MUSQUEAM INDIAN BAND
6735 Salish Drive, Vancouver, BC
Phone: 604-263-3261
www.musqueam.bc.ca

APPROVED AS TO THE FORM BY THE MUSQUEAM INDIAN BAND PURSUANT TO THE MUSQUEAM LAND CODE

SIGNED BY MUSQUEAM INDIAN BAND PURSUANT TO THE MUSQUEAM LAND CODE

Signature:

Date: July 9, 2024.

Musqueam Land Code Permits and Authorizations

COMPREHENSIVE DEVELOPMENT PERMIT

COMPREHENSIVE DEVELOPMENT PERMIT	MIB-CDP-2024-06-001
Permit Issuance Date	July 2, 2024
Permit Expiration Date	July 2, 2025

OWNER or LEASEHOLDER	
Name	Musqueam Indian Band
Address	6735 Salish Drive, Vancouver, BC V6N 4C4
Phone	604-263-3261
Email	rhall@musqueam.bc.ca (Richard Hall, Lands Governance Director)
AGENT or APPLICANT	
☐ Check here if same as Owner; if not, complete below.	
Name	Vancouver Fraser Port Authority
Address	100 The Pointe, 999 Canada Place, Vancouver, BC, V6C 3T4
Contact Name	Tony Meysen, Construction Project Coordinator
Phone	604-665-9000 (work)
Email	tony.meysen@portvancouver.com

(Hereafter referred to as the "Permittee")

QUALIFIED CONTRACTOR (Hereafter referred to as the "Contractor")	
Company Name	To be determined by Vancouver Fraser Port Authority based on construction tender bid and review process. See attached document: Tender No. T240509-06 - Musqueam Foreshore Restoration
Business Number	To be determined

Address	To be determined
Contact Name	To be determined
Phone	To be determined
Email	To be determined
ENVIRONMENTAL CONSULTANT	
Company Name	Kerr Wood Leidal
Incorporation Number	BC 142837
Address	200-4185A Still Creek Dr, Burnaby, BC V5C 6G9
Contact Name	Clayton Hiles, P, Eng, Coastal Engineer / Patrick Lilley, MSc, RP Bio, BC-CESCL, Sector Leader
Phone	778-677-7682 (cell) / 604-812-2578 (cell)
Email	CHiles@kwl.ca / PLilley@kwl.ca
CERTIFIED ENGINEER	
Company Name	McElhanney Limited
Incorporation Number	BC 1203051
Address	200 – 858 Beatty Street, Vancouver, BC V6B 1C1
Contact Name	Anthony Peterson, Market Leader – Ports & Marine
Phone	604-788-2039 (cell)
Email	apeterson@mcelhanney.com
PROJECT MANAGEMENT	
Company Name	Core Project Management
Incorporation Number	BC 140111172
Address	375 Lynn Ave #102, North Vancouver, BC V7J 2C4
Contact Name	Cormac Linehan, P. Eng, Project Director
Phone	778-835-5430 (cell)
Email	cormac@corepm.ca

PROPERTY INFORMATION / LEGAL DESCRIPTION	
Property Address	Not Applicable
Legal Description	The legal boundaries of Musqueam Indian Reserve #2 in proximity to the Musqueam Foreshore Restoration Project consist of:

	1. The natural boundary within the project area (shown on Plan 100259 CLSR (2011) – partial survey of IR2 boundary); and 2. The rectilinear boundary within the project area (shown on Plan 88624 CLSR BC (2003) – District Lot 8015); and 3. The right of ways within the project area (shown on Plan 51119 CLSR BC (1962) and Plan 5204 CLSR BC (1959)). The boundary of Musqueam Indian Reserve #2 at the Fraser River is at the "present natural boundary", commonly used to describe the change in vegetation or soil due to the continuous presence of water. The present natural boundary is defined as the Ordinary High Water Mark (OHWM). Plan 100259 CLSR, dated 2011, provides the most recent delineation of the Reserve's waterward boundary. The project will not impact the legal boundaries of Musqueam Indian Reserve #2. The project's function is to protect the natural boundary of the river bank.
Musqueam Reserve #	Musqueam Indian Reserve #2
Lease Registration #	Not Applicable

(Collectively, the "Lands" or the "Permit Area")

BACKGROUND

1. The Vancouver Fraser Port Authority (VFPA) and Musqueam Indian Band (xʷməθkʷəy̓əm) are working to improve bank protection and restore the Fraser River foreshore at Musqueam Indian Reserve 2 (IR2). Currently, much of IR2's foreshore is protected by a haphazardly placed, improvised revetment comprised of broken waste concrete pieces. The Musqueam foreshore is exposed to coastal and river hazards, including wind waves, ship waves, high tide, storm surge, freshet and river flooding that have the potential to destabilize the armouring, contribute to land loss, and threaten the safety of the community.

2. Proposed works include:
   (a) Removal of 100 m improvised riprap (broken concrete pieces) and replacement with new rock riprap.
   (b) Partial removal of 50 m of mixed improvised and rock riprap and augmentation with new rock riprap.
   (c) Installation of five angled "digger log" structures to provide habitat enhancement along an approximately 150 m section of Musqueam Creek below the existing tide gate.

TERMS AND CONDITIONS

The following are hereby authorized under the following terms and conditions:

1. For the proposed development on the Lands, the following are approved, all as set out in the Application and Application Package "2024-05-21_Foreshore_MIB DP FINAL" submitted to Musqueam Indian Band by Core Project Management, dated May 21, 2024:
   (a) Removal of 100 m improvised riprap (broken concrete pieces) and replacement with new rock riprap;
   (b) Partial removal of 50 m of mixed improvised and rock riprap and augmentation with new rock riprap;
   (c) Installation of five angled "digger log" structures to provide habitat enhancement along an approximately 150 m section of Musqueam Creek below the existing tide gate; and
   (d) Clearing and site preparation as outlined in the construction tender and as required for the above works.

   This Comprehensive Development Permit approval is solely for these items.

   This Comprehensive Development Permit is approved in strict accordance with:
   (e) the application package attached as **Schedule "A" (the "Application")**, including;
      i. signed Musqueam Indian Band Subdivision, Development and Servicing Application Form; and
      ii. completed Musqueam Indian Band Development, Subdivision and Servicing Law Checklist
   (f) the project plan submitted with the Application, attached as **Schedule "B" (the "Plan")**, including:
      i. Musqueam Foreshore Restoration Cover Sheet, Drawing Index, And Key Plan;
      ii. Musqueam IR2 Foreshore Restoration Environmental Assessment;
      iii. Musqueam IR2 Foreshore Restoration Environmental Management Plan;
      iv. Tender T240509-06 Musqueam Foreshore Restoration;
      v. Musqueam Indian Band Land Status Report for Musqueam Foreshore Restoration Project;
      vi. Musqueam Reserve Lands Knotweed and Giant Hogweed Treatment Report 2023; and
      vii. Musqueam First Nation Phase II Environmental Site Assessment
   (g) this Permit; and
   (h) all Musqueam Indian Band laws including the *Subdivision, Development, and Servicing Law* and any design guidelines approved as part of the Law or the Musqueam Land Use Plan.

2. Total estimated cost of construction: **approximately $ 1,100,000**

3. Permit Fee: **$288.75**

4. Development Cost Charge: **Not applicable**

5. Community Benefit Contributions: **Not applicable**

6. This Permit is issued subject to the following general conditions:
   (a) By signing an application and accepting a permit, an applicant agrees that they are the Owner or have been duly authorized by the Owner, and that the agent, Owner and all people and contractors involved in the Construction agree to the permit conditions;
   (b) The Permittee will verify that the information contained within this document and associated documents and plans is correct, and describes a use, a building, or a work which complies with all applicable laws and codes. The Permittee will acknowledge that responsibility for compliance with laws rests with the Permittee and the Permittee's contractors and agents. The Permittee will agree to

indemnify and save harmless the Musqueam Indian Band, and each of its elected officials, officers, employees, solicitors, agents and servants of and from any and all claims, liabilities, and expenses of every kind, in respect of anything done or not done pursuant to this application or ensuing Permit, including negligence and/or the failure to observe any Law or legal requirement;

(c) Prior to commencing any use, activities, site preparation or construction, the Contractor will agree to obtain and carry insurance (as described in Tender T240509-06 Musqueam Foreshore Restoration – Insurance Schedule "A") against any structural failure, accident, incident or liability, and provide a copy of insurance to the Musqueam Lands Governance Office;

(d) No substantial alterations are to be made to the plans and designs set out in paragraph 1 and approved in this Comprehensive Development Permit without first notifying Musqueam Indian Band in writing and seeking further approval for these substantial alterations;

(e) The Permittee and the Contractor will provide notice to the community a minimum of two (2) weeks prior to the commencement of the work approved by this Permit, including;

i. Notice of construction start date and anticipated end date;
ii. Construction schedule;
iii. Notice of dedicated work area and any prohibited access to the foreshore area;

(f) The Permittee and the Contractor will ensure access to the existing boat ramp be open to Musqueam as required;

(g) The Permittee and the Contractor are required to allow access to the Lands at all times by Musqueam Indian Band staff, Council, agents, engineers, monitors and enforcement officers and to not hinder or prevent access to the Lands.

7. Quality Control Plan and Soil Testing

(a) As described in section 4.1.1 SECTION 01 00 00 General Requirements of Tender T240509-06 Musqueam Foreshore Restoration, the Contractor must conduct additional inspections, tests, or audits beyond those described in the Tender, as directed by Musqueam or Musqueam's technical advisors;

(b) Any soil or fill material brought to the project site from outside Musqueam reserve lands must be certified clean to residential quality standards; and

(c) Deposit and transport on Musqueam reserve lands of any excavated soil, sediment, or fill material requires a lined holding cell with 6mm poly-vinyl material on the ground beneath the material and covering the material.

8. Term and Renewal

(a) This permit is valid for one year from the date of issuance. Musqueam Indian Band may approve an extension or renewal of this permit provided that the Permittee is in compliance with all substantive requirements and provide a written request for extension or renewal six weeks prior to the expiration date.

9. Included Documents

The following documents are attached to and form part of this Permit:

(a) Schedule "A" – signed Application Form and Checklist;

(b) Schedule "B" – Plan.

This Comprehensive Development Permit **MIB-CDP-2024-06-001** is hereby approved by a quorum of Council of the Musqueam Indian Band, the Musqueam Lands Governance Director, or their designate and signed by the following authorized Musqueam Indian Band representative:

Date	July 9 2024	Signature	
Title	Lands Governance Director	Name	J. Richard W. Hall

This Comprehensive Development Permit MIB-CDP-2024-06-001 is hereby accepted by the applicant.

Date	July 10, 2024	Applicant Signature	
Title	Construction Project Coordinator	Applicant Name	Tony Meysen

I have the authority to bind the Lease-holder.

Date	July 10, 2024	Witness Signature	
Title	Project Director	Witness Name	Cormac Linehan

Date		Applicant Signature	
Title		Applicant Name	

I have the authority to bind the Lease-holder.

Date		Witness Signature	
Title		Witness Name	

MIB-CDP-2024-06-001
MUSQUEAM FORESHORE RESTORATION PROJECT

SCHEDULE "A" - APPLICATION

DOCUMENT CAN BE PROVIDED ON REQUEST FROM MIB LANDS GOVERNANCE OFFICE.

SCHEDULE "B" - PLAN

DOCUMENT LIST:

i. Musqueam Foreshore Restoration Cover Sheet, Drawing Index, And Key Plan
PAGES 8-15

ii. Musqueam IR2 Foreshore Restoration Environmental Assessment
PAGES 16-77

iii. Musqueam IR2 Foreshore Restoration Environmental Management Plan
PAGES 78-119

iv. Tender T240509-06 Musqueam Foreshore Restoration
DOCUMENT CAN BE PROVIDED ON REQUEST FROM MIB LANDS GOVERNANCE OFFICE.

v. Musqueam Indian Band Land Status Report for Musqueam Foreshore Restoration Project
DOCUMENT CAN BE PROVIDED ON REQUEST FROM MIB LANDS GOVERNANCE OFFICE.

vi. Musqueam Reserve Lands Knotweed and Giant Hogweed Treatment Report 2023
DOCUMENT CAN BE PROVIDED ON REQUEST FROM MIB LANDS GOVERNANCE OFFICE.

vii. Musqueam First Nation Phase II Environmental Site Assessment
DOCUMENT CAN BE PROVIDED ON REQUEST FROM MIB LANDS GOVERNANCE OFFICE.

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PORT of vancouver

Vancouver Fraser Port Authority

MUSQUEAM FORESHORE RESTORATION

KEY PLAN
SCALE: NTS

DRAWING INDEX

CONSULTANT DRAWING No.	DESCRIPTION	REVISION No.	SHEET
2121-00983-C0-001	COVER SHEET, DRAWING INDEX, AND KEY PLAN	D	1 OF 7
2121-00983-C0-002	DESIGN CRITERIA AND GENERAL NOTES	D	2 OF 7
2121-00983-C0-003	GENERAL ARRANGEMENT - OVERALL SITE	D	3 OF 7
2121-00983-C1-101	SHORELINE PROTECTION - PLAN	D	4 OF 7
2121-00983-C1-102	SHORELINE PROTECTION - SECTIONS AND DETAILS	C	5 OF 7
2121-00983-C2-101	CREEK HABITAT ENHANCEMENT - PLAN	D	6 OF 7
2121-00983-C2-102	CREEK HABITAT ENHANCEMENT - DETAILS	D	7 OF 7

Ref. No.	REFERENCE

Approved Sealed

McElhanney
Suite 200
858 Beatty Street
Vancouver BC
Canada V6B 1C1
T 604 683 8521

No.	Date	REVISION	Dr'n	Ch'd
D	2023-11-30	ISSUED FOR TENDER	K.Y.	A.P.
C	2023-09-19	ISSUED FOR PERMITTING	K.Y.	A.P.
B	2023-09-18	ISSUED FOR REVIEW (90% DESIGN)	K.Y.	A.P.
A	2023-07-24	ISSUED FOR REVIEW	K.Y.	A.P.

PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	B.WHITEHOUSE
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-11-30
SCALE	NTS
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
COVER SHEET, DRAWING INDEX, AND KEY PLAN

SIZE	DWG.	SHEET	REV.
D	2121-00983-C0-001	1 OF 7	D

DESIGN CRITERIA

1. FORESHORE RIPRAP HAS BEEN DESIGNED TO MEET OR EXCEED THE QUALITY OF ORIGINAL RIPRAP

   i) RIPRAP HAS BEEN SIZED TO PROTECT AGAINST THE FRASER RIVER WATER VELOCITIES DURING A 200-YEAR FLOOD EVENT AND ANY VESSEL-GENERATED WAVES.

   ii) A SELF-LAUNCHING RIPRAP TOE HAS BEEN DESIGN TO PROTECT THE FORESHORE FROM ESTIMATED FRASER RIVER SCOUR OF 4.0m.

2. MUSQUEAM CREEK HABITAT IMPROVEMENTS DOWNSTREAM OF THE OUTLET HAVE BEEN DESIGN TO PROVIDE ADDITIONAL FISH HABITAT FOR AQUATIC LIFE AND IMPROVE FISH PASSAGE.

   i) HABITAT IMPROVEMENTS HAVE BEEN DESIGNED TO BE EFFECTIVE AT LOW FLOW AND BE RESILIENT UP TO THE 200-YEAR MUSQUEAM CREEK AND FRASER RIVER FLOOD.

HABITAT GAINS & LOSSES		
	ACTIVITY	AREA (m^2)
HABITAT GAINS	AQUATIC IMPROVEMENT AREA	1280
HABITAT LOSSES	SHORELINE PROTECTION ADDITIONAL RIPRAP AREA	80
NET	1200	

GENERAL NOTES

1. GENERAL:

   i) THESE GENERAL NOTES REPRESENT THE ENTIRETY OF THE PROJECT TECHNICAL SPECIFICATIONS.

   ii) BASEPLAN PROVIDED BY MCELHANNEY LTD.

   iii) HORIZONTAL DATUM: UTM NAD83, ZONE 10 NORTH.

   iv) BATHYMETRY AND TOPOGRAPHIC SURVEY PROVIDED BY MCELHANNEY LTD AND TAKEN FROM AVAILABLE REFERENCES.

   v) ELEVATIONS AND CONTOURS ARE IN METRES AND DECIMALS THEREOF TO HYDROGRAPHIC (TIDE AND CHART) DATUM.

   vi) ALL LOCATIONS AND ELEVATIONS OF EXISTING ELEMENTS AS SHOWN ON THE DRAWINGS ARE APPROXIMATE VALUES ONLY, AND ARE SUBJECT TO CONSTRUCTION VARIATIONS. THE CONTRACTOR SHALL VISIT THE SITE OF THE WORK, TAKE THEIR OWN MEASUREMENTS OF ALL EXISTING STRUCTURES, GROUND AND OTHER WORK, MAKE THEIR ESTIMATE OF ACTUAL JOB CONDITIONS AND THE CORRECTNESS OF THE INFORMATION GIVEN. ALL DIMENSIONS AND DETAILS SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO FABRICATION AND CONSTRUCTION. DISCREPANCIES SHALL PROMPTLY BE BROUGHT TO THE ATTENTION OF THE VFPA REPRESENTATIVE.

   vii) RIPRAP QUANTITIES ASSUME THAT 50% OF THE RIPRAP VOLUME REQUIRED IN THE PARIAL REPLACEMENT ZONES VOLUME CAN BE SOURCED FROM EXISTING MATERIAL IN THE PROJECT SITE.

2. SITE PREPARATION:

   i) REMOVE ALL EXISTING LOGS, TIMBER, PILES, METAL DEBRIS, CONCRETE DEBRIS AND OTHER DELETERIOUS MATERIALS ON THE EXISTING SLOPE WITHIN THE WORK AREA.

   ii) DISPOSE OF ALL REMOVED MATERIALS OFF SITE, IN ACCORDANCE WITH MUNICIPAL, PROVINCIAL, AND FEDERAL REGULATIONS.

3. SHORELINE REPAIRS:

   i) REPAIRS MATERIALS:

   i) ALL REPAIRS MATERIALS SHALL BE APPROVED BY THE VFPA REPRESENTATIVE PRIOR TO INSTALLATION.

   ii) ALL REPAIRS MATERIALS SHALL BE ROUGH ANGULAR QUARRIED STONE OF A DENSE, HARD, DURABLE CHARACTER, FREE OF ORGANIC MATERIALS, UNFILLED JOINTS, SEAMS OR OTHER DEFECTS, RESISTANT TO BREAKDOWN BY HANDLING, FROST ACTION OR WEATHERING, AND NOT SUBJECT TO DETERIORATION IN SEA WATER. AS A MINIMUM, RIPRAP SHALL MEET THE FOLLOWING:

TEST #	TEST	REQUIREMENT
1	ABSORPTION (ASTM C127)	NOT MORE THAN 2.0%
2	ABRASION, 1000 REVOLUTIONS (ASTM C535)	NOT MORE THAN 20.0% LOSS
3	MAGNESIUM SULFATE SOUNDNESS, (ASTM C88)	NOT MORE THAN 15.0% LOSS
4	PETROGRAPHIC EXAMINATION	ABSENCE OF WEAKNESS OR MATERIALS THAT COULD RESULT IN SIGNIFICANT STONE ALTERATION AND REDUCTION IN DURABILITY
5	DEGRADATION (ASTM D3744)	NO INDEX LESS THAN 35

   iii) THE REPAIRS SHALL HAVE A UNIT MASS NOT LESS THAN 2650 kg/m³; I.E A SPECIFIC GRAVITY NOT LESS THAN 2.65 (SD).

   iv) THE REPAIRS SHALL BE GRADED BETWEEN THE LIMITS SPECIFIED, WITH THE LONGEST DIMENSION OF ANY PIECE NOT GREATER THAN 2.5 TIMES ITS LEAST DIMENSION.

ESTIMATED GRANULAR QUANTITIES		
CLASS 250kg RIPRAP	1650	m^3
GRANULAR FILTER	220	m^3

   v) MASS GOVERNS AND THE GRADATION AND NOMINAL SIZE IS DEFINED AS:

$$D = 1000 \times \left(\frac{W}{2650}\right)^{\frac{1}{3}}$$

   WHERE MASS (W) IS IN kg AND D IS THE NOMINAL SIZE IN mm.

   vi) RIPRAP SHALL BE CLASS 250 kg.

GENERAL NOTES (CON'T)

   vii)RIPRAP AND FILL SHALL BE IN CONFORMANCE WITH SS 205 AND MEET THE SPECIFIED GRADATIONS AND QUALITY IN TABLES 205-A, 205-B AND 205-C (REPRODUCED BELOW FOR REFERENCE)

TABLE 1: RIPRAP HORIZONTAL DIMENSIONS			
CLASS OF RIPRAP (kg)	NOMINAL RIPRAP THICKNESS (mm)	SURFACE WIDTH, H (mm)	
		2H : 1V SLOPE	1.5H : 1V SLOPE
10	350	783	631
25	450	1006	811
50	550	1230	992
100	700	1566	1262
250	1000	2236	1803
500	1200	2684	2163
1000	1500	3355	2704
2000	2000	4473	3606
4000	2500	5591	4507

TABLE 205-A: GRADATION OF ROCK SIZES IN EACH CLASS OF RIPRAP - MASS (kg)				
CLASS OF RIPRAP (kg)	NOMINAL RIPRAP THICKNESS (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)		
		15%	50%	85%
10	350	1	10	30
25	450	2.5	25	75
50	550	5	50	150
100	700	10	100	300
250	1000	25	250	750
500	1200	50	500	1500
1000	1500	100	1000	3000
2000	2000	200	2000	6000
4000	2500	400	4000	12000

TABLE 205-B: APPROPRIATE AVERAGE DIMENSION OF EACH SPECIFIED ROCK CLASS MASS (Sg=2.640) - EQUIVALENT DIAMETER (mm)				
CLASS OF RIPRAP (kg)	APPROXIMATE AVERAGE DIMENSION (mm)			
	15%	50%	85%	<100%
10	90	195	280	330
25	120	260	380	450
50	155	330	475	565
100	195	415	600	715
250	260	565	815	965
500	330	715	1030	1220
1000	415	900	1295	1535
2000	525	1130	1630	1935
4000	660	1425	2055	2440

REF: BRITISH COLUMBIA MINISTRY OF TRANSPORTATION AND INFASTRUCTURE

   viii) GRANULAR FILTER SHALL BE 75mm MINUS THAT CONFORMS TO TABLE 2:

TABLE 2:	
INTERMEDIATE DIMENSION (mm)	PERCENTAGE SMALLER
75	100
25	50
0.15	15
0.08	10

GRANULAR FILTER MATERIAL MUST BE APPROVED BY VFPA REPRESENTATIVE BEFORE PLACEMENT

GENERAL NOTES (CON'T)

   iii) PLACEMENT OF SHORELINE REPAIRS:

   i) PERFORM A SITE REVIEW PRIOR TO CONSTRUCTION ACTIVITIES COMMENCING WITH THE VFPA REPRESENTATIVE TO IDENTIFY AND CONFIRM THE EXTENT AND LOCATIONS OF THE RIPRAP.

   ii) PLACE THE RIPRAP MATERIALS IN THE LOCATIONS AND TO THE ELEVATIONS, THICKNESS AND DETAILS AS INDICATED ON THE DRAWINGS AND AS DIRECTED BY THE VFPA REPRESENTATIVE.

   iii) TRIM EXISTING SLOPE AS REQUIRED TO FIT THE RIPRAP INTO THE AREAS INDICATED ON THE DRAWINGS.

   iv) PLACE RIPRAP SUCH THAT THE FINISHED SURFACE IS DENSELY PLACED, WELL KEYED, AND UNIFORM. FILL VOIDS, REWORK REPAIRS NOT PROPERLY EMBEDDED, AND REMOVE PROTUBERANCES TO THE SATISFACTION OF THE VFPA REPRESENTATIVE.

   v) IN FULL REPLACEMENT ZONES, ENSURE GRANULAR FILTER IS PLACED AS PER DRAWING SPECIFIED THICKNESS BEFORE PLACEMENT OF ANY RIPRAP MATERIAL.

   vi) RIPRAP PLACED BELOW THE EXISTING TOE WILL BE KEYED IN AT GRADE. SEE SHEET C1-102 FOR ADDITIONAL DETAILS.

   iv) TOLERANCES:

   i) PLACE RIPRAP INDIVIDUALLY, KEYING AND INTERLOCKING STONES TO MINIMIZE OPENINGS BETWEEN ROCKS TO PROVIDE A SMOOTH FINISHED SURFACE.

   ii) FINISHED SLOPE ANGLES OF RIPRAP SHALL BE WITHIN ± 2% OF THE ANGLE CORRESPONDING TO THE SLOPE SPECIFIED, WHEN MEASURED BY LAYING A STRAIGHT EDGE BOARD OF MINIMUM 2m LENGTH ALONG THE FALL LINE OF THE SLOPE AND MEASURING THE SLOPE ON THE BOARD. THE CONTRACTOR SHALL PROVIDE A SUITABLE BOARD FOR CHECKING SLOPE ANGLES.

   v) FIELD QUALITY CONTROL:

   i) MAINTAIN A COMPLETE, ACCURATE LOG OF CONTROLS AND SURVEYS AS THE WORK PROGRESSES.

   ii) THE CONTRACTOR SHALL PERFORM A PRE AND POST CONSTRUCTION BATHYMETRIC AND TOPOGRAPHIC SURVEYS. PRE CONSTRUCTION SURVEY SHALL BE PROVIDED TO VFPA REPRESENTATIVE FOR REVIEW AND WRITTEN APPROVAL PRIOR TO COMMENCING WORKS. POST CONSTRUCTION SURVEY SHALL BE PROVIDED TO VFPA REPRESENTATIVE FOR REVIEW AND WRITTEN APPROVAL PRIOR TO SITE DEMOBILIZATION.

   iii) SURVEYS SHALL BE CARRIED OUT WITH THE VFPA REPRESENTATIVE IN ATTENDANCE.

   iv) DETAILED PRE AND POST CONSTRUCTION PHOTOGRAPHIC IMAGERY SHALL BE PROVIDED BY THE CONTRACTOR TO SUPPORT ITS INVOICES AND TO AID IN VALIDATIONS OF WORKS AND PROJECT RECORDS.

4. MUSQUEAM CREEK HABITAT IMPROVEMENTS:

   i) MATERIALS:

   i) ALL MATERIALS SHALL BE APPROVED BY THE VFPA REPRESENTATIVE PRIOR TO INSTALLATION.

   ii) BANK ARMOUR AND ROCK APRON ROCK SHALL BE HARD, DURABLE ROUNDED STONE, ALLUVIAL IN NATURE, FREE FROM DEBRIS, WITH A SPECIFIC GRAVITY OF 2650 kg/m³. THE ROCK SHALL CONFORM TO TABLE 3:

TABLE 3: BANK ARMOUR AND ROCK APRON GRADATION	
INTERMEDIATE DIMENSION (mm)	PERCENTAGE SMALLER
140	100
100	85
75	50
40	15

   iii) DIGGER LOGS AND LARGE WOODY DEBRIS SHALL BE EITHER CEDAR, SPRUCE, OR DOUGLAS FIR WITH A DIAMETER OF 0.45 TO 0.6m.

   iv) BALLAST ROCK SHALL BE 600mm IN DIAMETER ANGULAR QUARRIED ROCK OF A DENSE, HARD, DURABLE CHARACTER, FREE OF ORGANIC MATERIALS, UNFILLED JOINTS, SEAMS OR OTHER DEFECTS, RESISTANT TO BREAKDOWN BY HANDLING, WITH A SPECIFIC GRAVITY OF 2650 kg/m³.

   v) LOG ANCHORING MATERIALS INCLUDE 16mm GALVANIZED STEEL AIR CRAFT CABLE AND TWO-PART EPOXY SUITABLE FOR USE IN WATER AND SENSITIVE AQUATIC HABITAT.

   ii) PLACEMENT OF MUSQUEAM CREEK HABITAT IMPROVEMENTS:

   i) PERFORM A SITE REVIEW PRIOR TO CONSTRUCTION ACTIVITIES COMMENCING WITH THE VFPA REPRESENTATIVE TO IDENTIFY AND CONFIRM THE EXTENT AND LOCATIONS OF THE DIGGER LOGS AND LARGE WOODY DEBRIS.

   ii) PLACE THE DIGGER LOGS AND LARGE WOODY DEBRIS MATERIALS IN THE LOCATIONS AND TO THE ELEVATIONS, THICKNESS AND DETAILS AS INDICATED ON THE DRAWINGS AND AS DIRECTED BY THE VFPA REPRESENTATIVE.

   iii) ENSURE DIGGER LOG IS SLOPED TO ENSURE A LOW POINT WHERE LOW FLOWS WILL BE DIRECTED.

Ref. No.	REFERENCE

Approved Sealed

McElhanney
Suite 200
858 Beatty Street
Vancouver BC
Canada V6B 1C1
T 604 683 8521

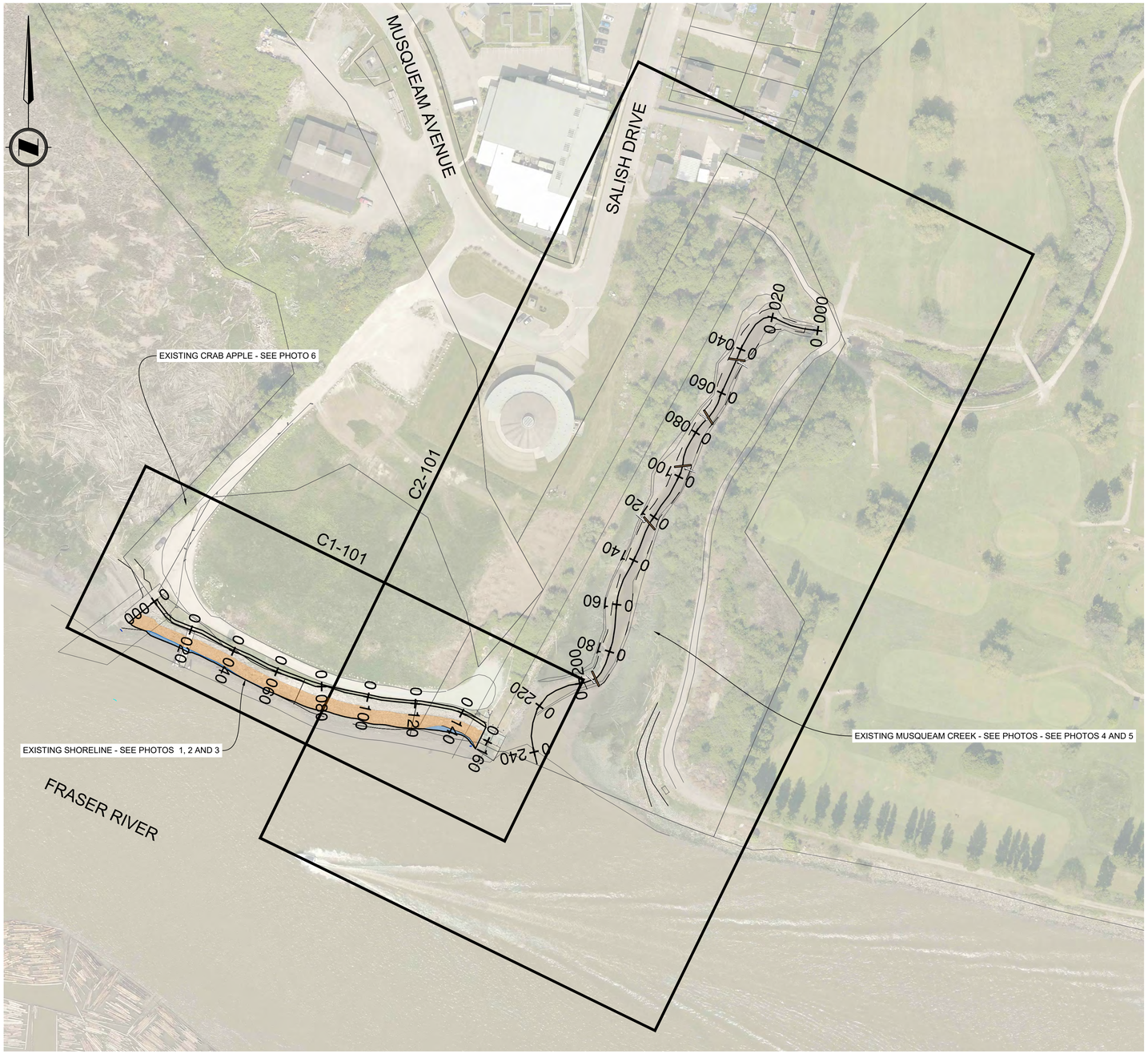
No.	Date	REVISION	Dr'n	Ch'd
D	2023-11-30	ISSUED FOR TENDER	K.Y.	A.P.
C	2023-09-19	ISSUED FOR PERMITTING	K.Y.	A.P.
B	2023-09-18	ISSUED FOR REVIEW (90% DESIGN)	K.Y.	A.P.
A	2023-07-24	ISSUED FOR REVIEW	K.Y.	A.P.

PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	B.WHITEHOUSE
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-11-30
SCALE	NTS
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
DESIGN CRITERIA AND GENERAL NOTES

SIZE	DWG.	SHEET	REV.
D	2121-00983-C0-002	2 OF 7	D



PLAN
SCALE 1:2000

PHOTO 1: EXISTING SHORELINE, (LOOKING UPSTREAM)

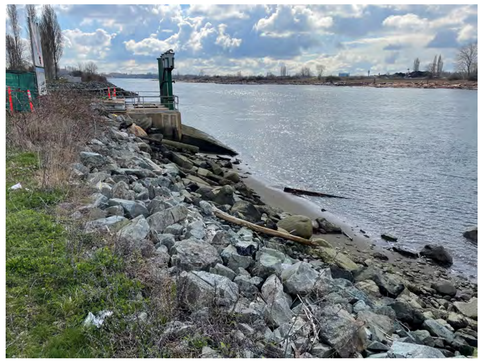


PHOTO 2: EXISTING SHORELINE, (LOOKING UPSTREAM)

PHOTO 3: EXISTING SHORELINE, (LOOKING DOWNSTREAM)

PHOTO 4: MUSQUEAM CREEK (LOOKING UPSTREAM)

PHOTO 5: MUSQUEAM CREEK (LOOKING DOWNSTREAM)

PHOTO 6: EXISTING CRAB APPLE TREE NOT TO BE DAMAGED

0 1:2,000 100

NOTES

1. FOR DESIGN CRITERIA AND GENERAL NOTES SEE DWG. 2121-00983-C0-002

Ref. No.	REFERENCE

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D	2023-11-30	ISSUED FOR TENDER	K.Y.	A.P.
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A	2023-07-24	ISSUED FOR REVIEW	K.Y.	A..P.

PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	B.WHITEHOUSE
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-11-30
SCALE	1:2000
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
GENERAL ARRANGEMENT
OVERALL SITE

SIZE	DWG.	SHEET	REV.
D	2121-00983-C0-003	3 OF 7	D

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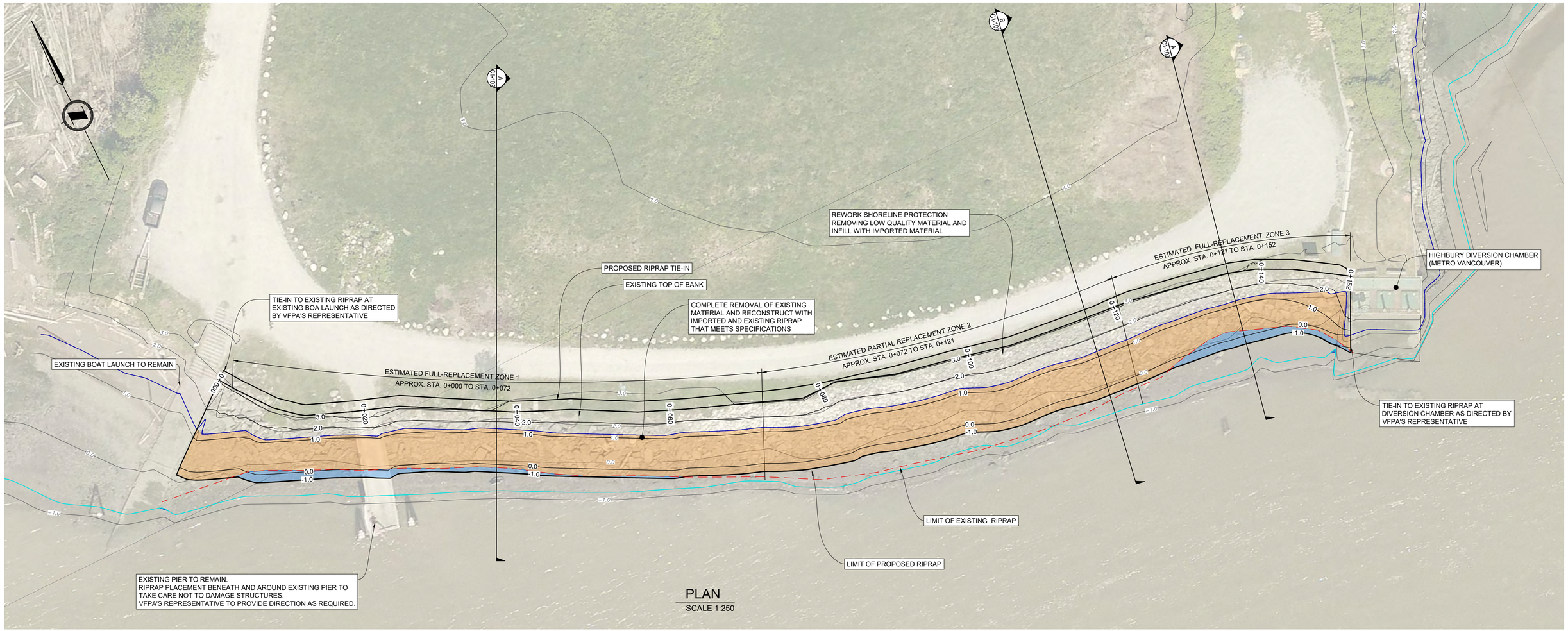

PLAN
SCALE 1:250

LEGEND

- EXISTING RIPRAP TOE
- 3.0 PROPOSED CONTOURS
- 3.0 EXISTING CONTOURS
- C EXISTING COMM
- S EXISTING SANITARY
- HIGH WATER LINE
- LOW WATER LINE
- EXISTING FOOTPRINT OF SHORELINE PROTECTION (HWL TO EXISTING TOE): 830m^2
- NEW TIDAL FOOTPRINT (EXISTING TOE TO LWL): 80m^2

NOTES

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2. ALL DIMENSIONS ARE IN METRES OR MILLIMETRES UNLESS OTHERWISE STATED.
3. TOPOGRAPHIC SURVEY ON MARCH 10 AND 13, 2023. ELEVATIONS ARE REFERRED TO GEODETIC DATUM CVD28. THE GRID COORDINATES ARE UTM ZONE 10, NAD83 (CSRS) AND ARE DERIVED FROM DUAL FREQUENCY GPS DIFFERENTIAL CARRIER PHASE OBSERVATIONS.
4. THIS PLAN SHOWS GRID MEASURED DISTANCES. TO COMPUTE GROUND LEVEL DISTANCES, DIVIDE GRID DISTANCES BY A COMBINED FACTOR OF 0.9996050.
5. THE RIPRAP ZONE EXTENTS TO BE DETERMINED BY VFPA'S REPRESENTATIVE BASED ON IN-SITU CONDITIONS DURING THE WORKS.

0 1:250 10

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PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	B.WHITEHOUSE
DRAWN BY	K.YANG
APPROVED	B.WHITEHOUSE
DATE	2023-11-30
SCALE	1:250
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION
SHORELINE PROTECTION
PLAN

SIZE	DWG.	SHEET	REV.
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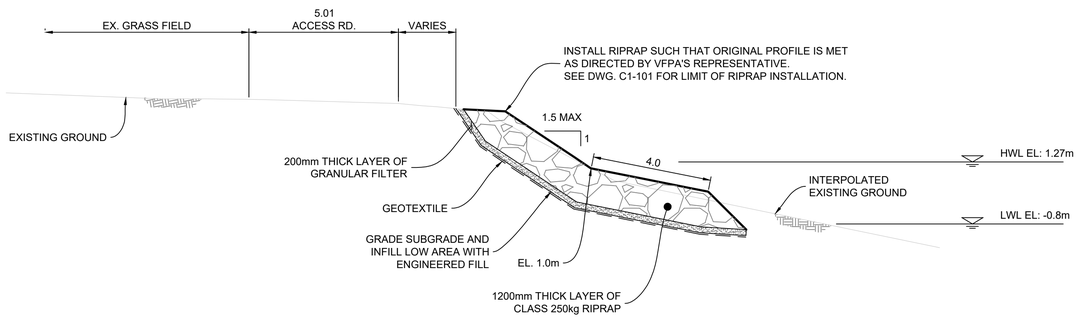

SECTION A: FULL REPLACEMENT ZONES 1 AND 3

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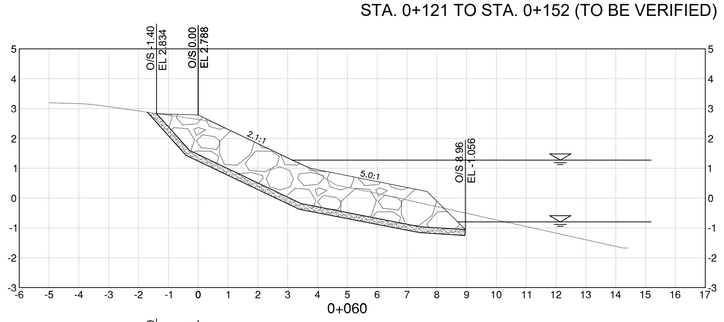
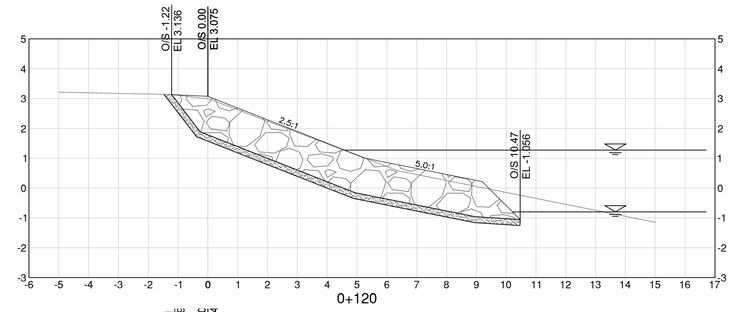
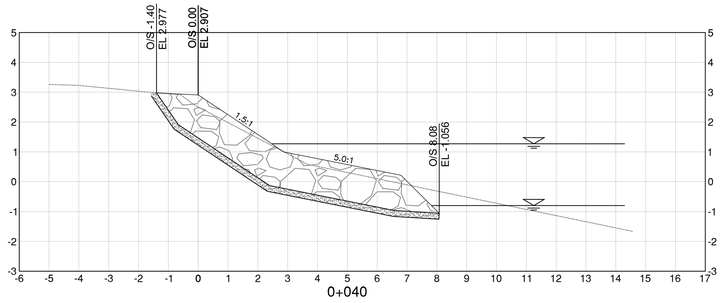
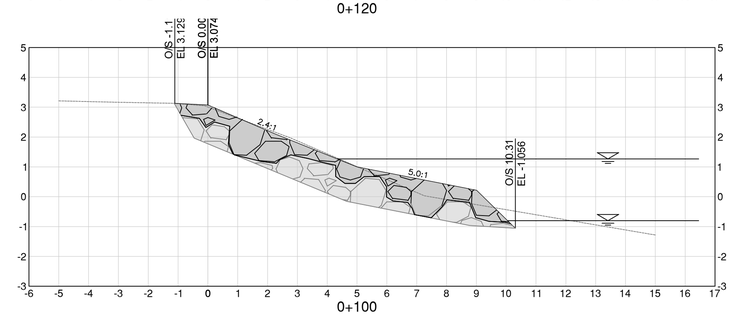
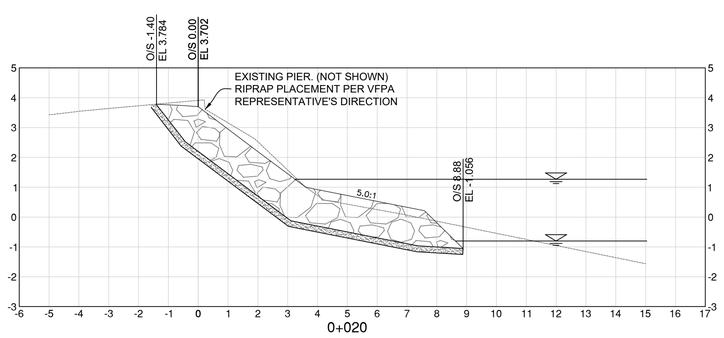
STA. 0+121 TO STA. 0+152 (TO BE VERIFIED)

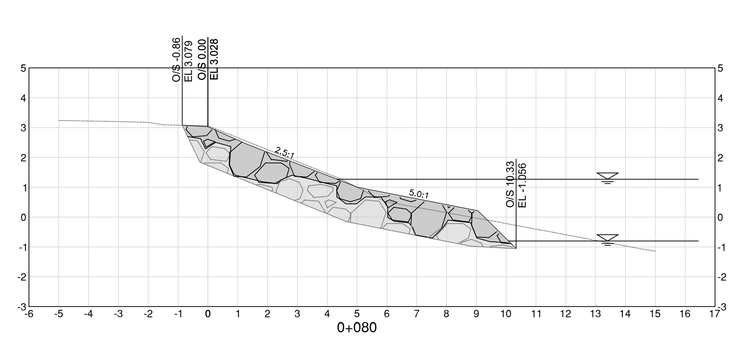


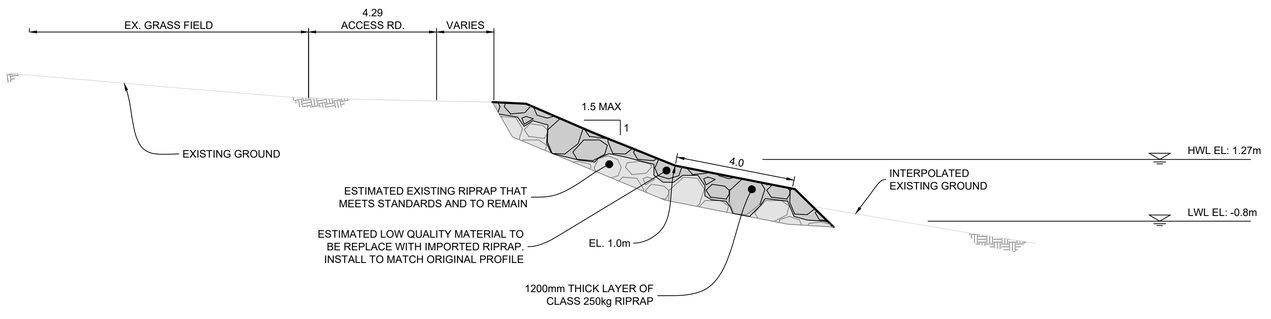








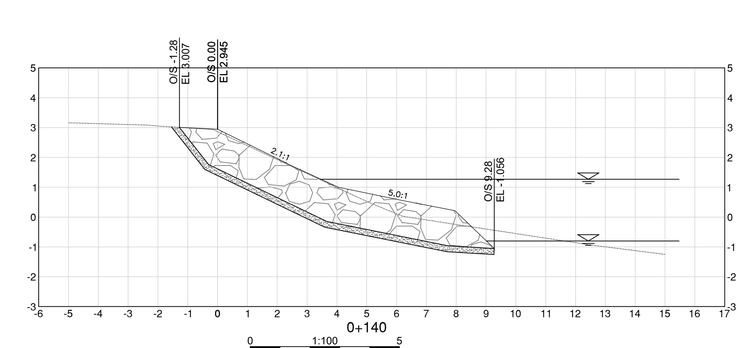




SECTION B: PARTIAL REPLACEMENT ZONE 2

STA. 0+072 TO STA. 121 (TO BE VERIFIED)

NOTE: GRANDULAR FILTER AND GEOTEXTILE TO BE INSTALLED AS REQUIRED (AND PER VFPA REPRESENTATIVES DIRECTION) WHERE EXISTING FILL OR SMALL GRADATION ROCK PRESENT.



0 1:100 5

NOTE: DUE TO THE SURFACE INTERPOLATION OF THE DESIGN MODEL, IT IS ESTIMATED THAT EXISTING GROUND AT THE TOE OF EACH RIPRAP IS APPROX. 0.5m LOWER THAN SHOWN ON ALL ABOVE SECTIONS. IT IS EXPECTED THAT RIPRAP PLACED BELOW THE EXISTING TOE WILL BE KEYED IN AT EXISTING GRADE.

Ref. No.	REFERENCE

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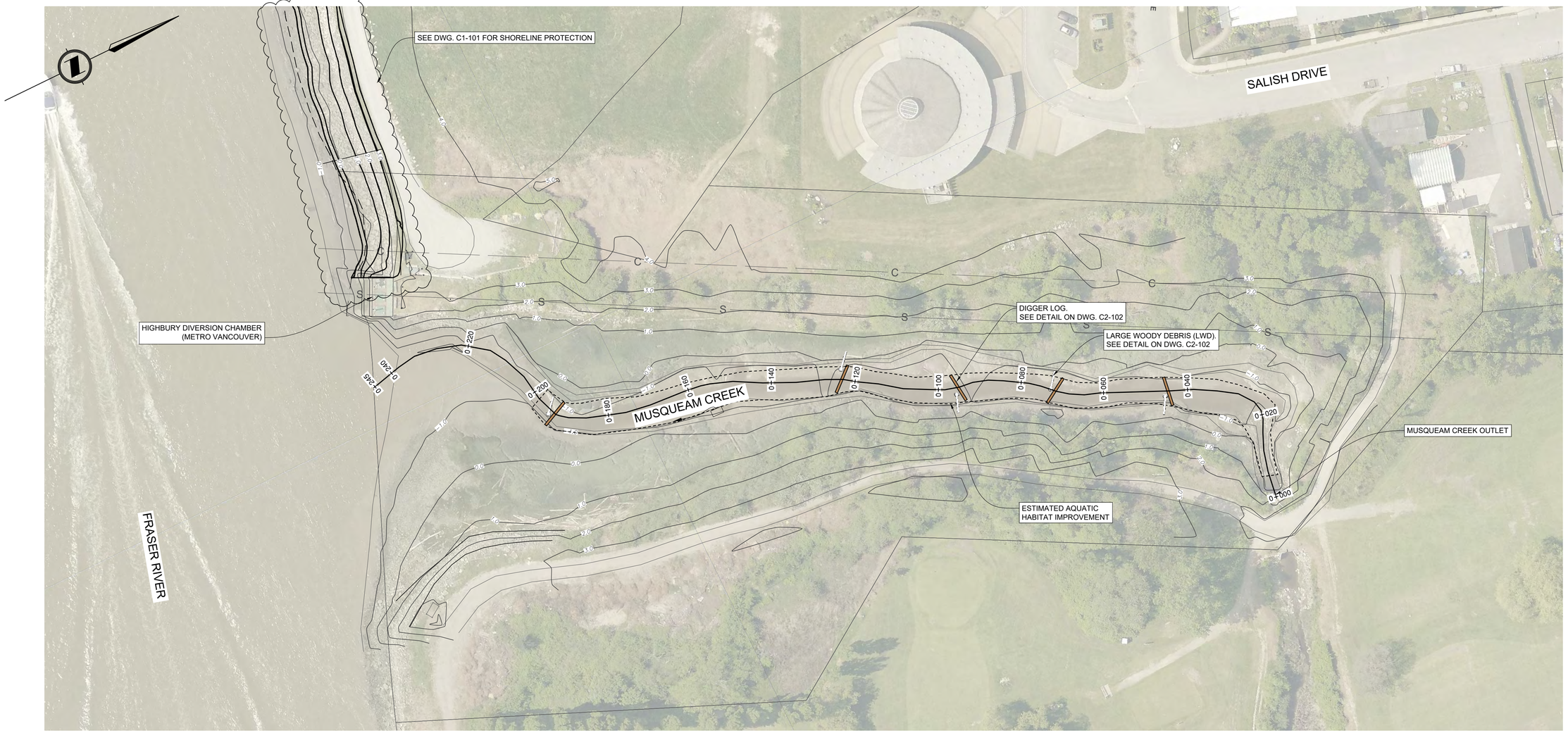
PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	B.WHITEHOUSE
DRAWN BY	K.YANG
APPROVED	B.WHITEHOUSE
DATE	2023-11-30
SCALE	1:100
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION
SHORELINE PROTECTION
SECTIONS AND DETAILS

SIZE	DWG.	SHEET	REV.
D	2121-00983-C1-102	5 OF 7	C



PLAN
SCALE 1:500

LEGEND

- DIGGER LOG
- AQUATIC HABITAT IMPROVEMENT
- 3.0 EXISTING CONTOURS
- C EXISTING COMM
- S EXISTING SANITARY
- HIGH WATER LINE
- LOW WATER LINE

0 1:500 25

NOTES

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4. THIS PLAN SHOWS GRID MEASURED DISTANCES. TO COMPUTE GROUND LEVEL DISTANCES, DIVIDE GRID DISTANCES BY A COMBINED FACTOR OF 0.9996050.
5. LOCATIONS OF DIGGER LOG AND LWD TO BE DETERMINED BY VFPA'S REPRESENTATIVE BASED ON IN-SITU CONDITIONS DURING THE WORKS.

Ref. No.	REFERENCE

Approved Sealed

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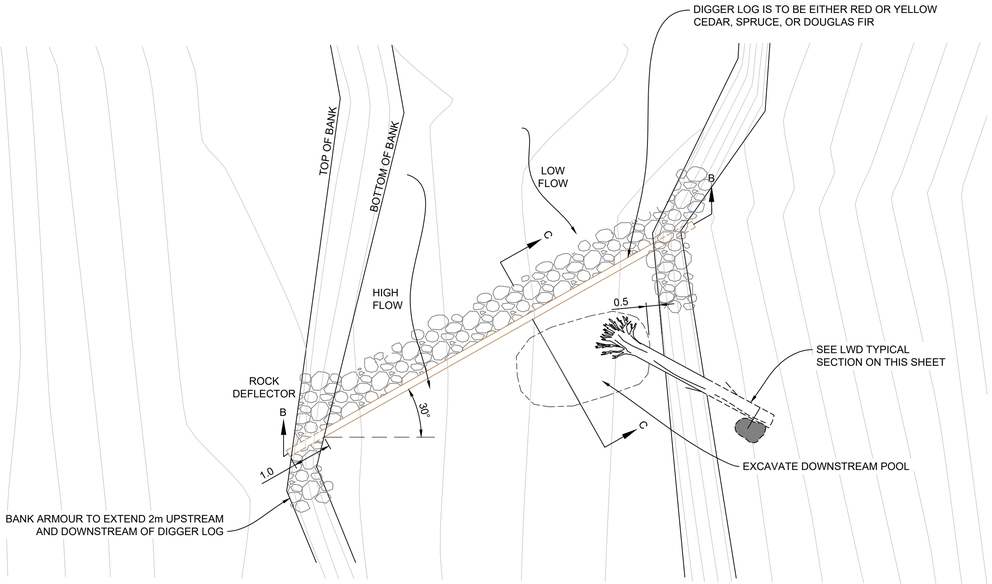
PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

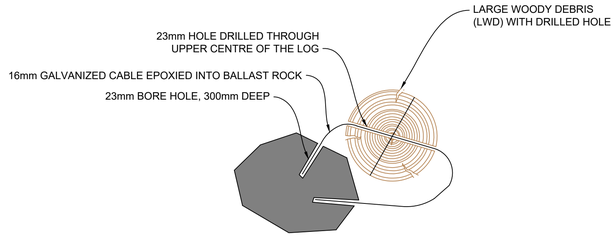
DESIGN BY	N.LINDSEY
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-11-30
SCALE	1:500
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION CREEK HABITAT ENHANCEMENT PLAN

SIZE	DWG.	SHEET	REV.
D	2121-00983-C2-101	6 OF 7	D



PLAN - TYPICAL



LWD ANCHORING DETAIL

SCALE 1:20

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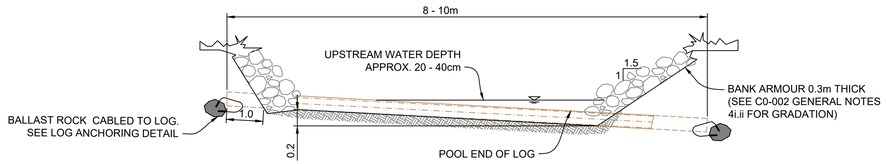

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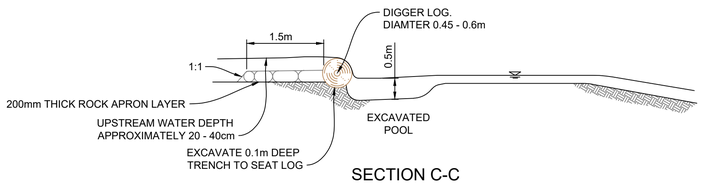
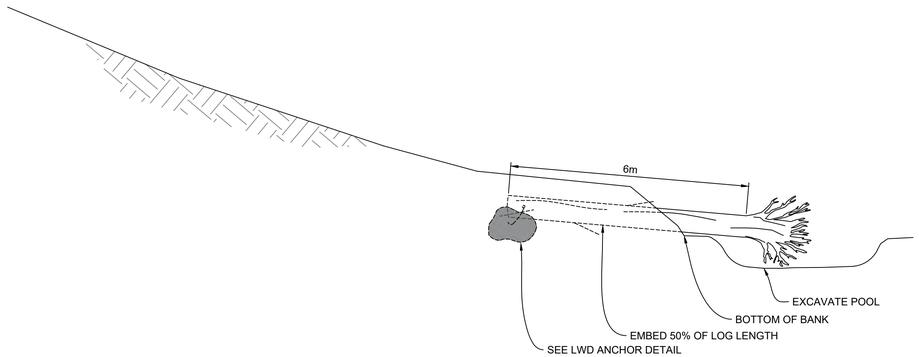


SECTION C-C

DIGGER LOG DETAIL - TYPICAL

SCALE NTS



LWG - TYPICAL SECTION

SCALE 1:50

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Ref. No.	REFERENCE

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PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	N.LINDSEY
DRAWN BY	K.YANG
APPROVED	N.LINDSEY
DATE	2023-11-30
SCALE	NTS
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION CREEK HABITAT ENHANCEMENT DETAILS

SIZE	DWG.	SHEET	REV.
D	2121-00983-C2-102	7 OF 7	D

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KERR WOOD LEIDAL
consulting engineers

Greater Vancouver
200 - 4185A Still Creek Drive
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Musqueam IR2 Foreshore Restoration

Environmental Assessment

Draft Report
October 18, 2023
KWL Project No. 0755.034

Prepared for:
Vancouver Fraser Port Authority

Contents

Figures

Tables

Appendices

1. Introduction

1.1 Project Background

The Vancouver Fraser Port Authority (VFPA) and Musqueam First Nation (xʷməθkʷəy̓əm) are working to improve bank protection and restore the Fraser River foreshore at Musqueam Indian Reserve 2 (IR2). Currently, much of IR2's foreshore is protected by a haphazardly placed, improvised revetment comprised of broken waste concrete pieces. The Musqueam foreshore is exposed to coastal and river hazards, including wind waves, ship waves, high tide, storm surge, freshet and river flooding that have the potential to destabilize the armouring, contribute to land loss, and threaten the safety of the community.

McElhanney, supported by Kerr Wood Leidal Associates Ltd. (KWL), has been retained by VFPA to provide engineering design and field review services for the assessment, design, and construction of upgrades to the Fraser River shoreline and Musqueam Creek. KWL's scope includes coastal analysis and the specification of design conditions for shoreline restoration and environmental assessments and management of the permitting process.

Proposed works include:

1. Removal of 100 m improvised riprap (broken concrete pieces) and replacement with new rock riprap.
2. Partial removal of 50 m of mixed improvised and rock riprap and augmentation with new rock riprap.
3. Installation of five angled "digger log" structures to provide habitat enhancement along an approximately 150 m section of Musqueam Creek below the existing tide gate.

This Environmental Assessment (EA) report provides details of the existing conditions present at the site and will support regulatory submissions for the project, specifically the VFPA's Project and Environmental Review (PER) process, a Fisheries and Oceans Canada (DFO) Request for Review application, and a *Water Sustainability Act* (Section 11) Change Approval application for works in and about a stream.

1.2 Proposed Work and Locations

Musqueam Foreshore Bank Protection Improvements

Partial and complete replacement of existing riprap will occur along the southern foreshore of Musqueam IR2 on the north arm of staɬəw̓, the Fraser River (Figure 1-1). Complete replacement will occur in a 70 m and a 30 m section on the eastern and western ends of the foreshore project site (Figure 1-2) while partial replacement will occur in the middle 50 m section (Figure 1-2). The project will consist of the removal of the improvised riprap revetment, regrading of the slope, and replacement with appropriately sized, engineered riprap armouring between the Musqueam boat launch and Highbury Interceptor Diversion Chamber (between 49°13'20.7"N 123°12'06.3"W and 49°13'19.0"N 123°11'58.3"W). Additional riprap will be added at the toe of the revetment for stability and foreshore protection. Material excavated onsite may be used to create a landscape berm immediately north of the foreshore and adjacent to the Musqueam Cultural Centre (Figure 1-4). A minor increase is expected to the permanent footprint of the riprap revetment, so a minor loss in habitat is expected as a result of armouring improvements along the Musqueam foreshore.

Figure 1-1: General Project Location
Figure by McElhanney

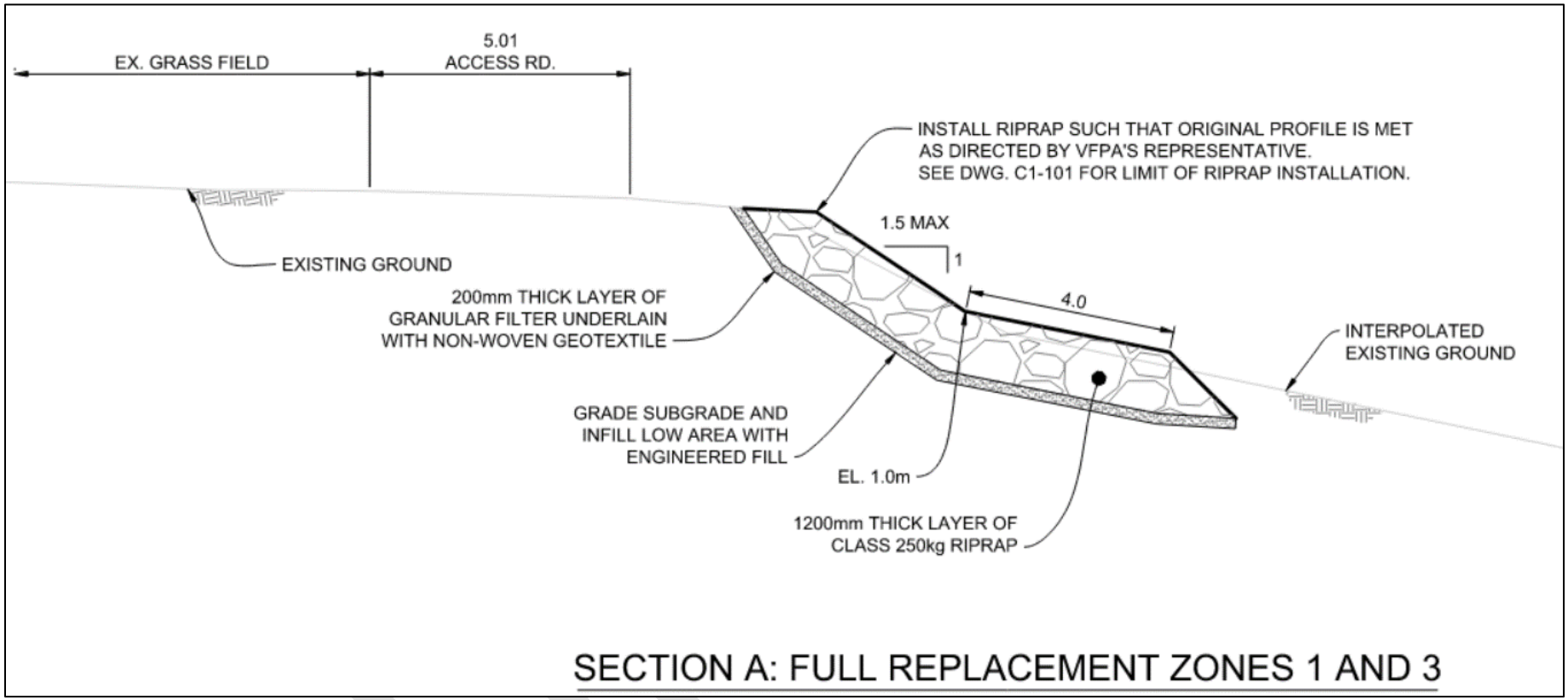

Figure 1-2: Typical Section of Areas Along the Foreshore Requiring Full Riprap Replacement
Figure by McElhanney

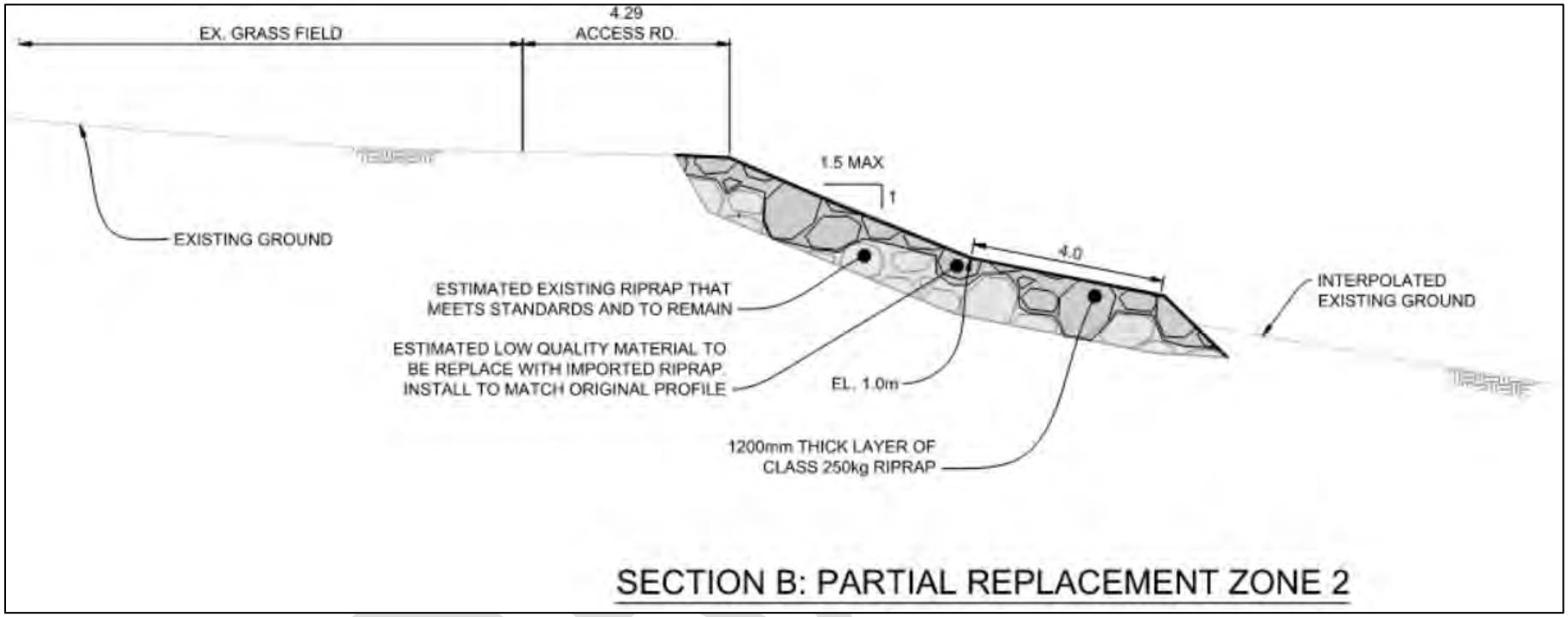

Figure 1-3: Typical Section of Areas Along the Foreshore Requiring Partial Riprap Replacement
Figure by McElhanney

Figure 1-4: Map of Musqueam Foreshore Indicating Locations of Proposed Works Along the Fraser River Shoreline and Within Mouth of Musqueam Creek

Musqueam Creek Habitat Enhancement

This project also proposes the enhancement of aquatic habitat in the mouth of statl̓əw̓, Musqueam Creek (49°13’20.2”N 123°11’55.8”W). Fish passage from the north arm channel through to the floodbox at the head of the estuary is currently limited at low tide by shallow water depths and a lack of pools and instream cover.

The proposed enhancements include the installation of angled “digger logs” in several locations along the length of the creek. The placement of these strategically placed pieces of large woody debris (LWD) should result in the formation of riffles and downstream scour pools, improving fish passage. The addition of these features will increase habitat complexity and coarseness to an otherwise relatively smooth flat streambed and provide areas of refuge for salmonids during times of low flow and upstream migration (Figure 1-5). The streambed enhancements to Musqueam Creek are expected to result in a gain of approximately 1,200 m^2 of fish habitat.

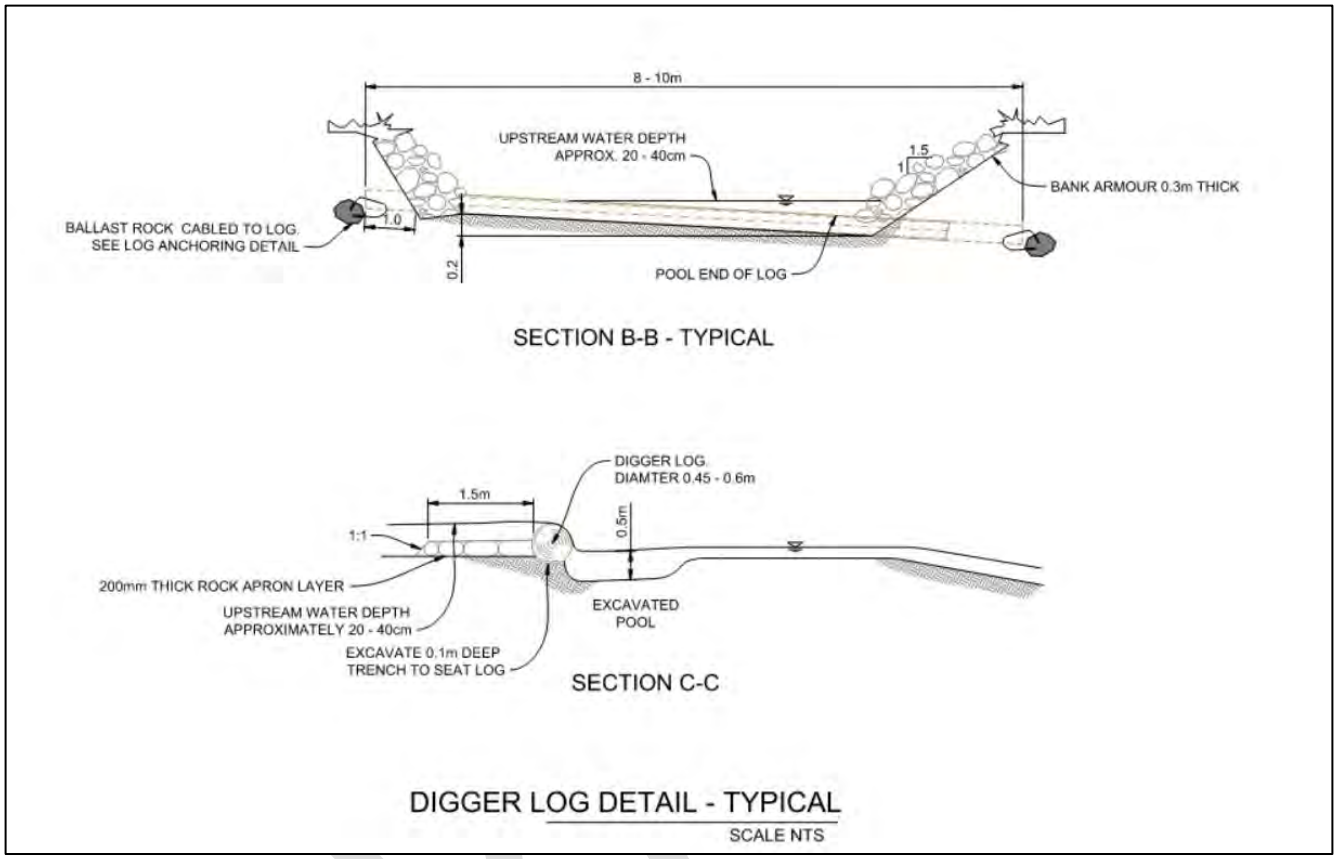

Figure 1-5: Typical Design Detail of an Angled "Digger Log"
Figure by McElhanney

2. Construction

2.1 Construction Methods

The construction activities may include clearing and grubbing of current invasive dominated vegetation cover, site preparation, isolation of the foreshore, placement of materials in the foreshore, and site restoration as described in Table 2-1 below.

Table 2-1: Proposed Construction Methods

Stage	Activity	Description of Activity
Site Preparation	Clearing and Grubbing	Removal of ground cover along the existing alignment to allow for site access and construction. Additional areas may be cleared for material staging.
	Site Isolation	Installation of isolation measures such as a floating silt curtain (if applicable), parallel to the toe of slope where practicable. Floating silt curtains will provide fish isolation and contain potential suspended sediment generated from the removal and replacement of riprap. Passive isolation measures will be contemplated at the time of construction and will occur in consultation with the QEP and contractor.
	Fish & Wildlife Salvage	Fish and wildlife salvage (if required/feasible). Seining and dip netting in the isolated work area maybe done if there is fish presence. Amphibian salvages will be conducted as necessary. Bird nest surveys and implementation of bird nest protection zones will be done in accordance with the *Migratory Bird Convention Act.*
Construction	Excavation	Excavation and grading of the slope to design parameters where needed. Slopes will be prepared for installation of dike repair materials if deemed necessary. Excavation and regrade of the creek will be conducted in the dry or at low tide.
	Riprap Placement	Placement of riprap revetment as necessary.
	Digger Log Placement	Placement of digger logs and creation of riffles, glides, and pools as per engineering specification. Final design of habitat features will be field fit based on-site conditions and will occur in consultation with the QEP and contractor.
Restoration	Planting	Planting riparian vegetation where designated by the planting plan and feasible.
	Site Restoration and Enhancement	Returning the site to its original conditions and taking advantage of opportunities for habitat enhancement.

2.2 Proposed Project Schedule

Pending regulatory approval, construction is scheduled to begin in 2024 during the marine/estuarine timing window for the protection of fish and fish habitat for Marine/Estuarine Timing Window for Area 28 (Vancouver), Fraser River estuary, from the mouth to the Oak Street bridge (July 16 to February 28). Construction of the bank protection and restoration works described herein are expected to last six weeks.

The Project design was initiated in 2022 and construction is anticipated to be completed by 2024. The Project can be broken down into six phases (Table 2-2):

1. Engineering design
2. Environmental permitting
3. Tendering
4. Construction
5. Post-construction
6. Monitoring

Table 2-2: Proposed Project Schedule

Phase	Description	Proposed Timeline
Engineering Design	• Exploration of options. • Selection of foreshore enhancement option(s). • Complete Final 100% Design Drawings.	Summer/Fall 2023
Environmental Permitting	• Submission of a Project and Environmental Review application to Vancouver Fraser Port Authority. • Submission of a Request for Project Review to Fisheries and Oceans Canada under the *Fisheries Act.* • Section 11 *Water Sustainability Act* Approval to the Ministry of Forests. • Notification and Submission to Transport Canada through the Navigation Protection Program as per the *Canadian Navigable Waters Act.* • Request for appropriate fish and wildlife salvage permits from the Ministry of Environment & Climate Change Strategy	Fall 2023
Tendering	• Submit Project for tendering and select successful proponent.	Winter 2024
Construction	• Clearing and grubbing. • Installation of revetment improvements. • Habitat enhancement at Musqueam Creek. • Field review and environmental auditing.	Summer 2024
Post-Construction	• Replanting and site restoration/enhancement. • Record drawings. • Completion reporting for environmental and engineering components of the Project.	Fall / Winter 2025
Monitoring	• Ongoing monitoring. • Potential adaptive management.	Fall / Winter 2025 to 2029

3. Biophysical Conditions

3.1 Study Methods

Assessment of existing conditions in and around the project site were conducted using desktop and field reviews. The desktop study included a review of available information to determine which aquatic and terrestrial wildlife species have the potential to occur near the project site, with an emphasis on species at risk designated on Schedule 1 of the *Species at Risk Act* (SARA). The following data sources were reviewed:

- BC HabitatWizard 50K Freshwater Atlas and Stream Reports
- BC Fish Information Data Query (FIDQ)
- Fisheries and Oceans Canada Aquatic Species at Risk Maps
- BC Conservation Data Centre (BC CDC) Species and Ecosystems Explorer Database
- BC CDC iMap
- BC Ecological Reports Catalogue (EcoCat)

KWL biologist, Gadwyn Gan (RPBio), completed a site visit on April 4, 2023. The site visit included a characterization of vegetation, identification of ecosystem features, and opportunistic wildlife observations.

Study Area

A 3 km buffer around the project was used to identify species of conservation concern with the potential to occur within the project area. A 1 km buffer was used to identify nearby critical habitats that could be affected by project works. The assessment area included the north arm of the Fraser River, as well as Musqueam Creek.

3.2 Existing Site Conditions

The Project site for the riprap improvements is bounded by the Musqueam boat launch on the western end (Photo 3-1), and by Metro Vancouver's Highbury Interceptor Diversion Chamber on the eastern end (Photo 3-2). A gravel access road is adjacent to the site, and the Musqueam Pier is on the project foreshore. During the site visit a large red tote and a poplar tree were also noted on the foreshore within the project area (Photo 3-3). The current armouring on the revetment mostly consisted of rebar-reinforced broken concrete pieces (Photo 3-4) with a small section of what appears to be well-engineered riprap towards the eastern extent of the project site (Photo 3-5). The concrete material varies in size and thickness along the approximately 7 m protected slope. The substrate at this point of the river is primarily composed of fine silts, giving a mudflat characteristic.

The Musqueam Pier appears to be in disrepair, having large sections of concrete missing from the pier itself and infilled with gravel (Photo 3-6). The Musqueam pier may need to be repaired or removed based on the preference of Musqueam and the VFPA. Discussions regarding this scope of work are ongoing.

The proposed enhancement reach of Musqueam Creek includes the mudflat area at the mouth of the creek (Photo 3-7), downstream of the self-regulating tidegate (SRT) at the head of the estuary. This area was used as barge access for the construction of the Highbury Interceptor sewer pipe which connects the Vancouver Sewerage Area to the Iona Island WWTP under the north arm of the Fraser River. The SRT was installed in 2010 to improve fish passage compared to the previous tidegate while also maintaining flood protection for the Musqueam Golf Course and Musqueam IR2.

Additionally, an anthropogenically installed step-pool feature has been installed directly downstream of the SRT (Photo 3-8).

Photo 3-1: Musqueam boat launch looking south from access road.

Photo 3-2: View of Highbury Interceptor Diversion Chamber looking east from access road.

Photo 3-3: View of Musqueam pier, red tote, and poplar tree on the foreshore looking west from access road.

Photo 3-4: Typical improvised armouring, looking west from Musqueam pier.

Photo 3-5: Portion of bank armouring with engineered riprap looking east from access road.

Photo 3-6: Damaged portions of Musqueam pier.

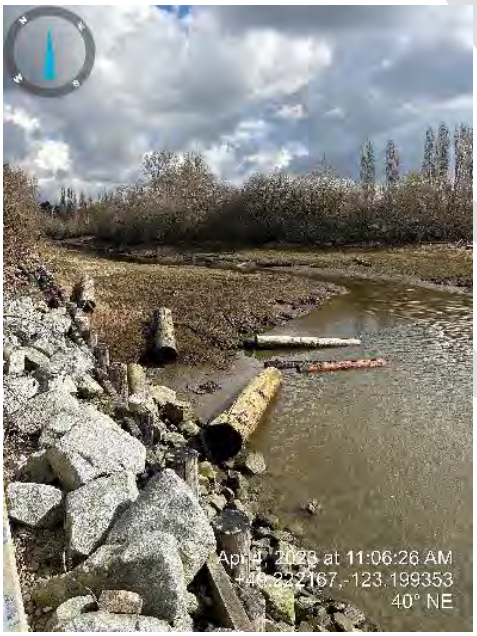

Photo 3-7: Mouth of Musqueam Creek showing mudflat-like characteristics, logs and sedges, looking northwest from the access road.

Photo 3-8: Downstream view of Musqueam Creek showing step-pool sequence and 1 cherry tree, looking downstream from the SRT.

3.3 Biophysical Conditions

Terrestrial Habitat

The Musqueam foreshore restoration project site is within the Eastern Very Dry Maritime Variant of the Coastal Western Hemlock (CWHxm1) biogeoclimatic zone. This Variant is characterized by warm dry summers that experience moist, relatively mild winters with little snowfall. Climax plant communities in these zones are typically dominated by coastal Douglas-fir (*Pseudotsuga menziesii*) with western hemlock (*Tsuga heterophylla*) and lesser amounts of western redcedar (*Thuja plicata*). Understorey vegetation for this zone typically contains salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*), red huckleberry (*Vaccinium parvifolium*) with layers of step moss (*Hylocomium splendens*), and Oregon beaked moss (*Kindbergia oregana*).

The project site has historically been and continues to be highly disturbed by a variety of land uses. The project site and areas around it have primarily been used for recreation and cultural practices but is also heavily used for hunting and fishing activities. As such, there are often cars, boats, and other equipment in and around the area. The site is also actively used by Musqueam members, and the access road is used by Metro Vancouver to maintain sewer infrastructure. Additionally, the field directly north of the site plays host to camping and gathering activities for ceremonies, as well as the annual canoe race that Musqueam hosts.

A significant number of invasive plant species can be found throughout the area including Scotch broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus armeniacus*), purple deadnettle (*Lamium purpureum)*, and common tansy (*Tanacetum vulgar*e). The invasive plant populations pose a significant threat to the overall health of the existing plant communities in the area and may cause direct damage to the bank stability, such as with Japanese knotweed (*Reynoutria japonica*) which was detected less than 200 m from the project site.

Riparian Vegetation

The riparian vegetation within the project site is relatively poor. Most of the bank is vegetated with mixed species of grass and interspersed with invasive purple deadnettle and non-native plantain (*Plantago major*). Barring the single poplar tree, and small patches of Himalayan blackberry, the riparian vegetation does not provide any overhanging vegetation or shade to the Fraser River on the bank armouring project site (Photo 3-9).

Musqueam Creek at the proposed enhancement location retains mudflat characteristics, with vegetation primarily comprised of low-growing sedges and rushes. One cherry tree is present on the northern portion of Musqueam Creek, less than 30 m west of the SRT (Photo 3-8). The shrub layer around Musqueam Creek is primarily composed of invasive Himalayan blackberry with purple deadnettle and mixed grasses as ground cover (Photo 3-10). Logs from the surrounding area are common in the mouth of the creek (Photo 3-7).

Photo 3-9: Typical riparian vegetation along bank of project site, looking east from access road.

Photo 3-10: Typical ground cover around the project area and Musqueam Creek showing purple deadnettle and shotgun shells as evidence of heavy hunting use, looking northwest from access road.

Aquatic Habitat

There are two waterbodies associated with the project, staləw̓ (the Fraser River) and statləw̓ (Musqueam Creek). The bank protection improvements are located in the Fraser River and the site of the habitat enhancement is at the mouth of Musqueam Creek. Fish species in both waterbodies were not sampled for this assessment, however, both waterways are heavily studied with fish sampling occurring locally throughout the year.

Fraser River

The bank protection improvements are located along the north side of the north arm of the Fraser River, on the banks of Musqueam IR2. The approximate bankfull width at this location is around 200 m. From the project site, the North Arm follows the path of the Iona jetty downstream, and ultimately discharges to the Strait of Georgia. The Fraser River North Arm is considered tidally influenced and may convey approximately 10–15% of the total Fraser River discharge[1].

[1] Fraser River Estuary Management Program. 2006. Environmental Management Strategy for Dredging in the Fraser River Estuary. http://www.dfo-mpo.gc.ca/Library/349130.pdf (accessed May 01, 2023).

The lower Fraser River including the North Arm of the Fraser River provides important habitat for over 25 species of fish[2] including Pacific salmon. The north arm also supports winter and summer runs of steelhead salmon (*Oncorhynchus mykiss*), coastal cutthroat trout, white sturgeon (*Acipenser transmontanus*), green sturgeon (*Acipenser medirostris*), eulachon (*Thaleichthys pacificus*) and smelt (*Spirinchus sp.*). Additionally, it also supports non-migratory species such as prickly sculpin, peamouth chub (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*) and northern pikeminnow (*Ptychocheilus oregonensis*)[3].

The aquatic habitat at the project site is relatively poor. The existing bank is already armoured with improvised riprap made of debris and reinforced concrete. There is a lack of riparian and overhanging vegetation in the riparian area, and what vegetation does exist is typically mowed grass or invasive. The streambed at the project site is homogeneous, low gradient, and typically consist of fines and silts.

Musqueam Creek

Located on the south side of the Point Grey Peninsula, Musqueam Creek is the last wild salmon-bearing stream in the City of Vancouver. The creek flows generally southeasterly and southerly from its headwaters in Pacific Spirit Regional Park, through Musqueam IR2, and into the north arm of the Fraser River, where it discharges through an SRT. The average gradient is 2%, with a flat lowland area at the mouth of the creek on Musqueam IR2.

Musqueam Creek supports runs of Coho (*Oncorhynchus kisutch*), Chum (*Oncorhynchus keta*), and Cutthroat Trout (*Oncorhynchus clarkii clarkii*). The watercourse within the assessed area is inhabited by salmonids year-round and primarily used as a transit route to higher quality spawning and rearing habitat further upstream in the watershed. Since the 1990s, salmon fry have not been observed in large enough numbers to be reliably captured or to constitute a population estimate[4].

During a previous sediment removal in 2022, KWL performed a fish salvage. Species salvaged included Coho salmon, threespine stickleback (*Gasterosteus aculeatus*), western brook lamprey (*Lampetra richardsoni*), and coastal cutthroat trout[5]. Prickly sculpin (*Cottus asper*) is also known to inhabit Musqueam Creek but was not encountered during the salvage[1]. The assessed area of the creek does not contain critical habitat for any aquatic species protected under Schedule 1 of Canada's *Species at Risk Act*.

The aquatic habitat is low quality and heavily degraded by gradual sediment deposition since the 1990s and is likely to receive contaminant input from the upper Musqueam Creek watershed (which drains large residential and recreational areas on the west side of Vancouver) as well as potential seepage from the mainline sanitary sewer that runs adjacent to the creek[2]. The assessed area is likely to only support the transit of migrating salmonids, and it does not appear to provide valuable spawning or rearing areas. This is consistent with the previously mentioned observations from Musqueam Indian Band members.

[2] Richardson, J.S., T.J. Lissimore, M.C. Healy and T.G. Northcote. 2000.Fish Communities of the Lower Fraser River (Canada) and a 21-year Contrast. Environmental Biology of Fishes 59:125-140.
[3] Fisheries and Oceans Canada. 2019.British Columbia Marine/Estuarine Timing Windows for the Protection of Fish and Fish Habitat - South Coast and Lower Fraser Areas. http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/bc-s-eng.html#area-29 (accessed May 01, 2023).
[4] W. Sparrow (Musqueam Indian Band), personal communication. August 2022.
[5] KWL technical report for Ministry of Environment and Climate Change Strategy. March 2023.

3.4 Wildlife

The greatest diversity of wildlife in BC is found within the Fraser Lowland portion of the biogeoclimatic zone[6]. Urban areas in the Lower Mainland support a variety of wildlife species including Coyote (*Canis latrans*), Striped Skunk (*Mephitis mephitis*), and Raccoon (*Procyon lotor*). These larger animals commonly occur in Pacific Spirit Regional Park and therefore potentially onsite, along with smaller mammals such as Douglas squirrel (*Tamiasciurus douglasii*) and a variety of mole, vole, and mice species.

Additional wildlife species observed by Musqueam Indian Band members in the assessed area include Pacific Tree Frog (*Pseudacris regilla*), Rough-skinned Newt (*Taricha granulosa*), Northwestern Salamander (*Ambystoma gracile*), Fisher (*Pekania pennanti*), and North American River Otter (*Lontra canadensis*). Harbour Seals (*Phoca vitulina*), Harbour Porpoise (*Phocoena phocoena*), and Double-crested Cormorant (*Nannopterum auritum*), have also been observed adjacent to the project area.

The surrounding area also provides significant nesting and foraging habitat for songbirds and raptors. Over 150 different species of birds have been observed within the nearby Pacific Spirit Regional Park, including migratory birds which use the area as a resting, refuelling stopover[7]. Redwing Blackbird (*Turdus iliacus*), Golden-crowned Sparrows (*Zonotrichia atricapilla*), Northern Harrier (*Circus hudsonius*) and Bald Eagles (*Haliaeetus leucocephalus*) were all observed during the April site visit.

3.5 Species and Ecosystems of Conservation Concern

Terrestrial Species and Ecosystems at Risk

The British Columbia Conservation Data Centre (CDC) collects and disseminates vegetation and wildlife ecosystems at risk in BC. A search of the CDC's database was completed to generate a list of both federally and provincially listed species at risk occurring in the assessment area.

Occurrences of Pacific Water Shrew (*Sorex bendirii*) and Trowbridge's Shrew (*Sorex trowbridgii*) were identified within the assessment area, but approximately 1.5 km north of the project site. Horned Lark (*Eremophila alpestris*) and Roell's brotherella moss (*Brotherella roellii*) also had occurrences within Musqueam IR2 but are unlikely to be on the project site. A historical occurrence of Southern Red-backed Vole, *occidentalis* subspecies (*Myodes gapperi occidentalis*) is also known from the area.

Pacific Water Shrew is listed as Endangered on Schedule 1 of the *Species at Risk Act*. Trowbridge's Shrew and Southern Red-backed Vole, *occidentalis* subspecies are provincially Blue-listed (special concern) and Red-listed (endangered or threatened), respectively. Wetlands and mature forest ecosystems are the key habitats for many species at risk including Pacific Water Shrew, Trowbridge's Shrew, and Southern Red-backed Vole.

No species at risk identified by CDC are likely to be within the project site while construction activities are occurring. The lack of forest and wetland habitats, as well as the highly trafficked nature of the site, means it is unlikely that cryptic species such as Pacific Water Shrew will occur. The area also lacks the appropriate characteristics to support Roell's brotherella moss (*Brotherella roellii*), however adjacent areas may be suitable for a Horned Lark, as evidenced by the abundance of other passerines.

[6] Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. Special Report Series 6. BC Ministry of Forests. Victoria, BC
[7] Environment Canada, 2012. Biodiversity Profiles – Vancouver 2010.

No sensitive or rare ecological communities are expected within the vicinity of the project site due to the site being dominated by invasive vegetation and highly disturbed nature. However, dune wildrye – beach pea, and large-headed sedge herbaceous vegetation-sensitive ecological communities were detected less than 2 km away on Iona Island.

Aquatic Species and Ecosystems at Risk

The assessed area did not contain critical habitat for any aquatic species protected under Schedule 1 of Canada's *Species at Risk Act* within Musqueam Creek. However, the North Arm of the Fraser River supports a high number of fish species, some of which are listed. The table below summarizes species at risk potentially within the area, based on the Fisheries and Oceans Canada Aquatic Species at Risk maps, and discusses the likelihood of occurrence within the project site (Table 3-1).

Table 3-1: Summary of Federal Species at Risk within the Assessment Area

English Name	Scientific Name	SARA Status	Potential to Occur
Green Sturgeon	*Acipenser medirostris*	Schedule 1, Special Concern	Has the potential to occur within proximity of project site.
Yelloweye Rockfish (Pacific Ocean outside waters population)	*Sebastes ruberrimus*	Schedule 1, Special Concern	Typically found over complex substrate; unlikely to occur within proximity of project site.
Basking Shark (Pacific population)	*Cetorhinus maximus*	Endangered	Unlikely to occur within proximity of project site.
Bluntnose Sixgill Shark	*Hexanchus griseus*	Schedule 1, Special Concern	Typically found at 90 m depths; unlikely to occur within proximity of project site.
Tope	*Galeorhinus galeus*	Special Concern	Unlikely to occur within proximity of project site.
Grey Whale (Northeast Pacific population)	*Eschrichtius robustus*	Schedule 1, Special Concern	Unlikely to occur within proximity of project site.
Northern Abalone	*Haliotis kamtschatkana*	Endangered	Mostly found in subtidal areas at <10 m depth. They prefer a firm substrate, usually rock; unlikely to occur within proximity of project site.
Rougheye Rockfish	*Sebastes sp. type I and II*	Schedule 1, Special Concern	Typically found at 90 m depths; unlikely to occur within proximity of project site.
Harbour Porpoise (Pacific Ocean population)	*Phocoena phocoena vomerina*	Special Concern	Has the potential to occur within proximity of project site.

English Name	Scientific Name	SARA Status	Potential to Occur
Humpback Whale (North Pacific population)	*Megaptera novaeangliae kuzira*	Special Concern	Unlikely to occur within proximity of project site.
Killer Whale (Resident and Transient populations)	*Orcinus orca*	Endangered	Only occasionally found in brackish water; unlikely to occur within proximity of project site.
Leatherback Sea Turtle (Pacific population)	*Dermochelys coriacea*	Endangered	Often pelagic, rarely observed in Canadian Pacific waters, with only 126 unique sightings reported in British Columbia waters from 1931 to 2009; unlikely to occur within proximity of project site.
Steller Sea Lion	*Eumetopias jubatus*	Special Concern	Has the potential to occur within proximity of project site.
Longspine Thornyhead	*Sebastolobus altivelis*	Special Concern	Prefers deep, poorly oxygenated water; unlikely to occur within proximity of project site.

4. Construction Impacts

4.1 Proposed Construction Activities

The project is expected to include the following construction activities:

- Clearing and grubbing
- Excavation and removal of reinforced concrete pieces and existing rock riprap
- Regrading
- Installation of new rock riprap
- Installation angled digger logs along Musqueam Creek (habitat enhancement)
- Backfilling
- Demobilization
- Replanting and site restoration

4.2 Potential Effects of the Project

No change is expected to the permanent footprint of the riprap revetment along the Musqueam foreshore. However, there may be other temporary impacts during construction. Vegetation may be cleared at the site to enable access, construction, and laydown of materials. Terrestrial wildlife habitat may be impacted from construction activities during and following construction. Birds and mammals may be temporarily impacted during construction from removal of terrestrial vegetation, disruption to normal travel routes, and changes in light, noise, and vibration.

Potential impacts to fish and aquatic habitat include introduction of sediments or contaminants into watercourses. These changes may alter habitat conditions for fish by changing nutrient inputs, water volumes, sedimentation rates, and/or stream temperature. Habitat enhancement measures in Musqueam Creek are designed to improve habitat conditions for fish by increasing stream coarseness and increasing instream habitat quality.

The potential impact of project works and mitigation measures for fisheries and aquatic resources, riparian vegetation, and wildlife are outlined in the following sections.

Fisheries and Aquatic Resources

The project works are anticipated to result in permanent positive effects on fisheries and aquatic resources due to habitat enhancement measures, but construction works may result in temporary effects. All potential impacts to fisheries and aquatic resources that may result from the Project are outlined in Table 4-1.

Table 4-1: Potential Impacts to Fisheries and Aquatic Resources

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact	Area of Impact (m^2)
Temporary Impacts					
Clearing and grubbing of riparian vegetation	Riparian vegetation	Removal of vegetation is not anticipated along the foreshore but may be necessary to allow laydown of materials for creek enhancement works.	Moderate	Low	Nil
Excavation, removal & replacement of existing concrete & riprap	Aquatic habitat	Removal and replacement of riprap material within 70 m and 30 m sections of the Musqueam foreshore.	High	Low	80
Habitat enhancement in Musqueam Creek	Aquatic habitat	Installation of five (5) angled digger logs along Musqueam Creek.	High	Low	20

Recommended Avoidance and Mitigation Measures

Engineering approaches will be used to avoid impacts to fisheries resources and aquatic habitat. The following mitigation measures are recommended to reduce impacts to fish and fish habitat within the project area.

Instream Works

- All instream works will be done with an Environmental Monitor present under the supervision of a Qualified Environmental Professional (QEP) and within the least risk window for fish whenever possible.
- The construction area will be isolated, and fish and amphibians will be salvaged before works and relocated to areas outside of work area.
- Exclusion zones to avoid impacts to marine mammals may be implemented.

Riparian Vegetation

- Areas of existing native vegetation and plant communities located on or near the Project footprint will be avoided, where possible.
- Any clearing of riparian vegetation will be limited to areas necessary for the works. Existing roads, trails, and other access points will be used where possible.
- Vegetation will be replanted where temporary clearing is needed to accommodate the works.

Erosion and Sediment Control

- Stockpiles of excavated soil will be covered with polyethylene sheeting or an alternative to prevent erosion, to be determined in consultation between the EM and contractor.
- Silt fencing will be installed at the limit of disturbed areas to capture sediment (as applicable).
- All construction materials, garbage, and erosion and sediment control materials will be removed from the site after the Project is complete.
- Water used in any concrete works (mixing, washing, curing, runoff, grout, etc.) will be managed to prevent entry into storm drains and watercourses.

Spill Prevention and Management

- All fueling of vehicles and equipment will be done off-site or onsite in a designated fueling area over a spill containment tray at least 30 m from any storm drain and watercourses.
- All equipment washing (i.e., concrete truck washout) must be done off-site or onsite in a designated area at least 30 m from storm drains and watercourses in a manner that will prevent wash from reaching any waterway.
- Generators, pumps, and other stationary equipment will be placed on spill trays. Where possible, generators will be located at least 30 m from any waterway.
- All machinery will be clean, in good working condition and free of excess oil and grease. Equipment will be inspected daily and documented.
- Containers will be labelled according to the Transportation of Dangerous Good Act and Workplace Hazardous Materials Information Systems (WHMIS) regulations.
- Oil waste, filters, absorbent pads, and cartridges will be collected and disposed of off-site at an appropriate facility in accordance with federal, provincial, and municipal regulatory requirements.
- A spill kit will be onsite, and staff trained in its use.
- Any spill of a listed substance according to the *Spill Reporting Regulation* will be immediately reported to the Provincial Emergency Program 24-hour phone line at 1-800-663-3456. KWL and the EM will be notified of the spill.

Residual Impacts

Minor residual impacts are anticipated due to riprap replacements along the Musqueam foreshore. Any riparian vegetation that is removed will be replanted and thus will not have a residual impact to fish and aquatic habitat. There may, however, be a temporary impact until vegetation is established and becomes fully functional. Residual impacts associated with sedimentation or pollution of aquatic habitats are not anticipated provided the mitigation measures described above are in place.

Residual impacts due to habitat enhancements in Musqueam Creek will include increased habitat complexity, and increased occurrences of pools and riffles for fish. These features will benefit fish by providing resting and refuge locations during upstream migration. Overall, the project is expected to provide a net gain of 1,200 m^2 in functional aquatic habitat.

4.3 Riparian Vegetation

Construction works may have a temporary impact of on riparian vegetation to allow for the laydown of materials for Musqueam Creek enhancement works. Impacts will be minimized using existing roads for access and long reach excavators. Along the foreshore no impact to riparian vegetation is anticipated as the permanent riprap footprint will remain the same and access to site will also be obtained using existing access roads. Any riparian vegetation that is removed will follow the mitigation measures outlined the sections below.

Table 4-2: Potential Impacts to Riparian Vegetation

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact	Area of Impact (m^2)
Temporary Impacts					
Clearing and grubbing of riparian vegetation	Riparian vegetation	Removal of vegetation is not anticipated along the foreshore but may be necessary to allow laydown of materials for creek enhancement works.	Moderate	Low	Nil

Recommended Avoidance and Mitigation Measures

A Qualified Environmental Professional (QEP) will be consulted throughout the site preparation (i.e., clearing, grubbing, and isolation/salvage) and construction phases to minimize impacts to vegetation communities. The following mitigation measures will be implemented to reduce impacts to vegetation communities:

Riparian Vegetation Communities

- Prior to work commencing, the QEP and foreman will review each section of the Project to ensure impacts to surrounding trees are reduced, identify best access routes for machinery, identify any additional trees that may have to be removed, and identify any areas where excavation must be supervised by the QEP.
- Areas of native vegetation and plant communities located on or near the Project footprint will be avoided, where possible. Where this cannot be avoided, vegetation will be documented (diameter at breast height for species > 200 mm), and enumerated and replaced according to standard replacement criteria.
- Clearing will be limited to areas necessary for the works. Existing roads, trails, and other access points will be used where possible.
- Vegetation will be replanted, where temporary clearing is needed to accommodate the works.

Invasive Plants

- All machinery will be inspected and cleaned before entering or leaving the construction site to remove any invasive plant propagules.
- All invasive vegetation removed will be disposed of off site at an appropriate facility.
- All material used on site (e.g., straw, hydroseeding, etc.) must be certified weed-free.
- Upon Project completion, native shrubs and trees will be planted in disturbed areas within the footprint to maintain soil stability and to minimize the potential for invasive species colonization.
- If patches of knotweed or hogweed are encountered during site clearing or other works in the Project area, they will be flagged off and reported to the QEP immediately. Knotweed must be managed carefully as it is able to reproduce from rhizomes and stem fragments. The following procedures should be adhered to:
  - all plant and soil material must be removed from site in a way as to minimize transfer of plant parts to other areas;
  - all plant parts must be removed, potentially by hand with appropriate personal protective equipment, sealed in plastic bags, and disposed of appropriately off site; and
  - topsoil within 10 m of the extent of the knotweed patch may not be used as backfill. The soil should be disposed of appropriately off site at an appropriate waste management facility experiences in dealing with knotweed-contaminated soils.

Stream Protection

- Prior to the start of construction, Project component boundaries near streams will be marked off to restrict vehicle and personnel access which will minimize potential secondary impacts to any wetlands or tidally influenced areas.

Vegetation Restoration

- Restoration following construction will include:
  - replanting of any native trees, shrubs, and grasses in areas that may be impacted by construction activities; and
  - replacement of any trees removed for construction.

Residual Impacts

The Project is not expected to have residual impacts to riparian vegetation as little to no removal or grubbing is required for project works. Any riparian vegetation that is removed will be replanted and thus will not have residual impacts on fish or fish habitat.

4.4 Wildlife

Due to the highly disturbed nature of the site, and the lack of forest and wetland habitats, project works are not anticipated to impact habitat features important for wildlife. Construction works may have temporary impacts to wildlife in the area however due to increased traffic, disturbance, and noise.

Table 4-3: Potential Impacts to Wildlife

Activity	Type of Potential Impact	Potential Impact	Probability of Impact	Magnitude of Impact	Area of Impact (m^2)
Temporary Impacts					
Clearing and grubbing of riparian vegetation	Riparian vegetation	Removal of vegetation is not anticipated along the foreshore but may be necessary to allow laydown of materials for creek enhancement works.	Moderate	Low	Nil
Disturbance, noise, and increased traffic	Wildlife connectivity	Temporary loss of connectivity value and disruption of wildlife behaviour	High	Low	Project footprint and surroundings

Proposed Avoidance and Mitigation Measures

A Qualified Environmental Professional (QEP) will be consulted throughout the site clearing and construction phases to minimize impacts to terrestrial and aquatic habitat features. The following mitigation measures will be implemented to reduce impacts to terrestrial wildlife habitat:

Timing

- Vegetation clearing and tree removal should be scheduled outside the general bird timing window for the Lower Mainland (March 1 to August 31) which will protect breeding birds and bats in the assessment area. If vegetation clearing or tree removal is needed during this window, a bird nest survey should be conducted by a QEP familiar with bat habitat prior to vegetation removal, in accordance with the Canadian Wildlife Service recommendations for compliance with the *Migratory Bird Convention Act*.

Habitat Protection

- A QEP will oversee any excavations and provide input on tree protection measures to minimize compaction and damage to tree roots during construction.
- Where topping or removing dead limbs of danger trees will remove the hazard, this option is preferred over removing the entire tree.
- All vegetation removal will be carried out in a manner to protect nesting birds.

Habitat Restoration

- Any trees removed will be replaced in areas cleared for construction purposes.
- Any trees, limbs, and brush that are removed will be placed in the forest as large woody debris to provide habitat structure for wildlife.
- Disturbed and cleared areas should be replanted with native shrubs and trees to promote natural regeneration of the riparian area.

Residual Impacts

The Project is expected to have minor residual adverse impacts on terrestrial wildlife habitat. Construction activities are unlikely to require the removal of large trees which may have cavities or provide roosts to wildlife. Wildlife habitat will be improved through the planting of native species, the removal of invasive vegetation, and the introduction of habitat complexity features in the creek.

5. Applicable Legislation and Permitting Requirements

All project-related works must be completed in compliance with applicable legislation, guidelines, and commitments outlined below in Table 5-1.

The following environmental legislation does not apply to the Project:

- Provincial *Environmental Assessment Act* [SBC 2018, c. 51]*:* This Project does not meet the criteria for a reviewable project described in the Reviewable Projects Regulation (BC Reg. 243/2019).

Table 5-1: Environmental Legislation and Regulations Applicable to the Project

Legislation	Agency	Area of Regulation	Permits/Actions Required
Federal			
Impact Assessment Act [S.C. 2019, c. 28, s. 1]	Vancouver Fraser Port Authority	Project and environmental review.	• As a funder of the project and a federal entity, VFPA must review the project to determine if the project has the potential to result in adverse environmental effects. • Project and Environmental Review (PER) submission will be required for this purpose. • The project does not meet the criteria for a designated project under the *Act*.
Fisheries Act [R.S.C., 1985,c. F-14]	Fisheries and Oceans Canada (DFO)	Protection of fish and fish habitat.	• Submit a request for review to the Fish and Fish Habitat Protection Program to identify potential risks to the conservation and protection of fish and fish habitat. • If the death of fish, or harmful alteration, disruption or destruction of fish habitat will likely result from the Project, Authorization will be required.
Migratory Birds Convention Act [SC 1994, c. 22]	Environment and Climate Change Canada (ECCC)	Prohibiting injury, molestations, and destruction of migratory birds and their nests.	• Breeding bird surveys will be required prior to any construction occurring within the passerines timing window of March 1–August 31.
Species at Risk Act [SC 2002, c. 29]	Environment and Climate Change Canada (ECCC); Fisheries and Oceans Canada (DFO)	Protection of species designated on Schedule 1 of the Act and their critical habitat.	• Salvage permits may be required.

Legislation	Agency	Area of Regulation	Permits/Actions Required
Provincial			
Water Sustainability Act [SBC 2014, c. 15]	Ministry of Forests (FOR)	Regulates activities being carried out in and about a stream.	• Submit a Section 11 Change Approval for works in and about a stream for sediment removal. • Ensure all works adhere to the conditions of the Change Approval.
Wildlife Act [RSBC 1996,c. 488, S. 34]		Regulates works that impact wildlife species in BC.	• Permitting for salvage of amphibians and small mammals in riparian areas.
Weed Control Act [RSBC 1996, c. 487]		Requires all land occupiers to control the spread of provincial and/or regional noxious weeds on their land.	• Ensure proper identification and management of invasive plants throughout Project works.
Heritage Conservation Act (HCA) *[RSBC 1996 c. 187]*		All archaeological sites in BC are protected through designation as "Provincial heritage sites" or through automatic protection by virtue of having historic or archaeological value.	• Heritage inspection permits should be applied for, and an alteration permit may be required. • Any potential heritage site may not be altered or changed in any manner without a permit.
First Nations			
Lands Permit	Musqueam Indian Band (MIB)	Ensures compliance with Musqueam Indian Band laws and land governance priorities.	• Request approval from Musqueam Indian Band if required.
Archaeology Permit		Ensures consideration of Musqueam Indian Band's sensitivity to land altering activities and potential impacts on cultural heritage.	• Request approval and/or permit from Musqueam Indian Band as required. • Archaeological monitoring and a Change Find Management Procedure will likely be required.

6. Habitat Balance

The detailed breakdown of works being conducted for the Project are described in the habitat balance tables (Table 6-1). Detailed Project plan view is outlined in Appendix A and B. The explanation of how each component was considered a gain or a loss is explained as follows:

- Removal of existing riprap material, regrading the slope, and replacement of existing concrete or erosion protection is considered a net zero impact on the riparian ecosystem because works will be conducted on the same footprint and will have equal habitat value.
- A slight loss in fish habitat is expected as a result of additional riprap necessary for stability and flood protection.
- Musqueam Creek enhancement works is considered positive as it increases instream habitat complexity for fish.

While the restoration of the Musqueam foreshore requires the use of hard engineering structures, only a minimal loss in habitat value is expected as the majority of these structures will follow the existing footprint. When also considering enhancement measures being undertaken in Musqueam Creek, the Project will provide a net gain of 1,200 m^2 of aquatic habitat.

Table 6-1: Habitat Balance for Aquatic Habitat

Impacts		Gains/Restoration	
Description	**Area (m^2)**	**Description**	**Area (m^2)**
Placement and enhancement of additional riprap to existing revetment	80	Installation of digger logs, gravels, and streambed enhancements	1,280
Total Impacts	**80**	**Total Gains**	**1,280**
Aquatic Habitat Net Gain/Loss: Gain of 1,200 m^2			

6.1 Environmental Management

KWL will prepare an Environmental Management Plan (EMP) consisting of specific directions on the implementation of mitigation measures to avoid and mitigate impacts, and any other site-specific instructions for the contractor(s) to follow. The EMP will include all measures required to comply with environmental regulations, permits, and best practices.

Throughout the duration of Project works, the proponent will provide an Environmental Monitor to ensure compliance with the EMP, standards and best practices, and applicable legislation. Monitoring site visits will be conducted during key stages of works, such as vegetation removal and works in riparian areas and near watercourses.

Any additional mitigation measures not detailed in this document will be added to the EMP to ensure environmental resources are protected and managed during construction.

7. Monitoring

This section describes monitoring required during and after construction of the measures to mitigate habitat impacts from the Musqueam Foreshore Restoration Project. Monitoring will occur over a five-year period after construction. Full monitoring details are described in the EMP.

7.1 Construction Monitoring for Mitigation Measures

Environmental Management Plan

Avoidance and mitigation measures proposed by the Environmental Monitor will be guided by the following:

- Requirements and Best Management Practices for Making Changes In and About A Stream in British Columbia, Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2022.
- Standards and Best Practices for Instream Works, Ministry of Water, Land and Air Protection, 2004.
- Measures to Protect Fish and Fish Habitat, Fisheries and Oceans Canada, 2019.
- A Field Guide to Fuel Handling, Transportation and Storage, Ministry of Water, Land and Air Protection, 3rd Edition, 2002.
- B.C. Approved Water Quality Guidelines, Ministry of Environment and Climate Change Strategy, Updated 2018.
- Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia, Ministry of Environment and Climate Change Strategy, 2014.
- Land Development Guidelines for the Protection of Aquatic Habitat, Fisheries and Oceans, 2nd Edition, 1993.

A EMP will be developed based on the aforementioned guidance documents and supplemented by requirements and recommendations listed in regulatory permits. The EMP will:

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

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

Construction Environmental Monitoring

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

- To monitor and provide recommendations to ensure compliance with all applicable permits (i.e., Fisheries Act Authorization and Water Sustainability Act Approval), best management practices, and the Construction Environmental Management Plan.
- To provide additional recommendations to avoid and mitigate impacts to fish and fish habitat to the greatest extent possible.
- To provide recommendations for field fit components of the design and ensure the design is executed as approved.

Reporting

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

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

7.2 Implementation and Effectiveness Monitoring

Post-construction monitoring is needed to ensure the works provide the expected ecological function over time. This monitoring, known as implementation or compliance monitoring, will occur for five years following construction using the approach, objectives, and protocol outlined below.

Approach

The post-construction monitoring approach proposed in this EMP is based on the advice and guidance found in the following documents:

- Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act (DFO 2019).
- Requirements and Best Management Practices for Making Changes In and About A Stream in British Columbia (Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2022).
- Standards and Best Practices for Instream Works (BC Ministry of Water, Land, and Air Protection, 2004).
- Guidelines for In-Stream and Off-Channel Routine Effectiveness Evaluation (BC Ministry of Water, Land, and Air Protection 2003).
- Marsh and Riparian Habitat Compensation in the Fraser River Estuary: A Guide for Managers and Practitioners (Lievesley et al. 2016).
- Monitoring and Assessment of Fish Habitat Compensation and Stewardship Projects: Study Design, methodology, and Example Case Studies (Pearson et al. 2005).

Monitoring Objectives

The purpose of implementation monitoring is to ensure bioengineering works are functioning as designed. Implementation monitoring will be focused on the following components of the bioengineering solutions:

- Bank stabilization or erosion of the revetment
- Riparian restoration development
- Vegetated riprap development and habitat value

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

Monitoring Protocol

Both implementation and effectiveness monitoring will be conducted by appropriate QEP or team of QEPs. Generally, it is expected that monitoring will be completed by (or under supervision of) a Registered Professional Biologist (R.P. Bio.) and a Professional Engineer (P.Eng.) working in tandem. Monitoring will take place both immediately after project completion (implementation monitoring) and at appropriate time intervals after the project has experienced the full range of flow conditions and vegetation has established (effectiveness monitoring).

Routine Maintenance and Adaptive Management

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

- Replacement planting
- Invasive plant management (especially in the first few growing seasons)

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

8. Summary and Conclusions

This EA evaluates the magnitude and duration of environmental impacts associated with the construction and restoration of the Musqueam Foreshore Restoration project. This report has identified sensitive habitat features and their potential interaction with the Project. Mitigation measures have been recommended to minimize or avoid potential adverse environmental effects associated with the Project. Here we summarize expected residual effects of the Project.

In summary, this report found that environmental impacts for the preliminary designs can be mitigated, that the project should result in a net gain in habitat due to the incorporation of habitat enhancements to Musqueam Creek, and that the project is not expected to result in adverse environmental effects provided the mitigation measures are fully implemented.

The findings of this report will be used as a basis for stakeholder engagement and as part of the submission to regulatory bodies, including VFPA, DFO, MOF, and MIB. Final requirements for mitigation measures, including offsetting if required, will be determined by these approval-issuing agencies.

Report Submission

We trust that this preliminary EA meets your requirements at present. Please do not hesitate to contact Gadwyn Gan at ggan@kwl.ca or 604-968-9361 if you have any questions or concerns.

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Gadwyn Gan, M.Sc., RPBio
Biologist

Reviewed by:

Patrick Lilley, M.Sc., RPBio, BC-CESCL
Technical Reviewer

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of Vancouver Fraser Port Authority for the Environmental Assessment. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

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

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Revision History

Revision #	Date	Status	Revision	Author
A	October 13, 2023	Draft		GCG
B	October 18, 2023	Draft		GCG

KERR WOOD LEIDAL
consulting engineers

Appendix A

Musqueam Foreshore Engineering Memo

Musqueam Foreshore Restoration

Detailed Design Memo

September 12, 2023

Submitted to: Vancouver Fraser Port Authority

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Our file: 2121-00983-00

Your Challenge.
Our Passion.

Our File: 2121-00983-00

September 12, 2023

Vancouver Fraser Port Authority
100 The Pointe, 999 Canada Place
Vancouver , BC, V6C 3T4

Attention: Tony Meysen, Construction Project Coordinator – Engineering and Asset Management

Vancouver Fraser Port Authority – Detailed Design Memo Draft

McElhanney Ltd. (McElhanney) is pleased to submit the Musqueam Foreshore Restoration Detailed Design Memo. This memo is part of the Detailed Design Submission for the Musqueam Foreshore Restoration, which documents the design approach and intent for the restoration works.

We have incorporated the Vancouver Fraser Port Authority (VFPA) and partner's feedback received thus far from the 50% Design Submission and comments received through ongoing discussions. We trust this report provides the necessary information.

Sincerely,

Prepared by:

Unsigned draft

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1. Introduction

The VFPA has retained McElhanney Ltd (McElhanney) and Kerr Wood Leidal (KWL) to undertake environmental and engineering services for a Foreshore Restoration project in the Musqueam First Nation (MFN) territory along the Fraser River. The project seeks to improve the condition of the existing foreshore protection and provide an improved habitat corridor at the Musqueam Creek outlet to the confluence of the Fraser River. The riprap in-place along Musqueam's foreshore does not meet provincial or federal standards and requires rehabilitation. While work is being undertaken along the foreshore, it has been identified that it would be ideal to improve the aquatic habitat in Musqueam Creek upstream of its confluence with the Fraser River. Therefore, this project will concurrently provide a design that primarily improves fish passage up Musqueam Creek and generally improves overall fish habitat. This memo summarizes the design approach and intent of the foreshore protection works and Musqueam Creek habitat improvement work. This memo accompanies the detailed design drawing packages submitted July 23, 2023.

The project footprint is an approximate 250 m reach of the North bank of the Fraser River and 200 m of Musqueam Creek from the Musqueam Flood Box to its confluence in the Fraser River. The exact location of the works can be seen in **Drawing C0-003,** included as part of the submission of this report**.**

1.1. SCOPE OF WORK

The overall scope of work for the project includes the following:

- Site survey and locates, geotechnical and environmental site investigations,
- Design Criteria and environmental approach development,
- Preliminary design, costing and environmental permitting,
- Detailed design and Class A Cost Construction Cost Estimate
- Construction environmental management plan development,
- Tender package submission and tendering services,
- Construction administration

The design criteria, environmental permitting, and management plans are submitted as separate documents by KWL; they will be included in the *Appendix* in a future version of the memo.

2. Existing Conditions & Design Criteria

MFNs foreshore borders the Fraser River from Wallace Ditch to the east to Musqueam's Boat Launch in the West; approximately 800 m of foreshore. The project extent consists of the western 250 m of foreshore and its protection measures. Currently, the foreshore protection comprises what appears to be 100 kg riprap that is aging and includes reinforced broken concrete. The riprap and concrete bank is sloped between 3: and 1.5:1 with loose singular rocks at its toe. A pier is located about 40 m east of the boat launch and is expected to be rehabilitated. Metro Vancouver's Highbury diversion chamber is at the easternmost end of the foreshore project. This chamber diverts a large catchment of the City of Vancouver sanitary flow from a pipe 3 m in diameter to three smaller pipes before it crosses the Fraser River to the Iona treatment plant. An access road to the chamber runs along the top of the riprap embankment.

Musqueam Creek flows through Musqueam's golf course to the east of the project area, and discharges through a flood box into a channel within its constricted estuary, eventually discharging into the Fraser River 200 m to the south. The flood box outlet has a flap gate, and a few small rock weirs have been constructed immediately downstream. Within the estuary, Musqueam Creek flows through very silty, soft material until it meets with the Fraser River. The margins of the estuary consist of small trees, brush and grasses. At the top of the eastern bank in the corridor is a dirt road with access from Salish Drive to the North.

Figure 1 provides the general arrangement of the Project Area.

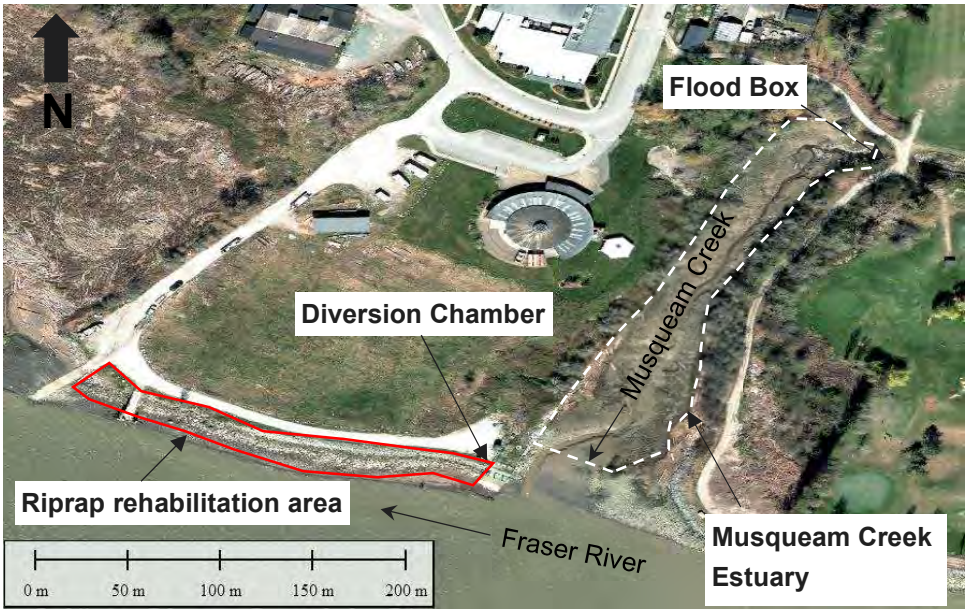

Figure 1. General Arrangement of the Project Area.

2.1. DESIGN CRITERIA AND ANALYSIS METHODOLOGY

KWL completed the hydraulic analysis to determine the input values for the Fraser River and Musqueam Creek designs. The design values and criteria were part of their stand-alone design criteria memo.

The relevant criteria outlined in the KWL design criteria memo, and used in McElhanney's design are the following:

- **Foreshore Protection**
  - Vessel-generated design wave, 1 m,
  - Wind-generated design wave, 0.8 m,
- **Musqueam Creek Habitat Improvements**
  - Peak velocities and water depths for 2-,10-, 20- and 100-year flows in Musqueam Creek with allowances for climate change.

The appended KWL Design Criteria memo outlines the completed analysis to determine the design values and criteria.?

McElhanney utilized the following design guidelines for the analysis of shoreline protection and habitat enhancement:

1. *HEC-11 Design of Riprap Revetment*, Federal Highway Administration, (1989).
2. *National Large Wood Manual,* U.S. Department of the Interior Bureau of Reclamation and U.S. Army Corps of Engineers (2016).
3. *Particle Densimetric Froude Number for Estimating Sediment Transport*, Aguirre-Pe, J., Olivero, M.L. and Moncada, A.T. Journal of Hydraulic Engineering (2003)

3. Design Approach

The restoration design for the 250 m of Musqueam First Nation foreshore ultimately sought to maintain the existing embankment profile while improving the riprap protection measures. The foreshore protection design considered future wind, wave, and Fraser River velocities but is not intended to mitigate against water levels above the existing riprap. The Musqueam Creek estuary design sought to improve the aquatic habitat at low tide conditions, resulting in more pools and paths for fish to traverse Musqueam Creek. The hydrotechnical analysis completed by KWL supported the design by simulating future hydraulic effects from the Fraser River, Musqueam Creek, and Strait of Georgia, such that:

- 250 m of Fraser River foreshore riprap protection from Musqueam Creek to the Musqueam boat launch is restored to meet provincial and federal standards,
- habitat for aquatic species in Musqueam Creek is improved and does not detrimentally alter the channel hydraulics, including increased flooding or erosion potential and
- existing infrastructure, such as the boat launch, diversion, and the pier is protected into the future.

3.1. LIMITATIONS AND CONSTRAINTS

Based on the analysis approach taken, the following project-specific limitations are applicable:

- Hydrologic/hydraulic computational model results for this project represent an approximation of the conditions within the watershed at a particular time. Their results are a calculated interpretation and are subject to uncertainties related to computational restraints, including runoff characteristics, the boundary and roughness conditions selected, and the flow.
- Detailed designs were developed based on McElhanney's understanding of current site conditions established through site visits, topographic survey, and LiDAR. These site conditions may change over time, resulting in modifications to the proposed design, future changes, or maintenance of the configuration.
- The intent of the restoration design for Musqueam's foreshore is to improve the efficacy of the riprap protection. The current design will not protect against water levels that exceed the existing bank elevations. No analysis was undertaken to establish a relationship between return period flows and water levels in the Fraser River.

3.2. ADDITIONAL DESIGN CRITERIA

The following criteria was developed in addition to the hydraulic criteria KWL established through their analysis:

1. Minimize impacts from construction activities in the Musqueam Creek outlet corridor,

2. Reuse riprap material that is suitable for foreshore protection,
3. Protect infrastructure such as Musqueam's pier, boat launch, and Metro Vancouver's diversion chamber.

This criterion was based on conversations with the VFPA, Metro Vancouver, and Musqueam's communicated wishes.

3.3. PROPOSED DESIGN

The proposed foreshore restoration maintains the existing embankment profile with additional riprap extents at the toe to protect against scour. The 250 m foreshore protection features:

- Embankment side slopes of 1.5H:1V to 3H:1V based on the existing embankment survey.
- Extended riprap extents at the toe to protect against an estimated 4.0 m of scour in the Fraser River along its north bank.
- Class 250 kg riprap, sized with the Hudson equation, which protects against all the hydraulic effects present.
- Zones of partial riprap replacement where half of the existing riprap will be reused in the final design – upon confirmation in the field.
- Zones of full replacement where it is assumed all riprap will be replaced with imported material and founded on a granular filter.
- Increased riprap thickness and alignment downstream of Metro Vancouver's Highbury diversion to improve hydraulic efficiency.
- Incorporation of large woody debris to provide habitat complexing for fish species. The incorporation of instream cover elements, including large woody debris (LWD) and root wads to provide refuge.

The proposed habitat improvement design in the Musqueam Creek outlet corridor minimized construction activities in the channel while improving the area of intertidal pools that will support more aquatic species. The habitat improvements include a series of five log structures, known as 'Digger logs', which consist of the following pertinent features:

- 0.4-0.6 m diameter 6- 8 m long logs laid onto the creek bed, oriented 30 degrees from the bank, with the ends embedded 1.0 m into the bank and additional ballasting provided by 0.6 m diameter boulders cabled to the logs end.
- Log species of either red, or yellow cedar, douglas fir, or spruce.
- A 0.4 m thick rock apron extending 1 m upstream of the log will mitigate erosion.
- Bank treatments include lining the banks at 1.5H:1V with cobbles to the bank's top and extending 2 m upstream and downstream of the log – rock size was determined following the guidance outlined in Federal Highway Administration, Hydraulic Circular No. 11, Design of Riprap Revetment.
- A coble rock apron extends 2 m upstream of the Digger Log preventing undercutting of the log – rock sizing was determined following the guidance in the Journal of Hydraulic Engineering, Particle Densimetric Froude Number for Estimating Sediment Transport.

- Excavation of a 0.5 m deep pool downstream of the log with additional habitat enhancement provided with LWD complexing that consists of root wads protruding from the bank.

Velocities in the Musqueam Creek outlet corridor were modelled by KWL for the 2- and 100-year Musqueam Creek flows under low and ebb tide conditions. The velocities under the proposed design do not exceed 1.5 m/s anywhere in the channel downstream of the Musqueam flap gate at any point in the simulation. At such a velocity the existing vegetation lining the existing channel will mitigate any potential erosion.

3.4. CONSTRUCTABILITY

Based on the proposed design, standard construction equipment is expected to be required to construct all the proposed works. This includes excavators and hauling equipment. No specialty equipment is expected to be required for the channel construction. Actions should be taken to reduce the impact to the Musqueam Creek channel when constructing the log weirs and required ballasts. Care is also recommended around infrastructure such as the pier and diversion chamber.

Access routes to the Musqueam Creek outlet corridor is preferred on the west bank by the golf course to minimize equipment on top of the Highbury sanitary right-of-way.

4. Summary

Musqueam's foreshore and Creek restoration design will improve shoreline protection and habitat. The designs maintain and protect the existing Musqueam and Metro Vancouver infrastructure while minimizing environmental impacts.

Based on the hydrotechnical analysis and design, the design mitigates the erosion potential of 200-year flows, vessel generated waves and wind generated waves. The designs do not increase erosion risk to any Metro Vancouver infrastructure.

APPENDIX A
STATEMENT OF LIMITATIONS

Statement of Limitations

Use of this Report. This report was prepared by McElhanney Ltd. ("McElhanney") for the particular site, design objective, development and purpose (the "Project") described in this report and for the exclusive use of the client identified in this report (the "Client"). The data, interpretations and recommendations pertain to the Project and are not applicable to any other project or site location and this report may not be reproduced, used or relied upon, in whole or in part, by a party other than the Client, without the prior written consent of McElhanney. The Client may provide copies of this report to its affiliates, contractors, subcontractors and regulatory authorities for use in relation to and in connection with the Project provided that any reliance, unauthorized use, and/or decisions made based on the information contained within this report are at the sole risk of such parties. McElhanney will not be responsible for the use of this report on projects other than the Project, where this report or the contents hereof have been modified without McElhanney's consent, to the extent that the content is in the nature of an opinion, and if the report is preliminary or draft. This is a technical report and is not a legal representation or interpretation of laws, rules, regulations, or policies of governmental agencies.

Standard of Care and Disclaimer of Warranties. This report was prepared with the degree of care, skill, and diligence as would reasonably be expected from a qualified member of the same profession, providing a similar report for similar projects, and under similar circumstances, and in accordance with generally accepted engineering and scientific judgments, principles and practices. McElhanney expressly disclaims any and all warranties in connection with this report.

Information from Client and Third Parties. McElhanney has relied in good faith on information provided by the Client and third parties noted in this report and has assumed such information to be accurate, complete, reliable, non-fringing, and fit for the intended purpose without independent verification. McElhanney accepts no responsibility for any deficiency, misstatements or inaccuracy contained in this report as a result of omissions or errors in information provided by third parties or for omissions, misstatements or fraudulent acts of persons interviewed.

Effect of Changes. All evaluations and conclusions stated in this report are based on facts, observations, site-specific details, legislation and regulations as they existed at the time of the site assessment/report preparation. Some conditions are subject to change over time and the Client recognizes that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site may substantially alter such evaluations and conclusions. Construction activities can significantly alter soil, rock and other geologic conditions on the site. McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein upon any of the following events: a) any changes (or possible changes) as to the site, purpose, or development plans upon which this report was based, b) any changes to applicable laws subsequent to the issuance of the report, c) new information is discovered in the future during site excavations, construction, building demolition or other activities, or d) additional subsurface assessments or testing conducted by others.

Independent Judgments. McElhanney will not be responsible for the independent conclusions, interpretations, interpolations and/or decisions of the Client, or others, who may come into possession of this report, or any part thereof. This restriction of liability includes decisions made to purchase, finance or sell land or with respect to public offerings for the sale of securities.

Construction Cost Estimates. This construction cost estimate has been prepared using the design and technical information currently available. Furthermore, McElhanney cannot predict the competitive environment, weather or other unforeseen conditions that will prevail at the time that contractors will prepare their bids. The cost estimate is therefore subject to factors over which McElhanney has no control, and McElhanney does not guarantee or warranty the accuracy of such estimate.

APPENDIX B
KWL DESIGN CRITERIA MEMO

KWL Memo will be provided in a future version of this report.

Contact
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McElhanney

CANADA BEST MANAGED COMPANIES

KERR WOOD LEIDAL
consulting engineers

Appendix B

Engineering Drawings

PORT of vancouver

Vancouver Fraser Port Authority

MUSQUEAM FORESHORE RESTORATION

KEY PLAN
SCALE: NTS

DRAWING INDEX		
CONSULTANT DRAWING No.	DESCRIPTION	REVISION No.
2121-00983-C0-001	COVER SHEET, DRAWING INDEX, AND KEY PLAN	A
2121-00983-C0-002	GENERAL ARRANGEMENT	A
2121-00983-C0-003	DESIGN CRITERIA AND GENERAL NOTES	A
2121-00983-C1-101	FORESHORE RESTORATION - PLAN AND SECTIONS	A
2121-00983-C2-101	CREEK HABITAT ENHANCEMENT - PLAN	A
2121-00983-C2-102	CREEK HABITAT ENHANCEMENT - DETAILS	A

PERMIT TO PRACTICE
McElhanney Ltd.
PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

Ref. No.	REFERENCE

McElhanney
Suite 200
858 Beatty Street
Vancouver BC
Canada V6B 1C1
T 604 683 8521

No.	Date	REVISION	Dr'n	Ch'd
A	2023-07-24	ISSUED FOR REVIEW	K.Y.	A.P.

PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-07-24
SCALE	NTS
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
COVER SHEET, DRAWING INDEX, AND KEY PLAN

SIZE	DWG.	SHEET	REV.
D	2121-00983-C0-001	1 OF 6	A

DESIGN CRITERIA

TO BE UPDATED IN 90% DETAILED DESIGN

GENERAL NOTES

1. GENERAL:

i) THESE GENERAL NOTES REPRESENT THE ENTIRETY OF THE PROJECT TECHNICAL SPECIFICATIONS.

ii) BASEPLAN PROVIDED BY MCELHANNEY LTD.

iii) HORIZONTAL DATUM: UTM NAD83, ZONE 10 NORTH.

iv) BATHYMETRY AND TOPOGRAPHIC SURVEY PROVIDED BY MCELHANNEY LTD AND TAKEN FROM AVAILABLE REFERENCES.

v) ELEVATIONS AND CONTOURS ARE IN METRES AND ARE REFERRED TO GEODETIC DATUM CVD28

vi) ALL LOCATIONS AND ELEVATIONS OF EXISTING ELEMENTS AS SHOWN ON THE DRAWINGS ARE APPROXIMATE VALUES ONLY, AND ARE SUBJECT TO CONSTRUCTION VARIATIONS. THE CONTRACTOR SHALL VISIT THE SITE OF THE WORK, TAKE THEIR OWN MEASUREMENTS OF ALL EXISTING STRUCTURES, GROUND AND OTHER WORK, MAKE THEIR ESTIMATE OF ACTUAL JOB CONDITIONS AND THE CORRECTNESS OF THE INFORMATION GIVEN. ALL DIMENSIONS AND DETAILS SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO FABRICATION AND CONSTRUCTION. DISCREPANCIES SHALL PROMPTLY BE BROUGHT TO THE ATTENTION OF THE VFPA REPRESENTATIVE.

2. SITE PREPARATION:

i) REMOVE ALL EXISTING LOGS, TIMBER, PILES, METAL DEBRIS, CONCRETE DEBRIS AND OTHER DELETERIOUS MATERIALS ON THE EXISTING SLOPE WITHIN THE WORK AREA.

ii) DISPOSE OF ALL REMOVED MATERIALS OFF SITE, IN ACCORDANCE WITH MUNICIPAL, PROVINCIAL, AND FEDERAL REGULATIONS.

3. SHORELINE REPAIRS:

i) REPAIRS MATERIALS:

i) ALL REPAIRS MATERIALS SHALL BE APPROVED BY THE VFPA REPRESENTATIVE PRIOR TO INSTALLATION.

ii) ALL REPAIRS MATERIALS SHALL BE ROUGH ANGULAR QUARRIED STONE OF A DENSE, HARD, DURABLE CHARACTER, FREE OF ORGANIC MATERIALS, UNFILLED JOINTS, SEAMS OR OTHER DEFECTS, RESISTANT TO BREAKDOWN BY HANDLING, FROST ACTION OR WEATHERING, AND NOT SUBJECT TO DETERIORATION IN SEA WATER. AS A MINIMUM, RIPRAP SHALL MEET THE FOLLOWING:

TEST #	TEST	REQUIREMENT
1	ABSORPTION (ASTM C127)	NOT MORE THAN 2.0%
2	ABRASION, 1000 REVOLUTIONS (ASTM C535)	NOT MORE THAN 20.0% LOSS
3	MAGNESIUM SULFATE SOUNDNESS, (ASTM C88)	NOT MORE THAN 15.0% LOSS
4	PETROGRAPHIC EXAMINATION	ABSENCE OF WEAKNESS OR MATERIALS THAT COULD RESULT IN SIGNIFICANT STONE ALTERATION AND REDUCTION IN DURABILITY
5	DEGRADATION (ASTM D3744)	NO INDEX LESS THAN 35

iii) THE REPAIRS SHALL HAVE A UNIT MASS NOT LESS THAN 2650 kg/m³; I.E A SPECIFIC GRAVITY NOT LESS THAN 2.65 (SD).

iv) THE REPAIRS SHALL BE GRADED BETWEEN THE LIMITS SPECIFIED, WITH THE LONGEST DIMENSION OF ANY PIECE NOT GREATER THAN 2.5 TIMES ITS LEAST DIMENSION.

GENERAL NOTES (CON'T)

v) MASS GOVERNS AND THE GRADATION AND NOMINAL SIZE IS DEFINED AS:

$$D = 1000 \times \left(\frac{W}{2650}\right)^{1/3}$$

WHERE MASS (W) IS IN kg AND D IS THE NOMINAL SIZE IN mm.

vi) RIPRAP SHALL BE CLASS 250 kg.

vii) RIPRAP AND FILL SHALL BE IN CONFORMANCE WITH SS 205 AND MEET THE SPECIFIED GRADATIONS AND QUALITY IN TABLES 205-A, 205-B AND 205-C (REPRODUCED BELOW FOR REFERENCE)

TABLE 1: RIPRAP HORIZONTAL DIMENSIONS

CLASS OF RIPRAP (kg)	NOMINAL RIPRAP THICKNESS (mm)	SURFACE WIDTH, H (mm)	
		2H : 1V SLOPE	1.5H : 1V SLOPE
10	350	783	631
25	450	1006	811
50	550	1230	992
100	700	1566	1262
250	1000	2236	1803
500	1200	2684	2163
1000	1500	3355	2704
2000	2000	4473	3606
4000	2500	5591	4507

TABLE 205-A: GRADATION OF ROCK SIZES IN EACH CLASS OF RIPRAP - MASS (kg)

CLASS OF RIPRAP (kg)	NOMINAL RIPRAP THICKNESS (mm)	ROCK GRADATION PERCENTAGE SMALLER THAN GIVEN ROCK MASS (kg)		
		15%	50%	85%
10	350	1	10	30
25	450	2.5	25	75
50	550	5	50	150
100	700	10	100	300
250	1000	25	250	750
500	1200	50	500	1500
1000	1500	100	1000	3000
2000	2000	200	2000	6000
4000	2500	400	4000	12000

TABLE 205-B: APPROPRIATE AVERAGE DIMENSION OF EACH SPECIFIED ROCK CLASS MASS (Sg=2.640) - EQUIVALENT DIAMETER (mm)

CLASS OF RIPRAP (kg)	APPROXIMATE AVERAGE DIMENSION (mm)			
	15%	50%	85%	<100%
10	90	195	280	330
25	120	260	380	450
50	155	330	475	565
100	195	415	600	715
250	260	565	815	965
500	330	715	1030	1220
1000	415	900	1295	1535
2000	525	1130	1630	1935
4000	660	1425	2055	2440

REF: BRITISH COLUMBIA MINISTRY OF TRANSPORTATION AND INFASTRUCTURE

GENERAL NOTES (CON'T)

iii) PLACEMENT OF SHORELINE REPAIRS:

i) PERFORM A SITE REVIEW PRIOR TO CONSTRUCTION ACTIVITIES COMMENCING WITH THE VFPA REPRESENTATIVE TO IDENTIFY AND CONFIRM THE EXTENT AND LOCATIONS OF THE RIPRAP.

ii) PLACE THE RIPRAP MATERIALS IN THE LOCATIONS AND TO THE ELEVATIONS, THICKNESS AND DETAILS AS INDICATED ON THE DRAWINGS AND AS DIRECTED BY THE VFPA REPRESENTATIVE.

ii) TRIM EXISTING SLOPE AS REQUIRED TO FIT THE RIPRAP INTO THE AREAS INDICATED ON THE DRAWINGS.

iv) PLACE RIPRAP SUCH THAT THE FINISHED SURFACE IS DENSELY PLACED, WELL KEYED, AND UNIFORM. FILL VOIDS, REWORK REPAIRS NOT PROPERLY EMBEDDED, AND REMOVE PROTUBERANCES TO THE SATISFACTION OF THE VFPA REPRESENTATIVE.

iv) TOLERANCES:

i) PLACE RIPRAP INDIVIDUALLY, KEYING KEYING TOGETHER TO MINIMIZE OPENINGS BETWEEN ROCKS TO PROVIDE A SMOOTH FINISHED SURFACE.

ii) FINISHED SLOPE ANGLES OF RIPRAP SHALL BE WITHIN ± 2% OF THE ANGLE CORRESPONDING TO THE SLOPE SPECIFIED, WHEN MEASURED BY LAYING A STRAIGHT EDGE BOARD OF MINIMUM 2m LENGTH ALONG THE FALL LINE OF THE SLOPE AND MEASURING THE SLOPE ON THE BOARD. THE CONTRACTOR SHALL PROVIDE A SUITABLE BOARD FOR CHECKING SLOPE ANGLES.

v) FIELD QUALITY CONTROL:

i) MAINTAIN A COMPLETE, ACCURATE LOG OF CONTROLS AND SURVEYS AS THE WORK PROGRESSES.

ii) THE CONTRACTOR SHALL PERFORM A PRE AND POST CONSTRUCTION BATHYMETRIC AND TOPOGRAPHIC SURVEYS. PRE CONSTRUCTION SURVEY SHALL BE PROVIDED TO VFPA REPRESENTATIVE FOR REVIEW AND WRITTEN APPROVAL PRIOR TO COMMENCING WORKS. POST CONSTRUCTION SURVEY SHALL BE PROVIDED TO VFPA REPRESENTATIVE FOR REVIEW AND WRITTEN APPROVAL PRIOR TO SITE DEMOBILIZATION.

iii) SURVEYS SHALL BE CARRIED OUT WITH THE VFPA REPRESENTATIVE IN ATTENDANCE.

iv) DETAILED PRE AND POST CONSTRUCTION PHOTOGRAPHIC IMAGERY SHALL BE PROVIDED BY THE CONTRACTOR TO SUPPORT ITS INVOICES AND TO AID IN VALIDATIONS OF WORKS AND PROJECT RECORDS.

PERMIT TO PRACTICE
McElhanney Ltd.
PERMIT NUMBER: 1002299
Engineers and Geoscientists of BC

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No.	Date	REVISION	Dr'n	Ch'd
A	2023-07-24	ISSUED FOR REVIEW	K.Y.	A.P.

PORT of vancouver
Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-07-24
SCALE	NTS
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
DESIGN CRITERIA AND GENERAL NOTES

SIZE	DWG.	SHEET	REV.
D	2121-00983-C0-002	3 OF 6	A

PLAN
SCALE 1:2000

PERMIT TO PRACTICE
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PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

0 1:2,000 100

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Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	
DRAWN BY	K.YANG
APPROVED	A.PETERSON
DATE	2023-07-24
SCALE	1:2000
VFPA SITE	SITE#

MUSQUEAM FORESHORE RESTORATION
GENERAL ARRANGEMENT

SIZE	DWG.	SHEET	REV.
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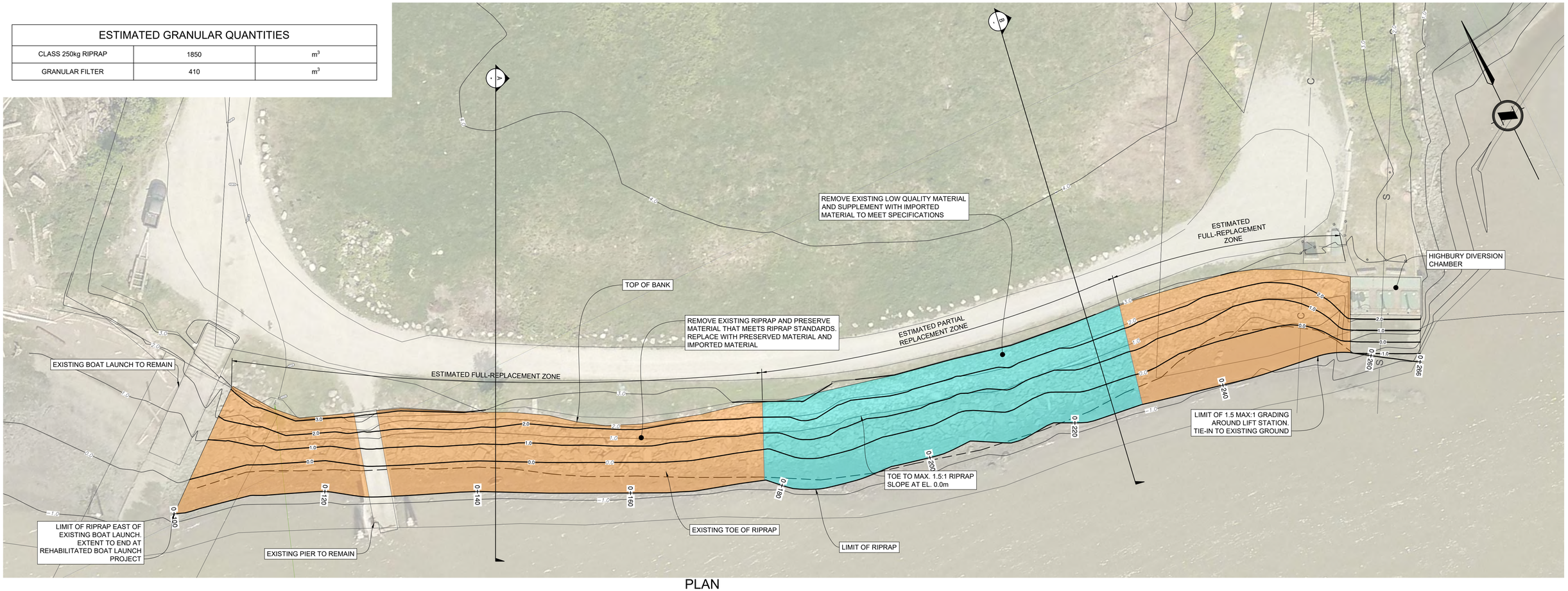
ESTIMATED GRANULAR QUANTITIES		
CLASS 250kg RIPRAP	1850	m^3
GRANULAR FILTER	410	m^3



PLAN
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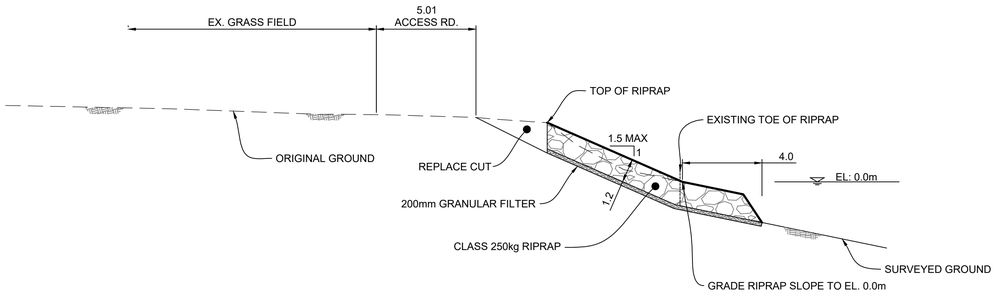
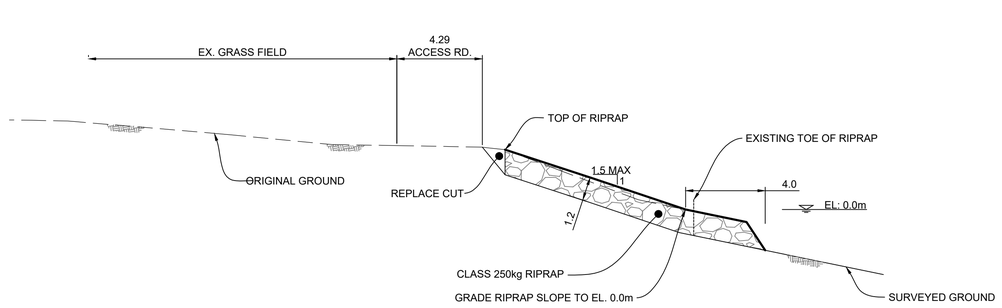


SECTION A: FULL REPLACEMENT
SCALE 1:150



SECTION B: PARTIAL REPLACEMENT
SCALE 1:150

LEGEND

- EXISTING RIPRAP TOE
- 3.0 PROPOSED CONTOURS
- 3.0 EXISTING CONTOURS
- C EXISTING COMM
- S EXISTING SANITARY
- CLASS 250kg RIPRAP
- FULL RIPRAP REPLACEMENT
- PARTIAL RIPRAP REPLACEMENT

0 1:150 6

0 1:250 10

PERMIT TO PRACTICE
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PERMIT NUMBER: 1003299
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GENERAL NOTES
1. ALL DIMENSIONS ARE IN METRES OR MILLIMETRES UNLESS OTHERWISE STATED.
2. TOPOGRAPHIC SURVEY ON MARCH 10 AND 13, 2023. ELEVATIONS ARE REFERRED TO GEODETIC DATUM CVD28. THE GRID COORDINATES ARE UTM ZONE 10, NAD83 (CSRS) AND ARE DERIVED FROM DUAL FREQUENCY GPS DIFFERENTIAL CARRIER PHASE OBSERVATIONS.
3. THIS PLAN SHOWS GRID MEASURED DISTANCES. TO COMPUTE GROUND LEVEL DISTANCES, DIVIDE GRID DISTANCES BY A COMBINED FACTOR OF 0.9996050.
4. RIPRAP QUANTITIES ARE BASED ON COMPLETE REPLACEMENT OF EXISTING MATERIAL. EXISTING RIPRAP MATERIAL CAN BE USED AT THE DISCRETION OF A QUALIFIED PROFESSIONAL.

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Vancouver Fraser Port Authority
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DESIGN BY	K.YANG
DRAWN BY	K.YANG
APPROVED	B.WHITEHOUSE
DATE	2023-07-24
SCALE	AS NOTED
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION
SHORELINE REHABILITATION
PLAN AND SECTION

SIZE	DWG.	SHEET	REV.
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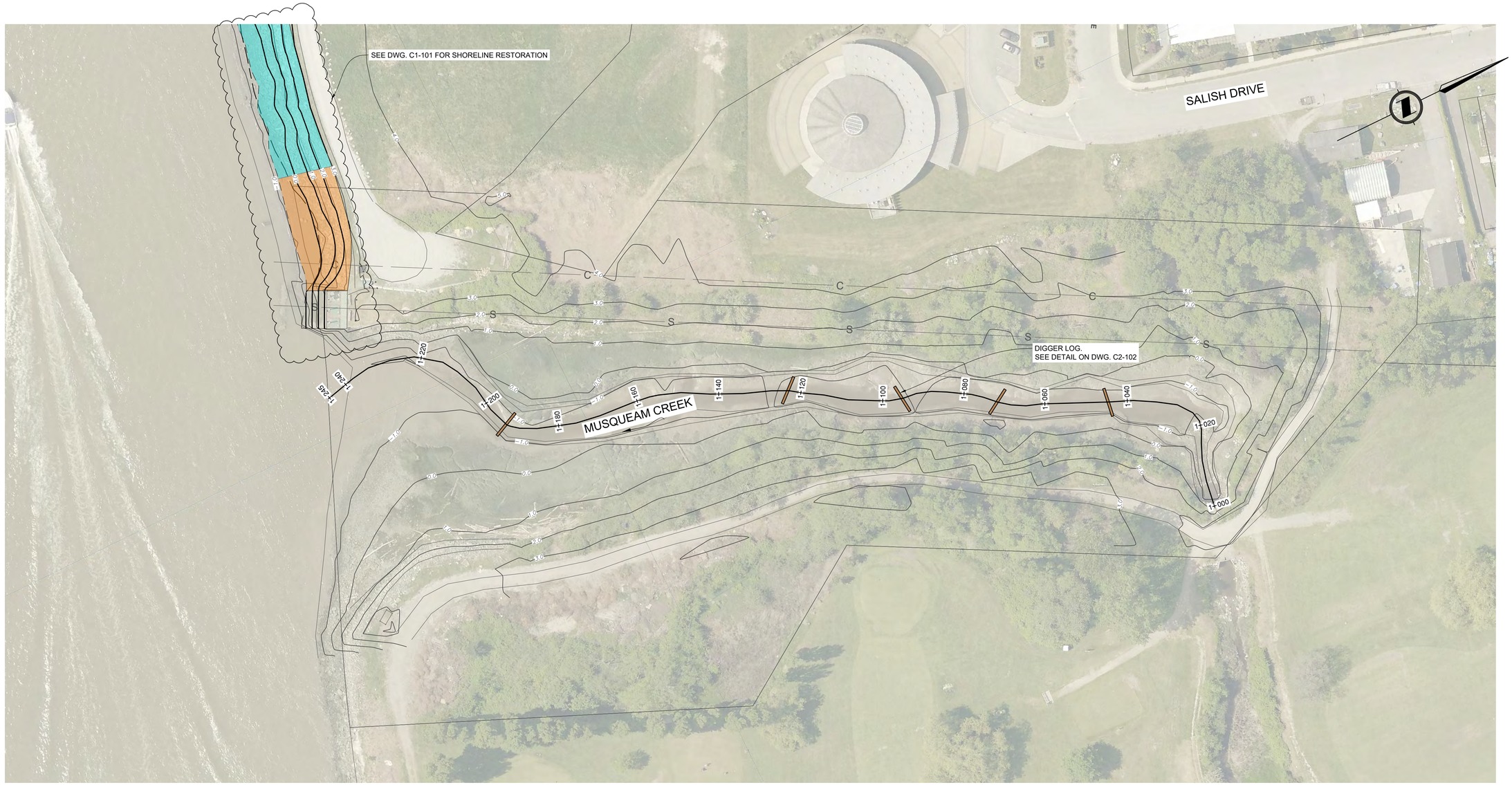

PLAN
SCALE 1:500

LEGEND

- DIGGER LOG
- 3.0 EXISTING CONTOURS
- C EXISTING COMM
- S EXISTING SANITARY

0 1:750 30

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PERMIT NUMBER: 1003299
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3. THIS PLAN SHOWS GRID MEASURED DISTANCES. TO COMPUTE GROUND LEVEL DISTANCES, DIVIDE GRID DISTANCES BY A COMBINED FACTOR OF 0.9996050.

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Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	N.LINDSEY
DRAWN BY	K.YANG
APPROVED	N.LINDSEY
DATE	2023-07-24
SCALE	1:500
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION
CREEK HABITAT ENHANCEMENT
PLAN

SIZE	DWG.	SHEET	REV.
D	2121-00983-C2-101	5 OF 6	A

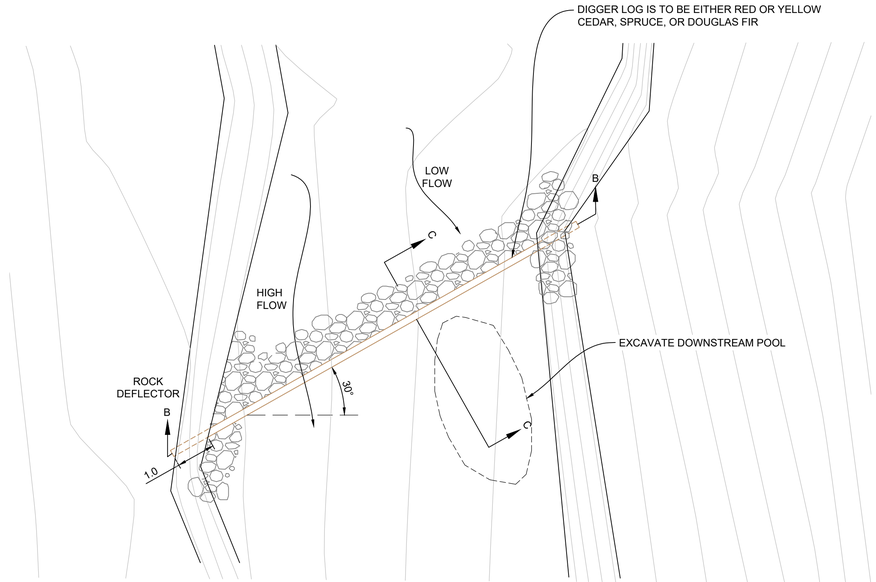
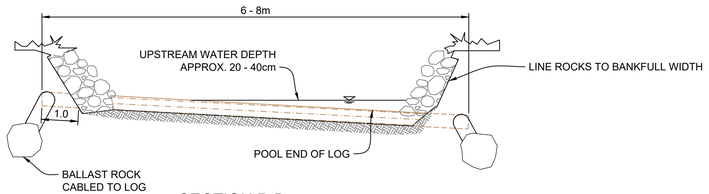
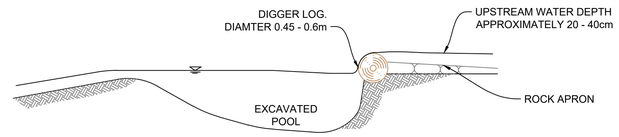


PHOTO 1: DIGGER LOG EXAMPLE



SECTION B-B



SECTION C-C

DIGGER LOG DETAIL

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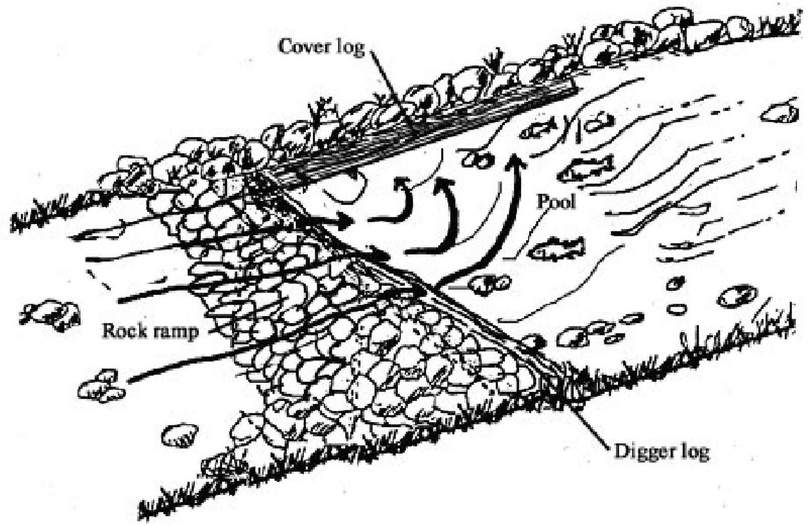

PHOTO 2: OBLIQUE EXAMPLE

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PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

0 1:750 30

Ref. No.	REFERENCE

GENERAL NOTES

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3. THIS PLAN SHOWS GRID MEASURED DISTANCES. TO COMPUTE GROUND LEVEL DISTANCES, DIVIDE GRID DISTANCES BY A COMBINED FACTOR OF 0.9996050.
4. PHOTO SOURCE: THE NOVA SCOTIA SALMON ASSOCIATION (NSSA) 2005, THE NOVA SCOTIA ADOPT-A-STREAM MANUAL, A WATERSHED APPROACH TO COMMUNITY-BASED STEWARDSHIP.

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Vancouver Fraser Port Authority
ENGINEERING DEPARTMENT

DESIGN BY	N.LINDSEY
DRAWN BY	K.YANG
APPROVED	N.LINDSEY
DATE	2023-07-24
SCALE	NTS
VFPA SITE	

MUSQUEAM FORESHORE RESTORATION CREEK HABITAT ENHANCEMENT DETAILS

SIZE	DWG.	SHEET	REV.
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KERR WOOD LEIDAL
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Musqueam IR2 Foreshore Restoration

Environmental Management Plan

Final Report - Revision 1
January 23, 2024
KWL Project No. 0755.034

Prepared for:
Vancouver Fraser Port Authority

Contents

Figures

Tables

Appendices

List of Acronyms

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

1. Introduction

The Vancouver Fraser Port Authority (VFPA) and Musqueam First Nation (xʷməθkʷəy̓əm) are working to improve bank protection and restore the Fraser River foreshore at Musqueam Indian Reserve 2 (IR2). Currently, much of IR2's foreshore is protected by a haphazardly placed, improvised revetment comprised of broken waste concrete pieces. The Musqueam foreshore is exposed to coastal and river hazards, including wind waves, ship waves, high tide, storm surge, freshet and river flooding that have the potential to destabilize the armouring, contribute to land loss, and threaten the safety of the community.

McElhanney, supported by Kerr Wood Leidal Associates Ltd. (KWL), has been retained by VFPA to provide engineering design and field review services for the assessment, design, and construction of upgrades to the Fraser River shoreline and Musqueam Creek. KWL's scope includes coastal analysis and the specification of design conditions for shoreline restoration and environmental assessments and management of the permitting process.

Proposed works include:

1. Removal of 100 m improvised riprap (broken concrete pieces) and replacement with new rock riprap.
2. Partial removal of 50 m of mixed improvised and rock riprap and augmentation with new rock riprap.
3. Installation of five angled "digger log" structures to provide habitat enhancement along an approximately 150 m section of Musqueam Creek below the existing tide gate.

This Environmental Assessment (EA) report provides details of the existing conditions present at the site and will support regulatory submissions for the project, specifically the VFPA's Project and Environmental Review (PER) process, a Fisheries and Oceans Canada (DFO) Request for Review application, and a *Water Sustainability Act* (Section 11) Change Approval application for works in and about a stream.

1.1 Purpose of the Construction Environmental Management Plan

The purpose of this EMP is to ensure that work is completed in a manner that follows all applicable environmental legislation and does not cause harm to the environment for current and future generations. The Project is within the territory of xʷməθkʷəy̓əm, and the EMP acknowledges the 1976 xʷməθkʷəy̓əm Declaration, and the 2017 Musqueam Land Code. This EMP seeks to align itself with the laws and values of xʷməθkʷəy̓əm.

This EMP provides overarching guidance and sets out the requirements and measures that will be adopted to avoid, minimize, and mitigate the potential adverse environmental impacts of the Project. This plan is to be implemented and followed by contractors, sub-contractors or any company and its field staff hired by the Project Proponent during construction of the Project. The EMP intends to provide overarching guidance for how environmental considerations will be implemented and monitored during the construction phase of the Project.

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

1.2 Roles and Responsibilities

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

1. The Project Proponent (Vancouver Fraser Port Authority) shall:
    a. ensure that the appropriate resources are available to establish, implement, maintain, and improve environmentally responsible construction practices;
    b. liaise with the Environmental Monitor (EM), who will be a Qualified Environmental Professional (QEP), about potential impacts to environmental components during construction;
    c. contract Qualified Professionals[1] (QPs) with specific expertise required for the Project to liaise with all QPs as needed; and
    d. provide resources required for environmental awareness and protection training, environmental documents specific to the Project, and financial resources.
2. The Contract Administrator (McElhanney) and Engineers of Record (McElhanney and KWL) shall:
    a. have specific expertise or knowledge needed to advise and/or support the Contract Administrator, the EM, and the Contractor where specific engineering input is required related to environmental concerns;
    b. consult with the EM about potential impacts to environmental components during construction; and
    c. consult with any other QPs involved with the project as needed.
3. The Environmental Monitor (KWL) shall:
    a. advise the Contractor on environmental protection and monitor environmental protection measures;
    b. identify deficiencies of the Projects or works and communicate with the Contractor on how to address deficiencies;
    c. have written authority to halt or modify any construction activity if it is deemed necessary to protect fish and wildlife populations or their habitats; and
    d. report to the Contract Administrator.
4. The Contractor includes any company and its field staff retained by the Contract Administrator to construct a component of the Projects. The Contractor shall:
    a. plan and conduct activities in compliance with the EMP and all applicable legislation, approvals, and best management practices;
    b. report directly to the Contract Administrator regarding all site activities;
    c. ensure that there is no release of deleterious substances into any nearby water sources;
    d. ensure all staff, including subcontractors, are familiar with the EMP, and know their responsibilities in meeting the outcomes of the plan;

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

e. communicate changes in construction plans or activities that could impact the implementation of the EMP to the Contract Administrator, the EM as quickly as possible; and

f. keep a copy of the EMP on-site at all times.

1.4 Guiding Documents

The following guidance documents were used to develop the EMP:

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

2. Project Location and Scope of Work

2.1 Project Location and Physical Setting

Musqueam Foreshore Bank Protection Improvements

Partial and complete replacement of existing riprap will occur along the southern foreshore of Musqueam IR2 on the north arm of stal̓əw̓, the Fraser River (Figure 2-1). Complete replacement will occur in a 70 m and a 30 m section on the eastern and western ends of the foreshore project site (Figure 2-2) while partial replacement will occur in the middle 50 m section (Figure 2-3). The project will consist of the removal of the improvised riprap revetment, regrading of the slope, and replacement with appropriately sized, engineered riprap armouring between the Musqueam boat launch and Highbury Interceptor Diversion Chamber (between 49°13’20.7”N 123°12’06.3”W and 49°13’19.0”N 123°11’58.3”W). Additional riprap will be added at the toe of the revetment for stability and foreshore protection. Material excavated onsite may be used to create a landscape berm immediately north of the foreshore and adjacent to the Musqueam Cultural Centre (Figure 2-4). A minor increase is expected to the permanent footprint of the riprap revetment, so a minor loss in habitat is expected as a result of armouring improvements along the Musqueam foreshore.

Figure 2-1: General Project Location
Figure by McElhanney

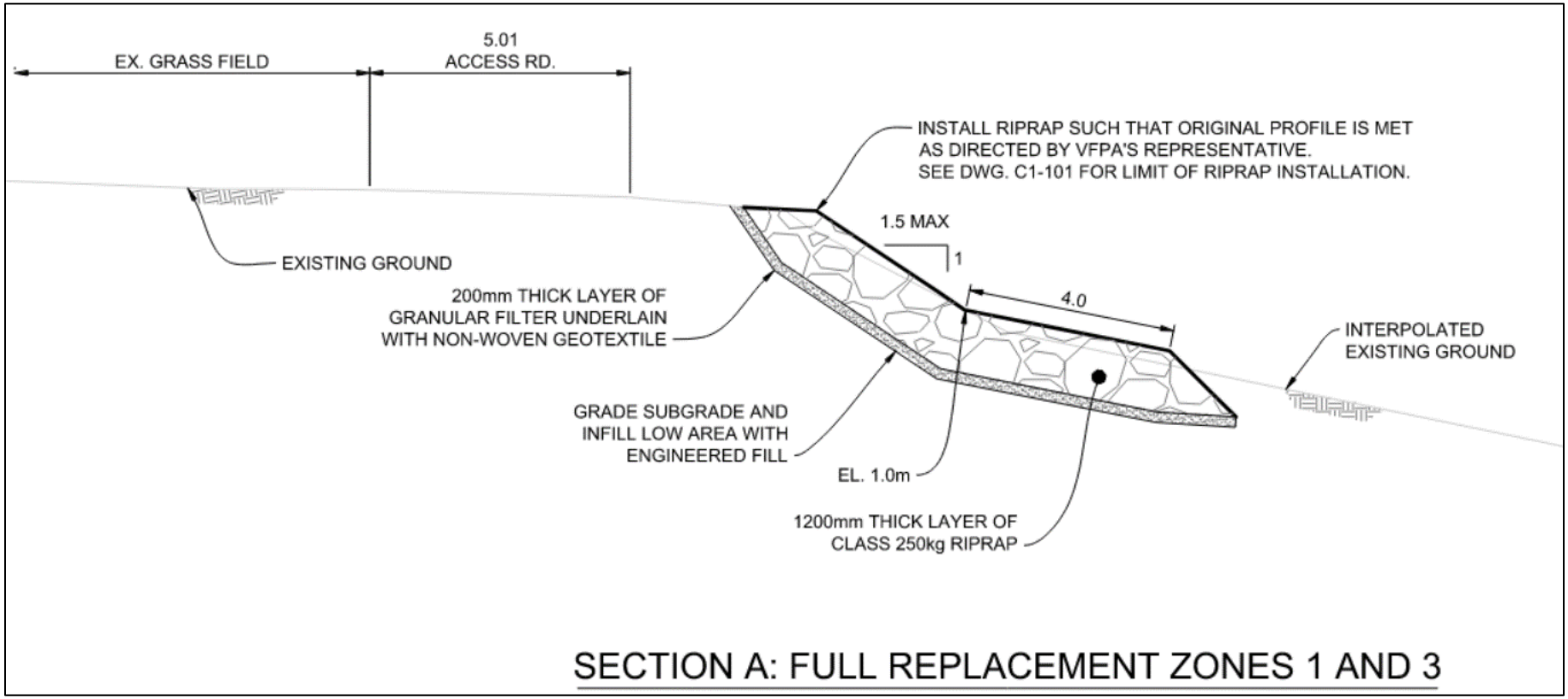

Figure 2-2: Typical Section of Areas Along the Foreshore Requiring Full Riprap Replacement
Figure by McElhanney

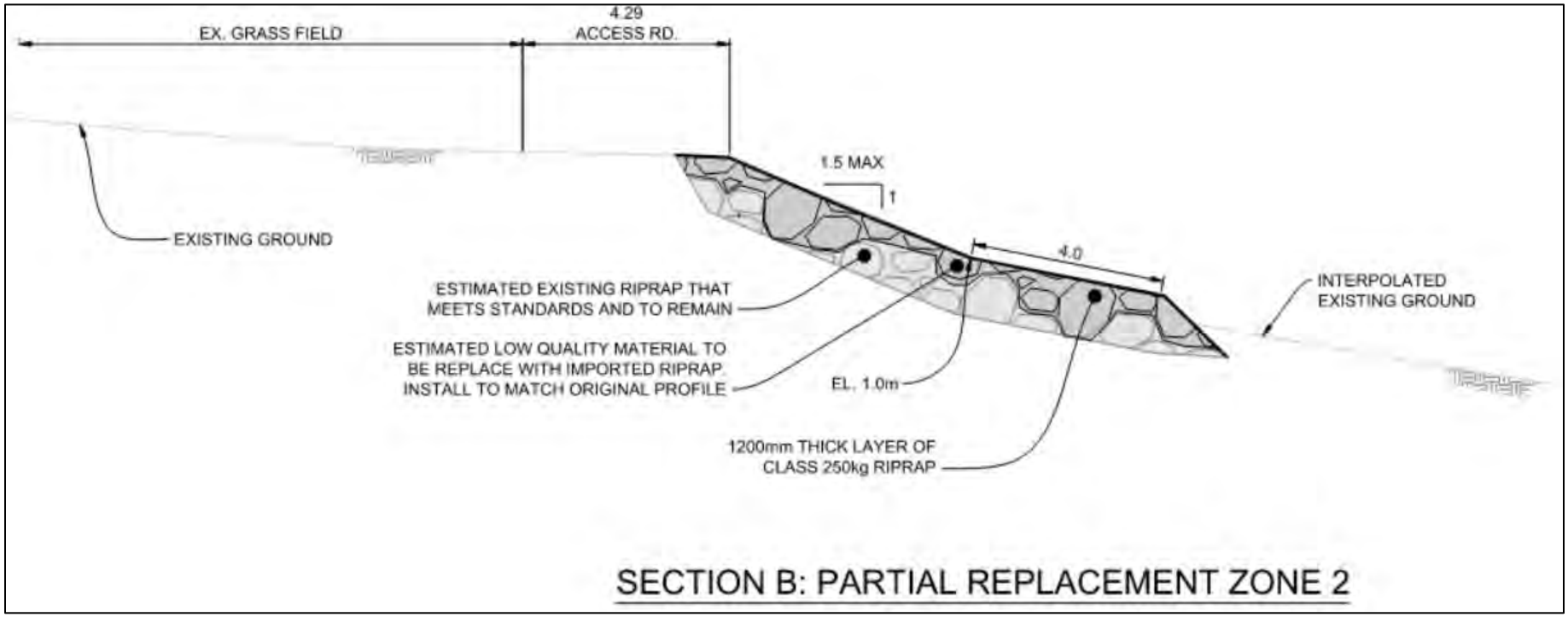

Figure 2-3: Typical Section of Areas Along the Foreshore Requiring Partial Riprap Replacement
Figure by McElhanney

Figure 2-4: Map of Musqueam Foreshore Indicating Locations of Proposed Works Along the Fraser River Shoreline and Within Mouth of Musqueam Creek

Musqueam Creek Habitat Enhancement

This project also proposes the enhancement of aquatic habitat in the mouth of statl̓əw̓, Musqueam Creek (49°13’20.2”N 123°11’55.8”W). Fish passage from the north arm channel through to the floodbox at the head of the estuary is currently limited at low tide by shallow water depths and a lack of pools and instream cover.

The proposed enhancements include the installation of angled “digger logs” in several locations along the length of the creek. The placement of these strategically placed pieces of large woody debris (LWD) should result in the formation of riffles and downstream scour pools, improving fish passage. The addition of these features will increase habitat complexity and coarseness to an otherwise relatively smooth flat streambed and provide areas of refuge for salmonids during times of low flow and upstream migration (Figure 2-5). The streambed enhancements to Musqueam Creek are expected to result in a gain of approximately 1,200 m^2 of fish habitat.

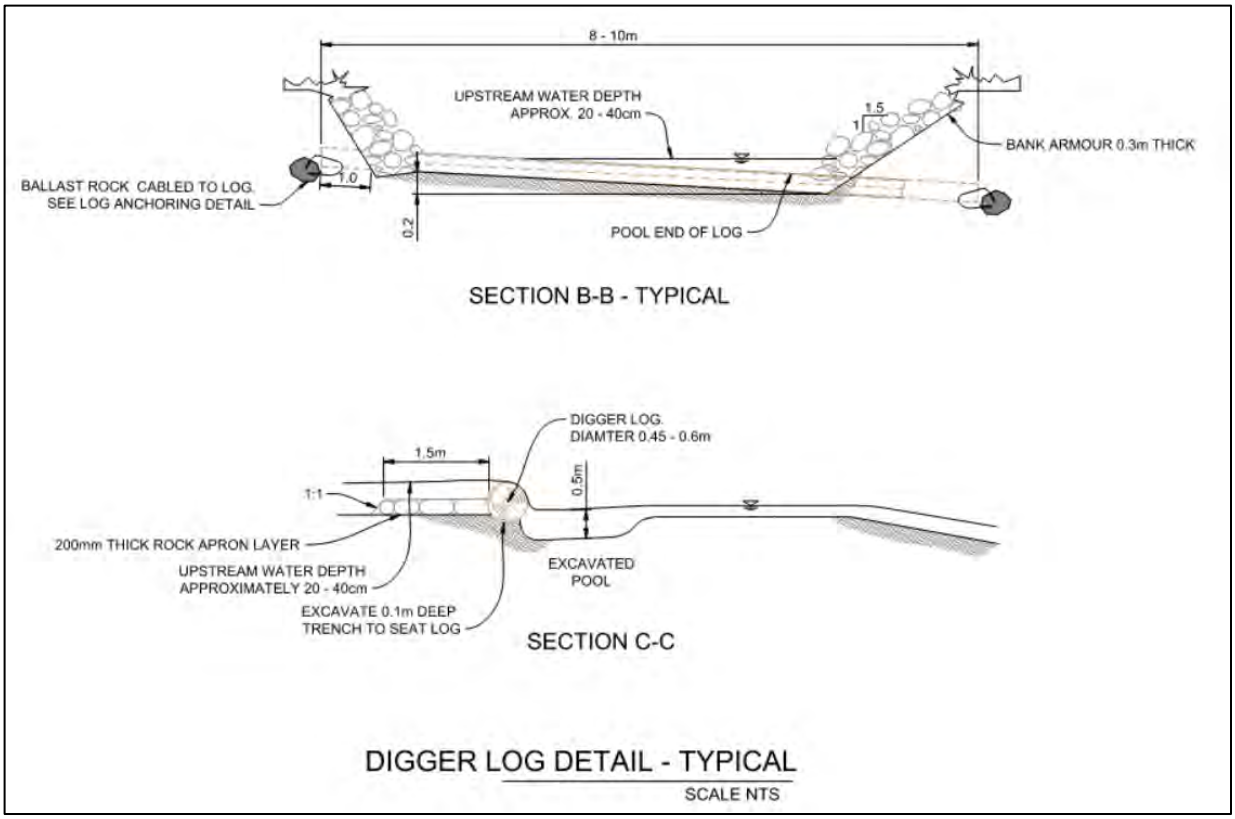

Figure 2-5: Typical Design Detail of an Angled "Digger Log"
Figure by McElhanney

The construction activities may include clearing and grubbing of current invasive dominated vegetation cover, site preparation, isolation of the foreshore, placement of materials in the foreshore, and site restoration as described in Table 2-1 below.

Table 2-1: Proposed Construction Methods

Stage	Activity	Description of Activity
Site Preparation	Clearing and Grubbing	Removal of ground cover along the existing alignment to allow for site access and construction. Additional areas may be cleared for material staging.
	Site Isolation	Installation of isolation measures such as a floating silt curtain (if applicable), parallel to the toe of slope where practicable. Floating silt curtains will provide fish isolation and contain potential suspended sediment generated from the removal and replacement of riprap. Passive isolation measures will be contemplated at the time of construction and will occur in consultation with the QEP and contractor.
	Fish & Wildlife Salvage	Fish and wildlife salvage (if required/feasible). Seining and dip netting in the isolated work area maybe done if there is fish presence. Amphibian salvages will be conducted as necessary. Bird nest surveys and implementation of bird nest protection zones will be done in accordance with the *Migratory Bird Convention Act.*
Construction	Excavation	Excavation and grading of the slope to design parameters where needed. Slopes will be prepared for installation of dike repair materials if deemed necessary. Excavation and regrade of the creek will be conducted in the dry or at low tide.
	Riprap Placement	Placement of riprap revetment as necessary.
	Digger Log Placement	Placement of digger logs and creation of riffles, glides, and pools as per engineering specification. Final design of habitat features will be field fit based on-site conditions and will occur in consultation with the QEP and contractor.
Restoration	Planting	Planting riparian vegetation where designated by the planting plan and feasible.
	Site Restoration and Enhancement	Returning the site to its original conditions and taking advantage of opportunities for habitat enhancement.

2.2 Proposed Project Schedule

Pending regulatory approval, construction is scheduled to begin in 2024 during the marine/estuarine timing window for the protection of fish and fish habitat for Marine/Estuarine Timing Window for Area 28 (Vancouver), Fraser River estuary, from the mouth to the Oak Street bridge (July 16 to February 28). Construction of the bank protection and restoration works described herein are expected to last six weeks.

The Project design was initiated in 2022 and construction is anticipated to be completed by 2024. The Project can be broken down into six phases (Table 2-2):

1. Engineering design
2. Environmental permitting
3. Tendering
4. Construction
5. Post-construction
6. Monitoring

Table 2-2: Proposed Project Schedule

Phase	Description	Proposed Timeline
Engineering Design	• Exploration of options. • Selection of foreshore enhancement option(s). • Complete Final 100% Design Drawings.	Summer/Fall 2023
Environmental Permitting	• Submission of a Project and Environmental Review application to Vancouver Fraser Port Authority. • Submission of a Request for Project Review to Fisheries and Oceans Canada under the *Fisheries Act.* • Section 11 *Water Sustainability Act* Approval to the Ministry of Forests. • Notification and Submission to Transport Canada through the Navigation Protection Program as per the *Canadian Navigable Waters Act.* • Request for appropriate fish and wildlife salvage permits from the Ministry of Environment & Climate Change Strategy	Fall 2023
Tendering	• Submit Project for tendering and select successful proponent.	Winter 2024
Construction	• Clearing and grubbing. • Installation of revetment improvements. • Habitat enhancement at Musqueam Creek. • Field review and environmental auditing.	Summer 2024
Post-Construction	• Replanting and site restoration/enhancement. • Record drawings. • Completion reporting for environmental and engineering components of the Project.	Fall / Winter 2025
Monitoring	• Ongoing monitoring. • Potential adaptive management.	Fall / Winter 2025 to 2029

3. Environmental Setting

3.1 Environmental Setting

The project site is bounded by the Musqueam boat launch on the western end and by Metro Vancouver's Highbury Interceptor Diversion Chamber on the eastern end. A gravel access road is adjacent to the site, and the Musqueam pier is on the project foreshore. The current armouring on the revetment mostly consisted of rebar-reinforced broken concrete pieces with a small section of what appears to be well-engineered riprap towards the eastern extent of the project site. The concrete material varies in size and thickness along the approximately 7 m protected slope. The substrate at this point of the river is primarily composed of fine silts, giving a mudflat characteristic.

The proposed enhancement reach of Musqueam Creek includes the mudflat area at the mouth of the creek, downstream of the Self-Regulating Tidegate (SRT). This area was used as barge access for the construction of the Highbury Interceptor sewer pipe which connects the Vancouver Sewerage Area to the Iona Wastewater Treatment Plant under the north arm of the Fraser River.

Aquatic Habitat

There are two waterbodies associated with the project, statl̓əw̓ (Musqueam Creek) and stal̓əw̓ (the Fraser River). Musqueam Creek will be the site of the habitat enhancement, and the Fraser River will be the revetment placed on its banks at Musqueam IR2.

Musqueam Creek

Musqueam Creek is the last wild salmon-bearing stream in the City of Vancouver. The creek flows generally southeasterly and southerly from its headwaters in Pacific Spirit Regional Park, through Musqueam IR2, and into the north arm of the Fraser River, where it discharges through an SRT.

Musqueam Creek supports runs of Coho (*Oncorhynchus kisutch*), Chum (*Oncorhynchus keta*), and Cutthroat Trout (*Oncorhynchus clarkii clarkii*). The watercourse within the assessed area is inhabited by salmonids year-round and primarily used as a transit route to higher quality spawning and rearing habitat further upstream in the watershed.

During a previous sediment removal in 2022, KWL performed a fish salvage. Species salvaged included Coho salmon, threespine stickleback (*Gasterosteus aculeatus*), western brook lamprey (*Lampetra richardsoni*), and coastal cutthroat trout [2]. prickly sculpin (*Cottus asper*) is also known to inhabit Musqueam Creek but was not encountered during the salvage[1]. The assessed area of the creek does not contain critical habitat for any aquatic species protected under Schedule 1 of Canada's *Species at Risk Act*.

The aquatic habitat is low quality and heavily degraded by gradual sediment deposition since the 1990s and is likely to receive contaminant input from the upper Musqueam Creek watershed as well as potential seepage from the mainline sanitary sewer that runs adjacent to the creek[2].

[2] KWL technical report for Ministry of Environment and Climate Change Strategy. March 2023.

Fraser River

The armouring project site is located along the north side of the Fraser River North Arm, on the banks of Musqueam IR2. The Fraser River North Arm is considered tidally influenced. The lower Fraser River including the North Arm of the Fraser River provides important habitat for over 25 species of fish[3] including Pacific salmon. The north arm also supports winter and summer runs of steelhead salmon (*Oncorhynchus mykiss*), coastal cutthroat trout, white sturgeon (*Acipenser transmontanus*), green sturgeon (*Acipenser medirostris*), eulachon (*Thaleichthys pacificus*) and smelt (*Spirinchus sp.*). Additionally, it also supports non-migratory species such as prickly sculpin, peamouth chub (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*) and northern pikeminnow (*Ptychocheilus oregonensis*)[4].

The aquatic habitat at the project site is relatively poor. The existing bank is already armoured with improvised riprap made of debris and reinforced concrete. There is a lack of riparian and overhanging vegetation in the riparian area, and what vegetation does exist is typically mowed grass or invasive. The streambed at the project site is homogeneous, low gradient, and typically consist of fines and silts.

Terrestrial Habitat

The Musqueam foreshore restoration project site has historically been and continues to be highly disturbed by a variety of land uses. The project site and areas around it have primarily been used for recreation and cultural practices but is also heavily used for hunting and fishing activities. As such, there are often cars, boats, and other equipment in and around the area. The site is also actively used by Musqueam members, and the access road is used by Metro Vancouver to maintain sewer infrastructure.

A significant number of invasive plant species can be found throughout the area including Scotch broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus armeniacus*), purple deadnettle (*Lamium purpureum)*, and common tansy (*Tanacetum vulgar*e). The invasive plant populations pose a significant threat to the overall health of the existing plant communities in the area and may cause direct damage to the bank stability, such as with Japanese knotweed (*Reynoutria japonica*) which was detected less than 200 m from the project site.

Riparian Vegetation

The riparian vegetation within the project site is relatively poor. Most of the bank is vegetated with mixed species of grass and interspersed with invasive purple deadnettle and non-native plantain (*Plantago major*). Barring the single poplar tree, and small patches of Himalayan blackberry, the riparian vegetation does not provide any overhanging vegetation or shade to the Fraser River on the bank armouring project site.

Musqueam Creek at the proposed enhancement location retains mudflat characteristics, with vegetation primarily comprised of low-growing sedges and rushes. One cherry tree is present on the northern portion of Musqueam Creek, less than 30 m west of the SRT. The shrub layer around Musqueam Creek is primarily composed of invasive Himalayan blackberry with purple deadnettle and mixed grasses as ground cover. Logs from the surrounding area are common in the mouth of the creek.

[3] Richardson, J.S., T.J. Lissimore, M.C. Healy and T.G. Northcote. 2000.Fish Communities of the Lower Fraser River (Canada) and a 21-year Contrast. Environmental Biology of Fishes 59:125-140.
[4] Fisheries and Oceans Canada. 2019.British Columbia Marine/Estuarine Timing Windows for the Protection of Fish and Fish Habitat - South Coast and Lower Fraser Areas. http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/bc-s-eng.html#area-29 (accessed May 01, 2023).

4. Regulatory Requirements

4.1 Permits and Approvals

All project-related works must be completed in compliance with applicable legislation, guidelines, and commitments outlined below in Table 4-1.

The following environmental legislation does not apply to the Project:

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

Table 4-1: Environmental Legislation and Regulations Applicable to the Project

Legislation	Agency	Area of Regulation	Permits/Actions Required
Federal			
Federal *Impact Assessment Act* [S.C. 2019, c. 28, s. 1]	Vancouver Fraser Port Authority (VFPA)	Project and environmental review.	• As a funder of the project and a federal entity, VFPA must review the project to determine if the project has the potential to result in adverse environmental effects. • Project and Environmental Review (PER) submission will be required for this purpose. • The project does not meet the criteria for a designated project under the *Act*.
Fisheries Act [R.S.C., 1985,c. F-14]	Fisheries and Oceans Canada (DFO)	Protection of fish and fish habitat.	• Submit a request for review to the Fish and Fish Habitat Protection Program to identify potential risks to the conservation and protection of fish and fish habitat. • If the death of fish, or harmful alteration, disruption or destruction of fish habitat will likely result from the Project, Authorization will be required.
Migratory Birds Convention Act [SC 1994, c. 22]	Environment and Climate Change Canada (ECCC)	Prohibiting injury, molestations, and destruction of migratory birds and their nests.	• Breeding bird surveys will be required prior to any construction occurring within the passerines timing window of March 1–August 31.
Species at Risk Act [SC 2002, c. 29]	Environment and Climate Change Canada (ECCC); Fisheries and Oceans Canada (DFO)	Protection of species designated on Schedule 1 of the Act and their critical habitat.	• Salvage permits may be required
Provincial			
Water Sustainability Act [SBC 2014, c. 15]	Ministry of Forests (FOR)	Regulates activities being carried out in and about a stream.	• Submit a Section 11 Change Approval for works in and about a stream. • Ensure all works adhere to the conditions of the Change Approval.
Wildlife Act [RSBC 1996,c. 488, S. 34]		Regulates works that impact wildlife species in BC.	• Permitting for salvage of amphibians and small mammals in riparian areas.
Weed Control Act [RSBC 1996, c. 487]		Requires all land occupiers to control the spread of provincial and/or regional noxious weeds on their land.	• Ensure proper identification and management of invasive plants throughout Project works.
Heritage Conservation Act (HCA) *[RSBC 1996 c. 187]*		All archaeological sites in BC are protected through designation as “Provincial heritage sites” or through automatic protection by virtue of having historic or archaeological value.	• Heritage inspection permits should be applied for, and an alteration permit may be required. • Any potential heritage site may not be altered or changed in any manner without a permit.
First Nations			
Lands Permit	Musqueam Indian Band (MIB)	Ensures compliance with Musqueam Indian Band laws and land governance priorities.	• Request approval from Musqueam Indian Band if required.
Archaeology Permit		Ensures consideration of Musqueam Indian Band’s sensitivity to land altering activities and potential impacts on cultural heritage.	• Request approval and/or permit from Musqueam Indian Band as required. • Archaeological monitoring and a Change Find Management Procedure will likely be required.

5. Environmental Management Plan

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

5.1 Environmental Monitoring

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

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

Monitoring Frequency

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

Environmental Monitoring Reporting Procedure

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

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

Contingency

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

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

5.2 Timing of Works

- Project activities will be scheduled for dry weather conditions whenever possible.
- All instream work should occur within the Marine/Estuarine Timing Window for Area 28 (Vancouver), Fraser River estuary, from the mouth to the Oak Street bridge (July 16 to February 28).
- Vegetation clearing and tree removal should be scheduled outside the general bird timing window for the Lower Mainland (March 1 to August 31), which will protect breeding birds and bats in the assessment area. If vegetation clearing or tree removal is needed during this window, a bird nest survey should be conducted by a QEP familiar with bat habitat prior to vegetation removal, in accordance with the Canadian Wildlife Service recommendations for compliance with the *Migratory Bird Convention Act*.

5.3 Protection of Fish and Fish Habitat

- The proposed work area will be isolated following DFO best management practices for isolation.
- All applicable provincial and federal salvage permits will be acquired should fish or wildlife species be encountered as site preparation is undertaken or at any stage throughout the course of the project.
- If fish or wildlife presence is detected in the work area, a QEP will salvage any fish and wildlife present, where it is safe and practicable, prior to commencement of work.
- Slow commencement of in-water activities is recommended to encourage mobile aquatic species to leave the construction area.
- The duration of in-water work, and activity will be minimized so that it does not diminish the ability of fish to carry out one or more of their life processes. Suggested methods include keeping machinery on the banks during works, removing sediment from the highest point first and gradually work your way down to minimize disturbance instream.
- Minimize disturbance to existing native vegetation on and adjacent to the banks wherever possible.

Guidelines and Water Quality Parameters

For the purposes of monitoring the potential impacts of construction activities on surface water quality, in situ monitoring of turbidity and alkalinity will be the primary indicators. If required, laboratory analysis for total suspended sediments (TSS) may be completed for the purposes of documenting defensible sediment load concentrations during background and elevated flow conditions.

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

- Induced downstream turbidity/total suspended sediment should not exceed background levels by more than 8 Nephelometric Turbidity Unit (NTU) (average) in 24 hours, or more than 25 NTU or 25 mg/L at any time during dry weather and 75 NTU or 75 mg/L during wet weather.
- Induced downstream pH should remain between pH6.5 and pH9.0, and not more than 10% of background if less than pH6.

Additional in situ or ex situ laboratory analysis for other water quality parameters including, but not limited to, the following list will be sampled as required over the course of project works on an as-needed basis as determined by the EM and will be subject to current working and approved BC Water Quality Guidelines for the Protection of Aquatic Life[5] (BCWQG-AL):

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

[5] British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (MOE, 2018)

5.4 Vegetation Management

- Vegetation clearing should be scheduled outside the general bird timing window for the Lower Mainland (March 1 to August 31) which will protect breeding birds in the assessment area. If vegetation clearing or tree removal is needed during this window, a bird nest survey should be conducted by a QEP familiar with bird habitat prior to vegetation removal, in accordance with the Canadian Wildlife Service recommendations for compliance with the *Migratory Bird Convention Act*.
- Clearing will be limited to areas necessary for the works. Existing roads, trails, and other access points will be used where possible.
- A tree or other structure containing a nest of eagles, Peregrine Falcons, Gyrfalcons, Ospreys, herons, Burrowing Owls, or Pileated Woodpecker must not be felled, even outside of the breeding season for these species. This is in accordance with Section 34(b) of the Wildlife Act.
- Nests of birds in Schedule 1 of the Migratory Birds Regulation (2022) will be reported as required by the regulations and will be protected for the duration of time required by the regulations (e.g., 36 months for Pileated Woodpecker).
- Wildlife trees will be retained if possible. They provide essential habitats to birds and other wildlife.
- Where topping or removing dead limbs of danger trees will remove the hazard, this option is preferred over removing the entire tree.
- Vegetation should be replanted, where temporary clearing is needed to accommodate the works.
- Areas of native riparian vegetation located near the Project footprint will be avoided, and will be protected from construction damage by establishment of construction boundaries.

5.5 Invasive Plant Management

- All machinery will be inspected and cleaned before entering or leaving the construction site to remove any invasive plant propagules.
- All invasive vegetation removed will be disposed of off site at an appropriate facility.
- All material used on site (e.g., straw, fill, etc.) must be certified weed-free.
- Upon Project completion, native shrubs and trees will be planted in disturbed areas within the footprint to maintain soil stability and to minimize the potential for invasive species colonization.
- If patches of knotweed or hogweed are encountered during site clearing or other works in the Project area, they will be flagged off and reported to the QEP immediately. Knotweed must be managed carefully as it is able to reproduce from rhizomes and stem fragments. The following procedures should be adhered to:
    - all plant and soil material must be removed from site in a way as to minimize transfer of plant parts to other areas;
    - all plant parts must be removed, potentially by hand with appropriate personal protective equipment, sealed in plastic bags, and disposed of appropriately off site; and
    - topsoil within 10 m of the extent of the knotweed patch may not be used as backfill. The soil should be disposed of appropriately off site at an appropriate waste management facility experiences in dealing with knotweed-contaminated soils.

5.6 Erosion and Sediment Control Plan

The purpose of ESC is to prevent the introduction of sediments (e.g., silts, clays, and sand) into watercourses. The ESC Plan prescribes methods to prevent the erosion and mobilization of sediment of exposed areas by rainfall or water flow through the work site, to intercept and manage sediment-laden runoff from works prior to leaving the work site and entering the watercourse, and/or manage the risk of a sediment discharge. The ESC provides measures that should be implanted prior to, during, and after construction to prevent erosion and the discharge of sediment into receiving environments. ESC implementation and maintenance will be the responsibility of the contractor and will be monitored by the EM during construction.

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

ESC measures include the following:

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

General Mitigation Measures

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

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

Site Access and Laydown Areas

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

Air Quality and Dust Suppression

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

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

Site Preparation

As part of site preparation, the Contractor will excavate as needed. The following best management practices will be adhered to during excavation works:

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

Worksite Isolation

Prior to clearing, grubbing and site preparation outlined above, the Contractor(s) will isolate the instream work area by placing sein nets and other isolation devices.

It is not anticipated that an aquatic life-form salvage will be required, however the EM will be present to assess the need and remove any fish or wildlife if necessary. The EM will have all applicable salvage permits on hand.

Site Stabilization and Restoration

A site-specific stabilization and restoration plan will be developed for all temporary disturbance areas by the Contractor(s) for review and approval of the EM. The plan should include the following in all temporary disturbance areas within 30 m of the 40 m wide project area:

- Covering of mineral soils at final grade, where rock is not applied, with an organic topsoil mix for growing medium.
- Silt fencing will be installed at the limit of disturbed areas to capture sediment (as applicable).
- Access areas, signage, and fencing will be removed following completion of the project.
- All construction materials, garbage, and erosion and sediment control materials will be removed from the site after the Project is complete.

5.7 Deleterious Substance Control and Spill Management

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

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

Potential Causes of Spills

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

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

Spill Prevention Measures and Contingency

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

- Fuel should not be stored on site wherever possible. If fuel is stored on site, it will be contained within a locked, clearly marked container with secondary spill containment and in a pre-determined designated area. The use of self-bailing spill trays with hydrocarbon filters shall be used in place of normal secondary containment during periods of heavy rainfall.
- In order to ensure compliance with applicable federal and provincial legislation, including national/provincial Fire Code, all short-term storage (i.e., <24hr) will be conducted as per the latest edition of BC Fuel Guidelines.
- All fuel transportation to and off site will be conducted as per the Canada Transportation of Dangerous Goods Regulation.
- The Contractor(s) will conduct daily visual inspections on all equipment such as containment receptacles, pumps, hoses, and staging gear. No equipment will be operated onsite if it does not pass inspection.
- All fueling of vehicles and equipment will be done off-site or onsite in a designated fueling area over a spill containment tray at least 30 m from any watercourse.
- Fueling of small (e.g., pumps, generators) will be conducted on level ground over a portable flexible spill tray in good condition.
- All equipment washing must be done off-site or onsite in a designated area at least 50 m from any watercourse or in a manner that will prevent wash from reaching any waterway.
- All machinery will be clean, in good working condition and free of excess oil and grease. All hydraulic machinery used in the channel of the stream will use environmentally sensitive hydraulic fluids which are non-toxic to aquatic life, and which are readily or inherently biodegradable. Equipment will be inspected daily and documented.
- Containers will be labelled according to the *Transportation of Dangerous Good Act* and *Workplace Hazardous Materials Information Systems* (WHMIS) regulations.
- All equipment on site will be equipped with portable spill kits.
- Oil waste, filters, absorbent pads, and cartridges will be collected and disposed of off-site at an appropriate facility in accordance with federal, provincial, and municipal regulatory requirements.
- If maintenance of onsite equipment is required, it will be conducted by an appropriate service technician from a reputable organization. Any/all fluid changes will be conducted on level ground over portable flexible spill tray(s), and all waste fluids will be removed from site by the Contractor.
- Contaminated materials (e.g., rags, oil filters etc..) will be stored in sealed container(s), in absence of precipitation, and routinely removed from site for disposal at an appropriate facility.
- Storage of unused maintenance fluids and/or fuels will be conducted in a dedicated and marked area, in absence of potential precipitation, with secondary containment, and with barriers to machinery collision.
- A spill response plan and spill kit(s) will be on site and suitable for all substances on-site, and staff trained in its use.

Spill Response Plan Reporting/Investigation

The contractor must prepare an emergency spill response plan. In the event of a spill, the Contractor(s) shall immediately take the necessary steps to resolve the incident. The Contractor must:

- Prepare a spill management plan which includes notification procedures, contact telephone numbers and spill report forms.
- Have a spill kit that will remain on site during construction. The kit will be stocked with appropriate supplies for the site size and conditions (e.g., absorbent pads, booms, granular absorbent). Staff will be trained in the proper use of the kit.
- Provide the necessary labour, equipment, and materials to contain and remove the spill.
- Report any spill of a toxic or deleterious substance over the reportable limits as outlined in the Ministry of Environmnet Spill Reporting Factsheet (MOE, 2021) will be reported immediately to the BC Provincial Emergency Program 24-hour phone line at 1-800-663-3456 [6];
- If a spill of toxic or deleterious substances occurs within a watercourse or waterbody both FOR and DFO will be notified immediately. All spills will be reported to the EM immediately. Clean up the affected area.
- Dispose of waste materials at an approved disposal site.
- Restore the area to the satisfaction of the EM.

Spills should be reported utilizing a standard Spill Report Form, the Contractor will provide this form to the Project Owner and EM prior to the onset of the project for review. Written notification of the spill must follow within two weeks of this verbal report. For spill reporting requirements breakdown by substance spilled and volume, refer to Table 5-1. Contact List will be updated as necessary in Table 5-2.

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

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

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

Table 5-2: Project Emergency Response Contact List

Agency / Person	Telephone Number
Fire, Police, Ambulance	**911**
Provincial Environmental Emergency Program (**EEP**) – *24hr Hotline*	1-800-663-3456
DFO – *24hr Hotline*	1-800-465-4336
Owner: VFPA	
TBD	
TBD	
Contract Administrator:	
TBD	
TBD	
Contractor:	
TBD	
TBD	
Musqueam Indian Band	
Environmental Monitor	

This list will be populated as the project progresses.

5.8 Reporting

After cleanup, the EM with support from the contractor will prepare a detailed report outlining the environmental emergency, including:

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

5.9 Waste Management

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

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

Procedures

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

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

Hazardous Waste

No hazardous waste is expected to be found on site. Any hazardous materials and/or waste used and/or generated on site must be removed daily by Contractor(s) upon completion of daily activities. Potentially hazardous waste for Project may include but not be limited to the following:

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

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

- Material Safety Data Sheets (MSDSs) for all on-site controlled products will be maintained by the Contractor, whoever is responsible for the products.
- No hazardous waste will be disposed of onsite. All the above listed hazardous wastes will be stored onsite for daily export and proper offsite disposal in appropriate containment to prevent unsafe human exposure or release to local terrestrial, aquatic, or atmospheric receiving environments. Storage will be conducted in compliance with WHMIS, MSDS, WorkSafe BC, and BC Hazardous Waste Regulation requirements, and transport will be conducted as per BC Transport of *Dangerous Goods Act*.
- Hazardous waste storage will be conducted in isolation of precipitation and within secondary containment (e.g., impermeable spill catchment pans with sufficient volume) to prevent release to ground and leaching of toxic materials to local terrestrial and aquatic receiving environments and/or groundwater contamination. Storage facilities should also be clearly marked and be protected from machinery movement to prevent vehicle/container collisions and accidental spills, as much as possible.
- Absorbent materials or soils contaminated with oil, or any quantity of hydrocarbon fuels must be handled and transported as hazardous waste. Any contaminated soil will be excavated and hauled off-site to an authorized treatment/disposal area in accordance with the BC Hazardous Waste Regulations.

- In the event that material believed to be contaminated or hazardous is discovered during excavation at the site, the EM must be notified immediately. If the hazardous material is stable and does not pose an immediate threat, operations should be ceased until the EM or appropriately qualified professional determines the appropriate course of action for removal of the hazardous material. If the hazardous material poses an immediate threat and is unstable, then spill response procedures should be immediately followed to contain the hazardous material.

Non-hazardous

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

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

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

5.10 Vehicle and Site Maintenance

In order to mitigate environmental issues arising from Contractor vehicle and machinery maintenance issues, the Contractor(s) is responsible for implementing the following:

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

5.11 Wildlife Management

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

General Wildlife Mitigation Measures

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

Birds

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

- Vegetation clearing will occur within the least-risk window for nesting birds whenever possible (September 1 through to February 28).
- If vegetation clearing must occur outside of the least-risk window (i.e., between March 1 and August 31), a QEP will conduct a pre-clearing nest survey.
- If an active nest is identified, a buffer (i.e., no-work zone) will be established around the active nest, and nest activity will be monitored to ensure nest occupants are not being disturbed by surrounding works. The QEP will determine the appropriate buffer based on the species of bird:
    - once the QEP has determined that the occupants of the nest have fledged, clearing within the no-work zone will continue; and
    - if no active nests are found in surveyed areas, vegetation clearing can commence, but must begin within 24–48 hours of the active bird nest survey.
- Prior to construction activities, a QEP should complete a raptor nest survey to identify, if present, any new eagle nests (or other species protected under the BC Wildlife Act) that may be impacted by construction activities. If an eagle nest is identified, further mitigation (determined by a QEP) will be implemented to avoid impacts to the nests. If impacts are not avoidable, the appropriate regulatory authority will be consulted.
- If no active nests are found in surveyed areas, vegetation clearing can commence. Erosion and sediment control measures must be implemented across the Site to prevent erosion and sedimentation, and potential degradation of instream and riparian habitat. Spill prevention, response, and clean up must be conducted in accordance with the Emergency Response Plan. Fuel must be contained or stored away from watercourses or water bodies.
- Trees with cavity nests, and/or nests of birds in Schedule 1 of the Migratory Birds Regulation (2022) will be reported as required by the regulations and will be protected for the duration of time required by the regulations (e.g., 36 months for Pileated Woodpecker).

Human-wildlife Conflict Management

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

Education

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

Avoidance

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

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

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

5.12 Species at Risk

A QEP will scan the works area for presence of species at risk prior to sediment removal.

Discovery Protocol for Species at Risk

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

Step 1

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

Step 2

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

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

Step 3

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

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

5.13 Clean up and Restoration

- All construction materials and garbage will be removed from site after the Project is complete.
- Erosion and sediment control devices and measures will be removed following the stabilization of all disturbed areas.
- All disturbed areas of the banks of the stream shall be restored to their original condition. Vegetation removed for the purposes of temporary access must be replanted using native species that are suitable for the site conditions.
- The contractor will be responsible for leaving the site in compliance with all Permits, Approvals, and Authorizations.

5.14 Daily Checklist

KWL has compiled a Daily Checklist of relevant measures for environmental protection that the Contractor shall comply with during construction (Appendix A). This checklist will be completed by the EM on each site visit and will be completed by the Contractor daily when the EM is not on site.

Throughout the duration of the project, any changes made to the EMP must be approved by the contract administrator and the Environmental Monitor. All personnel, including the Environmental Monitor, the Contractor, and all QEP, must be notified before the commencement of any relevant construction activities. The VFPA, Contract Administrator and Environmental Monitor may request changes to the EMP at their discretion. An updated copy of the EMP must be kept on-site at all times.

6. Archaeology

It is not expected that any heritage resources will be disturbed or detected on site, however, the Musqueam Archaeology Department is aware of the project and may send an Archaeological Monitor. The Musqueam Chance Find Management Procedure (CFMP) will be followed throughout the project. Musqueam has applied for a Heritage Conservation Act permit for the project, which will be required before Musqueam Archaeological Department can complete their final Archaeological Impact Analysis report for the project. If suspected archaeological or cultural materials or features are encountered during Program activities (such as pieces of bones, atypical rocks, and so forth), the contractor will immediately stop work in the vicinity and refer to the CFMP.

7. Limitations

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

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

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Report Submission

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Statement of Limitations

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

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Revision History

Revision #	Date	Status	Revision	Author
1	January 23.2024	Rev 1	Added self bailing spill trays as per Musqueam Review	GCG
0	November 7, 2023	Final		GCG
B	October 18, 2023	Draft		GCG
A	October 13, 2023	Draft	For Client Review	GCG

Appendix A

Daily Checklist

Appendix A: Daily Checklist

Project: Musqueam IR2 Foreshore Restoration **Site Location:** Musqueam IR2, Vancouver BC
Construction stage/status during inspection:
Inspection Date: **Inspection Time:**
Inspected by: **Weather:**

Inspection Item	Compliant	Non-Compliant	Not Applicable	Comments
General Conditions				
Site appears tidy and maintained within designated project area				
Site access via existing road				
Site laydown area				
All garbage and construction materials are contained and covered during rainfall.				
Fish Protection				
Appropriate fish exclusion measures installed prior to any works, both upstream and downstream of work area.				
Salvaged fish placed in habitat of equal or better quality than that salvaged from.				
All dewatering pumps have fish screens on intakes with a maximum mesh size of 2.54 mm.				
Erosion and Sediment Control (ESC)				
ESC measures are in good working condition.				
Disturbed areas (i.e., hillslopes and stock piles) are covered with poly, where possible.				
All rock and materials to be used within the stream banks have been cleaned and are free of sediment, debris, or other substances that are harmful to aquatic life (i.e., oil).				
Silt curtains in place in water prior to installation of cofferdams or other in stream works.				
Vegetation Clearing & Invasive Plant Management				
Vehicle and foot traffic have been designated to specific areas. Riparian disturbance is kept at a minimum.				
All vegetation to be cleared must be verified by EM.				
Invasive plant species on site have been identified and control spread protocols implemented (i.e., marked).				
All equipment and materials are free from seeds, roots, shoots, or other tissue of invasive plants prior to arrival on site.				

Appendix A: Daily Checklist

Inspection Item	Compliant	Non-Compliant	Not Applicable	Comments
All equipment and materials are free from seeds, roots, shoots, or other tissue of invasive plants prior to any instream work.				
Fuel Management & Spill Response				
Measures in place (i.e., silt fencing, spill trays) to keep sediment, turbid water, oil, grease, lubricant, and all other deleterious substances from entering watercourses.				
Before arrival on site, all equipment and machinery will be in good working condition, power washed, and free of leaks, excess oil, and grease.				
Machinery must be inspected daily prior to use to ensure there are no leaks.				
Machinery is using vegetable-based hydraulic fluid, if possible.				
If possible, all equipment refuelling, washing, and servicing done at least 30 m from any watercourse, or in a designated location pre-approved by the EM.				
Spill cleanup kit is on site, complete, easily accessible and in proper working order.				
All staff on site are trained to use the spill cleanup kit. Any spill of toxic or deleterious substance is reported immediately to the Provincial Emergency Program 24-hour phone line.				
All generators, pumps, and other stationary equipment are placed on spill trays.				
Machinery parked on site will be located away from Fraser River top of bank and will have proper containment for leaks.				

Additional Comments:

_____

_____

_____

*Each site visit must include a photos log of site conditions.

Photos Checklist:

- ☐ Sediment fencing
- ☐ Stockpiles
- ☐ Access/Egress points
- ☐ Spill kits
- ☐ Fuel storage
- ☐ Fish fence/isolation
- ☐ Laydown area
- ☐ Construction progress