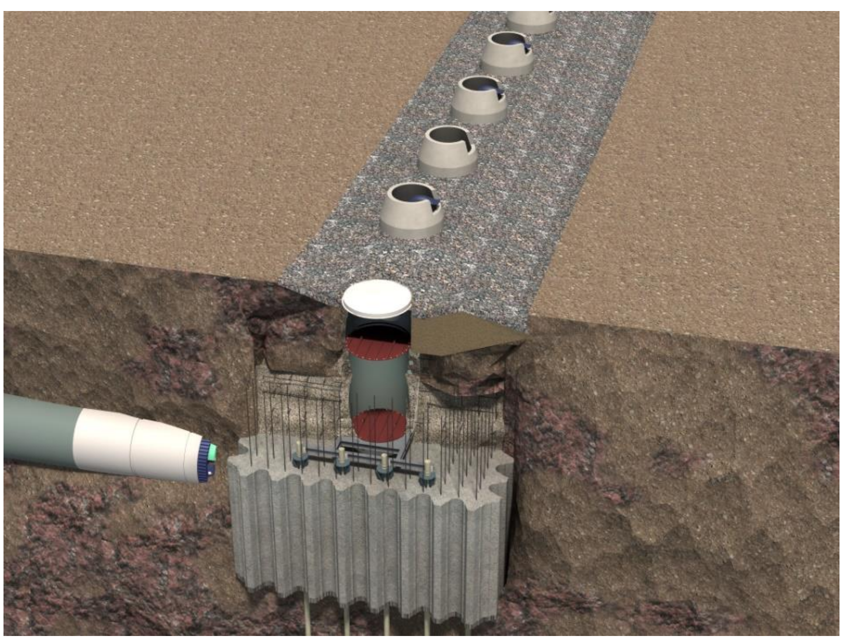
Vancouver Fraser Port Authority PROJECT AND ENVIRONMENTAL REVIEW APPLICATION

Annacis Island WWTP New Outfall System

CDM Smith Canada ULC



Prepared for:

metrovancouver

SERVICES AND SOLUTIONS FOR A LIVABLE REGION

December 29, 2017

CDM Smith

Golder Associates

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List of Abbreviations

ADWF	Average dry weather flow
AEP	Annual Exceedance Probability
AIWWTP	Annacis Island Waste Water Treatment Plant
BCMOE	BC Ministry of Environment
CCG	Canadian Coast Guard
CCTs	Chlorine Contact Tanks
CDAC	Computerized Data Acquisition and Control system
CEMP	Construction Environmental Management Plan
CFD	Computational Fluid Dynamics
CGVD28/GSC	Geodetic Datum, 1977 HT97 Geoid Adjustment
CoD	City of Delta
CVD28GVRD2005	Geodetic Datum, 2005 GVRD Adjustment
DAS	Disposal at Sea
DFO	Fisheries and Oceans Canada
EMA	Provincial Environment Management Act
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Study
FLNRO	Forests, Lands, Natural Resource Operations & Rural Development
GD	Geodetic Datum
GVS&DD	Greater Vancouver Sewerage and Drainage District
GVWD	Greater Vancouver Water District
IDZ	Initial Dilution Zone
LCS	Level Control Structure
LOS	level of service
MLD	Million Liters per Day
MoE	Ministry of Environment
MV	Metro Vancouver
MVHC	Metro Vancouver Housing Corporation
MVRD	Metro Vancouver Regional District
MWR	Municipal Wastewater Regulation
NBCC 2010	National Building Code of Canada 2010
NBCC 2015	National Building Code of Canada 2015
NOS	New Outfall System
NTP	Notice to Proceed
OD	Outside Diameter
PER	Project and Environmental Review Application
PCLC (Delta)	Port Community Liaison Committee in Delta
PDBCO	Post Disaster Bypass Conduit to Outfall
PWWF	Peak wet weather flow
SSI	South Surrey Interceptor
SRY	Southern Railway
TBM	Tunnel Boring Machine
VFPA	Vancouver Fraser Port Authority
WSER	Federal Wastewater Systems Effluent Regulation

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Section 1

General Submission Requirements

1.1 Application Form

Refer to the attached Project Permit Application Form for Category C & D Reviews.

1.2 Contact List

Table 1-1 is a list of the key project personnel by organization and role.

Table 1.1: Contact List

Organization	Name	Title	Address	Contact
Metro Vancouver Owner	Ken Masse	Senior Project Engineer	4730 Kingsway, Burnaby, BC	778-452-2627
CDM Smith, Engineer	John Newby	Project Manager	4710 Kingsway, Burnaby, BC	604-330-2494
Hatch, Construction Manger	Tim Langmaid	Project Manager	1066 West Hastings Street, Suite 400 Vancouver, BC	604-639-1014
VFPA, Project Permit	Gord Tycho	Project Lead	999 Canada Place Vancouver, BC	604-665-9561

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Project Permit Application Form for Category C & D Reviews

Please do NOT submit an application if you have not yet submitted a Preliminary Project Inquiry to Vancouver Fraser Port Authority (VFPA) for your proposed project. Category C and D applications will only be accepted after VFPA has conducted a Preliminary Review of the proposed project.

Information in this form and attached documents may be made public and sent to other authorities during the Project and Environmental Review Process and is subject to the Access to Information Act.

The following fees will apply:
Please submit a cheque for $13,125(Category C) or $23,625(Category D) payable to Vancouver Fraser Port Authority and a documentation deposit equal to 1% of project cost (min. $1500 - max. $10,000). Payment will be processed when VFPA considers the application to be complete. Document deposits will be returned upon completion of construction and submission of as-built drawings.

PROJECT TITLE

Annacis Island Wastewater Treatment Plant New Outfall System

PROPOSED CATEGORY OF REVIEW (C OR D): C

PER REFERENCE NUMBER: 16-054

SECTION A. CONTACT INFORMATION

TENANT OR COMPANY NAME: Greater Vancouver Sewerage and Drainage District

ADDRESS: 4730 Kingsway

CITY	PROV/STATE	COUNTRY	POSTAL/ZIP CODE
Burnaby	BC	Canada	V5H 0C6

PRIMARY CONTACT NAME: Ken Masse

CONTACT COMPANY AND POSITION: Metro Vancouver, Senior Project Engineer

ADDRESS: 4730 Kingsway

CITY	PROV/STATE	COUNTRY	POSTAL/ZIP CODE
Burnaby	BC	Canada	V5H 0C6

PHONE: 778-452-2627

EMAIL: ken.masse@metrovancouver.org

SECONDARY CONTACT NAME: John Newby

CONTACT COMPANY AND POSITION: CDM Smith Canada, Project Manager

ADDRESS: 1001 - 4710 Kingsway

CITY	PROV/STATE	COUNTRY	POSTAL/ZIP CODE
Burnaby	BC	Canada	V5H 4M2

PHONE: 6043302494

EMAIL: newbyje@cdmsmith.com

SECTION B. PROJECT LOCATION

If the project location is not the same as the tenant address provided in Section A, please attach a map such as a Google satellite screen shot indicating the location of the project, and a site plan showing the project area and components.

STREET ADDRESS OR LOCATION DESCRIPTION
1299 Derwent Way
MUNICIPALITY
Delta, BC

SECTION C. ESTIMATED COST AND PROPOSED TIMING AND DURATION OF PROJECT

If the project location is not the same as the tenant address provided in Section A, please attach a map such as a Google satellite screen shot indicating the location of the project, and a site plan showing the project area and components.

ESTIMATED PROJECT COST ($)	DOCUMENTATION DEPOSIT AMOUNT (1% OF PROJECT COSTS TO MAX. $10,000)
$ 200,000,000.00	$ 10,000.00
PROPOSED START DATE (MM/DD/YYYY)	PROPOSED COMPLETION DATE (MM/DD/YYYY)
01/01/2019	01/31/2022

WILL ALL CONSTRUCTION ACTIVITIES TAKE PLACE MONDAY TO SATURDAY BETWEEN 7:00 AM AND 8:00 PM EXCLUDING HOLIDAYS?
IF NO, PLEASE DESCRIBE PROPOSED CONSTRUCTION HOURS AND RATIONALE.

General work hours during non-tunneling construction will be between 6am to 5pm, with a 5-day work week. During tunnel advancement, however, the work schedule is assumed to proceed 7-days a week, 24-hours a day with two 8-hour tunnel mining shifts and one 8-hour maintenance shift. Weekends are anticipated to be for maintenance purpose therefore, tunneling advancement is not expected.

SECTION D. PROJECT SUMMARY

Please provide a brief summary of the project including the purpose of the project and all proposed works.

Metro Vancouver's Annacis Island Wastewater Treatment Plant (AIWWTP) existing outfall does not meet the requirements for plant Stage V flow capacity upgrade (to 18.9 m3/s), and BC Ministry of Environment (BCMoE) requirement for in-river dilution. As well, the existing system does not meet the latest Seismic Design Criteria based on the National Building Code of Canada 2015. This project will construct a new post-disaster rated effluent outfall that can meet the Stage V effluent capacity requirements (and beyond), including dilution and seismic requirements. The outfall system will connect to the AIWWTP chlorine contact tank and convey effluent through a deep tunnel system for discharge in the Fraser River.

Attach detailed project description, as required.

SECTION E. LIST OF RELEVANT PLANS, STUDIES, REPORTS AND OTHER DOCUMENTS

Please list the relevant plans, studies, reports and other documents that are attached to the application.

Please refer to project PER submission TOC for Appendices A to R for a complete listing. General listing provided here:
Appendix A Design Drawings
Appendix B Geotechnical Reports
Appendix C Geomorphological Studies
Appendix D Works Protocol
Appendix E Traffic Studies
Appendix F Navigation Studies
Appendix G Dredging Studies

Attach plans and reports.

SECTION F. ADDITIONAL PROJECT CONSIDERATIONS, MITIGATIONS AND INFORMATION

Describe any other additional information, such as mitigation measures that are not provided elsewhere in the plans and reports attached to the submission, as applicable.

N/A

Attach plans and reports, as applicable.

SECTION G. OTHER REGULATORY APPROVALS

Has the project been submitted for review to another agency or regulatory authority (e.g. Environment Canada for a Disposal at Sea Permit)? If yes, describe.

Department of Fisheries and Oceans for Request for Project Review
Ministry of Environment for Stage 1 and Stage 2 Environment Impact Study
Environment Canada Climate Change Canada at Sea Disposal Sediment Characterization
Transportation Canada for Navigation Protection Program
Corporation of Delta Project Permits

SECTION H. BUILDING PERMITS

Are there structures that are considered to be reviewable under the 2015 National Building Code and National Fire Code?

YES (●) NO ( )

Will the submission of building permits be phased? If yes, please attach schedule describing each phase.

YES ( ) NO (●)

SECTION I. SUBMIT

Please attach a copy of the completed application form and send to the email address: PER@portvancouver.com

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Section 2

Project Description

2.1 General Scope

2.1.1 Metro Vancouver

Metro Vancouver (MV) is a political body and corporate entity designated by provincial legislation as one of the regional districts in British Columbia, Canada. Now officially known by the legal name of the Metro Vancouver Regional District, the organization was formerly known as the Greater Vancouver Regional District (GVRD) from mid-1968 to early 2017. Further, it was known as the Regional District of Fraser–Burrard for nearly one year upon originally incorporating in mid-1967. The MV boundary is shown in **Figure 2-1**.

The MV is under the direction of 23 local authorities; it delivers regional services, sets policy and acts as a political forum. The regional district's most populous city is Vancouver, and Metro Vancouver's administrative offices are located in the City of Burnaby.

Metro Vancouver technically comprises four separate corporate entities: the Metro Vancouver Regional District (MVRD), the Greater Vancouver Sewerage and Drainage District (GVS&DD), the Greater Vancouver Water District (GVWD) and the Metro Vancouver Housing Corporation (MVHC).

The Greater Vancouver Water District and the Greater Vancouver Sewerage and Drainage District were established in 1924 and 1956 respectively. The Government of British Columbia incorporated a regional district for this western portion of the Lower Mainland named the Regional District of Fraser-Burrard on June 29, 1967. Just under a year later, the regional district was renamed as Greater Vancouver. The regional district was formally renamed a second time by the Government of British Columbia on January 30, 2017 to the Metro Vancouver Regional District.

Within the GVS&DD, Metro Vancouver operates and maintains the liquid waste infrastructure, which includes managing the network of trunk sewers, pumping stations and wastewater treatment plants that connect with municipal sewer systems. Throughout operations, the organization is committed to protecting public health and the environment, and recovering as much resources (energy, nutrients, etc.) as possible out of the waste stream.

The liquid waste utility is committed to the goals and strategies in the Integrated Liquid Waste and Resource Management plan, as approved by the MV board. The three goals are:

- "Protect public health and the environment"
- "Use liquid waste as a resource"
- "Effective, affordable and collaborative management"

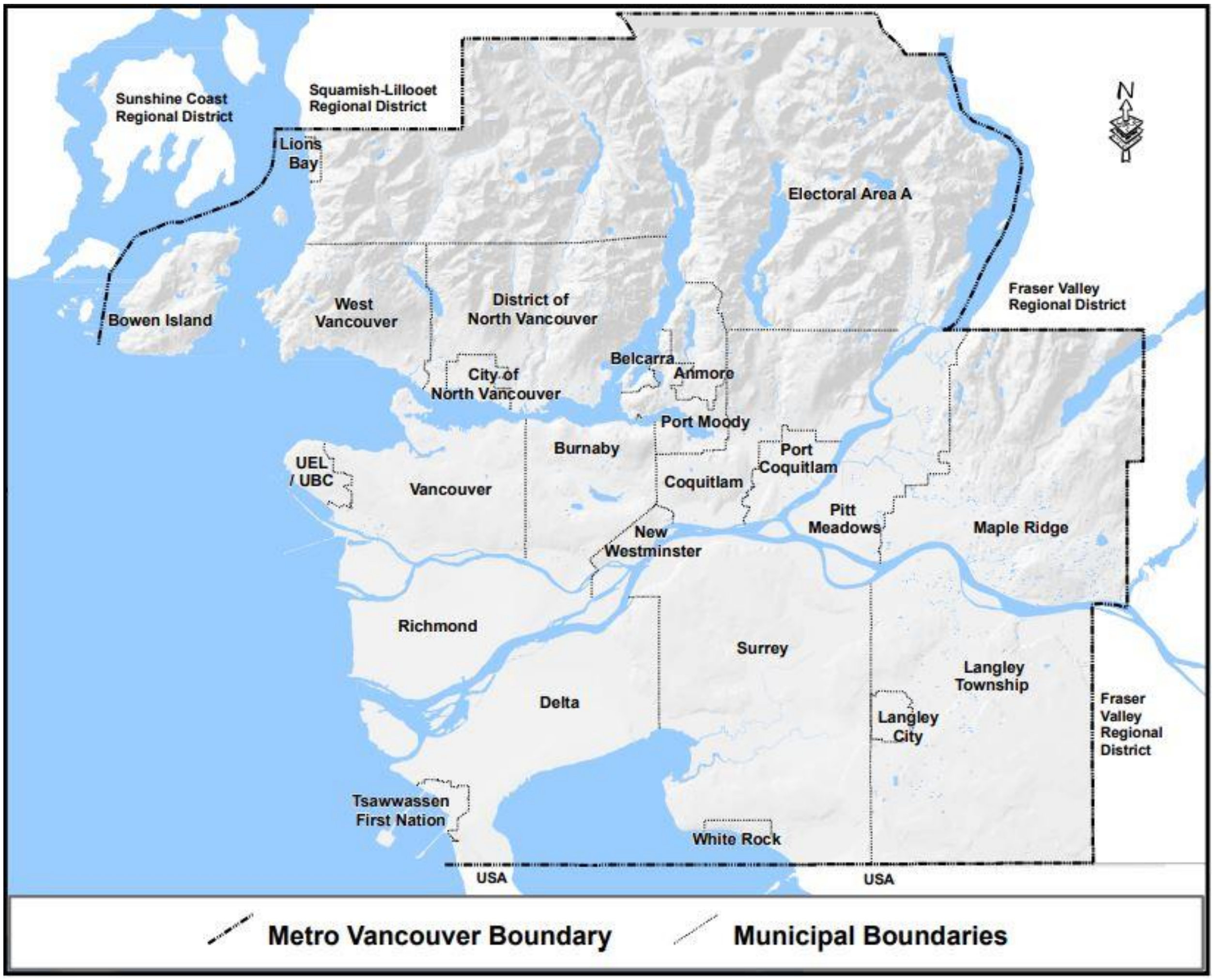

Figure 2-1: Metro Vancouver Region Map

2.1.2 Annacis Island WWTP History

MV owns and operates the AIWWTP. The original AIWWTP was commissioned in 1975 as a primary treatment plant. In 1999, the secondary treatment portion of the treatment plant (Stage IV expansion) was commissioned after a 10-year design and construction period. The Stage IV expansion was designed to provide average-day treatment capacity up to approximately 500 million liters per day (MLD). Pre-design of the Stage V expansion commenced in summer 2012. The purpose of the Stage V expansion is to increase the AIWWTP secondary treatment capacity by over 25% to an average dry weather flow (ADWF) of 637 MLD, with a peak wet weather flow (PWWF) of 18.9 m^3/s. The ultimate plant buildout is Stage VIII, which will have a PWWF of 25.3 m^3/s. Construction of the first phase of the Stage V expansion is expected to be completed by the end of 2021, with the second phase completed by the end of 2026.

The existing outfall was constructed in 1974 to transfer effluent flows from the CCTs to the diffuser structure located in the Fraser River, and consists of on-land and marine sections. Both sections were constructed using traditional open-cut methods. The on-land outfall conduit consists of a buried concrete box culvert (3,050 mm x 2,135 mm) and marine section consists of three (3) steel pipes (two 1,670 mm OD and one 1,220 mm OD), buried approximately 6 m below the river bed. These steel outfall pipes transport effluent to a system of riser pipes which release the effluent into the Fraser River. The outfall pipes are buried in the same trench as the existing South Surrey Interceptor (SSI).

2.1.3 Project Rational

The capacity of the existing outfall is approximately 14.5 m^3/s and dilution ratios at the edge of the IDZ have been estimated to be as low as 7:1 under adverse conditions. The existing outfall currently has neither the capacity to handle anticipated Stage V flows (18.9 m^3/s) nor the ability to meet the desired dilution ratio of 20:1 under several discharge scenarios. Further, the National Building Code of Canada 2010 (NBCC 2010) requires new wastewater facilities to be designed as post-disaster level facilities, capable of remaining operational following a seismic event with an Annual Exceedance Probability (AEP) of 1 in 2,475.

As the existing outfall system does not meet the design criteria, MV is proceeding with design and construction of the New Outfall System to increase the outfall capacity to serve the AIWWTP buildout (Stage VIII) capacity of 25.3 m^3/s, achieve a 20:1 dilution ratio, and to meet the AEP seismic criteria.

2.1.4 Project Overview

As mentioned in previous sections the capacity of the existing outfall (approximately 14.5 m^3/s) and dilution ratios at the edge of the IDZ (estimated to be as low as 7:1 under adverse conditions), do not meet the following requirements:

- Ability to handle Stage V flows (18.9m^3/s);
- Dilution ratio of 20:1 under several discharge scenarios, per BCMOE requirements; and
- MV's latest Seismic Design Criteria which requires post-disaster level performance for wastewater treatment plants.

To utilize the design capacity of AIWWTP's Stage V upgrades, replacement of the existing outfall is required. Therefore, the project objectives for the new AIWWTP outfall are as follows:

1. Provide an outfall system with a total capacity of 25.3 m^3/s (i.e., Stage VIII Peak Wet Weather Flow) at a river level of 103.18 m GD (defined as CVD28GVRD2005 geodetic datum elevation + 100m) without impacting the treatment plant hydraulic gradeline.
2. Achieve a minimum dilution ratio of 20:1 under slack water and low flows in the river.

The project will construct a new post-disaster performance effluent outfall for the AIWWTP starting from the CCT level control structure and terminating in the Fraser River. The main components of this project are:

- Level Control Structure (LCS) – A new structure with new level control gates connecting the existing CCTs and to the new Effluent Shaft.
- Effluent Shaft – An on-land shaft connecting the LCS to the Effluent Tunnel.
- Outfall Shaft – An on-land shaft for launching the tunnel boring machine (TBM) to excavate the Effluent and Outfall Tunnels, providing a home for the future Effluent Pump Station, and providing a connection for a future Post Disaster Bypass Conduit to Outfall (PDBCO) tunnel.

- PDBCO Shaft – An on-land shaft for connecting the Secondary Clarifiers to the PDBCO Tunnel. The design for the PDBCO was brought only to 60% as the PDBCO tunnel is no longer included in this project. The future PDBCO system will provide a means for the treatment plant to bypass flow to the outfall from the secondary clarifiers instead of through the CCTs.
- River Riser – A vertical riser pipe constructed within an in-river shaft connecting the Outfall Tunnel to the Diffuser Manifold.
- Effluent Tunnel – A TBM mined tunnel between the Outfall and Effluent Shafts.
- PDBCO Tunnel – A future mined tunnel between the Outfall and the future PDBCO Shaft. The PDBCO Tunnel is not part of this project.
- Outfall Tunnel – A TBM mined tunnel between the Outfall and Riser Shafts.
- PDBCO Tie-In – Provisions to facilitate connection of the future PDBCO Tunnel to the Outfall Shaft. This tie-in will be part of this project.
- Diffuser Manifold - In-river buried diffuser pipeline with vertical risers for discharging effluent into the Fraser River.
- Effluent Pump Station – Future pump station located within the Outfall shaft as required for future effluent flow and river level changes.

As presented in **Figure 2-2**, surface components of the project are located on the MV-owned AIWWTP property, within Annacis Island industrial area. Deep-tunneled components of the project are in noted Right-Of-Ways (ROW), and the outfall riser and diffuser structures are in the bed of the Fraser River, just outside from the navigable channel north boundary. This drawing can be found in the project drawing set attached in **Appendix A** as Drawing Number A10 X-G0101 – General Site Works NOS Aerial Map.

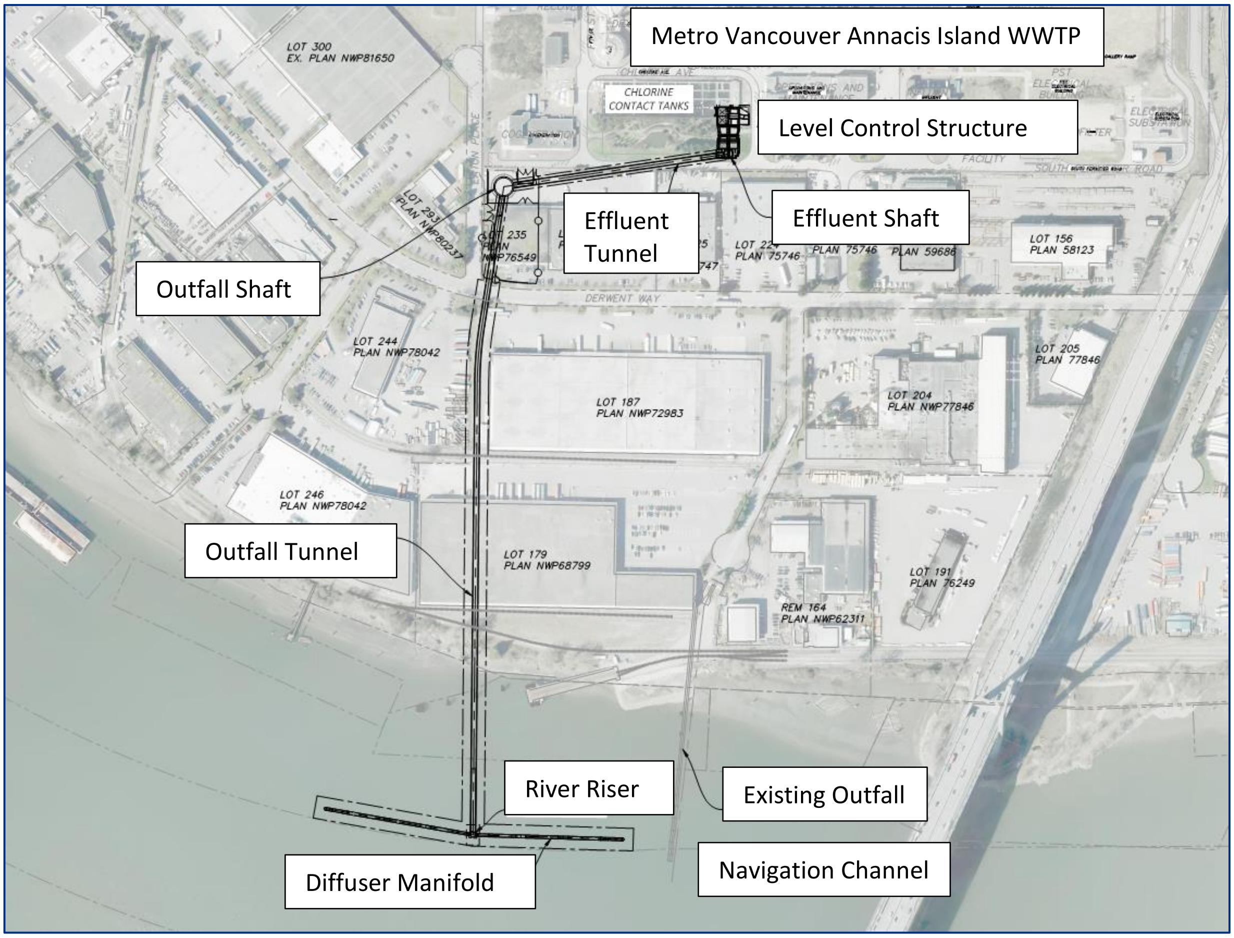

Figure 2-2: Project Overview (Drawing Number A10 X-G0101)

2.1.5 Potential Post-Construction Impacts

There are no anticipated post-construction project impacts on the adjacent community and businesses. Also, due to the buried nature of the new outfall system, and operation by gravity flow outside the AIWWTP, no additional traffic or operational requirements are anticipated outside of the Annacis Island WWTP boundary.

In the river, the new diffuser system will be installed in the river bed which and protected by riprap along entire length of the Diffuser Manifold. The diffuser risers will protrude up from the Diffuser Manifold and discharge towards the river center. Each diffuser will be surrounded by a concrete cap to protect them from impact related damages. Potential impacts on the river hydraulics and geomorphology were evaluated to determine possible impacts including any impacts to Southern Railway of British Columbia's maintenance dredging for their Railcar Barge Terminal. Computational fluid dynamics (CFD) analysis was conducted as part of the final diffuser design and determined that minimal impacts to river morphology and surrounding stakeholders are expected. Additional details of this analysis are presented in **Section 4.2** – Hydraulic Process and Alterations Report, and in **Appendix C.2**.

The Port actively dredges the Fraser River within the confines of the navigation channel. Due to the proximity of the new outfall diffuser system to the edge of the navigation channel, a Works Protocol is been developed between the port authority and Metro Vancouver to streamline intra-organizational notifications for future dredging near the outfall location. Details of the Works Protocol can be found in **Section 4.3**, Works Protocol and in **Appendix D**.

This project will not include the removal of the existing outfall system, or the removal or alteration of the South Surrey Interceptor. However, impact of these scenarios was modeled through CFD, and the results presented in the Hydraulic Process and Alterations Report.

For details of post-construction environmental impacts, please refer to **Section 2.2.2**, Operational Impacts, **Section 4.10**, Assessment of Effluent Discharge, and **Section 4.11**, Habitat Assessment.

2.1.6 Studies

The list of studies that have been completed in support of this application is presented in **Table 2-1**. These studies can be found in the appendices attached to this document.

Table 2-1: Study List

Appendix	Title	Description
B	Seismic Design Criteria and Performance Expectations	Guidance for consideration on seismic performance objectives of the project.
B	Ground Deformation Analysis	Results of 1D and 2D ground response analyses.
C	Overview of Fluvial Geomorphology	Review of the morphological changes along the Annieville Channel Reach of the Lower Fraser River over the last 50 years.
C	Hydraulic Process and Alteration Analysis	CFD modelling conducted to analyze the potential alterations to river hydraulics and bed stability due to construction of the new diffusers.
E	Traffic Impact Study	Traffic impact study to determine the potential effects on transportation access and mobility in the surrounding project area.
E	Traffic Management Guideline	General traffic management guidelines and restrictions that the contractor will need to follow for this project.
F	Navigation Impact Assessment	An assessment of potential navigation impacts and mitigation measures for construction and operation of the new outfall system. Includes Results of a simulation manoeuvring assessment of SeaSpan's barge operations serving the Southern Railway (SRY) Annacis Island Railcar Barge Terminal.
G	Sediment Characterization Report	The sediment characterization report performed according to a sampling and analysis plan reviewed and approved by Environment and Climate Change Canada intended for inclusion in a potential Disposal at Sea permit application.
H	Noise Assessment Project Score Sheet	Screening sheet per PER requirements to determine if this project warrants a full noise assessment of operational noise.
H	Baseline Environmental Noise Study	A baseline noise impact assessment was completed for this project concerning a nearby bald eagle habitat.
I	Outfall Options Analysis	A report describing the process of refining outfall system options based on cost and risk and recommending the option selected for final design.

Appendix	Title	Description
J	Geo-Environmental Assessment Report	An assessment of the geo-environmental conditions encountered along the proposed alignment corridor and the outfall locations
J	Construction Environmental Management Plan	The Construction Environmental Management Plan (CEMP) identifies prospective impacts and the measures required to mitigate construction related impacts within the immediate environment and surrounding community resources.
K	Stage 1 Environmental Impact Study (EIS)	Stage 1 EIS is intended to provide a preliminary assessment of potential impacts of effluent discharge from the new outfall based on the preliminary outfall diffuser design and existing effluent and receiving environment
K	Stage 2 Environmental Impact Study	The Stage 2 EIS is intended as a technical assessment of predicted water quality to evaluate whether adverse effects on aquatic and public health might result from the proposed effluent discharge.
L	Habitat Assessment	Description of existing fish and wildlife and habitat; assessment of impacts and mitigation during project construction and operation
L	DFO Request for Review	Request for review submission to the Fisheries and Oceans Canada (DFO) regarding fish and fish habitat impacts in the surrounding environment and mitigative measures during and post construction.

2.2 Operation

2.2.1 Capacity

The original AIWWTP was commissioned in 1975 as a primary treatment plant. In 1999, the secondary treatment portion of the treatment plant (Stage IV expansion) was commissioned after a 10-year design and construction period. The Stage IV expansion was designed to provide treatment capacity up to approximately 500 MLD. As a next step in increasing the plant's capacity do to increase in population in the plan's collection area (Fraser Sewerage Area), the pre-design of the Stage V expansion commenced in summer 2012. The purpose of the Stage V expansion is to increase the AIWWTP secondary treatment capacity by over 25% to an ADWF of 637 MLD, with a PWWF of 18.9 m^3/s. Construction of the first phase of the Stage V expansion is expected to be completed by the end of 2020, with the second phase completed by the end of 2022. The ultimate plant buildout is Stage VIII with a PWWF of 25.3 m^3/s.

The capacity of the existing outfall, constructed in 1974, is approximately 14.5 m^3/s and dilution ratios at the edge of the IDZ have been as low as 7:1 under adverse conditions. The existing outfall currently has neither capacity to handle anticipated Stage V flows (18.9 m3/s) nor ability to meet the desired dilution ratio of 20:1 under several discharge scenarios.

The New Outfall System project is designed to serve the AIWWTP ultimate buildout (Stage VIII) capacity of 25.3 m^3/s. It will be achieved with phased approach, with the conveyance capacity of the tunnel and riser sufficient for the buildout flow rate, and the diffuser ports sufficient to handle the Stage V flows. The diffuser's capacity will be increased for the future stages by opening more ports in the structure. These ports will be preinstalled and blind-flanged to maintain desired diffuser discharge velocities under Stage V flows.

2.2.2 Operational Impacts

Potential impacts for this project during the operational phase can include environmental impacts as it pertains to effluent discharge in the receiving water and impairment of use, navigation impacts, and other operational impacts as it pertains to uses by surrounding communities and stakeholders.

The new outfall diffuser will discharge treated effluent from the AIWWTP. Due to the change in location of discharge and increase in volume of effluent over time, an amendment of the plant's Operational Certificate under the BC Municipal Wastewater Regulation (MWR) is required. This amendment requires an Ministry of Environment Environmental Impact Study (EIS) to evaluate impacts of the increased discharge and location of discharge in the receiving environment and public health. The mitigative strategy is to design the new outfall to maximize the dilution of the project design flows in the receiving environment under various plant effluent flow rates and Fraser River hydraulic conditions. Detailed dilution modelling was conducted to assess the anticipated impacts on the receiving environment both near the edge of the diffuser IDZ, as well as further downstream and upstream of the discharge for various constituents of concern. Additional details of the current modelling can be found in **Section 4.10**, Assessment of Effluent Discharge, and as an attachment to **Appendix K.2**.

While the new outfall diffusers and protection caps will protrude from the river bed to 8.6 m below chart datum, these structures are located outside the navigation channel within the navigation channel safety boundary, thus not impacting the normal river navigation in the area. During the operational phase, the outfall will need to be inspected annually, risers repaired, if necessary, additional risers installed for future plant flow expansion, and riser ports replaced (approximately every 30+/- years). Details of the operational impacts to navigation are presented in **Section 4.5**, Navigation Impact Assessment, and in **Appendix F.2**.

The project's hydraulic impacts to neighbours upstream and downstream of the site can be found in **Section 4.2**, Hydraulic Process and Alterations Report, and in **Appendix C.2**. Details of the Works Protocol develop by the port authority and Metro Vancouver can be found in **Section 4.3**, Works Protocol, and in **Appendix D**.

2.3 Construction

2.3.1 Construction Schedule and Staging

The proposed construction period for new outfall system is anticipated to start in January 2019 and finish early to mid 2022. General work hours are assumed to be 5-days a week, 8-hours per day from 07:00 to 19:00 with a 1-hour lunch break. Other than during tunnel mining, extended work hours may be required for some construction activities such as extended concrete pours or equipment mobilization outside normal work hours.

During tunnel advancement, the work schedule is assumed to proceed 7-days a week, 24-hours a day with two 8-hour tunnel mining shifts and one 8-hour maintenance shift. This work will be located exclusively on land, and will be subject to a City of Delta (CoD) Noise Variance. Weekends are anticipated to be for maintenance purpose therefore, tunneling advancement is not expected. Work crews during tunneling are anticipated to work 10-hour shifts.

Figure 2-3 below presents a summary schedule for this project during construction, with the anticipated Notice to Proceed (NTP) date of January 2019. It includes the key durations for shaft construction and tunneling, in-river construction, and construction of the on-land structures. Critical path for the construction phase will be procurement of the tunnel boring machine (TBM) and subsequent re-assembly and drive to the different shafts. The completion of the Outfall Shaft (also known as the future pump station, PS) will be one of the final steps prior to plant tie-in and project commissioning.

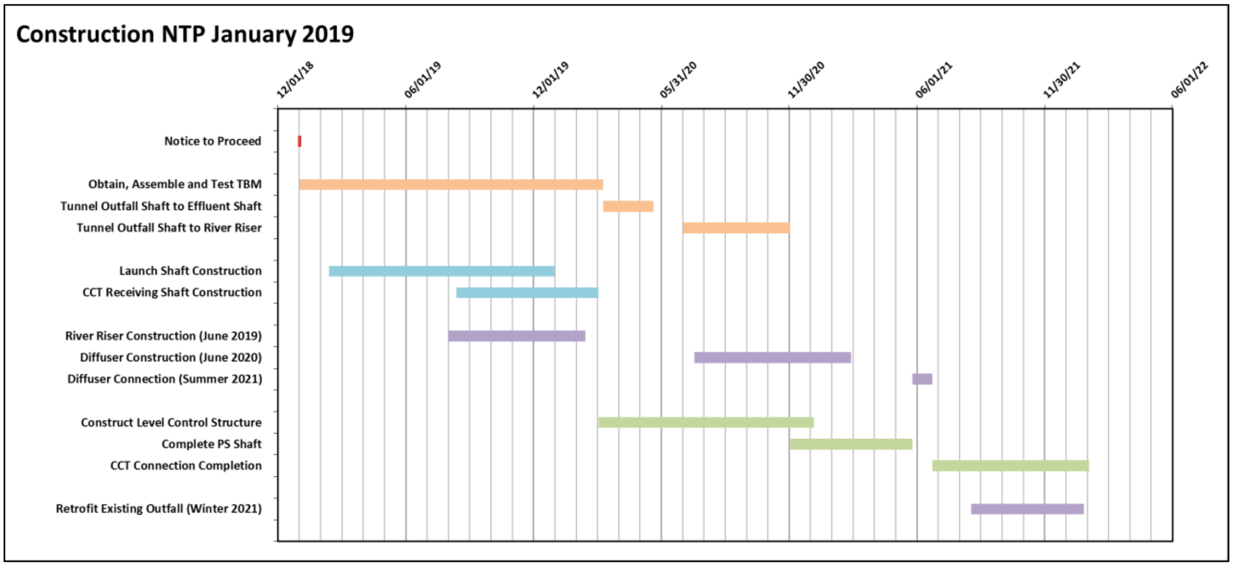

Figure 2-3: Construction Schedule

Generally, construction of the New Outfall System is anticipated to be in the order listed below. Additional schedule details for the in-river work is presented in the DFO Request for Review Supplemental Report located in **Appendix L.4**. A condensed item list for the staging of both land-based and marine-based construction works is as follows:

1. Contractor mobilization including setting up site trailers;
2. Install environmental controls;
3. Utility relocation/protection;
4. TBM (procure and deliver TBM);
5. Installation of instrumentation and monitoring;
6. Outfall Shaft (TBM launch shaft) construction (except final liner);
7. Effluent Shaft (TBM receiving shaft) construction (except final liner);
8. Tunneling from Outfall Shaft to Effluent Shaft (Tunnel Section 1);
9. Effluent Tunnel final lining;
10. River Riser construction (first river construction work window);
11. Effluent Level Control Structure construction;
12. Diffuser Manifold installation (second river construction work window);

13. Tunneling from Outfall Shaft to the Riser Shaft (Tunnel Section 2);
14. Outfall Tunnel final lining;
15. PDBCO Tie-in (simultaneously with final lining);
16. Diffuser Connection;
17. Flood the tunnel and commission the LCS gates;
18. Commission New Outfall System and divert all flow from Existing Outfall;
19. Complete connection at CCT; and,
20. Retrofit Existing Outfall.

2.3.2 In-River Construction Method

The design of the in-river diffuser portion of the New Outfall System (see **Figure 2-4**) considered the limitations associated with the in-river construction windows (in-river construction work is restricted from March 1st to June 15th) and impacts on river navigation. The diffuser design was developed such that all in-river construction could be completed in three or four in-river construction windows. The anticipated construction method for each in-river construction widows is discussed below. In-river work areas for each of the four construction seasons are described in **Section 4.5.3** and **Appendix F.2**. Additional information on work activities and potential risks for fish and fish habitat are presented in **Appendix L.4**.

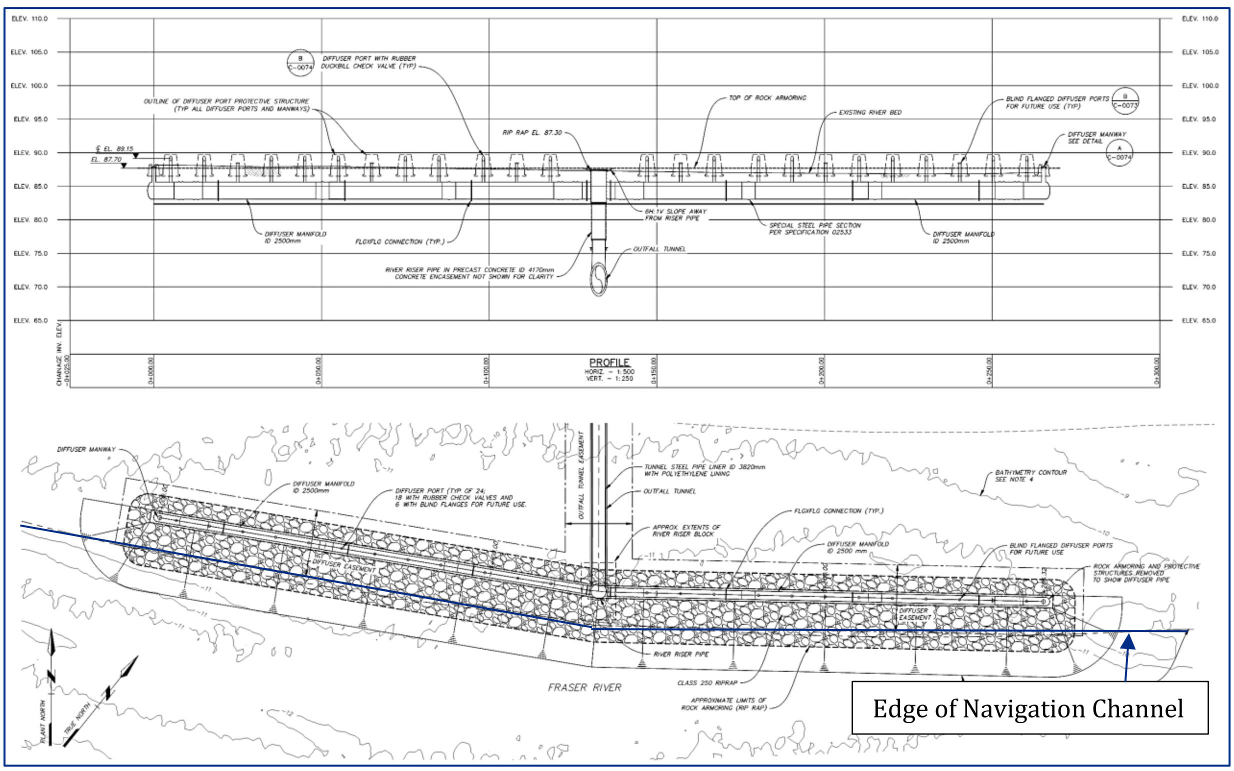

Figure 2-4: Diffuser Plan and Section (Drawing Number A61C0005)

Note that elevations shown on the drawings for all facilities are referenced to AIWTTP Plant Datum. AIWTTP elevations equal to geodetic elevations (CVD28GVRD2005 Datum) plus 100 m. Bathymetric contours are referenced to Chart Datum as used by the port authority, Fisheries and Oceans Canada (DFO), and the Canadian Coast Guard (CCG). **Table 3-1** in **Section 3** presents various relevant project water elevations, and the relationship between datums.

2.3.2.1 Season 1: River Riser

Figure 2-5 shows the concept for the River Riser to be constructed during in-river Season 1 (2019). See Drawing Number X-A61S0081 to Drawing Number X-A61S0083 in **Appendix A** for the complete construction sequence which includes the following activities:

- Temporary cofferdam construction and excavation to El. 64.1 m within the cofferdam.
- Install riser foundation piles with a bottom tip El. of 40 m.
- Install first reinforced structural concrete backfill sequence by tremie method with the Top of Concrete (TOC) at El. 67.6.
- Allow concrete to cure for 7 days.
- Install second reinforced structural concrete backfill sequence with the TOC at El. 74.3 m.
- Build the riser pipe support frame and install pre-assembled riser pipe inside cofferdam.
- Install second reinforced structural concrete backfill sequence with the TOC at El. 82 m.
- Install the riser pipe tee/cap. Lift weight approximately 37 metric tonnes.
- Remove the temporary cofferdam.

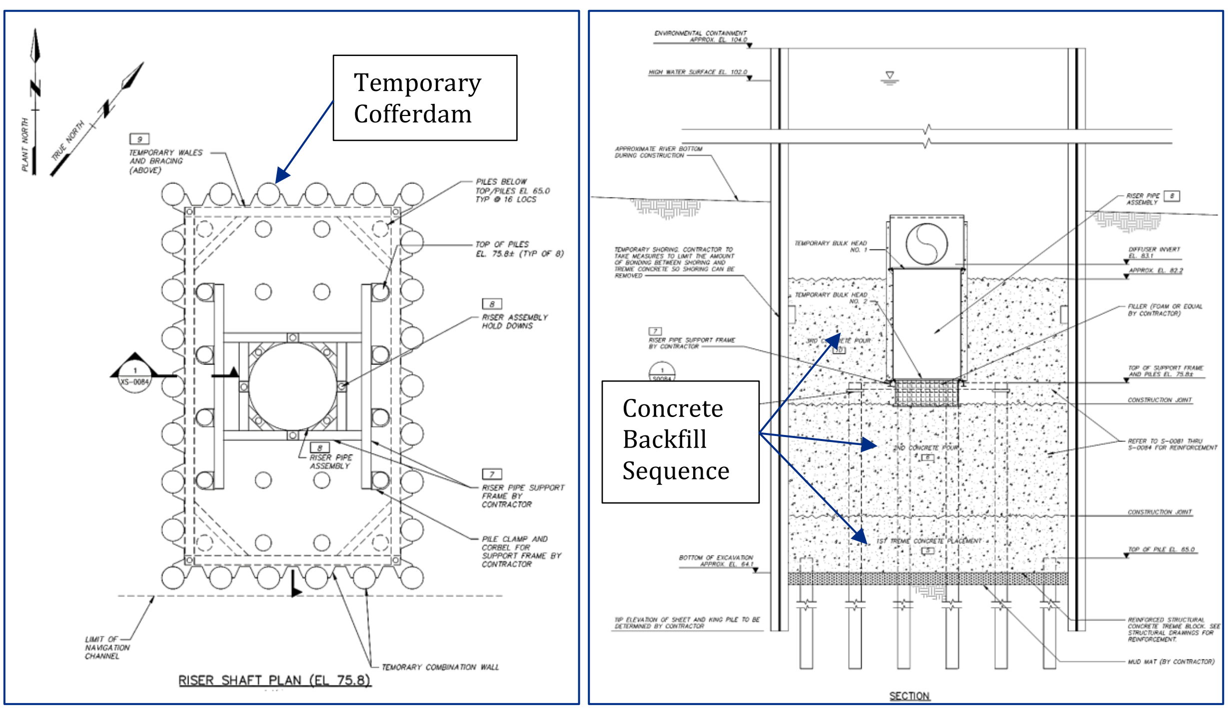

Figure 2-5: River Riser Construction (Drawing Number X-A61S0082)

The River Riser design anticipates that a temporary cofferdam excavation support system is installed by the contractor that would consist a combination steel piles and sheets extending above the high river water level surface. The size of the coffer dam will be approximately 12 metres by 19 metres to provide enough room for construction of the River Riser structure. Due to the depth of the river shaft excavation, the temporary shoring will require internal bracing.

In addition to providing a temporary excavation support, excavation support system will serve as a sedimentation containment and protective barrier from the river flow. While the contractor may elect to have a sealed cofferdam, and perform the work in the dry, the River Riser design anticipates all work inside the cofferdam to be done under water.

2.3.2.2 Season 2: Diffuser Installation

During in-river Season 2 (2020), both arms of the Diffuser Manifold will be installed (**Figure 2-6**). See Drawing Number A61C0071 to Drawing Number A61C00073 in **Appendix A** for section views of the Diffuser Manifold. The contractor will install each arm of the diffuser in one or more sections using the following construction sequence:

- Install temporary sheeting along land side of the diffuser alignment to limit the extent and volume of dredging;
- Dredge trench in river bed for the Diffuser Manifold;
- Place Diffuser Manifold pipe bedding material at the base of the trench;
- Install pre-assembled sections of Diffuser Manifold pipeline, and connect sections together and to the River Riser;
- Backfill trench with native river sand and cover backfill with armor rock; and
- Install concrete diffuser protective structures and install flexible diffuser ports with check valves.

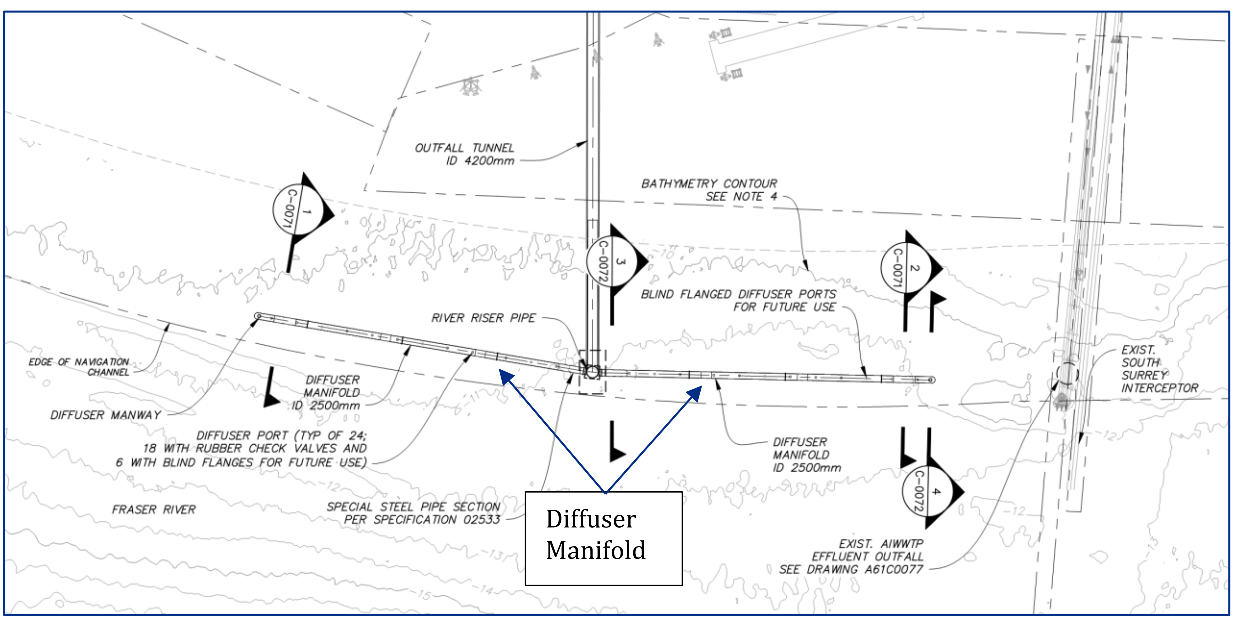

Figure 2-6: Diffuser Installation Construction (Drawing Number A61C0070)

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2.3.2.3 Season 3: Diffuser Connection

Following the completion of tunnel mining during in-river Season 3 (2021), the tunnel will be flooded and the connection between the River Riser and Diffuser Manifold will be completed by:

- Removal of the riser cap;
- Equalization of internal water pressure and removal of the double bulkheads within the River Riser pipe; and
- Reinstallation of the riser cap.

2.3.2.4 Season 3/4: Bypass Outfall Repair

Following commissioning of the New Outfall System, the existing outfall will be rehabilitated to allow it to continue to serve as an emergency influent bypass. The work is anticipated to take a few weeks to install new flexible valves on the top of the existing 21 vertical steel riser pipes extending above the river bed.

2.3.3 Tunnel Construction Method

This project requires two tunnel drives; first drive is to construct the Effluent Tunnel from the Outfall Shaft to the Effluent Shaft and the second drive is to construct the Outfall Tunnel from the Outfall Shaft to the River Riser. Plan and profile views of the tunnels are shown on Drawing Number A61C0002 to Drawing Number A61C0004 in **Appendix A**. The tunnel inside diameter is 4,200 mm and the tunnel invert elevation is at El. 69 metres.

The tunnel excavation is anticipated to be carried out using a pressurized-face TBM along with installing concrete liner segments (i.e., one-pass support system consisting of approximately 25 centimetres-thick precast concrete segments). The TBM can be either a slurry pressure balance (SPB) TBM, earth pressure balance (EPB) machine, or a hybrid that includes components of both machine types. Activities and equipment associated with excavating the tunnel and installing tunnel lining include the following:

- TBM tunnel mining;
- Processing of TBM slurry (SPB) or removal of tunnel spoil from the shaft (EPB);
- Temporary stockpiling of tunnel spoils on-site;
- Hauling of tunnel spoils to permitted upland disposal site;
- Delivery and storage of pre-cast tunnel lining segments;
- Delivery and installation tunnel lining segments as TBM advances;
- Use of grout and ground conditioning materials;
- Extension of process and ventilation piping, as well as rails or conveyors for muck removal, as the tunneling proceeds;
- Removal of the TBM from the Effluent Shaft following Effluent Tunnel mining; and
- Abandonment of the TBM in the River Riser with completion of the tunnel lining and connection to the riser pipe as shown in **Figure 2-7**.

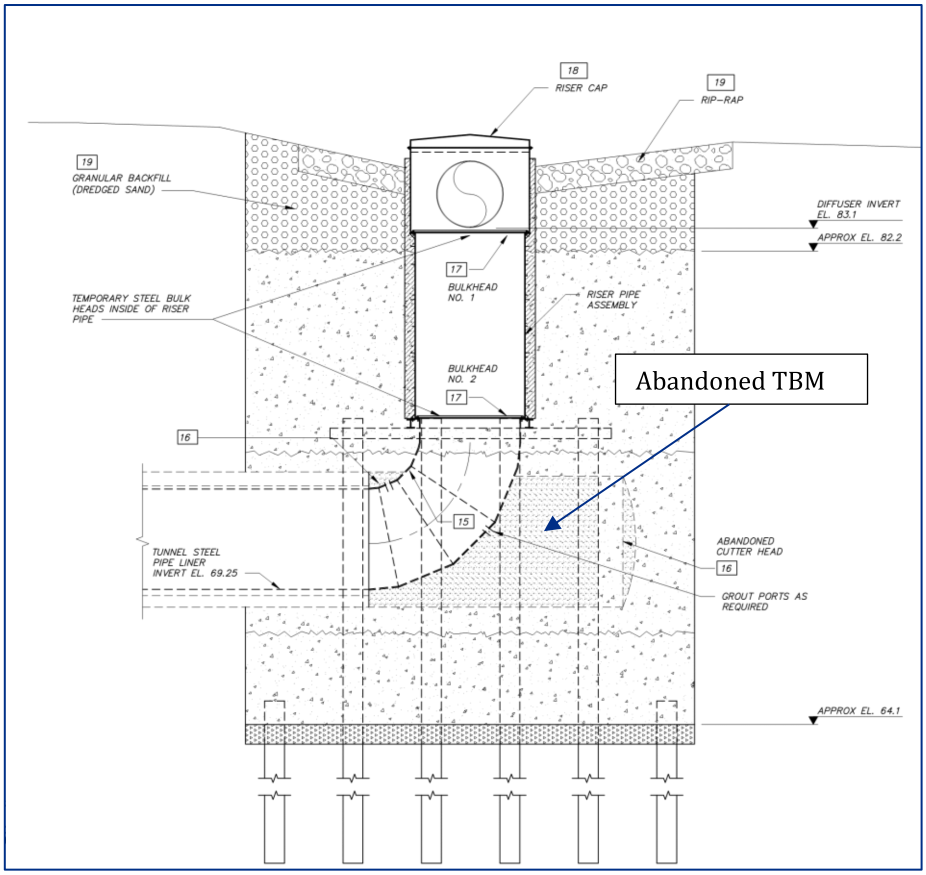


Figure 2-7: Tunnel Connection to River Riser Pipe (Drawing Number X-A61S0083)

Assumptions related to the tunneling operations include:

- Tunnel lining segments will be delivered by truck to a storage area near the launch shaft adequate for a two- to three-day supply (15 m by 33 m). Lining segments would be delivered to the shaft via truck or special carrier vehicle and lowered into the shaft by crane.
- Tunnel excavation spoil will be removed from shaft using a crane or vertical conveyor and placed in a temporary stockpile adjacent to the shaft (about 6 m by 20 m), then transported off-site by truck. Alternatively, the spoil could be placed directly into a hopper feeding a conveyor belt system for muck transfer to a temporary muck storage area on or near the plant site, and then transported off-site by truck.

Completion of the tunneling phase includes removal of the tunneling related equipment from the shaft and site, lining system completion, and installation of the internal steel liner and connections.

2.3.4 Construction Equipment

A summary table listing the equipment to be utilized in the different major construction phases of this project is presented in **Table 2-2**.

Table 2-2: Construction Equipment

Process / Activity	Equipment Required by Activity
TBM Tunneling	
Procure and Deliver TBM	Flatbed trucks, 200-Ton Boom Crane
Assemble and Test TBM	Crane, Welding equipment, Air compressor.
Tunnel Mining	TBM, Diesel power generators, Slurry plant (SPB TBM), Cranes, Vertical and horizontal conveyor belts, Muck cars and rails, Concrete batch plant, Grout pumps, Dump trucks, Frontend loader, Backhoe excavator, Flatbed trucks, Forklifts, Tunnel ventilation fans.
Decommission and Remove TBM	200-Ton boom crane, Support crane, Welding equipment, Air compressor.
Shafts: Effluent and Outfall	
Prepare Launch Shaft Site	Pickup trucks, Dump trucks, Concrete saw, Jackhammer, Frontend loader, Backhoe excavator.
Build Slurry Walls	Crane with Hydromill, Dump trucks, Concrete truck, Slurry plant.
Excavate Shaft	Crane with clamshell bucket, Frontend loader, Backhoe excavator, Dump truck, Ventilation fans.
Cast Base Slab	Crane, Welding equipment, Concrete trucks, Concrete pumps.
Grout, Clean, and Prepare for TBM	Dump truck, Backhoe excavator, Jet grout rig, Grout pumps, Air compressor.
River Riser (First In-River Construction Season)	
Prepare and Mobilize on Water	Crane barge, Support barge, Worker transport launches.
Install Temporary Cofferdam	Crane barge, Vibratory pile driver.
Excavate and Backfill Riser	Crane barge with clamshell bucket, Material barges, Concrete truck, Concrete pump, Diving equipment.
Complete Riser and Prep. Pipe Connection	Crane barge, Support crane barge, Welding equipment.
Secure Site and Demobilize	Crane barge, Vibratory pile removal, Material barges, Barge demobilization.
Diffuser Second In-River Construction Season)	
Prepare and Mobilize on Water	Crane barge, Support barge, Worker transport launches.
Dredge for Pipeline and Manifold	Crane barge, Vibratory pile driver, Dredge with clamshell bucket, Material barges.
Install Pipeline and Manifold	Crane barges, Delivery barges, Diving equipment.
Backfill and Place Armor Rock	Crane barges with clamshell bucket or skip, Material barge, Diving equipment.
Secure Site and Demobilize	Crane barge, Vibratory pile removal, Material barges, Barge demobilization.
Level Control Structure	
Transition Site	Crane, Frontend loader, Backhoe excavator, Pickup trucks, Dump trucks.
Construct Distribution Channel Complete Flexible Connection Channel Construct Level Control Gate Structure	Crane with vibratory pile driver, Frontend loader, Backhoe excavator, Dump trucks, Concrete trucks, Concrete pumps, Concrete saw, Jackhammer, Flatbed trucks, Rebar assembly equipment.
Complete New Construction / Prepare for Tie-In	Crane, Pickup truck, Flatbed truck.

Process / Activity	Equipment Required by Activity
Complete Shafts	
Prepare Shaft for Construction	Crane, Pickup trucks.
Build Final Lining, Interior Wall, Riser Connection	Crane, Welding equipment, Concrete trucks, Concrete pumps, Flatbed trucks, Rebar assembly equipment.
Flood Tunnel	Crane, Water pumps.
Diffuser Connection (Third In-River Construction Season)	
Prepare and Mobilize on Water	Crane barge, Worker transport launches.
Remove Double Bulkhead	Crane barge, Diving equipment.
Secure Site and Demobilize	Crane barge, Barge demobilization.
CCT Connection Completion	
Channel Work	Crane, Concrete trucks, Concrete pumps, Concrete saw, Jackhammer, Flatbed trucks, Rebar assembly equipment.
Complete LCS Tie-In	Crane, Water pumps.
Retrofit Existing Outfall (Third In-River Construction Season)	
Prepare and Mobilize on Water	Crane barge, Worker transport launches.
Repair Old Outfall	Crane barge, Material barge, Diving equipment.
Secure Site and Demobilize	Barge demobilization.

2.3.5 Construction Impacts

2.3.5.1 Traffic Impacts

All the on-land portions of the New Outfall System will be constructed on Annacis Island WWTP property and have limited construction impacts outside the plant. The primary impact will be construction traffic (worker vehicles, construction material deliveries, and excavation spoil hauling). Traffic related impacts and mitigation are described in **Section 4.4** and **Appendix E.1**. Traffic management guidelines are presented in **Appendix E.2**.

2.3.5.2 Navigation Impacts

The in-river portion of the New Outfall System is located just outside the northern boundary of the navigation channel within Annieville Channel of the Fraser River. Diffuser manifold pipes will extend upstream and downstream from the riser, aligned approximately parallel with and immediately shoreward of the northern margin of the navigation channel. As per **Figure 2-8**, the distance from the edge of the navigation channel to the centerline of the diffuser manifold is about 10 m.

Navigation impacts and mitigation are described in **Section 4.5**, **Appendix F.1**, Marine User Information Session, and **Appendix F.2**, Navigation Impact Assessment.

2.3.5.3 Dredging Impacts

Figure 2-8 presents the anticipated extent (Drawing Number A61C0005 in **Appendix A**) of dredging required for the installation of the Diffuser Manifold (approximately 12,750 m^2).

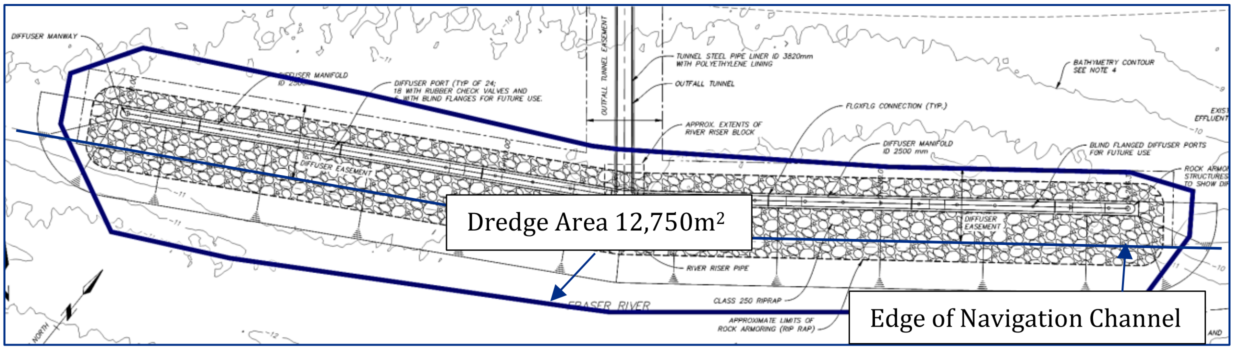


Figure 2-8: Extent of Diffuser Dredging (Drawing Number A61C0005)

Dredge area, volume, methods, and dredging impacts and mitigation are described in **Section 4.6**. Dredging impacts and mitigation related to fish and fish habitat are discussed in **Appendix G.1**. Additional details related to habitat assessment is presented in **Section 4.11** and a complete discussion of potential risks for fish and fish habitat is contained in the DFO Request for Review and supplemental information contained in **Appendix L.2** to **Appendix L.4**.

2.3.5.4 Noise Impacts

Noise impacts and mitigation are described in **Section 4.7**, a Noise Assessment Screening Worksheet is presented in **Appendix H.1**, and a Baseline Environmental Noise Study is presented in **Appendix H.2**.

Construction activities and construction-related traffic can generate short-term, temporary increases in noise and vibration levels. Both noise and vibration dissipate with distance and may only affect receptors that are closest to the project site. The goal of construction noise management is to minimize construction noise and vibration impacts to neighbours. Once construction is complete, the operation of the New Outfall System will not generate any noise.

Discussions with the City of Delta during project pre-permitting meetings indicated a preference for issuing a 24/7 noise variance for a duration of one year to initiate the project (and renewed as required). This is in line with other construction projects currently occurring at the Annacis Island WWTP. Application of the noise variance permit will be made two months prior to project tender, as indicated by the City of Delta. Once approved, the noise variance permit will be submitted to the port authority to satisfy the anticipated conditions of the PER permit.

The New Outfall System contractor is to comply fully with the requirements of the City of Delta Noise Control Bylaw. Key mitigation measures by Contractor for this project include:

- Regardless of City of Delta noise variance permit, limit high impact or heavy equipment construction noise to hours between 7:00 to 19:00, Monday to Friday, and between 9:00 or 17:00 on Saturday, per Delta Noise Control Bylaw No. 1906.
- Support communication with neighbours when requested by MV. This includes providing necessary information about the project, construction hours, and potential noise and vibration due to the proposed construction activities, and measures to be taken to mitigate potential noise and vibration.
- List contact information for complaints and respond to noise complaints.

The contractor will also be required to implement the following best practice sound attenuation measures to limit impacts to surrounding neighbours and confirm noise mitigation procedures are in place prior to commencing noisy work activities:

- Turn off equipment when not in use to minimize idling.
- Use quietest type of equipment that is available and appropriate for each task.
- Maintain and utilize equipment with noise attenuation to minimize noise generation (e.g., exhaust mufflers, acoustically attenuating shields, shrouds, or enclosures).
- Operate equipment at the minimum engine speed possible for the task and/or within load tolerances and ratings.
- Train on-site workers to be aware of noise and vibration issues and how to minimize noise and vibration generation where possible.
- Select haul schedule and routes to minimize impacts to noise-sensitive receptors.
- Provide appropriate level of sound attenuation to minimize noise levels.

2.3.5.5 Lighting Impacts

Construction site lighting both on-land and in-water will be designed and setup by the contractor based on the requirements of the construction and staging areas. Lighting during construction will need to minimize impacts to surrounding neighbours on-land, and not impact river navigation requirements during in-river construction works. Submission and approval of the construction lighting design will be a condition of the Port PER permit for this project, and will be completed upon selection of the preferred project contractor.

Section 3

Design Drawings

The Annacis Island WWTP New Outfall System design drawings are presented in **Appendix A**. They comprise select drawings specific to the port authority's PER Application Submission Requirements, and are at the 90% design level. **Section 3** provides commentary for the drawings in relation to the specific PER submission requirements.

3.1 Site Plan

3.1.1 General Drawings

Drawings A10G0031 and A10 X-C0101 show the general project location and plan.

3.1.2 Lease and Property Boundaries, Easements, and Right of Ways

Drawings A10 X-G0101, X-A61C0028 to X-A61C0031 show Lot plans and Right of Ways.

3.1.3 Elevations and Legal High-Water Mark

Elevations shown on the drawings for all facilities are referenced to AIWTTP Plant Datum. AIWTTP elevations are equal to geodetic elevations (CVD28GVRD2005 Datum) plus 100 m. Bathymetric contours are referenced to Chart Datum as used by the port authority, Fisheries and Oceans Canada (DFO), and the Canadian Coast Guard (CCG). A Low Water (LW) river surface elevation is used as the Chart Datum. DFO published information indicates the Chart Datum elevation is equivalent to CGVD28/GSC Datum Elevation -1.58 m at the Alex Fraser Bridge. The exact relationship of the CVD28GVRD2005 Datum to the CGVD28/GSC Datum is not published, but we estimate it to be about 0.143 m. based on similar relationships published for nearby on-land benchmarks. **Table 3-1** presents various relevant project elevations and their estimated relationship to Chart Datum elevations.

The maximum Design River Stage elevation (El. 103.18) was provided by Metro Vancouver for design of the New Outfall System. See drawing A10 X-G-001. We understand it to be based on an interpolated valued from the Fraser River Hydraulic Model Update Final Report, by the Ministry of Environment, dated March 2008.

The legal high-water mark or high-tide mark forms the natural boundary where the land below the natural boundary is defined as the foreshore belongs to the Federal government at the project site. The land above the boundary is upland and riparian land. This point of demarcation is typically also termed the normal high-water mark. While the actual location is determined by survey, the legal high-water mark can be approximated the high-water datum, which is at about Elevation 3.58 Chart Datum at the Alex Fraser Bridge.

Table 3-1. Estimated Tidal Datums for New Outfall System Site

Datum	Elevation (m)		Description
	AIWTTP Plant Datum [1]	Chart Datum [2]	
DRS w/ SLR [3]	104.18	5.90	Design River Stage w/ Sea Level Rise
DRS [3]	103.18	4.90	Design River Stage, 200-yr peak winter flood level
HW	101.86	3.58	High Water at Alex Fraser Bridge
CVD28GVRD2005 [4]	100.00	1.72	Geodetic Datum, 2005 GVRD Adjustment
CGVD28/GSC	99.86	1.58	Geodetic Datum, 1977 HT97 Geoid Adjustment
LW	98.28	0.00	Chart Datum at Outfall Location
Low River	96.78	(1.50)	River Low Elevation at Outfall Location (99.5 Percentile)
Outfall Depth	89.70	(8.58)	Top of Diffuser Protective Covers
Dredge Grade	87.38	(10.90)	Navigation Channel Dredging Grade (+/- 0.01 m)
Dredge Subgrade	85.43	(12.85)	Navigation Channel Dredging Subgrade (+/- 0.16 m)

1) AIWWTP Datum Elevation = CVD28GVRD2005 Elevation + 100 metres.
2) Chart Datum = Low Water Datum based on CGVD28/GSC.
3) Design River Stage Elevations provided by Metro Vancouver.
4) CVD28GVRD2005 Elevation = CGVD28/GSC Elevation - 0.143 m. Estimated based on 2005 GVRD Regional Refresh for Benchmark 80333 (GCM No. 87H3501) along outfall alignment.

3.1.4 Location and Dimensions of all Existing and Proposed Buildings

For the location and dimensions of all existing and proposed buildings, structures, equipment, and marine structures in immediate vicinity of works area, see drawings A61C0001 to A61C0005.

3.1.5 Construction Access Points

The following are the details regarding the Construction access points, including roadways, driveways, parking areas, walkways, berths, gangways, and docks:

- All access for the in-river construction will be via the Fraser River with labor, equipment, and materials mobilized from locations along the river selected by the contractor. There are no provisions for access from the nearby shore of Annacis Island. Marine navigation requirements will be the same as for all other commercial navigation on the river.
- The contractor will be required to prepare a project specific Navigation Protection Plan (NPP) (see **Appendix F.2**) addressing anticipated marine navigation activities between barge or vessel loading sites along the Fraser River and the project site.
- For on-land construction access points, see drawings X-A10C0007 and X-A10C0008.
- In-river construction work areas are defined in **Appendix F.2**, Navigation Impact Assessment and **Appendix L.4**, DFO Request for Review Supplemental Report.

3.2 Land Structures and Equipment

3.2.1 Excavation Depths

The anticipated excavation depths below grade are provided in drawings A61C0001 to A61C0005. **Table 3-2** shows the excavations depth of land structures.

Table 3-2: Excavation Depths for On-Land Structures

Facility	Excavation	
	Type	Depth, m
Effluent Level Control Structure[1]	Open-Cut	2.7
Effluent Connection Channel[1]	Open-Cut	2.7
Effluent Shaft Top Structure[1]	Open-Cut	2.7
Effluent Shaf Top Structure Piles[1]	Driving	53
Effluent Shaft[1]	Open-Cut	50.5
Effluent Shaft Slurry Wall[1]	Driving	56.5
Effluent Tunnel[1]	Tunneling	35.5
Outfall Shaft	Open-Cut	50.5
Outfall Shaft Slurry wall	Driving	58.5
Outfall Tunnel[2]	Tunneling	35.5

Notes:
.1 Structures that are not under this permit
.2 Outfall Tunnel extends from Outfall Shaft on land to River Riser in the river

3.2.2 Site Loading

3.2.2.1 Outfall Shaft

Outfall Shaft, located on land, will facilitate launching of the Tunnel Boring Machine (TBM) to excavate the Effluent Tunnel and Outfall Tunnel. The Outfall Tunnel extends from the Outfall Shaft to the River Riser that is located approximately 160 m from the shoreline.

The Outfall Shaft construction methodology is assumed to be by slurry panels. Slurry panels are designed as plain concrete in accordance with CSA A23.3, Chapter 22, using factored soil and groundwater lateral loads. Slurry panels are 3,000 mm long by 1,220 mm wide with a total of 24 panels to make the slurry wall shaft circumference.

A 3.75-metre-thick reinforced concrete base slab will be keyed into the slurry wall panels approximately between El. 63.85 and 67.60 metres. Slurry wall shaft buoyancy during construction neglects the slurry wall panel length contribution embedded below the bottom of the base slab. Assuming the shaft is empty and prior to the final lining, the factor of safety is 2.2 including shaft dead weight and friction. Slurry panels will extend to El. 46.00 meters. Seepage calculations indicate a negligible vertical gradient in the Unit 3B sand and a factor of safety for base stability of 1.61. Detailed information on the project geotechnical conditions and design requirements are presented in **Section 4.1**, Geotechnical Report, and in **Appendix B**.

The Outfall Shaft final lining is designed to resist all horizontal loads including seismic loading assuming the slurry panels are not resisting loads. For additional information on design seismic requirements, refer to **Section 4.1**, Geotechnical Report, and in **Appendix B**.

3.2.2.2 Outfall Tunnel

Design calculations were performed to establish a minimum thickness of segmental lining for the project tunnels under hydrostatic and soil loads. Two critical sections were selected for this preliminary calculation, based on the maximum thickness of soil layer above the tunnel and the maximum hydrostatic pressure. The first critical section is located close to the Effluent and Outfall Shafts and the second critical section is located at vicinity of River Riser. The respective calculations indicate the minimum thickness of reinforced concrete segmental lining should be 25.4 cm (10.0 inches). A steel liner will be installed within the segmental lining within 20m of the shafts where seismically induced stresses could be larger.

The steel liner is carbon steel coated with 1.27mm (50 mils) of polyurethane coating on the inside for corrosion protection and improved hydraulic capacity. The exterior will not need to be coated as it is will be encased by the grout that fills the void between the precast segment liner and the secondary steel liner.

3.3 Marine Structures and Equipment

Drawings A61C0077, A61C0078 show the Existing Outfall that will not be impacted by the construction of the New Outfall, except that the plant effluent will switch from the Existing Outfall to the New Outfall System after its completion.

For new marine structures (New Outfall System), see drawings A61C0070, A61C0052, A61C0053 and A61C0071 to A61C0074.

3.3.1 Temporary Marine Structures and Equipment

Table 3-3 presents excavation depths for the temporary marine structures.

Table 3-3: Excavation Depths for Temporary Marine Structures

Facility	Depth of Excavation, m
Support of Excavation for River Riser	23
Support of Excavation for Diffuser Manifold	4.15

Marine works associated with this project include construction of the; 1) River Riser structure (~12 m x 19 m) that includes the installation of piles, tremie concrete, installation of the riser pipe and the riser cap, 2) two Diffuser Manifolds (2.5 m ID), and 3) Outfall Tunnel (4.2 m ID) into the River Riser structure (see **Figure 3-1**).

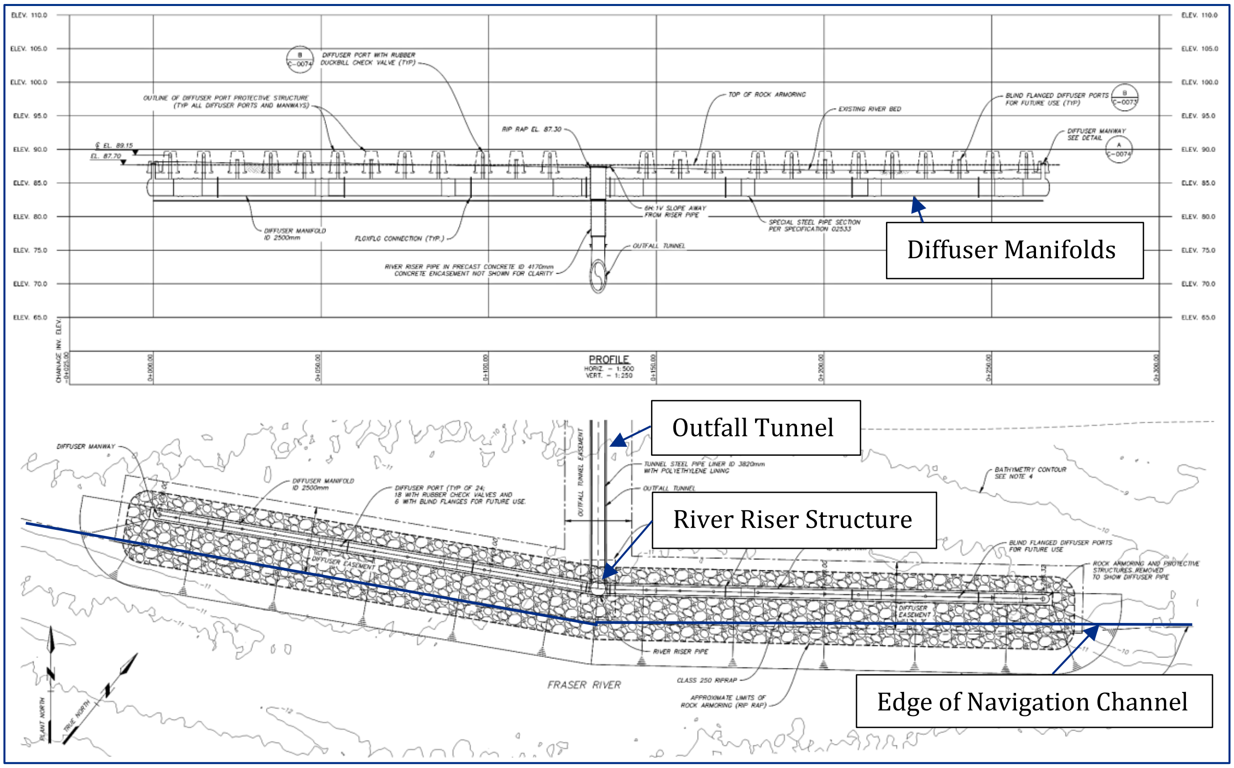


Figure 3-1: Outfall Tunnel and Diffuser Manifold Plan (Drawing Number A61C0005)

3.3.1.1 Support of Excavation for River Riser

The general approach for the construction of the River Riser structure is to safely install the riser pipe using a temporary excavation support system. This system will control the excavation, installation of permanent pile supports, placement of concrete, setting of the riser pipe, and encasement of the riser pipe in concrete. This temporary shoring will also be used to mitigate sedimentation from construction activities and provide a barrier from the river flow. While the contractor may elect to have a sealed coffer dam to do work in the dry, the current design anticipates all work inside the coffer dam to be done under water with the water surface inside the cofferdam maintained at, or near the river surface level.

The design anticipated that the temporary excavation support system (i.e., cofferdam) would consists of a combination wall of circular king piles and z-sheet piles (see **Figure 3-2**) extending above the high river water level surface (El. 102.0). The actual cofferdam design will be the marine contractor's responsibility. It will be approximately 12 metres by 19 metres to provide enough room to make the tunnel to riser pipe connection. The anticipated excavation is about 23 m (~El. 64) below the river bed elevation (~El. 87).

Due to the depth of the River Riser excavation and to account for hydrostatic loads and lateral loads from soils, the temporary shoring will require internal bracing at several elevations. The internal bracing will be removed as the cofferdam is backfilled and the temporary excavation system will be removed after construction.

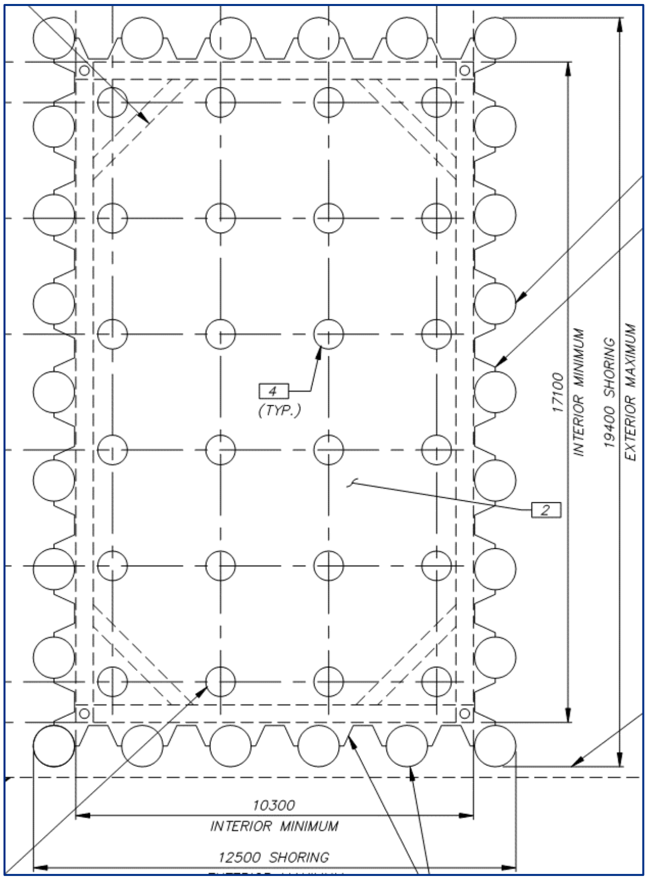


Figure 3-2: Cofferdam Temporary Excavation Support (Drawing Number X-A61S0081)

3.3.1.2 Support of Excavation for Diffuser Manifold

To facilitate the construction of the Diffuser Manifolds (i.e., two diffuser manifolds, each approximately 130 m long and 2.5 m diametre), dredging is required to a depth of about 4.5 m below the river bottom (~El. 87.0). The slope of the dredged prism on the navigation channel end is anticipated to be 1:6, while temporary shoring to be selected by the contractor will be required on the shoreline side of the dredge prism to limit the extent of landward excavation (and excavation volume) and to help facilitate dredging and installation of the Diffuser Manifolds (see **Figure 3-3**). The temporary shoring will be removed as the diffuser installation progresses.

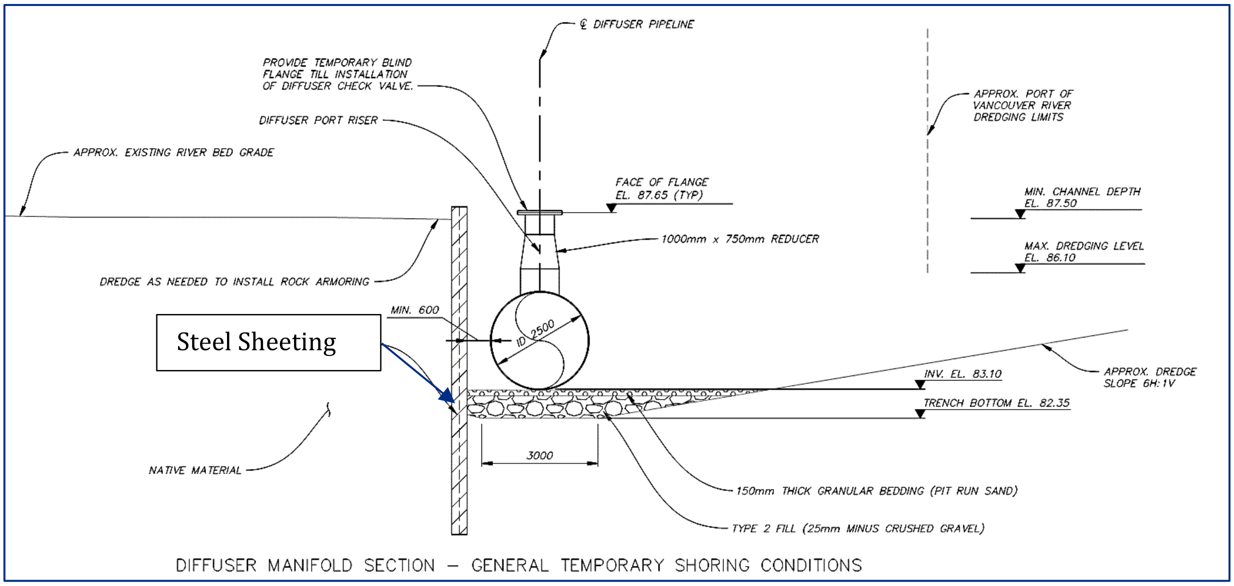


Figure 3-3: Diffuser Manifold Temporary Excavation Support (Drawing Number A61C0073)

Marine equipment such as barges (main barge, say 40m x 30m, support barges (1 to 2), approximately 30m x 20m), a tug boat, and crane(s) mounted on marine barges, are anticipated to be mobilized to carry out the marine work. In addition, a marine vessel(s) will have to be utilized to haul the excavated material and/or dredged material away from the site.

3.3.2 Permanent Marine Structures

Table 3-4 lists excavation depths for permanent marine structures of the New Outfall System.

Table 3-4: Excavation Depths for Permanent Marine Structures

Facility	Excavation	
	Type	Depth, m
River Riser	Dredging	23
River Riser Piles	Driving	47
Diffuser Manifold	Dredging	4.15
Outfall Tunnel[1]	Tunneling	35.5

Note: 1. Outfall Tunnel extends from Outfall Shaft on land to River Riser in the river

3.3.2.1 River Riser

The River Riser structure (riser pipe and riser cap) will facilitate the connection of the Outfall Tunnel to the Diffuser Manifolds (see **Figure 3-4**). The River Riser structure is a concrete block founded on 24 steel pipes. The size of the concrete block is approximately 12 metres by 19 metres to provide enough room to make the connection between the tunnel and riser pipe. The anticipated height is about 23 m (~El. 64) below the river bed elevation (~El. 87).

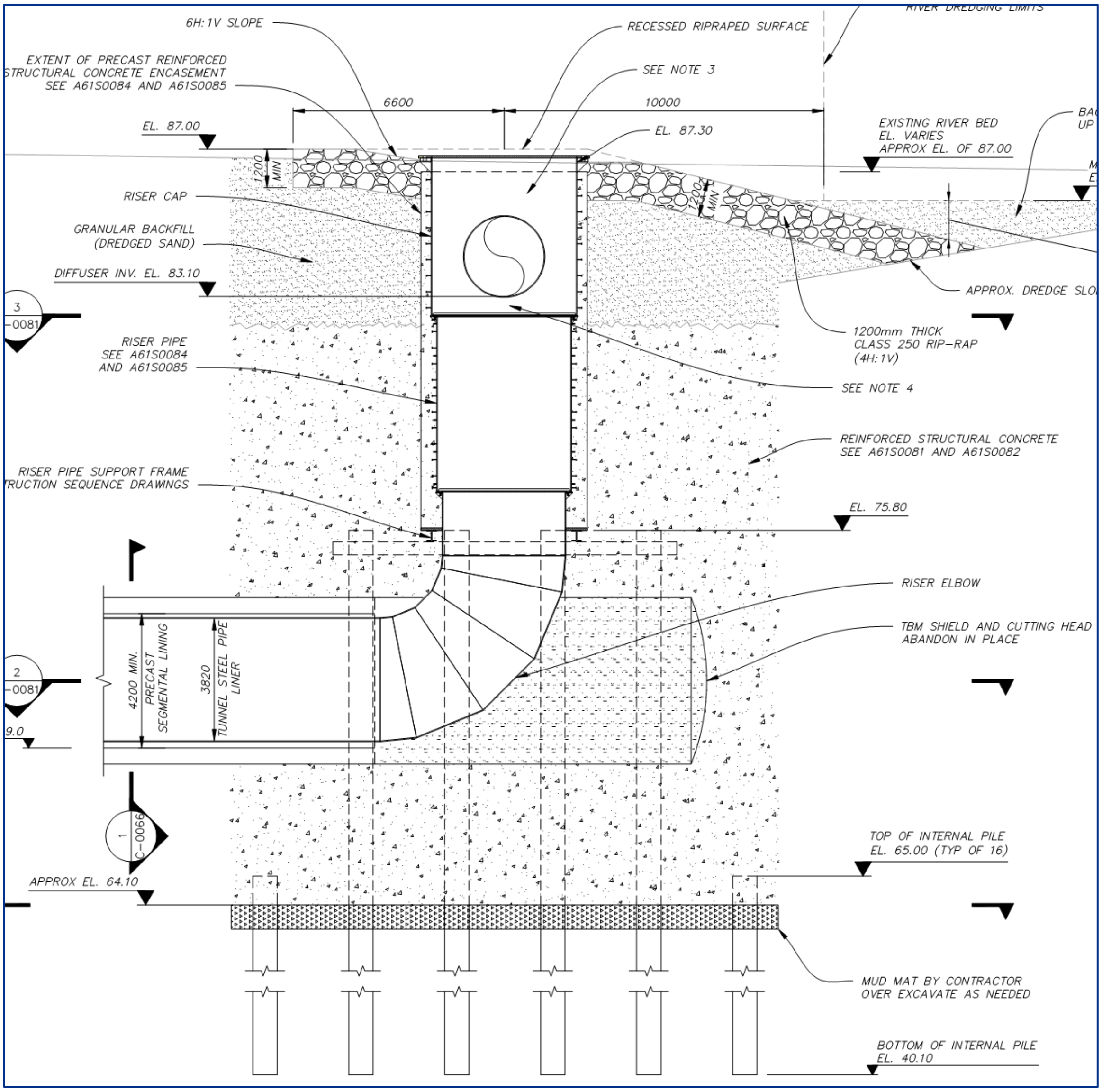


Figure 3-4: River Riser Structure (Drawing Number A61C0053)

CDM Smith

The Riser Pipe will be a fabricated steel pipe with polyethylene (PE) internal coating as shown in **Figure 3-5** below.

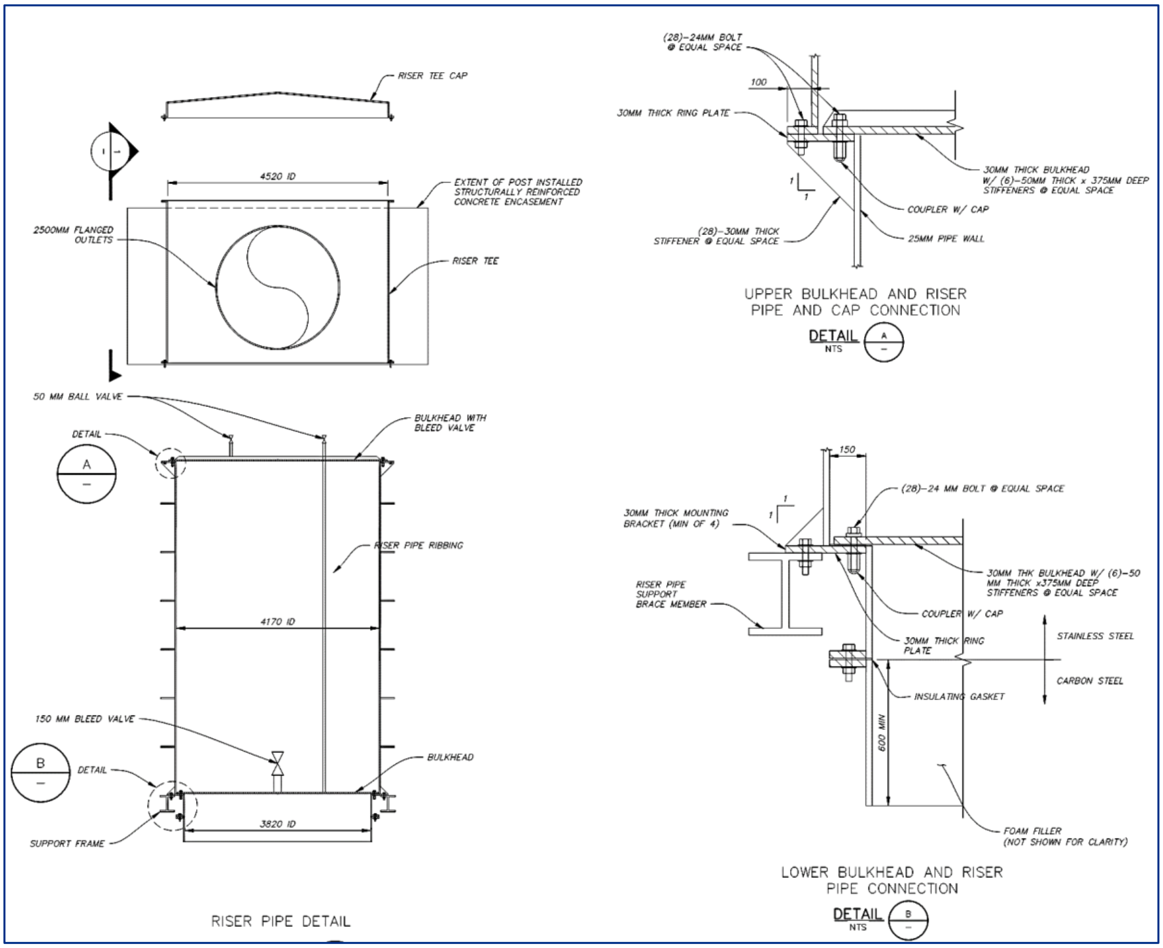


Figure 3-5: Riser Pipe and Riser Cap

3.3.2.2 River Riser Piles

The river riser piles are designed to withstand lateral loading induced by a design earthquake event. 24 steel pipe piles will be driven to El. 40.1 m to support the River Riser concrete structure during such seismic loading event. The internal diameter of the steel pipe piles is approximately 760 mm and the wall thickness is 25.4 mm. These piles will be filled with concrete. The following sequence is anticipated for the construction of the River Riser structure.

1. Complete cofferdam construction and excavate to El. 64.1 m from river bottom elevation of 87.0 m.
2. Place a template to facilitate pile driving.
3. Drive 24 steel pipe piles to El. 40.10 m.
4. Clean the inside pipe piles and place the concrete.
5. Cut the piles off and connect them to the riser concrete structure

3.3.2.3 Diffuser Manifold

The Diffuser Manifold pipes are designed to withstand lateral loading induced by a design earthquake event. The design anticipates installing Diffuser Manifold in an excavated trench as shown in **Figure 3-1 and 3-3**. Diffuser Manifold pipes will extend upstream and downstream from the river riser, aligned approximately parallel with and immediately shoreward of the northern margin of the navigation channel. As per **Figure 3-1**, the distance from the edge of the navigation channel to the centerline of the Diffuser Manifold is about 10m.

Figure 3-6 presents the location of the cofferdam in relation to the edge of the navigation channel. Though not infringing into the navigation channel, the length of time it will be present (up to 6 to 8 months) was a key concern for navigation discussed in consultation with the marine user group (**Appendix F.1**) and addressed in the Navigation Impact Assessment (**Appendix F.2**). **Figure 3-7** presents the anticipated extent of the dredging required for the installation of the Diffuser Manifold and rock armor. The contractor will be required to install the Diffuser Manifold with shoring (per **Figure 3-3**), which can reduce the effected area of river bed to 12,750 m^2. **Figure 3-8** presents a typical section of the Diffuser Manifold upon construction completion.

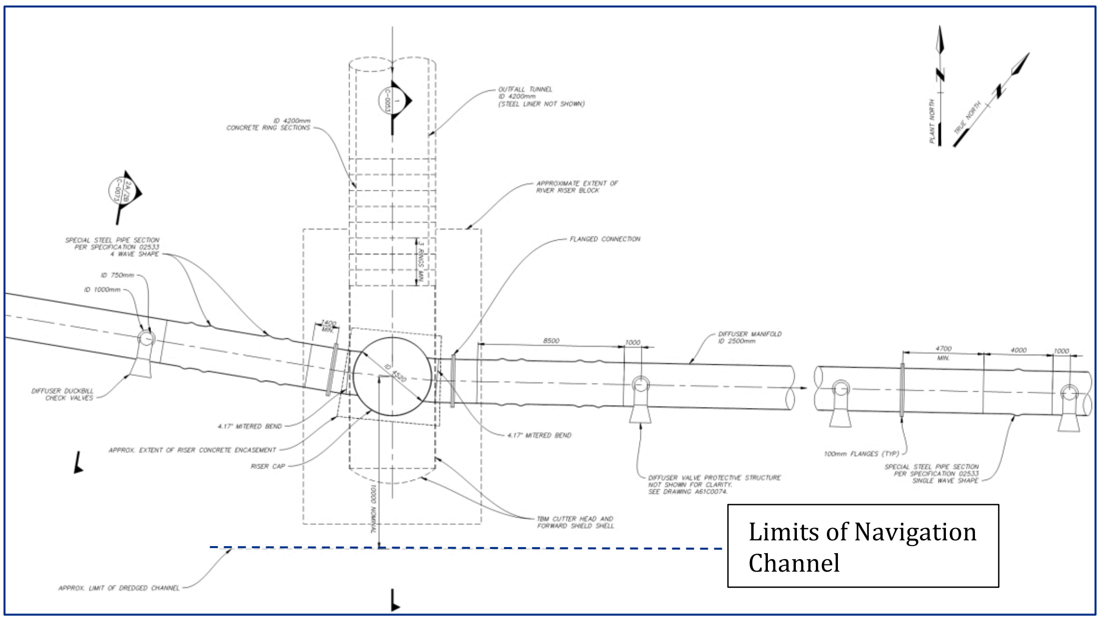


Figure 3-6: River Riser Construction (Drawing Number A61C0052)

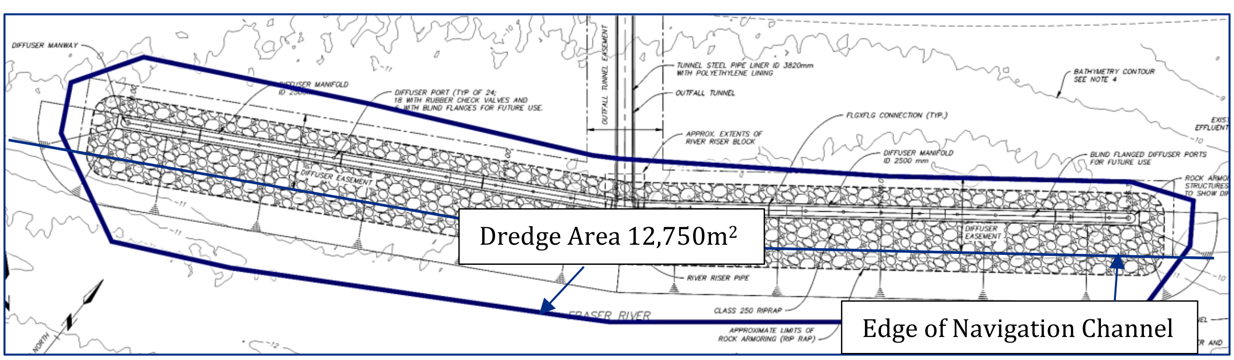


Figure 3-7: Extent of Diffuser Dredging (Drawing Number A61C0005)

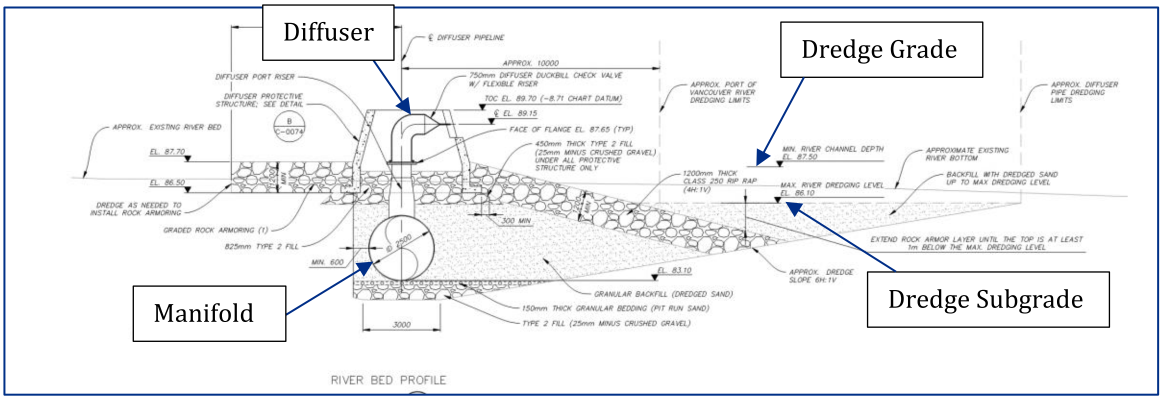


Figure 3-8: Diffuser Manifold Section (Drawing Number A61C0072)

3.3.2.4 Outfall Tunnel

Refer to **Section 3-1** for details. No substantial impact on the commerce in the river are anticipated from the tunnel excavation activities, since the tunnel invert is at El 69 (i.e., approximately 20 m below the river bottom).

3.4 Lot Grading and Utilities

3.4.1 Lot Grading

For lot grading see drawings A61C0001 to A61C0005.

3.4.2 Utilities

The Contractor will develop an accurate site plan that locates all utilities on site and a plan to protect all existing utilities. Below are currently known utilities, all of which need to be protected along with other potential utilities on the site. For all existing known utilities, see drawings A61C0001 to A61C0005.

The Contractor is required to submit design drawings, signed, and sealed by a Professional Engineer, showing how the following utilities are to be supported during excavation. Drawings will be submitted for review at least four weeks prior to commencing the crossing work.

- BC Hydro, 150mm duct, electrical wire, 35m
- BC Hydro, Switchgear box
- City of Delta, 300mm, water, 30m
- City of Delta, 200mm, water (abandoned), 30m
- Fortis BC, 80mm, natural gas, 15m
- Metro Vancouver, 200mm, Plant Effluent Water (unchlorinated), 15m

Contractor will also contact BC One Call to locate all other potential unknown utilities.

There is no new service connection required from any third-party authorities or jurisdictions for this project.

3.5 Lighting Plan

3.5.1 Construction Phase Lighting

The Contractor is required to submit to the port authority design drawings for both marine-based and land based lighting during the construction, signed, and sealed by a Professional Engineer. Drawings will be submitted for the port authority's review at least four weeks prior to commencing the work.

The drawings shall include the location, type of bulbs, orientation, and level of illuminance.

3.5.2 Operational Phase Lighting

Operational phase lighting plan is shown in drawings A50E4721 and A61E5212.

Operational phase lighting for the Level Control Structure (LCS) (drawing A50E4721) and Outfall Shaft Structure (drawing A61E5212) has been designed as indicated in the lighting plans to provide the minimum of 48 lux and a 3.0/1 (max./min) ratio, as required by Metro Vancouver. Placement of the pole lighting at the LCS was developed to allow unobstructed placement of bulkheads within the LCS effluent channels during annual maintenance via crane.

Placement of the pole lighting at the Outfall Shaft structure was developed to provide optimal lighting levels at the access stairs located along the southwest perimeter of the structure, with pole heights set at 10 metres to maintain optimal lighting levels on the top of the structure.

Control of both the LCS and Outfall Shaft site lighting will be via the plant Computerized Data Acquisition and Control (CDAC) system.

Section 4

Studies and Reports

4.1 Geotechnical Reports and Analysis

4.1.1 Geotechnical Investigations

Golder Associates carried out geotechnical field investigations in two phases, including on-land and offshore boreholes and cone penetration tests along the proposed conceptual outfall alignments, referred to as the western and central alignments, as part of the conceptual study (initially under a separate contract to Black & Veatch Canada) and the predesign contract with CDM Smith. **Figure 4-1** presents the geotechnical sampling locations and the outfall alignment options.

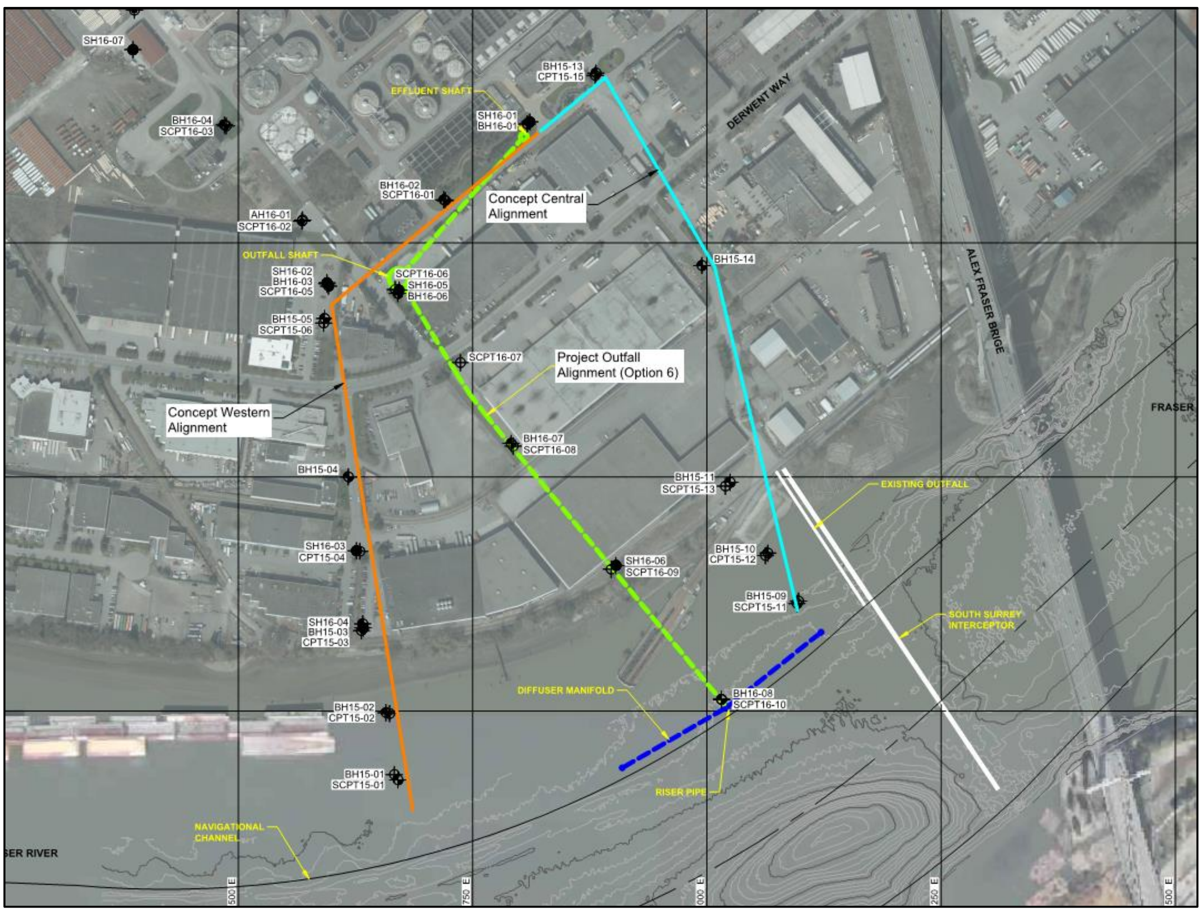


Figure 4-1: Geotechnical Exploration Plan

A western alignment, located 500 m west of the existing outfall, was initially selected as the preferred alignment following completion of the Phase II investigations. The subsequent Phase III investigation included subsurface exploration at the potential shaft locations associated with the conveyance system (Effluent Shaft and Outfall Shaft).

Following further evaluation of the outfall alignment options and selection of a preferred Outfall Shaft site as presented in **Section 4.8**, Alternative Siting Options, the preferred alignment was shifted east to a location some 200-m west of the existing outfall. This shift was done to allow the riser pipe and diffuser system to be located at a position within the river channel where the potential impacts due to sedimentation are minimized. This final alignment is referred to as the “Option 1B Outfall Alignment” selected for detailed design. Additional subsurface exploration (Phase IV) was carried out along the selected final Option 1B outfall alignment corridor.

Geotechnical laboratory tests, including water content and Atterberg limits determination, grain size analyses, organic content measurements, specific gravity, and unit weight measurements, were conducted on select samples collected from the test borings. Cyclic direct simple shear tests and monotonic direct simple shear tests were carried out on selected samples to characterize the cyclic softening behavior and to establish the shear strength parameters, respectively, for the fine-grained soils underlying the site. One-dimensional consolidation tests were carried out on select samples to establish the consolidation characteristics of the fine-grained soils underlying the site. Petrographic analysis was also conducted to determine the mineralogical composition on soil samples collected from the proposed tunnel elevation. The explorations and laboratory testing is presented in the Geotechnical Data Report that will become part of the construction contract documents and is included as **Appendix B.1**.

4.1.2 Seismic Analysis

4.1.2.1 Seismic Design Criteria

Metro Vancouver requires all structures associated with the new outfall system be designed to meet the post-disaster performance level (except for connection to the existing CCT which was not designed to a post-disaster performance level). This requires the new outfall system to remain functional following design ground motions corresponding to an earthquake event with the return period of 2,475 years. Additional information on the seismic design criteria for the project is presented in **Appendix B.2**.

4.1.2.2 Ground Response Analysis

Results of preliminary ground response analyses carried out using equivalent linear approach with the computer program SHAKE 2000, together with the liquefaction triggering chart established by Idriss and Boulanger (2015) indicate the following:

- The upper 25 to 30 meters of the sand deposit at the Effluent and Outfall Shaft locations and the entire sand deposit at the offshore and the nearshore locations are considered potentially liquefiable under both the 2010 National Building Code of Canada (NBCC) and 2015 NBCC ground motions for crustal and inslab earthquakes.
- The M9 subduction earthquake associated with the 2015 NBCC could result in deeper liquefaction up to 40 meters at the Outfall Shaft location and the entire sand deposit at the offshore and the near shore locations.

Non-linear 1D and 2D ground response analyses utilizing the finite-difference computer code FLAC and UBCSAND was used to further assess potential liquefaction of the site soils, the vertical extent of liquefaction, and the resulting lateral and vertical deformations was performed as described in **Appendix B.3 and B.4**.

Based on the outcome of the non-linear ground response analysis, the following key geotechnical issues were considered during final design:

- The tunnel invert elevation was selected such that the tunnel is located below the vertical extent of significant liquefaction (30 meters).
- The Effluent and Outfall Shaft will be subject to loss of lateral support within the liquefiable sand and subject to down-drag forces resulting from post-seismic settlement.
- The River Riser and diffuser system will be subject to lateral spreading resulting from potential liquefaction as well as post-seismic settlement.
- The Effluent Connection Channel between the Level Control Structure and the CCTs will be subject to differential movement due to post-seismic settlement and may not be able to convey effluent to the Level Control Structure and Effluent Shaft. The Level Control structure is designed to allow the new outfall system to be isolated from the seismically damaged structures such that damaged sections of the CCTs and Effluent Connection Channel could be restored to operational conditions.

Geotechnical conditions considered during design is presented in the following subsections.

4.1.3 Seismic Design

4.1.3.1 Effluent and Outfall Shafts

The Effluent and Outfall Shaft final lining is designed to resist all horizontal loads including seismic loading assuming the slurry panels are not resisting loads. Seismic loading evaluation included three-dimensional (3D) soil-structure interaction analyses using the finite difference program FLAC3D Version 5.0. The FLAC3D analyses were based on a pseudo-static approach. The models developed for these 3D pseudo-static analyses capture more details of the configurations of the shafts and the tunnels as well as connection between the shafts and the tunnels.

In the analysis, the predicted free-field ground displacements caused by soil liquefaction from the design earthquake scenario are applied as the prescribed boundary conditions, and post-liquefaction soil stiffness is used to evaluate the response of shaft and tunnel structures to the free-field ground displacements. These free-field ground displacements were generated based on the ground motions for the design earthquakes corresponding to a return period of 2,475 years consistent with the 2010 NBCC. The seismic analyses evaluated the seismic demands of the shaft and tunnel structures induced by the free-field ground displacements caused by the design earthquakes.

4.1.3.2 Tunnel Connection to Effluent and Outfall Shafts

Design calculations were performed to establish a minimum thickness of segmental lining for Annacis Outfall Tunnel project under hydrostatic and soil loads. The respective calculations indicate the minimum thickness of reinforced concrete segmental lining should be 25.4 cm.

The results of the seismic analyses indicated high stress concentrations in the tunnel segmental lining near the areas of connections to the shafts. Thus, a steel liner will be installed at the outfall shaft connection with the outfall tunnel and the effluent tunnel. The length of the steel liner is 20 m, with a wall thickness of 19 mm, and an internal diameter is 3,820 mm. **Figure 4-2** below presents the location of the steel liners at the Outfall Shaft.

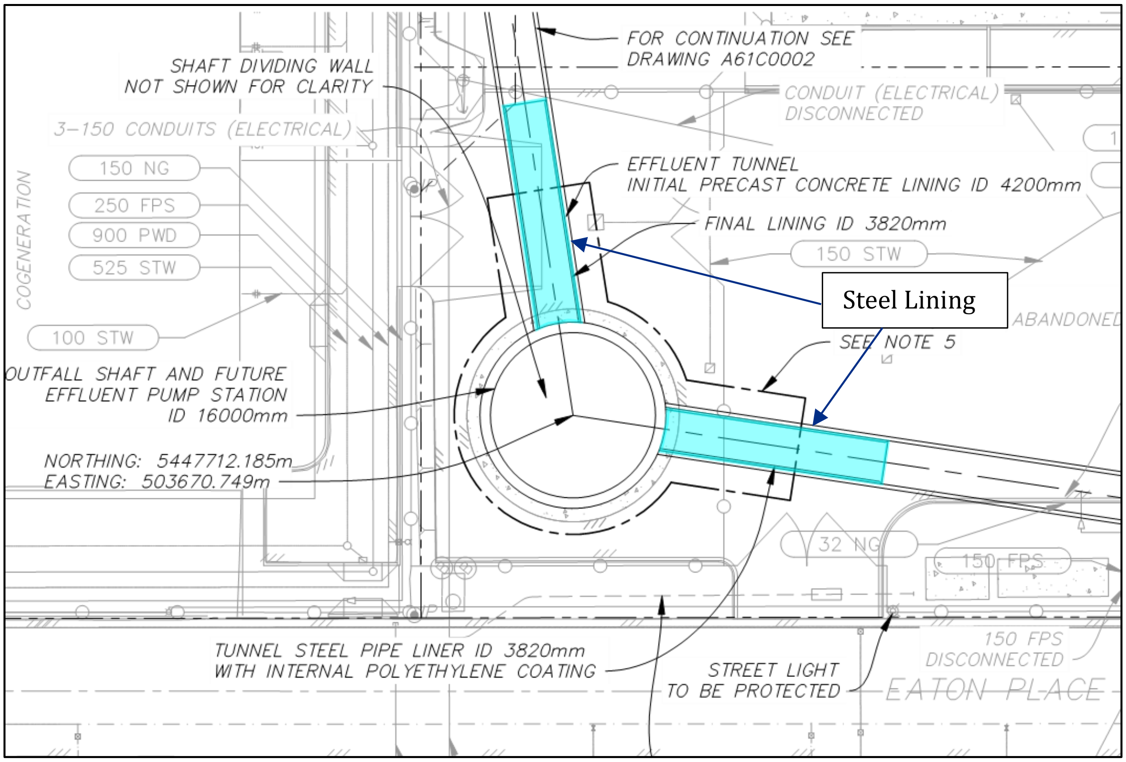


Figure 4-2: Outfall Shaft Tunnel Steel Liner Plan View (Drawing Number A61C0003)

4.1.3.3 Outfall Tunnel

The results of seismic analyses also indicated high stress concentrations in the tunnel segmental lining near the area of connection to the river riser. Thus, a steel liner will be installed at the river riser connection with the outfall tunnel. The length of the steel liner is 50 m, with a wall thickness of 25.4 mm, and an internal diameter of 3,820 mm. **Figure 4-3** below presents the Outfall Tunnel steel liner at the River Riser.

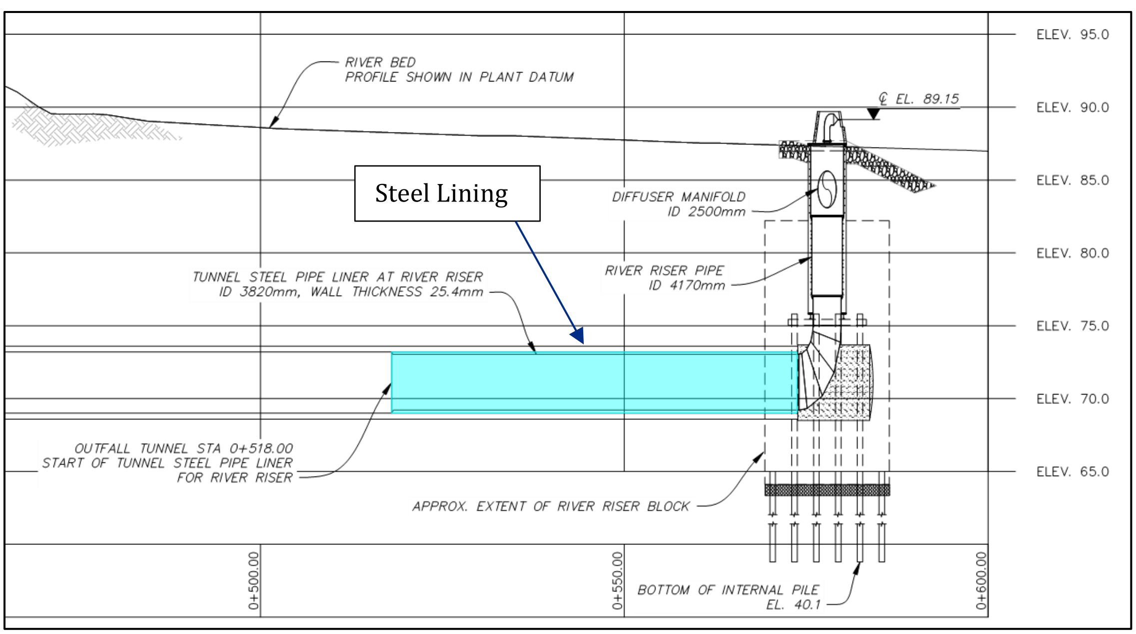


Figure 4-3: Outfall Tunnel Steel Liner at River Riser (Drawing Number A61C0004)

4.1.3.4 River Riser

The River Riser structure (riser pipe and riser cap) is designed to resist lateral spreading to limit risk of damage to the Outfall Tunnel. The River Riser structure is a will be an intact concrete block founded on steel pipes. The size of the concrete block is approximately 12 metres by 19 metres to provide enough room to make the connection between the tunnel and riser pipe. **Figure 4-4** presents a cross section view of the River Riser.

The river riser design includes 24 steel pipe piles to withstand lateral loading induced by the design earthquake event. The internal diameter of the steel pipe pile is approximately 760 mm, with a wall thickness of 25.4 mm. These piles will be filled with concrete.

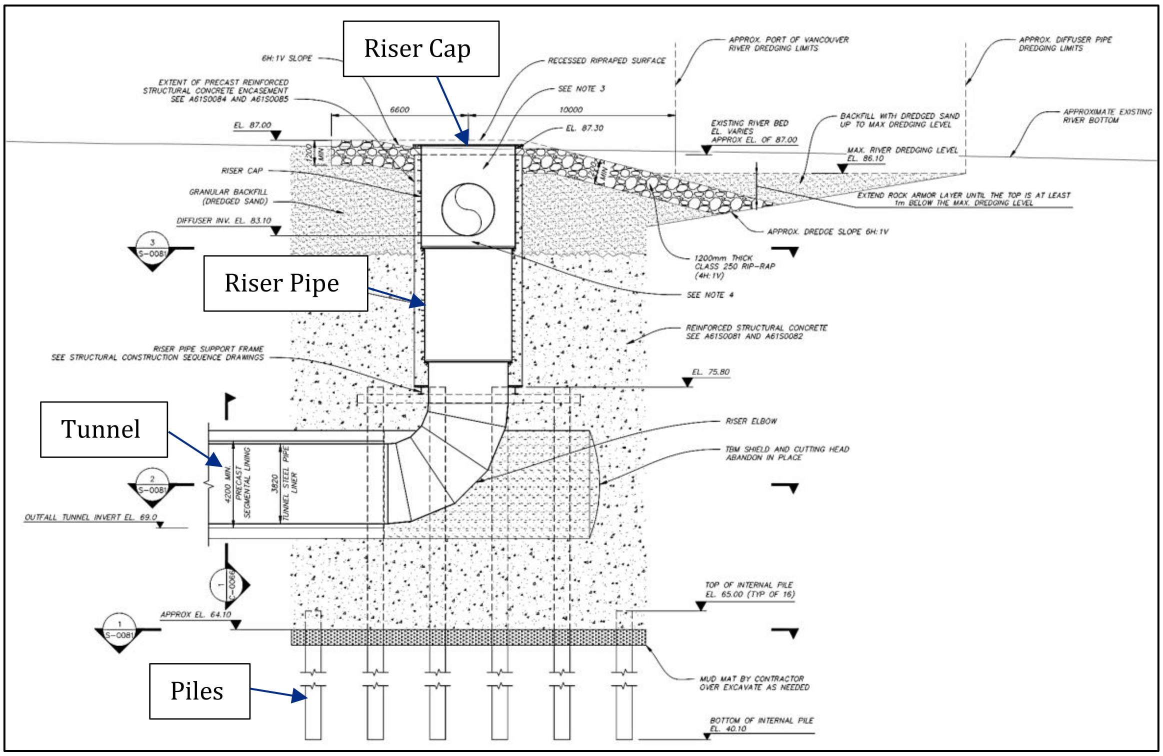


Figure 4-4: Outfall River Riser Section View (Drawing Number A61C0053)

Seismic design of the River Riser included three-dimensional (3D) soil-structure interaction analyses using the finite difference program FLAC3D Version 5.0. The FLAC3D analyses were based on a pseudo-static approach. The models developed for these 3D pseudo-static analyses capture more details of the configurations of the river riser and the outfall tunnel, as well as connection between the river riser and the tunnel.

The seismic analyses also evaluated lateral deflections for the River Riser structure. Predicted free-field ground displacements caused by soil liquefaction from the design earthquake scenario were applied as the prescribed boundary conditions, and post-liquefaction soil stiffness was used to evaluate the response of shaft and tunnel structures to the free-field ground displacements.

4.1.3.5 Diffuser Manifold Pipeline Seismic Design

The diffuser manifold pipe will be installed by dredging a channel in the river bottom, installing the diffuser pipes in sections, backfilling the trench, and then covering with rip-rap for protection, as shown in **Figure 4-5** below

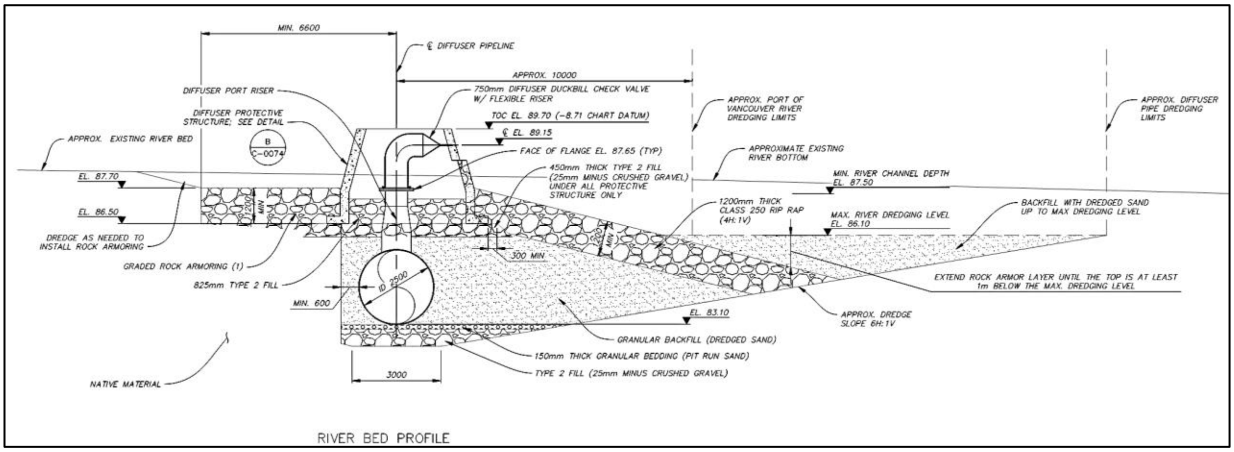


Figure 4-5: Diffuser Section (Drawing Number A61C0071)

To comply with the post-disaster requirements, the diffuser manifold pipeline will be designed to withstand permanent ground deformations (both lateral and vertical) anticipated from the potential liquefaction. It is anticipated that the post-disaster survivability of steel pipe is much greater than other pipe materials because it is a continuous pipe with good flexibility and high strength. To accommodate the large ground movements, sections of the pipe will be designed to yield and deform in a controlled manner without breaking.

To accomplish this, a special section of pipe that has been developed by JFE Engineering of Japan will be used. This engineered product, called Seismic Pipe for Crossing Fault (SPF), is fabricated with a wave, or wrinkle, to act like a bendy straw as shown in **Figure 4-6** to accommodate large deformation of the pipe segment without complete failure. **Figure 4-7** presents the location of the SPF installed on the diffuser manifold. In this case, the SPF fittings have been custom designed to accommodate a post-seismic lateral diffuser manifold displacement of 1.5 m.

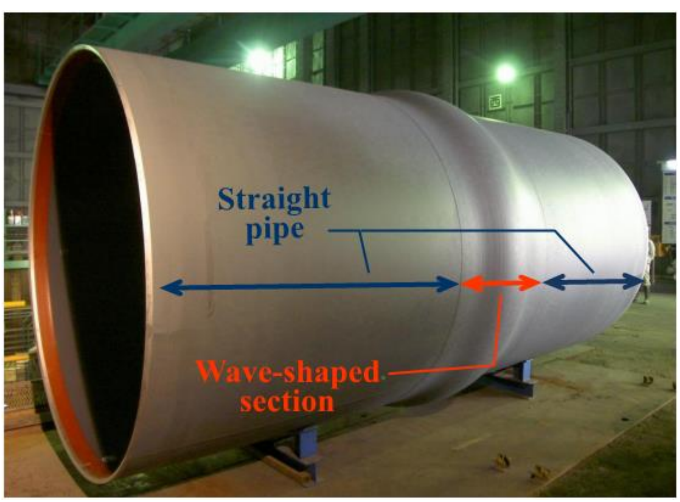


Figure 4-6: SPF Pipe section (Courtesy of JFE Engineering)

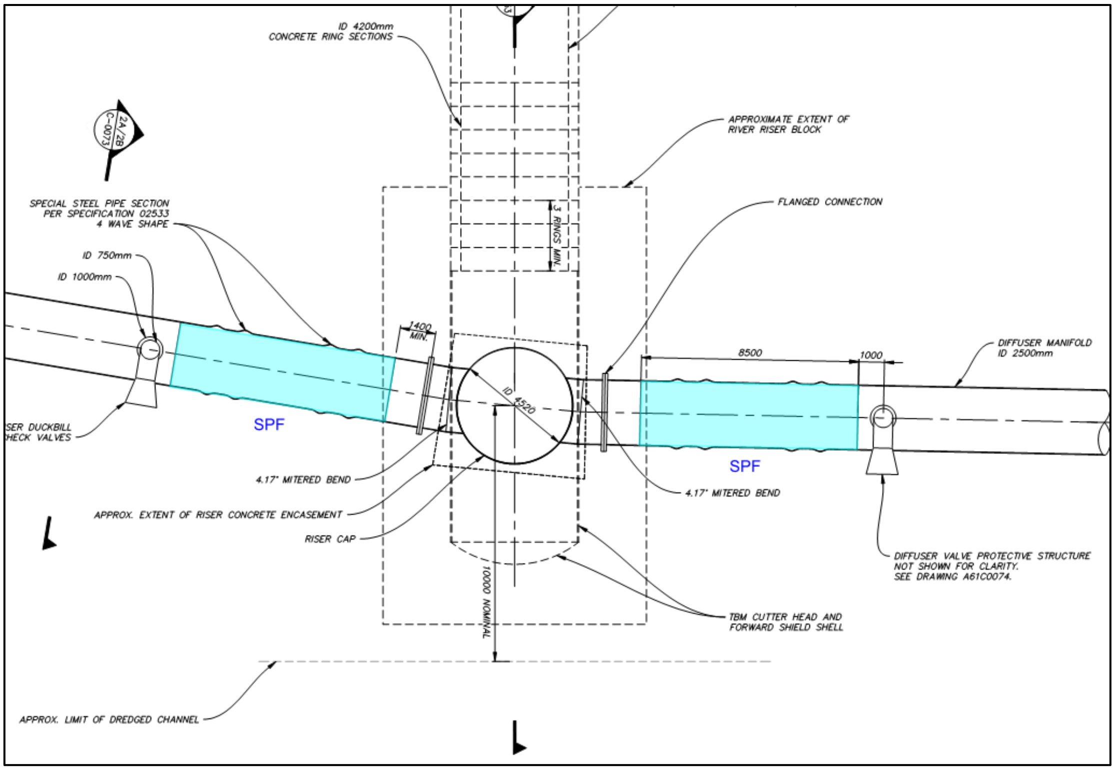


Figure 4-7: Diffuser Manifold SPF Sections (Drawing Number A61C0052)

4.1.4 Geotechnical Instrumentation and Monitoring

Construction activities such as slurry wall construction, shaft excavation, tunnel excavation, pile driving, installation of excavation support systems, and dewatering can cause surface settlements, and/or ground vibration. Geotechnical instrumentation and monitoring is included in the design to serve as an early warning system so the mitigation measures can be taken in a timely manner.

The planned geotechnical instrumentation includes: Settlements points, inclinometers, and extensometers to measure ground movements; piezometers to measure groundwater levels; and geophones to monitor ground vibration. The instruments will be installed in the zone of influence which constitutes the area containing any existing conditions that may potentially be damaged or otherwise adversely impacted due to the construction activities. Geotechnical instrumentation will be removed/ decommissioned following the project completion.

4.2 Geomorphological Studies

4.2.1 Overview of Fluvial Geomorphology

Sediment transport within the Fraser River is a continuous phenomenon with areas of the river experiencing sediment accumulation or sediment erosion. A fluvial geomorphological study was performed for the project to evaluate sediment transport and select provide a basis for selection of the most favorable outfall diffuser location. The study report is included as **Appendix C.1**.

This study reviewed morphological changes along the Annieville Channel Reach of the Lower Fraser River over the last 50 years using historical surveys and dredging records and information compiled from past studies on hydrology and sediment transport. A one-dimensional hydrodynamic model was used to characterize the seasonal variations in water levels and mean velocities. A three-dimensional hydrodynamic model was used to assess the flow patterns, velocities and shear stresses at the site for extreme flood conditions to support the scour investigations.

The river bed lowered at least 20 m near the project site over the last 40 years in response to three main factors:

- Construction of the ship collision structures at the Alex Fraser Bridge in 1984, which created a notable constriction and zone of flow separation along the south bank.
- Construction of a raised riprap apron over the South Surrey Interceptor around 1995 that has acted as a sill.
- Ongoing dredging and navigation channel improvements, which have lowered the riverbed by 2 to 3 metres upstream of the site.

The planned outfall diffuser location on the north side of the navigation channel is in a relatively stable section of the river compared to the south side and locations further downstream. Since the mid-1980s, the bed elevation has varied up to 2 m, with no clear association with reach-wide patterns, local infrastructure change, or flood flows. Presently, the bed in this area is near a historical low suggesting that aggradation could occur in the absence of continued reach-wide degradation. Short-term periodic scour and fill by dunes (sand-waves) that migrate through the reach is anticipated to occur.

4.2.2 Hydraulic Process and Alterations Report

The port authority requested a Hydraulic Process and Alterations Report to addresses potential impacts of the new diffuser system on hydraulics and geomorphology. One immediate neighbor (Southern Railway), has requested similar information to determine what the impacts might be to their maintenance dredging for the Railcar Barge Terminal. Furthermore, the port authority has requested the review of the hydraulic process that are driving the apparent relative stability of the river bed elevation on the north side of the Fraser, and the implications of removing the South Surrey Interceptor (SSI) riprap apron. However, this project will not involve removal of the existing SSI riprap apron, or the existing outfall diffusers.

The hydraulic processes driving the geomorphological stability along the north side of the Fraser River are influenced by both man-made instream structures and natural conditions. These include the influence of St. Mungo's Bend, the prominent shoal in St. Mungo's Bend, the Alex Fraser Bridge, and the apron over the SSI. A detailed review of these features and an accompanying numerical modelling exercise helped identify possible implications a new outfall diffuser may have on the river hydraulics, local deposition/erosion, and consequences for immediate neighbours. **Figure 4-8** presents the modeling results for depth-averaged velocity fields predicted at the proposed outfall under high river flow conditions.

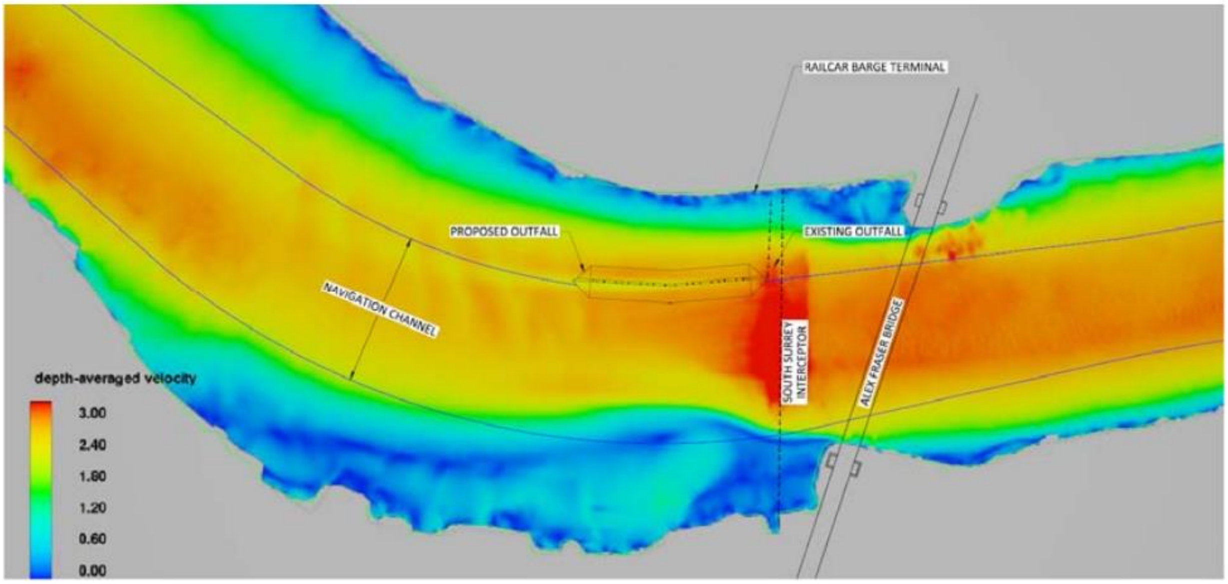


Figure 4-8: Geomorphological Modeling Results

The CFD modelling identified that the river processes along the north side of the Fraser River have more influence on the geomorphology than the presence or operation of the either the existing or proposed outfalls. Although there may be some small local sedimentation downstream of the diffusers, the results of this effort helped conclude that no major impact on the navigation channel is expected from either structure.

The apron over the SSI has helped define the bathymetry downstream of the Alex Fraser Bridge and the geomorphological review and CFD modelling identified that the possible response to the removal of the SSI riprap apron could be:

- The deep scour hole near the south side of channel partially fills in and migrates downstream resulting in conditions similar to those observed in 1994;
- Local sedimentation develops downstream of the diffuser due to reduction of bed shear stress.

Note that role of the sill (SSI) in generating scour is being investigated in more detail study under a separate project for Metro Vancouver. This work is ongoing and is expected to be complete by the end of 2017.

The full details of the Hydraulic Process and Alteration Report can be found in **Appendix C.2**.

4.3 Works Protocol

A draft version of the Works Protocol for dredging & other activities near Metro Vancouver's outfall has been developed, and is attached in **Appendix D**. If work is proposed on or near Metro Vancouver's outfall, the protocol is to be followed.

The protocol describes reporting requirements for any work within 100 m of the outfall. The draft Works Protocol will be finalized before the project is completed.

4.4 Traffic Studies

A Traffic Impact Study report (TIS) prepared for the construction phase of the Annacis Island WWTP New Outfall System project is summarized herein and attached as **Appendix E.1**. Once complete, the project will not create additional traffic during the operation phase. The TIS will also be submitted by Metro Vancouver to the City of Delta for review. Additionally, a Highway Use Permit (HUP) will be obtained by the Contractor from the City of Delta. **Appendix E.2** presents a Traffic Management Guideline that will be provided to the contractor as a guiding document for preparation of a Traffic Management Plan for submission to the City of Delta.

Construction is anticipated to take place over a 3-year period. Construction routes to and from the project site are anticipated to mostly use the Alex Fraser Bridge and the interchange at Cliveden Avenue. Vehicles coming from Highway 91 would use either westbound Cliveden Avenue towards Eaton Way and then east on Derwent Way, or head east on Cliveden Avenue, south on Chester Road, and west on Derwent Way, to access the project site. **Figure 4-9** presents the construction traffic routing to the project site.

Worker vehicle parking during construction has not yet been identified, and will be up to the contractor to identify and acquire parking supply sufficient to support demand during construction. It is anticipated that parking supply around the project site will be sufficient to support the parking demand for the construction worker vehicles.

For the TIS, the eight intersections shown in **Figure 4-9** located near the project site were analyzed for existing conditions during the weekday AM peak hour (the highest hour between 6 AM and 9 AM) and the weekday PM peak hour (the highest hour between 2 PM and 6 PM) of a typical work day. The results where then compared with the additive hour-by-hour traffic and parking demand anticipated to be generated from the project construction.

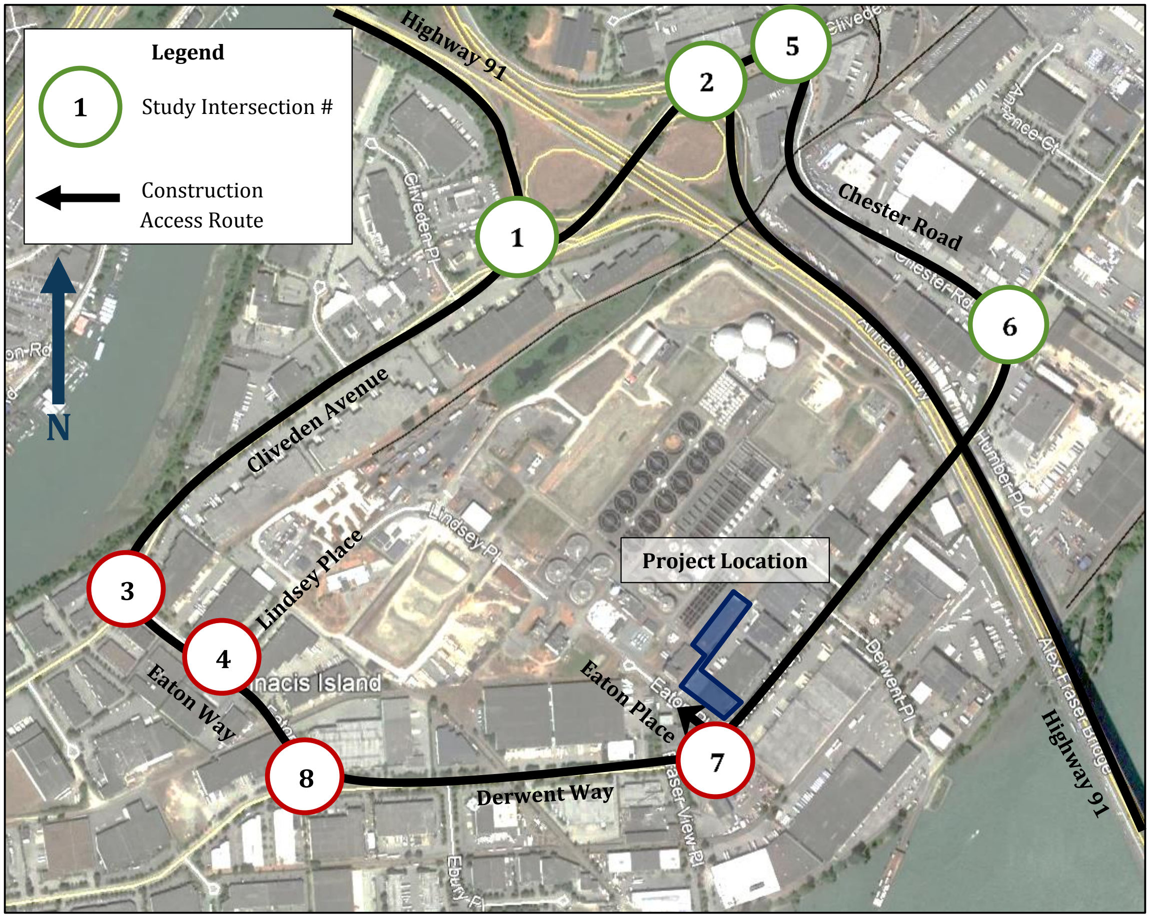


Figure 4-9: Construction Traffic Routing

Intersections were evaluated using the Highway Capacity Manual 2010 (HCM 2010) methodology, which determines the level of service (LOS) at signalized and unsignalized intersections. In accordance with the port authority requirements, the traffic performance criteria expect intersections to operate at LOS D or better overall, have a volume-to-capacity (v/c) ratio of less than 0.9, and sufficient turning bay storage and driveway spacing to accommodate 95 percentile queues during the peak hour.

Table 4-1 shows the AM and PM peak hour LOS and delay values under existing conditions, with the Cliveden Avenue/Chester Road intersection during the PM peak hour being the only study intersection that operates at LOS E or worse in the study area.

To determine the number of vehicle trips that would be generated, estimates were made for anticipated weekly worker and equipment trips based on the scheduled construction activity and number of laborers expected to work on the assigned activity. The busiest construction weeks were identified to occur for approximately 11 weeks of the three-year construction period. Based on the analysis, an hourly maximum of 43 project construction-generated trips was identified, during the 6 AM to 7 AM hour. Additionally, using the anticipated shift schedules, 54 parking spaces were calculated to be the maximum amount of parking demand to be generated during construction.

Table 4-1: Existing Intersection Operations – AM/PM Peak Hours

No.	Study Intersection	Traffic Control	AM Peak Hour		PM Peak Hour	
			Delay	LOS	Delay	LOS
1	Cliveden Avenue/Highway 91 Southbound Ramps	Signal	22.1	C	15.4	B
2	Cliveden Avenue/Highway 91 Northbound Ramps	Signal	23.5	C	11.7	B
3	Cliveden Avenue/Eaton Way	OWSC	10.0 (NB)	B	33.2 (NB)	D
4	Eaton Way/Lindsey Place	OWSC	10.0 (WB)	B	12.0 (WB)	B
5	Cliveden Avenue/Chester Road	Signal	48.3	D	**61.2**	**E**
6	Chester Road/Derwent Way	Signal	10.2	B	11.6	B
7	Derwent Way/Eaton Place	OWSC	10.7 (SB)	B	9.7 (SB)	A
8	Eaton Way/Derwent Way	TWSC	11.2 (SB)	B	12.8 (SB)	B

Notes:

- Intersections 1 and 2 were evaluated using HCM 2000 due to phasing issues not allowing HCM 2010 outputs
- OWSC – One-way Stop-Controlled, TWSC – Two-way Stop-Controlled
- NB – Northbound, WB – Westbound, SB – Southbound
- Delay is presented in seconds per vehicle.
- For unsignalized intersections, delay and LOS values are presented for the worst-operating approach.
- **Bold** represents LOS E or F.

Based on the anticipated number of trips and spaces of parking demand generated during construction, no significant impacts to the traffic as a direct result of project construction is expected, even during the peak weeks of the three-year construction period. The proposed project is conservatively anticipated to generate 43 peak hour trips and 54 spaces of parking demand during construction.

To minimize any potential additional traffic/parking concerns or effects during construction, the project contractor will be encouraged to schedule and arrange for worker and construction trips to and from the project site to occur during non-peak periods of traffic. The contractor will also need to arrange for sufficient parking supply to meet or exceed the maximum anticipated parking requirements, and arrange for shuttle service to transport workers to and from the project site should the distance exceed walking distance.

4.5 Navigation Impact Assessment

4.5.1 Navigation Outreach

Activities during project design in support of a marine navigation assessment included:

- Several meetings with the Vancouver Fraser Port Authority (the port authority) to discuss the project's objectives, constraints, design elements, construction methods, and operating conditions. One meeting focused on marine navigation and was attended by Transport Canada (TC) representatives.
- A presentation to at a regular meeting of the Port Community Liaison Committee - Delta (**see Appendix O.5**).
- An information session and workshop conducted for marine users to provide an overview of the project and gather information about their marine operations. The meeting was attended by representative for the port authority and TC, water lot owners, Fraser River Pilots, Council of Marine Carriers, barge and tug operators, and marine contractors. Meeting notes are attached as **Appendix F.1**.
- A simulation manoeuvring assessment of Seaspan's barge manoeuvring operations at the Southern Rail Terminal performed by Lantec Marine at British Columbia Institute of Technology Marine Campus in conjunction with Seaspan Marine's (Seaspan) Port Captain and Tug Masters (attachment in **Appendix F.2**).
- A meeting with Souther Railway of British Columbia (SRY) and Seaspan to discuss results of the manoeuvring simulation and identified mitigation measures that would minimize risk created by any of their manoeuvring operations near the construction site.

4.5.2 Navigation Impact Assessment Report

A Navigation Impact Assessment report was prepared and is attached as **Appendix F.2**. The assessment addresses potential navigation impacts and their mitigation related to construction and operation of the project, including:

- Navigation authority and regulation.
- River conditions including the navigation channel, physical conditions, water lots and existing facilities, and navigability.
- Anticipated in-river construction activities and completed outfall configuration.
- Potential marine impacts and obstructions either within the navigation channel or marine safety channel boundaries.
- Mitigation measures to address risks during the construction phase and ongoing operation and maintenance of the outfall.

Refer to the Navigation Impact Assessment report for details on the first three items. Potential marine navigation impacts and mitigation measures are summarized in the following subsections.

4.5.3 Construction Phase Navigation Impact Assessment

4.5.3.1 Fraser River Navigation

During construction of the new outfall system, increased vessel traffic for transport of labour, equipment, and materials to the in-river construction site is expected to be minimal (typically less than 10 vessel trips per day).

4.5.3.2 Seaspan Railcar Barge Operations

The new outfall system in-river construction activities were identified as having potentially significant marine navigation impacts to railcar barge operations perform by Seaspan at Southern Railway's Railcar Barge Terminal. A simulation assessment of Seaspan's barge manoeuvring operations was performed to assess the impact and develop mitigation measures. A Summary Report of Manoeuvring Analysis is included in Navigation Impact Assessment (**Appendix F.2**).

The analysis evaluated potential impacts to navigation, including:

- Potential for the river riser cofferdam to encroach on manoeuvring;
- Tidal cycle and associated river current flow conditions that create higher risks;
- Seaspan Towing procedures that could mitigate risks; and
- Marine contractor procedures to minimize risk created by their manoeuvring operations.

4.5.3.3 In-River Construction Work Areas

In-river work areas for each of the four construction seasons, as described in **Section 2.3.2** and **Appendix F.2**, were defined and are shown on **Figure 4-10** to **Figure 4-13**. These areas were grouped according to potential navigation impacts as follows:

- **Area A**: Contractor exclusive work areas where work will be undertaken in deep water (i.e., generally greater than 10 m below Chart Datum) within the area between navigational channel and safety boundary using equipment and machinery located on a spud-anchored or jack-up barges. Construction activities within Area A are expected to have little or no interference on deep-sea navigation, which is restricted to the navigation channel.
- **Area A'**: The portion of Area A identified in the manouvering analysis as within the zone where construction activities could have an significant navigation impact on Seaspan Railcar Barge Operations.
- **Area B**: Contractor staging areas within the area between navigational channel and safety boundary where equipment and material may be staged during construction. Construction activities within Area B are expected to have little or no interference on deep-sea navigation, which is restricted to the navigation channel.
- **Area C**: Contractor temporary work area within Navigation Channel. The contractor may temporarily occupy a 37 m to 90 m wide (depending on vessel size) within the defined navigation channel. During these times, large vessel ship traffic would need to be restricted to a single direction past the construction site.
- **Area C'**: The portion of Area C identified in the manouvering analysis as within the zone where construction activities could have an significant navigation impact on Seaspan Railcar Barge Operations.

Figure 4-10: In-River Work Areas – River Riser

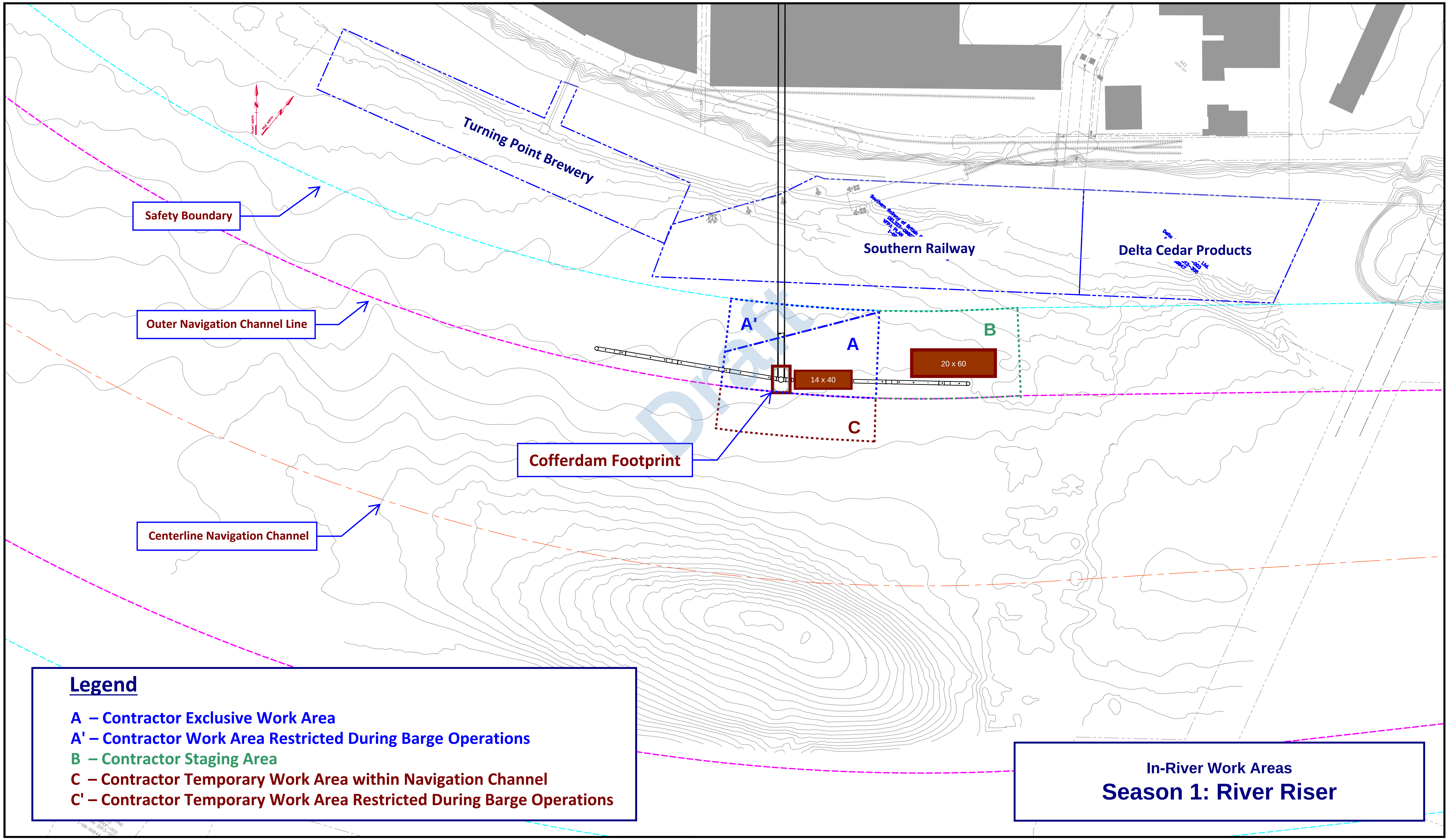


Figure 4-11: In-River Work Areas – Diffuser Construction

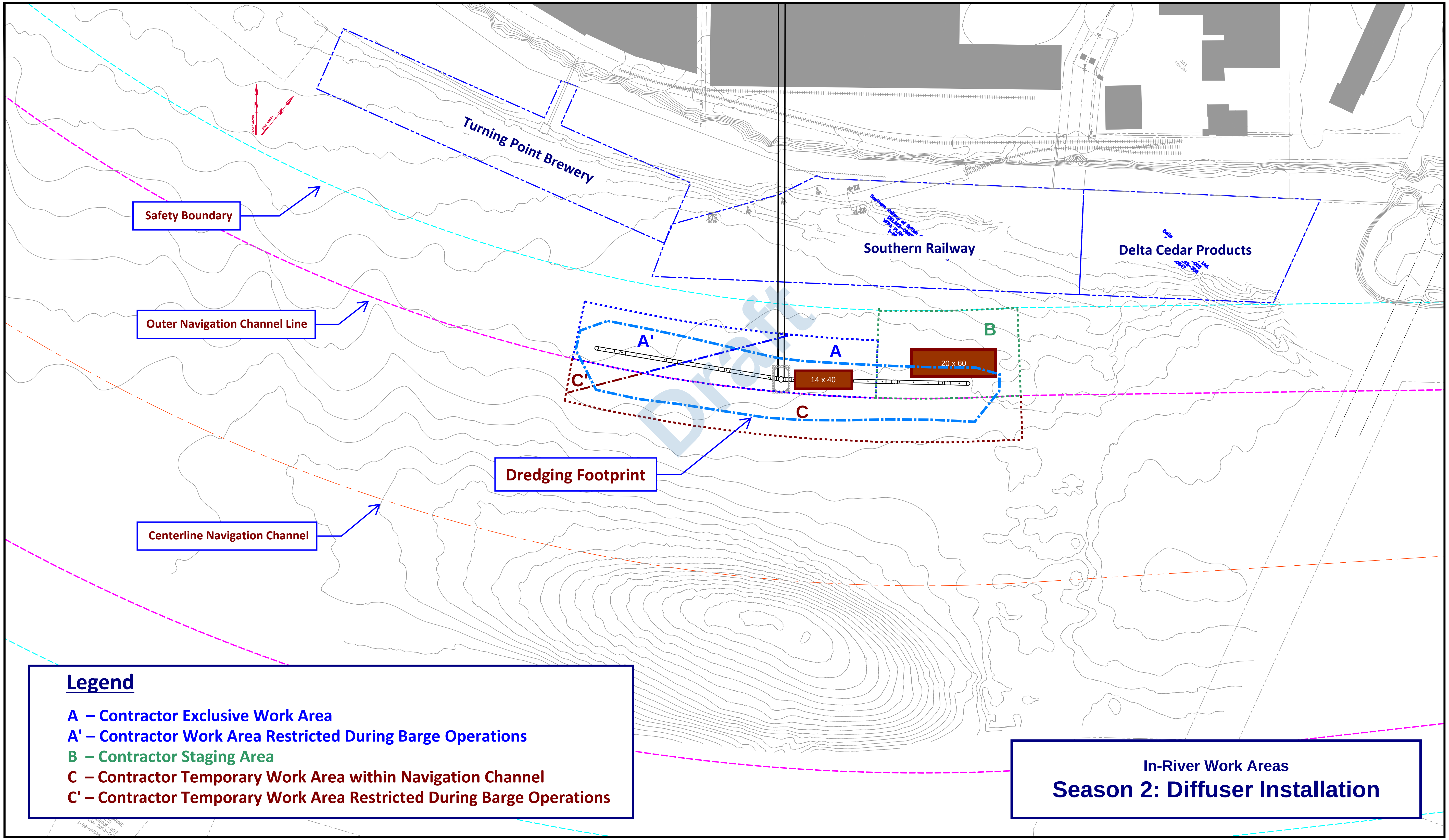


Figure 4-12: In-River Work Areas – Diffuser Connection

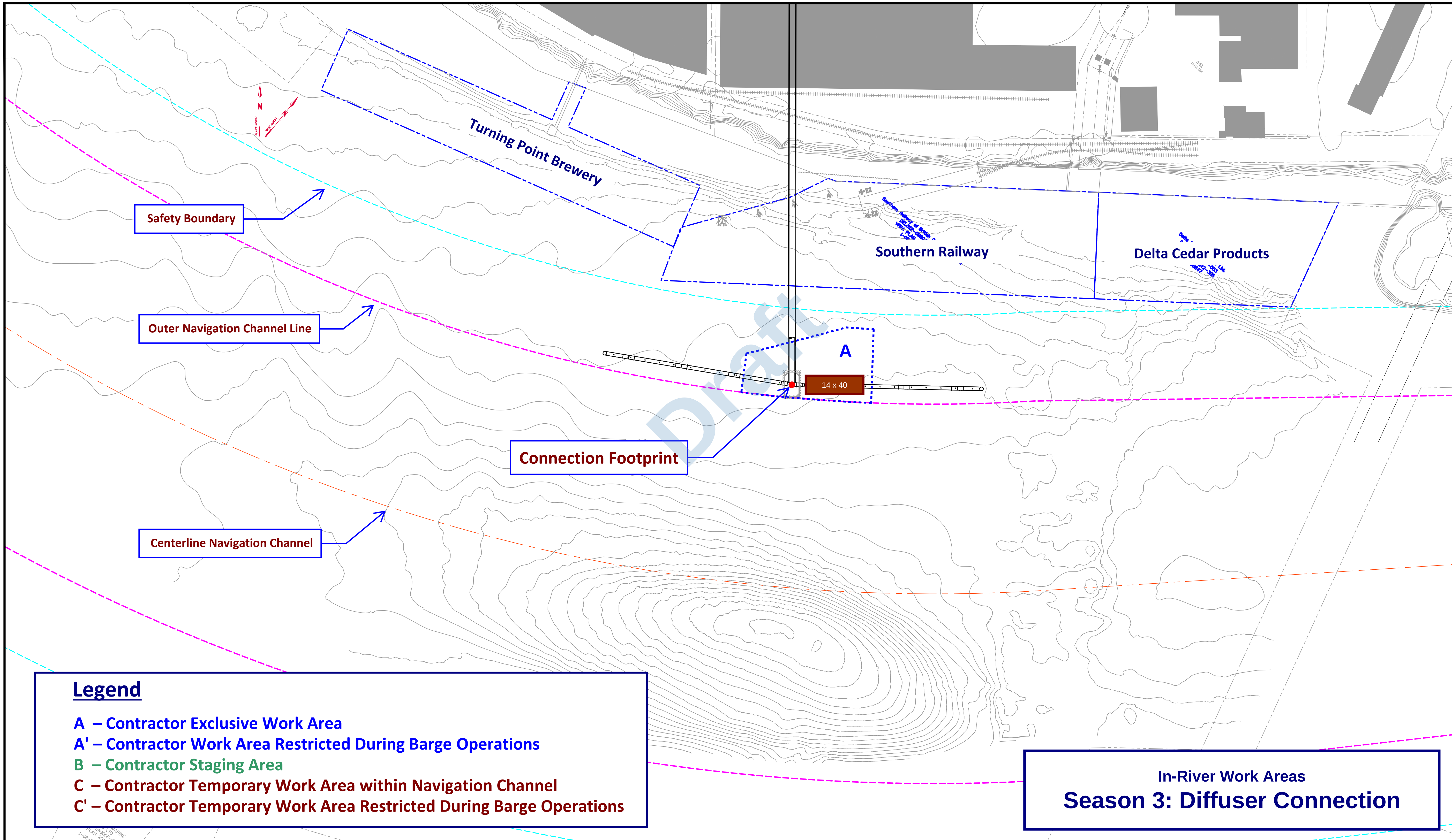
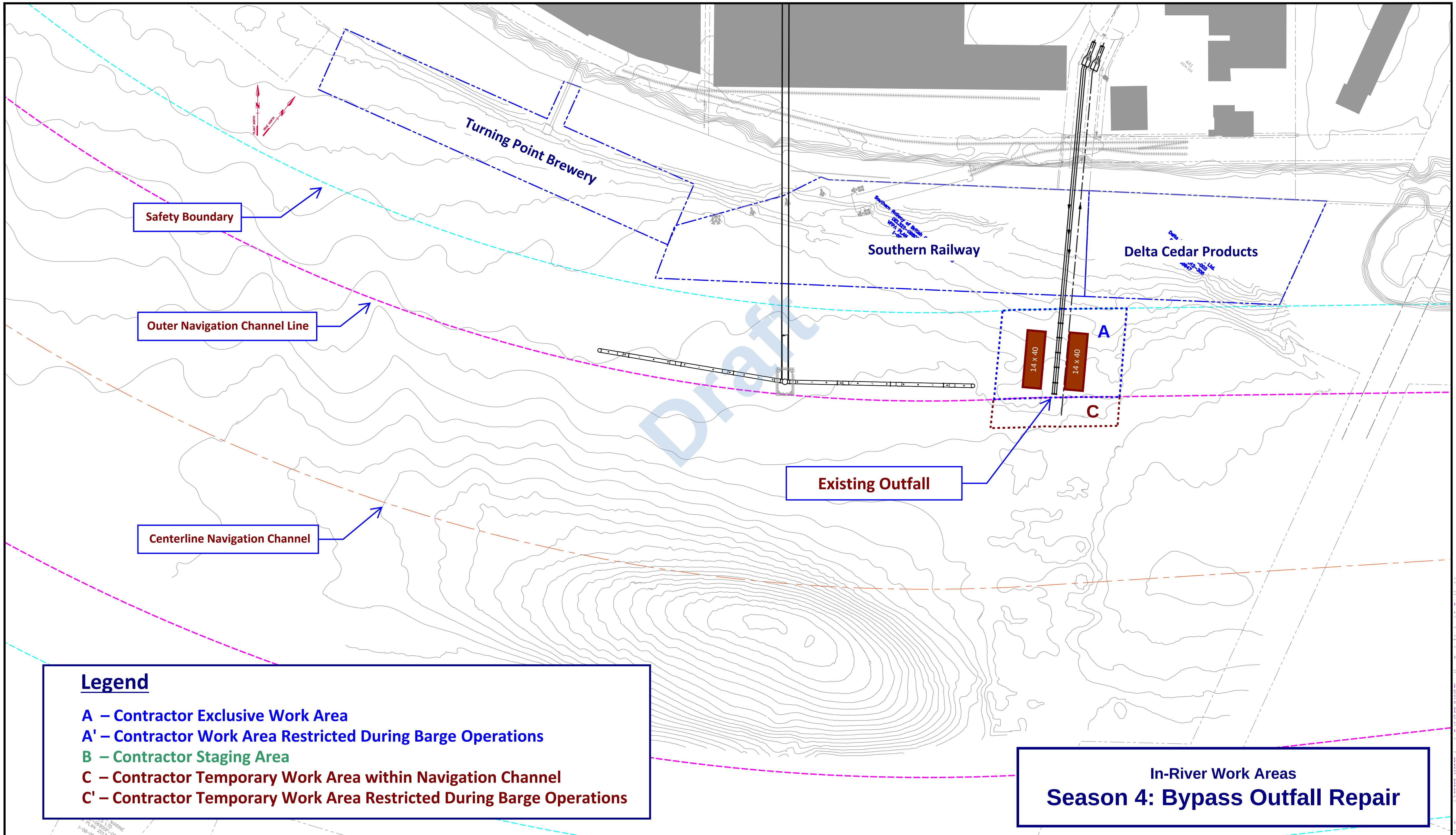


Figure 4-13: In-River Work Areas – Existing Outfall Rehabilitation



4.5.4 Construction Phase Navigation Impact Mitigation

4.5.4.1 Fraser River Navigation

The contractor will be required to prepare a project specific Navigation Protection Plan (NPP) addressing all anticipated marine navigation activities between barge or vessel loading sites along the Fraser River and the new outfall system project site. These activities will also be subject to the other contractor requirements for coordination of the work with marine users, including:

- Meetings with Marine Users
- Marine Communications Plan
- Temporary Notice to Mariners
- Weekly Notice to Shipping Advisories
- Public Notices

4.5.4.2 Seaspan Railcar Barge Operations

Recommendations for procedures to mitigate risks associated with the railcar barge moments are detailed in the Navigation Impact Assessment report as agreed upon in follow up meetings with Southern Railway and Seaspan. These mitigation measures will be required by the contract specifications and are summarized as follows:

- **Coordination of Barge Movements**: Establish a procedure between Southern Rail Terminal/ Seaspan Towing Dispatch and the marine contractor to provide at least twenty-four hours advanced notification of all planned barge manoeuvres by Seaspan and movement of major construction equipment by the contractor.
- **Protection of Contractor Personnel**: As a risk mitigation measure personnel working in the cofferdam should be removed at least 15 minutes prior to scheduled barge moves.
- **Stand-by Tug**: The marine contractor should have a stand-by tug present throughout the riser construction season and most other significant in-river construction activities to provide response/ assistance
- **Tethering of Seaspan Assist Tug**: For the duration of the cofferdam construction and riser installation process, all barge moves to and from Southern Rail must be conducted by two tugs, both of which are tethered. The preferred position for the "Assist Tug" is tethered at or near midships on the river side of the barge.
- **Flood Tide Restrictions**: For the duration of the cofferdam construction, barge arrivals and departures from the Railcar Barge Terminal should not be performed when upriver flood tide currents are present. This proposed restriction would typically not exceed more than two, 3-hour windows on any given day.
- **Defined Approach Corridors**: A rail barge transit exclusion zone was defined that will be kept free during barge manoeuvres from any floating apparatuses, construction barges, cranes or other devices that are required as part of the construction. Also, simultaneous manoeuvres at Southern Rail and the construction site should be avoided. The practice of conducting movements at Southern Rail on the ebb tide, and at the construction site on the flood tide will facilitate this procedure.

- **Simulation of Final Operational Procedures**: Prior to commencing construction operations, another two to three-day simulation session should be convened with participation from the marine contractor, Seaspan Towing, Southern Rail, and any other identified vested interest group to practice the proposed procedures and to conduct any procedural refinement that might be deemed necessary prior to commencing live operations.

4.5.4.3 In-River Construction Work Areas

Mitigation measures for each of the in-river work areas shown on **Figure 4-10** to **Figure 4-13** as follows:

- **Area A**: The mitigation measures identified in the manouvering analysis generally apply to all construction activities in Area A, particularly during the river riser construction.
- **Area A'**: The rail barge transit exclusion zone identified in the manouvering analysis will be kept clear of any floating apparatuses, construction barges, cranes or other devices that are required as part of the construction during railcar barge operations. The contractor may occupy this area between the navigation channel and safety boundary at other times.
- **Area B**: Mitigation measures identified in the manouvering analysis generally do not apply to construction activities in Area B.
- **Area C**: This area within the navigation channel could be used by marine construction equipment provided large vessel ship traffic is restricted to a single direction past the construction site in accordance with an approved communication plan and protocol developed in consultation with regulatory authorities and the marine industry. Fraser River Pilots would need to be consulted to determine if addition tug assist would be required for ships to safely avoid the area occupied by the contractor. The balance of the navigation channel would need to be clear of any equipment when ships are transiting past as well as 15 minutes (TBD) before a ship's ETA to the project site.
- **Area C'**: Like Area C', this exclusion zone will be kept clear of any marine contractor equipment during railcar barge operations. The contractor may occupy this area between the navigation channel and safety boundary at other times.

Additional restrictions on work areas may need to be negotiated between the marine contractor and Delta Cedar Products related to their barge activities during the Diffuser Installation season and during the Existing Outfall Rehabilitation season.

4.5.5 Operational Phase Navigation Impact Assessment

The permanent new outfall system facilities in the Fraser River are shown in plan view on **Figure 3-1** (Drawing Number A61C0005 in **Appendix A**) and as the diffuser cross section in **Figure 3-8** (Drawing Number A61C0072 in **Appendix A**). All permanent portions of the new outfall system will be located within the area between the navigation channel and the safety boundary and be more than 8.7 m below Chart Datum. Since deep-sea vessels do not operates in this area, no impacts to navigation are anticipated during normal operations.

Once the new outfall system is completed, activities in the Fraser River will be limited to inspection, maintenance, and repair consisting of:

- Routine annual or more frequent diving and/or sonar inspection.
- Repair of damaged risers, if necessary.
- Coordination with Navigation Channel maintenance dredging.
- Installation of additional risers for future plant flow expansion.
- Remotely Operated Vehicle (ROV) inspection access in case of seismic event, etc.
- Riser replacement (30+/- years).

Inspection, maintenance, and repair activities during the operation of the new outfall system will occur between the edge of the navigation channel and safety boundary and not likely to have a significant impact on marine navigation.

4.5.6 Operational Phase Navigation Impact Mitigation

For the permanent condition, the marine contractor will be required to perform a high density hydrographic survey and/or side scan survey to clearly demonstrate elevation of completed diffusers above the mud-line. This will be submitted to Transport Canada for inclusion in future updates to navigation charts and references.

Inspection, maintenance, and repair activities during the operation will generally require an activity specific permit from the port authority. An exception is routine maintenance dredging activities performed by the port authority subject to the Works Protocol (see **Appendix D**).

4.6 Dredging

4.6.1 Dredge Area and Volume

To install the outfall's manifold pipe and diffusers, dredging is anticipated to occur during the second season of in-river work within DFO's marine/estuarine timing window for the protection of fish and fish habitat (June 16 – February 28). **Figure 4-14** presents the anticipated dredge area (12,750 m^2) for diffuser manifold installation. Dredging will not extend into water lots outside the navigation channel safety area and will not encroach on riparian areas. Temporary shoring (**Figure 4-15**) will be utilized on the shoreline side as necessary to control the dredging and limit the dredge slope from extending further toward the shore. All shoring will be removed upon completion. Dredging volume is estimated to be less than 35,000 m^3.

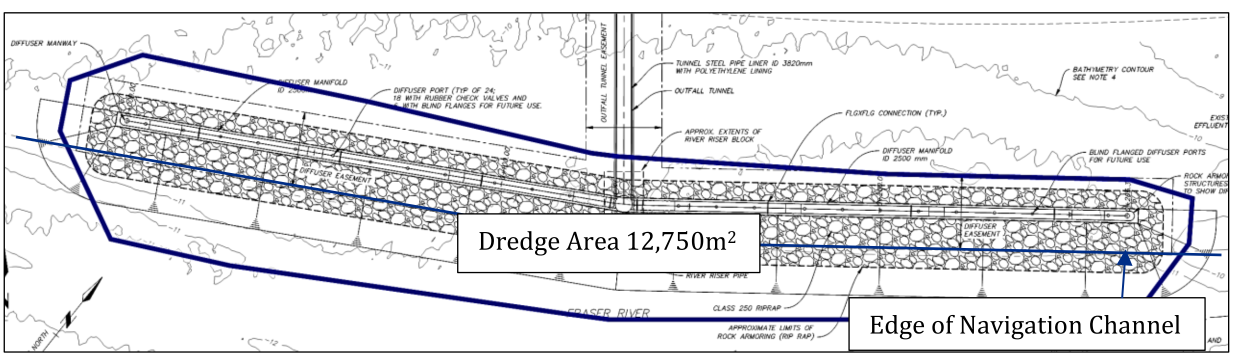


Figure 4-14: Extent of Diffuser Dredging (Drawing Number A61C0005)

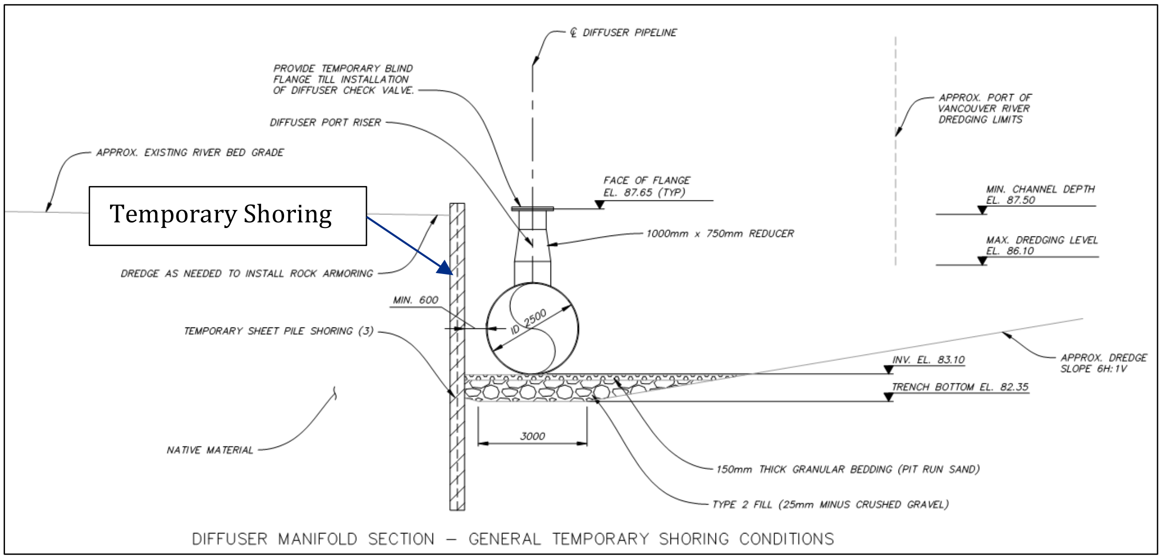


Figure 4-15: Diffuser Manifold Temporary Shoring (Drawing Number A61C0073)

4.6.2 Dredge Methods

Dredging will be conducted using a clamshell dredge (i.e. a crane equipped with a clamshell bucket). A clamshell dredge was selected, in part, due to its ability to precisely excavate to the limits delineated by the design and limit impacts on the river bed associated with construction. Clamshell dredging is mechanical dredging and is effective in minimizing induced turbidity, as opposed to the hydraulic dredging. Hydraulic dredges, such as cutterhead suction and hopper dredges, tend to over-excavate, especially where sand is the dominant sediment.

The crane with bucket would be operated from a floating spud-derrick. The bucket is operated through a series of cables fitted to the crane. Dredged material is deposited onto a barge. It is anticipated that a portion of the dredged material would be utilized to restore the river bottom (sediment and elevation) upon completion of the installation of the manifold.

Refer to **Section 2.3.1**, Construction Schedule and Staging and **Section 2.3.4**, Construction Equipment for additional information for schedule, hours, and anticipated equipment for dredging.

4.6.3 Dredge Impacts and Mitigation

Dredging impacts and mitigation related to fish and fish habitat are discussed in **Appendix G.1**. Additional details related to habitat assessment is presented in **Section 4.11** and a complete discussion of potential risks for fish and fish habitat is contained in the DFO Request for Review and supplemental information contained in **Appendix L.2** to **Appendix L.4**.

Extraordinary mitigation measures for the containment of sediment plumes attributable to dredging, such as silt curtains, are not proposed for dredging activities. Silt curtains cannot be maintained in place due to fluvial and tidal currents. Other means of containment, such as steel sheet pile, are cost-prohibitive and not appropriate for the scale of dredging proposed. Measures to implement such containment would dramatically exceed the scope of work associated directly with dredging.

4.6.4 Dredge Material Disposal

It is anticipated that material not used to restore the river bed at and about the riser and diffuser manifold would be disposed at sea (Disposal-at-Sea Permit) or barged to an marine unloading facility and hauled to an upland disposal site. The choice will depend on the marine contractors selected means and methods and work sequence for dredging and backfilling.

To provide the marine contractor with sediment data which would expedite a Disposal-at-Sea permitting process if the contractor elected to dispose dredge material at sea, Metro Vancouver undertook sediment sampling. A sampling and analysis plan (SAP) was prepared consistent with Environment and Climate Change Canada (ECCC) Pre-Application Phase guidance for a permit pursuant to the Disposal at Sea Regulations (SOR/2001-275, DAS Regulations). A conservative maximum limit for the boundaries of the dredge pocket (19,600 m^2) was purposely selected to prepare the sampling plan and assure adequate sample coverage. The SAP was approved by ECCC and the sampling was performed. **Appendix G.2** contains the Sediment Characterization Report, which describes the sampling program and presents the results. The report has been submitted to ECCC.

The sediment sampling results were consistent with surface and sub-surface sampling performed near the dredge pocket to support of outfall design, as well as typical of mid-channel sediment chemistry documented in the lower Fraser River. Constituent concentrations in surface sediments met the regulated DAS Regulation lower level concentrations for cadmium, mercury, total polycyclic aromatic hydrocarbons, and total polychlorinated biphenyls. Concentrations of these and other sediment constituents not regulated under DAS were at or below applicable Canadian Council of Ministers of the Environment interim sediment quality guidelines.

4.7 Noise Study

As per the port authority’s PER requirement, a noise self-assessment of the proposed project to the adjacent community was carried out and is presented in **Appendix H.1**. The noise self-assessment is applicable to operational use as this project is not anticipated to generate any operational noise. During operation, the new outfall system will convey effluent water from the Chlorine Contact Tank (CCT) at the level control structure (Annacis Island WWTP) to the Fraser River. The effluent water will run through underground tunnels, shafts, river riser and diffuser manifold with no noise generation. The new outfall system will replace the existing outfall which operates with no noise generation, therefore the adjacent community will not be affected by the proposed project.

The self-assessment questionnaire results in a total weighted score of 18 points (**Table 4-2**). Therefore, the noise assessment is not applicable to this project because it does not meet the self-assessment threshold (30 points). Noise generation and mitigation during construction is addressed in the Construction Environmental Management Plan (**Appendix J.2**).

Table 4-2: Noise Self-Assessment During Operation

No.	Attribute of Project or Project Setting	Score	Importance Weighting	Weighted Score
1	New Activity, Replacement or Expansion	3	1.2	3.6
2	Noise Levels Expected on Project Site	1	1.8	1.8
3	Presence of Undesirable Characteristics	0	1.6	0.0
4	Presence of High Energy Impulsiveness Noise	0	1.6	0.0
5	Hours/Days of Operation	5	1.2	6.0
6	Proximity to Noise Sensitive Areas	1	1.6	1.6
7	Presence of Noise Shielding or Reflection	0	1.8	0.0
8	Baseline Noise Environment	1	1.6	1.6
9	Population Potentially Exposed to Project Noise	1	1.0	1.0
10	Level of Community Concern About Noise	2	1.2	2.4
			Total Weighted Project Score:	**18.0**

Bald Eagles nest on Annacis Island with the closest nest located in a large cottonwood tree on the banks of the Fraser River approximately 700 metres upstream of the project location and upstream of the Alex Fraser Bridge. Since construction noise can negatively affect nesting success, a noise study was performed (**Appendix H.2**) to assess prospective impacts of noise on nesting activities of Bald Eagles. The study determined that the prospective increase in noise attributable to construction activities is not significant.

4.8 Alternative Siting Options

During preliminary design of the new outfall system, alternatives for the outfall system alignment and structures were evaluated. This section summarizes the resulting Outfall System Options Analysis attached as **Appendix I**. The optimum location for the outfall diffuser was determined as described in a report titled "Multiport Diffuser Design and Initial Dilution Modeling" which is included as an appendix to the Outfall System Options Analysis.

4.8.1 New Outfall System

4.8.1.1 Options Evaluated

Black & Veatch (B&V) was initially retained by MV to prepare a conceptual and preliminary design of outfall upgrades for the AIWWTP. Their Preliminary Design Brief (Black & Veatch, 2015) recommended an option that included two outfall alignment corridors, termed the Western Tunnel corridor and Central Tunnel corridor, each terminating in a diffuser pipe at the edge of the Fraser River shipping channel. For each of these corridors, deep and shallow tunnel alignment options were proposed between the AIWWAP and the Fraser.

To ensure that MV implements the best options for the new outfall, the outfall system options analysis was conducted to a sufficient level of detail to adequately support a recommended option that achieves MV's objectives as described in **Section 2.1.4**.

The following four conveyance options were analyzed:

1. One new gravity outfall with a capacity of 25.3 m^3/s;
2. Two new gravity outfalls with a total capacity of 25.3 m^3/s;
3. One new gravity outfall which supplements the existing outfall for a total combined capacity of 25.3 m^3/s; and
4. One new outfall to provide a capacity of 25.3 m^3/s via a new pump station.

Ultimately it was decided that a single gravity outfall with provisions for a future pump station would best meet MV's objectives. The use of two gravity outfall system is not justifiable from a cost and impact perspective. Technical limitations precluded the use of the existing outfall.

4.8.1.2 Alignment Options

Factors considered during the outfall alignment options development included: Topography/ Bathymetry, Right-of-Way Alignment Corridors, Structures and Utilities, Hydraulics, Geotechnical Conditions, Seismic Setting and Risk, Archeological, Fluvial Geomorphology, Fraser River Navigation Channel, and Operations and Maintenance.

From these factors, three alignment corridors were developed and presented in **Figure 4-16** for further evaluation. They were:

- West Alignment Corridor
- West Alignment Corridor (Modified)
- Central Alignment Corridor

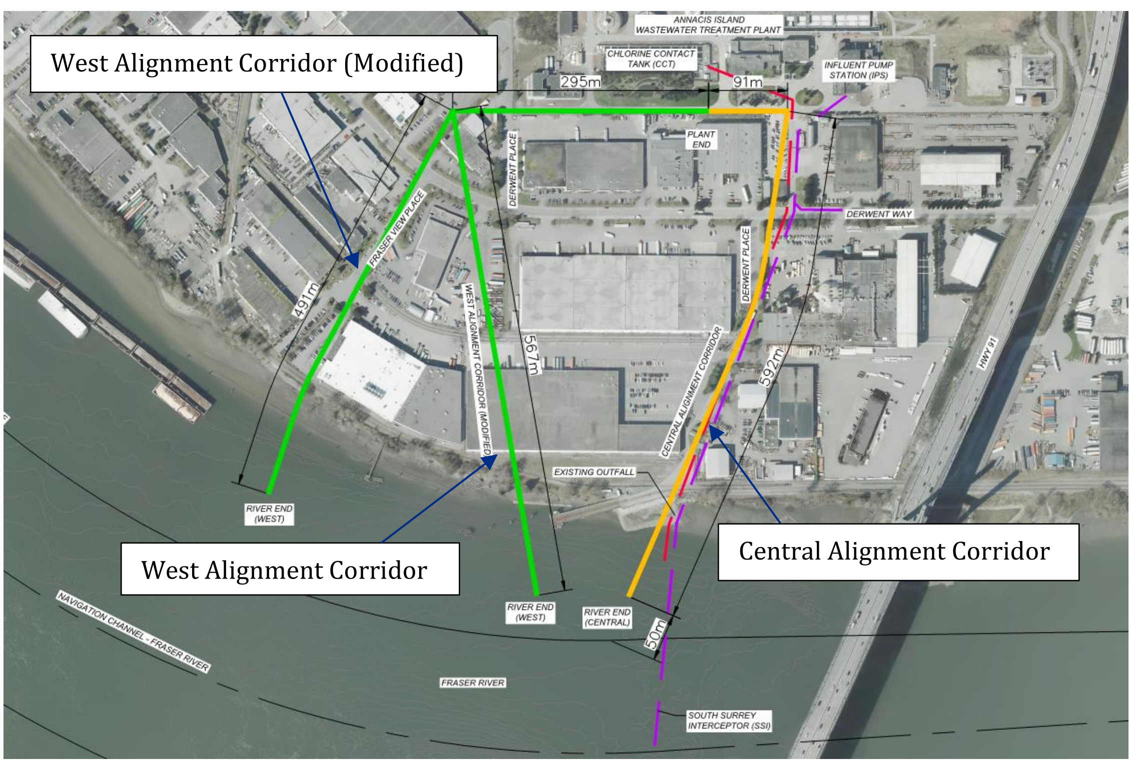


Figure 4-16: Alignment Corridor Options

In refining elements of the alignment options carried forward for the outfall system options analysis, CDM Smith considered all the factors described in previous section. The following is the list of comprising elements for each alignment option selected for analysis:

- Effluent Conveyance Alignment
- Buried Conduits vs. Mined Tunnels
- Vertical Tunnel Alignment
- Tunnel Shaft Locations
- Potential Pump Station
- River Risers and Shafts
- Connection to the WWTP
- River Diffuser System

Following identification of the preferred outfall diffuser location, eight sub-options for further evaluation were developed. **Figure 4-17** presents the sub-options, while **Table 4-3** summarizes the eight sub-options.

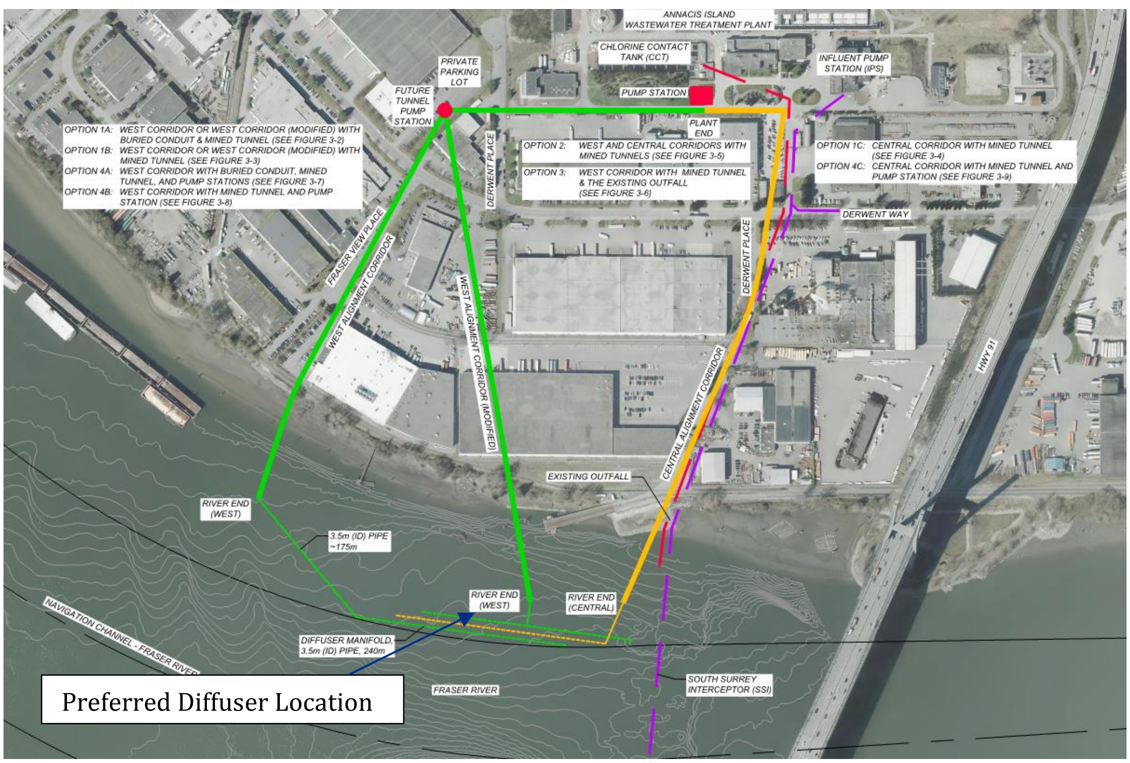


Figure 4-17: Alignment Corridor Sub-Options

Table 4-3: Outfall Sub-Options and Estimated Dimensions

Outfall Options	Estimated Dimensions	Description
Option 1a: West Corridor or West Corridor (Modified) with buried conduit & mined tunnel	Buried conduit: ~4 m x 3.5 m Mined tunnel: ~4.2 m ID	A buried conduit from the CCTs to a launch shaft located in the private parking lot and a mined tunnel from the launch shaft to river riser (West)
Option 1b: West Corridor or West Corridor (Modified) with mined tunnel	Mined tunnel: ~4.2 m ID	A mined tunnel from a launch shaft located in the private parking lot to a receiving shaft near the CCTs and a mined tunnel from the launch shaft to the river riser (West)
Option 1c: Central Corridor with mined tunnel	Mined tunnel: ~4.2 m ID	A mined tunnel from a launch shaft located in the vicinity of IPS to a receiving shaft near the CCTs and a mined tunnel from the launch shaft to the river riser (Central)
Option 2: West Corridor or West Corridor (Modified) and Central corridors with mined tunnels	Mined tunnel: ~3.4 m ID	West: A mined tunnel from a launch shaft located in the private parking lot to a receiving shaft near the CCTs and a mined tunnel from the launch shaft to the river riser Central: A mined tunnel from a second launch shaft located in the vicinity of IPS to the same receiving shaft near the CCTs and a mined tunnel from the second launch shaft to the river riser
Option 3: West Corridor or West Corridor (Modified) mined tunnel & the existing outfall	Mined tunnel: ~3.6 m ID	A mined tunnel from a launch shaft located in the private parking lot to a receiving shaft near the CCTs and a mined tunnel from the launch shaft to the river riser to supplement the existing outfall
Option 4a: West Corridor or West Corridor (Modified) with buried conduit, mined tunnel, and pump station	Buried conduit: ~3.5 m x 2.1 m Mined tunnel: ~3.0 m ID Pump station: 25 m by 20 m	A buried conduit from the CCTs to a launch shaft located in the private parking lot and a mined tunnel from the launch shaft to a river riser (West) with a pump station near the CCTs
Option 4b: West Corridor or West Corridor (Modified) with mined tunnel and pump station	Mined tunnel: ~3.0 m ID Pump station: 25 m by 20 m	A Mined Tunnel from a Shaft located in the Private Parking Lot to Plant End and a Mined Tunnel from the shaft to River End (West). A pump station would be located near the CCTs
Option 4c: Central Corridor with mined tunnel and pump station	Mined tunnel: ~3.0 m ID Pump station: 25 m by 20 m	A mined tunnel from a launch shaft located in the vicinity of IPS to a receiving shaft near the CCTs and a mined tunnel from the launch shaft to the river riser (Central). A pump station would be located near the CCTs

4.8.1.3. Evaluation of Cost and Risk

The opinion of probable construction cost presented in the Outfall Options Analysis Report was based on a Class 5 cost evaluation developed for options screening. All three sub-options for Option 1, were predicted to have the lowest costs.

Table 4-4: A Summary of Opinion of Probable Construction Cost

Outfall Options	Total Probable Cost; $ mil
Option 1a: West Corridor with buried conduit & mined tunnel	**$105.3**
Option 1b: West Corridor with mined tunnel	**$114.5**
Option 1c: Central Corridor with mined tunnel	**$107.4**
Option 2: West and Central corridors with mined tunnels	**$160.2**
Option 3: West Corridor mined tunnel & the existing outfall	**$138.7**
Option 4a: West Corridor with buried conduit, mined tunnel, and pump station	**$123.7**
Option 4b: West Corridor with mined tunnel and pump station	**$136.8**
Option 4c: Central Corridor with mined tunnel and pump station	**$130.6**

The options were subject to risk evaluation and analysis. A risk is an uncertain event or condition that, if it occurs, has an uncertain positive or negative effect on a project's objectives. Risks may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risks may influence many types of project objectives including cost, schedule, operational performance, working conditions and environmental sustainability. The methodology used and the results of the risk analysis are described in the Outfall System Options Analysis, attached in **Appendix I**.

The risk-based option evaluation for risks that are quantifiable in terms of cost. Option 1b had the least amount of cost quantifiable risk relative to all other options. Options 1a, 1c, 4a and 4b followed with lower cost quantifiable risk levels relative to Options 2, 3 and 4c.

4.8.1.4 Recommended Option

Based on the opinion of probable construction cost and evaluation of option risk, CDM Smith recommended implementing Option 1b alignment for the final design based on the following:

- Options 2, 3, 4a, 4b, and 4c all have higher probable construction cost as well as higher quantifiable and non-quantifiable cost risk than Options 1a, 1b, or 1c.
- The lower probable construction cost for Option 1a will likely be more than offset by risk costs, particularly the non-quantifiable ones associated with construction of buried conduits within the confines of the treatment plant, especially with regards to restrictions on future plant expansion and interferences with concurrent Stage V and Co-Generation construction activities.
- The lower probable construction cost for Option 1c will be more than offset by risk costs associated with constructing the new system within the same corridor as the existing outfall while keeping the existing outfall in operation.
- Option 1b provides the most flexibility in terms of potential future pump station construction, connection with the post-disaster effluent conduit (PDBCO), and connection to the river riser and diffuser locations in the Fraser River.

CDM Smith-recommended design of Option 1b includes:

- Selection of a preferred alignment in the West Alignment Corridor based on further evaluation of in-river diffuser design and modeling in concert with on-going discussions with the Ministry of Environment, along with construction access and cost factors.
- 30% design for a future pump station at the Outfall Shaft, to continue to meet effluent discharge dilution requirements for future plant flow increases beyond the current Annacis Island WWTP Stage V expansion.
- Managing the design process for the preferred option by using best practices for project risk management that are widely used for projects of similar size and complexity, both in British Columbia and internationally.

4.8.2 Outfall Shaft Location Options

4.8.2.1 Background

The recommended option for effluent conveyance to the river is a tunnel constructed using a tunnel boring machine (TBM) driven from an Outfall Shaft, as presented in previous sections. The Outfall Shaft need to be located along the tunnel alignment between the AIWWTP and the river.

The tunnel design is optimized to take advantage of the all available hydraulic driving head from the CCTs to the river in order to meet effluent discharge dilution requirements. However, it is envisioned that due to a combination of higher flows in the future (AIWWTP Stage 8 upgrades), on-going island-wide settlement, and rising ocean elevations, an effluent pump station will be required to meet minimum required dilution in the river. Preliminary design studies indicated that it would make the most sense to use the launch shaft as the future pump station structure. When the pump station is implemented in the future, the effluent pumps will be installed within the Outfall Shaft.

Construction of the Outfall Shaft and mining of two or more tunnel drives from the shaft involve significant construction activities and space. Frequent truck access is also required to bring in shaft and tunnel construction materials and take out tunnel spoil (mined earth). A portion of the construction area around the shaft needs to be reserved for the future pump station support building and ancillary structures.

4.8.2.2 Location Options

Several possible locations for the Outfall Shaft were identified both on Metro Vancouver property and private parcels adjacent to the AIWWTP. Out of four alternative locations for the launch shaft construction and future pump station site, a site located at 1331 Derwent Way was selected based on a business case evaluation. Primary factors favoring this selection are:

- Reduced risks for construction complications, cost increases, and schedule delays.
- Reduced risk of business impacts related to current and future plant use and expansion.
- Improved hydraulic performance with respect to pump station layout and head losses.

The selected Outfall Shaft site and its relationship to the rest of the effluent conveyance system is shown on **Figure 4-18**. The launch shaft and pump station are located in the western portion of the property (Lot 235) currently occupied by a warehouse structure which will need to be demolished prior to start of the outfall construction contract.

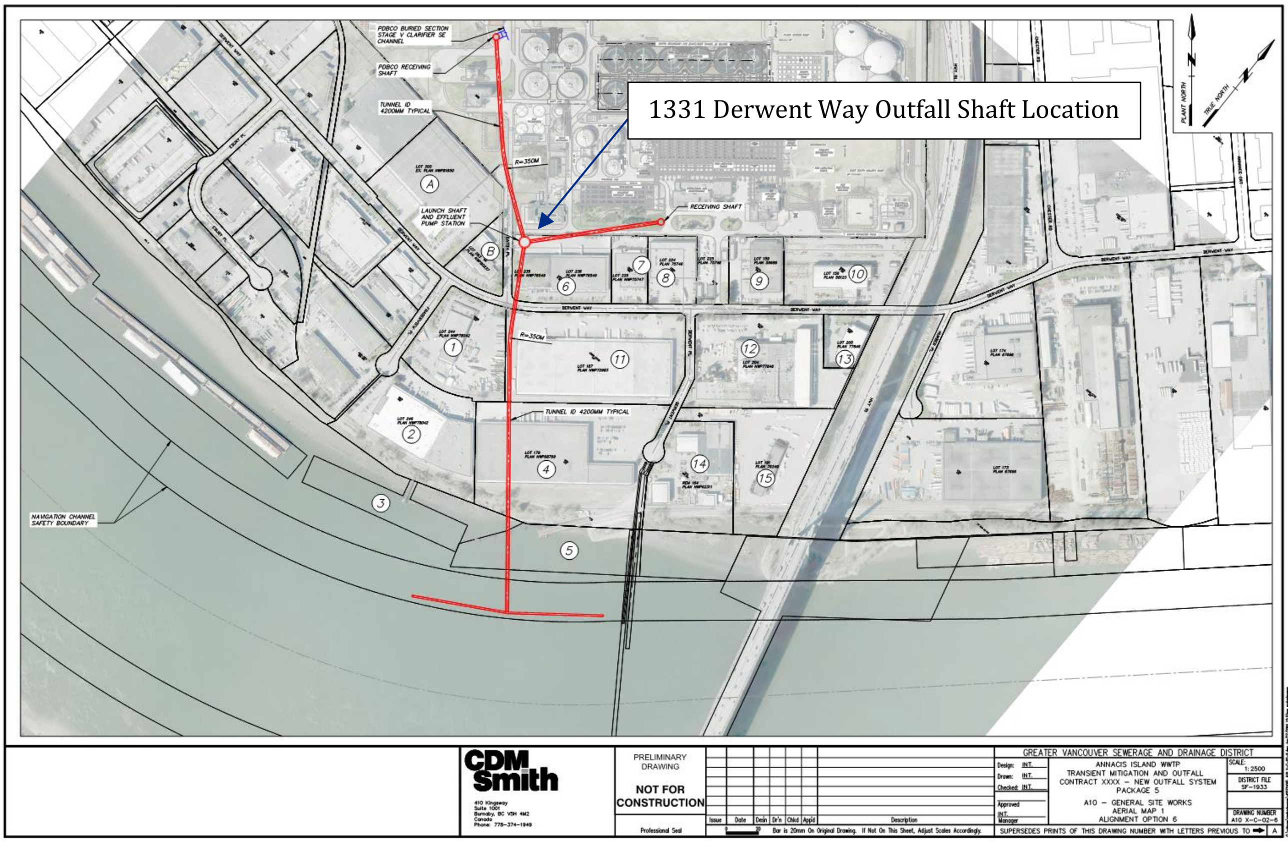


Figure 4-18: Selected Outfall Shaft Location

4.9 Environmental Studies

4.9.1 Geo-Environmental Studies

4.9.1.1 Geo-Environmental Investigation

Initial investigation of the two new gravity outfall alignments was carried out in 2015, as part of the preliminary design phase. Following selection of the final outfall alignment additional investigations were performed and Geo-Environmental Assessment Report was prepared as included in **Appendix J.1**. The scope of the Geo-Environmental Assessment was to summarize the results in relation to the final preferred alignment as follows:

- Interpreted soil, groundwater, and sediment conditions that underlie the outfall alignment extending from the Effluent to Outfall Shafts and the Outfall Shaft to River Riser.
- Perform laboratory testing results of soil, groundwater and sediment samples collected for environmental analyses.
- Interpretation of the results in relation to the conditions along the outfall alignment.

4.9.1.2 On-Land Findings

The observations of soil conditions in boreholes drilled along the proposed alignment on land did not identify any obvious indicators of significant contamination (i.e., no obvious staining, no identified odours, and limited debris in fill). Chloride was detected at concentrations exceeding CSR standards in soils samples collected at depths over 30m near the shoreline. This is most likely a reflection of intrusion of salt water from the salt-wedge that is present intermittently in the Fraser River. The presence of chloride in soil mined during tunneling in the near-shore and off-shore portion of the Outfall Tunnel may restrict disposal options to permitted disposal facilities.

Isolated areas of contamination that may not be detected using such widely-spaced locations. Therefore, there remains some risk of encountering other contamination during construction.

With respect to groundwater, minor dissolved metals, Polycyclic Aromatic Hydrocarbons (PAHs), and Volatile Organic Compounds (VOCs) concentrations were detected and they exceeded the applicable standards, but the concentrations detected were not considered indicative of significant groundwater contamination. All stormwater, dewatering water, and process water from the on-land construction areas will be treated on-site and discharge to the sanitary sewer in accordance with the discharge requirements of the jurisdictional authority (City of Delta) and/or Metro Vancouver. The low level of these constituents in ground water is not likely to require additional treatment that that required to address turbidity, oil and grease, and pH in order to meet the discharge requirements.

4.9.1.3 In-River Findings

In-river sediment conditions were assessed during the geo-environmental studies based on relatively shallow depth sediment samples and limited deeper samples recovered as part of the geotechnical drilling carried out within the Fraser River.

PAHs exceedances for both CSR and CCME applicable standards were detected in one of the samples collected within the proposed in-river diffuser construction area. While these concentrations were not substantially above guideline values, and they are usually associated with the industrial activities on the lower Fraser River, they could have an influence on the possible disposal options for sediments removed during construction.

Subsequent to the geo-environmental assessment, a sampling and analysis plan (SAP) was prepared consistent with the Pre-Application Phase guidance for a permit pursuant to the Disposal at Sea (DAS) Regulations. This sampling and the results are presented in **Section 4.6.4**, Dredged Material Disposal and in **Appendix G.2**, Sediment Characterization Report.

To summarize the results, constituent concentrations in sediments met the regulated DAS Regulation lower level concentrations for cadmium, mercury, total polycyclic aromatic hydrocarbons, and total polychlorinated biphenyls, were at or below applicable Canadian Council of Ministers of the Environment interim sediment quality guidelines, and were consistent with surface and sub-surface sampling recently undertaken by MV within the vicinity of the dredge pocket and typical of mid-channel sediment chemistry documented in the lower Fraser River.

Collectively, data collected by the Sediment Characterization Program and existing information summarized in the SAP provide a physical and chemical characterization that meets pre-application sampling requirements for a potential DAS permit application pursuant to the DAS Regulations. No further sediment collection is proposed within the dredge area for this purpose.

If dredged sediments are disposed at an upland site, additional sampling and analyses may be needed to characterize the sediment, and to confirm it meets the requirements of the contractor's selected disposal site. The presence of chloride in dredged sediment may restrict disposal options to permitted disposal facilities.

4.9.2 Construction Environmental Management Plan

This Construction Environmental Management Plan (CEMP) is the primary document to guide overall environmental best management practices to be implemented by the construction team for the project to reduce or eliminate effects on the environment and meet regulatory requirements. It will be provided to the contractor, including everyone engaged by or through the Contractor, as a prescriptive document for the protection of environmental resources consistent with the Contract Specifications (Section 01355 - Environmental Requirements). The CEMP provides a basis for the development of the site or activity-specific Environmental Protection Plan (EPP) to be prepared by the contractor, accounting for their selected construction practices and mitigation strategies prior to starting construction activities. The CEMP is included, along with a draft of Specification Section 01355, as **Appendix J.2**.

The CEMP and the contractors EPP may need revisions when the port authority makes a final determination on the suitability, completeness and adequacy of the CEMP, as well as when further site-specific information becomes available or project conditions change. The CEMP and EPP will be reviewed on an annual basis to ensure mitigation measures are appropriate for the current and scheduled construction activities at the Project site.

The CEMP describes the roles and responsibilities of MV and the project's contractor for implementing, inspecting, and reporting on the effectiveness of environmental protection and mitigation measures. Personnel involved with the planning and implementation of the Project's overall environmental program are presented in **Table 4-5**.

Table 4-5: Key Project Contacts

Name	Role	Organization
Ken Massé	Project Manager	Corporation
John Newby	Corporation's Engineer	CDM Smith
Tim Langmaid	Corporation's Construction Manager	Hatch
TBD	Corporation's Environmental Monitor	Golder
TBD	Contractor Project Manager	Contractor
TBD	Contractor Environmental Manager	Contractor
TBD	Contractor Environmental Specialist(s)	Contractor
TBD	VFPA Contact	VFPA
TBD	DFO Contact	DFO
TBD	TC Contact	Transport Canada
TBD	Delta Contact	Corp. of Delta

Roles defined in the CEMP include:

- **Metro Vancouver (Corporation)**: Responsibility for overall project implementation, including the administration of contracts, technical quality control, adherence to and performance of engineering requirements of contract specifications.
- **Corporation's Environmental Monitor**: Responsible for inspection, evaluation and audit of the work of the Contractor and its Environmental Manager and Environmental Specialist. This includes communication of the requirements of the CEMP, review of the contractor's EPP, review of the Contractor's environmental monitoring reports, and reporting to the Corporation on the effectiveness of mitigation measures and/or correction of deficiencies.
- **Contractor's Environmental Manager**: Responsible for compliance with project and environmental conditions of the port authority Project Permit and any other agency permit, approval or authorization issued to the Project; all relevant federal, provincial, and municipal laws, statutes, by-laws, regulations, orders and policies; and the project specifications, including preparation and implementation of the contractors EPP.

A summary of most important project mitigation measures and project specification requirements for environmental management and monitoring are described in the CEMP.

Environmental monitoring will be conducted at a frequency appropriate to the specific work activity being conducted, and the risk such an activity may adversely impact environmental resources. The higher the risk the greater the frequency and duration of environmental monitoring.

The Environmental Monitor will maintain complete records of activities related to the implementation of the CEMP. Any observations and/or measurements taken of biological, chemical and physical parameters, photographs and incident reports will be included in the record of activities which, in turn, will be appended to environmental monitoring reports.

The Environmental Monitor will submit Environmental Monitoring Reports to Metro Vancouver, the port authority, and other regulatory agencies at a frequency determined by the project permits. Reporting will be more frequent in the event of an incident of an unanticipated adverse effect to environment. For such an event, the effect will be described, the cause identified, implemented mitigative actions described, and residual outcomes presented. Upon completion of construction, a summary environmental monitoring report will be submitted to Metro Vancouver, the port authority and other regulatory agencies (as required) within 6 weeks of completion of construction.

4.10 Assessment of Effluent Discharge (EIS)

4.10.1 Stage 1 EIS

To discharge effluent from the new outfall, Metro Vancouver requires an amendment of its Operational Certificate under the Integrated Liquid Waste and Resource Management Plan (ILWRMP) pursuant to the provincial Environment Management Act (EMA). This amendment requires an Environmental Impact Study (EIS) of the effluent discharge to identify if receiving water uses could be impaired. The EIS is conducted in a staged process. Stage 1 evaluates a preliminary design and available data, and is followed by a pre-discharge monitoring program, if required, based on monitoring considerations suggested in Stage 1. The Stage 1 assessment is followed by a Stage 2 EIS, which is a refined evaluation of potential effluent-related impacts on the receiving environment and public health based on a final project design.

Overall, the Stage 1 assessment, based on conservative assumptions, indicated that pollution as defined under EMA is unlikely to occur as a result of the hydraulic upgrade to the AIWWTP and resultant treated effluent discharge; specifically:

- Adverse effects on aquatic life and impairment of other receiving environment uses identified for the Study Area (i.e., secondary recreational contact, wildlife use, agricultural use [i.e., irrigation and livestock watering]) are not expected based on a preliminary assessment of predicted concentrations at the edge of the Initial Dilution Zone (IDZ, around the diffusers).
- The secondary treated whole effluent at the point of discharge is not expected to be acutely lethal to aquatic life, and following dilution and mixing, conditions within the IDZ would likewise not be expected to be acutely toxic to aquatic life. Chronic toxicity is not expected beyond the IDZ boundary.

Based on the most recent characterization of effluent presented for the period 2011 to 2014, the AIWWTP effluent meets effluent limits specified in the ILWRMP for the Greater Vancouver Sewerage and Drainage District. The AIWWTP effluent also meets federal National Performance Standards (i.e., meets effluent limits and is not acutely toxic) and so is not considered a deleterious substance under the federal Fisheries Act.

The Stage 1 EIS was submitted to the BC Ministry of Environment (MoE) on August 26th, 2016, for review. Pre-discharge monitoring specific to the project started in September 2015 in consultation with BC MoE. The submission document, review comments from MoE, and subsequent responses to MOE are attached in **Appendix K.1**.

4.10.2 Stage 2 EIS

The scope and level of detail proposed for the Stage 2 EIS is based on Section 5.2.2 of BC Ministry of Environment, Lands and Parks (2000), and the project design as currently understood. The Stage 2 EIS provides a technical assessment of predicted water quality to evaluate whether the Stage V upgrade will result in adverse effects on the receiving environment and public health.

The objectives of the Stage 2 EIS were as follows:

- Refine the receiving environment characterization of the Study Area to include additional information gathered since the Stage 1 EIS was submitted.
- Refine effluent plume modelling to include near-field plume modelling and far-field hydrodynamic water quality dispersion modelling for various scenarios.
- Determine the initial dilution of the effluent plume via modeling and estimate constituent concentrations in the near-field at the edge of the initial dilution zone (IDZ) and in the far-field within the Study Area.
- Assess the potential for adverse effects on aquatic life and impairment of other receiving environment uses identified for the Study Area, through a risk-based impact assessment of the predicted near-field and far-field concentrations.
- Identify uncertainties in the impact assessment and provide recommendations to be considered in post-discharge monitoring for the AIWWTP outfall after the Stage V upgrade.

The Stage 2 EIS is included as **Appendix K.2**. In summary, the Stage 2 assessment indicates that pollution as defined by provincial Environment Management Act (EMA) is unlikely to occur from the hydraulic upgrade to the AIWWTP and resultant treated effluent discharge. This overall conclusion is supported by the following findings:

- Adverse effects on aquatic life and impairment of other receiving environment uses identified for the Study Area (i.e., secondary recreational contact, wildlife use, agricultural use) due to the Stage V upgrade are not expected based on the assessment of predicted concentrations at the edge of the IDZ and far-field nodes in the lower Fraser River.
- Adverse effects on wildlife and people consuming fish from the Fraser River are not expected for the Stage V upgrade based on an assessment of persistent, bioaccumulative, and toxic constituents (PBT) constituents.
- Secondary treated whole effluent at the point of discharge is not expected to be acutely lethal to aquatic life and conditions within the IDZ would likewise not be expected to be acutely lethal to aquatic life.

Based on the most recent characterization of effluent presented in the Stage 2 EIS (i.e., 2016), the AIWWTP effluent meets National Performance Standards (i.e., federal Wastewater Systems Effluent Regulation (WSER) limits and it is not acutely toxic); therefore, the effluent is not considered a deleterious substance under the federal Fisheries Act.

4.11 Habitat Assessment

The Habitat Assessment contained in **Appendix L.1** presents a baseline account of the existing environment at and about the Project location. Subject categories addressed include: 1) Existing Infrastructure; 2) Existing Channel Bed; 3) Hydrology, Hydraulics, and Salinity; 4) Fish and Fish Habitat; 5) Wildlife Species and Habitats; and, 6) Species at Risk. Impacts to Fish and Fish habitat, Wildlife and Wildlife Habitat, and Species at Risk are addressed specifically in the context of those species that are likely to occur within the design, construction, and operation footprints of the Project.

Additional details are provided in the Request for Review submission to Fisheries and Oceans Canada (DFO) regarding fish and fish habitat impacts in the surrounding environment and mitigative measures during and post construction. The DFO Request for Review is included as **Appendix L.2**, DFO correspondence is included in **Appendix L.3**, and a Supplemental Report is included as **Appendix L.4**.

Design related impacts are permanent. The design of the riser, diffusers, diffuser manifold and associated riprap would displace surficial sands of the river bottom. The residual effect of the design is the conversion of a limited area of surficial sand to armor rock and the presence of the riser protection caps above the level of sand waves that characterize design location. The overall area of exposed armor rock will typically be small, considerably less than 1,100 m^2, after the river bed reverts to its typical condition of scouring and re-deposition. The typical conditions are in the form of sand waves up to one metre in height, established by the first spring following construction, as the greatest amount of sand deposition and migration occurs during the freshet. The armor rock would be re-exposed for a limited period on the river side of the outfall during channel maintenance dredging by the port authority in the area between the navigation channel Dredging Grade and Dredging Subgrade shown on **Figure 3-8**.

Impacts to surficial sand on the river bed would not impair the life history stages of fish species, wildlife species and species at risk. Affected fish habitat, and habitat for a single species at risk (i.e. white sturgeon) is represented throughout the lower Fraser River, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island. The scale of impact on fish species and species at risk is not of consequence, especially in consideration of the abundance of similar habitat available to these species in proximity to the design location of the outfall. Wildlife habitat and habitat for other species at risk are not affected.

Construction related impacts are temporary. These impacts are mitigated through special measures that would be implemented during construction of the outfall pipe, riser, and diffuser manifold. Dredging required to facilitate construction of the diffuser would impact approximately 12,750 m^2 of river bottom. Most of this impact is temporary, and would largely be offset through restoration of the affected river bed, outside of the design impact of the outfall, to the pre-impact condition (sediment and elevation). Temporary construction impacts for the outfall would not substantively affect fish species, wildlife species and species at risk.

The operation of the outfall is defined by the discharge of secondary treated effluent. Effluent quality is not anticipated to change with the upgrade of the Treatment Plant. Analytical characterization and toxicity testing of the Treatment Plant effluent has demonstrated that effluent quality meets Wastewater Systems Effluent Regulations limits and is not acutely toxic; in the context of the Fisheries Act, impacts to commercial, recreational and Aboriginal (CRA) fish, including those fish that are listed as species at risk by the Province of British Columbia, are adequately mitigated.

The Stage 1 and Stage 2 Environmental Impact Statements (**Appendix K.1 and K.2**), based upon conservation assumptions, indicated that adverse effects on rainbow trout and impairment of other uses, such as wildlife use, are unlikely at the edge of the Initial Dilution Zone (IDZ) for effluent. Conditions within the IDZ are not expected to be acutely toxic to aquatic life, and chronic toxicity is not expected beyond the IDZ boundary.

4.12 Fire Safety Plan

A meeting on September 21, 2017 was arranged between Delta Fire-Rescue, Metro Vancouver, and CDM Smith regarding the Annacis Island WWTP New Outfall System project. Meeting minutes and a copy of the presentation can be found in **Appendix M**. The intent was to bring awareness of the project, identify concerns and safety measures, and establish a line of communication for collaboration. Battalion Chief Steve Raby and Deputy Chief Brad Wilson from Delta Fire-Rescue were present.

During the meeting the team discussed the challenges and safety requirements of the project, which often require specialized safety procedures and rescue requirements. The team agreed that Delta Fire-Rescue will be contacted and updated during different phases of project construction, ideally with the construction site coordinator. Involvement from Delta Fire-Rescue can potentially be construction activity familiarization; notification of other teams already present; project site access; and coordination to help. Delta Fire-Rescue also expressed interest to do some training if possible.

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Section 5

Engagement Status

5.1 First Nations Information Sharing and Engagement

This document explains the tools and processes by which Metro Vancouver will share information and engage with First Nations. Metro Vancouver is committed to working with First Nations before construction begins to identify potential project impacts and determine possible solutions. Because Metro Vancouver is not a Crown corporation, we do not have a duty to consult. Therefore, the Metro Vancouver Board approved process is defined as information sharing and engagement. This document is intended to meet all the requirements outlined in the Vancouver Fraser Port Authority's Draft Aboriginal Consultation Plan.

For this project, an initial engagement process took place from 2014 to 2015. This engagement included letters to 21 First Nations and distribution of an Archaeological Overview Assessment (AOA) report to determine if the proposed project site was within an area of low, moderate, or high archaeological potential. The initial alignment was shown to cross through an area of high potential on the foreshore of the Fraser River. It was later decided that the outfall would be constructed by tunneling deep underground, therefore avoiding archaeologically sensitive areas.

Given the passage of time since the initial engagement period, a second round of engagement began in December 2016. The second round is expected to continue until construction begins. The approach for this engagement is outlined in the First Nations Engagement Plan presented in **Appendix N.1**. **Appendix N.2** presents a First Nations Correspondence Tracker summarizing comments and outcomes of the engagement process as of November 2017.

A number of First Nations responded with comments and questions, and Metro Vancouver has been transparent and responsive.

All reports available to-date are posted on a project specific website, including the AOA and the Stage 1 Environmental Impact Assessment. Some First Nations requested these reports and have received them via email or hard copy.

Once Metro Vancouver submits its application to the port authority, First Nations will be provided with another opportunity to review and comment on the project. All comments will be considered in the project planning and design process. All requests to meet will be accommodated and all correspondence logged.

Formal letters to First Nations will include notification of Metro Vancouver's intent to engage on the procedural aspects of consultation on behalf of the Vancouver Fraser Port Authority and Transport Canada. The port authority will be notified about concerns from First Nations during the engagement process. After the nine-week engagement process has ended, Metro Vancouver will summarize all correspondence into an engagement report that will be submitted to the port authority, Transport Canada and Forests, Lands, Natural Resource Operations & Rural

Development (FLNRO). Metro Vancouver will continue to respond to questions or concerns from First Nations for the duration of the project, and attempt where possible to mitigate impacts.

5.2 Stakeholders and Community Engagement

This section covers stakeholder and community engagement to-date. Groups that have been part of this process include the City of Delta, businesses on and near Annacis Island, marine users, Transport Canada, fishing organizations, environmental groups, and the Port Community Liaison Committee (Delta).

Metro Vancouver's Engagement and Communications Strategy (**Appendix O.1**) provides a comprehensive approach and schedule for the stakeholder engagement process.

5.2.1 City of Delta

In October 2016 the project team provided the City of Delta with a presentation on the project and the public engagement strategy. The Power Point Presentation to the City of Delta is included as **Appendix O.2**. The City of Delta recommended that Metro Vancouver present the project to their Council as well as the Delta Farmer's Institute before construction begins. Delta's predominate concern was traffic impacts to Delta residents and Metro Vancouver agreed to monitor the increase in construction related traffic delays. Communication about the current work to upgrade the AIWWP is ongoing and will continue during the design and construction phases of the outfall project.

5.2.2 Port Community Liaison Committee – Delta

In March 2017 Metro Vancouver provided the Port Community Liaison Committee in Delta with a presentation to describe the project. The presentation is included in **Appendix O.3**. Metro Vancouver will return to share an update with the PCLC once the application is deemed complete.

5.2.3 Community

Annacis Island, the project location, is a predominantly industrial and commercial area made of medium and large warehouses and some storefront businesses. The outfall diffuser location is located within the Fraser River which is used by many marine vessels for navigation and delivery to and from Annacis Island.

Figure 5-1, Affected Community Map, identifies the key stakeholders impacted by this project and the degree of impact they will experience. The Engagement and Communications Strategy outlines the detailed engagement approach and timeline that is already underway. A list of current activities and outcomes can be found in **Appendix O.4**, Stakeholder Communications Tracking.

In April 2017 a project notification letter (or fact sheet) was distributed to all businesses on Annacis Island. This fact sheet can be found in **Appendix O.5**. A project website was also launched in April to provide detailed information. It is regularly updated with technical reports as they are completed. A Community Liaison Officer has been assigned to this project, and has been available to respond to questions and concerns. All correspondence had been logged and comments are being considered in the design and planning process.

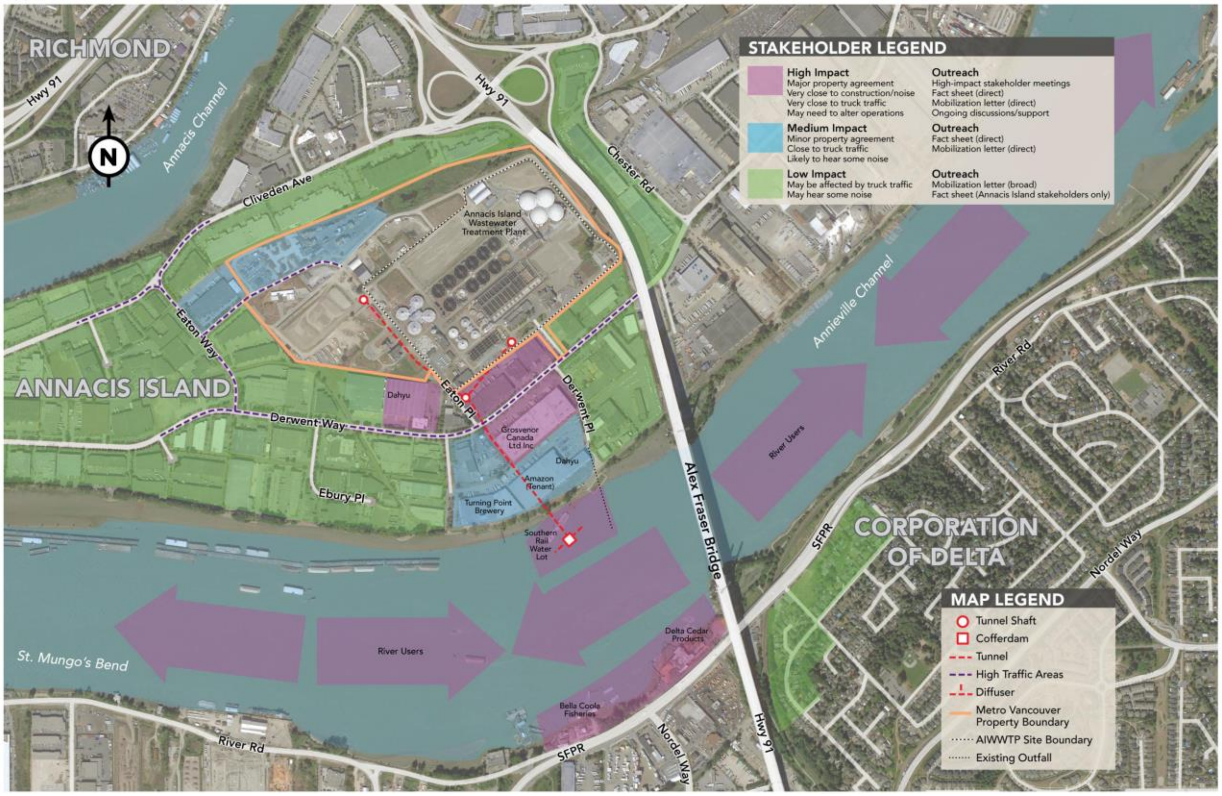

Figure 5-1: Affected Community Map

A meeting with marine users, Transport Canada and a number of business along the river's edge was offered in May 2017. **Appendix F.1** presents a summary of the Marine User Information Session. Metro Vancouver was able to share project details with these stakeholders and learn of challenging impacts that construction might impose on certain businesses, particularly Seaspan and Southern Railway of BC Ltd. As a result, a detailed marine vessel simulation program was conducted to better understand how these challenges could be managed. This simulation provided Metro Vancouver and Seaspan with the confidence to proceed with construction by recommending minor adjustments to the design and Seaspan's operation that would accommodate both parties. Delta Cedar Products will also be impacted particularly in season three of the river construction. Metro Vancouver may consider funding a tug boat that will allow them to operate further up the river (where currents are stronger) and avoid working around the construction zone. It was evident from all river users in attendance that the work site needs to be clearly marked and visible during the day and night. Clear and ongoing communication about the work to all river users is important for safety and operations.

Metro Vancouver committed to meeting with marine users again once the construction contract is awarded, and will discuss the feasibility of proposed construction methodology details and gather more input. Regular communication with these stakeholders will be a key priority during river construction.

A comprehensive summary of the engagement process will be prepared once before the application to the Vancouver Fraser Port Authority is accepted.

5.2.4 Construction Communications Plan

Once detailed information about the construction start date, hours of work, impacts such as noise, dust, traffic, and parking are known, Metro Vancouver will notify the community. The community will be provided a hand delivered notification at least 10 business days in advance of construction. The webpage will also provide updates on an ongoing basis. A Community Liaison Officer will be available to address any questions or concerns and relay them to the project team.

An emergency contact list will be provided to the City of Delta and the construction contractor should any media or public concerns arise.

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