TERMINAL REHABILITATION AND IMPROVEMENT PROGRAM PROJECT 2: BERTHS 8 AND 9 EXTENSION AND INFILL

BASIS OF DESIGN

PORT OF VANCOUVER, WASHINGTON, USA

PROJECT NO.: A19.0198.02
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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

The Port of Vancouver USA (port) is a deep-water port along the Columbia River that operates five terminals along with the largest mobile harbor cranes in North America. The port has identified several projects slated for improvement throughout the port, identified as the Terminal Rehabilitation and Improvement Program (TRIP).

The proposed project, identified as Project 2 within the TRIP program, will include the design and permitting of a wharf extension and wharf infill at Terminal 3, Berths 8 and 9. The modifications to the wharf will include up to a 230 foot long wharf extension at the downstream end of Berth 9, and two infill areas at Berths 8 and 9 that are approximately 365 feet long by 80 feet wide and 265 feet long by 70 feet wide. The wharf modifications provide improved access to longer and larger vessels that are now calling on Berth 9 and will accommodate ship loading equipment necessary to reach vessel holds. This work will facilitate the mooring of up to three vessels at Berths 7, 8, and 9 simultaneously.

As part of TRIP Project 1, the existing dolphin at Berth 9 will be removed and relocated downstream and waterward to be in-line with the existing face of Berth 9. This dolphin will subsequently be integrated into the wharf extension in Project 2.

The purpose of this document is to define design criteria required for the wharf modifications at Berths 8 and 9.

1.2 PROJECT LOCATION

The proposed Berth 9 wharf extension and infill project is located on the north bank of the Columbia River, at River Mile 104.19, on the downstream end of Berth 9; Latitude 45.64° N and Longitude 122.71° W.

1.3 IN-WATER WORK WINDOW

All work below the Ordinary High Water (OHW) line must be completed within the in-water work window. The anticipated in-water work window for the Columbia River mainstem below Bonneville Dam is between October 1, 2021 and January 31, 2022. Permits issued for the project will formally establish the work window that will govern project construction below the OHW.

2 GENERAL INFORMATION

2.1 EXISTING TERMINAL

Terminal 3 at the Port of Vancouver is a multiuse cargo dock that encompasses 258,000 square feet of covered storage space and 65 open acres. It contains two ship berths, Berth 8 and 9, and the ability to operate the port's two 140-metric ton Liebherr mobile harbor cranes. Berth 9 was constructed in the mid-1980s as a general cargo handling facility. The existing Berth 9 wharf is constructed with prestressed concrete deck panels, cast-in-place concrete pile caps, and prestressed concrete piles. The existing deck is covered with asphalt pavement over ballast.

Berth 8 and 9 consists of approximately 1,250 linear feet of total wharf length. An existing mooring dolphin, 8 feet by 13 feet in plan, is located downstream and connected to the wharf by a grated steel walkway that is approximately 120 feet long and 4 feet wide. The existing dolphin will be removed and relocated within TRIP Project 1. The relocated dolphin will be located approximately 160 feet downstream of the existing wharf, and in-line with the existing face of Berth 9. The existing mooring dolphin between Berth 9 and Berth 10, which is planned for relocation within Project 1, will be used by vessels at Berth 9.

For Terminal 3 general arrangement, see Figure 1. For general arrangement of the proposed wharf extension and wharf infill, see Figure 2.

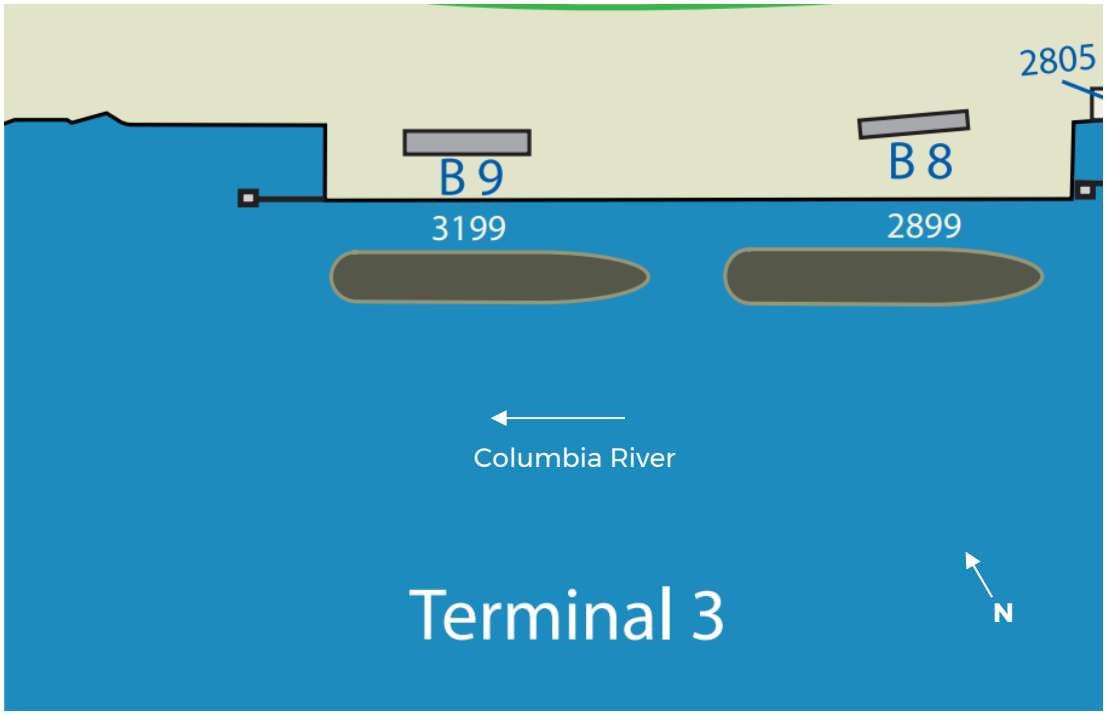

Figure 1. Terminal 3 Existing General Arrangement Plan

(Image from Port of Vancouver, USA website: www.portvanusa.com, 26 February 2015)

Figure 2. Proposed Wharf Extension and Infill (Preliminary)

2.2 SURVEY CONTROL

The project's transverse baseline is the fender face of the existing Berth 9 wharf. This line will be extended to define the fender face of the proposed wharf extension. The project's longitudinal baseline is the downstream face of the existing Berth 9 dock.

Horizontal Datum: The horizontal datum for this project is the Washington South State Plane Coordinate System (Zone 4602), and the North American Datum of 1983/2007, referenced to the Port of Vancouver control network.

Vertical Datum: The vertical datum for this project is the National Geodetic Vertical Datum of 1929 (NGVD29) pre-1947 adjustment.

Orientation: The orientation of the proposed wharf face will be parallel to the project's transverse baseline as noted above.

2.3 SITE SPECIFIC DATA

2.3.1 WATER LEVELS

The project is located at Columbia River Mile (RM) 104.19. The river mileage conforms to the River Mile Index of the Hydrology and Hydraulics Committee, Pacific Northwest River Basins Commission, July 1972.

At RM 104.19, Columbia River Datum (CRD) is 5.15 feet above the North American Vertical Datum of 1988 (NAVD88) and 1.60 feet above the National Geodetic Vertical Datum of 1929 (NGVD 29). Elevation adjustments are per the Columbia and Lower Willamette Rivers, Comprehensive Evaluation of Project Datum: Compliance Report 2014, United States Army Corps of Engineers (USACE), Portland District.

The ordinary high water mark at the project site is approximately 17.0 feet NGVD29 (15.4 feet CRD) per Table A-1 of the USACE, Portland-Vancouver Harbor Information Package Third Edition, October 2014.

The project datum is NGVD 29 pre-1947 adjustments (port datum) and is approximately 3.82 above NAVD88 datum and 1.33 feet below CRD.

Water levels at the project site vary during the year and are influenced by three primary variables: seasonal river flows, upstream reservoir regulation and astronomical tides. During river low flow months (July to November) the daily water elevation at Vancouver typically varies as much as 3 feet because of tidal influences. During river high flow months (December to June) the daily water elevation change due to tidal influence is negligible. Water elevations at the site are per the National Oceanic and Atmospheric Administration (NOAA) Tide Station 9440083 (accepted 16 June 2017).

The 100 year flood elevation for the project is determined from data provided in Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Map No. 53011C0364D. Because the base flood elevation is not uniform in the river zone around the project, the flood elevation for the project site is interpolated between the 30.0 feet and 31.0 feet base flood elevation contours shown on the map. Based on RM 104.19, the 100 year flood elevation is approximately 30.25 feet NAVD88.

The target dredged mudline elevation within the berth box for the project is -45.00 feet CRD. To account for an additional maximum 2 feet of over-dredge, the final dredged mudline elevation for design considerations is -47.00 feet CRD. The lowest assumed river elevation during operation is assumed to be 0.0 feet CRD.

Table 1 provides a summary of river elevations for this project in CRD, NAVD88, and the port Datum.

Table 1. Datum Elevations at RM 104.19 (ft.)

Elevation	CRD	Port Datum	NAVD88
100 Year Flood	25.10	26.43	30.25
Ordinary High Water Mark (OHWM) per USACE Table A-1	15.40	16.73	20.55
Mean Higher High Water (MHHW)	5.14	6.47	10.29
Mean High Water (MHW)	4.60	5.93	9.75
Mean Seal Level (MSL)	3.29	4.62	8.44
Mean Low Water (MLW)	2.16	3.49	7.31
Mean Lower Low Water (MLLW)	1.95	3.28	7.10
Columbia River Datum (CRD)	0.00	1.33	5.15
Port Datum (NGVD29 Pred-1947)	-1.33	0.00	3.82
NAVD88	-5.15	-3.82	0.00
Design Dredge Depth (-45.00 less 2 ft over-dredge)	-47.00	-45.67	-41.85

2.3.2 SEISMIC CRITERIA

The seismic criteria for the wharf extension and infill will be in accordance with ASCE 61-14. The bedrock earthquake motions for each of the seismic hazard levels will be based on geotechnical recommendations provided by the port's geotechnical consultant and will be summarized in Table 2.

Table 2. Seismic Design Parameters

Hazard Level	S_S	S_1	S_{DS}
Operating Level Earthquake	To be determined	To be determined	To be determined
Contingency Level Earthquake	To be determined	To be determined	To be determined
Design Earthquake	To be determined	To be determined	To be determined

2.3.3 GEOTECHNICAL HAZARDS

Preliminary conditions will be based on the following geotechnical data and recommendations.

- Geotechnical Report, dated April 24, 1985, prepared by Dames and Moore
- Geotechnical Investigation, Terminal 3 – Berth 9/10 Dolphin Replacement, prepared by GRI dated 26 August 2019.
- TRIP Project 2 preliminary geotechnical design criteria provided by GRI

Final design of the dock extension and infill will conform to geotechnical recommendations provided by the port's geotechnical consultant, GRI.

The geology of the upland site is made up of medium-dense to dense fill material with zones of less and more dense material. The matrix of the gravel is generally sandy or silty sand; however, the boring samples encountered zones in which matrix material was essentially absent.

Soil borings revealed sand and silty sand soils extending from the mudline to an underlying stratum of sandy gravel. The upper sandy soils are generally medium dense and contain thin lenses of silt. The upper surface of the gravel was encountered between elevations -25 feet to -35 feet except at locations where previous dredging extended to lower elevations. The gravel is sub-rounded to rounded and likely contains cobbles and occasional boulders. The composition and consistency of the gravels appear variable between boring locations and with depth. Prior projects indicated difficult driving conditions.

Preliminary geotechnical findings indicate that during a seismic event, the site is subject to liquefaction and lateral spreading. To limit the impact of lateral spreading deformations and forces, ground improvements just upland of the dock extension and infills is recommended. Additionally, the embankment along the dock extension and infills should be excavated down to an approximate elevation of 9.0 feet.

3 SITE CIVIL ENGINEERING

3.1 CODES AND STANDARDS

The codes and standards for civil engineering include the following.

- "Standard Specifications for Roads, Bridges, and Municipal Construction" as prepared by Washington State Department of Transportations, 2018 Edition
- Applicable Standards of the American Waterworks Association (AWWA)
- National Fire Protection Association NFPA 307: "Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves."
- City of Vancouver Municipal Code Title 14

Organizations with references for civil engineering include the following.

- American Association of State and Highway and Transportation Officials (AASHTO).
- American Association of Port Authorities (AAPA)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- U.S. Department of Defense, Military Handbook, Piers and Wharfs, MIL-HDBK-1025/1, 1987

3.2 SUPPORT STRUCTURES

3.2.1 FACILITIES

There are no upland facilities currently required for this project.

3.2.2 VEHICLE ACCESS

The minimum width for the roadway is 20 feet (two 10-foot lanes). The maximum drivable cul-de-sac radius is 50 feet in accordance with ICC Fire Code. The minimum length of turn-around arm is 60 degrees, measured from the center line of the perpendicular fire lane to the curb face. Access is provided for the following emergency vehicles.

- Fire Engine
- Ladder Truck
- Pump Truck
- Ambulance

3.3 DRAINAGE

3.3.1 DECK DRAINAGE

Deck drainage will be accomplished by sloping the surface at approximately 1 to 2 percent to cast in place trench drains or collection inlets. All runoff will be contained and conveyed to a drainage system located upland of the wharf.

3.4 STORMWATER TREATMENT AND DISPOSAL

3.4.1 STORMWATER MANAGEMENT

Runoff generated on the proposed wharf will be collected and conveyed upland. An existing stormwater system is located upland and on the existing berth that discharges for treatment to the Terminal 4 pond. Stormwater from the expanded berth is assumed to tie into the existing stormwater system. A pump station is not anticipated. Alternatives for stormwater management include use of the existing upland system and Terminal 4 pond for conveyance and treatment, segregation of the new berth areas and localized treatment immediately upland or intercepting the remaining Berth 8/9 stormwater and providing localized treatment for the entire expanded Berth 8/9 using a localized system immediately upland.

Stormwater up to the water quality treatment flow rate will be generated at the facility and will be conveyed upland to the Terminal 4 pond for treatment. After treatment in the pond, the runoff will be conveyed through the port's existing outfall to the Columbia River.

3.5 WATER SUPPLY

Water supply near Berth 8/9 is provided by the port's water system. The port operates their own Group A water system including drinking water well, treatment, and storage. It is anticipated that a water main will be extended to the wharf. On-berth fire protection will be developed in a future design to suit the specific end use of the facility.

Buried piping shall be cement lined ductile iron pipe and meet ANSI C104 and AWWA A21.4. Piping shall have a pressure rating of 200 psi minimum. Exposed piping shall be hot-dipped galvanized steel pipe meeting ASTM A53. Fittings shall be malleable iron with a pressure rating of 150 psi, meeting ASTM A47M, Grade 32510.

Water service connections shall conform to WSDOT standard specifications and the port requirements. A direct displacement-type water meter and backflow prevention device will be provided where the water service branches from the main line extension. All meters and backflow preventers will be placed in a flush-mounted concrete vault.

A new water line will be extended to the berth. The length of the new line is still to be determined. It will need to provide for both fire protection and a domestic water supply for the wharf. System demands are anticipated not to exceed 1,500 gpm for fire system and a domestic peak hour demand of 50 gpm. The new waterline will be ductile iron of a class sufficient to support anticipated wheel loads.

A 3-inch domestic water supply will be constructed to the outside face of the wharf. This water supply will serve two 2-inch-diameter provisioning connections, as well as up to two washdown water spigots on the wharf. This service will be metered using a compound meter assembly and protected from back siphonage using an approved backflow prevention device. The meter and vault will be installed in a flush-mounted vault in the upland area. Metering for the domestic water supplies to the wharf will allow water usage from ship provisioning to be measured.

All exposed water piping hung from the wharf structure will be heat-traced to prevent freezing. Pipe supported on hangers will be equipped with flexible couplings and expansion joints.

The following sizes will be used for the design of the utility support frames:

— One 3-inch Domestic Water

3.5.1 FIRE PROTECTION

New hydrants will be required for the project, located where the wharf connects to the land. These hydrants will be fed using 6-inch-diameter branch lines. Where possible, hydrants will be located outside of the paved areas to minimize the possibility of accidental impact.

3.6 SEWERAGE

There is no sanitary sewer work currently required for this project.

3.7 PAVING

Paving for drainage control will slope concrete or asphalt concrete surfacing matching the adjacent existing surfacing. Drainage will be sloped to cast-in-place drainage trenches or inlets.

4 MOORING AND BERTHING

4.1 DESIGN VESSEL

The design vessels consist of bulk handling carriers at Berth 9. The anticipated design vessels and design vessel data are summarized in Table 3.

Table 3. Design Vessels

Vessel	Displacement (Metric Tonnes)	Deadweight Tonnes (Metric Tonnes)	Length Overall (ft)	Beam (ft)	Draft (ft)
Handysize	~35,000	30,000	575	82	40
HandyMax	~60,000	50,000	629	105	40

4.2 VESSEL BERTHING

All vessels are anticipated to be berthed with tug assistance. Berthing velocity perpendicular to the berth was estimated per UFC 4-152-01 (see Figure 3) assuming a moderate condition. Berthing energy shall be determined based on PIANC "Guidelines for the Design of Fender Systems" 2002. Berthing energy for design of the fender system will be determined based on a fully loaded vessel.

Berthing velocity for vessels arriving at berth are as follows.

Vessel Displacement: 60,000 MT
Berthing velocity: 0.33 ft/s normal to berth

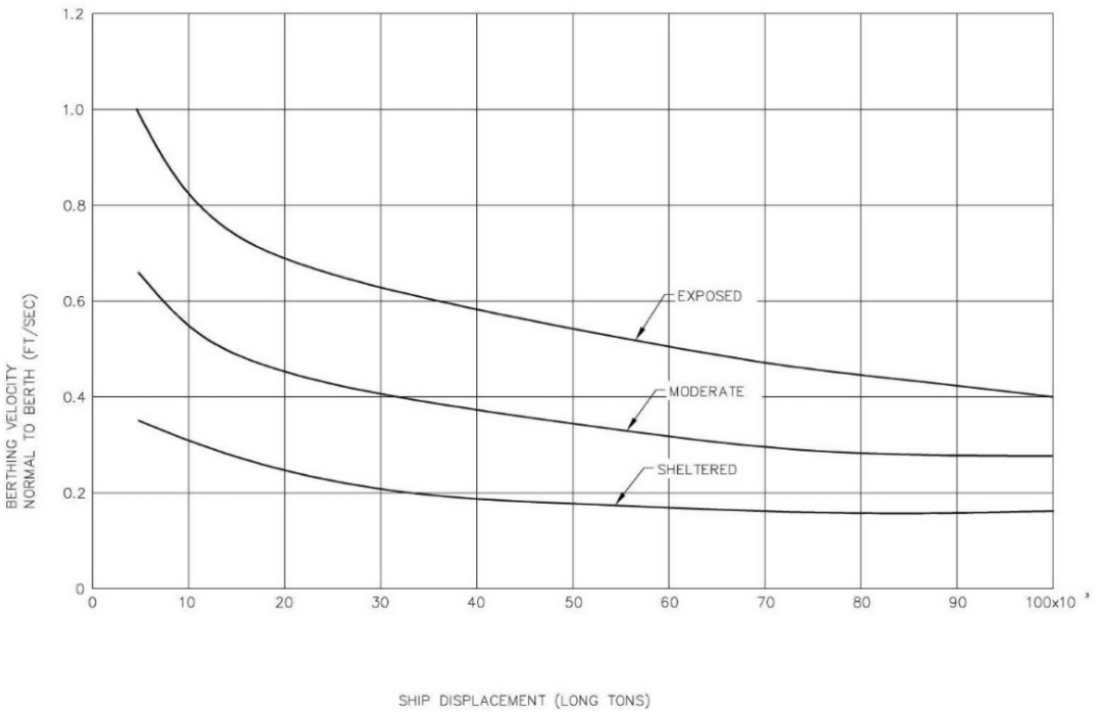

Figure 3. UFC 4-152-01 Berthing Velocity for Large Vessels

4.3 VESSEL MOORING

Mooring bollards will be located along the Berth 9 wharf extension. The bollard at the breasting dolphin relocated within the TRIP Project 1 construction will be included with the Berth 9 vessel mooring system design. The breasting dolphin will also be integrated into the proposed wharf structure. A dolphin approximately 430 feet downstream from Berth 9 dock will also be available for mooring vessels at Berth 9.

4.4 DESIGN CURRENT

Current loading will be based on criteria noted in the Port of Vancouver USA, Columbia Gateway, Terminal 4, Berth 10 Marine Structures construction drawings, dated May 1994.

Maximum current speed on vessel = 4.0 feet/sec parallel to shore.

4.5 DESIGN WIND

Wind loading for moored vessels at Berth 9 will be based on the UFC 4-159-03, mooring service type IIB storm mooring. When the forecast wind exceeds 64 knots, moored vessels will be required to depart the berth. Optimoor mooring analysis software is used to determine the wind loading forces transferred to the bollards and dolphin.

5 WHARF STRUCTURAL ENGINEERING

5.1 CODES AND STANDARDS

The primary reference codes for structural engineering will be as follows.

- International Building Code (IBC) 2015, as amended by the City of Vancouver
- American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, ASCE 7-10, 2010.
- American Concrete Institute (ACI), Building Code Requirements for Structural Concrete, ACI 318-14, 2014.
- American Institute of Steel Construction (AISC), Specification for Structural Steel Buildings, AISC 360-10, 2010.
- American Welding Society, "Structural Welding Code – Steel," 2015 Edition, (AWS D1.1).
- American Welding Society, "Structural Welding Code – Steel Reinforcing Bars," 2018 Edition, (AWS D1.4).
- U.S. Department of Defense, Unified Facilities Criteria, UFC-4-152-01 "Design: Piers and Wharves"

Wharf seismic design reference will be as follows.

- American Society of Civil Engineers (ASCE), Seismic Design of Piers and Wharves, ASCE 61-14, 2014. American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, ASCE 7-05, 2015.

Additional references include the following.

- U.S. Department of Defense, Unified Facilities Criteria, UFC-4-159-03 "Design: Moorings"
- California Building Code (CBC), Chapter 31 – Marine Oil Terminals (MOTEMS), 2016.
- PIANC "Guidelines for the Design of Fender Systems" 2002.

5.2 STRUCTURAL COMPONENTS

5.2.1 WHARF EXTENSION

The Berth 9 wharf extension will be constructed downstream of Berths 8 and 9 and will measure up to approximately 230 feet long parallel to shore and 170 feet wide. The wharf will be constructed with precast concrete deck panels, cast-in-place concrete pile caps and steel pipe piles. The Leibherr mobile crane will be required to operate everywhere along the Berth 9 wharf extension including the ship-breasting dolphin with load restrictions matching the existing wharf.

5.2.2 WHARF INFILL

The wharf infill will be constructed downstream and upstream of Berths 8 and 9 and will measure up to approximately 365 feet long by 80 feet wide and 265 feet by 70 feet wide respectively. The wharf infill will be constructed with similar components to the wharf extension. The wharf infill will be designed and detailed to be modular so that the port can add sections of infill as required throughout the service life of the Berths 8 and 9 wharf.

5.2.3 BOLLARDS

Bollards will be steel pipe bollards located along the new wharf extension as well as on the ship-breasting dolphin constructed in TRIP Project 1 and integrated with the proposed dock extension. For bollard loads, see "Mooring Loads" section.

5.2.4 FENDER SYSTEM

The fender system will be located along the dock face it will match the ship-breasting dolphin fender system used for TRIP Project 1. The fender system will be designed to absorb the berthing impact energy from the design vessels. The fender system will be designed to have the capacity to absorb 1.5 times the normal energy at the near-failure state.

A combination of fender panel and fender pile system will be designed to prevent the fender panel from being caught on vessel openings. The contact pressure between the mooring vessel and the fender panel will be determined from the Optimoor analysis and maximum pressure will be limited based on the type of vessel. In accordance with UFC 4-159-03, mooring service type IIB, the height of the fender panel will be designed to accommodate the design vessels at berth from extreme low to mean higher high-water level. The required elevation range of the fender panel is from approximately 11.34 feet (10.00 feet CRD) to the top of Berth 9 existing fender pile elevation 28.34 feet (27.00 feet CRD).

The pier headline of the Berth 9 dock extension will match the existing Berth 8 and 9 pier headline. The existing pierhead line allows for 2 feet 8 inches from face of wharf to face of fender system.

5.2.5 WHARF AND INFILL FOUNDATION

Pile types are anticipated to be steel pipe piles and may be plumb or batter piles. The piles will be designed to resist gravity and lateral forces from berthing, mooring, seismic, liquefaction and lateral spreading.

Preliminary geotechnical findings indicate piles will be subjected to very large lateral spreading forces in the soil crustal zone, defined as the soil embankment zone located above the average river elevation of approximately 7.5 feet. To limit these large lateral spreading forces, the embankment at the crustal zone and within the dock and infill areas, will be excavated down to an approximate elevation of 9.0 feet. A sheet pile bulkhead wall will be installed at the landside edge of the dock extension and infills in order to retain the cut slope.

In addition, it is anticipated that deep soil mixing ground improvements is required just upland of the dock extension and infills, and along the length of the dock extension and infill areas. The deep soil mixing will extend down to the gravel layer, approximately 55 feet below the surface.

5.3 DESIGN LOADS

The wharf extension and infill will be designed for the governing conditions produced by the loading and load combinations specified in ASCE 61-14 and ASCE 7-10 supplemented by the following.

5.3.1 DEAD LOADS

Dead loads shall include the weight of the entire structure, including any permanent attachments such as mooring hardware, light poles, service utility lines and other appurtenances.

5.3.2 LIVE LOADS

Live loads shall include the following.

Wharf Uniform Loading 750 psf

Mobile Crane (LHM 500) 840 kip outrigger load (extreme). Outrigger located on pile caps only.

Outrigger Length =	26.2 ft
Outrigger Width =	6.6 ft
Outrigger Area =	173 sf
Outrigger Pressure =	4.88 ksf (extreme)
Outrigger Spacing =	39.4 ft x 39.4 ft
Number of Axle Sets =	20
Axle Set Loading =	69.4 kips (extreme)

Highway Truck	HS 25-44
Conveyors and Material Handling Equipment	To be determined

5.3.3 MOORING LOADS

Mooring loads shall include all the forces acting on the moored vessel, including wind and current forces. This does not include wind and current forces that act directly upon the dock extension or infills. Mooring loads are determined based on the design criteria established in "Vessel Mooring" section.

Mooring loads will be determined considering the effect of the wharf shielding wind loads on the vessel below the deck surface, as well as various load cases that account for vessel locations, current speed and direction, and wind speed and direction.

Calculated mooring loads will be checked with defined mooring bollard loads for the project. The following bollard capacities are established for the project and bollard demands will be determined and verified using Optimoor analysis software.

Line Pull	200 kips
Range of horizontal angle	0 to 180 degrees parallel to Harbor Line
Range of vertical angle	0 to 30 degrees above vertical

5.3.4 BREASTING LOADS

Breasting loads are the result of ship berthing energy impact forces imparted on the dock fender system. Berthing energies are a function of vessel displacement and berthing velocities as outlined in "Vessel Berthing" section.

The required fender capacity is as follows.

Minimum Energy	302 ft-kips

5.3.5 LATERAL LOADS

The project will be designed in conformance with the current International Building Code (IBC, 2015) as adopted and amended by the City of Vancouver. IBC refers to the ASCE Minimum Design Loads for Buildings and Other Structures (ASCE 7) for determining seismic loads. ASCE 7 states that design of piers and wharves that are not accessible to the general public are not covered by that document. Therefore, this wharf will be designed in accordance with the ASCE Seismic Design of Piers and Wharves (ASCE 61-14) for the performance objectives and associated spectral accelerations. The procedures of ASCE 61-14 are based on seismic criteria set forth in ASCE 7-05, therefore the seismic design criteria for the project will be based on provisions of ASCE 7-05. Note that the Seismic Mass is equal to the structure dead load plus 10 percent of the design uniform live load.

Operating Level Earthquake (OLE):

The OLE corresponds to a ground motion probability of exceedance of 50 percent in 50 years with a return period of 72 years. All wharf structure elements and their foundations shall be capable of resisting the OLE without sustaining damage requiring post-earthquake remedial action. The structure exhibits a near elastic response with minor or no residual deformations and no loss of serviceability.

Contingency Level Earthquake (CLE):

The CLE corresponds to a ground motion probability of exceedance of 10 percent in 50 years with a return period of 475 years. All wharf structure elements and their foundations shall be capable of resisting the CLE. The structure experiences limited inelastic deformations at locations where repair is possible, the required repairs result in loss of serviceability for no more than several months, and no loss of containment of materials resulting in hazard to public health.

Design Earthquake (DE):

The DE is developed using the response spectra based on the ASCE 7-05 ground motions associated with the Maximum Considered Earthquake (MCE). The DE is taken as two-thirds the MCE and corresponds to a ground motion probability of exceedance of 2 percent in 50 years with a return period of 2,475 years. All wharf structure elements and their foundation shall be capable of

resisting the DE without collapse, while maintaining life safety. Damage to the structure does not prevent egress and there is no loss of containment of materials resulting in hazard to public health.

Liquefaction and Lateral Spreading

Preliminary geotechnical findings indicate the site is subject to liquefaction and lateral spreading. Liquefaction and lateral spreading is expected in the soft soils located above the gravel layer at approximate elevation -31 feet near the pierhead line and at -25 feet near the landside edge of the dock. Piles located within the liquefiable soft soils will be subjected to lateral spreading and down drag forces. Additionally, piles located within in the soil crustal zone, defined as the soil embankment zone located above the average river elevation of approximately 7.5 feet, are subjected to very large lateral spreading forces. To limit these large lateral spreading forces, the crustal zone within the dock extension and infill areas should be excavated down to an approximate elevation of 9.0 feet.

Preliminary geotechnical recommendations are that 100 percent of the liquefaction and lateral spreading forces be combined with 50 percent of the forces from the dock seismic inertial loads.

It is anticipated that deep soil mixing ground improvements is required along the length of the dock extension and infill areas. These ground improvements will be designed to limit soil deformations and lateral spreading loads on the abutments and first row of piles at the dock extension and infills.

Relative Movement:

Relative horizontal and vertical movement, including that caused by shrinkage, temperature change, and mooring and berthing shall be accommodated at all wharf joints. The amount of movement to be accommodated shall be sufficient such that utility lines will not rupture. Interruption of utility service will be minimized in the event of a major earthquake.

The Berth 8/9 wharf extension and infill strutures will be deisgned to act independent of the existing wharf structures therefore seismic joints between the existing and proposed structures will need to be provided. The seismic joints will be required to accomodate relative seismic motions between any two adjacenet structures.

6 ELECTRICAL

To be determined.

7 CONSTRUCTABILITY

7.1 CONSTRAINTS

The design and construction of the Berth 9 wharf extension and infill shall consider the following site constraints.

- Existings power transmission lines appear to cross over the proposed Dolphin 1 and 2 locations. No temporary displacement, or de-enegergizing of power lines will be required during the construction of both dolphins. Adequate clearance between the pile driving equipment and the power transmission lines shall be verified and provided.
- Berths 9 and 10 will remain in operations during project construction therefore construction activites should not disrupt operations at the berths.
- As the dock extension is concructed around the existing Dolphin 1, significant during of the dolphin during mooring and berthing operations could occur, and consideration will need to be given to how these deflections are handled as the dock extension is fixed to the dolphin.
- Cobbles below the mudling may be present during pile installation. Drilling equipment is not expected for the site however a reinforced pile tip or spud may be required to penetrate boulders or cobbles below the mudline should they be encountered.

8 PROJECT CADD STANDARDS

The project will use AutoCAD version 2018 for development of construction drawings.