockpile sites, existing habitats, and site-specific mitigation plans. Excavation designs are based on the established BMPs for the Vedder River Sediment Removal program that are described in section 3 above.

Estimated quantities have been calculated to take sloped edges into account. Specific LWD placements have not been identified, although it is expected that each excavation will include some LWD. Habitat enhancement excavations have been added to excavation sites where appropriate.

Each bar is identified with a unique identifier that includes the year, cross section and location within the channel. The first two digits show the year, the next two digits show the cross section, followed by a 'C' for cross sections in the canal. The final letter shows position, 'R' for bars adjacent or near the right bank, 'L' for bars adjacent or near the left bank and 'M' for mid channel bars (e.g. 20-23L for Bergman Bar, see Figure 1).

A description of the habitat conditions found at each of the excavation sites is provided in this section. These conditions will be delineated and quantified using the habitat mapping methodologies described in (NPE 2016). An updated set of aerial photos will be taken to ensure that unrelated changes occurring during the current freshet are excluded from the analysis.

Habitat descriptions are consistent with the terminology used during the assessment phase as in the previous Vedder River sediment removal habitat assessment report (NPE 2016).

7.1: Giesbrecht Bar

Site Name: Giesbrecht Bar **Site Number:** 1
Identifier: 22-42L **Coordinates:** 49.0.97705 ° N, -122.985498° W
Location: From foot of Giesbrecht Rd. along setback dyke and Rotary Trail. Giesbrecht stockpile site.
Ownership: Provincial Crown

Previous Excavations: 1996 (Peach, right), 2008 (Peach, right), 2016. (Approximate location by XS identifier)
Stockpile: Giesbrecht Stockpile
Length: 130 m
Width: 46 m
Depth: 4 m
Expected Sediment Yield: 18,600 m^3

Bar Access and Stockpile

From Giesbrecht road along the dyke to Giesbrecht stockpile and then east along rotary trail to downstream end of bar. (Figure 2). The existing, large stockpile site is well away from the active channel, adjacent to the dyke. Commencing about 50m to the west there is a series of enhanced groundwater fed rearing ponds and a channel that connects to the mainstem river upstream of the campground. However, this is far enough from the stockpile site so that there is unlikely to be any interference.

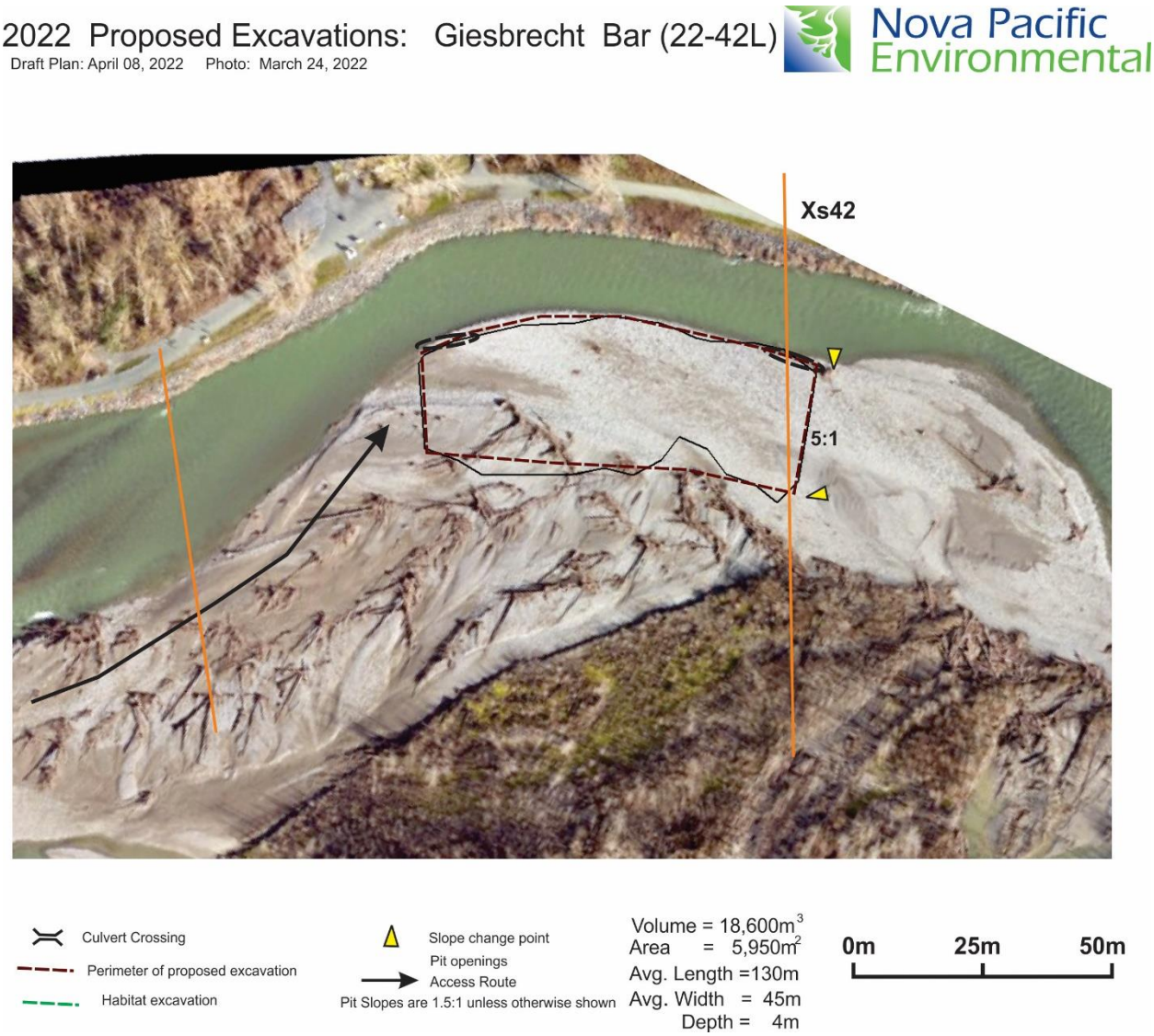

Figure 2: Giesbrecht Bar excavation.

Objectives and Effectiveness

The main purpose of this excavation would be to intercept sediment upstream of the area of freeboard limitation. The bar is estimated to be 1m in height above low water levels resulting in a 4m excavation depth and higher yield of sediment.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed, particularly those related to hauling material. Measures including "stand-by" silt fencing, sediment traps, and strict maintenance would be incorporated to prevent input of sediment into the river or habitat channel related to any culverts that are required. Excavation design mitigation includes the gently sloped upstream end of the excavation and two wide openings to ensure fish to not become trapped. The excavation is located along a single glide between two riffles and options for enhancements such as placement of LWD are limited.

Habitat Considerations

Habitats at this location include a riffle section, followed by a fast glide or run along the bar with a second riffle downstream. The main channel flows along the right bank which is armoured. A secondary channel branches off well upstream of the excavation site and provides a diversity of habitats with good riparian vegetation. This is separated from the excavation area by a large, vegetated Island. There are substantial log jams located on the bar surface that could provide refugia during higher flows.

Fish Habitat Utilization

This section of the river functions primarily as a migratory path for salmonids although some rearing of salmonid juveniles could be expected within the channel along the edges and downstream of riffles. Relatively high velocities, and laminar flow limit conditions for spawning at this location. The distribution of pink and chum spawners in the Vedder River, tends to be further downstream with almost all pink salmon found to be spawning in the Middle and Lower reaches of the Vedder River and upstream half of the Vedder Canal.

Anticipated Outcome

It is expected that the pit will refill quickly, returning to the current configuration without significantly affecting any of the adjacent features. Habitat values before and after are expected to be similar.

7.2: Peach Rd Downtream

Site Name: Peach Road D/S **Site Number:** 2
Identifier: 22-40 R **Coordinates:** 49.096466° N, -122.992368° W
Location: Downstream of Peach Park
Ownership: City of Chilliwack

Previous Excavations: 1996 (Giesbrecht, left), 2006 (Giesbrecht, left), 2008, 2016 (Giesbrecht, left) (approximate location by XS identifier).
Stockpile: Hooge Stockpile

Length: 145 m
Width: 37 m
Depth: 3.75 m
Expected Sediment Yield: 12700 m³

length (scalp): 87 m
width (scalp): 40 m
depth (scalp): 1 m
expected sediment yield (scalp): 3450 m³

Bar Access and Stockpile

Access is from the south end of Peach Road, 250 m west along the Rotary Trail. (Figure 9). There is no immediately adjacent stockpile site however it may be an option to travel along the setback dykes to the Hooge stockpile. Alternatively, the material can be transported directly offsite.

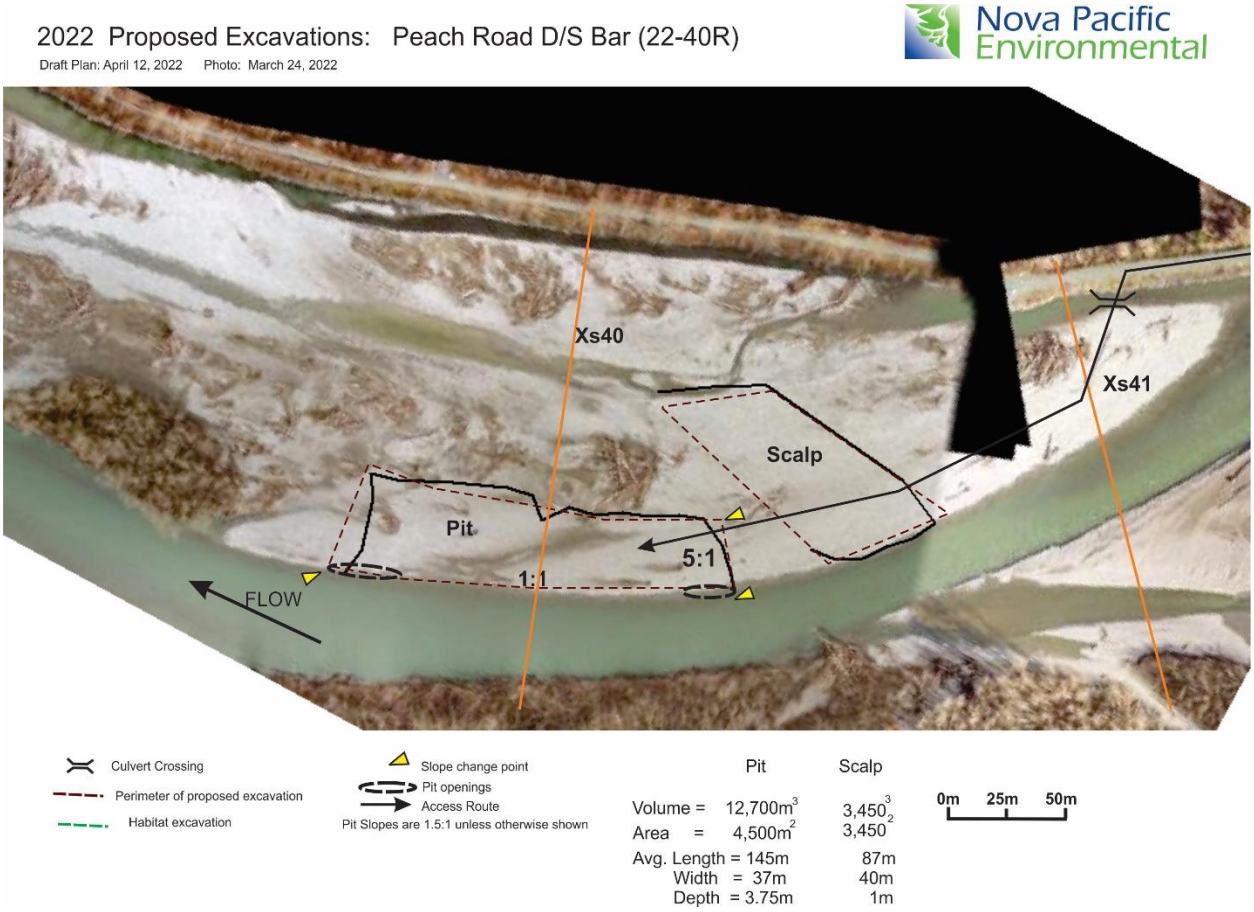

Figure 9: Peach Road D/S Bar excavation and scalp.

Objectives and Effectiveness

The purpose of the excavation at this site is to trap sediment upstream of the freeboard limited area. The scalp section of the excavation is intended to draw higher flows away from the left bank and into the right channel. The scalp can be excavated to a depth which will allow the formation of riffle and thereby increase habitat value at this location.

Mitigation Plans

The mitigation measures relating to access and excavation practices described in Section 4.0 of this document will be followed. Installation of a culvert will be required near the upstream end of the bar and a ramp will be constructed from the Rotary trail down to the bar. Access from there to the site will be limited to a single track. Installation of the culvert will be completed using tactics that most effectively limit any impacts on fish in that channel. Isolation of the area and fish salvage will be employed if required. Some LWD from within the excavation footprint will be keyed in at strategic locations along the bank and channel.

The site design includes a gentle upstream slope and a steeper slope along the thalweg so that the remnant of the berm will tend to collapse into the excavation.

In combination these two excavations may help to mitigate the erosion on the left bank and by directing some of the flow away from the left channel help to stabilize new channels that developed downstream due to a recent avulsion.

Habitat Considerations

Peach D/S Bar is a large point bar with a secondary channel on the right. LWD on the site is abundant, and there is a stand of cottonwoods on the bar just downstream of the pit which was previously attached to the left bank. The habitat types adjacent to the deep pit excavation at Peach Bar are mainly glide with riffles upstream and downstream of the proposed excavation footprint.

Erosion along the left bank of the river is apparent as the flow is directed around the bar. Excavation of the bar will take some of the pressure off this bank and help to maintain the integrity of the bank without the requirement of armoring. Reduced erosion could allow riparian vegetation to colonize the area and limit the introduction of fine sediments into the river at this location.

Fish Habitat Utilization

The main channel fronting this excavation is used for fish migration and to a lesser extent for rearing and spawning. The cut bank opposite is eroding rapidly which limits its value as rearing habitat although the cover provided by LWD being recruited at this location and the overhanging cutbacks would be of high value if the erosion rate was lessened or if this bank became stable. The secondary channels on the right bank are expected to support significant amounts of chum spawning as well as rearing for juvenile salmonids.

Anticipated Outcome

The deep pit excavation is expected to refill without significantly changing the habitat configuration in the vicinity. The scalp area may refill or remain as a riffle and continue to provide additional flow to the secondary channels along the right bank. The scalp provides channel capacity and hydraulic improvements and offers significant benefits for fish habitat if it remains as a riffle. Overall, Impacts to fish are expected to be neutral with potential significant gains from the scalp component of the excavations.

7.3: Lickman Bar

Site Name: Lickman Bar **Site Number:** 3
Identifier: 20-34 R **Coordinates:** 49.116460° N, -122.090187° W
Location: Downstream of Lickman Vedder River Parking Lot

Ownership: City of Chilliwack
Previous Excavations: Lickman (right bank): 1998, 2006 (Campground, right) 2008, 2008 (Campground, left), 2016**.** (approximate location by XS identifier)
Stockpile: Hooge Stockpile

	Scalp
Length: 130 m	**Length (scalp):** 130 m
Width: 40 m	**Width (scalp):** 38 m
Depth: 4 m	**Depth (scalp):** 1 m
Expected Sediment Yield: 16,500 m^3	**Expected Sediment Yield:** 5,000 m^3

Bar and Stockpile Access

Access to this site is from the parking lot at the end of Lickman Road, downstream along the Vedder River Rotary Trail for approximately 100 m. A ramp and culvert will be used to access the bar approximately halfway along. This location provides the easiest access and keeps the required culvert away from the steep bank providing for easier management of the crossing and minimizing the on-bar haul requirements. A ramp can be installed directly from the parking lot area down onto the bar.

There is no adjacent stockpile site however it may be an option to travel along the setback dykes to the Hooge stockpile. Alternatively, the material can be transported directly offsite.

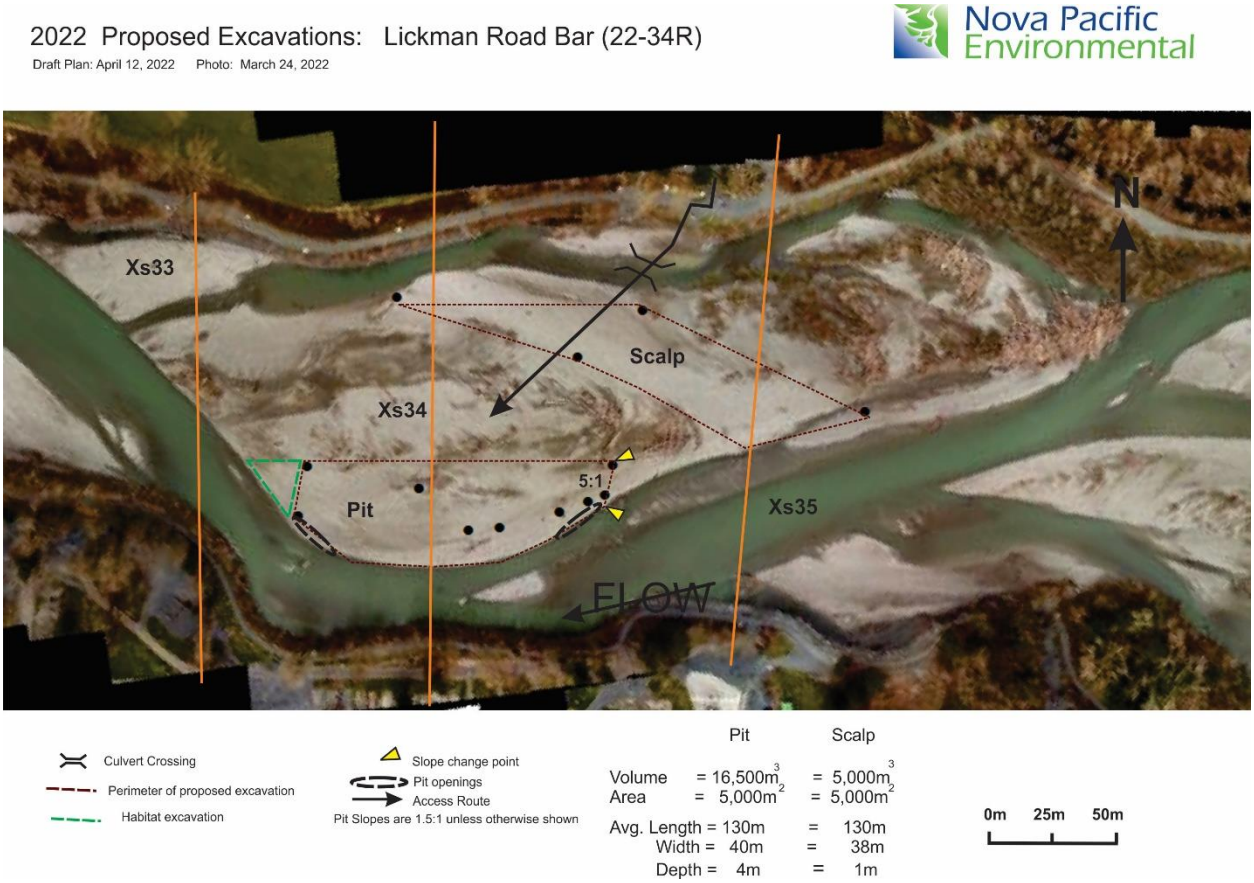

Figure 9: Lickman Bar excavation.

Objectives and Effectiveness

The main objectives of this excavation are to trap sediment upstream of freeboard limited sections of the channel and to reduce flow pressures on the left bank. The scalp will also create riffle habitat and improve the connection of low flows to the secondary channel.

Mitigation Plans

This excavation is very similar to the Peach Road excavation, immediately upstream, and the mitigation plans are similar. Installation of a culvert will be required near the downstream end of the proposed scalp area. Installation of the culvert will be completed using tactics that most effectively limit any impacts on fish in that channel. Isolation of the area and fish salvage will be employed if required. Some LWD from within the excavation footprint or nearby, will be keyed in at strategic locations along the bank and channel.

The site design includes a gentle upstream slope and a steeper slope along the thalweg so that the remnant of the berm will tend to collapse into the excavation. A small riffle has been included at the downstream end of the excavation as a habitat enhancement feature.

In combination these two excavations may help to mitigate the erosion on the left bank and by directing some of the flow away from the left channel help to stabilize new channels that developed downstream due to a recent avulsion.

Habitat Considerations

The upstream section of the bar includes ample LWD as well as areas of established vegetation. There is a secondary channel that branches off at the upstream end of the bar. This channel provides a variety of habitat features before it rejoins the main channel downstream. The left bank across from the site is a steep cut bank that is contributing LWD to the river, however as it is unstable and eroding rapidly the loss of riparian habitat and contribution of sediment to the river negate the habitat value contributions typical of cutbanks. The main channel along the bar is glide habitat, with riffles at both the upstream and downstream ends and as the main channel has moved left, the bar has expanded. The excavation will not extend past the slope breaks upstream and downstream to prevent significant changes in the local morphology.

Fish Habitat Utilization

As with Peach Bar, the main channel fronting this excavation is used for fish migration and to a lesser extent for rearing and spawning. The cut bank opposite is eroding rapidly which limits its value as rearing habitat although the cover provided by LWD being recruited at this location and the overhanging cutbacks would be of high value if the erosion rate was lessened or if this bank became stable.

Previous years assessments have shown pink and chum salmon spawning in the vicinity of XS35 near where the current excavation is proposed, however the current configuration in the main channel appears to offer limited potential for spawning. Glide tail habitat located near the downstream end of the proposed excavation could support pink salmon spawning. The secondary channels on the right bank are expected to support significant amounts of chum spawning as well as rearing for juvenile salmonids.

Riffle habitats are located below the glide tail areas and within the microchannels crossing the bar. These areas support primary production of algae and macro-invertebrates, providing food to rearing salmon. The proposed Lickman Bar excavation is planned to limit changes to this basic geomorphology and so protect the basic habitat characteristics of this section of the Vedder River. Riffle habitat areas are avoided because if they are bypassed their control on water elevation upstream can be lost and this could induce potentially detrimental habitat changes.

The excavation at this location is expected to refill with most of the existing habitat features remaining largely unchanged.

Anticipated Outcome

The deep pit excavation is expected to refill without significantly changing the habitat configuration in the vicinity. The scalp area may refill or remain as a riffle and continue to provide additional flow to the secondary channels along the right bank. The scalp provides channel capacity and hydraulic improvements and offers significant benefits for fish habitat if it remains as a riffle. Overall, impacts are expected to be neutral with potential significant gains from the scalp components of the excavations.

The scalp excavation will create riffle habitat and direct additional flow to the downstream half of the secondary channel. Mitigating erosion on the left bank at this location is expected to yield a small improvement of habitat edge properties on the right bank.

7.4: Campground Bar

Site Name: Campground **Site Number:** 4
Identifier: 20-31 L-32 L **Coordinates:** 49.116460° N, -122.090187° W
Location: Downstream of Vedder River Campground
Ownership: City of Chilliwack

Previous Excavations: 1994, (approximate location by XS identifier)

Stockpile: Hooge Stockpile

Length: 140 m
Width: 55 m
Depth: 3.5 m
Expected Sediment Yield: 23,400 m^3

Bar Access and Stockpile Site

Site access is through the Vedder River Campground approximately 500m downstream from Giesbrecht Road or from the Bergman Stockpile approximately 1.25 kms upstream along the Rotary Trail. A third alternative is from the foot of Browne Road across the group campsite of the Vedder River Campground. There is also a small parking lot at the foot of Brown Road that has been used as a stockpile site.

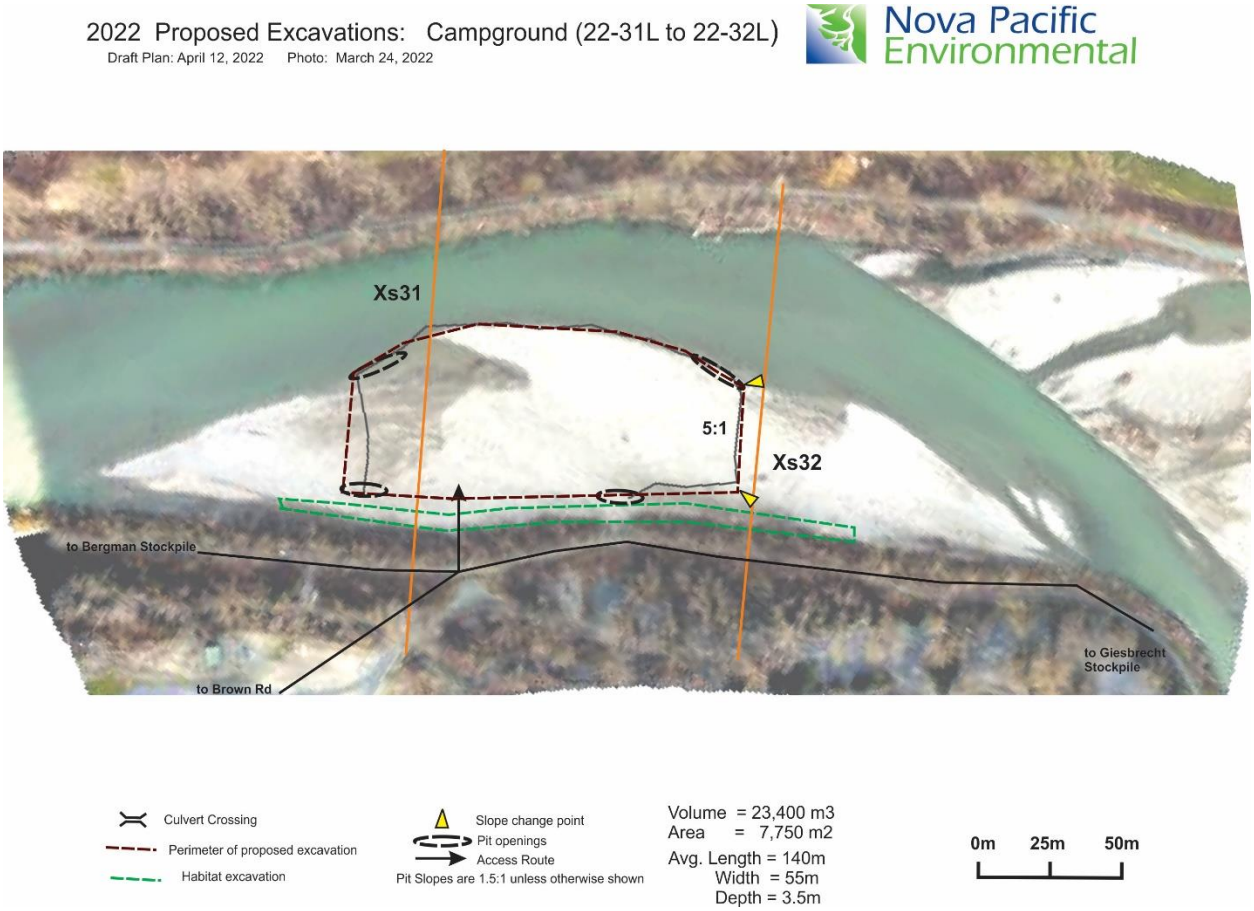

Figure 9: Campground Bar excavation.

Objectives and Effectiveness

The primary objective for this excavation is to trap sediment upstream and thereby reduce the amount of sediment that accumulates downstream where the amount of freeboard is limited. A secondary objective is to reduce flows along the cutbank on the right side of the channel to help limit erosion. The habitat channel on the left bank will be excavated to provide spawning and rearing habitat for salmonids. The surface inlet for the Browne Creek wetlands is also in this channel but has been infilled with sediment. The habitat excavation will be constructed to help restore flow through this inlet.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed, particularly those related to hauling material. Measures including “stand-by” silt fencing, sediment traps and strict maintenance would be incorporated to prevent input of sediment into the river or habitat channel related. Culverts will not be required for this excavation. LWD available on site will be keyed into the habitat channel to provide cover and channel complexity.

Habitat Considerations

The channel fronting the Campground D/S excavation site provides riffle habitat upstream and downstream with glide habitat in the middle section. There is a cut bank on the right side of the channel where the bank is eroding. Its worth noting that in addition to the surface water intake, the Brown Creek wetlands, are also groundwater fed. Excavation at this site will be field fit, with input from DFO and the Fraser Valley Watersheds Coalition (FVWC) who were the designers of this project to ensure to ensure optimal flow objectives are met.

Fish Habitat Utilization

Erosion on the right bank is probably slow enough to make this cutbank habitat suitable for juvenile salmonids, however, it would still be beneficial to help the bank to stabilize by drawing some of the flow away from the bank. There is likely chum spawning habitat at the upstream and downstream riffles, as well as the microchannel between the bar and the left bank. There is also potential pink spawning habitat at the glide tail at the downstream section of the bar. The habitat excavation may create additional chum spawning and juvenile salmonid rearing habitat.

Anticipated Outcome

This excavation is the largest of the proposed excavations for the 2022 program and is expected to refill without significantly changing the habitat configuration in the vicinity. Impacts to fish are expected to be neutral with some loss of glide edge habitat offset by increases in habitat edge and microchannel habitat. Mitigating erosion on the right bank at this location is expected to yield a small improvement of habitat edge properties on the right bank. It is anticipated that this bar will fill relatively slowly, providing increased pool habitat and microchannel habitat along the left bank as this happens. This site is immediately upstream of one of the identified freeboard deficient sections (KWL 2022)

7.5: Railway Bar

Site Name: Railway Bar **Site Number:** 5
Identifier: 20-19R **Coordinates:** 49.092699° N, -122.035152° W
Location: Approximately 180m upstream from the railway bridge
Ownership: Provincial Crown

Previous Excavations: 1994,1998, 2004, 2006, 2008, 2010, 2014, 2016 (approximate location by XS identifier).
Stockpile: Hooge Stockpile
Length: 109 m
Width: 27 m
Depth: 3.25 m
Expected Sediment Yield: 7,500 m^3

Bar Access and Stockpile

From Keith Wilson Rd, south on Sinclair Rd. then east along the setback dyke to parking area. Proceed west along the trail atop the bank protection works. (Trail bypass remains but vehicle access has been closed off and the old haul route has been redeveloped as a trail). The distance from the excavation site to the Hooge stockpile adjacent to the parking area is about 750m which is on the Rotary Trail. This would create some requirement for trail restoration.

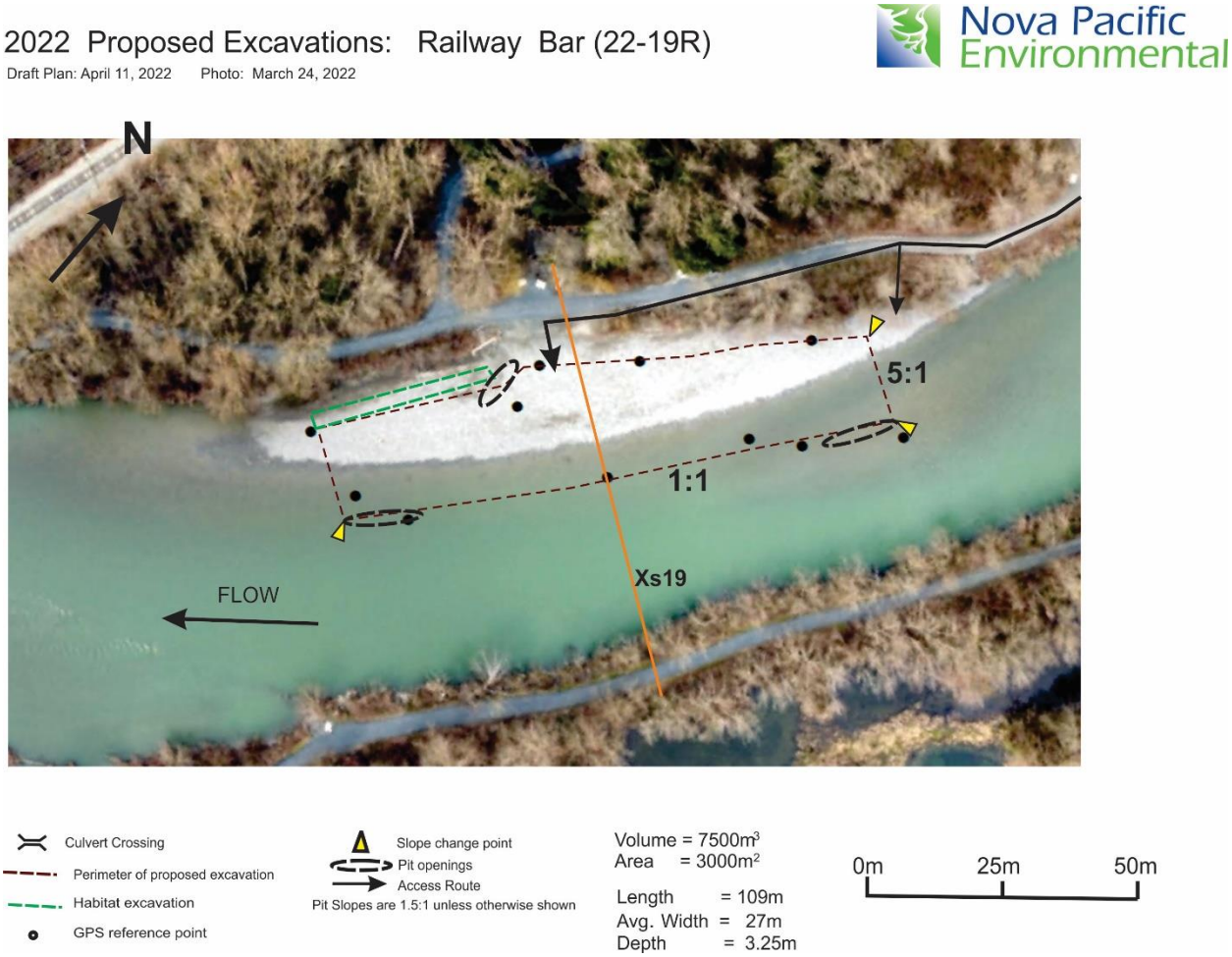

Figure 3: Railway Bar excavation.

Objectives and Effectiveness

This excavation will reduce the amount of sediment moving downstream into a freeboard limited section of the river below the railway as well as address a slight limitation of freeboard at this location. Excavations at this location have typically refilled quickly.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed. A gentle upstream slope and wide openings will be constructed to limit risk of fish trapping with this excavation site.

Excavating the habitat channel at the downstream corner of the pit will restore the habitat values of the small channel downstream of the excavation. This simple enhancement has been maintained on a regular basis whenever this site has been excavated.

Since the last excavation, a culvert connection to off channel Salwein Creek habitat has been added. However, this culvert has been infilled and the armour rocks placed in the channel immediately upstream were not evident during field investigation (March 31, 2022). They have likely been undermined and sunk below the level of the sediment. The channel will be excavated to allow for spawning and rearing and if possible, the rocks and culvert will be restored. This work will be done in cooperation with the FVWC.

Habitat Considerations

Due to the flatter slope at this location, the pattern of glide, glide tail and riffle is less evident but there are slight glide-riffle sequences upstream and downstream of the proposed excavation. Immediately downstream of the excavation, on the right bank, there is an area of habitat edge with overhanging riparian vegetation. Railway Bar has not been accessible for vehicles since late 2015 when the dyke road was upgraded to a pedestrian trail and a locked gate was installed. The bar surface was often compacted as a result of previous years' traffic but now provides a more typical unvegetated sediment bar configuration.

Fish Habitat Utilization

In 2016, the habitat area at the tail of the bar showed heavy chum salmon spawning.

In 2017, a significant area of pink salmon spawning was observed in the main channel downstream of the excavation area. This activity is associated with a glide tail/riffle sequence. The complex shallows habitat on the left bank is located above the riffle downstream so it also functions like a glide tail in attracting pink spawners. Some pink salmon spawning was also observed throughout the channel along the bar and in the backwater.

The diversity of habitat on the left bank provides lots of fry rearing opportunity but this area typically remains undisturbed by the activity at Railway Bar.

The habitat edges provide suitable rearing opportunities for salmonid fry. The opposite bank provides habitat complexity particularly where parts of the original bank armour has disintegrated providing cut bank and boulder clusters.

Anticipated Outcome

Railway Bar has been excavated several times in recent years as it tends to refill in the same pattern each year. This excavation will result in less accumulation of sediment in freeboard limited sections of the channel immediately downstream. Chum salmon spawning habitat will increase as a result of the habitat excavation at the downstream section of the bar. Only minor changes to the surrounding habitat configurations are expected as a result of this removal.

7.6: Bar D/S of Railway

Site Name: Railway D/S **Site Number:** 6
Identifier: 22-16 R **Coordinates:** 49.091412° N, -122.039829 ° W
Location: Downstream of Railway on right bank
Ownership: City of Chilliwack

Previous Excavations: 2000 (Yarrow, left bank), 2006 (Yarrow, right bank), 2008 (Yarrow, left bank) (approximate location by XS identifier).
Stockpile: Hooge Stockpile

Length: 100 m
Width: 37 m
Depth: 3 m
Expected Sediment Yield: 8,150 m^3

Bar Access and Stockpile

Access to this bar and Yarrow Bar immediately downstream presents significant challenges. and if either bar is accessed, then accessing the second is best across the sediment bar within the active channel. Accordingly, this section addresses access for both sites. Three options have been considered.

Option one requires access through the Great Blue Heron Reserve, however, there is a bridge in the existing network of roads that would require upgrades to support the necessary haul trucks. This option has the advantage of direct access onto Yarrow Bar (see section 7.7) on an existing route directly under the powerlines although this route is now somewhat overgrown, primarily by Himalayan Blackberry. Railway D/S could be accessed from the Yarrow Bar, requiring one culvert crossing of a secondary channel. Travel on the bar would have minimal impacts as the route would be confined, with the exception of the crossing, to areas of unvegetated dry sediment. There would be no stockpile available for this option.

Option two would involve constructing two temporary ramps, on either side of the BC Southern Rail Bridge to create a temporary level crossing. This option could use the Hooge stockpile about 1 kilometer upstream. Part of the haul route would be on the Rotary Trail requiring pre-grading

and then trail restoration, however, most of that, approximately 750m will be used as haul road for the Railway Bar excavation. The final segment would require a ramp off the bank with a culvert for the secondary channel. A second culvert would allow access to travel on the bar to the Yarrow site. This option would require approval by BC Southern Rail which may not be attainable.

The third option would require access along about 1km of Rotary Trail from the Greendale stockpile site with about half of that distance to be required for access to the Greendale Bar excavation site. Access would again be via the Yarrow Bar and require a culvert crossing. This route would require bypassing two pedestrian bridges on the Rotary Trail, one of which crosses Salwein Creek which supports salmonids and the endangered Salish sucker. Determination of the best option for access is still in progress and it may be determined that this site and the Yarrow site are not feasible.

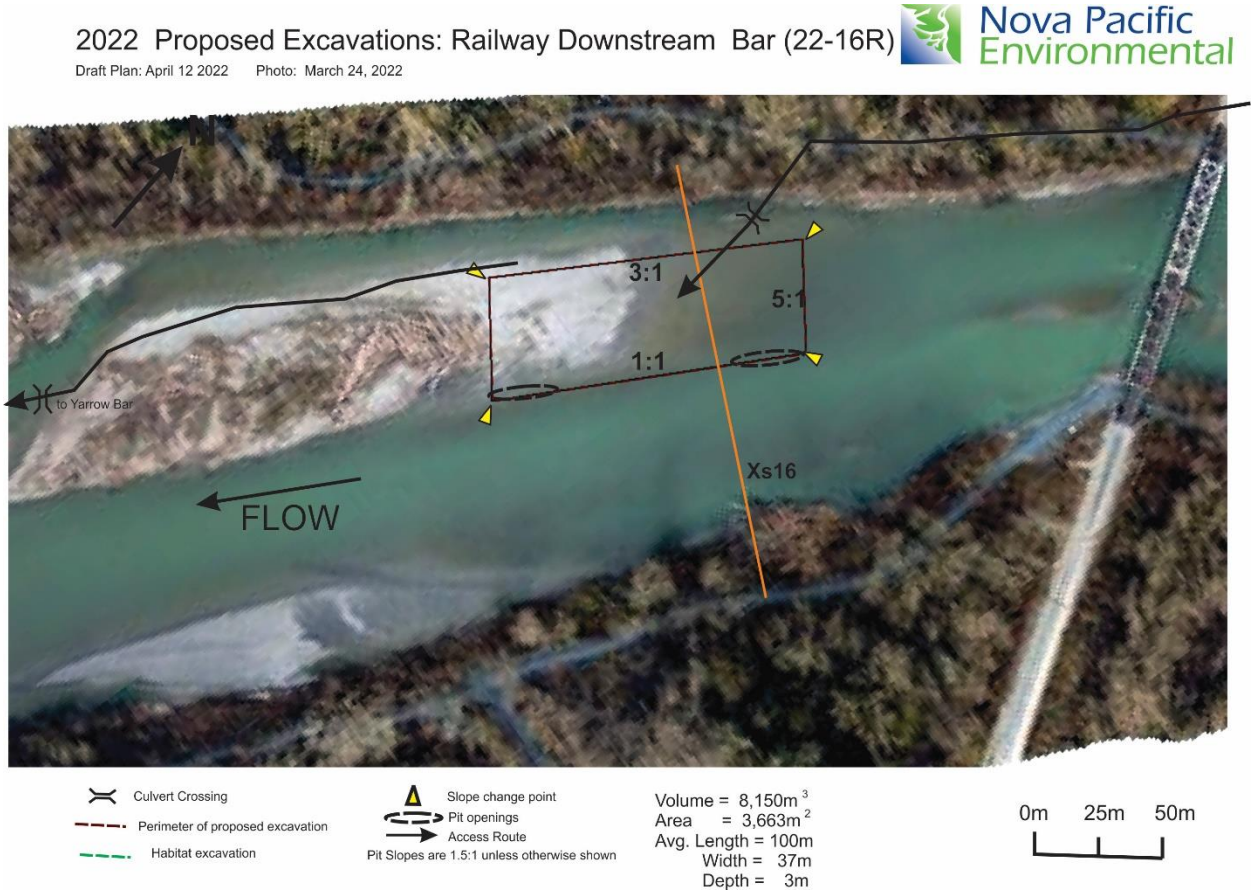

Figure 9: Railway D/S Bar excavation.

Objectives and Effectiveness

The main purpose of this excavation is to remove sediment from the free board limited reach of the channel to directly increase channel capacity.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed. Gentle slopes at the upstream end will help to ensure that the excavation does headcut towards the habitat complexities around the railway bridge. The excavation may also help to reduce erosion on left bank although much of the remaining vegetated bank and microchannel present in 2020 and earlier is now gone so the rate of erosion has likely diminished. A culvert crossing will be required onto the bar and fish salvage will be conducted for the instream crossing if warranted. There is an opportunity to key some of the abundant LWD on site into the secondary channel on the right bank.

Habitat Considerations

This section of the river has changed substantially since the assessment following the 2016 excavation. At that time, high value for spawning of pink and chum salmon in the area was evident and it is anticipated that with similar slopes and complex bar configuration that spawning will continue to be significant. The excavation designs are intended to limit impacts on spawning by avoiding significant head changes across the excavation, constructing wide openings and providing gentle slopes. Right bank secondary channels will support fry rearing and accordingly, a buffer has been left between the excavation and the secondary channels. Like the conditions at Lickman Bar, the left bank across from the site is a steep cut bank that is contributing LWD to the river, however as it is unstable and continuing to erode. The loss of riparian habitat and contribution of sediment to the river offsets habitat value contribution.

Fish Habitat Utilization

D/S Rail Bridge Bar has shown steady growth over the last several years and this has tended to push the flow onto the left bank causing erosion and the formation of a steep cut bank. Due to fast flows and continuing erosion, this habitat is not likely to provide much rearing habitat value. The excavation strategy at this location seeks to slow this flow and associated bank erosion by increasing the channel cross section at this location. This would allow the habitat edge value to be realized. More persistent LWD would help support rearing salmonids and provide cover for migrating adults.

Much of the habitat upstream of the bar is riffle and glide tail and this provides valuable primary productivity and rearing opportunity for salmonids. The channel along the bar is glide habitat with a small section of riffle along the bar edge downstream.

There is a secondary channel along the right bank which returns to the main channel, dividing this bar from the Yarrow Bar excavation site. This channel is characterized by bank complexity and quality riparian vegetation and could be expected to provide good rearing habitat as well as refugia in higher flows. The proposed addition of LWD would significantly improve the habitat values at this location.

This section of the river supports significant spawning by pink and chum salmon. In earlier assessments, the bar head above Yarrow Bar was regularly noted to be glide tail habitat that supported heavy pink salmon spawning but with the present configuration, this area is glide habitat which does not tend to support spawning. Nonetheless, spawning of both chum and pink salmon is expected to occur in some of the smaller habitat niches at the bar head and in the secondary channel.

Anticipated Outcome

Excavation will provide some direct freeboard benefits. It will refill in approximately the same configuration.

7.7: Yarrow A+B Excavations

Site Name: Yarrow Bar **Site Number:** 7
Identifier: 20-12/13R **Coordinates:** 49.090116° N, -122. 048096° W
Location: Directly opposite Wilson Road stockpile site, approximately 600m downstream of the Southern BC Railway bridge.
Ownership: City of Chilliwack
Previous Excavations: 1994 (left), 1996 (right), 1998 (right), 2010 (right), 2012 (left), 2016 (left) (approximate location by XS identifier).

Stockpile: Hooge or Greendale or directly off site depending on selected access option.

Length(A): 110 m
Width (A): 33 m
Depth (A): 3.25 m
Expected Sediment Yield (A): 9,250 m^3

Length (B): 100 m
Width (B): 30 m
Depth (B): 3.25 m
Expected Sediment Yield (B): 6,973 m^3

Bar Access

See the bar access discussion for Railway D/S Bar.

Nova Pacific Environmental

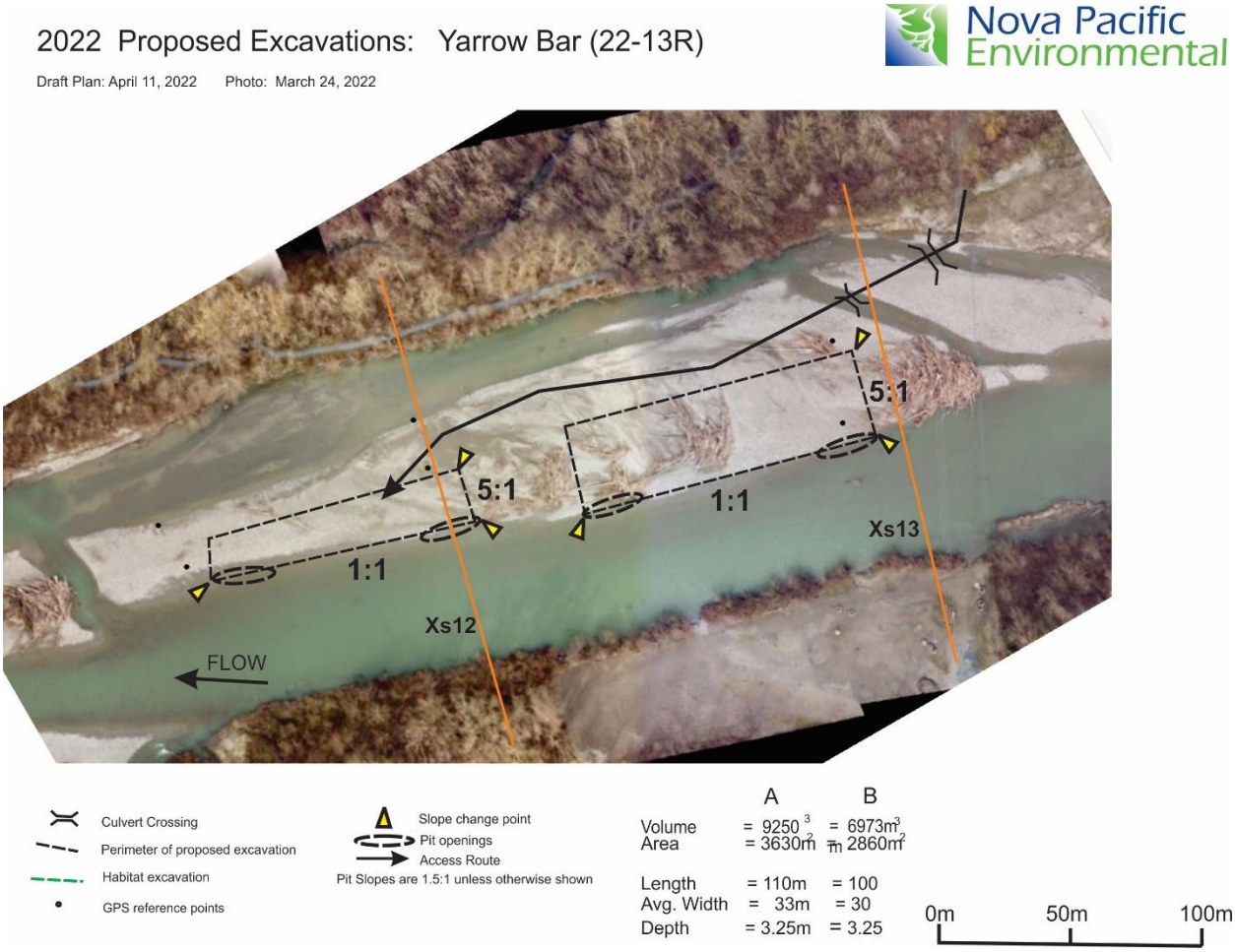

Figure 4: Yarrow Bar excavation.

Objectives and Effectiveness

This excavation is located in the freeboard limited reach and is expected to contribute to increased floodway capacity.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed. Installation of culverts will be required near the upstream end of the bar and a ramp will be constructed from the Rotary trail down to the bar. Access from there to the site will be limited to a single track. Installation of the culvert will likely be completed while the channel is dry and if not, impacts on fish will be minimized with seine nets or silt barriers. As the channel is away from the bank and likely to be dry or small, fish salvage is not anticipated. Some LWD from within the excavation footprint will be keyed in at strategic locations along the bank and channel. A buffer between the excavations and the microchannel habitat on the right will ensure that habitat values are not negatively impacted.

Due to the high quality of habitats around the bar, the footprint of the excavation has been kept relatively small and divided into two sections to help ensure that the buffers provided are adequate.

Habitat Considerations

This section of the river is flatter, and the channel is somewhat braided with the result that the riffle features are less pronounced. There is a glide along the length of the bar and slight breaks in the slope above and below the excavation. At the upstream end these features are related to the railway bridge. The Rotary Trail is set back from the river along this section and as a result the riparian cover is quite dense.

Yarrow Bar has several habitat features including braided microchannels, with riffle habitat and excellent riparian cover. At the upstream end of the bar, a large LWD complex ties into the habitat channel and provides cover for pool habitat beneath it.

A section of riffle habitat along the right bank across from the bar is bordered on the right by a good quality habitat edge with significant riparian habitat.

Braided channels are also evident at the bar immediately downstream of Yarrow Bar, which continue the habitat complexity of this part of the river. LWD features will be incorporated where suitable.

Fish Habitat Utilization

Chum and pink salmon spawning is common in this reach section of the river. With the slightly wider active channel, generally good riparian cover and diversity of habitats, there are numerous rearing opportunities. For juvenile salmonids and other species. Pink salmon spawning has been observed above the glide tail/riffle sequence upstream and downstream of the excavation. The downstream area provided a significant contiguous area of spawning that extended downstream beyond the end of the study area.

Anticipated Outcome

It is expected this excavation would refill in a similar configuration and that the high degree of fish habitat complexity will be retained at this site.

7.8: Greendale Bar

Site Name: Greendale Bar **Site Number:** 8

Identifier: 22-3R-4R **Coordinates:** 49.088418° N, -122.058839° W (downstream)
49.089433° N, -122.063018° W (upstream)

Location: Approximately 400 meters upstream of the Greendale Stockpile site

Ownership: City of Chilliwack

Previous Excavations: 1994, 1998, 2000, 2004, 2006, 2008, 2010 & 2012 (approximate location by XS identifier)

Stockpile: Greendale Stockpile

Length (d/s): 120 m **Length (scalp):** 131 m

Width (d/s): 22 m **Width (scalp):** 36 m

Depth (d/s): 3 m **Depth (scalp):** 0.75 m

Expected Sediment Yield (d/s): 6,000 m³ **Expected Sediment Yield (scalp):** 3,600 m³

Bar Access

Along north dike access road from east end of Keith Wilson Bridge to parking area at Greendale Stockpile. Thence along the Rotary Trail to existing access point One or two culvert crossings may be required to access the excavation area.

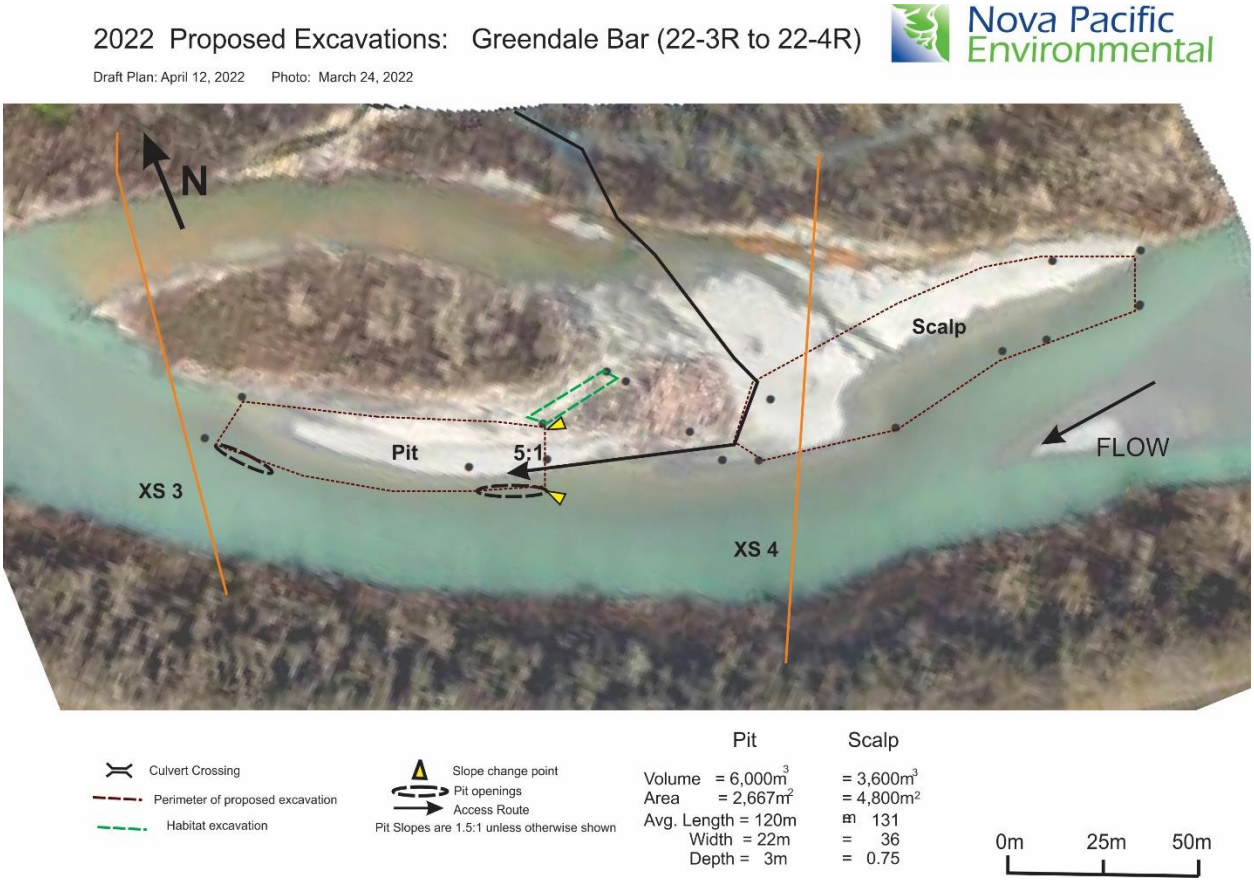

Figure 5: Greendale Bar excavation.

Objectives and Effectiveness

The purpose of this excavation is to remove sediment from the freeboard limited section of the river. the upstream scalp excavation is intended to provide additional sediment whilst maintaining similar separation of flows around the vegetated island.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed. Measures including "stand-by" silt fencing, sediment traps and strict maintenance of these structures would be incorporated to prevent input of sediment into the river or habitat channel related to any culverts that are required.

The two components of the excavation have been situated such that the integrity of the island, secondary channel and LWD complex are maintained.

Habitat Considerations

Greendale Bar is adjacent to a longstanding vegetated island which provides additional bank habitat. The flow splits around the island with the main flow on the left bank and a secondary channel along the right bank. This secondary channel provides riffle habitat at its upstream extent and glide habitat downstream. There is high-quality riparian habitat along the length of the banks and the island.

The downstream excavation site is adjacent to high-quality microchannel habitat that flows adjacent to and under a large LWD complex. This channel may require a crossing to access the downstream site, depending on water levels at the time of excavation as well as small changes that could occur during the spring freshet. A habitat excavation will be added to the pit to encourage flow in this microchannel habitat.

Fish Habitat Utilization

The microchannel and LWD complex at the upstream end of the island provide excellent rearing opportunities for juvenile salmonids. the secondary channel provides additional room capacity as well as some chum spawning habitat.

Pink salmon spawning habitat is abundant in this area, extending from Salad Bar upstream along the full width of the main channel along with the outer edge of the island and continuing to the upstream bar.

Anticipated Outcome

Greendale bar has been excavated at least eight times previously and has refilled in a similar fashion but with variation in the split around the island. It is expected that the bar will refill with a potentially persistent riffle habitat feature into the secondary channel.

7.9: Salad Bar

Site Name: Salad Bar A **Site Number:** 9
Identifier: 22-C37R **Coordinates:** 49.092662° N, -122.067025° W
Location: 100m downstream of the Greendale Stockpile site
Ownership: City of Chilliwack

Previous Excavations: 1994, 2004, 2006, 2008, & 2014 (approximate location by XS identifier).

Stockpile: Greendale Stockpile

Length: 125 m
Width: 32 m
Depth: 3 m
Expected Sediment Yield: 8, 400 m^3

Bar Access

East along Dyke Crest Rd. from east end of Keith Wilson Bridge to blocked access road approximately 100m west of the parking area at the Greendale Stockpile site. The access road would need to be unblocked and crossing to the bar would likely require two culverts.

Nova Pacific Environmental

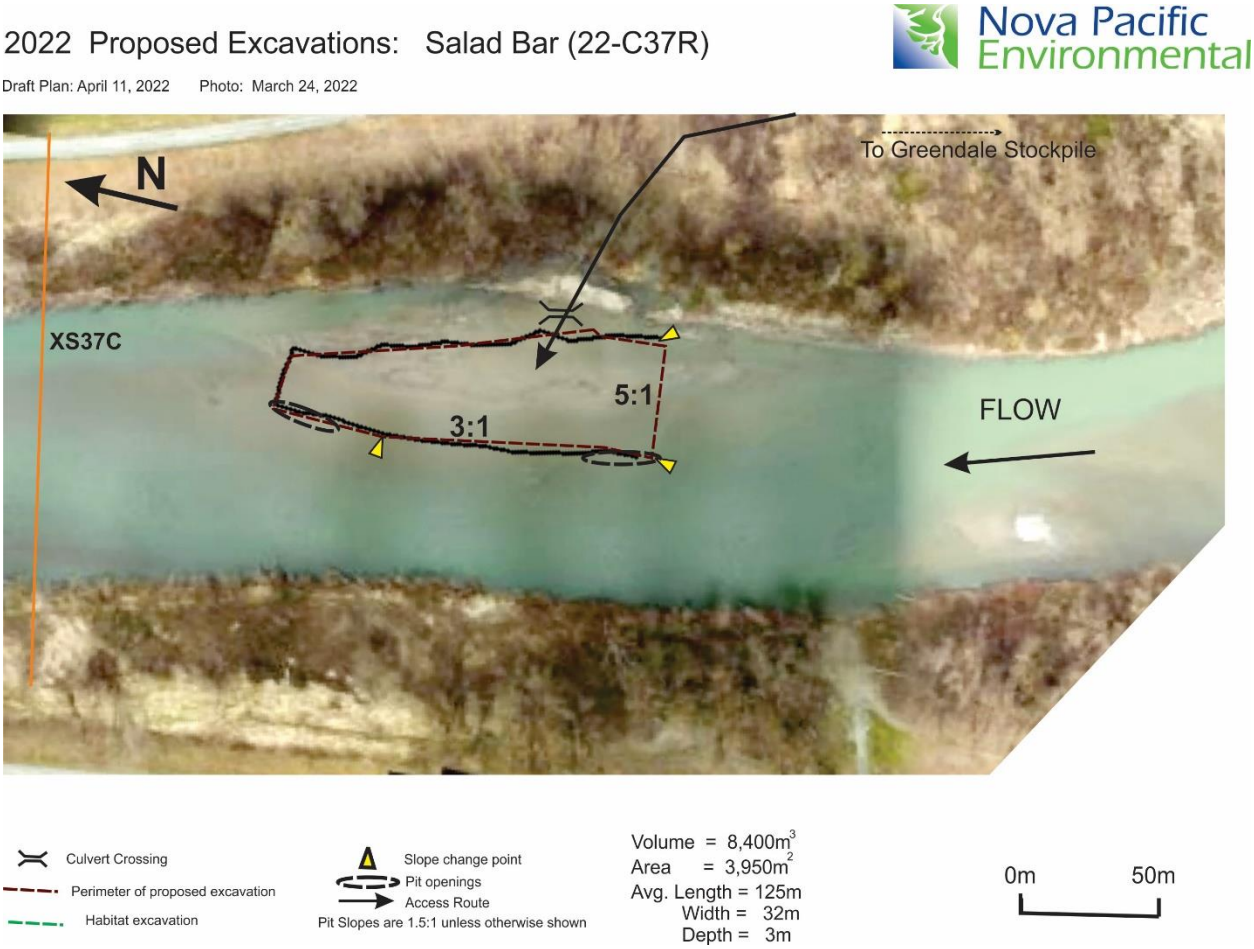

Figure 6: Salad Bar A excavation.

Objectives and Effectiveness

This sediment bar is located in the freeboard limited section and is expected to directly lower water levels in the area. Habitat priorities are to ensure that the pink salmon spawning habitat upstream and the existing habitat channel along the right bank are maintained.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed. The excavation perimeter has been set back from the microchannel along the right bank to maintain the integrity of existing habitat. A flatter slope along the outer edge has been incorporated to maintain the existing riffle configuration. As this bar has a very low profile and requires a culvert crossing, measures including "stand-by" silt fencing, sediment traps at the crossing and strict maintenance would be incorporated to prevent input of sediment into the river or habitat channel.

Habitat Considerations

The primary habitat considerations at Salad Bar are the existing microchannel along the right bank and the availability of pink salmon spawning opportunities along the bar. There is a wedge of sediment extending across the river from salad bar in a downstream direction. Upstream of this wedge there is extensive pink salmon spawning. There is good complexity in the bank conditions and elderly present in the microchannel that provides instream cover and areas of flow velocity reduction. The riparian vegetation along the right bank provides good quality cover and includes numerous large cottonwood trees.

There is little enhancement opportunity at this bar, but some LWD will be keyed in as appropriate. The existing habitat channel along the right bank will be maintained and culverts will be utilized to cross the channel at the upstream end of the bar. The existing access road extends right to the bank so no damage to riparian vegetation will occur.

Fish Habitat Utilization

Rearing habitat for juvenile salmonids is present along the bank. There is significant overhanging vegetation as well as some LWD availability for cover. Pink salmon spawning is typically prolific in the area Immediately upstream of this bar, however, chum salmon spawning drops off here as the sediments are finer and sub sediment percolation lessens.

Anticipated Outcome

Salad bar is expected to refill to the current configuration. Being downstream it may fill more slowly than some of the upstream bars. Increased riffle habitat may be present as the excavation fills in.

7.10: Powerline Bar

Site Name: Powerline Bar **Site Number:** 10
Identifier: 22-C29L **Coordinates:** 49.101119° N, -122.076004° W
Location: 200 m upstream of Keith Wilson Bridge
Ownership: City of Chilliwack

Previous Excavations: 1994 & 2004
Stockpile: Boundary Road Stockpile

Length: 105 m
Width: 31 m
Depth: 3 m
Expected Sediment Yield: 7, 500 m^3

Bar Access

North along the left bank dike road from the Fisherman's Corner parking lot to Keith Wilson Bridge. The existing ramp down from the dyke road allows trucks to travel under the bridge and thence upstream to the bar access point. A ramp down to the bar will need to be constructed and at least one culvert would be required.

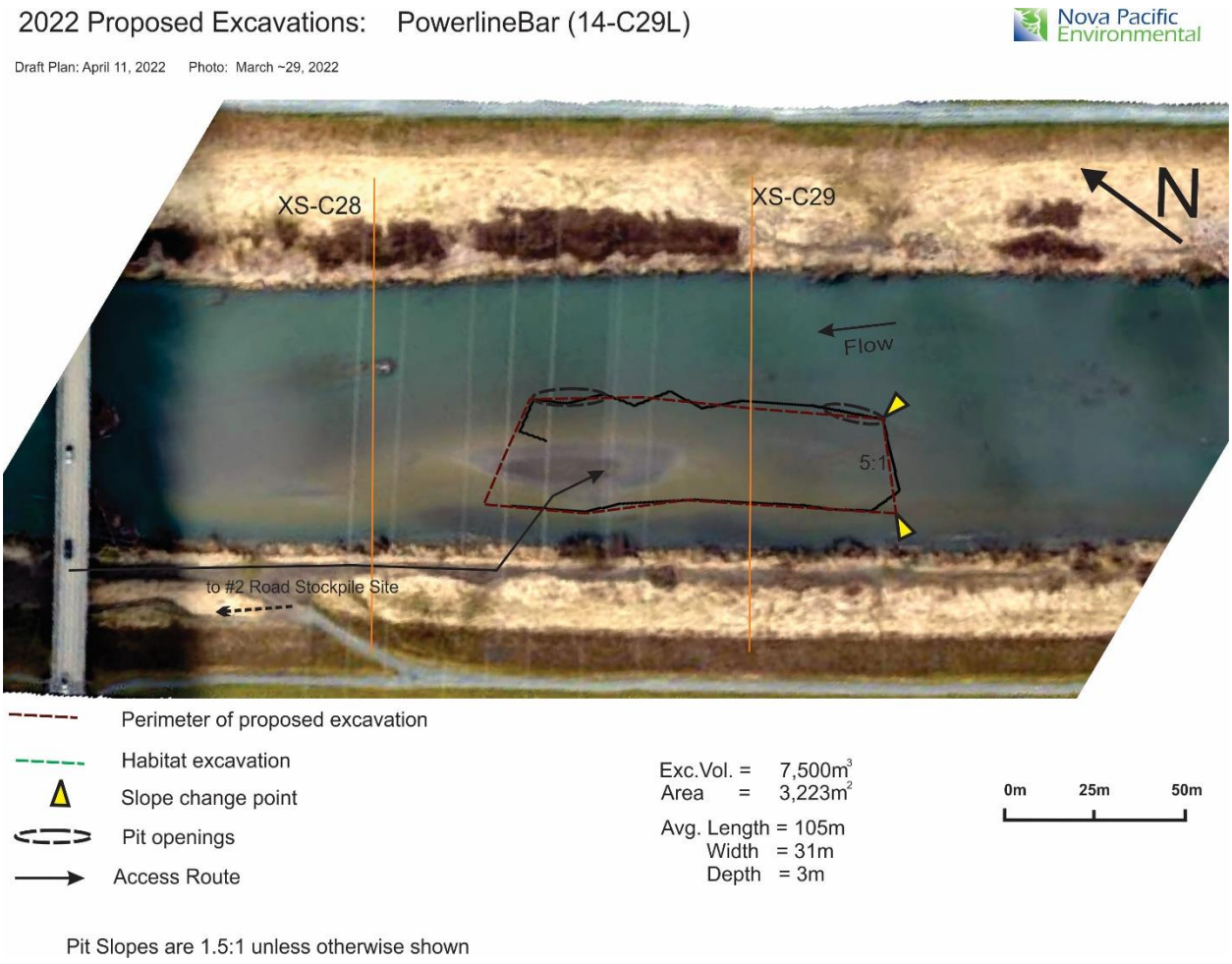

Figure 7: Powerline Bar excavation.

Objectives and Effectiveness

Lower water levels in the freeboard limited area through backwater curve reduction. This excavation will likely refill slowly, providing riffle and pool habitat features through a few freshet cycles.

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed, particularly in relation to culverts. The excavation area has been set back from the microchannel along the left bank to maintain the integrity of the existing habitat. Measures including "stand-by" silt fencing, sediment traps, and strict maintenance would be incorporated to prevent input of sediment into the river or habitat channel related to any culverts that are required.

Habitat Considerations

The habitat channel along the left bank is the primary habitat consideration at Powerline Bar. Additionally, maintenance of riffle habitat at the upstream and downstream extents of the bar will be important.

Protection of the secondary channel along the left bank is required, and as such the pit excavation has been offset from the channel accordingly. This channel will further be enhanced with LWD if any is available. The lateral riffle downstream of the bar will be enhanced by scalping the downstream end of Powerline Bar to water level or below to encourage flow.

Fish Habitat Utilization

The canal section of the Vedder River in general is primarily used by salmonids for migration to and from spawning areas upstream, however this section of the river provides rearing and foraging habitat for salmonids and is utilized by other fish as well.

Powerline Bar has well-established edge habitat along the left bank that provides rearing and habitat for salmonids. Depending on water levels and the configuration of the bar this edge habitat may be in the form of microchannel. This habitat will be maintained during the excavation of the bar and enhanced where possible with LWD found during sediment removal.

The shallow riffle habitat along the head and edge of the bar provides potential habitat for juveniles and potential spawning opportunities for pink salmon.

Anticipated Outcome

This excavation will likely refill slowly, providing riffle and pool habitat features through a few freshet cycles.

7.11: Boundary Bar

Site Name: Boundary Bar **Site Number:** 7
Identifier: 20-C22L **Coordinates:** 49.108821° N, -122.083095° W
Location: 800 meters downstream of Keith Wilson Bridge
Ownership: City of Abbotsford

Previous Excavations: 2002 & 2014 (approximate location by XS identifier)
Stockpile: Boundary Road Stockpile

Length: 200 m
Width: 31 m
Depth: 3 m
Expected Sediment Yield: 14,000 m^3

Bar Access

Northwest along the left bank dike road from the Fisherman's Corner parking lot. A ramp down from the dyke top to the low bank and then a second ramp down to the bar would be required. A culvert may be required to cross the microchannel along the left bank.

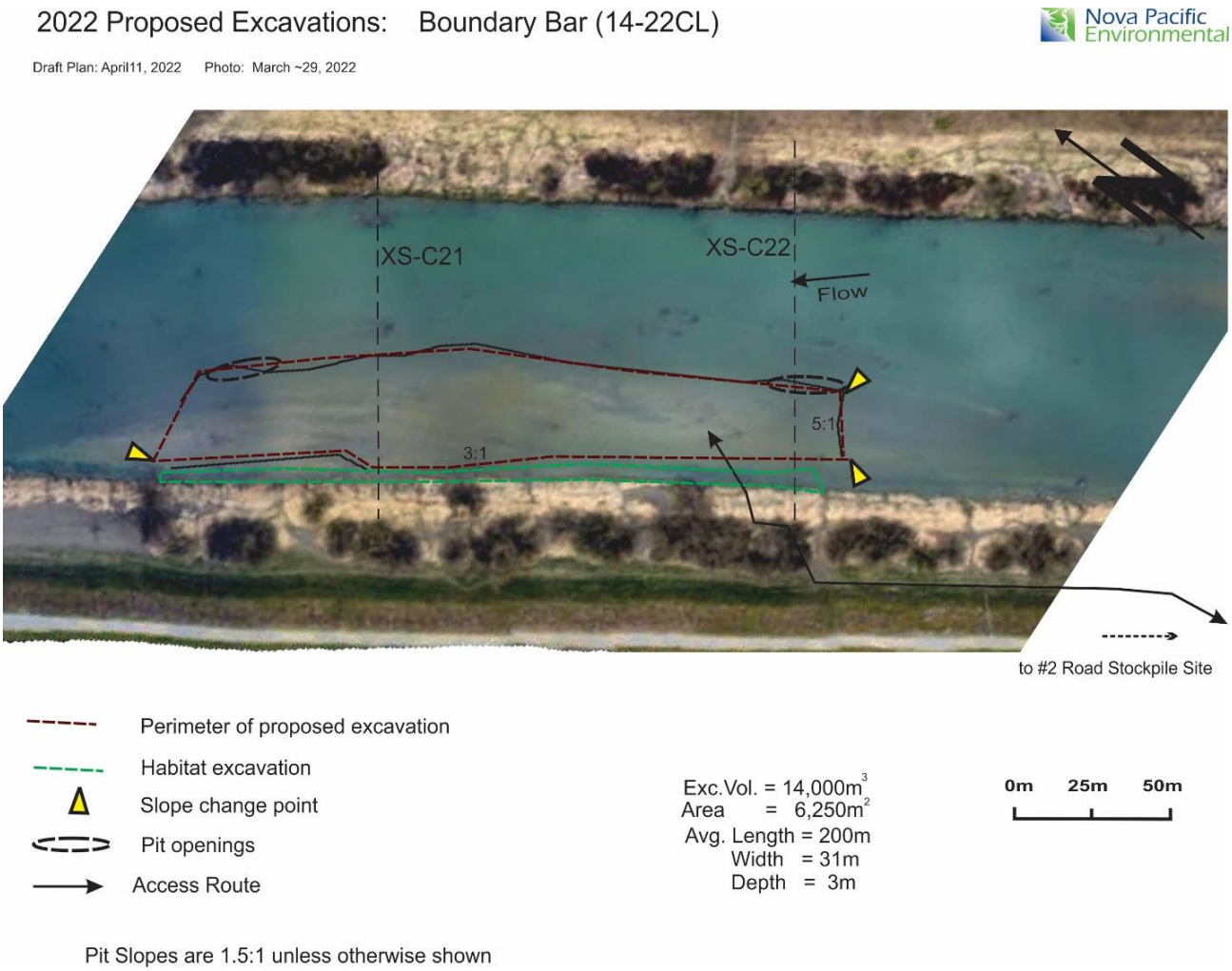

Figure 8: Boundary Bar excavation.

Objectives and Effectiveness

To improve the backwater curve, reducing risk of dyke overtopping upstream in the freeboard limited section of the Vedder River. In terms of flood risk benefits, this is the most effective of the proposed excavations. (KWL 2022)

Mitigation Plans

The mitigation measures described in Section 4.0 of this document will be followed, particularly those related to hauling material. Measures including "stand-by" silt fencing, sediment traps and strict maintenance would be incorporated to prevent input of sediment into the river or microchannel.

Habitat enhancements will be added along the length of the microchannel including deepening of shallow sections and addition of LWD. The excavation will be extended to the left bank 2/3 of the way downstream where the microchannel has completely filled.

Habitat Considerations

Despite limited cover and shallow depths, the left bank microchannel supports juvenile salmonids and other fish. The alternating bar configuration in the canal reach provides a variety of edge habitats but due to the low profile and find substrates spawning is limited or absent. Maintaining the integrity of the individual bars nonetheless remains important to minimize disruption of habitat values in the reach.

Fish Habitat Utilization

Boundary Bar does not provide opportunities for chum or pink salmon spawning, due to relatively slower flows and fine substrate size. As with other canal reach bars, there is limited riparian vegetation and LWD along the edges of Boundary Bar. The canal section of the Vedder River in general is primarily used by salmonids for migration to and from spawning areas upstream along with some rearing habitat opportunities for salmon fry noted along the bar edges.

Anticipated Outcome

Presence of fines and woody debris may limit the excavation depth. It is expected this excavation will significantly improve water levels upstream through removal of a significant amount of sediment from the canal section of the Vedder River. Impacts to fish add fish habitatare expected to be neutral at this excavation site.

8.0: OFFSETTING

Following the flood of 1975 and subsequent setback dyke construction, the Vedder River Management Area Plan identified the ongoing need to remove sediment and to maintain fish habitat within the river.

Since 1994, mapping of habitats has shown that the ongoing removal program as it has been executed has allowed habitat values to persist. A higher percentage of excavations that show an increase in habitat value from pre to post suggest that ongoing aggradation tends to lower the habitat ratings as measured by the method employed and that periodic excavation allows an increase in habitat ratings. The adaptive system of constraints, guidelines and planning procedures in use at least since 1998 has provided a successful approach for meeting floodway capacity objectives while maintaining habitat values, the core objectives of the VRMAC. Standard mitigation measures including excavation site slopes, excavation outside of flowing waters, and location of site in relation to existing river features and sensitive habitats have resulted in a mostly positive or neutral set of outcomes across the 90 previously completed excavations. It is worth noting that the changes to the river following excavation are attributable to the freshet conditions and the volume of sediment moved each year as well as the excavations. While these effects are not readily separated, natural changes may outweigh those that appear to be related

to the excavations. However, in designing and evaluating individual excavations understanding, or at least considering, how the changes caused by the excavation influence the natural processes is needed to provide an approach that meets the habitat objectives.

Overall, this approach results in a no net loss of habitat but there remain some short-term effects which in turn are offset by habitat excavation and enhancement activities that are built into each individual excavation. Broadly speaking, sediment removal replaces areas of higher bar habitat with large pools that begin to return to the previous condition with the beginning of fall freshet conditions. During higher flows, these submerged bar habitats are reduced. A second concern relates to use of the pits by spawners which could lead to losses if the excavations are not stable. These effects are mitigated by the characteristics of each pit.

Habitat mitigation consists primarily of placement of LWD, deepening entrances to secondary channels, complexing secondary channels, creating riffles, particularly at inlets and outlets to excavation sites, and providing modest habitat type excavations in conjunction with the larger pit type excavations. Placement of LWD is dependent on local supply and opportunity for placement but typically most sites allow a few LWD complexes consisting of 1 to 3 pieces. Key LWD features created will be georeferenced and tracked. additional placements in less desirable locations may be completed but not tracked. Entrances to channels are deepened as required to ensure that secondary channels continue to flow. Channel enhancements are undertaken when previously existing channels have filled or when temporary channels can be effectively deepened. An additional benefit arises where sediment flows can be enhanced by deepening channels adjacent to excavations. Typically, one or two significant channel improvement projects are undertaken in each cycle. For 2022, this includes a channel at Campground Bar, with additional smaller channel enhancements at, Greendale, and Boundary to re-establish flow along the riparian zone. Addition of riffle habitat at Peach Road D/S Lickman and Greendale Bars as a result of the proposed scalp excavations is also anticipated.

The following table shows the specific offsets planned for each site and mitigations of the temporary impacts that have been incorporated into the excavation design. These mitigations are different to the construction management BMPs discussed in Section 4 of this document. Due to the nature of the river and the large amount of sediment movement, the impacts and benefits are uncertain. There is also potential for spring freshet changes to alter the conditions so that planned habitat work is not feasible or desirable. Should this be the case, changes to the habitat work will be discussed along with the habitat mapping after the 2022 spring freshet.

9.0: CONCLUSION

Fish utilize a wide variety of habitats in the Vedder River and are present in wetted habitats adjacent to each proposed excavation. The pattern of that usage is correlated to habitat types that are the focus of the ongoing assessment and management of the Vedder River Sediment Removal Program. The program relies on careful and detailed application of the excavation design guidelines to avoid detrimental impacts to these habitats and to ensure that high habitat values are maintained in the Vedder River despite the high rate of natural and anthropogenic change.

The proposed work is expected to substantially meet the program objectives to increase flow conveyance and improve dyke freeboard with no net loss to fish habitat.

10.0: REFERENCES

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Wright, B.F., T. Kozlova, and M. Richard. (2018). 2016 Vedder River Sediment Excavations Habitat Changes and Environmental Impacts. Prepared for the Vedder River Management Area Committee.

APPENDIX A – LIST OF DOCUMENTS BEING SUBMITTED WITH PERMITTING APPLICATIONS TO DFO & MOF

THESE DOCUMENTS HAVE BEEN REFERENCED THROUGH THIS REPORT AND ARE BEING SUBMITTED DIRECTLY TO DFO/MOF IN PDF FORMAT AS APPENDICES TO THE PERMIT APPLICATIONS

1. 2022 Vedder River Hydraulic Assessment (KWL - May 2022)
2. 2016 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts (NPE - Jan 2018)
3. 2016 Vedder River Sediment Removal - Monitor's Report (NPE - Dec 2016)

APPENDIX B – LIST OF VEDDER RIVER ENVIRONMENTAL REPORTS PREPARED BY NPE FROM 1994 to 2016

COMPENDIUM OF VEDDER RIVER ENVIRONMENTAL REPORTS PREPARED BY NPE FROM 1994-2016

Most of these reports are available at: http://vedderriver.ca/

1. Wright, B.F. and M. Robinson. (1994). Environmental Monitors Report Vedder River Gravel Removal Project 1994. Prepared for the Ministry of Environment and Vedder River Management Committee. 16 p.
2. Wright, B.F. and M. Robinson. (1995). Assessment of the Environmental Impacts from 1994 Vedder River Gravel Bar Excavations. Prepared for Ministry of Environment Lands and Parks, District of Chilliwack, City of Abbotsford. 13 p.
3. Wright, B.F. and M. Robinson. (1995). Vedder River Gravel Removal Environmental Monitor's Report 1995. Prepared for Ministry of Environment Lands and Parks, District of Chilliwack, City of Abbotsford. 14 p.
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13. Murray, R. and B.F. Wright. (2007). Assessment of Fish Habitat Changes in the Vedder River Following Gravel Excavations in 2004 and a Review of the Assessment Methodology. Prepared for the Vedder River Management Area Committee. 35 p.
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15. Nova Pacific Environmental. (2008). Post Excavation Assessment of 2006 Vedder River Gravel Excavations. Prepared for the Vedder River Management Area Committee. 57 p.
16. Nova Pacific Environmental. (2008). 2008 Vedder River Gravel Excavations Environmental Monitors Report. Prepared for the Vedder River Management Area Committee.
17. Wright, B.F., P.S. Scholz and K. DeBoer. (2010). 2008 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts. Prepared for the Vedder River Management Area Committee.
18. DeBoer, K. and B.F. Wright. (2010). 2010 Environmental Monitors Report. Prepared for the Vedder River Management Area Committee. 48 p.
19. Wright, B.F., and T. Kozlova. (2012). 2010 Vedder River Gravel Excavation – Habitat Changes and Environmental Impacts. Prepared for the Vedder River Management Area Committee.
20. Kozlova, T. and B.F. Wright. (2010). 2012 Vedder River Sediment Removal Environmental Monitors Report. Prepared for the Vedder River Management Area Committee.
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23. Wright, B.F., T. Kozlova, and D. Campbell. (2016). 2014 Vedder River Gravel Excavations Habitat Changes and Environmental Impacts. Prepared for the Vedder River Management Area Committee.
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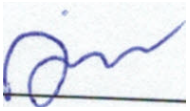
Date and Signature Page

The effective date of this report titled "Proposed 2020 Vedder River Sediment Removal Project" is May 29, 2020.

Signed,

Bruce F. Wright, B.Sc. MBA, RPBio Dated: May 17, 2022

Signed,



Josef Eriksson, BSc. Dated: May 29, 2020

Signed,

Michael Richard, B.Sc. Geo/Env Sci Dated: May 29, 2020