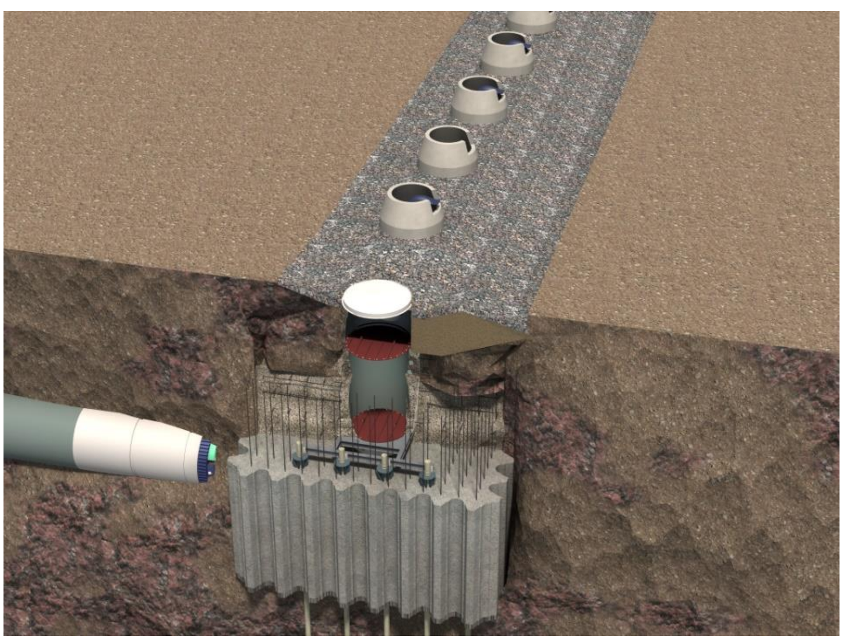
APPENDIX L
HABITAT ASSESSMENT

L.2: DFO Request for Review and Report

Annacis Island WWTP New Outfall System

Vancouver Fraser Port Authority
Project and Environmental Review Application



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SERVICES AND SOLUTIONS FOR
A LIVABLE REGION

CDM Smith

envirowest

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Request for Review

A) Contact information

Name of Business/Company:	Select additional contact: Contractor/Agency/Consultant *(if applicable):*
Greater Vancouver Sewerage and Drainage District	
Name of Proponent:	CDM Smith Canada John E. Newby, Principal
Ken Masse, Senior Project Engineer	
Mailing address:	**Mailing address:**
4330 Kingsway	4710 Kingsway Metrotower I, Suite 1001
City/Town:	**City/Town:**
Burnaby	Burnaby
Province/Territory:	**Province/Territory:**
British Columbia	British Columbia
Postal Code:	**Postal Code:**
V5H 4G8	V5H 4M2
Tel. No. :	**Tel. No. :**
604-432-6200	604-431-0242
Fax No.:	**Fax No.:**
Email:	**Email:**
Ken.Masse@metrovancouver.org	NewbyJE@cdmsmith.com

Is the Proponent the main/primary contact? (•) Yes ( ) No

If no, please enter information for the primary contact or any additional contact.

B) Description of Project

If your project has a title, please provide it.

Annacis Island Wastewater Treatment Plant New Outfall System

Is the project in response to an emergency circumstance*? ◯ Yes ◉ No

Does your project involve work in water? ◉ Yes ◯ No

If yes, is the work below the High Water Mark*? ◉ Yes ◯ No

What are you planning to do? Briefly describe all project components you are proposing in or near water.

Greater Vancouver Sewerage and Drainage District (Metro Vancouver) is currently expanding the Annacis Island Wastewater Treatment Plant (Treatment Plant) to increase secondary treatment hydraulic capacity. A new outfall diffuser is required within Annieville Channel of the Main Arm of the Fraser River as the existing outfall system would not be able to meet regulatory requirements with increased hydraulic loading. The outfall would consist of a 4.2 metre diameter pipe extending from the Treatment Plant below ground to a riser located in Annieville Channel approximately 160 metres off the southern shoreline of Annacis Island. Diffuser manifold pipes would extend approximately 120 to 150 metres upstream and downstream of the riser, for a total of 240 to 300 metres. Multiple diffusers would rise from the pipes into the water column.

How are you planning to do it? Briefly describe the construction materials, methods and equipment that you plan to use.

Outfall Pipe: The installation of the outfall pipe would utilize a trenchless methodology, specifically tunneling. The tunnel would occur beneath intertidal and nearshore subtidal river bottom and terminate at the design location of the riser. A boring machine would be used for tunneling. The machine would be launched from an upland access portal. Waste sediments would be disposed to a permitted upland site and/or disposed at sea. The outfall pipe would be installed within the tunnel as the boring machine proceeds.

Riser: The riser would be installed in isolation of Fraser River waters. This would be achieved through installation of a coffer dam. The coffer dam would extend from the river bed through the water column, above the high water elevation. The coffer dam would be composed of metal pipe piles and sheet piles; piles would be installed using a vibratory hammer. Underwater pressures associated with use of a vibratory hammer would be below Fisheries and Oceans Canada's 30kPa threshold to prevent harm to fish. Dam installation would occur during the inwater work window of June 16 through to February 28. The riser would be connected to outfall pipe within the coffer dam.

Diffuser Manifold: The diffuser manifold would be installed through dredging a shallow trench in the river bed. Temporary shoring would be utilized to mitigate sloughing of bank sediments into the trench. Dredging would be conducted using a clamshell dredge. Dredging beyond the design footprint of the diffuser manifold is mitigated by the restoration of native sediments. It is anticipated that material not used to restore the river bed at and about the diffuser manifold would be disposed at a permitted upland site and/or disposed at sea. Rip rap comprising the revetment of the diffuser manifold would be installed by clamshell. Dredging, restoration of native sediments, and rip rap placement would occur during the inwater work window of June 16 through to February 28.

Include a site plan (figure/drawing) showing all project components in and near water.

Are details attached? ◉ Yes ◯ No

Identify which work categories apply to your project.

- ☐ Aquaculture Operations
- ☐ Aquatic Vegetation Removal
- ☐ Beaches
- ☐ Berms
- ☐ Blasting / Explosives
- ☐ Boat Houses
- ☐ Boat Launches / Ramps
- ☐ Breakwaters
- ☐ Log Handling / Dumps
- ☐ Log Removal
- ☐ Moorings
- ☐ Open Water Disposal
- ☐ Piers
- ☐ Riparian Vegetation Removal
- ☐ Seismic Work
- ☐ Shoreline Protection

- ☐ Bridges
- ☐ Cable Crossings
- ☐ Causeways
- ☐ Culverts
- ☐ Dams
- ☐ Dewatering / Pumping
- ☐ Docks
- ☒ Dredging / Excavation
- ☐ Dykes
- ☐ Fishways / Ladders
- ☐ Flow Modification (hydro)
- ☐ Groundwater Extraction
- ☐ Groynes
- ☐ Habitat Restoration
- ☐ Ice Bridges
- ☐ Stormwater Management Facilities
- ☐ Surface Water Taking
- ☐ Tailings Impoundment Areas
- ☒ Temporary Structures
- ☐ Turbines
- ☐ Water Control Structures
- ☐ Water Intakes / Fish Screens
- ☒ Water Outfalls
- ☐ Watercourse Realignment
- ☐ Weirs
- ☐ Wharves
- ☐ Wind Power Structures
- ☒ Other Please Specify: inwater riprap revetment

Was your project submitted for review to another federal or provincial department or agency? (●) Yes ( ) No

If yes, indicate to whom and associated file number(s).

Vancouver Fraser River Port Authority, PER No. 16-054
BC Ministry of Environment, File No.000387

C) Location of the Project

Coordinates of the proposed project Latitude: 49deg 9min 30.99sec N Longitude: 122deg 56min 51.35sec W

OR UTM zone ________ ; ________ Easting ________ Northing

Include a map clearly indicating the location of the project as well as surrounding features.

Name of Nearest Community (City, Town, Village): Annacis

Municipality, District, Township, County, Province: Delta, British Columbia

Name of watershed (if applicable): Fraser River

Name of watercourse(s) or waterbody(ies) near the proposed project: Annieville Channel, Fraser River

Provide detailed directions to access the project site:

Accessible by water from the Fisheries and Oceans Canada's Delta Field Office (3 - 100 Annacis Parkway), travelling within Annacis Channel upstream to the upstream tip of Annacis Island, and downstream within Annieville Channel along the southern shoreline of Annacis Island.

Accessible by land from the Fisheries and Oceans Canada's Delta Field Office, travelling southwest along Derwent Way, turning south (left) at Derwent Place, and through the Southern Railway Annacis Terminal entrance and yard.

D) Description of the Aquatic Environment

Identify the predominant type of aquatic habitat where the project will take place.

- ○ Estuary (Estuarine)
- ○ Lake (Lacustrine)
- ○ On the bank/shore at the interface between land and water (Riparian)
- ◉ River or stream (Riverine)
- ○ Salt water (Marine)
- ○ Wetlands (Palustrine)

Provide a detailed description of biological and physical characteristics of the proposed project site.

Please see the attached report.

The predominant habitat is both estuarine and riverine.

The bed elevation of the design location of the diffuser outfall is approximately 10 metres (m) below chart datum. Bottom substrates consist of a range of fine to coarse sands. These sands are readily transported by flows characteristic of the proposed outfall location, facilitating the formation of dunes throughout parts of Annieville Channel within and in proximity to the outfall.

Flows at the design location of the outfall are approximately 80 percent of flows documented for the Fraser River at a recording station at Port Mann, upstream of Annacis Island. Monthly average flows at Port Mann from 1965 to 1992 range from 1030 cubic metres during winter to 11,900 cubic metres during freshet in early summer. The variation in mean velocities at the outfall location for a simulated 2012 flood condition, coinciding to a 20-year return period event, ranged from 1.2 m/s to 2.5 m/s.

The outfall occurs within the lower part of the Fraser River estuary. The oceanographic characteristics of the lower part of the estuary are strongly affected by the quantity, quality, and timing of freshwater discharge and by the tides and winds of the Strait of Georgia. A halocline occurs within the lower estuary.

A salt wedge occurs within the lower estuary. Salt water along the river bottom is overlain by fresh water. The position of the salt wedge occurs upstream of the design location of the outfall when freshwater discharge is low, typically during, and is pushed out to the delta front when discharge is highest, during freshet.

Adult salmon utilize Annieville Channel as a migratory corridor to upstream spawning habitats. Juvenile salmon the nearshore environment for either downstream migration, rearing or both, dependent upon species and specific life history strategies. Juvenile salmon generally occur within the upper 2 metres of the water column; it is highly unlikely that juvenile salmon would occur at the design depth of the outfall.

Adfluvial Dolly Varden char and resident cutthroat likely utilize the nearshore environment for feeding.

Adult eulachon utilize Annieville Channel as migratory corridor to access upstream spawning habitats. Juvenile eulachon likely move through Annieville Channel as they migrate to marine waters during their first year of life.

Adult white sturgeon utilize the design location of the outfall for feeding. It is likely that juvenile white sturgeon largely occur within nearshore environments, at depths typically shallower than that of the design location of the outfall.

Numbers of juvenile sturgeon caught by historical studies along the shorelines of Annacis Island were the highest of sample locations downstream of the Mission Bridge. Many of these sturgeon were captured within the secondary treated effluent plume, including the Initial Dilution Zone (IDZ), of the existing outfall. The IDZ is the three-dimensional zone around the point of discharge where mixing of the effluent and receiving water occurs.

Characteristics of the secondary treated effluent discharged by the new outfall will not markedly differ from the effluent of the existing outfall. The co-occurrence of juvenile sturgeon and effluent suggests that effluent does not deter use of nearshore environments by juvenile sturgeon.

Include representative photos of affected area (including upstream and downstream area) and clearly identify the location of the project.

E) Potential Effects of the Proposed Project

Have you reviewed the Pathways of Effects (PoE) diagrams (http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html) that describe the type of cause-effect relationships that apply to your project?

(●) Yes ( ) No

If yes, select the PoEs that apply to your project.

- [ ] Addition or removal of aquatic vegetation
- [ ] Change in timing, duration and frequency of flow
- [ ] Cleaning or maintenance of bridges or other structures
- [x] Dredging
- [ ] Excavation
- [ ] Fish passage issues
- [ ] Grading
- [ ] Marine seismic surveys
- [ ] Organic debris management
- [ ] Placement of marine finfish aquaculture site
- [x] Placement of material or structures in water
- [ ] Riparian Planting
- [ ] Streamside livestock grazing
- [ ] Structure removal
- [ ] Use of explosives
- [x] Use of industrial equipment
- [ ] Vegetation Clearing
- [x] Wastewater management
- [ ] Water extraction

Will there be changes (i.e., alteration) in the fish habitat*? (●) Yes ( ) No ( ) Unknown

If yes, provide description.

Sand on the river bottom will be replaced by riprap revetment.

Will the fish habitat alteration be permanent*? (●) Yes ( ) No ( ) Unknown

Is there likely to be destruction or loss of habitat used by fish? ( ) Yes (●) No ( ) Unknown

What is the footprint (area in square meters) of your project that will take place below the high water mark*?

Please see attached report.

The design footprint is largely attributable to the riprap that protects the diffuser manifold. Impacts to the river bed will be transitory in nature. It is anticipated that most of the riprap would be buried by sand through deposition associated with freshet. During other times of the year, this sand would be progressively eroded by currents, eventually exposing previously buried riprap.

Dredging of the navigation channel, adjacent to the design location of the outfall, would also affect the extent of impacts. Dredging occurs when the river bed elevation is above the minimum depth elevation for navigation. At this elevation, approximately 1100 square metres of surficial sand on the river bed would be replaced by riprap; exposed riprap would occur above the minimum channel depth elevation. At the maximum dredging depth for the channel, approximately 4100 square metres of surficial sand on the river bed would be replaced by riprap.

Surficial sand is replaced by riprap. It is a permanent alteration, not destruction, of habitat.

Is your project likely to change water flows or water levels? ( ) Yes (●) No ( ) Unknown

If your project includes withdrawing water, provide source, volume, rate and duration.

N/A

If your project includes water control structure, provide the % of flow reduction.

N/A

If your project includes discharge of water, provide source, volume and rate.

Treated effluent from the Annacis Island WWTP: average annual capacity of 732 million liters per day (MLD) with a peak wet weather capacity of 1632 MLD when flows reach Stage V expansion capacity (estimated 2033 to 2040).

Will your project cause death of fish? ○ Yes ◉ No ○ Unknown

If yes, how many fish will be killed (for multi-year project, provide average)? What species and lifestages?

N/A

Are there aquatic species at risk (http://www.sararegistry.gc.ca/species/aquatic_e.cfm) present? If yes, which ones?

No

What is the time frame of your project?

The construction will start on 06/16/2019 and end by 12/31/2021

If applicable, the operation will start on 12/31/2021 and end by 120 + years

If applicable, provide schedule for the maintenance

Annual inspection; replace duckbills on diffuser ports every ~30 years.

If applicable, provide schedule for decommissioning

N/A

Are there additional effects to fish and fish habitat that will happen outside of the time periods identified above? ○ Yes ◉ No

(If yes, provide details)

N/A

Have you considered and incorporated all options for redesigning and relocating your project to avoid negative effects to fish and fish habitat?

◉ Yes ○ No

If yes, describe.

The diffuser location in the Fraser River was selected for the best combination of effluent dilution and minimum construction and long-term impacts to fish and fish habitat. No construction or river bottom disturbance will take place in the near-shore area or in shallow water. The diffuser will be located in deep water at the edge of the dredged navigation channel where up to about 1 metre of sand sediment is deposited and eroded during freshet flows.

Have you consulted DFO's Measures to Avoid Harm to Fish and Fish Habitat (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html) to determine which measures apply to your project?

◉ Yes ○ No

Will you be incorporating applicable measures into your project?

◉ Yes ◯ No

If yes, identify which ones. If No, identify which ones and provide reasons.

Please see attached report.

Measures applicable are associated with: timing; site selection, erosion and sediment control, fish protection and operation of machinery.

Have you considered and incorporated additional best practices and mitigation measures recommended in relevant guidelines to avoid negative effects to fish and fish habitat?

◯ No ◉ Yes

If Yes, include a list of the guidelines being used to avoid negative effects to fish and fish habitat.

A comprehensive Construction Environmental Management Plan (CEMP) would be developed specific to the Project. A preliminary table of contents for the CEMP is as follows.

1.0 INTRODUCTION
2.0 PROJECT LOCATION
3.0 PROJECT SCHEDULE
4.0 PROJECT DESCRIPTION
5.0 SITE DESCRIPTION
6.0 CONTACTS AND RESPONSIBILITIES
6.1 Contractor
6.2 Environmental Monitor
7.0 RELEVANT ENVIRONMENTAL LEGISLATION
8.0 PROJECT MITIGATION MEASURES AND ENVIRONMENTAL SPECIFICATIONS
8.1 Training and General Practices
8.2 Site Access, Mobilization and Laydown/Moorage Areas
8.3 Machinery and Equipment
8.4 Equipment Refueling Procedures
8.5 Emergency Response
8.5.1 Emergency and Spill Response Plan
8.6 Hazardous Material Management and Spill Prevention
8.7 Contaminated Soil and Groundwater Management
8.8 Concrete
8.9 Air Quality
8.10 Erosion and Sediment Control
8.11 Fish and Fish Habitat
8.12 Vegetation and Wildlife
8.13 Historical and Archaeological Management
8.14 Noise and Vibration
8.15 Non-Hazardous Waste Management
9.0 REFERENCES

Applicable best management practices and standards for the protection of the environment would be employed, such as those presented by http://www.env.gov.bc.ca/wld/instreamworks/downloads/GeneralBMPs.pdf.

Are there any relevant best practices or mitigation measures that you are unable to incorporate? ◯ Yes ◉ No

(If yes, identify which ones.)

N/A

Can you follow appropriate Timing Windows (http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/index-eng.html) for all your project activities below the High Water Mark*?

(•) Yes ( ) No

(If no, provide explanations.)

N/A

What residual effects to fish and fish habitat do you foresee after taking into account the avoidance and mitigation measures described above?

The residual effect to fish habitat is the replacement of surficial sand by surficial riprap. Impacts to surficial sand on the river bed, whether it be 4100 or 1100 square meters, or some area in between, will not impair the life history of fish that support commercial, recreational or Aboriginal (CRA) fisheries. Affected habitat is represented throughout the Fraser River estuary, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island. The scale of impact on CRA fish is not of consequence in consideration of the abundance of similar habitat available to such fish in proximity to the design location of the outfall.

There is no residual effect to fish; the secondary treated effluent discharged by the new outfall is characterized by constituents at concentrations similar to those of secondary treated effluent discharged by the existing outfall. Acute toxicity is not associated with secondary treated effluent that would be discharged by the new outfall.

Residual effect is not considered residual serious harm to fish.

F) Signature

I, ____________ (print name) certify that the information given on this form is to the best of my knowledge, correct and completed.

Signature

Date

Information about the above-noted proposed work or undertaking is collected by DFO under the authority of the *Fisheries Act* for the purpose of administering the fisheries protection provisions of the *Fisheries Act*. Personal information will be protected under the provisions of the *Privacy Act* and will be stored in the Personal Information Bank DFO-PPU-680. Under the *Privacy Act*, Individuals have a right to, and on request shall be given access to any personal information about them contained in a personal information bank. Instructions for obtaining personal information are contained in the Government of Canada's Info Source publications available at www.infosource.gc.ca or in Government of Canada offices. Information other than "personal" information may be accessible or protected as required by the provision of the *Access to Information Act*.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

Guidance on Submitting a Request for Review

This document explains the requirements for a Request for Review by DFO under the fisheries protection provisions of the *Fisheries Act*. To determine whether you should request a review, follow the steps for proponent Self-Assessment on DFO's Projects Near Water webpage (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).

Incomplete Requests for Review will be returned to the applicant without review by DFO. All information requested must be provided. If you attach documents to your application with additional information, you must still provide appropriate summaries in the spaces provided on the application document or your application will be considered incomplete.

Section A: Contact Information

Provide the full legal name of the proponent and primary mailing address for the proponent. When the proponent is a company, identify the full legal registered name of the company.

If applicable, also provide the contact information of the duly authorized representative of the proponent. Please note that a copy of correspondence to Contractor/Agency/Consultant will also be sent to the Proponent.

Section B: Description of Project

This information is meant to provide background about the proposed project. All components of the proposed project in or near water, must be described.

Proponents should provide information about all appropriate phases of the project, i.e., the construction, operation, maintenance and closure phases for the proposed project.

All details about the construction methods to be used, associated infrastructure, permanent and temporary structures, building materials to be used, machinery and equipment to be used must also be provided. For example, the construction of permanent structures may require the construction of temporary structures such as temporary dikes, in conjunction with other associated activities like the withdrawal of water, land clearing, excavation, grading, infilling, blasting, dredging, installing structures, draining or removing debris from water. Similarly, the equipment and materials to be used may include hand tools, backhoes, gravel, blocks or armor stone (provide the average diameter), concrete (indicate if pre-cast or poured in-water), steel beams or wood.

When physical structures in or near water are proposed, provide the plan and specifications of those works which would require a review.

Section C: Location of the Project

The purpose for this information is to describe and illustrate the location of the proposed project, and to provide geographical and spatial context. The information should also facilitate an understanding of how the project will be situated in relation to existing structures.

The details to be provided must include:

- Coordinates of the project (e.g., Latitude and Longitude or Universal Transverse Mercator Grid coordinates);
- A map(s), site plan, or diagrams indicating the high water mark and the location, size and nature of proposed and existing structures (e.g., floating or fixed), landmarks and proposed activities. In a marine setting, it may be helpful to depict the approximate location of the proposed development on a nautical chart or showing the relation of the site to sea marks or other navigational aids. These plans, maps or diagrams should be at an appropriate scale to help determine the relative size of the proposed structures and activities, the proximity to the watercourse or waterbody and the distance from existing structures;
- The community nearest to the location of the proposal as means to provide a general reference point. When possible, proponents should use geographical names recognized by the Geographical Names Board of Canada (http://www.nrcan.gc.ca/earth-sciences/geography-boundary/geographical-name/11680).
- If available, provide aerial photographs or satellite imagery of the water source(s) and waterbody(ies);
- Names of the watershed(s), water source(s) and/or waterbody(ies) likely to be affected by the proposal; and
- Brief directions to access the proposed project site.

Section D: Description of the Aquatic Environment

Proponents must describe the environmental context and aquatic resources present at the proposed site. The information must identify the current state of the fish and fish habitat prior to the carrying on of the project.

It is important to include information about the fish species present, the biological, chemical, physical features present (habitat characteristics), and the fish life-cycle functions (fish characteristics).

The spatial scope for assessing fish and fish habitat should encompass the direct physical footprint of the project, and the upstream and downstream areas affected.

As an example, the following is a non-exhaustive and non-prescriptive list of some common attributes which may characterize the aquatic environment:

- Type of water source or watercourse (groundwater, river, lake, marine, estuary, etc.);
- Characteristics of the water source or waterbody could include:
  - Substrate characterization - describe the types of substrate (e.g., bedrock, boulder, cobble, gravel etc.), identify the predominant substrate type (e.g., 80% cobble, 20% gravel etc.) and provide maps of the substrate;
  - Aquatic and riparian vegetation characterization - identify the prevalent types of vegetation (e.g. rooted, submerged, emergent, etc.), identify the relative abundance of the vegetation (e.g., 10% cattails, 80% grass, 10% sedge) , indicate the predominant vegetation (e.g., by species or types) and identify the vegetation densities (e.g., type of vegetation/ area);
  - Flow characterization - specify if the flow is controlled or if it is natural, identify if the flow is permanent or intermittent, identify the current and tide (marine environment) etc.;
  - Physical waterbody characterization - identify the average depth of water for water bodies, identify bathymetry of water bodies, provide bathymetric maps where available, channel width (determine the width of the channel from the high water mark), slope ;
  - Water quality characterization - (e.g., annual or average pH, salinity, alkalinity, total dissolved solids, turbidity, temperature etc.);
  - Biological water quality characterization - (e.g., benthic macro-invertebrates, zooplankton, phytoplankton, etc.)
- Fish species characterization - identify the fish species (including molluscs, crustaceans, etc.) known or suspected to be in the area, predator prey relationships etc. Identify what source of information was used and to determine the presence of fish in that area; and
- Estimate the fish abundance - estimate the number of fish present, estimate the year class for each species etc.

There are many different methods and attributes available to characterize fish and fish habitat. Proponents must describe all sources of information used, all fish and environment sampling techniques used, all modelling techniques used and all other approaches used to define the fish and fish habitat. Proponents are encouraged to use recognized fisheries inventory methods such as those approved by DFO or provinces and territories, or scientifically defensible methodologies and techniques whenever possible.

Whenever possible, proponents should support descriptions of the aquatic environment with the use of detailed drawings, such as plans or maps and photographs of the habitat features. In an offshore marine setting, photos may not be useful to depict the proposed development site. Instead describe and/or sketch the specific features of the sea floor which may include the presence of submarine features such as canyons, cliffs, caverns, etc.

Section E: Potential Effects of the Proposed Project

The objective of this section is to identify all anticipated effects on fish and fish habitat likely to be caused by the project. Proponents should consider all mitigation or avoidance techniques.

The description must include qualitative and/or quantitative information about the predicted/potential effects to fish species and fish habitat. Some examples of likely effects may include mortality to fish, changes to the life stages of fish affected, area of habitat loss, change to flow, changes to habitat function, reduction in prey availability etc.

The spatial scope of the aquatic effects assessment would include the direct physical "footprint" of the proposed project, and any areas indirectly affected, such as downstream or upstream areas. This may also include areas in or on the water, on the shoreline, coast or bank(s) (i.e., in the riparian zone).

The assessment must include the following attributes:

- Identification of all fish species affected by the proposed project ;
- Identification of the type of fish habitat affected (e.g., spawning habitat - gravel and cobble, feeding and rearing areas - side channel slough, small tributaries, etc.), estimate of the affected area (e.g., square meters or hectares);
- Of the affected fish, identify the life stages affected (e.g., juvenile, yearling, adult etc.);
- Description of the effect (e.g., mortality to fish from entrapment, delayed migration of spawning adults, reduction in prey availability, etc.)
- Probability of the effect - this is the likelihood of the effect occurring (e.g., probability of fish strike from turbines for specific fish sizes, probability of sediment plume within a distance from source, etc., or qualitative assessment: low, medium, high)
- Magnitude of the effect - this is the intensity or severity of the effect (e.g., total number of fish affected, or qualitatively assessment: low, medium, high).
- Geographic extent of the effect - this is the spatial range of the effect (e.g., localized to 100m from the work, channel reach or lake region, entire watershed etc.); and
- Duration of the effect - this is the temporal period for which the effect will persist (e.g., duration of delay to fish migration in hours, days, months or years).

The information to be provided must also describe the methods and techniques used to conduct the assessment. As much as possible, methods and techniques used should be scientifically defensible.

The schedule should, at minimum, identify the proposed start and end dates for carrying out each proposed activity, and where applicable, identify the respective phase of the proposal; i.e., the construction, operation, maintenance and closure phases. In some cases, in order to provide additional context, it may be relevant to identify other information such as the expected life span of permanent and temporary structures.

Proponents must provide comprehensive information about all best available measures and standards that are proposed to avoid or mitigate potential serious harm.

Residual serious harm to fish is any serious harm to fish remaining after the consideration of the application of proposed measures or standards to avoid or mitigate serious harm.

It is important to clearly describe and quantify residual serious harm because DFO will use this information as part of its decision making on whether an authorization is required under subsection 35(2)(*b*) of the *Fisheries Act*.

Section F: Submission and Signature

The proponent must sign the application. A signed original of the Request for Review must be provided to the regional DFO office (http://www.dfo-mpo.gc.ca/pnw-ppe/contact-eng.html), even if an electronic copy was sent by email. Should the review of your project indicate that residual serious harm to fish is likely, the information provided in the Request for Review document can be referred to in the subsequent Application for an Authorization under Paragraph 35(2)(*b*) of the *Fisheries Act*.

Section G: Definitions

Emergency circumstance: If your project must be conducted in response to an emergency, you may apply for an Emergency Authorization. The emergency situations are:

- The project is required as a matter of national security
- The project is being conducted in response to a national emergency where special temporary measures are being taken under the federal *Emergencies Act*

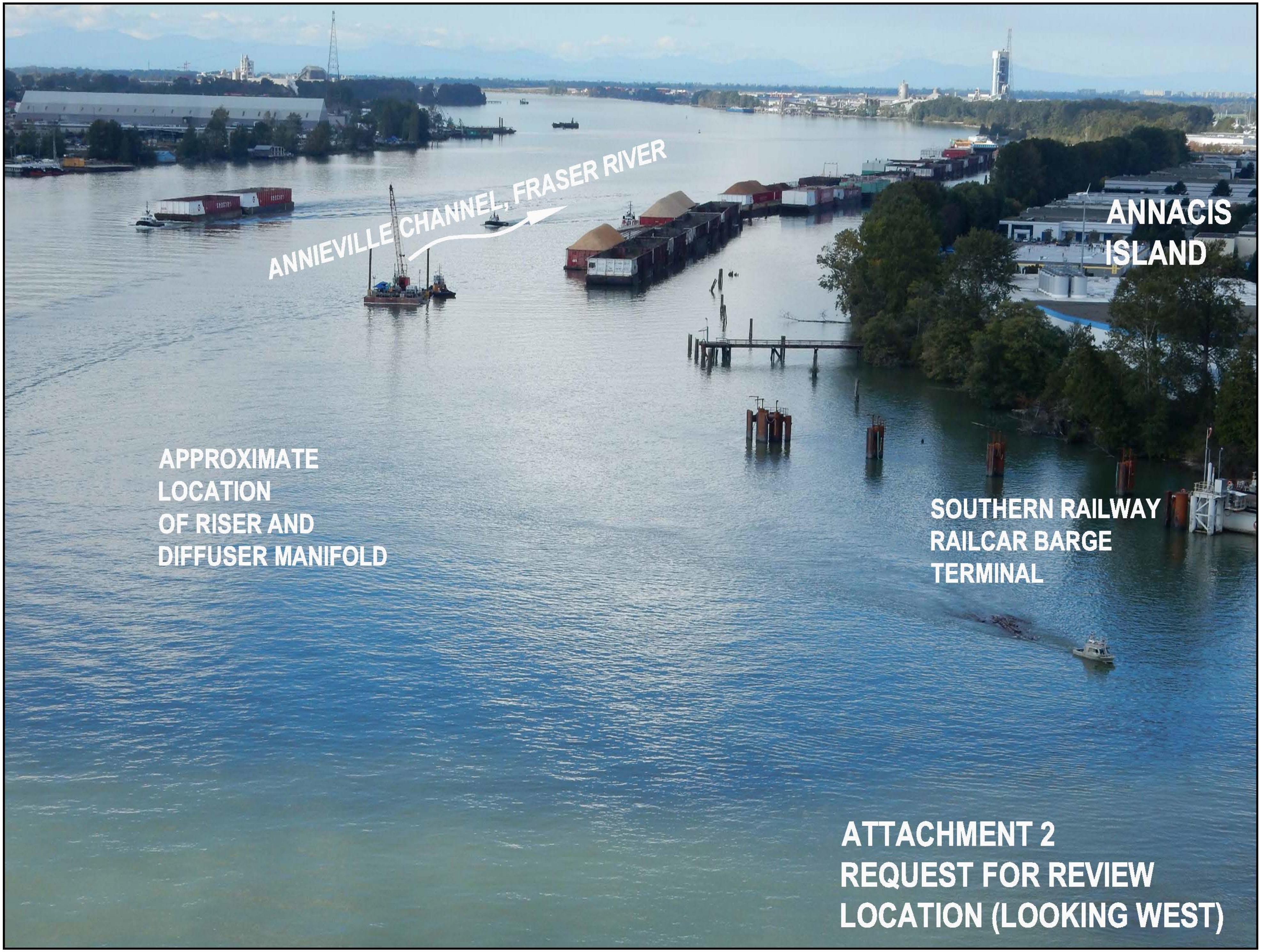
- The project is required to address an emergency that poses a risk to public health or safety or to the environment or property.

Fish habitat: Means spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes.

High Water Mark: The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to leave a mark on the land.

Permanent alteration to fish habitat: An alteration of fish habitat of a special scale and a duration that limits or diminishes the ability of fish to use as spawning grounds for nursery or rearing, or as food supply, or as a migration corridor in order to carry out one or more of their life processes.


ALEX FRASER BRIDGE
ANNIEVILLE CHANNEL, FRASER RIVER
DIFFUSER MANIFOLD
OUTFALL PIPE
ANNACIS ISLAND
ATTACHMENT 1
REQUEST FOR REVIEW
LOCATION (LOOKING SOUTH)


ANNIEVILLE CHANNEL, FRASER RIVER
ANNACIS ISLAND
APPROXIMATE LOCATION OF RISER AND DIFFUSER MANIFOLD
SOUTHERN RAILWAY RAILCAR BARGE TERMINAL
ATTACHMENT 2
REQUEST FOR REVIEW
LOCATION (LOOKING WEST)

FISHERIES AND OCEANS CANADA
REQUEST FOR REVIEW

ANNACIS ISLAND WASTEWATER TREATMENT PLANT
NEW OUTFALL - ANNIEVILLE CHANNEL, FRASER RIVER

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June 01, 2017

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EXECUTIVE SUMMARY

Project Description

The Greater Vancouver Sewerage and Drainage District (Metro Vancouver) is currently expanding the Annacis Island Wastewater Treatment Plant (Treatment Plant) to increase secondary-treatment hydraulic capacity. A new diffuser outfall within Annieville Channel of Main Arm of the Fraser River is required as the existing outfall system would not be able to meet regulatory requirements with increased hydraulic loading.

The Treatment Plant is located on Annacis Island, Delta, British Columbia. The plant currently discharges an average of approximately 483 million litres per day (MLD) of secondary-treated effluent into the Fraser River. The current peak wet-weather capacity is 1089 MLD. The Treatment Plant is currently being expanded to increase the hydraulic capacity of secondary treatment. This Stage V expansion will increase the average annual capacity to 732 MLD with a peak wet-weather capacity of 1632 MLD. Sewage consists of industrial, commercial and domestic wastewaters.

The new outfall would extend generally from the Treatment Plant to the edge of the north boundary of the navigation channel within Annieville Channel of the Fraser River. The outfall would consist of a 4.2 metre (m) diameter pipe extending below ground from the Treatment Plant to a riser located in the channel. Diffuser manifold pipes would extend approximately 120 to 150 m upstream and downstream from the riser, for a total of 240 to 300 m, aligned approximately parallel with and immediately shoreward of the northern margin of the navigation channel. Multiple diffusers would rise from the pipes into the water column.

Fisheries and Oceans Canada and the *Fisheries Act*

This correspondence is supporting documentation for a Fisheries and Oceans Canada Request-for-Review for the design, construction and operation of the new outfall (Project).

The *Fisheries Act* prohibits “serious harm to fish” that are part of or support a commercial, recreational or Aboriginal fishery.

> “Serious harm to fish is the death of fish or any permanent alteration to, or destruction of, fish habitat”.
>
> As per the *Fisheries Act*, fish include “(a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals”.
>
> Fish that are part of a fishery are “fish that may be fished as part of a commercial, recreational or Aboriginal fishery”.
>
> Fish that support a fishery are “fish that contribute to the productivity of a commercial, recreational or Aboriginal fishery”.

> Fish habitat means “spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life history processes”.

The *Fisheries Act* prohibits “the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter such water”.

> Deleterious substance means, in part,
>
> “(a) any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that is rendered or is likely to be rendered deleterious to fish or fish habitat or the use by man of fish that frequent that water, or
>
> (b) any water that contains a substance in such quantities or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or the use by man of fish that frequent that water”.

The Wastewater Systems Effluent Regulations of the *Fisheries Act*, “apply in respect of a wastewater system that, when it deposits effluent via its final discharge point, deposits a deleterious substance”.

The Regulations contain mandatory effluent conditions for specific deleterious substances contained within municipal effluent to be achieved through secondary wastewater treatment. As per the Regulations, effluent conditions according to each of these substances are as follows:

- <u>carbonaceous biochemical oxygen demanding matter</u> – the average carbonaceous biochemical oxygen demand does not exceed 25 milligrams/litre (mg/L);
- <u>suspended solids</u> – the average concentration of suspended solids does not exceed 25 mg/L;
- <u>total residual chlorine</u> - the average concentration of residual chlorine does not exceed 0.02 mg/L, if chlorine in any form is used in the treatment of wastewater; and
- <u>un-ionized ammonia</u> – the maximum concentration of un-ionized ammonia, expressed as nitrogen, is less than 1.25 mg/L at 15 degrees Celsius (^{o}C) +/- 1^{o}C.

Also, effluent can only be discharged if it is not acutely lethal to rainbow trout as determined by standard toxicity test methods specified in the Regulations.

Subsections (1) and (2) of Section 35 of the *Fisheries Act*, with regard to “serious harm to fish” and “exception”, respectively, are administered by Fisheries and Oceans Canada. “Exception” presents circumstances whereby “serious harm to fish” may occur, including works, undertakings or activities carried on in accordance with regulations of the *Fisheries Act*.

Subsections (3) and (4) of Section 36 of the *Fisheries Act*, with regard to "deposit of deleterious substance prohibited" and "deposits authorized by regulation", and the Wastewater Systems Effluent Regulations, are administered by Environment and Climate Change Canada.

The Request-for-Review is processed by Fisheries and Oceans Canada. Those parts of the *Fisheries Act* administered by Environment and Climate Change Canada are presented in this supporting documentation as the discharge of a "deleterious substance" can result in "serious harm to fish".

<u>Fish and Fish Habitat</u>

Fish and fish habitats addressed within this section support commercial, recreational or Aboriginal (CRA) fisheries.

The design location of the outfall is characterized by sandy river bed, approximately 10 metres below chart datum. Bottom sediments are transitory, with deposition and erosion associated with changes in river discharge, and degradation associated with dredging of the navigation channel. Fines become a conspicuous element of bottom sediments progressively landward of the design location of the outfall, towards and within intertidal environments that occur within the hydraulic shadow of inwater structures and moored barges.

Seven (7) species of salmon (*Oncorhynchus* spp.) occur within the lower Fraser River, specifically: chinook salmon (*O. tshawytscha*); chum salmon (*O. keta*); coho salmon (*O. kisutch*); pink salmon (*O. gorbuscha*); sockeye salmon (*O. nerka*); cutthroat trout (*O. clarkii clarkii*); and, steelhead trout (*O. mykiss*). Adult salmon migrate upstream annually to spawn, and juvenile salmon migrate downstream annually to and through the estuary and ultimately to the sea.

Adult salmon utilize Annieville Channel as a migratory corridor to upstream spawning habitats. Juvenile salmon utilize the nearshore environment for either downstream migration, rearing or both, dependent upon species and specific life history strategies. Juvenile salmon generally occur within the upper 2 metres of the water column.

Anadromous Dolly Varden char (*Salvelinus malma*) likely display a life history similar to salmon, including anadromous cutthroat trout. Adfluvial Dolly Varden char and resident cutthroat trout utilize the nearshore environment for feeding. Prey is likely dominated by larval and juvenile fishes.

Eulachon (*Thaleichthys pacificus*) is an anadromous smelt. Eulachon utilize Annieville Channel as a migratory corridor to access upstream spawning habitats. Juvenile eulachon appear to enter marine waters within their first year of life.

White sturgeon (*Acipenser transmontanus*) occurs throughout a large part of the Fraser River system, from the estuary to the main stem upstream of Prince George, and in the Nechako River, from its confluence within the Fraser River to upstream of Vanderhoof.

Adult white sturgeon utilize the design location of the outfall for feeding. Prey is likely dominated by benthic fishes and invertebrates. Seasonally, the carcasses of spent spawners, comprised predominantly of salmon and eulachon, may be important. It is likely juvenile white sturgeon occur predominantly within nearshore environments, at depths typically shallower than that of the design location of the outfall. Prey of juvenile sturgeon are characterized by benthic invertebrates, small fish and fish eggs.

Impacts to Fish and Fish Habitat

Design related impacts are permanent impacts. Design impacts are associated with the displacement of surficial sand of the river bed, and are attributable to the riser, diffusers, and diffuser manifold and associated riprap.

Impacts to the river bed by riprap would be transitory in nature. It is anticipated that most of the riprap would be buried by sand through deposition associated with freshet. During other times of the year, this sand would be progressively eroded by currents, eventually exposing previously buried riprap. Typically, the diffusers and a narrow strip of riprap would be exposed above the river bed.

Dredging of the navigation channel, adjacent to the design location of the outfall, would also affect the extent of impacts. Dredging occurs when the river bed elevation is above the minimum channel depth elevation for navigation. At this elevation, approximately 1100 m^2 of surficial sand on the river bed would be displaced by riprap; the riprap associated with this impact would occur above the minimum channel depth elevation. At the maximum dredging depth for the channel, approximately 4100 m^2 of surficial sand on the river bed would be displaced by riprap.

Impacts to surficial sand on the river bed, whether it be 1100 m^2, 4100 m^2 or some area in between, would not impair the life history stages of CRA fish such that the productivity of associated fisheries are affected. Affected habitat is represented throughout the Fraser River estuary, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island. The scale of impact upon CRA fish is not of consequence, especially in consideration of the abundance of similar habitat available to such fish in proximity to the design location of the outfall.

Construction related impacts are temporary. These impacts are mitigated through special measures and best management practices 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 impacts associated with the construction of the outfall would not substantively affect CRA fish.

Operation related impacts are those that may be associated with 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 Waste Systems Effluent Regulations limits and is not acutely toxic. In this regard, impacts to CRA fish are adequately mitigated.

1.0 INTRODUCTION

The Greater Vancouver Sewerage and Drainage District (Metro Vancouver) is currently expanding the Annacis Island Wastewater Treatment Plant (Treatment Plant) to increase secondary-treatment hydraulic capacity. A new diffuser outfall within Annieville Channel of the Main Arm of the Fraser River is required to replace existing outfall facilities.

This report is supporting documentation for a Fisheries and Oceans Canada (DFO) Request-for-Review for the design, construction and operation of the new outfall (Project).

2.0 PROJECT DESCRIPTION

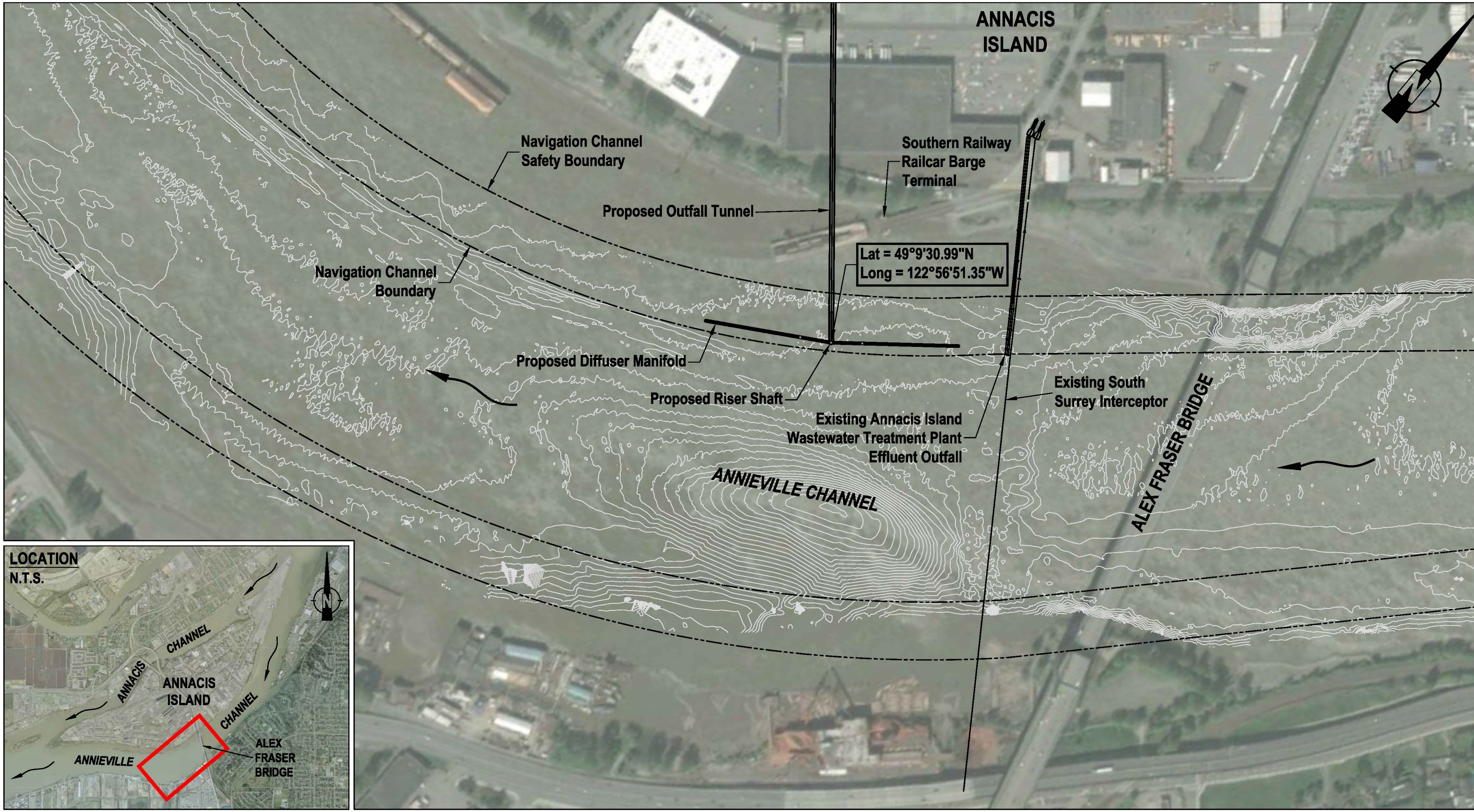
The Treatment Plant is located on Annacis Island, Delta, British Columbia (BC). The plant currently discharges an average of approximately 483 million litres per day (MLD) of secondary-treated effluent into the Fraser River through the existing outfall to a distance of 160 metres (m) off the southern shoreline of Annacis Island, immediately downstream of the Alex Fraser Bridge (Enkon Environmental Limited 2015). The current peak wet-weather capacity of the plant is 1089 MLD. Sewage consists of industrial, commercial and domestic wastewaters (Golder Associates Ltd. 2016).

The Treatment Plant is currently being expanded to increase the hydraulic capacity of secondary treatment. This Stage V expansion will increase the average annual capacity to 732 MLD with a peak wet-weather capacity of 1632 MLD. A new outfall is required as the existing outfall system is unable to sufficiently dilute effluent, particularly during slack tide and low discharge in the river, and lacks sufficient hydraulic capacity to discharge estimated increased flows during high water in the river (CDM Smith Canada ULC 2016).

The new outfall would commence at the Treatment Plant and terminate at the edge of the north boundary of the navigation channel within Annieville Channel (Figure 1). The outfall would consist of a 4.2 m diameter pipe extending below ground from the Treatment Plant to a riser located in the river. Diffuser manifold pipes would extend approximately 120 to 150 m upstream and downstream from the riser, for a total of 240 to 300 m, aligned approximately parallel with and immediately shoreward of the northern margin of the navigation channel. These pipes would be buried at a relatively shallow depth; multiple diffusers would rise from the pipes into the water column.

The design of the new outfall is presented by the following drawings (CDM Smith Canada ULC; Appendix A):

- Drawing No. A10 X-G-001 “Hydraulic Profile New Outfall System” (March 2017);
- Drawing No. A61 X-C-001 “A61 − General Site Works, Site Plan Sheet Key Map 2” (March 2017);
- Drawing No. A61 C0003 “A61 – NOS, Tunnel Plan and Profile 3” (March 2017);
- Drawing No. A61 C0004 “A61 – NOS, Tunnel Plan and Profile 4” (March 2017);
- Drawing No. A61 C0052 “A61 – NOS, Riser Shaft Plan Top Level” (March 2017);
- Drawing No. A61 C0053 “Riser Shaft Initial Temporary Conditions” (March 2017);
- Drawing No. A61 C0054 “Riser Shaft Intermediate Conditions” (March 2017);



REFERENCE DRAWINGS

1. Drawing No. Sheet 3. Issue. E. "South Surrey Interceptor Fraser River Crossing Plan and Profile Sta. 0+415.14 to Sta. 0+748.89". March 2015. Greater Vancouver Sewerage And Drainage District.
2. Drawing No. Sheet 4. Issue. D. "South Surrey Interceptor Fraser River Crossing Plan and Profile Sta. 0+748.89 to Sta. 1+108.56". March 2015. Greater Vancouver Sewerage And Drainage District.
3. Drawing No. A61C0072. Issue P2. "A61 - NOS Diffuser Manifold Plan". January 2017. CDM Smith Inc.
4. 2004 Ortho Photograph From Metro Vancouver.
5. 2015 Ortho Photograph From Google Earth.

METRO VANCOUVER

ANNACIS ISLAND
WASTEWATER TREATMENT PLANT OUTFALL
FISHERIES AND OCEANS CANADA
REQUEST FOR REVIEW

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PROJECT LOCATION

DESIGN:	DRAWN: SDJ	CHECKED: MAA	REVISION: 00 REVISION DATE:
SCALE: 1:4000			DRAWING NUMBER: FIGURE 1
DATE: April 19, 2017			

DATE: 2017-05-11 - 5:01pm
PATH: \\anv-fs-r\Alpha\Envirowest Files\2017\Fraser River\2098-01 Annacis Is Outfall\AutoCAD\Final\Figure 1 - Location.dwg
LAYOUT: FIGURE 1

- Drawing No. A61 C0055 “Riser Shaft Final Conditions” (March 2017);
- Drawing No. A61 C0071 “Diffuser Manifold Section” (March 2017);
- Drawing No. A61 C0072 “A61 – NOS, Diffuser Manifold Plan” (March 2017);
- Drawing No. A61 C0073 “A61 – NOS, Existing River Bed Profile at Diffuser Manifold Sections 1 of 2” (March 2017); and,
- Drawing No. A61 C0074 “A61 – NOS, Existing River Bed Profile at Diffuser Manifold Sections 2 of 2” (March 2017).

3.0 PROJECT SCHEDULE

Construction of the Project is proposed to commence June 16, 2019. The anticipated date of completion of construction is December 31, 2021.

Inwater elements of construction would be restricted to the timing window for inwater works of least risk to fish, specifically June 16 through to February 28 (Fisheries and Oceans Canada 2017a).

4.0 ENVIRONMENTAL SETTING

4.1 Existing Infrastructure

4.1.1 Alex Fraser Bridge

The Alex Fraser Bridge occurs upstream of the proposed diffuser outfall. It was constructed in 1984. The bridge has a span of 464 m (Northwest Hydraulic Consultants Ltd. 2015). The alignment of the bridge is approximately 30 degrees to the alignment of Annieville Channel; the effective waterway opening is 370 m (Northwest Hydraulic Consultants Ltd. 2015). The channel width upstream and downstream of the bridge is 450 m and 800 m, respectively. The bridge forms a significant constriction to flows within the channel.

The two bridge towers are protected against ship collisions by large sand islands that are armoured with riprap. The islands extend into flows, forming short guide banks (Northwest Hydraulic Consultants Ltd. 2015). A conspicuous back eddy occurs downstream of the north island, facilitating deposition of sediments and collection of woody debris shoreward of the proposed diffuser outfall location.

4.1.2 South Surrey Interceptor

The South Surrey Interceptor occurs approximately 500 m downstream of the Alex Fraser Bridge, approximately 190 m upstream of the proposed outfall diffuser. It is a conduit for influent that enters the Treatment Plant. It was constructed in 1974 (Northwest Hydraulic Consultants Ltd. 2015). The Interceptor consists of two 48 inch outside diameter (OD) cement-lined steel pipes and a 36 inch OD steel pipe in an excavated trench that is backfilled with native river bed material (Northwest Hydraulic Consultants Ltd. 2015). The pipes occurred from 6.0 to 6.4 m below the bed of the river at the time construction was complete (Northwest Hydraulic Consultants Ltd. 2015).

Riprap scour protection has been added atop the pipes on several occasions, the first time in 1984, and the last time in 1995 (Northwest Hydraulic Consultants Ltd. 2015).

4.1.3 Existing Treatment Plant Outfall

The existing outfall is aligned along and immediately downstream of the South Surrey Interceptor. The outfall is comprised of three pipes (two 1676 millimetre (mm) OD pipes and one 1219 mm OD pipe) that extend 165 m into Annieville Channel from the north bank of Annacis Island (Northwest Hydraulic Consultants Ltd. 2015). Secondary-treated effluent is discharged through seven sets of steel risers that are situated between 105 and 165 m from the north bank (Northwest Hydraulic Consultants Ltd. 2015). The risers consist of 450 mm diameter, 6.1 m high pipes; the top of these pipes are approximately flush with the bed of the channel (Northwest Hydraulic Consultants Ltd. 2015). There is limited scour protection around the pipes.

4.1.4 Southern Railway Railcar Barge Terminal

The design alignment of the outfall pipe engages the distal half of the moorage basin of Southern Railway's railcar barge terminal. The moorage basin is dredged on a regular basis to maintain the design depth of the basin, specifically 6.0 m below chart datum (Pedersen 2005).

4.2 Existing Channel Bed

4.2.1 Intertidal

Intertidal flats occur as a narrow fringe within the design alignment of the effluent pipe. Sediments consist of silts to fine sands. The riverward margin of intertidal flats are demarcated by the moorage basin of Southern Railway's railcar barge terminal.

The flats are particularly wide downstream and upstream of the design alignment of the pipe, as a result of the hydraulic shadows associated with moored chip barges and the north sand island of the Alex Fraser Bridge, respectively. Sediments at lower elevations of the flats are predominantly silts and fine sands; coarser sands are prevalent at and about the high water elevation where waves frequently break upon bottom sediments.

Intertidal marsh occurs as discontinuous patches along the higher margins of the flats. Characteristic species include spikerush (*Eleocharis palustris*), articulated rush (*Juncus articulatus*), Lyngby's sedge (*Carex lyngbyei*), reed canarygrass (*Phalaris arundinacea*), bentgrass (*Agrostis stolonifera*), American bugleweed (*Lycopus americanus*), knotweed (*Polygonum* sp.), and aster (*Aster* sp.).

4.2.2 Subtidal

The bed elevation at the design location of the diffuser outfall is approximately 10 m below chart datum. Since the construction of the Alex Fraser Bridge, the bed elevation at the design outfall location has varied up to 2 m (Northwest Hydraulic Consultants Ltd. 2015).

The formation and migration of dunes on the channel bottom at and about the location of the outfall diffusers is likely accountable for this variability in bed elevations. Dunes have been observed at the location of the diffusers across a range of observed flows (Northwest Hydraulic Consultants Ltd. 2015). They are transient in nature, with the largest dunes being prevalent during low river discharge, and the smallest dunes associated with high river discharge.

Bottom sediments consist of a range of fine to coarse sands (Golder Associates Ltd. 2017). These sands are readily transported by flows characteristic of the proposed outfall location, facilitating the formation of dunes observed throughout those parts of the channel within and in proximity to the outfall location (Northwest Hydraulic Consultants Ltd. 2015).

4.3 Hydrology, Hydraulics and Salinity

The Fraser River has a snowmelt-dominated flow regime, with the discharge typically rising in April, peaking between May and July, and then receding during the autumn and winter months (Northwest Hydraulic Consultants Ltd. 2015). The long-term mean flow at Mission is 3200 m^3/s (Northwest Hydraulic Consultants Ltd. 2015). The discharge at Mission for the 20-year return period is estimated at 13,700 m^3/s (Northwest Hydraulic Consultants Ltd. 2015). Monthly average flows from 1965 to 1992 at the Port Mann Pump Station, upstream of Annacis Island, ranged from 1030 m^3/s in winter to 11,900 m^3/s during freshet in early summer (Water Office 2017). The distribution of flows amongst the branches of the lower Fraser River was measured by Public Works Government Services Canada in May-June 2002. (Northwest Hydraulic Consultants Ltd. 2015). The measurements revealed that Annieville Channel carried 80 percent of the flow measured at New Westminster, upstream of the trifurcation of the main stem of Fraser River into the North Arm, Annacis Channel and Annieville Channel.

The variation in mean velocities for the simulated 2012 flood condition at the design location of the outfall, coinciding to a 20-year return period event, ranged from 1.2 m/s to 2.5 m/s (Northwest Hydraulic Consultants Ltd. 2015).

The design location of the outfall occurs within the lower part of the Fraser River estuary. The oceanographic characteristics of the lower part of the estuary are strongly affected by the quantity, quality, and timing of freshwater discharge and by the tides and winds of the Strait of Georgia (Adams and Williams 2004). Fresh waters of the river are less dense than the salt waters of the strait. As a result, a halocline occurs within the lower estuary.

During a flood tide, salt waters tend to flow upstream beneath the downstream-flowing fresh waters until an equilibrium of vertical pressures is reached (Tamburi and Hay 1978). A curved interface is formed between salt and fresh waters when this equilibrium is reached, forming a salt wedge. The interface touches the bottom when the salt water reaches a point of zero velocity. The position of the salt wedge varies with both tide and freshwater discharge.

The position of the salt wedge occurs upstream of the Alex Fraser Bridge when freshwater discharge is low, typically during winter (Tamburi and Hay 1978). During freshet, from May through to early July, when discharge is highest, the upstream-most position of the salt wedge is often at the delta front (Tamburi and Hay 1978).

5.0 FISH AND FISH HABITAT

5.1 Regulatory Setting

The *Fisheries Act* prohibits "serious harm to fish" that are part of or support a commercial, recreational or Aboriginal fishery.

> "Serious harm to fish is the death of fish or any permanent alteration to, or destruction of, fish habitat".
>
> As per the *Fisheries Act*, fish include "(a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals".
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The *Fisheries Act* prohibits "the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter such water".

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> "(a) any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that is rendered or is likely to be rendered deleterious to fish or fish habitat or the use by man of fish that frequent that water, or
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> (b) any water that contains a substance in such quantities or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or the use by man of fish that frequent that water".

The Wastewater Systems Effluent Regulations of the *Fisheries Act*, "apply in respect of a wastewater system that, when it deposits effluent via its final discharge point, deposits a deleterious substance".

The Regulations contain mandatory effluent conditions for specific deleterious substances contained within municipal effluent to be achieved through secondary wastewater treatment. As per the Regulations, effluent conditions according to each of these substances are as follows:

- carbonaceous biochemical oxygen demanding matter – the average carbonaceous biochemical oxygen demand does not exceed 25 milligrams/litre (mg/L);
- suspended solids – the average concentration of suspended solids does not exceed 25 mg/L;
- total residual chlorine - the average concentration of residual chlorine does not exceed 0.02 mg/L, if chlorine in any form is used in the treatment of wastewater; and
- un-ionized ammonia – the maximum concentration of un-ionized ammonia, expressed as nitrogen, is less than 1.25 mg/L at 15 degrees Celsius (^{o}C) +/- 1^{o}C.

Also, effluent can only be discharged if it is not acutely lethal to rainbow trout as determined by standard toxicity test methods specified in the Regulations.

Subsections (1) and (2) of Section 35 of the *Fisheries Act*, with regard to “serious harm to fish” and “exception”, respectively, are administered by Fisheries and Oceans Canada. “Exception” presents circumstances whereby “serious harm to fish” may occur, including works, undertakings or activities carried on in accordance with regulations of the *Fisheries Act*.

Subsections (3) and (4) of Section 36 of the *Fisheries Act*, with regard to “deposit of deleterious substance prohibited” and “deposits authorized by regulation”, and the Wastewater Systems Effluent Regulation, are administered by Environment and Climate Change Canada.

The Request-for-Review is processed by Fisheries and Oceans Canada. Those parts of the *Fisheries Act* administered by Environment and Climate Change Canada are presented in this supporting documentation as the discharge of a “deleterious substance” can result in “serious harm to fish”.

5.2 Fish Species and Habitats

Fish and fish habitats addressed within this section support commercial, recreational or Aboriginal (CRA) fisheries.

5.2.1 Salmon

Seven (7) species of salmon (*Oncorhynchus* spp.) occur within the lower Fraser River, specifically: chinook salmon (*O. tshawytscha*); chum salmon (*O. keta*); coho salmon (*O. kisutch*); pink salmon (*O. gorbuscha*); sockeye salmon (*O. nerka*); cutthroat trout (*O. clarkii clarkii*); and, steelhead (*O. mykiss*) (Water and Land Use Committee 2006). Adult salmon migrate upstream annually to spawn, and juvenile salmon migrate downstream annually to and through the estuary and ultimately to the sea.

Salmon have been and continue to be important to First Nations for food, social and ceremonial purposes (Fisheries and Oceans Canada 2017b). Tens of thousands of recreational fishers engage in catch and release and retention fisheries throughout British Columbia, a large part of which occur within the Fraser River (Fisheries and Oceans Canada 2017b). Fraser River stocks support several commercial fisheries.

Juvenile downstream migration is associated with spring freshet, which brings flow, sediment, and nutrients to peripheral areas of the active channel (Rempel *et al.* 2012); smolt downstream migration appears to be dependent upon adequate river current (Bjornn and Reiser 1991). Migration occurs rapidly on time scales of days to weeks, with interspecific variability in time required to reach the river mouth (Melnychuk *et al*. 2010). Migration rates also vary with run type, distance from the ocean, date, and fish size (Carter *et al.* 2009).

Juvenile salmon generally move along the shoreline at depths between 0.1 m and 2.0 m (Southard *et al.* 2006).

Juvenile downstream migration is considered a sensitive life stage as localized impacts to the survivorship of juvenile salmon may disproportionately affect specific runs of adult salmon.

Chinook Salmon (*O. tshawytscha*)

The chinook salmon is the largest of the Pacific salmon. A large number of populations characterize Fraser River chinook salmon (Fisheries and Oceans Canada 1999). Fraser chinook stocks are divided into four major geographical complexes. The complexes include the upper Fraser River system (upstream of Prince George), middle Fraser system (downstream of Prince George, excluding the Thompson River), the Thompson River system, and the lower Fraser system, which is largely defined by Harrison River fish (Fisheries and Oceans Canada 1999).

The geographical complexes fit into three seasonal spawning runs. The spring run moves through the lower Fraser River before July 15. Summer chinook migrate through the lower Fraser River between July 15 and September 01. The fall run is largely represented by Harrison River and Chilliwack River chinook that enter the lower Fraser River after September 01 (Fisheries and Oceans Canada 1999). The majority of spawners are 3, 4 and 5 years in age (Fisheries and Oceans Canada 1999).

Spawning typically occurs between August and December (Fisheries and Oceans Canada 1999). Spawning occurs upstream of the area of tidal influence in the river. The Harrison River population represents spawning within the lowest part of the watershed. Most spawning, in contrast, occurs within the middle and upper regions of the watershed (Fisheries and Oceans Canada 1999).

Fry emerge from March through June (Schmidt *et al.* 1979; Fraser *et al.* 1982). Upon emergence, chinook fry slowly migrate downstream (Mattson 1962; Reimers 1968; Lister and Genoe 1970), largely utilizing the lower Fraser River for rearing.

Based on the length of freshwater rearing, chinook fry may follow one of three life history strategies (Fraser *et al.* 1982), specifically:

- “immediate-type”, where fry migrate directly to the estuary upon emergence;
- “ocean-type”, where fry reside in freshwater from approximately 60 to 150 days before migrating seaward; and,
- “stream-type”, where fry reside in freshwater for a year or more before migrating seaward.

Since Fraser *et al.* (1982), the immediate-type has been grouped in with the ocean-type life history strategy (Anonymous 2011). It is now considered a variation of the “ocean-type”.

The estuary, that portion of the lower Fraser River, from Mission downstream to the delta front, where maritime influence is prevalent, provides important rearing habitat for juvenile chinook. Juvenile fish utilize a variety of habitat types, including non-natal streams, sloughs, nearshore shallows, and tidal flats, marshes and channels (Dunford 1975; Levy *et al.* 1979; Delaney and Olmstead 1981; Levy and Northcote 1982; P.A. Harder and Associates Ltd. 1988; Murray and Rosenau 1989;).

The age of chinook on spawning grounds within the Fraser River system is typically 4 years (Healey 1991). This is the most abundant age class for male and female ocean-type and male stream-type fish. Five (5) years is the most abundant age class for stream-type females (Healey 1991).

Chum Salmon (*O. keta*)

Chum salmon is the second largest Pacific salmon species (Salo 1991). The largest run of chum in British Columbia occurs in the Fraser River (Grant and Pestal 2009a). Two conservation units have been identified for chum based on life history and lineage (Grant and Pestal 2009a), specifically the Lower Fraser River, and the Fraser Canyon.

Chum salmon are managed as a single run with adult upstream migration occurring between September and December (Grant and Pestal 2009a). Prior to upstream migration, adults may delay at the mouth of the river for up to four weeks (Palmer 1966).

Fraser River adult chum salmon spawn in approximately 110 streams, including the Fraser River mainstem. Over 90 percent of the total production results from major tributaries (Grant and Pestal 2009a). The Harrison/Chehalis/Weaver, the Chilliwack/Vedder, and the Stave watersheds sustain the largest of the Fraser River stocks (Grant and Pestal 2009a). All Fraser River spawning occurs downstream of the Fraser Canyon (Grant and Pestal 2009a). Spawning occurs between late September and January, peaking in late October (Grant and Pestal 2009a). Spawning in small tributaries typically lasts for two to three weeks whereas in large tributaries spawning can last up to several months (Grant and Pestal 2009a).

Fry typically emerge in February, and subsequently migrate seaward from February through June, with most of the migration during March and April (Todd 1966; Grant and Pestal 2009a).

The Fraser River estuary provides important rearing habitat for juvenile chum salmon. Juveniles may be found within the estuary between March and July. Juvenile fish utilize a variety of habitat types, including nearshore shallows, sloughs, and tidal flats, marshes and channels (Dunford 1975; Levy *et al.* 1979; Delaney and Olmstead 1981; Levy and Northcote 1982; P.A. Harder and Associates Ltd. 1988).

The age of individuals returning to spawn in natal streams ranges from 3 to 5 years (Beacham and Murray 1987).

Coho Salmon (*O. kisutch*)

Coho salmon utilize most coastal streams in British Columbia (Fisheries and Oceans Canada 2013a). Several populations of coho salmon occur in the Fraser River, including the interior Fraser River population. This population is genetically distinct from the lower Fraser River population (COSEWIC 2002).

The interior Fraser River population is designated as “threatened” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Government of Canada 2017a). It is not listed on Schedule 1 of the federal *Species at Risk Act* (SARA) (Government of Canada 2017a). Schedule 1 is the official list of species at risk in Canada.

Coho salmon do not display discrete seasonal runs like other salmon species and, as such, populations of coho of the lower Fraser River are managed as a single entity (Pacific Salmon Treaty 2014).

Coho salmon begin their migration through the lower Fraser River to natal streams between late August and mid-October (Fisheries and Oceans Canada 2015). Spawning occurs between November and January (McPhail 2007). Preferred spawning habitat includes riffles in small streams and the side channels of larger rivers (Interior Fraser Coho Recovery Team 2006). Depth of water (<0.3 metre), gravel diameter (<0.15 metre) and high dissolved oxygen concentrations are all important spawning habitat requirements.

Fry emerge from the gravel the following spring and take refuge in streams (McPhail 2007). Coho fry rarely occur within the lower Fraser River (Fraser *et al*. 1982). Coho typically exhibit a stream-type life history with individuals typically residing in freshwater streams for one year before migrating to the ocean as smolts (McPhail 2007).

Downstream migration of smolts typically occurs between April and late June with peak migration between early May and early June (McPhail 2007). Coho smolts have been captured within the lower estuary from late April through to mid-June, and off Roberts Bank and Sturgeon Bank from mid-May until late August (Fisheries and Marine Service 1975). Utilization of habitats in the lower Fraser River by juvenile coho occurs primarily between March and August, with the main channel and estuary providing important rearing habitat for juveniles during their downstream migration (Kistritz and Scott 1992). Coho smolts utilize habitat similar to that of juvenile chinook (Rosberg and Byers 1985; Rosberg and Millar 1987).

Adult fish return to natal streams to spawn after spending up to 18 months in coastal inland waters (McPhail 2007).

Pink Salmon (*O. gorbuscha*)

Pink salmon is the most numerically abundant salmon species in BC (Healey 1993) with spawning runs occurring in most rivers and streams along the coast (Riddell and Beamish 2003). Pink salmon are known to spawn closer to the ocean than other Pacific salmon species and are unable to navigate barriers such as waterfalls or cascades (Grant and Pestal 2009b). However, within the Fraser River system, pink salmon do migrate to the Thompson and Bridge river systems, approximately 300 kilometres upstream from the delta front, with individuals reaching the Quesnel River on occasion, representing a migration distance of approximately 690 kilometres (McPhail 2007).

Pink salmon differ from other Pacific salmon species in that they have a fixed two-year life cycle (Grant and Pestal 2009b; McPhail 2007). In odd years, the Fraser River supports the largest run of pink salmon in BC (Grant and Pestal 2009b), with the majority of spawning occurring in the lower river, within tributary watercourses of the estuary to the Fraser Canyon (Fisheries and Oceans Canada 1995). Pink stocks are broadly categorized into early and late runs (McPhail 2007). Early-run pink salmon spawn in upstream tributaries and main stem shoals and bars, while late-run adults typically spawn in tributaries below Hope, particularly in the Harrison and Chilliwack rivers (Fisheries and Oceans Canada 1995; Riddell and Beamish 2003). Most Fraser River pink salmon return to their natal streams during September to October (Grant and Pestal 2009b).

Fry emerge from gravels in early spring between 3 to 5 months after hatching (McPhail 2007). Once surface swimming begins, pink salmon fry quickly migrate downstream. This downstream migration begins as early as late February in the Fraser and lasts until May; the main migration occurs in mid-April (Fisheries and Oceans Canada 1995). Juveniles reach the Fraser River estuary about May and disperse to southern areas of the Strait of Georgia (Grant and Pestal 2009b).

Sub-adults rear in the ocean for approximately 12 to 18 months before beginning their upstream migration to natal streams (McPhail 2007).

Sockeye Salmon (*O. nerka*)

Sockeye salmon is the second most abundant salmon species in British Columbia with approximately 900 unique stocks occurring in the province (Henderson and Graham 1998). The Fraser River is the largest producing system for sockeye salmon in British Columbia (Henderson and Graham 1998).

Adult sockeye migrate through the lower Fraser River between June and November (Cooke *et al.* 2004). Individual Fraser River sockeye salmon populations have particular times for returns or runs (Gable and Cox-Rogers 1993), specifically:

- early Stuart run (June);
- early summer run (July);
- mid-summer run (August); and
- late run (September to November).

The late run includes the Cultus Lake population. This population is designated as “endangered” by the Committee on the Status of Endangered Wildlife in Canada (Government of Canada 2017b). It is not listed on Schedule 1 of the federal *Species at Risk Act* (SARA) (Government of Canada 2017b). Schedule 1 is the official list of species at risk in Canada.

Late run individuals often delay at the river mouth for up to several weeks before migrating upstream; the early and summer runs typically travel upstream without delay (Cooke *et al.* 2004). Since 1995, upstream migrations have been occurring up to six weeks earlier than historically observed (Cooke *et al.* 2004; Johannes *et al.* 2011; Martins *et al.* 2011).

Spawning occurs in Fraser River tributaries between September and December (British Columbia Conservation Data Centre 2016). Sockeye salmon have two typical life history strategies, lake-type and river-type (Johannes *et al.* 2011). River-type sockeye comprise less than 1 percent of the Fraser River sockeye population

The incubation period for sockeye eggs is six to nine weeks (British Columbia Conservation Data Centre 2016). Alevins remain in the gravel after hatching for two to three weeks prior to emerging (British Columbia Conservation Data Centre 2016). River-type individuals migrate downstream immediately after emerging and remain in the lower Fraser River and estuary for two to six months, rearing in creek mouths, sloughs and side channels (Johannes *et al.* 2011). Lake-type individuals spend a year or more in freshwater lakes before migrating downstream (Hoos and Packman 1974), spending between seven and ten days in the lower Fraser River (Johannes *et al.* 2011) before moving seaward. Downstream migration of juvenile sockeye, of both types, occurs largely from April through May (Johannes *et al.* 2011).

Sockeye salmon remain in ocean conditions for one to four years (Henderson and Graham 1998), with return runs exhibiting a four year cycle in abundance (Henderson and Graham 1998; Fisheries and Oceans Canada 2013b).

Coastal Cutthroat Trout (*O. clarkii clarkii*)

Coastal cutthroat trout occur along much of the Pacific Northwest coast and is broadly distributed throughout coastal British Columbia (Costello 2008). Coastal cutthroat trout are known to occupy a wide range of habitats including small streams, large rivers, bogs, sloughs, ponds, large lakes, coastal lagoons, estuaries and ocean beaches (Slaney and Roberts 2005).

Lower Fraser River populations display diverse life history traits and migratory behaviour (Slaney and Roberts 2005). Four life history forms exist, with all forms being supported within the lower Fraser River (Slaney and Roberts 2005). Specifically, these life history forms are:

- resident populations inhabiting small headwater streams (non-migratory);
- fluvial populations that undergo in-river migrations between small tributaries and large mainstem foraging areas;
- adfluvial populations that migrate between lakes and streams for spawning and or foraging purposes; and
- anadromous populations that migrate to the ocean for less than a year before returning to freshwater.

It is predicted that coastal cutthroat trout operate via migratory cycles, with not all individuals in a population restricted to a single cycle (Slaney and Roberts 2005).

Resident coastal cutthroat trout populations reside in the tributaries of the lower Fraser River. Anadromous sea-run populations occur throughout the lower Fraser River system (McPhail

2007). Anadromous trout typically enter freshwater spawning streams during late fall through to early winter (Scott and Crossman 1973), in advance of spawning from December through to May (Trotter 1989). Peak spawning occurs during February (Trotter 1989).

Anadromous trout spend 1 to 4 summers in freshwater before migrating to the ocean. Details of the downstream migration patterns of coastal cutthroat trout in the Fraser River are not well known. In other large Pacific Northwest rivers (e.g. Columbia River), downstream movements of coastal cutthroat trout were greatest during an outgoing tide (Zydlewski *et al.* 2008). Similar to other salmonids, downstream movements also appeared to be influenced by diel cycle, with movements peaking during the hours just after sunrise and just after sunset. In the Columbia River, migrating coast cutthroat trout were observed travelling near the shore, although several individuals were observed to cross the shipping channel and travel in the main channel for several hours (Zydlewski *et al.* 2008).

Steelhead Trout (*O. mykiss*)

Steelhead trout is the anadromous form of rainbow trout. Three (3) races of steelhead trout occur within the Fraser River system, specifically coastal-winter, coastal-summer and interior-summer (Anonymous 1998).

Coastal-winter steelhead migrate through the Fraser River to spawning habitats of tributaries from November through to April (Anonymous 1998). Approximately 21 streams of the lower Fraser River support spawning by steelhead (Anonymous 1998).

Only 3 summer runs of coastal-summer steelhead are supported by the Fraser River, namely stocks associated with the Coquihalla River, Chehalis River and Silverhope Creek. Winter runs are also associated with these watercourses. Summer fish ascend streams to spawn from April through to July (Anonymous 1998).

Interior-summer steelhead are organized according to three subcatchments of the Fraser River, specifically the Thompson River, Chilcotin River and west Fraser tributaries (Anonymous 1998).

Movement into the lower Fraser River for Thompson and Chilcotin stocks peaks in early fall (Anonymous 1998). Fish of both stocks often overwinter in larger watercourses before moving upstream to spawn (Anonymous 1998).

West Fraser tributaries steelhead migrate through the Fraser River during fall, with fish overwintering in the mainstem of the Fraser River before moving into spawning tributaries during February through to May (Anonymous 1998).

Fry emerge in late spring or early fall (Quinn 2005). Steelhead typically reside in freshwater from 1 to 3 years before migrating to sea. They typically spend 1 to 3 years at sea before returning to spawn (Quinn 2005). Adults may survive to spawn 2 or more times (Quinn 2005).

5.2.2 Char

Dolly Varden (*Salvelinus malma*)

Dolly Varden is divided into two district forms, specifically the northern form and the southern form, with a third form potentially associated with the Bering Sea (COSEWIC 2010). Little is known about Dolly Varden populations in the lower Fraser River; as such, information from other BC populations is applied to the description for lower Fraser River.

Three life history strategies are utilized by Dolly Varden in BC (McPhail 2007), specifically anadromous, stream-resident, and adfluvial. Anadromous individuals migrate between freshwater and ocean conditions, spending much time in estuaries (McPhail 2007). Stream-residents reside in rivers and streams for their entire lives, and adfluvial individuals reside in lakes for most of their life and spawn in streams (McPhail 2007). Both mature and immature anadromous Dolly Varden have been recorded migrating between freshwater and ocean conditions (McPhail 2007), and as such migration may not be strictly related to reproductive processes but may also be related to feeding opportunities (British Columbia Ministry of Fisheries 1999).

Stream-resident Dolly Varden typically spawn locally whereas anadromous and adfluvial populations migrate upstream to spawning sites (McPhail 2007). Although adfluvial populations have not been directly studied, observations suggest these individuals migrate short distances to spawn (i.e. less than 1 kilometre) (McPhail 2007). Anadromous populations migrate to spawning streams between May and December (British Columbia Conservation Data Centre 2016).

In southern BC, Dolly Varden spawning typically occurs during the fall (McPhail 2007). Anadromous adults, after spawning, overwinter in lakes and move back downstream in spring (McPhail 2007). Fry emerge from gravels from April to May (McPhail 2007).

Stream-resident juveniles prefer shallow, slow moving areas with adequate cover such as pools and side channels (McPhail 2007). Anadromous fry initially stay close to river margins and move into areas of higher water velocities by mid-summer (McPhail 2007). Anadromous parr may migrate to the lower stream reaches in spring and return upstream in late summer to fall (McPhail 2007). These individuals remain in freshwater for three to four years before migrating to estuarine and marine environments (British Columbia Ministry of Fisheries 1999).

Dolly Varden reach sexual maturity between three and six years (McPhail 2007; British Columbia Conservation Data Centre 2016), although for most individuals this occurs after the fifth growing season (McPhail 2007). Southern form adults may spawn every year after reaching maturity (British Columbia Ministry of Fisheries 1999). The life span of Dolly Varden is estimated to be ten to twelve years (British Columbia Conservation Data Centre 2016).

5.2.3 Smelt

Eulachon (*Thaleichthys pacificus*)

Eulachon is an anadromous smelt occurring along the Pacific coast of North America from Alaska to southern California (McPhail 2007). Eulachon spends over 95 percent of its life at sea (COSEWIC 2011), and spawns in the lower reaches of typically glacier-fed rivers that experience spring freshets (McPhail 2007). Within British Columbia, eulachon occurs in at least 38 rivers (COSEWIC 2011), but spawns in only 12 to 20 rivers including the lower Fraser River (McPhail 2007).

Eulachon spawns in the lower Fraser River in April and May (McPhail 2007). Most spawning occurs between Mission and Chilliwack (approximately 60 to 120 kilometres upstream), where the substrate changes from silt and sand to gravel (McPhail 2007). Further downstream, near the confluence of the Fraser and Pitt rivers, eulachon spawning habitat is characterized by substrates of fine-to-medium sands and coarse sands with pebbles, depths of 5 to 10 metres, and maximum current speeds of 0.3 to 0.7 metres per second (m/s) (Plate 2009). Spawning locations downstream of Mission are determined by the availability of appropriate spawning substrate. Locations targeted by Fisheries and Oceans Canada for eulachon egg and larval out-drift sampling in recent years include Deas Island, Tilbury Island, New Westminster, Barnston Island, Iona Island, the upper North Arm, and the lower Pitt River area (McCarter and Hay 2003). Spawning stock biomass during sampling from 1995 to 2012 was typically much higher in the South Arm than in the North Arm (Fisheries and Oceans Canada 2014b).

Adult eulachon use migration corridors within the river to reach spawning locations. Migration corridors occur in side channels and the main channel of the river, including near structures such as bridges (Plate 2009). Eulachon appear to congregate in estuaries prior to migrating upriver to spawning locations (McPhail 2007).

Juvenile eulachon appear to disperse into marine waters within their first year of life. The juvenile migration portion of the eulachon life cycle is poorly understood (McPhail 2007).

Eulachon are an important, energy-rich prey species in the springtime for marine and freshwater fishes, mammals and birds (COSEWIC 2011). Timing of the eulachon run coincides with otherwise seasonally low prey availability, and predation is heavy during pre-spawning aggregations in the lower reaches of rivers (COSEWIC 2011).

Eulachon populations have declined along the Pacific coast of North America in recent decades (McPhail 2007). The Fraser River population has been designated “endangered” by the Committee on the Status of Endangered Wildlife in Canada (Government of Canada 2017c). It is not listed on Schedule 1 of SARA (Government of Canada 2017c). Schedule 1 is the official list of species at risk in Canada.

5.2.4 Sturgeon

White Sturgeon (*Acipenser transmontanus*)

White sturgeon is a large freshwater fish whose marine distribution spans the Pacific Coast of North America from Alaska to California. Spawning populations are known only from the Sacramento-San Joaquin, Columbia, and Fraser river systems. Within the Fraser River system, white sturgeon occurs within the estuary to upstream of Prince George, as well as in the Nechako River from its confluence with the Fraser River to upstream of Vanderhoof. White sturgeon also occurs in large lakes associated with these two rivers (McPhail 2007).

White sturgeon spawn in June and July in the Fraser River between Hope and Chilliwack (McPhail 2007). Sturgeon do not spawn every year, and spawning migrations are not conspicuous due to the length of the spawning season and small number of spawners (McPhail 2007).

Late juvenile (over two years) and adult white sturgeon habitat is typically located in large rivers, large natural lakes, and large reservoirs (COSEWIC 2012). River habitat is typically characterized by deep waters with backwater and eddy flow characteristics, adjacent to heavy flows, with a sand and fine gravel substrate (Fisheries and Oceans Canada 2014a). Within the Fraser River, adult white sturgeon are present in the main channel for much of the year, moving upstream to spawn and downstream to exploit seasonal food availability (Nelson *et al.* 2004). Downstream of Mission, the substrate is characterized by sandy silt, with water depths of 10 metres (m) to 20 m and turbid water (Nelson *et al*. 2004). Adult sturgeon spend the winter (October to March) in a low-activity state in deep, low-velocity locations (Nelson *et al*. 2004). Adults occasionally occur within brackish waters of the lower estuary and may spend extended periods in the marine environment (McPhail 2007).

Little is known about juvenile (less than two years) white sturgeon habitat in British Columbia, but evidence suggests that juveniles are typically associated with areas of slow to moderate water velocities, in areas such as the lower reaches or confluence points of tributaries, large backwaters, side channels, and sloughs (Lane and Rosenau 1995). Water depth and substrate are varied (Lane and Rosenau 1995). Juveniles leave these areas, most likely for the main channel, once water temperatures fall below 13 to 15 °C (Lane and Rosenau 1995).

Juvenile white sturgeon have been documented to occur in proximity to the outfall location (Glova *et al.* 2008; Glova *et al.* 2009). Significant catches of juvenile (> 5 individuals) occurred immediately downstream of the north sand island tower footing of the Alex Fraser Bridge, and at and about the confluence of Annacis and Annieville channels, in proximity to Purfleet Point, and Don and Lion islands. Juvenile sturgeon occurred predominantly nearshore.. The bulk of sampling in 2007-08 occurred during September through November 2007 (Glova *et al.* 2008), while sampling in 2008 occurred during June, July and September 2008 (Glova *et al.* 2009).

The lower Fraser River population of white sturgeon has been designated “threatened” by the Committee on the Status of Endangered Wildlife in Canada (Government of Canada 2017d). It is not listed on Schedule 1 of SARA (Government of Canada 2017d). Schedule 1 is the official list of species at risk in Canada. Loss of habitat quality and quantity is identified by the federal Recovery Strategy (Fisheries and Oceans Canada 2014a) as posing a high relative risk to this population and its habitat.

6.0 IMPACTS AND MITIGATION

6.1 Design

Design impacts are permanent impacts. The design displaces surficial sands of the river bed. These impacts are largely attributable to the riser, diffusers, and diffuser manifold and associated riprap (see Drawing No. A61 C0071 "Diffuser Manifold Section"; Appendix A).

Impacts to the river bed by riprap would be transitory in nature. It is anticipated that most of the riprap would be buried by sand through deposition associated with freshet. During other times of the year, this sand would be progressively eroded by currents, eventually exposing previously buried riprap. Typically, the diffusers and a narrow strip of riprap would be exposed above the river bed.

Dredging of the navigation channel, adjacent to the design location of the outfall, would also affect the extent of impacts. Dredging occurs when the river bed elevation is above the minimum depth elevation for navigation. At this elevation, approximately 1100 m^2 of surficial sand on the river bed would be displaced by riprap; exposed riprap would occur above the minimum channel depth elevation (Figure 2). At the maximum dredging depth for the channel, approximately 4100 m^2 of surficial sand on the river bed would be displaced by riprap.

Juvenile salmon generally occur within the upper 2 metres of the water column (Southard *et al.* 2006), and along the shoreline, and would not be affected by changes in the river bed at the design location of the outfall.

Adult Pacific salmon, particularly coho, chinook, sockeye, pink and chum salmon, and steelhead and anadromous cutthroat trout, are unlikely to stage at the design location of the outfall during upstream migration. The outfall likely falls along the margins of the migratory corridor to upstream spawning habitats. Changes to the river bottom at this location would not markedly affect adult Pacific salmon.

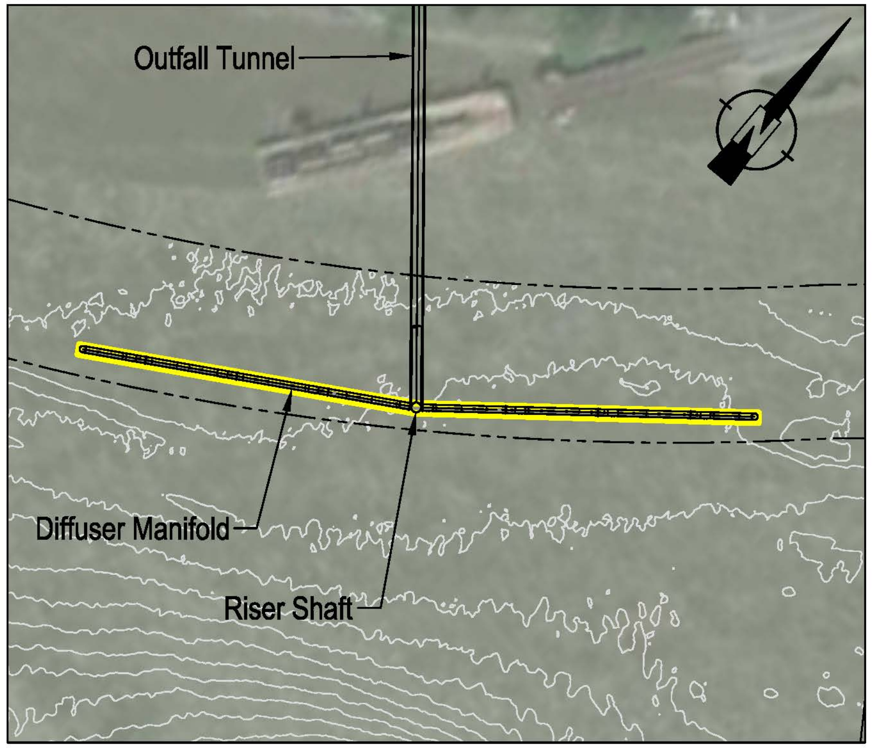
Dolly Varden char and coastal cutthroat trout likely move throughout the immediate shoreline environment, where preferred prey, such as larval and juvenile fish, occur. It is highly unlikely that the design river bottom provides foraging opportunities for Dolly Varden char and cutthroat trout. Changes to the river bottom would not markedly affect these fish.

Eulachon do not spawn at the design location of the outfall. The outfall likely falls along the margins of the migratory corridor to upstream spawning habitats. Changes to the river bottom at this location would not markedly affect eulachon.

Adult white sturgeon occur throughout Annieville Channel, and likely occur periodically within the design footprint of the riser and diffuser manifold. White sturgeon within the lower Fraser River feed upon invertebrates and fish, including the carcasses of spent spawners of eulachon and Pacific salmon (Fisheries and Oceans Canada 2014a). Bottom fish that are likely prey for adult sturgeon, such as juvenile starry flounder (*Platichthys stellatus*), that move in with the salt wedge, likely occur at the design location of the riser and diffuser manifold. The change in the bottom, in terms of area, and in context of the transitory nature of the river bottom at this location, should not affect the availability of such prey for adult sturgeon.

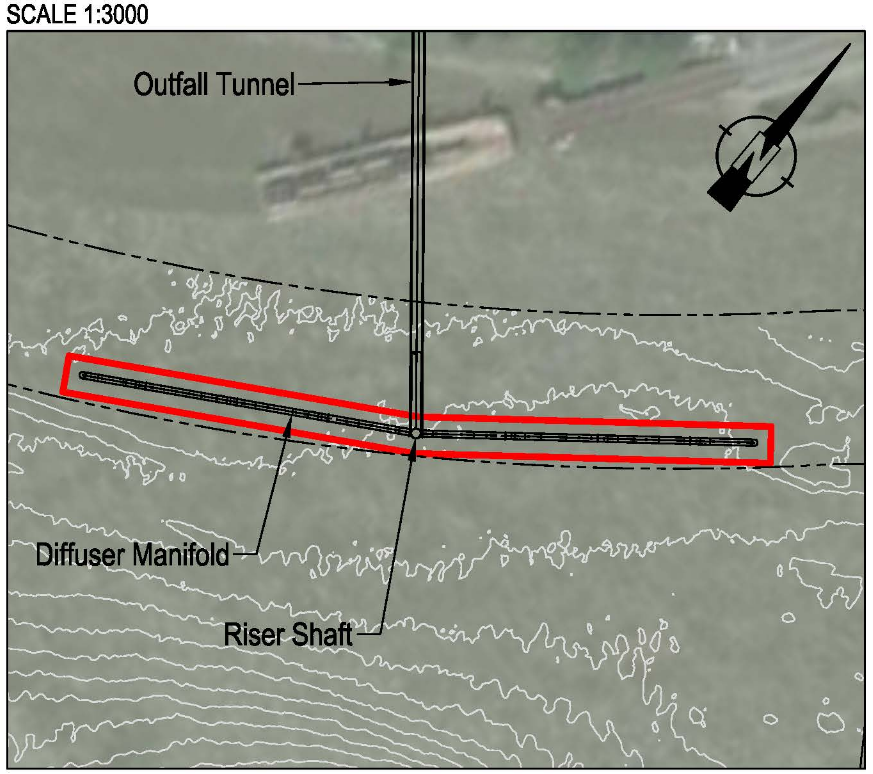
PLAN - MINIMUM CHANNEL DEPTH

SCALE 1:3000



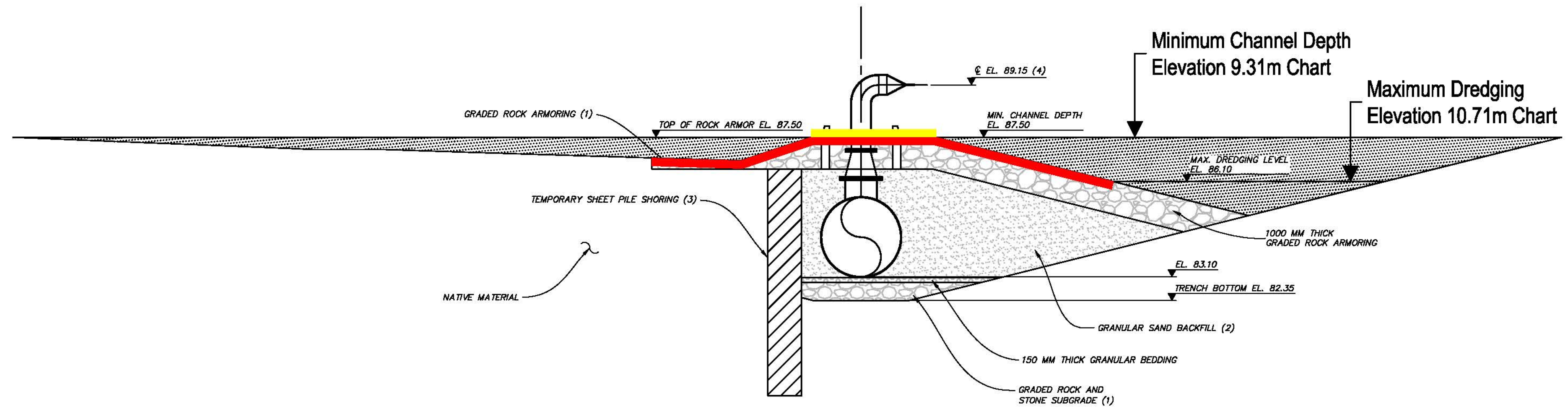
PLAN - MAXIMUM CHANNEL DEPTH

SCALE 1:3000



SECTION - MINIMUM AND MAXIMUM CHANNEL DEPTH

SCALE 1:200



REFERENCE DATUM

0m Geodetic = 98.41m Annacis Island Wastewater Treatment Plant

-1.60m Geodetic = 0m Chart

0m Chart = 96.81m Annacis Island Wastewater Treatment Plant

Design Impact @ Minimum Channel Depth (1,100m²)

Design Impact @ Maximum Channel Depth (4,100m²)

REFERENCE DRAWINGS

1. Drawing No. A61C0072. Issue P2. "A61 - NOS Diffuser Manifold Plan". January 2017. CDM Smith Inc.
2. Drawing No. A61C0071. Issue P2. "Diffuser Manifold Section". January 2017. CDM Smith Inc.
3. 2015 Ortho Photograph From Google Earth.

METRO VANCOUVER

ANNACIS ISLAND
WASTEWATER TREATMENT PLANT OUTFALL
FISHERIES AND OCEANS CANADA
REQUEST FOR REVIEW

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DIFFUSER MANIFOLD
DESIGN IMPACTS

DESIGN:	DRAWN:	CHECKED:	REVISION:	REVISION DATE:
MAA	SDJ	MAA	00	
SCALE: As Shown			DRAWING NUMBER: FIGURE 2	
DATE: April 19, 2017				

DATE: 2017-05-11 - 5:20pm
PATH: \\env-fs-r\Alpha\Envirowest Files\2017\Fraser River\2098-01 Annacis Is Outfall\AutoCAD\Final\Figure 2 - Design Impacts.dwg
LAYOUT: FIGURE 2

The nearshore subtidal and intertidal areas between Annacis Island and the design location of the outfall are characterized by relatively slower flows and fine sediments known to be preferred habitat of juvenile white sturgeon (Glova *et al.* 2008; Glova *et al.* 2009).

River bottom elevations at and about the location of the dredge pocket are approximately 10 metres below chart datum. Catches of juvenile sturgeon presented by Glova *et al.* (2008) largely occurred at depths less than 10 metres. For Glova *et al.* (2009), catches occurred largely at depths less than 15 metres. Sampling depths for these studies were not referenced to tidal height. It is unlikely that sampling occurred during local low water, with the majority of catches likely occurring at depths less than 10 metres below chart datum. In this regard, the design location of the riser and diffuser manifold is likely utilized to a lesser extent than shallower, more landward bottom habitats of Annieville Channel.

Glova *et al.* (2008) did not catch sturgeon at bottom salinities greater than 0.6 part per thousand. Glova *et al.* (2009) did not report salinities. Young juvenile sturgeons are intolerant of saline waters (Amiri *et al.* 2009). The salt wedge extends up to the existing outfall during low river discharge. This would pre-empt juvenile sturgeon during at least part of the year at and in proximity to the design location of the new outfall.

Juvenile sturgeon feed upon benthic invertebrates, small fish and fish eggs (Scott and Crossman 1973; McCabe *et al.* 1993). Displacement of small fish by a change in bottom substrate, from sand to riprap, is not likely to affect the availability of such fish. Most small fish will be associated with nearshore environments, at depths considerably shallower than the design depth of the new outfall. It is likely that fish eggs as food at the design location of the outfall is restricted to drift of eulachon eggs from upstream spawning habitats. The availability of fish and fish eggs as food would not be affected by changes to the river bottom attributable to the design of the outfall.

Design riprap would displace habitat for benthic invertebrates. Benthic invertebrates are likely a food resource at the design location of the outfall; however, this resource is likely limited, as bottom sediments that serve as habitat are transitory (see Northwest Hydraulic Consultants Ltd. 2015), with depopulation of, and recolonization by benthic invertebrates a frequent recurring event.

Impacts to surficial sand on the river bed, whether it be 1100 m^2, 4100 m^2, or some area in between, would not impair the life history stages of CRA fish such that the productivity of associated fisheries are affected. Affected habitat is represented throughout the Fraser River estuary, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island. The scale of impact on CRA fish is not of consequence, especially in consideration of the abundance of similar habitat available to such fish in proximity to the design location of the outfall.

6.2 Construction

Construction of the Project would employ Fisheries and Oceans Canada's measures to avoid causing harm to fish and fish habitat (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html; February 14, 2016; Appendix B). Best management practices and standards for the protection of the environment would also be applied (e.g.

http://www.env.gov.bc.ca/wld/instreamworks/downloads/GeneralBMPs.pdf; February 14, 2016; Appendix B)

A Construction Environmental Management Plan (CEMP) would be required of the contractor prior to the commencement of construction of the Project. A preliminary table of contents for the CEMP is as follows.

1.0 INTRODUCTION
2.0 PROJECT LOCATION
3.0 PROJECT SCHEDULE
4.0 PROJECT DESCRIPTION
5.0 SITE DESCRIPTION
6.0 CONTACTS AND RESPONSIBILITIES
 6.1 Contractor
 6.2 Environmental Monitor
7.0 RELEVANT ENVIRONMENTAL LEGISLATION
8.0 PROJECT MITIGATION MEASURES AND ENVIRONMENTAL SPECIFICATIONS
 8.1 Training and General Practices
 8.2 Site Access, Mobilization and Laydown/Moorage Areas
 8.3 Machinery and Equipment
 8.4 Equipment Refueling Procedures
 8.5 Emergency Response
  8.5.1 Emergency and Spill Response Plan
 8.6 Hazardous Material Management and Spill Prevention
 8.7 Contaminated Soil and Groundwater Management
 8.8 Concrete
 8.9 Air Quality
 8.10 Erosion and Sediment Control
 8.11 Fish and Fish Habitat
 8.12 Vegetation and Wildlife
 8.13 Historical and Archaeological Management
 8.14 Noise and Vibration
 8.15 Non-Hazardous Waste Management
9.0 REFERENCES

6.2.1 Outfall Pipe

The installation of the outfall pipe would utilize a trenchless methodology, specifically tunneling. The tunnel would occur beneath intertidal and nearshore subtidal river bottom and terminate at the design location of the riser.

Tunnel construction may utilize conventional or micro- tunneling methods. Conventional tunneling utilizes a boring machine that is operated directly by construction personnel, while microtunneling utilizes a machine that is remotely operated. In both instances, the boring machine is launched from an upland access portal. The machine would bore into sediments, generating waste material for disposal. The waste sediments would be disposed to a permitted upland site and/or disposed at sea (Environment and Climate Change Canada Disposal-at-Sea Permit). The outfall pipe would be installed within the tunnel as the boring machine proceeds.

The incorporation of a trenchless methodology avoids impacts to the riparian, intertidal marsh, intertidal mudflat, and nearshore subtidal river bottom fish habitats. The upland access portal would be located within a developed landscape; natural features would not be impacted.

6.2.2 Riser

The construction methodology for the riser is presented by Drawing No. A61 C0052 "A61 – NOS, Riser Shaft Plan Top Level" through Drawing No. A61 C0055 "Riser Shaft Final Conditions" (Appendix A). The riser would be installed in isolation of Fraser River waters. This would be achieved through installation of a coffer dam. The coffer dam would extend from the river bed through the water column, above the high water elevation.

The coffer dam would be composed of metal pipe piles and sheet piles; piles would be installed using a vibratory hammer. It is anticipated that underwater pressures associated with the installation of the metal pipe and sheet piles with a vibratory hammer would be below the Fisheries and Oceans Canada's 30kpa threshold (Vagle 2003; Buehler *et al.* 2015) to prevent harm to fish. The coffer dam would be installed during the timing window for inwater works of least risk to fish (June 16 through to February 28) (Fisheries and Oceans Canada 2017a); work within the coffer dam could occur at any time throughout the year as the works would be isolated from Fraser River waters. The riser would be connected to the outfall pipe within the coffer dam. Details regarding the coffer dam are presented by the above referenced drawing and by Drawing No. A61 C0052 "A61 – NOS, Riser Shaft Plan Top Level" (Appendix A).

The interior of the coffer dam would be inspected for fish upon completion of installation. Any fish encountered would be salvaged and released to open waters of Annieville Channel.

It is highly unlikely that fish will be struck during installation of piles. Fish will engage in avoidance behaviour during installation of piles.

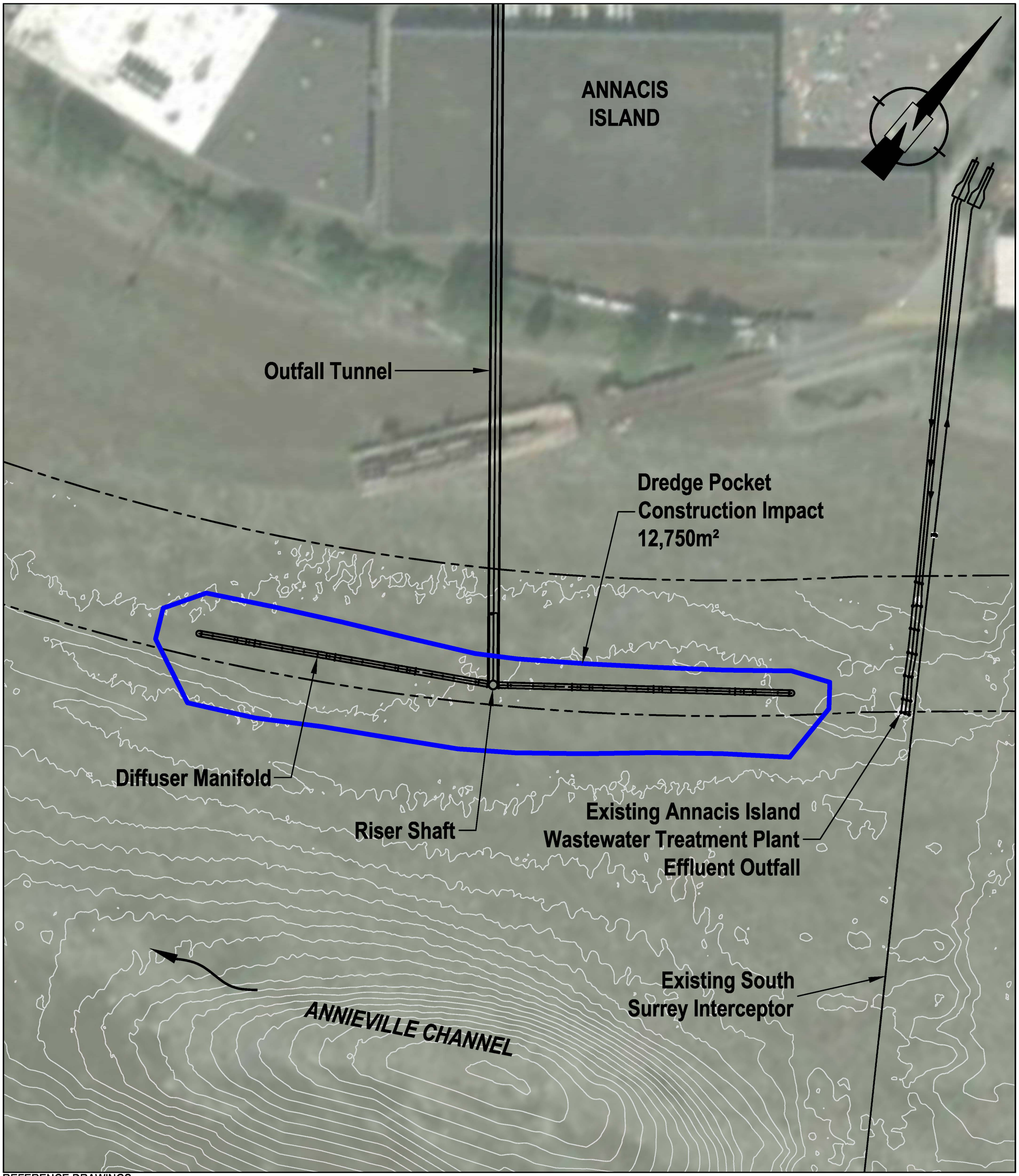
Impacts to the river bed related to the installation of the riser are extremely localized and temporary. The construction footprint of the riser falls within the design footprint of the riser and diffuser manifold.

6.2.3 Diffuser Manifold

The diffuser manifold would be installed through dredging a shallow trench in the river bed. It is anticipated that temporary shoring would be utilized to mitigate sloughing of bank sediments into the trench. Drawing No. A61 C0071 "Diffuser Manifold Section" (Appendix A) provides details regarding a diffuser manifold with shoring.

The installation of the diffuser manifold with shoring mitigates the area of river bed temporarily impacted by dredging; the temporary impact is approximately 12,750 m^2 (Figure 3).

Dredging beyond the design footprint of the diffuser manifold is mitigated by the restoration of native sediments. Temporary disturbance of sediments would be further mitigated by the annual deposition of sediments associated with freshet.



REFERENCE DRAWINGS

1. Drawing No. Sheet 3. Issue. E. "South Surrey Interceptor Fraser River Crossing Plan and Profile Sta. 0+415.14 to Sta. 0+748.89". March 2015. Greater Vancouver Sewerage And Drainage District.
2. Drawing No. Sheet 4. Issue. D. "South Surrey Interceptor Fraser River Crossing Plan and Profile Sta. 0+748.89 to Sta. 1+108.56". March 2015. Greater Vancouver Sewerage And Drainage District.
3. Drawing No. A61X-C092. Issue P2. "A61 - NOS Tunnel Plan And Profile 4". December 2016. CDM Smith Inc.
4. 2015 Ortho Photograph From Google Earth.

METRO VANCOUVER ANNACIS ISLAND WASTEWATER TREATMENT PLANT OUTFALL FISHERIES AND OCEANS CANADA REQUEST FOR REVIEW	envirowest consultants inc. Suite 101 - 1515 Broadway Street Port Coquitlam, British Columbia Canada V3C 6M2 office: 604-944-0502 facsimile: 604-944-0507 www.envirowest.ca	DREDGE POCKET CONSTRUCTION IMPACT DESIGN: / DRAWN: SDJ / CHECKED: MAA / REVISION: 00 / REVISION DATE: SCALE: 1:2500 / DRAWING NUMBER: FIGURE 3 DATE: April 19, 2017

DATE: 2017-05-11 - 5:22pm
PATH: \\env-fs-1\Alpha\Envirowest Files\2017\Fraser River\2098-01 Annacis Is Outfall\AutoCAD\Final\Figure 3 - Dredge Pocket.dwg
LAYOUT: FIGURE 3

Dredging would be conducted using a clamshell dredge (i.e. a crane equipped with a clamshell bucket). A clamshell dredge is selected, in part, due to its ability to precisely excavate to the limits delineated by the design. Hydraulic dredges, such as cutterhead suction and hopper dredges, have a tendency to over-excavate, especially where sand is the dominant sediment. The use of a clamshell limits impacts on the river bed associated with construction.

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.

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). Dredging would be conducted during the timing window for inwater works of least risk to fish (June 16 through to February 28) (Fisheries and Oceans Canada 2017a).

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.

Elevated turbidity and total suspended solids associated with sediment plumes are typically transitory and temporary (Water and Land Use Committee 2006). If juvenile salmon encounter a sediment plume, they will express avoidance behaviour (see ECORP Consulting, Inc. 2009). Prospective impacts to juvenile salmon are mitigated through restriction of dredging to the inwater work window (Water and Land Use Committee 2006).

Adult salmon and Dolly Varden char will be in the river outside of the inwater work window. It is anticipated that salmon and char will express avoidance behaviour in response to the operation of the clamshell. They will also express avoidance behaviour associated with the sediment plume generated by dredging activities.

Adult eulachon will not be in the Fraser River during the inwater work window.

Dredging with a clamshell has the potential to entrain adult and juvenile white sturgeon as they predominantly reside on the river bottom. The prospective impacts of dredging on all species of sturgeon, let alone white sturgeon, have been poorly studied. When such studies have been conducted, the focus has been upon the potential impacts of hydraulic dredging. The impacts of mechanical dredging, as represented by clamshell dredging, have not been studied in the Fraser River.

A perspective regarding the risk of harm or death of white sturgeon due to mechanical dredging may be derived from data pertaining to interactions between dredging and other species of sturgeon. Data pertaining to mortalities attributable to entrainment by mechanical dredging are provided by the US Army Corps of Engineers Sea Turtle Data Warehouse (2013) for the Atlantic and Gulf coasts. The data spans 18 years, from 1995 to 2013. Forty-two (42) sturgeon (3 Gulf sturgeon (*A. oxyrinchus desotoi*), 11 shortnose sturgeon (*A. brevirostrum*), and 34 Atlantic sturgeon (*A. oxyrinchus oxyrinchus*)) were taken during dredging. Five sturgeon survived their encounters with the dredges (2 shortnose sturgeon and 3 Atlantic sturgeon). The majority of mortalities were associated with hopper dredging (3 Gulf sturgeon, 5 shortnose sturgeon and 24 Atlantic sturgeon). Four (4) sturgeon (1 shortnose and 3 Atlantic sturgeon) were entrained by mechanical dredging. The Atlantic Sturgeon Status Review Team calculated a minimum entrainment of 0.6 Atlantic sturgeon per year, based strictly on hopper dredging operations and an assumption that dredging efforts were relatively similar among years (US Army Corps of Engineers Sea Turtle Data Warehouse 2006). As can be deduced from the US Army Corps of Engineers Sea Turtle Data Warehouse (2013) data, the rate of sturgeon entrainment by mechanical dredging appears to be substantively less than entrainment associated with hopper dredging.

COSEWIC (2012) does not identify dredging as a threat to sturgeon in terms of mortalities induced by the act of dredging. In this regard, and in consideration of US Army Corps of Engineers Sea Turtle Data Warehouse (2013) data and the scale and scope of dredging, it is unlikely that dredging would result in the death of white sturgeon.

6.3 Operation

The waste water treatment process, and associated effluent quality, is not anticipated to markedly change as part of the overall upgrade of the Treatment Plant. Based upon a review of 2014 effluent and toxicity data (Greater Vancouver Sewerage and Drainage District 2015) conducted as part of the Stage 1 Environmental Impact Statement (Stage 1 EIS) (Golder Associates Ltd. 2016) for the Project, the Treatment Plant effluent meets Wastewater Systems Effluent Regulations limits and is not acutely toxic. Tri-Star Environmental Consulting (2015) also reported that the effluent was not acutely lethal based on standardized acute toxicity testing undertaken on Treatment Plan effluent sampled between 2009 and 2012.

Key findings of a Stage 1 Environmental Impact Statement (Golder Associates Ltd. 2016), based upon conservative assumptions, the preliminary diffuser design, and effluent and ambient river water quality data from 2011 to 2014, indicate that

- adverse effects on rainbow trout and impairment of other receiving environment uses identified for the study area (i.e., secondary recreational contact, wildlife use, agricultural use) defined for the Stage 1 EIS are unlikely based on a preliminary assessment of predicted concentrations at the edge of the Initial Dilution Zone (IDZ), and
- as the effluent at the point of discharge is not acutely lethal to rainbow trout, and following dilution and mixing within the river, conditions within the IDZ would likewise not be expected to be acutely toxic to aquatic life, and chronic toxicity is not expected beyond the IDZ boundary.

The IDZ is the three-dimensional zone around the point of discharge where mixing of the effluent and receiving water occurs. For a large water body, the IDZ is commonly defined as a cylindrical body of water around the outfall, with a lateral radius the lesser of 100 m from the outfall or 25 percent the width of the receiving water body, and extending upwards through the water column to the surface.

It is worthy to note that juvenile sturgeon have been caught within the IDZ of the existing outfall (Glova *et al.* 2008; Glova *et al.* 2009). The numbers of juvenile sturgeon within the IDZ and elsewhere along the shorelines of Annacis Island were the highest of sample locations downstream of the Mission Bridge (Highway No.11), suggesting the effluent does not deter use of the nearshore environments of Annieville Channel by juvenile sturgeon.

As the Treatment Plant effluent meets Wastewater Systems Effluent Regulations limits and is not acutely toxic, impacts to CRA fish are adequately mitigated.

7.0 SUMMARY AND ASSESSMENT OF IMPACTS

Impacts to fish and fish habitat are addressed specifically in the context of those fish species that are likely to occur within the design, construction and operation footprints of the Project, and support a commercial, recreational or Aboriginal fishery.

Design related impacts are permanent. The design of the riser, diffusers, diffuser manifold and associated riprap would displace surficial sands of the river bed. The long term impacts on the river bottom, however, would vary. The bed elevation of the river bed will vary dependent upon maintenance dredging of the adjacent navigation channel. At the minimum channel depth elevation, approximately 1100 m^2 of surficial sand on the river bed would be displaced. Approximately 4100 m^2 of surficial sand would be displaced at the maximum dredging depth for the navigation channel.

Impacts to surficial sand on the river bed, whether it be 1100 m^2, 4100 m^2, or some area in between, would not impair the life history stages of CRA fish such that the productivity of associated fisheries are affected. Affected habitat is represented throughout the Fraser River estuary, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island. The scale of impact on CRA fish is not of consequence, especially in consideration of the abundance of similar habitat available to such fish in proximity to the design location of the outfall.

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 impacts associated with the construction of the outfall would not substantively affect CRA fish.

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 this regard, impacts to CRA fish are adequately mitigated.

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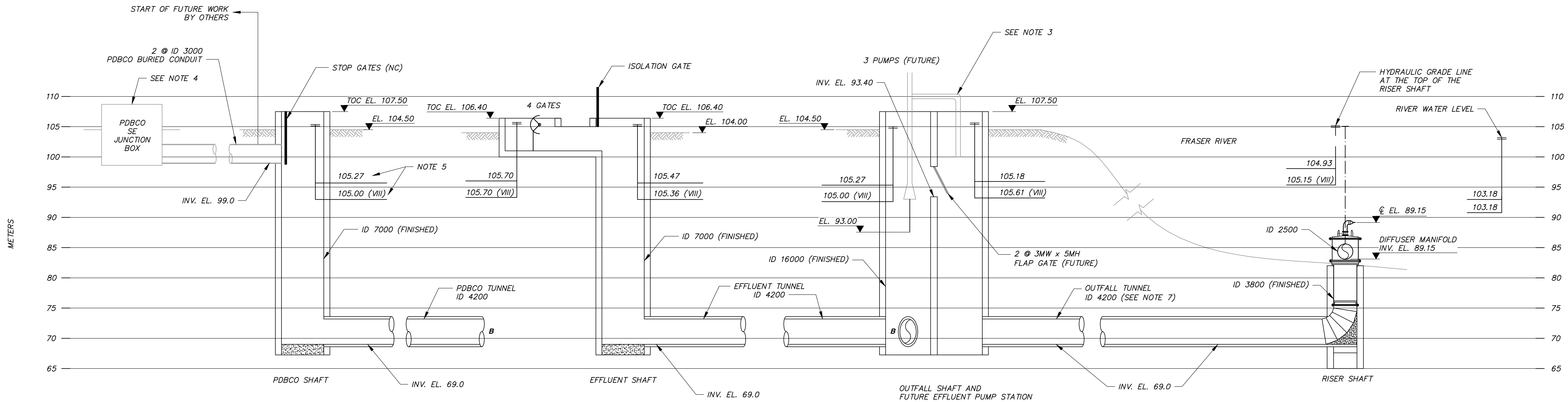
APPENDIX A
DESIGN DRAWINGS



HYDRAULIC PROFILE – NEW OUTFALL SYSTEM

NOTES:

1. ALL ELEVATIONS ARE IN METERS.
2. VERTICAL DATUM = CGVD28GVRD2005
3. FUTURE EFFLUENT PUMPS AND OUTFALL SHAFT FLAP GATE.
4. PDBCO BURIED CONDUIT CONSTRUCTION TO FOLLOW AFTER NOS UNDER SEPARATE CONSTRUCTION CONTRACT.
5. STATIC WATER LEVEL, NO FLOW THROUGH PDBCO.
6. TOC ELEVATIONS TO BE CONFIRMED DURING DETAILED DESIGN.
7. TUNNEL 3820mm STEEL LINER NOT SHOWN.

LEGEND:

WATER SURFACE ELEVATION IN METERS

XXX.XX ← STAGE V (18.9 CMS)

YYY.YY VIII ← STAGE VIII (25.3 CMS WITH PUMPING) (VIII)

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Canada
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P2	MAR. 2017	RM	VR	JNC	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	RM	VR	JNC	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

HYDRAULIC PROFILE
NEW OUTFALL SYSTEM

SCALE: NTS
DISTRICT FILE SF–1933
DRAWING NUMBER A10 X–G–001

SUPERSEDES PRINTS OF THIS DRAWING NUMBER WITH LETTERS PREVIOUS TO ➡ P2

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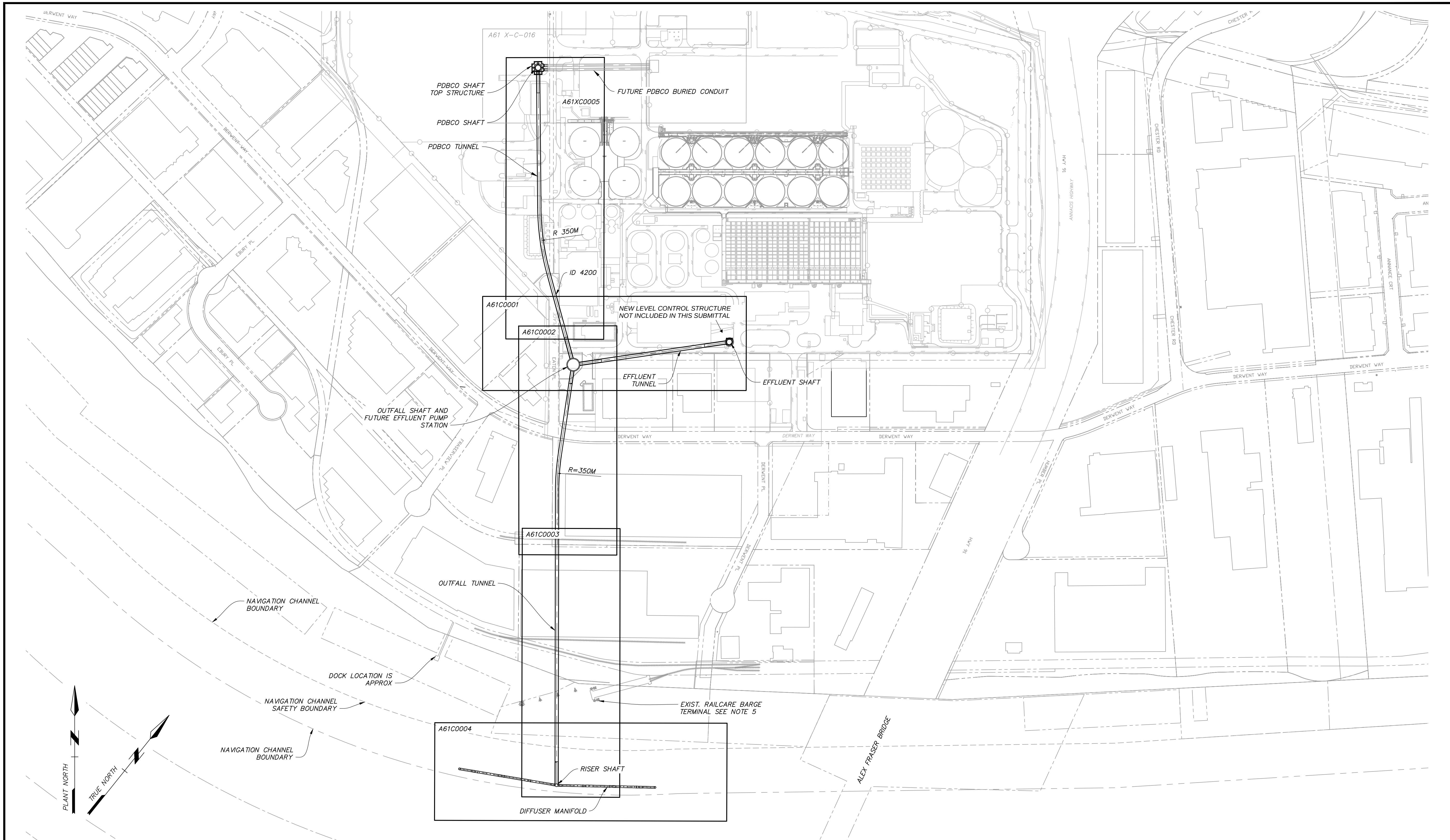

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P2	MAR. 2017	?	?	?	?	ISSUED FOR 60% DESIGN REVIEW
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A61–GENERAL SITE WORKS
SITE PLAN SHEET KEY MAP 2

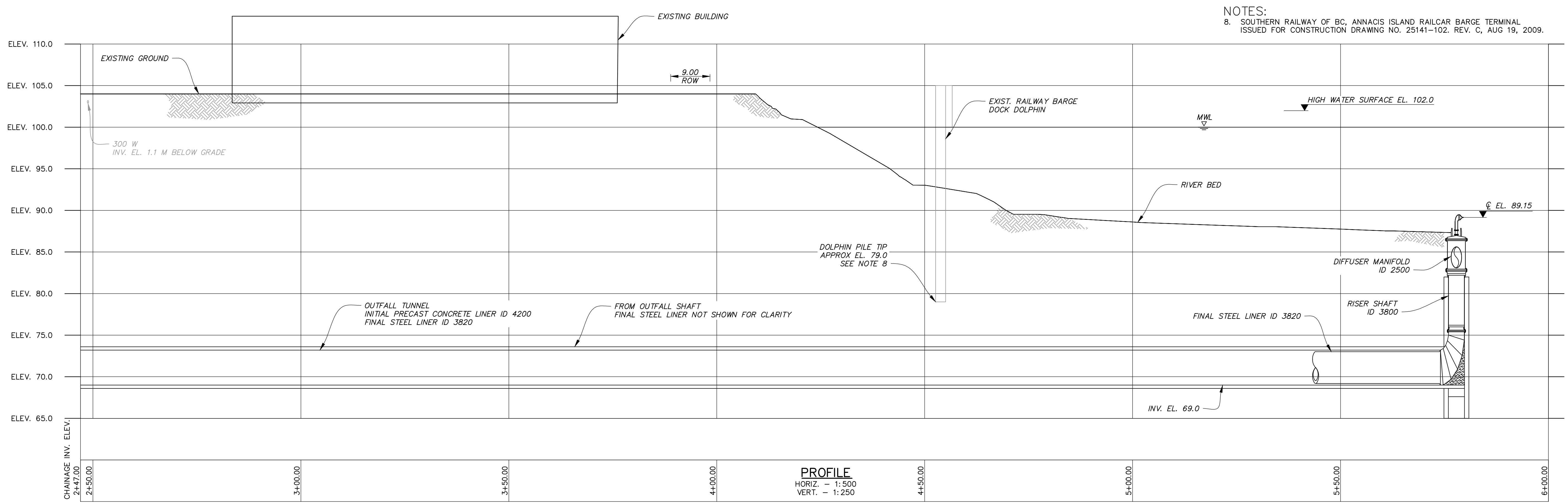
SCALE: 1:2500
DISTRICT FILE SF–1933
DRAWING NUMBER A61 X–C–001

SUPERSEDES PRINTS OF THIS DRAWING NUMBER WITH LETTERS PREVIOUS TO ➡ P2

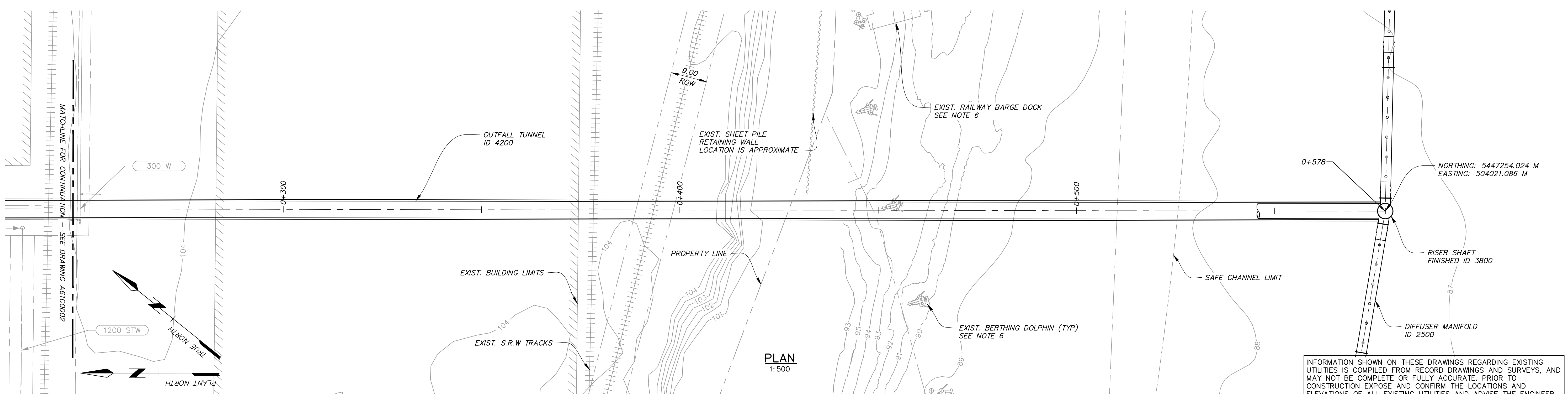
2017–03–06 14:24 Bilderbackce C:\cdmsmith\bilderbackce\d2522214\A61 X–C–001.dwg

xref files:

NOTES:
8. SOUTHERN RAILWAY OF BC, ANNACIS ISLAND RAILCAR BARGE TERMINAL ISSUED FOR CONSTRUCTION DRAWING NO. 25141-102. REV. C, AUG 19, 2009.



PROFILE
HORIZ. – 1:500
VERT. – 1:250



PLAN
1:500

INFORMATION SHOWN ON THESE DRAWINGS REGARDING EXISTING UTILITIES IS COMPILED FROM RECORD DRAWINGS AND SURVEYS, AND MAY NOT BE COMPLETE OR FULLY ACCURATE. PRIOR TO CONSTRUCTION EXPOSE AND CONFIRM THE LOCATIONS AND ELEVATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF ANY POTENTIAL CONFLICTS.

NOTES:
1. COORDINATES ARE UTM NAD83 ZONE 10 – 4.0.0.BC.1.GVRD GROUND UNITS. COMBINED SCALE FACTOR = 0.9996026.
2. ELEVATIONS ARE IN METERS AND REFER TO CVD28GVRD2005 GEODETIC DATUM. 100m HAS BEEN ADDED TO ALL ELEVATIONS AND TIED TO BENCHMARK 87H3501 (ELEV: 3.546'). TBM ELEV: 103.546'.
3. TOPOGRAPHICAL SURVEY PROVIDED BY PROTECH ON JANUARY 2013.
4. RIVER BOTTOM (BATHYMETRY ELEVATION IN TIDE & CHART DATUM (EL 0.00 GEODETIC=EL+1.59 TIDE & CHART). RIVER BATHYMETRY IS VARIABLE. CCG BATHYMETRY SURVEY DATA FROM JANUARY 2016.
5. NEW STRUCTURES AND DIFFUSER MANIFOLD PIPELINE ARE IN AIWWTP DATUM PER NOTE 2 ABOVE.
6. ANNACIS ISLAND RAILCAR BARGE TERMINAL LOCATION PER SOUTHERN RAILWAY BRITISH COLUMBIA DRAWING FILE 25141102, MAY 2009. LOCATION IS APPROXIMATE.
7. ALL LOCATIONS AND ELEVATIONS OF UTILITIES ARE APPROXIMATE. CONTRACTOR TO LOCATE, PROTECT, AND RELOCATE UTILITIES AS REQUIRED.

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P2	MAR. 2017	?	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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ANNACIS ISLAND WWTP
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CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

A61 – NOS
TUNNEL PLAN AND PROFILE 3

SCALE: AS NOTED
DISTRICT FILE SF–1933
DRAWING NUMBER A61C0003

SUPERSEDES PRINTS OF THIS DRAWING NUMBER WITH LETTERS PREVIOUS TO ➡ P2

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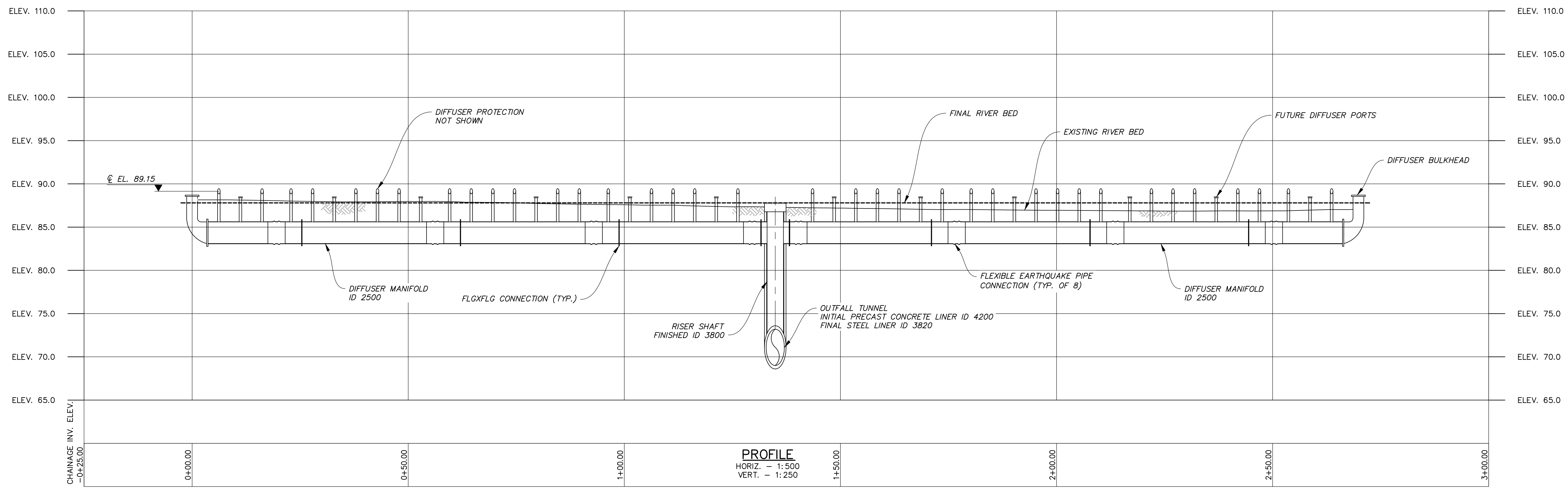
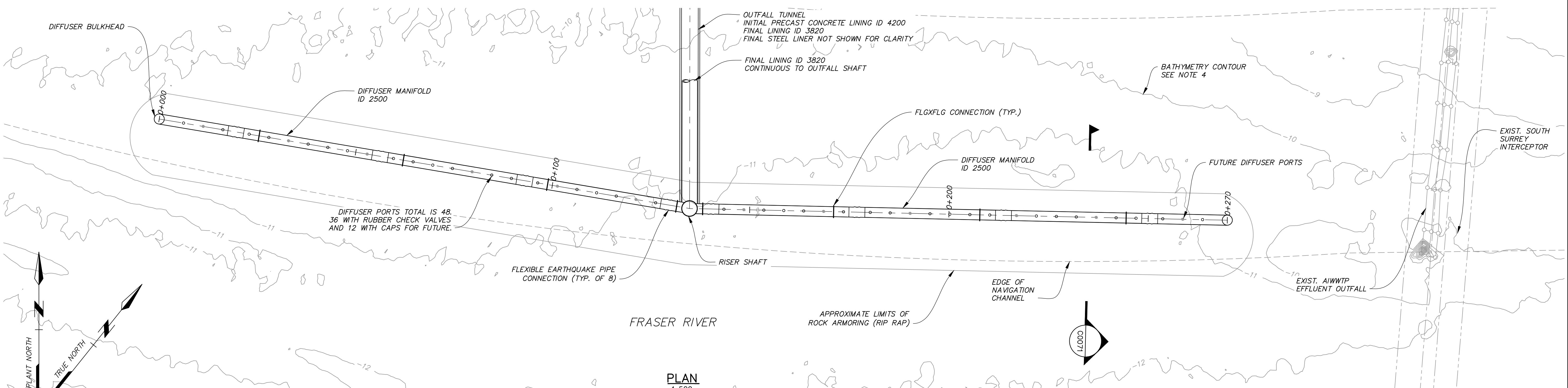


PROFILE
HORIZ. – 1:500
VERT. – 1:250



PLAN
1:500

NOTES:
1. COORDINATES ARE UTM NAD83 ZONE 10 – 4.0.0.BC.1.GVRD GROUND UNITS. COMBINED SCALE FACTOR = 0.9996026.
2. ELEVATIONS ARE IN METERS AND REFER TO CVD28GVRD2005 GEODETIC DATUM. 100m HAS BEEN ADDED TO ALL ELEVATIONS AND TIED TO BENCHMARK 87H3501 (ELEV: 3.546'). TBM ELEV: 103.546'.
3. TOPOGRAPHICAL SURVEY PROVIDED BY PROTECH ON JANUARY 2013.
4. RIVER BOTTOM (BATHYMETRY ELEVATION IN TIDE & CHART DATUM (EL 0.00 GEODETIC=EL+1.59 TIDE & CHART). RIVER BATHYMETRY IS VARIABLE. CCG BATHYMETRY SURVEY DATA FROM JANUARY 2016.
5. NEW STRUCTURES AND DIFFUSER MANIFOLD PIPELINE ARE IN AIWWTP DATUM PER NOTE 2 ABOVE.
6. ANNACIS ISLAND RAILCAR BARGE TERMINAL LOCATION PER SOUTHERN RAILWAY BRITISH COLUMBIA DRAWING FILE 25141102, MAY 2009. LOCATION IS APPROXIMATE.

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Issue	Date	Des'n	Dr'n	Chkd	App'd	Description
P2	MAR. 2017	?	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

A61 – NOS
TUNNEL PLAN AND PROFILE 4

SCALE: AS NOTED
DISTRICT FILE SF–1933
DRAWING NUMBER A61C0004

SUPERSEDES PRINTS OF THIS DRAWING NUMBER WITH LETTERS PREVIOUS TO ➡ P2

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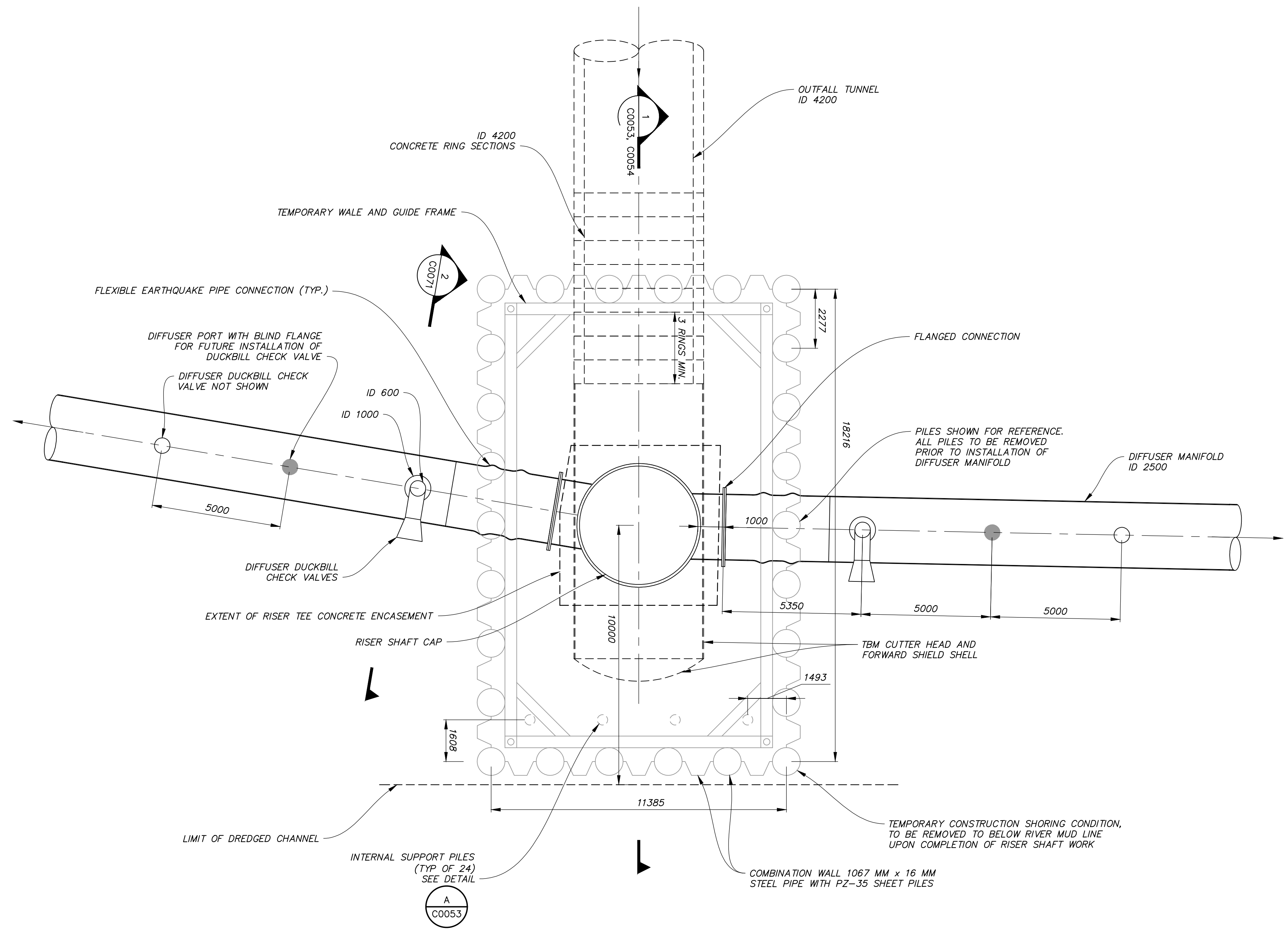
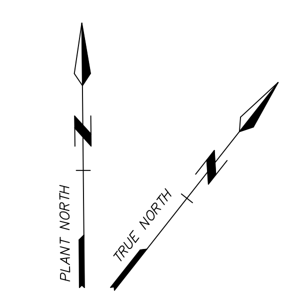
xref files:

NOTES:
1. CENTER TO CENTER SPACING BETWEEN TWO PORTS HAVING THE WAVE SHAPED FLEXIBLE PIPE FITTING IN BETWEEN THEM IS 6700 MM. SPACING BETWEEN ALL OTHER PORTS IS 5000 MM.



RISER SHAFT PLAN
1:100



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P2	MAR. 2017	?	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

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ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

A61 – NOS
RISER SHAFT PLAN
TOP LEVEL

SCALE: 1:100
DISTRICT FILE SF–1933
DRAWING NUMBER A61C0052

SUPERSEDES PRINTS OF THIS DRAWING NUMBER WITH LETTERS PREVIOUS TO ➡ P2

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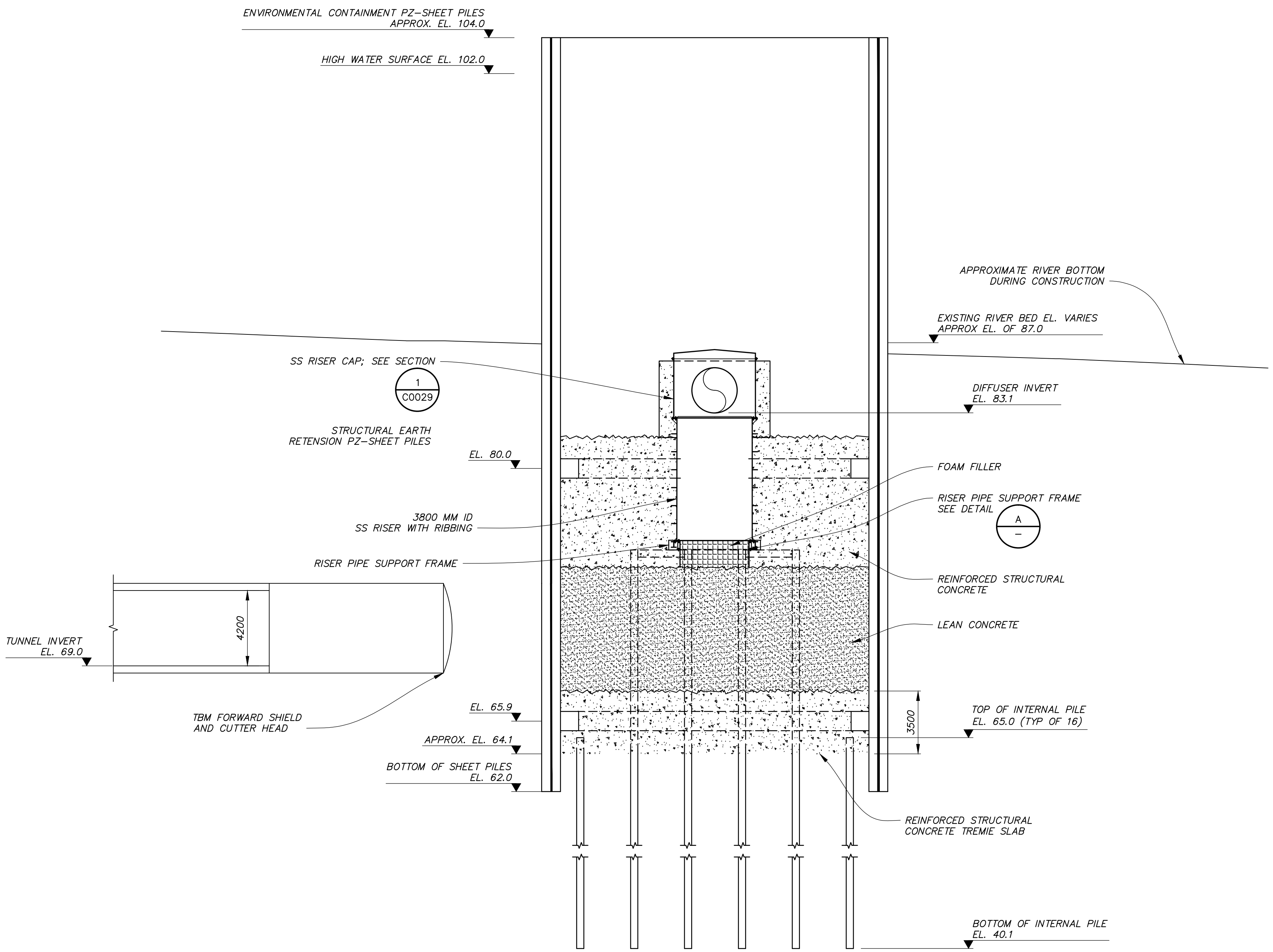

INITIAL TEMPORARY CONDITIONS

SECTION 1 / C0052
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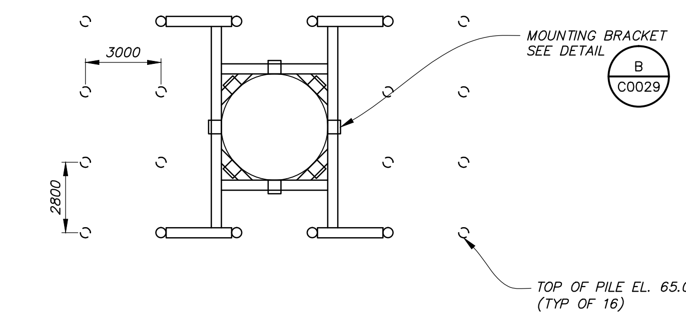

OPTIONAL RISER PIPE SUPPORT

DETAIL A / –
1:150

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Issue	Date	Des'n	Dr'n	Chkd	App'd	Description
P2	MAR. 2017	DAW	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

Design: INT.
Drawn: INT.
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ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

RISER SHAFT
INITIAL TEMPORARY CONDITIONS

SCALE: 1:150
DISTRICT FILE SF–1933
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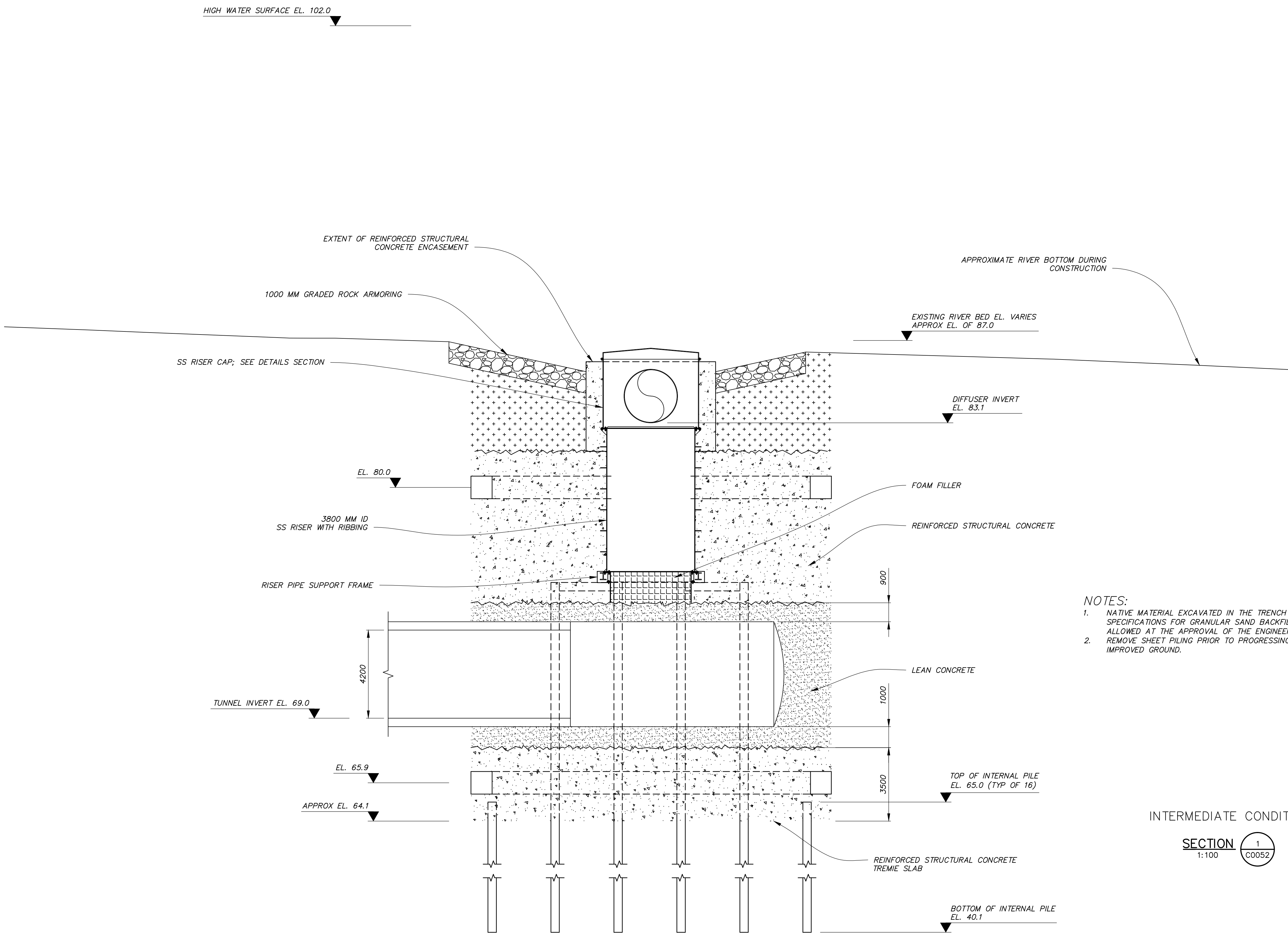

NOTES:
1. NATIVE MATERIAL EXCAVATED IN THE TRENCH MEETING THE SPECIFICATIONS FOR GRANULAR SAND BACKFILL MAY BE ALLOWED AT THE APPROVAL OF THE ENGINEER.
2. REMOVE SHEET PILING PRIOR TO PROGRESSING THE TBM INTO IMPROVED GROUND.

INTERMEDIATE CONDITIONS

SECTION 1 / C0052
1:100

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Issue	Date	Des'n	Dr'n	Chkd	App'd	Description
P2	MAR. 2017	DAW	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

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Checked: INT.
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ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

RISER SHAFT
INTERMEDIATE CONDITIONS

SCALE: 1:100
DISTRICT FILE SF–1933
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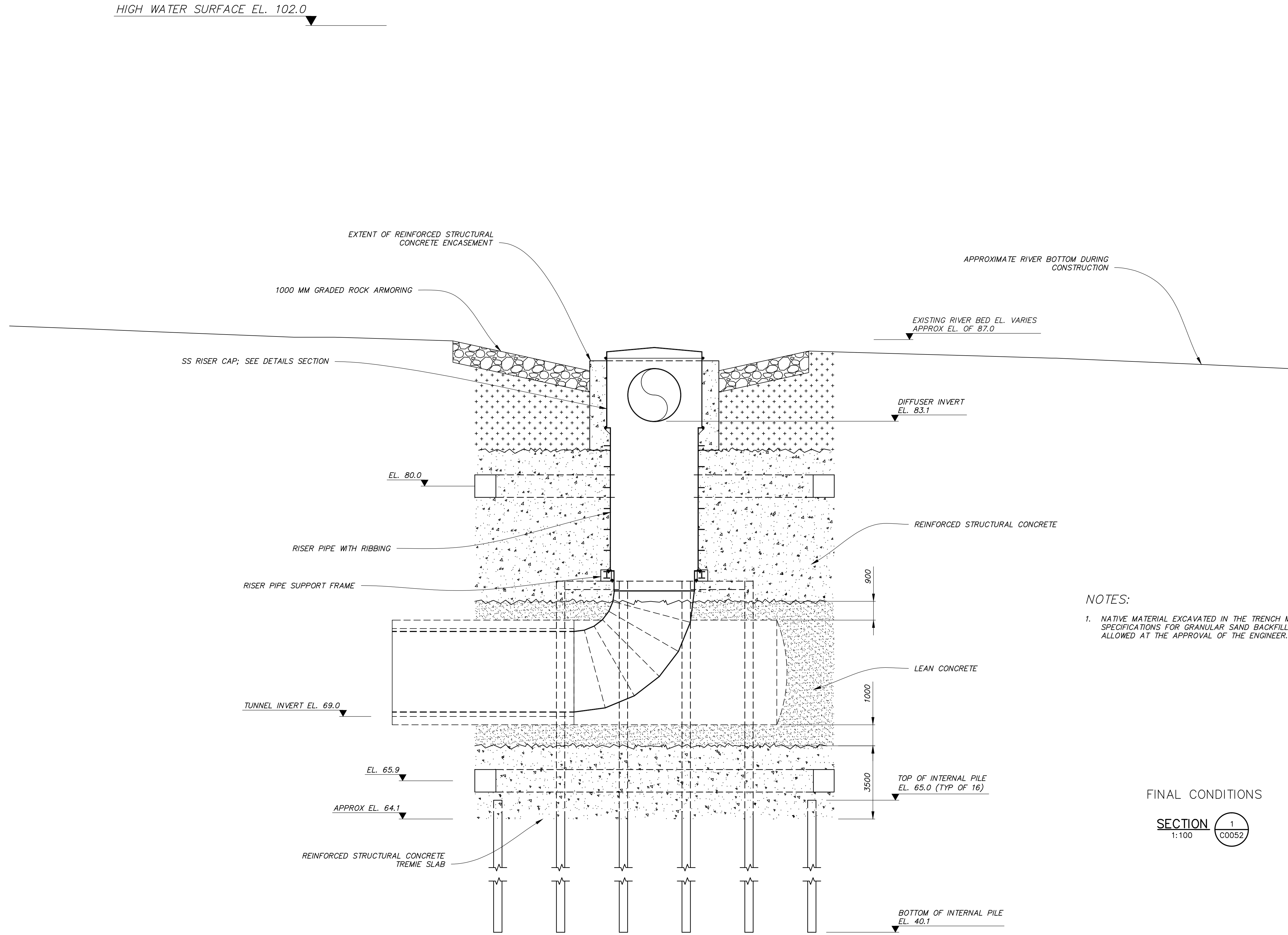

NOTES:

1. NATIVE MATERIAL EXCAVATED IN THE TRENCH MEETING THE SPECIFICATIONS FOR GRANULAR SAND BACKFILL MAY BE ALLOWED AT THE APPROVAL OF THE ENGINEER.

FINAL CONDITIONS

SECTION 1 / C0052
1:100

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Professional Seal

Issue	Date	Des'n	Dr'n	Chkd	App'd	Description
P2	MAR. 2017	DAW	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

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Drawn: INT.
Checked: INT.
INT. Approved
INT. Manager

ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

RISER SHAFT
FINAL CONDITIONS

SCALE: 1:100
DISTRICT FILE SF–1933
DRAWING NUMBER A61C0055

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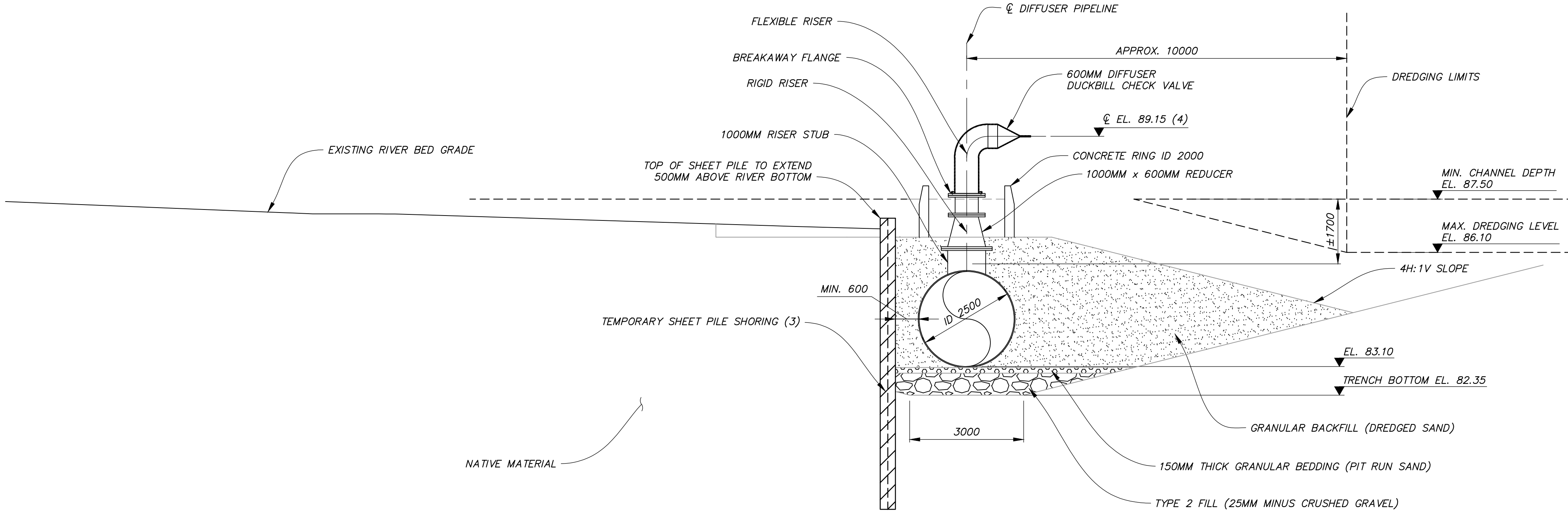
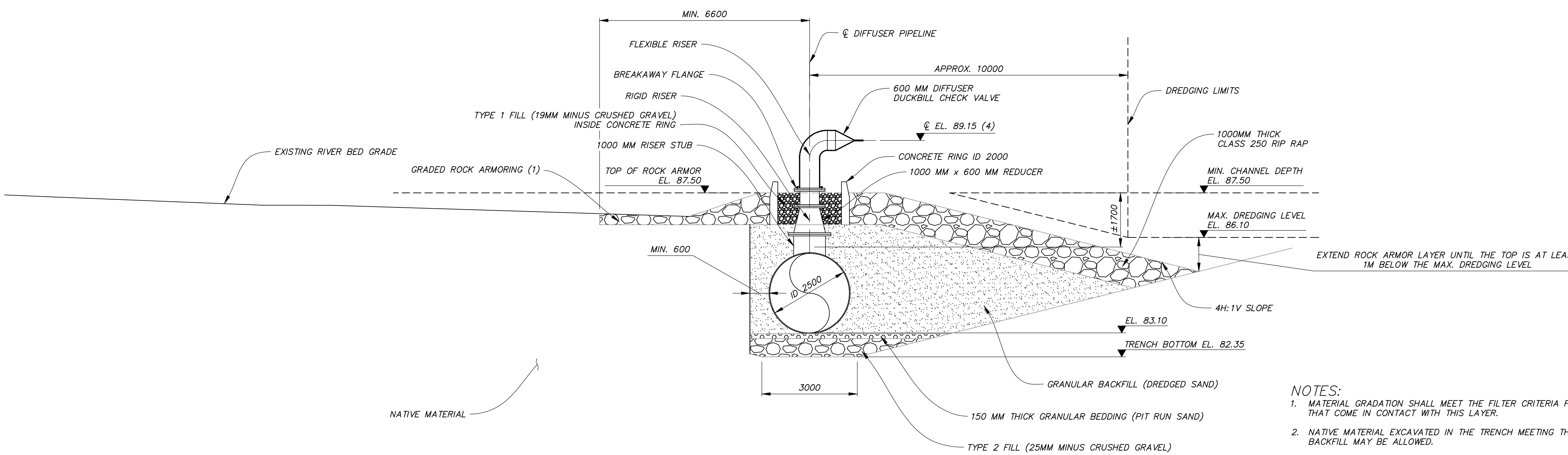


DIFFUSER MANIFOLD SECTION – TEMPORARY SHORING CONDITIONS

SECTION 2A / C0052
1:75



DIFFUSER MANIFOLD SECTION – INSTALLED CONDITIONS

SECTION 2B / C0052
1:75

NOTES:

1. MATERIAL GRADATION SHALL MEET THE FILTER CRITERIA FOR THE NATIVE AND IMPORTED MATERIALS THAT COME IN CONTACT WITH THIS LAYER.
2. NATIVE MATERIAL EXCAVATED IN THE TRENCH MEETING THE SPECIFICATIONS FOR GRANULAR SAND BACKFILL MAY BE ALLOWED.
3. TEMPORARY SHEET PILE SHORING MAY BE USED ON ONE OR BOTH SIDES OF THE DIFFUSER MANIFOLD PIPE TO REDUCE DREDGING VOLUME. SHEET PILES MUST BE REMOVED FOLLOWING INSTALLATION AND BACKFILL OF THE DIFFUSER MANIFOLD AND BEFORE PLACEMENT OF THE ARMOR ROCK AND PRE-CAST CONCRETE RINGS.
4. ALL DIFFUSER DUCKBILL CHECK VALVES SHALL BE INSTALLED TO THE SAME ELEVATION.

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Professional Seal

Issue	Date	Des'n	Dr'n	Chk'd	App'd	Description
P2	MAR. 2017	?	?	?	?	ISSUED FOR 60% DESIGN REVIEW
P1	AUG. 2016	?	?	?	?	ISSUED FOR PRELIMINARY DESIGN REVIEW

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GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

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Checked: INT.
Approved: INT.
Manager: INT.

ANNACIS ISLAND WWTP
TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

DIFFUSER MANIFOLD SECTION

SCALE: 1:75
DISTRICT FILE SF–1933
DRAWING NUMBER A61C0071

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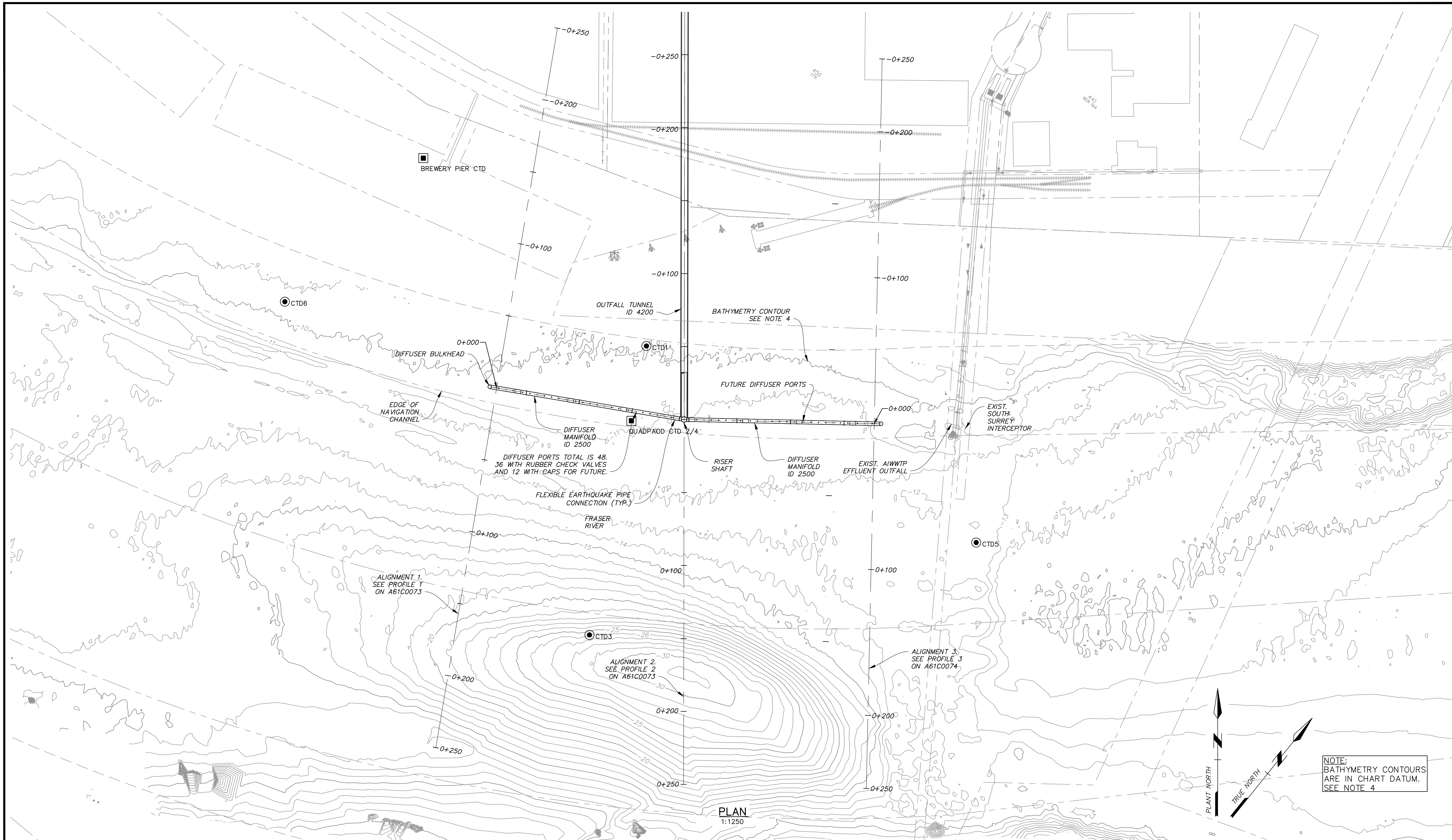

PLAN
1:1250

NOTES:

1. COORDINATES ARE UTM NAD83 ZONE 10 – 4.0.0.BC.1.GVRD GROUND UNITS. COMBINED SCALE FACTOR = 0.9996026.
2. ELEVATIONS ARE IN METERS AND REFER TO CVD28GVRD2005 GEODETIC DATUM. 100m HAS BEEN ADDED TO ALL ELEVATIONS AND TIED TO BENCHMARK 87H3501 (ELEV: 3.546'). TBM ELEV: 103.546'.
3. TOPOGRAPHICAL SURVEY PROVIDED BY PROTECH ON JANUARY 2013.
4. RIVER BOTTOM (BATHYMETRY ELEVATION IN TIDE & CHART DATUM (EL 0.00 GEODETIC=EL+1.59 TIDE & CHART). RIVER BATHYMETRY IS VARIABLE. CCG BATHYMETRY SURVEY DATA FROM JANUARY 2016.
5. NEW STRUCTURES AND DIFFUSER MANIFOLD PIPELINE ARE IN AIWWTP DATUM PER NOTE 2 ABOVE.
6. ANNACIS ISLAND RAILCAR BARGE TERMINAL LOCATION PER SOUTHERN RAILWAY BRITISH COLUMBIA DRAWING FILE 25141102, MAY 2009. LOCATION IS APPROXIMATE.

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A61 – NOS
DIFFUSER MANIFOLD PLAN

SCALE: 1:1250

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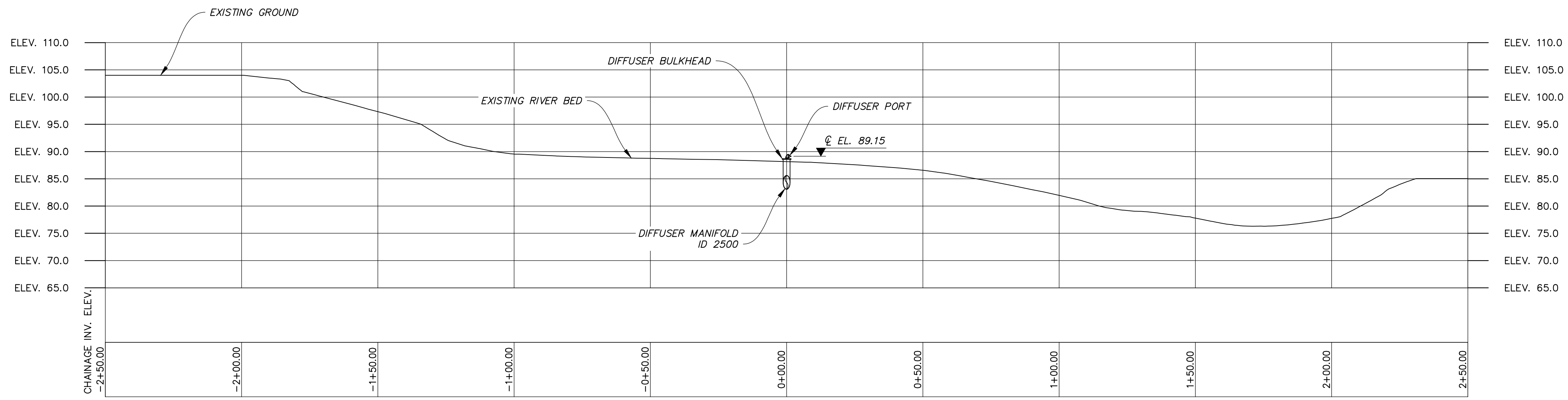
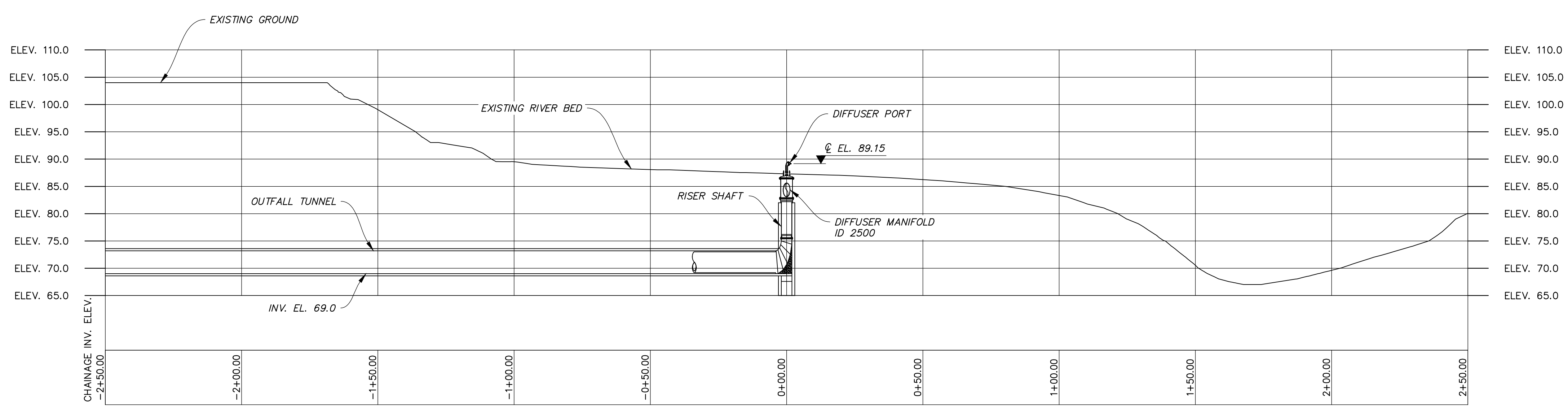


RIVER BED PROFILE 1
HORIZ. – 1:1000
VERT. – 1:500



RIVER BED PROFILE 2
HORIZ. – 1:1000
VERT. – 1:500

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Approved
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Manager

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TRANSIENT MITIGATION AND OUTFALL
CONTRACT XXXX – NEW OUTFALL SYSTEM
PACKAGE 5

A61 – NOS
EXISTING RIVER BED PROFILE AT DIFFUSER MANIFOLD SECTIONS 1 OF 2

SCALE: AS NOTED
DISTRICT FILE SF–1933
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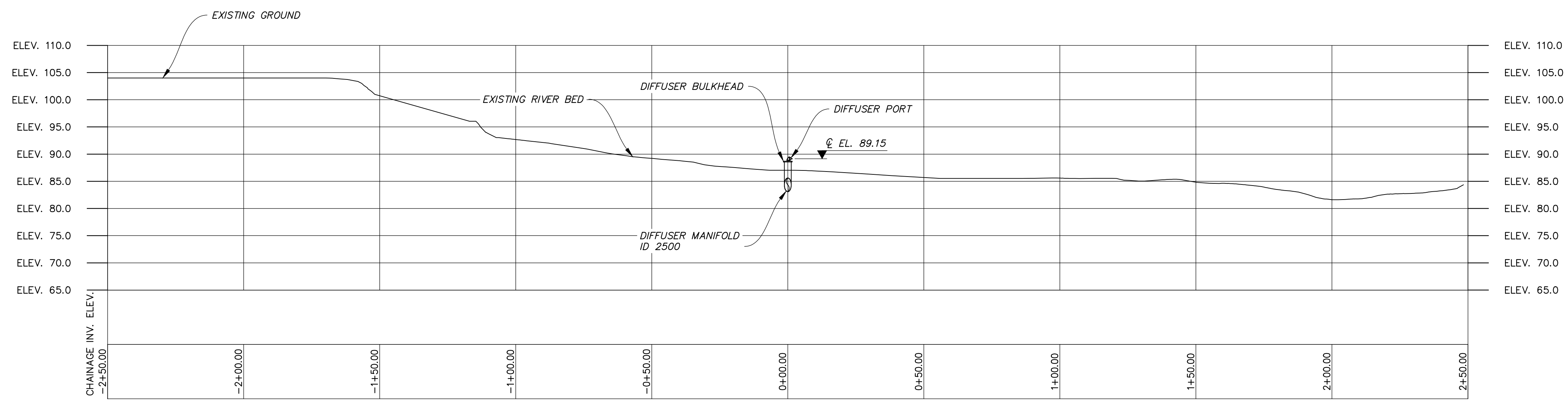

RIVER BED PROFILE 3
HORIZ. – 1:1000
VERT. – 1:500

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INT. Approved
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PACKAGE 5

A61 – NOS
EXISTING RIVER BED PROFILE AT DIFFUSER MANIFOLD SECTIONS 2 OF 2

SCALE: AS NOTED
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APPENDIX B
BEST MANAGEMENT PRACTICES

Canada

Fisheries and Oceans Canada

Home → Projects near water → Measures to Avoid Causing Harm

Measures to Avoid Causing Harm to Fish and Fish Habitat

If you are conducting a project near water, it is your responsibility to ensure you avoid causing serious harm to fish in compliance with the Fisheries Act. The following advice will help you avoid causing harm and comply with the *Act*.

PLEASE NOTE: This advice applies to all project types and replaces all "Operational Statements" previously produced by DFO for different project types in all regions.

Measures

▼ Project Planning

▼ Timing

- Time work in water to respect timing windows to protect fish, including their eggs, juveniles, spawning adults and/or the organisms upon which they feed.
- Minimize duration of in-water work.
- Conduct instream work during periods of low flow, or at low tide, to further reduce the risk to fish and their habitat or to allow work in water to be isolated from flows.
- Schedule work to avoid wet, windy and rainy periods that may increase erosion and sedimentation.

▼ Site Selection

- Design and plan activities and works in waterbody such that loss or disturbance to aquatic habitat is minimized and sensitive spawning habitats are avoided.
- Design and construct approaches to the waterbody such that they are perpendicular to the watercourse to minimize loss or disturbance to riparian vegetation.
- Avoid building structures on meander bends, braided streams, alluvial fans, active floodplains or any other area that is inherently unstable and may result in erosion and scouring of the stream bed or the built structures.
- Undertake all instream activities in isolation of open or flowing water to maintain the natural flow of water downstream and avoid introducing sediment into the watercourse.

▼ Contaminant and Spill Management

- Plan activities near water such that materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, or other chemicals do not enter the watercourse.
- Develop a response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit on site.
- Ensure that building material used in a watercourse has been handled and treated in a manner to prevent the release or leaching of substances into the water that may be deleterious to fish.

▼ Erosion and Sediment Control

- Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the project. Erosion and sediment control measures should be maintained until all disturbed ground has been permanently stabilized, suspended sediment has resettled to the bed of the waterbody or settling basin and runoff water is clear. The plan should, where applicable, include:
  - Installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body.
  - Measures for managing water flowing onto the site, as well as water being pumped/diverted from the site such that sediment is filtered out prior to the water entering a waterbody. For example, pumping/diversion of water to a vegetated area, construction of a settling basin or other filtration system.
  - Site isolation measures (e.g., silt boom or silt curtain) for containing suspended sediment where in-water work is required (e.g., dredging, underwater cable installation).

- Measures for containing and stabilizing waste material (e.g., dredging spoils, construction waste and materials, commercial logging waste, uprooted or cut aquatic plants, accumulated debris) above the high water mark of nearby waterbodies to prevent re-entry.
- Regular inspection and maintenance of erosion and sediment control measures and structures during the course of construction.
- Repairs to erosion and sediment control measures and structures if damage occurs.
- Removal of non-biodegradable erosion and sediment control materials once site is stabilized.

▼ Shoreline Re-vegetation and Stabilization

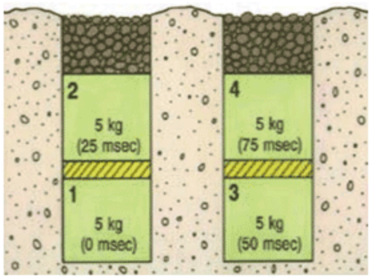
- Clearing of riparian vegetation should be kept to a minimum: use existing trails, roads or cut lines wherever possible to avoid disturbance to the riparian vegetation and prevent soil compaction. When practicable, prune or top the vegetation instead of grubbing/uprooting.
- Minimize the removal of natural woody debris, rocks, sand or other materials from the banks, the shoreline or the bed of the waterbody below the ordinary high water mark. If material is removed from the waterbody, set it aside and return it to the original location once construction activities are completed.
- Immediately stabilize shoreline or banks disturbed by any activity associated with the project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site.
- Restore bed and banks of the waterbody to their original contour and gradient; if the original gradient cannot be restored due to instability, a stable gradient that does not obstruct fish passage should be restored.
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, then ensure that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Remove all construction materials from site upon project completion.

▼ Fish Protection

- Ensure that all in-water activities, or associated in-water structures, do not interfere with fish passage, constrict the channel width, or reduce flows.
- Retain a qualified environmental professional to ensure applicable permits for relocating fish are obtained and to capture any fish trapped within an isolated/enclosed area at the work site and safely relocate them to an appropriate location in the same waters. Fish may need to be relocated again, should flooding occur on the site.
- Screen any water intakes or outlet pipes to prevent entrainment or impingement of fish. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself.
  - In freshwater, follow these measures for design and installation of intake end of pipe fish screens to protect fish where water is extracted from fish-bearing waters:
    - Screens should be located in areas and depths of water with low concentrations of fish throughout the year.
    - Screens should be located away from natural or artificial structures that may attract fish that are migrating, spawning, or in rearing habitat.
    - The screen face should be oriented in the same direction as the flow.
    - Ensure openings in the guides and seals are less than the opening criteria to make “fish tight”.
    - Screens should be located a minimum of 300 mm (12 in.) above the bottom of the watercourse to prevent entrainment of sediment and aquatic organisms associated with the bottom area.
    - Structural support should be provided to the screen panels to prevent sagging and collapse of the screen.
    - Large cylindrical and box-type screens should have a manifold installed in them to ensure even water velocity distribution across the screen surface. The ends of the structure should be made out of solid materials and the end of the manifold capped.
    - Heavier cages or trash racks can be fabricated out of bar or grating to protect the finer fish screen, especially where there is debris loading (woody material, leaves, algae mats, etc.). A 150 mm (6 in.) spacing between bars is typical.
    - Provision should be made for the removal, inspection, and cleaning of screens.
    - Ensure regular maintenance and repair of cleaning apparatus, seals, and screens is carried out to prevent debris-fouling and impingement of fish.
    - Pumps should be shut down when fish screens are removed for inspection and cleaning.
- Avoid using explosives in or near water. Use of explosives in or near water produces shock waves that can damage a fish swim bladder and rupture internal organs. Blasting vibrations may also kill or damage fish eggs or larvae.
  - If explosives are required as part of a project (e.g., removal of structures such as piers, pilings, footings; removal of obstructions such as beaver dams; or preparation of a river or lake bottom for installation of a structure such as a dam or water intake), the potential for impacts to fish and fish habitat should be minimized by implementing the following measures:
    - Time in-water work requiring the use of explosives to prevent disruption of vulnerable fish life stages, including eggs and larvae, by adhering to appropriate fisheries timing windows.
    - Isolate the work site to exclude fish from within the blast area by using bubble/air curtains (i.e., a column of bubbled water extending from the substrate to the water surface as generated by forcing large volumes of air through a perforated pipe/hose), cofferdams or aquadams.
    - Remove any fish trapped within the isolated area and release unharmed beyond the blast area prior to initiating blasting
    - Minimize blast charge weights used and subdivide each charge into a series of smaller charges in blast holes (i.e., decking) with a minimum 25 millisecond (1/1000 seconds) delay between charge detonations (see Figure 1).
    - Back-fill blast holes (stemmed) with sand or gravel to grade or to streambed/water interface to confine the blast.

- Place blasting mats over top of holes to minimize scattering of blast debris around the area.
- Do not use ammonium nitrate based explosives in or near water due to the production of toxic by-products.
- Remove all blasting debris and other associated equipment/products from the blast area.

Figure 1: Sample Blasting Arrangement



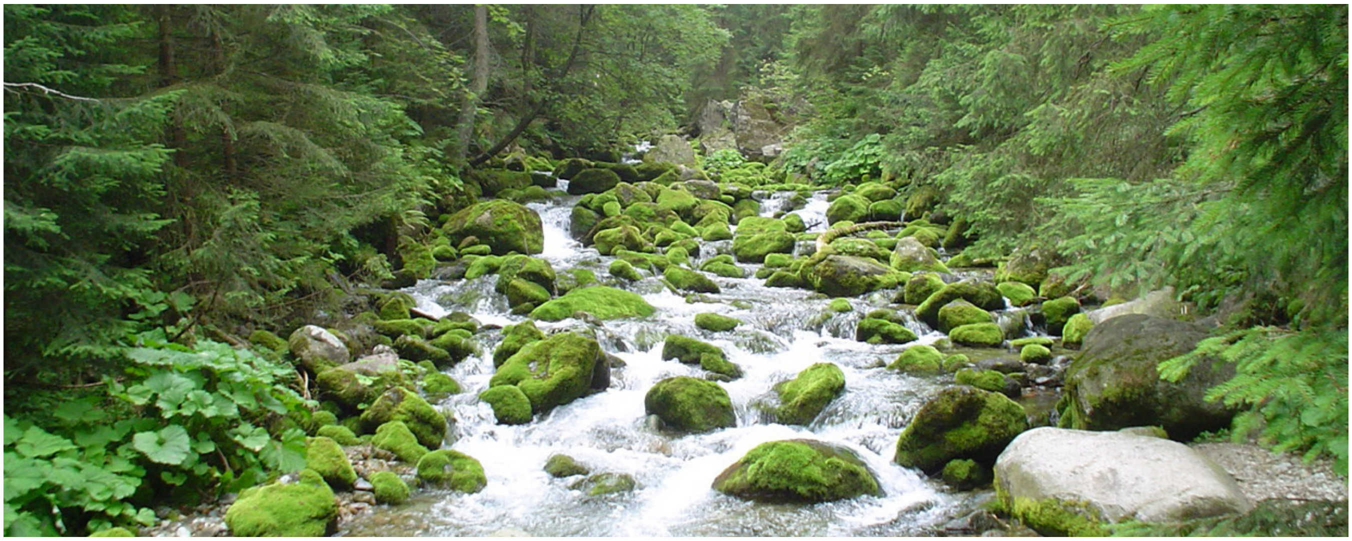
Per Fig. 1: 20 kg total weight of charge; 25 msecs delay between charges and blast holes; and decking of charges within holes.

▼ Operation of Machinery

- Ensure that machinery arrives on site in a clean condition and is maintained free of fluid leaks, invasive species and noxious weeds.
- Whenever possible, operate machinery on land above the high water mark, on ice, or from a floating barge in a manner that minimizes disturbance to the banks and bed of the waterbody.
- Limit machinery fording of the watercourse to a one-time event (i.e., over and back), and only if no alternative crossing method is available. If repeated crossings of the watercourse are required, construct a temporary crossing structure.
- Use temporary crossing structures or other practices to cross streams or waterbodies with steep and highly erodible (e.g., dominated by organic materials and silts) banks and beds. For fording equipment without a temporary crossing structure, use stream bank and bed protection methods (e.g., swamp mats, pads) if minor rutting is likely to occur during fording.
- Wash, refuel and service machinery and store fuel and other materials for the machinery in such a way as to prevent any deleterious substances from entering the water.

Date modified:
2013-11-25

Standards and Best Practices for Instream Works



General BMPs & Standard Project Considerations

Version 1.0

Other Guides in this Series

- **Users Guide**
- **Bank Stabilization**
- **Beaver Dam Removal**
- **Bridges**
- **Channel Maintenance**
- **Culverts**
- **Habitat Enhancement & Restoration**
- **Miscellaneous Works**
- **Pipeline Crossings**
- **Public Utility Works**
- **Urban Stormwater Management**
- **Wharf, Pier, Dock, Boathouse & Mooring**

Supporting Documents

- **General BMPs & Standard Project Considerations**
- **Regional Timing Windows**
- **Contact List**
  B.C. Ministry of Environment Contacts
  Fisheries and Oceans Canada (DFO) Contacts
- **Glossary**
- **MOE/DFO Notification, Approval & Authorization Instructions & Forms**

You have accessed this document to obtain further information on General Best Management Practices (BMPs). If your project involves any work in and about a stream, you will need to ensure that you:

- apply the appropriate General BMPs to fulfill the *Water Act* Regulation's Protection of Habitat Section 42(1) and Protection of Water Quality (Section 41) Standards; and,
- understand the federal *Fisheries Act* and ensure that you are in compliance with Section 35 of the *Act* which prohibits the Harmful Alteration, Disruption or Destruction (HADD) of fish habitat and Section 36 of the *Act* which prohibits the release of deleterious substances to a watercourse. Every effort should be made to incorporate applicable Regional Operational Statements into your project. Operational Statements outline measures and conditions for avoiding HADDs to fish habitat and thus allow works to proceed in compliance with subsection 35(1) of the *Fisheries Act*.

BRITISH COLUMBIA
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Fisheries and Oceans Canada
Pêches et Océans Canada

General Operational Best Practices

General BMPs detailed below provide Best Management Practices for any project undertaken in and about a stream. General BMPs have been organized into eleven (11) work-site categories and, if applicable, should be incorporated into your project:

1. qualified professionals (QPs);
2. monitoring;
3. timing of works (work windows);
4. deleterious substance control/spill management;
5. concrete works;
6. isolation of the work area;
7. salvage of fish and/or wildlife;
8. erosion & sediment control;
9. vegetation (riparian) management;
10. site restoration; and,
11. temporary diversion.

1. Qualified Professionals (QPs)

In order to assess and manage your project correctly it is strongly advised that you consult an appropriately Qualified Professional (QP) or team of professionals, depending on the scale and scope of your project.

Ensure that the assessment and design of your project completed by the professional considers the following:

GBP01	location of stream within the watershed, stream type and stream order;
GBP02	seasonal variations in stream flow (perennial, intermittent or ephemeral stream);
GBP03	local soil characteristics, composition and stability;
GBP04	compliance with the fedaral *Species at Risk Act* and provincial Red and Blue lists;
GBP05	existing or potential fish and wildlife use, aquatic and riparian habitat;
GBP06	access-related disturbances from machinery or other equipment (if required);
GBP07	existing bank morphology and potential impacts or changes to the channel;
GBP08	site erosion dynamics;

GBP09 potential **erosion** or sediment movement resulting from proposed works. Local currents and associated patterns of sediment transport, deposition, local shoreline and accretion dynamics should be considered in lake settings;

GBP10 stabilization techniques (e.g. vegetated or integrated) for implementation to prevent **Harmful Alteration, Disruption or Destruction (HADD)** of fish habitat through the release of **deleterious** substances (see **General BMPs and Standard Project Considerations: Erosion and Sediment section**);

GBP11 habitat features, such as planting of native vegetation ecologically suited to the site conditions (i.e., suited to the **biogeoclimatic subzone** and **site series**) above the **high water mark (HWM)**;

GBP12 use of natural materials, such as live vegetation and, where required, natural **acid free rock**;

GBP13 use of native shrubs, live stakes or live bundles techniques into proposed rockwork, together with sufficient rooting soil to ensure vegetation growth and survival;

GBP14 maintenance of existing wildlife access to the watercourse;

GBP15 prevention of anthropogenic material use (e.g. broken concrete, tires and other materials);

GBP16 design and/or locate the project to minimize the project works **footprint** and associated **foreshore** disturbance;

GBP17 addressing prevention of spread or colonization of **invasive species**;

GBP18 avoidance of impacts to other properties or services;

2. Monitoring

GBP19 construction activities for your project should be monitored full-time during start-up through to project completion for works including instream activities, sensitive activities (e.g. **fish salvage**) and any other construction activities;

GBP20 use of a qualified **environmental monitor**, who is an appropriately **qualified professional** and is provided with written authority to modify or halt any construction activity if it is deemed necessary to do so for the protection of fish and wildlife populations or their habitats;

GBP21 post a sign at the entrance to your job site or in the immediate vicinity listing the monitor's name, affiliation and phone number;

GBP22 a copy of the section of this document listing the Standards and Best Practices for your works and all appropriate plans, drawings, and documents should be provided to contractors and crew supervisor. This information should be readily available on-site while your work is proceeding;

GBP23 a pre-construction meeting should be held that includes the **environmental monitor** and persons undertaking work on-site to ensure a common understanding of the Best Practices for the project, safety, responsibilities reporting, Response Plans, etc;

GBP24 complete and submit a Monitoring Report from the project **environmental monitor**, if required, within 60 days of project completion to the authority (e.g. municipality, DFO and/or MOE) requesting monitoring be conducted;

3. Timing of Works

GBP25 where fish or **Species at Risk** are present, schedule works during reduced risk **Regional Timing Windows**. If absence cannot be definitively confirmed, complete in-channel or bank work during reduced risk **Regional Timing Windows** as identified by the Ministry and DFO;

GBP26 protect nesting birds by only clearing vegetation for worksite access during **Regional Timing Windows**;

GBP27 avoid in-channel work wherever possible when the presence of **species at risk** are known or expected, as **species at risk** typically have no window of reduced threat;

GBP28 undertake works during favourable weather and low water conditions to minimize impacts to the watercourse and prevent release of **deleterious** substances to a watercourse and **Harmful Alteration, Disruption or Destruction (HADD)** of fish habitat;

GBP29 avoid work during wet and rainy periods to prevent release of **deleterious** substances to a watercourse and **Harmful Alteration, Disruption or Destruction (HADD)** of fish habitat;

GBP30 complete works as quickly as possible once they are started to minimize impacts and disturbance to fish and wildlife species;

4. Deleterious Substance Control/Spill Management

GBP31 prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other **deleterious substances** into any ditch, watercourse, ravine, or storm sewer system. Consult DFO's **Land Development Guidelines for the Protection of Aquatic Habitat**, MOE's **Develop with Care** and **General BMPs and Standard Project Considerations: Erosion and Sediment Control** section of this document for sediment and erosion control management measures;

GBP32 ensure that equipment and machinery are in good operating condition, clean (power washed), free of leaks, excess oil, and grease. Do not refuel or service equipment within 30 m of any watercourse or surface water drainage;

GBP33 ensure hydraulic machinery, if required, uses environmentally-sensitive hydraulic fluids that are non-toxic to aquatic life and that are readily or inherently biodegradable;

GBP34 keep a **Spill Containment Kit** readily accessible onsite in the event of a release of a **deleterious substance** to the environment and ensure on-site staff are trained in spill response. Immediately report any spill of a substance of reportable quantities that is toxic, polluting, or deleterious to aquatic life to the ***Provincial Emergency Program*** Environmental Emergency Management Plan Incident Reporting Hotline **1-800-663-3456** and DFO's Observe, Record and Report Hotline **1-800-465-4336**;

GBP35 do not use treated wood products in any construction areas near the stream channel, to prevent the release of preservatives that are toxic to fish (see DFOs **Guidelines to Protect Fish and Fish Habitat from Treated Wood Used in Aquatic Environments** for further information);

5. Concrete Works

GBP36 to prevent release of **deleterious** substances ensure that all works involving the use of concrete, cement, mortars, and/or other Portland cement or lime-containing construction materials will not deposit (directly or indirectly) sediments, debris, concrete, leachate concrete fines, wash or contact water into or about any watercourse;

GBP37 cast in place concrete must remain isolated from water inside sealed formed structures until cured (approximately 48-72 hours), as concrete leachate is highly toxic to fish and other aquatic life;

GBP38 ensure a carbon dioxide (CO_2) tank with regulator, hose and gas diffuser is readily available during concrete work to neutralize pH levels should a spill occur. Staff must be trained in its proper use;

GBP39 provide containment facilities for wash-down water from concrete delivery trucks, concrete pumping equipment, and other tools and equipment;

GBP40 immediately report any spills of sediments, debris, concrete fines, wash or contact water of reportable quantities to the **Provincial Emergency Program** Environmental Emergency Management Plan Incident Reporting Hotline **1-800-663-3456** and DFO's Observe, Record and Report Hotline **1-800-465-4336**. Implement emergency mitigation and clean-up measures (such as use of CO_2 and immediate removal of the material);

GBP41 monitor pH frequently in the watercourse immediately downstream of the isolated worksite until the works are completed. Emergency measures should be implemented if downstream pH has changed more than 1.0 pH unit, measured to an accuracy of +/- 0.2 pH units from the background level, or is below 6.0 or above 9.0 pH units;

GBP42 prevent any water that contacts **deleterious** uncured or partly cured concrete (during activities like exposed aggregate wash-off, wet curing, or equipment washing) from directly or indirectly entering any watercourse or stormwater system;

GBP43 isolate and hold any water that contacts uncured or partly cured concrete until the pH is between 6.5 and 8.0 pH units and the turbidity is less than 25 nephelometric turbidity units (NTU), measured to an accuracy of +/- 2 NTU;

6. Isolation of the Work Area

GBP44 isolate your work areas from all flowing water, but do not cut off flow to downstream portions of the stream at any time during construction (see **General BMPs and Standard Project Considerations: Temporary Diversion** section for further information) and adhere to the appropriate mitigation measures as identified by the Ministry and DFO;

GBP45 temporarily divert, enclose, or pump water around the worksite. Ensure that the point of discharge to the creek is located immediately downstream of the worksite to minimize disturbance to downstream populations and habitats (see **General BMPs and Standard Project Considerations: Temporary Diversion** section);

GBP46 if it is not possible to fully isolate and divert flowing water from your work area (due to water depth and volume) isolate works with a structure (e.g., silt curtain, sheet pile, sand bags, aqua dam, etc.) to keep silty water from entering the watercourse;

7. Salvage of Fish and/or Wildlife

GBP47 complete a fish and amphibian salvage before the start of works if any portion of the wetted channel will be isolated or dewatered. An appropriately **Qualified Professional** must complete the salvage. It is the responsibility of the salvage crew to obtain the necessary permits required by B.C. ***Wildlife Act*** and Canada ***Fisheries Act*** before conducting salvage activities (see MOE **Application to Collect Fish for Scientific Purpose** and contact local **DFO office** for salvage permits);

GBP48 choose low impact salvage methods such as trapping and **seining** before opting for higher impact methods such as **electrofishing**;

GBP49 use special techniques and extra caution when completing salvages that might involve species at risk. If species at risk are expected to be present, contact the **regional MOE office** or Environment Canada's website (**www.sararegistry.gc.ca**) for information regarding assessment and salvage requirements for species at risk;

8. Erosion & Sediment Control

GBP50 ensure that machinery is operated from the bank and not in the stream channel to avoid disturbance to the banks of the watercourse and HADD of fish habitat and to minimize impacts and better enable mitigation of **sedimentation**;

GBP51 remove excavated material and debris from the site or place to a stable area above the **high water mark (HWM)** or **active floodplain** of the stream, as far as possible from the channel and preferably outside the **riparian** zone;

GBP52 use mitigating measures to protect excavated material from being eroded and reintroduced into the watercourse. Such measures include, but are not limited to, covering material with **erosion control blankets** or seeding and planting with native vegetation;

GBP53 when material is moved offsite, dispose of it in a manner that prevents its entry into any watercourse, floodplain, ravine, or storm sewer system;

GBP54 contingency plans must be designed and in place to address unforeseen storm events with associated potential overland erosion from rainfall impact and storm water run-off;

GBP55 minimize the amount of instream work required and complete the work as quickly as possible;

GBP55 use a **Qualified Professional** to establish an effective **Work Plan** that considers location, timing and construction techniques to avoid erosion and minimize impacts of sediment release;

GBP56 restrict the work area to as small an area as possible and isolate it from the rest of the watercourse (see **General BMPs and Standard Project Considerations: Isolation of Work** section), achievable through control-at-the-source and **sediment interception**;

GBP57 schedule instream activities during appropriate **timing windows** to reduce or eliminate sediment and turbidity impacts. Confirm **Regional Timing Window** and contact **regional DFO offices**;

GBP58 adopt instream sediment controls (e.g., **silt barriers**, **cofferdams**, instream **weirs**, **retention basins** or **settling basins**, **wet ponds** or pools) together with land-based **erosion controls** and proper construction practices, to minimize the amount of **deleterious** sediment introduced into a watercourse and prevent **Harmful Alteration, Disruption or Destruction (HADD)**. A **qualified professional** (QP) should be on-site during construction/installation of sediment and erosion controls (see **Sediment Control**, **Stormwater and Erosion Module of Aggregate Operators Best Management Practices Handbook** and **Best Management Practices Guide for Stormwater** documents for further information);

GBP59 design **silt barriers** to isolate instream work areas from as much of the watercourse as possible. Consult a **Qualified Professional** for appropriate silt barrier design;

GBP60 **cofferdam** installations should be designed and approved by **Qualified Professionals** following completion of geotechnical and hydrological studies. See **General BMPs and Standard Project Considerations: Coffer Dam Isolation** section for further information;

GBP61 **outlet protection** is required at the outlets of all ponds, stormwater systems, pipes, culverts, ditches and anywhere runoff is conveyed to a natural or man-made drainage feature such as a **stream**, **wetland**, lake or **ditch**;

GBP62 ensure that material such as rock, **riprap**, or other materials placed on the bank, or within the **active channel** or **floodplain** of the watercourse, is **inert** and free of silt, **overburden**, debris, or other substances **deleterious** to aquatic life;

GBP63 minimize the disturbance to existing vegetation on and adjacent to the stream banks as part of erosion control measures in order to prevent sediment release;

GBP64 construct any **ditches**, **water bars**, or water diversions within the work area so they do not directly discharge sediment-laden surface flows into the stream. Divert such flows to an adequately vegetated area (**vegetated filter strip**) where flows can slowly infiltrate;

9. Vegetation Management

GBP65 minimize the **riparian area** and/or watercourse temporarily disturbed by access activities along the adjacent upland property, and preserve trees, shrubs and grasses near the shoreline by using existing trails, roads or cut lines as access routes;

GBP66	limit machinery and equipment access and direct disturbance to **streambank** areas to prevent **Harmful Alteration, Disruption or Destruction (HADD)** to fish habitat;
GBP67	consider other options when contemplating the need to remove vegetation, as it is very often not the best choice and may cause **Harmful Alteration, Disruption or Destruction (HADD)** to fish and wildlife habitat and species. If vegetation removal is unavoidable, avoid grubbing and use vegetative maintenance and removal techniques such as pruning, mowing, girdling, topping and select tree removals that allow the root system to remain intact, to help bind the soil and encourage rapid colonization of low-growing plant species;
GBP68	wildlife trees are important for many wildlife, bird, and amphibian species. Avoid vegetation removal or management activities that will affect trees used by all birds and other wildlife while they are breeding, nesting, roosting or rearing young. **Section 34 (a)** of the ***Wildlife Act*** protects all birds and their eggs and ***Section 34 (c)*** protects their nests while they are occupied by a bird or egg. Different areas of the province have different breeding periods for birds, and therefore have different vegetation removal or management periods of least risk to nesting birds. To find out what the vegetation removal and management period of least risk is for the protection of breeding birds in your area, contact the **Regional Timing Windows**, **DFO office** and/or Environment Canada's **Species at Risk** website;
GBP69	**Section 34(b)** of the ***Wildlife Act*** protects the nests of eagles, peregrine falcons, gyrfalcons, ospreys, herons and burrowing owls year-round. Trees or other structures containing such a nest must not be felled or disturbed, even outside of the breeding season;
GBP70	if trees within the work area are suspected of being hazardous, then have them assessed by a qualified professional **arborist** who is also a **Wildlife Danger Tree Assessor**, to determine the presence and nature of the hazard;
GBP71	in cases where the topping or removal of a dead limb can eliminate the danger, do this rather than remove the entire tree;
GBP72	when falling or topping trees prevent branches from entering the stream channel;
GBP73	if any branches do inadvertently end up in the channel, remove them from the site to where they will not enter the channel during high flows;
GBP74	removal of limbs from the channel must be completed in a manner that will not disturb aquatic organisms;
GBP75	where the entire tree must be removed the **tree replacement criteria** should be applied;
GBP76	retain **large woody debris** (LWD) and the stubs of large diameter trees where it is safe to do so. These are important for preserving fish and wildlife habitat and populations;
GBP77	fall the tree away from the channel unless there is an immediate threat to the public, and remove the material within the instream work window;
GBP78	fall the tree across the stream only when no other method of tree removal is possible because of safety concerns (e.g., to protect fallers or buildings);

GBP79 removal of a felled tree must be completed in a manner that does not damage the banks or bed of the stream. If possible, leave and anchor the trunk, letting it remain as **large woody debris** within the **riparian zone**;

GBP80 schedule vegetation removal and the management or removal of **hazard trees** or limbs within the window of least risk for breeding birds and before the instream window, wherever possible. This will help to prevent work delays and allow your works to be scheduled within the instream work window;

GBP81 vegetate all disturbed soils, banks and riparian areas by seeding and/or planting trees and shrubs in accordance with the DFO guidance on **Riparian Re-vegetation**. Cover seeded and vegetated areas with appropriate measures to prevent soil erosion and to help seeds germinate. If there is insufficient time remaining in the growing season for the seeds to germinate, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring;

10. Site Restoration

GBP82 **grade** disturbed areas to a stable **angle of repose** after work is completed. As well, **revegetate** areas to prevent surface erosion and subsequent **siltation** of the watercourse;

GBP83 protect disturbed soil areas on the banks and areas adjacent to the stream from surface erosion by **hydroseeding** with a heavy mulch, **tackifier**, and seed mix; by installing erosion blankets; or by heavily revegetating;

GBP84 retain existing instream and **riparian** vegetation and other features, including trees, bushes, shrubs, weeds or tall grasses along any stream bank; mats of floating vegetation; overhanging vegetation; natural **large woody debris** and large boulders;

GBP85 restore all in-channel or **active floodplain** habitats that have been disturbed (and requiring DFO/MOE approval) during the completion of works to their original state and/or identified by DFO/MOE approvals. This meets the DFO goal of **no net loss** of fish and **wildlife habitat**;

GBP86 remove any remaining sediment and **erosion control** measures (i.e., silt fence). Ensure all equipment, supplies, and non-biodegradable materials have been removed from the site; and,

GBP87 ensure a qualified professional complete post-construction vegetation monitoring, as required by MOE and/or DFO, to ensure your revegetation meets full survival (see **Riparian Areas and Revegetation** and **Riparian Revegetation** for further information).

11. Temporary Diversions

GBP88 if pumps, pipes or conduits are used to divert water around or through the worksite:

- pumps, pipes or conduits must be sized to divert the 1 in 10 year maximum daily flow for the period of construction; and,
- any pump or intake withdrawing water from fish bearing waters must be screened in accordance with the Department of Fisheries and Oceans Fish Screening Directive (see **Freshwater Intake End-of-Pipe Fish Screen Guidelines**);

GBP89 if **cofferdams** are used, isolate successive parts of construction at the worksite:

- ensure **cofferdams** are designed by a professional engineer and constructed in accordance with that design; and,
- design the natural channel, remaining outside of the **cofferdams**, to adequately pass the 1 in 10 year maximum daily flow during the period of construction.

GBP90 if ditches are to be used to divert water flow around the worksite:

- allow diverted water to remain within the stream channel;
- design and construct ditches to divert the 1 in 10 year maximum daily flow around or through the worksite and protect from any anticipated **Harmful Alteration, Disruption or Destruction (HADD)** of fish habitat through erosion during the period of construction; and,
- backfill ditches and return the area as closely as possible to the natural state upon completion of works.

GBP91 ensure diversion design and implementation adheres to professional engineering specifications;

GBP92 if dewatering of the site is required, an **Environmental Monitor** holding all necessary permits required by fisheries agencies to collect and transport fish, should make the final decision regarding the need for a **fish salvage** program;

GBP93 if a **fish salvage** is necessary, recover and relocated fish to a safe area outside of the influence of the worksite (see **General BMPs and Standard Project Considerations: Salvage of Fish and/or Wildlife**);

GBP94 the work area should be isolated from all flowing water in a manner that does not cut off flow to downstream portions of the stream at any time during construction;

GBP95 ensure the point of discharge to the watercourse is located immediately downstream of the worksite to minimize disturbance to downstream fish populations and habitats;

GBP96 any machinery must work from the top of the bank of the stream and not in the stream channel;

GBP97 remove and stockpile the top 300 mm of spawning gravel substrate material, if channel substrates are to be removed, and replace upon completion of works;

GBP98 upon completion of works, remove the diversion from the upstream end first;

GBP99 upon completion of works, restore and stabilize the watercourse to its original configuration to prevent bank erosion around the temporary diversion;

GBP100 restore all in-channel or active floodplain habitats that have been disturbed during the completion of works to its original state;

Pumps, Pipes or Conduit Diversion

GBP101 ensure where pipes or conduits are required for temporary diversions, adequate consideration is given to flow capacity, size and length of pipes or conduits, area and depth of excavated area and stability of the stream bed substrate during excavation;

GBP102 isolate watercourse flow starting from the bottom end of the diversion channel, working upstream to minimize sediment production;

GBP103 complete diversion works as quickly as possible (preferably in a single day) during low flow periods;

GBP104 screen pump intakes to prevent entrainment of juvenile fish (see DFO's **Freshwater Intake End-of-Pipe Fish Screen Guideline** for more information);

GBP105 ensure the worksite contains back-up pumps, if diversion works require pumping;

GBP106 ensure water pump capacities, if required, are sufficient to handle watercourse flow (including unexpected storms) when moving water around the work site;

GBP107 install sediment traps and appropriate geotextiles along the diversion to prevent **Harmful Alteration, Disruption or Destruction (HADD)** to fish habitat;

GBP108 isolate the worksite both upstream and downstream of the dam to prevent backflow into the work area;

GBP109 discharge water pumped from within a contained work area to a vegetated upland site above the **high water mark (HWM)** to allow for sediment removal before it re-enters any watercourse;

GBP110 construct bypass flumes using durable pipe material that will be able to accommodate water flow;

Coffer Dam Isolation

GBP111 if cofferdams methods are to be used, design diversion works to incorporate materials based on the ease of maintenance and removal following construction activities. Suggested materials for cofferdam construction:

- rock;
- sand bags;
- wood;
- sheet metal;
- gravel or earthen plugs; and/or,
- synthetic inflatable systems.

GBP112 plan cofferdams such that they do not reduce watercourse width and lead to Harmful Alteration, Disruption or Destruction (HADD) of fish habitat through erosion of banks both upstream and downstream of the site or impede the movement of migration fish;

GBP113 isolate watercourse flow starting from the bottom end of the diversion channel, working upstream to minimize sediment production;

GBP114 complete diversion works as quickly as possible (preferably in a single day) during low flow periods;

GBP115 screen pump intakes to prevent entrainment of juvenile fish (see DFO's Freshwater Intake End-of-Pipe Fish Screen Guideline for more information);

GBP116 ensure your worksite contains back-up pumps, if diversion works require pumping;

GBP117 ensure pump capacities, if required, are sufficient to handle watercourse flow when moving water around the work site;

GBP118 anchor wood or sheet metal dams to the bank to prevent seepage and erosion around the edges of the dam and Harmful Alteration, Disruption or Destruction (HADD) to fish habitat;

GBP119 isolate the worksite both upstream and downstream of the dam to prevent backflow into the work area;

GBP120 repair any gaps, holes or scour around the dam immediately to prevent failure and Harmful Alteration, Disruption or Destruction (HADD) to fish habitat;

GBP121 the worksite should be isolated both upstream and downstream to prevent backflow into the work area;

GBP122 all water pumped from within a contained work area should be discharged to a vegetated upland site (above the high water mark [HWM]) to allow for sediment removal before it re-enters any watercourse;

GBP123 discharge water pumped from within a contained work area to a vegetated upland site above the **high water mark (HWM)** to allow for sediment removal before it re-enters any watercourse;

Ditch Diversion

GBP124 complete diversion works as quickly as possible (preferably in a single day) during low flow periods;

GBP125 the temporary diversion channel must be lined with plastic sheeting, filter cloth and/or clean gravel to prevent siltation from channel erosion;

GBP126 install sediment traps and appropriate geotextiles along the diversion to prevent **Harmful Alteration, Disruption or Destruction (HADD)** to fish habitat;

GBP127 ensure material removal does not lead to stream channel instability or increase the risk of **Harmful Alteration, Disruption or Destruction (HADD)** of fish habitat or **sedimentation** into the watercourse;

GBP128 work within the ditch diversion, including grading and bank stabilization, is to be completed prior to diversion of the watercourse flow to the ditch;

GBP129 any a plug of earth should be of a thickness and height specified by the consulting engineer (to prevent watercourse flow in the ditch during constructions) and retained at either end of the diversion ditch;

GBP130 diversion ditch width must be approximately the same width as the natural watercourse;

GBP131 ensure the diversion ditch contains no ridges or depressions that could trap fish or initiate erosion of the watercourse bottom;

GBP132 ensure diversion ditch side slopes do not exceed 2:1 (horizontal:vertical) ratio and cross-sectional area and gradient are approximately equal to the natural watercourse; and,

GBP133 backfill the diversion ditch upon completion of works and revegetate the area to a state that enhances the original condition.

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