AECOM

Chapter 8

Marine Resources

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8. Marine Resources

8.1 Introduction

Marine Resources were selected as an Environmental Component because of the potential interaction between the proposed Project and ecological values such as fish, fish habitat, marine birds, marine mammals, and Species of Conservation Concern[1], and their importance to Aboriginal groups and the public. Project activities that could affect marine resources during construction include terminal expansion, Ballantyne Pier removal and rehabilitation, dredging and infilling, stormwater discharge, and fugitive light and noise from construction activities. Project activities that could interact with marine resources during operations include light and noise from terminal activity, stormwater discharge, and marine shipping.

In recognition of the importance of minimizing the impacts of the proposed Project on marine resources, the PER Application Submission Requirements stipulate the requirement to conduct the following studies related to marine resources:

- biophysical survey
- Species at Risk assessment

Marine Resources were also confirmed as a key topic of review for the PER process by Aboriginal groups and the public during early engagement for the proposed Project. During the Preliminary Comment Period on the scope of technical and environmental studies for the proposed Project, the majority of respondents supported the need to conduct a biophysical study to characterize how the proposed Project would affect fish and fish habitat, marine birds, and marine mammals.

The port authority has developed *Project and Environmental Review Guidelines – Habitat Assessment* (PMV 2015e) (Habitat Guidelines) to assist applicants of projects on lands and waters managed by the port authority in the assessment of potential Project effects on biophysical resources including marine resources. This chapter summarizes the work conducted (Marine Resources Study) to determine changes in marine resources as a result of the proposed Project.

The Marine Resources Study was conducted in accordance with the Habitat Guidelines and taking into consideration feedback from early engagement. Some of the key themes from the Preliminary Comment Period that are reflected in the design of the Marine Resources Study include the following:

- assessing species and habitats that would be affected by Project activities such as infilling or shoreline modification
- assessing potential effects on fish habitat including both physical habitat and associated resources including marine invertebrates, marine plants, and algae

The Marine Resources Study focused on determining the potential effects on fish, fish habitat, marine birds, marine mammals, and species of conservation concern. Work conducted to support the Marine Resources Study is presented in the following sections and comprised:

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[1] *Regulators, Aboriginal groups, and other stakeholders are particularly concerned about species of conservation concern. For the purposes of this report, they are considered BC species:*

listed on Schedule 1 of SARA

assessed by COSEWIC as endangered, threatened, or special concern

provincially listed in BC as Red or Blue

- review of existing baseline information for fish, fish habitat, marine mammals, and marine birds that was available for the defined study areas
- underwater dive survey around Centerm to gather current data or existing conditions related to fish and fish habitat
- overlaying project footprint on mapping of habitats around Centerm to determine the extent of changes created by the proposed Project
- consideration of construction and operational activities and the potential consequences to fish, fish habitat, marine mammals, and marine birds

8.2 Scope of Review

The scope of review of effects on marine resources is listed in Table 8-1, which includes the following:

- **Project Interactions**: The components and activities of the proposed Project that are part of the review
- **Potential Effects**: The effects associated with the project interactions that are characterized
- **Study Area**: The geographic extent within which impacts are considered
- **Indicators**: The existing state of marine resources and the potential change that could occur as a result of project effects
- **Guidelines and Threshold References**: The thresholds or limits that are used to characterize the change to marine resources as a result of project effects

The Marine Resources study focus primarily on fish, fish habitat, marine birds, and marine mammals. Fish habitat includes those components of the marine environment that support the fish, including marine invertebrates, marine plants and algae, substrate, and types of cover.

8.2.1 Geographical Study Scope

The geographic boundaries for characterizing effects on marine resources include the following:

- Fish and Fish Habitat Study Area includes the marine environment within 250 m of the boundary of in-water works (Figure 8-1) as this was expected to be the extent of disturbance to fish habitat, particularly during construction and the greatest diversity of habitat and fish species are expected to occur in areas where water depths are less than 20 m.
- Marine Birds Study Area includes the Inner Harbour (Figure 8-2). This area was selected to capture the area of greatest interaction between vessels and marine birds, particularly during the construction phase.
- Marine Mammals Study Area includes the Inner Harbour and out to the port authority's western boundary for Burrard Inlet (Figure 8-3).

8.3 Regulatory Standards and Guidelines

The Canadian *Fisheries Act* provides protection to fish that are part of a commercial, recreational, or Aboriginal fishery or fish and fish habitat that support such a fishery. The work program included collecting information to determine whether the proposed Project would cause serious harm to fish. The *Marine Mammal Regulations* under the *Fisheries Act* include the protection of marine mammals. Project activities were evaluated to determine whether any activities would disturb a marine mammal. SARA protects the habitat of animals and plants listed by the Act, including marine fish and mammals.

Table 8-1: Interaction, Potential Effects, and Indicators for Marine Resources

	Project Interaction	Potential Effects of the Proposed Project	Study Area	Indicators	Guidelines and Threshold References
Fish and Fish Habitat	Construction: ▪ Footprint of terminal expansion on existing fish habitat ▪ Debris and other products entering the marine environment for the demolition and rehabilitation of Ballantyne Pier ▪ Dredging and infilling activities affecting fish and fish habitat ▪ Stormwater discharges affecting fish habitat ▪ Light from construction activities affecting fish behaviour ▪ Underwater noise from in-water construction activities affecting fish behaviour Operation: ▪ Light and noise from terminal activity ▪ Stormwater discharge	▪ Loss of fish habitat ▪ Serious harm to fish ▪ Deterioration of habitat quality from increased noise, degraded water quality, increased light levels, and deposition of contaminated sediment	The marine environment within 250 m of the boundary of in-water works	▪ Concentration of contaminants in water and sediment ▪ Presence of species of conservation concern[2] ▪ Quality and quantity of the habitat within the study area	▪ CCME *Sediment and Water Quality Guideline Criteria for Protection of Marine Aquatic Life* ▪ *Fisheries Act* ▪ *Species at Risk Act*
Marine Birds	Construction: ▪ On-water construction activity Operation: ▪ Marine shipping activities	▪ Disrupting feeding ▪ Disrupting nesting	Inner Harbour	▪ The diversity of marine birds present in the study area including species of conservation concern ▪ Habitat use in the study area	▪ *Migratory Birds Convention Act* ▪ *Species at Risk Act*
Marine Mammals	Construction: ▪ Underwater noise from in-water construction activities Operation: ▪ Marine shipping activities	▪ Deterioration of habitat quality from increased project activities such as increases in vessel movement causing changes in the acoustic environment and potential collisions with ships	Inner Harbour and out to the port authority's western boundary for Burrard Inlet	▪ Marine mammal presence including Species of Conservation Concern ▪ Relative abundance of marine mammals in the study area	▪ *Marine Mammal Regulations* under the *Fisheries Act* ▪ *Species at Risk Act*

[2] *Regulators, Aboriginal groups, and other stakeholders are particularly concerned about species of conservation concern. For the purposes of this report, they are considered BC species:*
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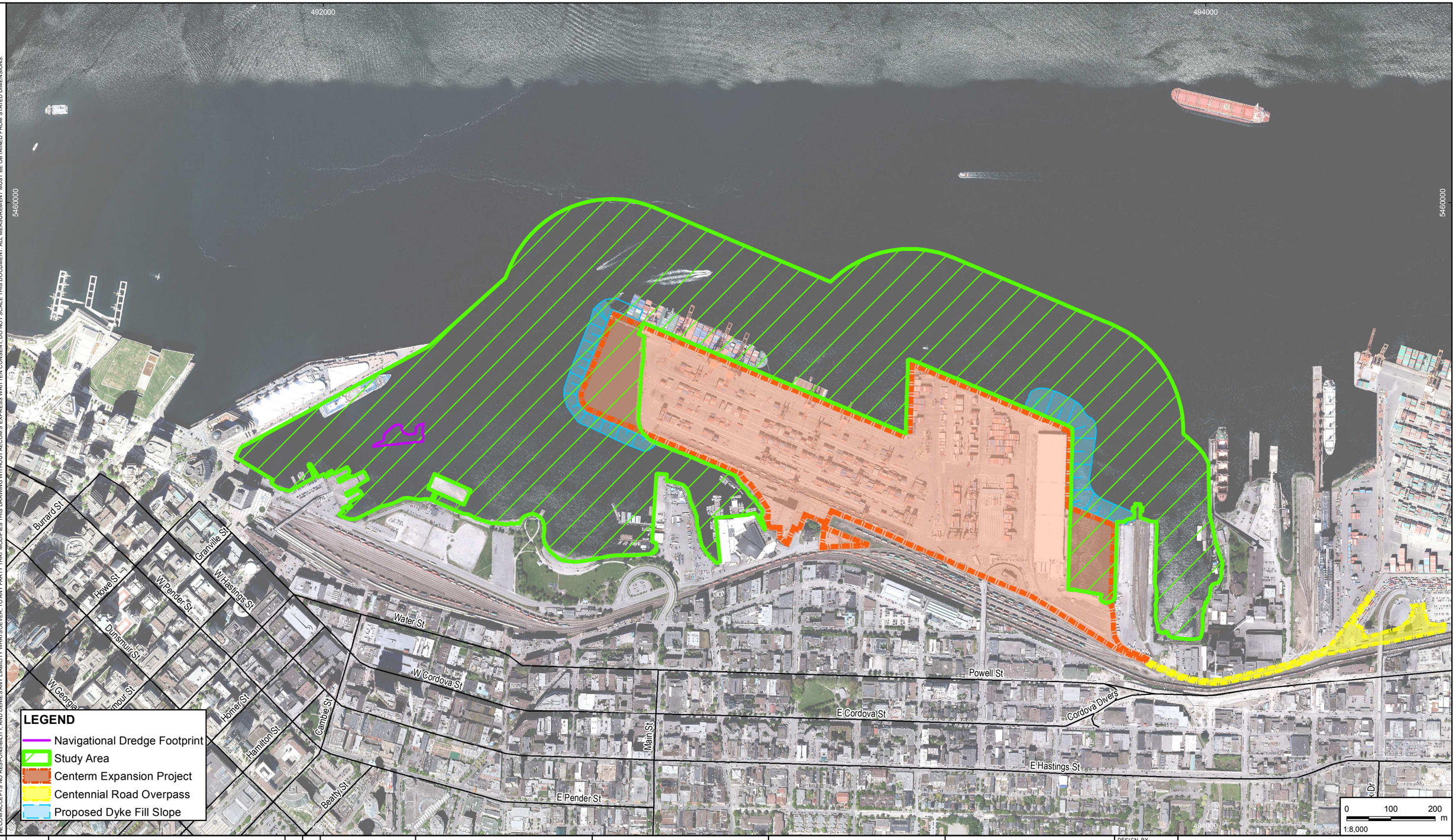

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B	2016/07/19	ISSUED FOR REVIEW	DL	NB
A	2016/05/08	ISSUED FOR REVIEW	DL	NB

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CENTERM EXPANSION PROJECT
ENVIRONMENTAL STUDY
FISH AND FISH HABITAT STUDY AREA
Figure 8-1

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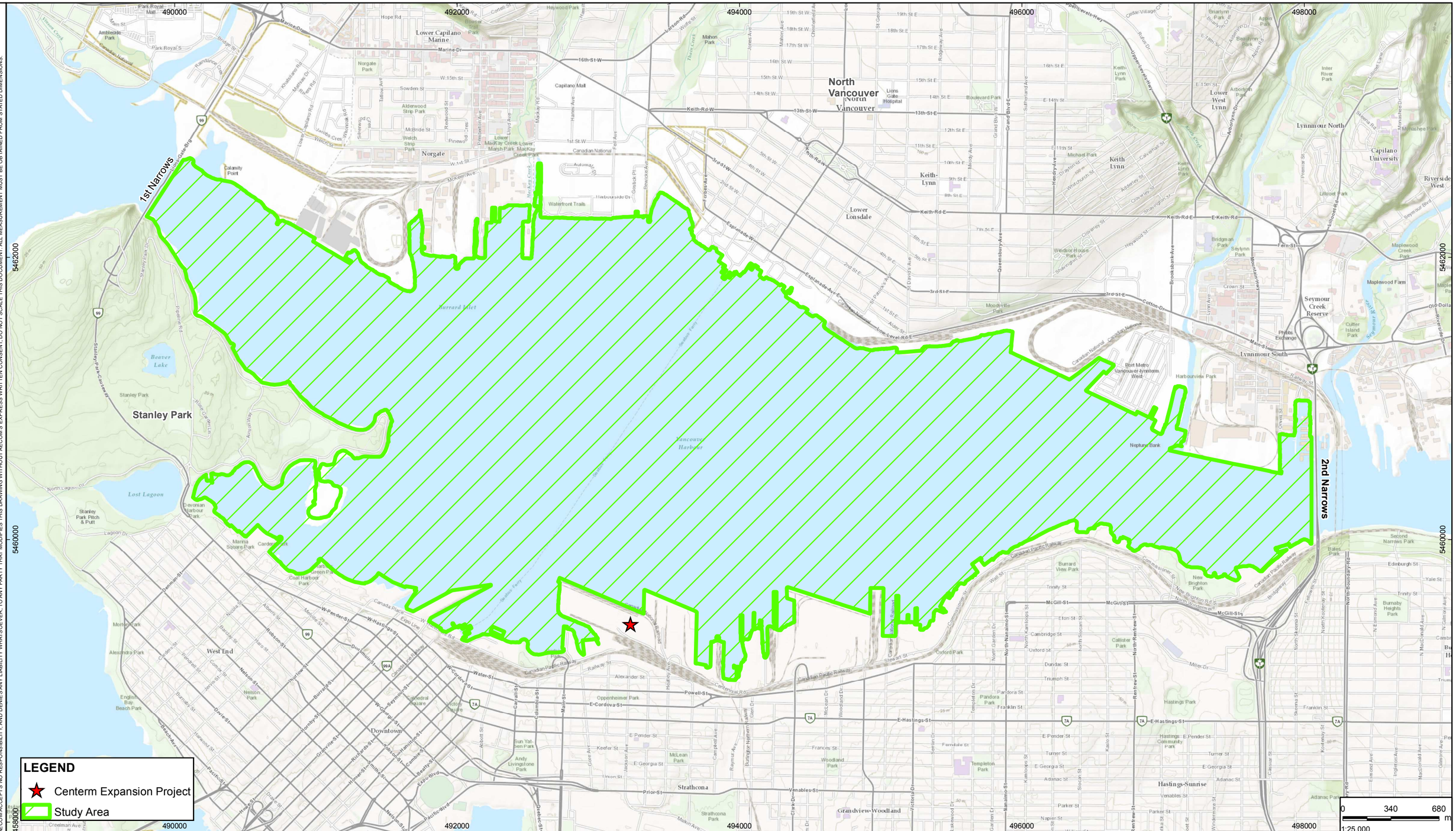

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ENVIRONMENTAL STUDY
MARINE BIRD STUDY AREA
Figure 8-2

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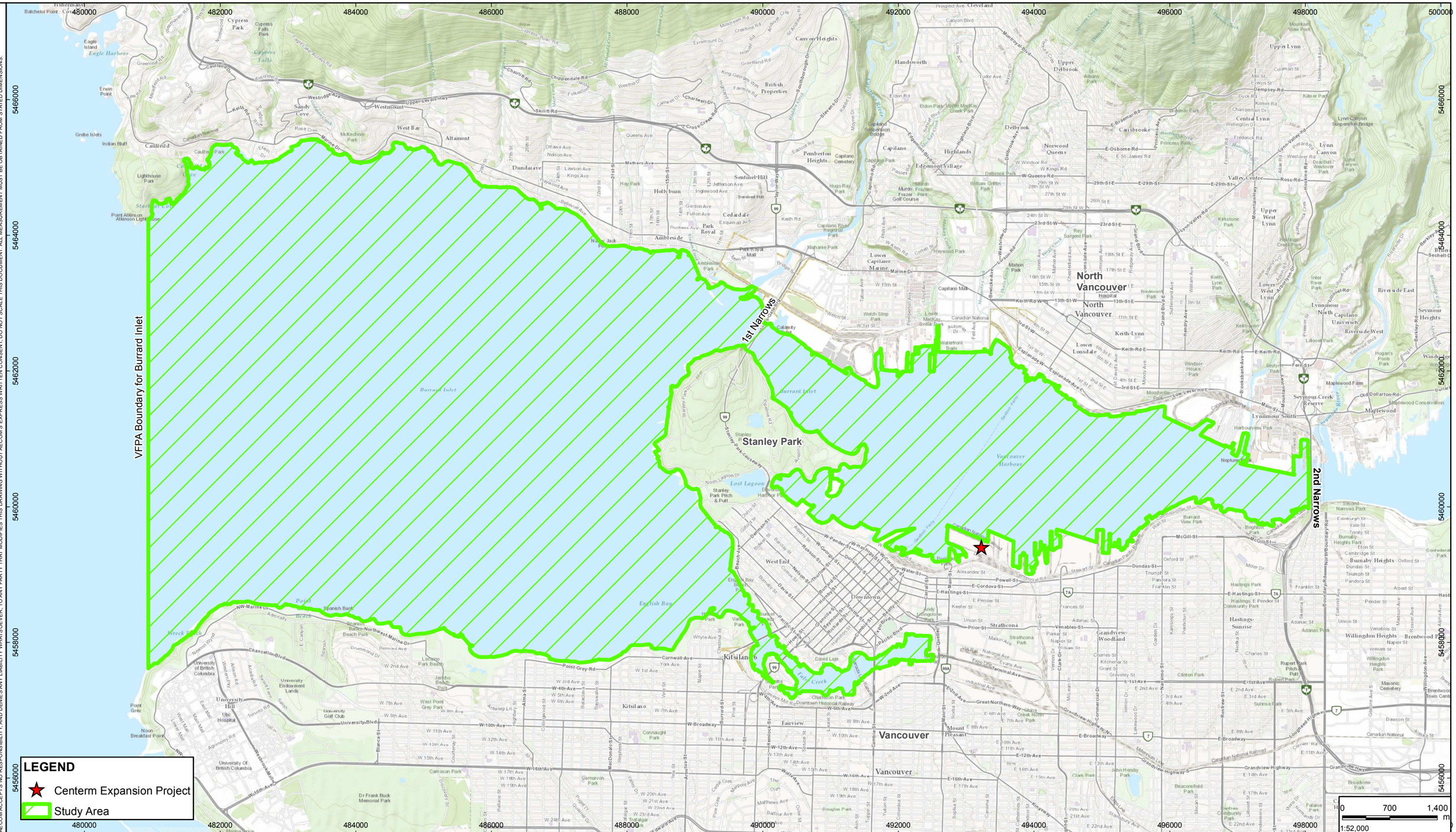

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CENTERM EXPANSION PROJECT
ENVIRONMENTAL STUDY
MARINE MAMMALS STUDY AREA

Figure 8-3

SIZE	MXD.	SHEET	REV.
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8.4 Study Methods

The marine fish and fish habitat study was based on data collected by Foreshore Technologies Inc. through dive surveys. Transects were established around the west and east ends of Centerm. Observational and semi-quantitative data were collected by divers as they surveyed the transects. Appendix G provides the Foreshore Technologies Inc. report with more detail on the study methods.

The marine bird and mammal study was a desktop assessment based on existing studies carried out in the study area, including reports on marine mammal occurrences, marine bird surveys in Burrard Inlet, and other environmental studies of proposed projects.

8.5 Existing Conditions

The *Burrard Inlet Environmental Action Plan* (BIEAP) (KWL 2015) and other studies divide the harbour into various sections as shown on Figure 1-1. Centerm is located in the Inner Harbour, which is the most industrialized section of Burrard Inlet and has experienced high levels of commercial and industrial port activity since the late 1800s. The harbour has developed significantly over time, and now includes a variety of port, industrial, residential, and recreational uses along the shoreline; however, almost all of the shoreline has been modified as a result of this development. Centerm extends 500 m from the shore into the harbour with much of the Terminal built on fill, but some sections are supported by caissons and other sections consist of deck supported on piles. Habitat for marine fish, birds, and mammals has been extensively modified by port development that has occurred over more than 100 years.

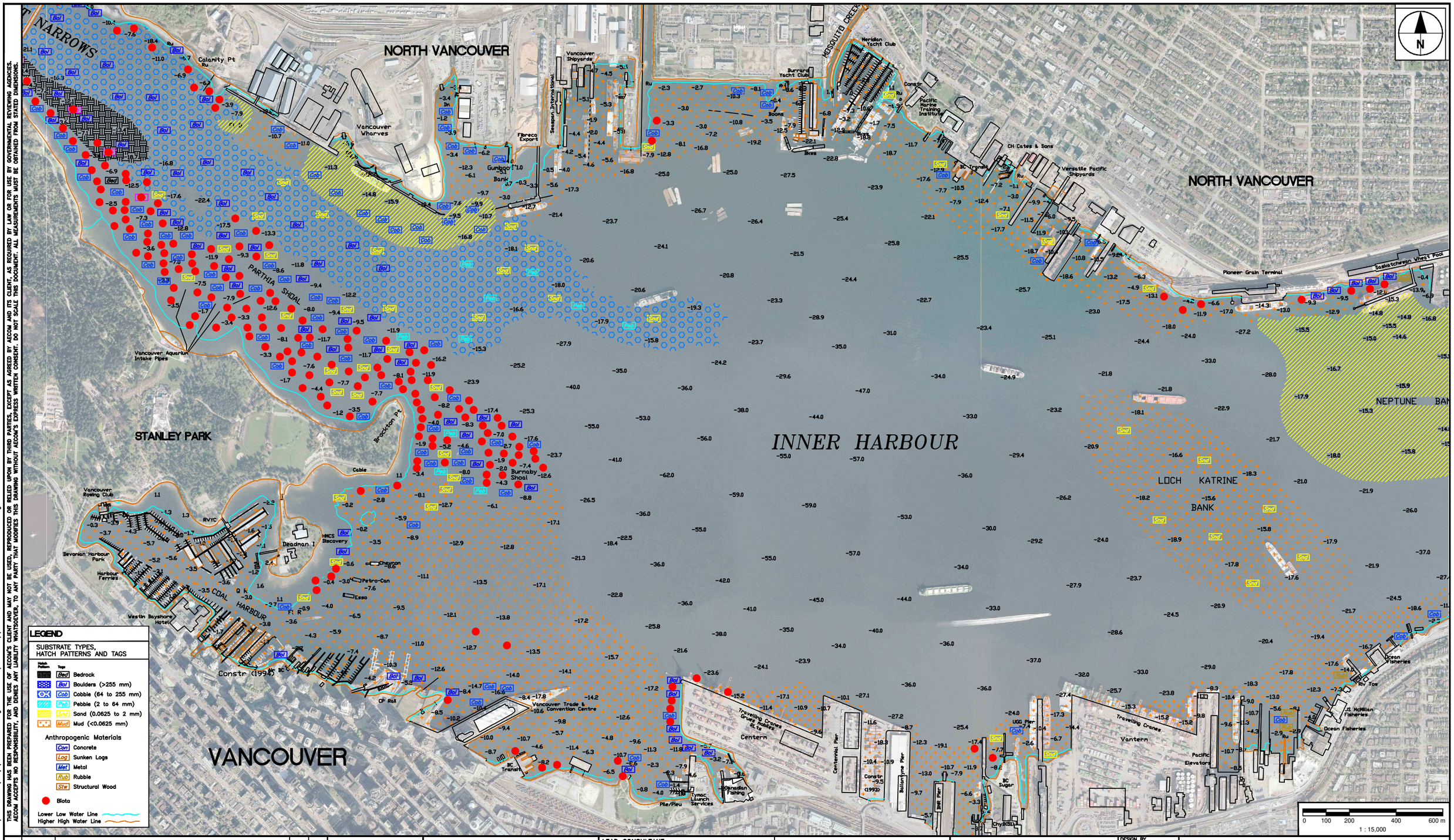
8.5.1 Fish and Fish Habitat

8.5.1.1 General Conditions

Initial information was provided by Foreshore Technologies Inc. (1996), which summarized the results of biophysical surveys of the Burrard Inlet Inner Harbour (Figure 8-4) and found that the tidal and subtidal areas along the south shore appeared to have low diversity of substrate and biota. The most diverse area of the Inner Harbour was the shore adjacent to Stanley Park between the Lions Gate Bridge and Brockton Point and around to Coal Harbour where pockets of eel grass beds are present. The west end of the Centerm dock was also shown to provide one of the more diverse areas along the south shore.

Haggarty (2001) reported that all species of Pacific salmon use the nearshore habitat of Burrard Inlet from early spring to late summer. Haggarty reported juvenile chum (*Oncorhynchus keta*) and Chinook (*O. tshawytscha*) near Portside Park (close proximity to the Centerm site). Adult salmon have been observed returning to 17 streams that flow into Burrard Inlet. Many of the juveniles migrating out of these streams pass through the Inner Harbour on their way to the Salish Sea and the open ocean. Pink salmon (*O. gorbuscha*) and chum are the first to leave their natal streams, sometimes as early as February, with coho (*O. kisutch*) and Chinook out-migrating later into spring in April or May.

In addition to salmon, Haggerty (2001) reported 75 other species of fish have been identified in Burrard Inlet. Commercially and culturally important species such as Pacific herring (*Clupea pallasii*), northern anchovy (*Engraulis mordax*), and lingcod (*Ophiodon elongatus*) are known to occur. Important forage fish species such as surf smelt (*Hypomesus pretiosus*) and sand lance (*Ammodytes hexapterus*) are also known to spawn on beaches in the Outer Harbour and in the Central Harbour. These forage fish do not spawn on or near the Centerm site because of the lack of suitable gravel beaches in the area.



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BIOPHYSICAL INVENTORY MAP

Figure 8-4

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The Inner Harbour is identified as DFO management Area 28-10. Fishing is restricted for a number of species and locations (i.e., a year-round prohibition of fishing from a boat between the Capilano River and Brockton Point for navigational safety). Other restrictions listed in Table 8-2 (DFO 2016a) are indicative of the fish managed within the Inner Harbour. Restrictions are imposed on bivalve shellfish due to potential contamination and on crabs, shrimp, and prawns to avoid conflicts with navigation.

Table 8-2: Fishing Restrictions for DFO Management Area 28-10 (Inner Harbour)

Restrictions	Species
Open Year-Round	Chum, Chinook, hatchery coho (from shore only), codfish, greenling, herring, mackerel, northern anchovy, Pacific sand lance, perch, sablefish, sculpin, salmon shark, spiny dogfish, skate, sole/flounder
Catch and Release Only	Wild coho, sockeye, sturgeon, wolfeel
Partial Closures	Surf smelt – June 15 to August 15
Closed Year-Round	Rockfish, eulachon, bivalve shellfish, crab, shrimp, prawns, shark, halibut

8.5.1.2 Current Conditions in the Study area

SCUBA supported dive surveys were conducted to collect information on the marine habitat including substrate type and biota present. Foreshore Technologies biophysical surveys of the intertidal and subtidal areas around the existing Centerm Terminal conducted in October 2015 focused on the west ends of Centerm where the expansion would extend into the marine environment, in February 2016 to collect data for the eastern expansion, and in July 2016 to collect data for the off-terminal dredge area (see Appendix G). The survey involved setting up a series of transects that the divers followed and recorded information along either side of the transect line including substrate type and the relative abundance of biota. The divers also made note of the conditions between the transect lines to confirm the transects were representative of the overall site conditions.

The survey of the west end of the Terminal confirmed the results of an earlier study (Foreshore Technologies 1996), which indicated the area has a varied substrate that supports diverse biota, including plants, such as brown and red algae and bull kelp, a variety of invertebrates, including California sea cucumber (*Parastichopus californicus*), shrimp (*Pandalus* spp.), and various crab species, including Dungeness (*Metacarcinus magister*), and fish, including kelp perch (*Brachyistius frenatus*), pile perch (*Rhacochilus vaccus*), and lingcod (Photograph 8-1). The transects on the west end extended beyond the riprap, boulder, and cobble substrate that forms the containment dyke for the existing terminal. Beyond the toe of the dyke the substrate grades from cobble to a uniform mud bottom where the diversity of sea life is much reduced as indicated in Photograph 8-2.

Photograph 8-1 ↑

Example of diverse habitat with red and brown algae growing on boulder substrate with bull kelp on the rock dyke at the west end

Photograph 8-2 ↑

Typical mud substrate habitat with the occasional invertebrate and cobble

The results of the biophysical survey indicate that there is considerable variation in the habitat types within the study area. The larger substrate including the existing riprap dyke supports a high diversity of marine life (Photograph 8-1). The areas of fine mud substrates such as along the western end of the Terminal support a lower diversity of marine life (Photograph 8-2). Figure 8-5 shows the different habitat types around the Terminal.

At the east end of the Terminal, the substrate was primarily fine mud overlying occasional cobbles, shell hash, and woody debris. Sea life observed in this area included occasional crabs and anemones (*Actiniaria* spp.). The east end of the Terminal was much less diverse than the west end of the Terminal.

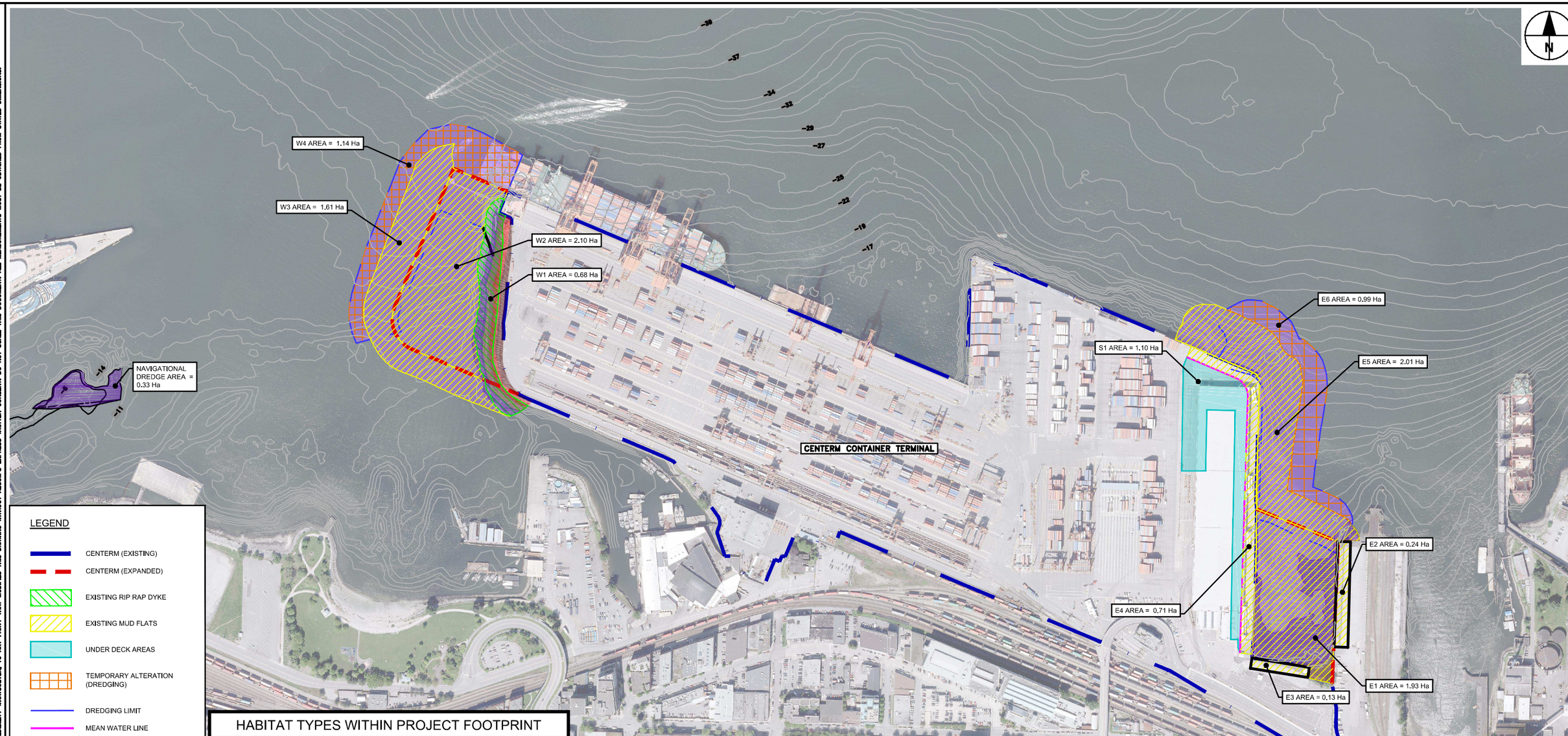
Various habitat features were built into the Centerm structures when it was upgraded in 2000 and 2006. The caissons at the west end of the existing terminal were designed with openings to create refugia for fish. However, the observations from the survey indicate that the refugia provide limited habitat, with most sea life found near the openings where water flow was the greatest (Appendix G). On visual inspection of the water conditions at the bottom of the caissons it appears that the water was stagnant and perhaps anoxic due to lack of mixing with fresh marine water; however, no water samples were analyzed to confirm this.

At the east end of the Terminal, a number of areas are pile supported with open water beneath. When the sections of dock at the east end of Centerm were constructed, various features were added to provide habitat for fish and other marine life. These features included caisson refugia with cargo nets suspended inside the caissons and cobble trays located below the low tide level. The dive survey noted that these areas lacked vegetation and the presence of invertebrates was low (Appendix G). Feather duster tubeworms (*Sabellastarte indica*) were the most abundant invertebrate attached to the cargo nets with shiny orange sea squirts (*Cnemidocarpa finmarkiensis*), mussels, and barnacles commonly attached to the refugia just around the openings (Appendix G).

The area to be dredged to meet navigation requirements is characterized as a “rise” in the seabed that runs northwestward, just in front of the SeaBus dock. The western side slope and upper sections of the rise are predominantly covered with more granular materials including boulders, cobbles, pebbles and sand. Larger cobbles and boulders were found at the southern end of the dredge area. Mud/silt was the predominant substrate in the lower reaches of the survey area beyond the toe of the “rise.” Mud/silt was also commonly found distributed amongst the coarser substrates. Derelict and broken off pilings were found at the southern and western areas of the survey.

Highest species’ presence and diversity was located on hard stable substrates including boulders, cobbles, derelict piles and anthropogenic debris located in the southern section of the survey area. The diversity consisted of red algae, sea stars, anemones and barnacles. Burrows (likely clam siphon holes) were commonly found in areas of mud/silt at the north end and east side. Dungeness crabs were scattered throughout the survey area. Appendix G contains Foreshore Technologies’ September 2016 report of the dive survey conducted in this area in July 2016.

Juvenile salmon migrate through the Centerm area from early March to the end of May. The rock habitat area at the west end of Centerm with the bull kelp and diversity of biota would be attractive to juvenile salmonids as they migrate through Burrard Inlet to the open ocean. However, the numbers would not be as high as would be expected in similar habitats closer to the estuary of spawning streams. No juvenile smolts were observed during the October 2015, February 2016, or July 2016 surveys, but this is not unexpected as the surveys took place outside of the main out migration period. Adult salmon would be less likely to use the habitat adjacent to Centerm when they are on their migration to their spawning grounds. If adults are unable to migrate directly into freshwater (i.e., due to low water conditions) they would spend time closer to the mouth of the stream.



LEGEND

- CENTERM (EXISTING)
- CENTERM (EXPANDED)
- EXISTING RIP RAP DYKE
- EXISTING MUD FLATS
- UNDER DECK AREAS
- TEMPORARY ALTERATION (DREDGING)
- DREDGING LIMIT
- MEAN WATER LINE

CHART DATUM ELEVATIONS:

- +5.0m TO +3.8m (UPPER INTERTIDAL ZONE)
- +3.8m TO -1.0m (MID INTERTIDAL ZONE TO SHALLOW SUBTIDAL)
- -1.0m TO -5.0m (SHALLOW SUBTIDAL TO SUBTIDAL)
- -5.0m TO -10.0m (SUBTIDAL TO DEEP WATER)
- -10.0m TO -30.0m (DEEP WATER)

HABITAT TYPES WITHIN PROJECT FOOTPRINT

LOCATION	RIP RAP DYKE	MUD FLATS	UNDER DECK AREAS
W1	0.69	-	-
W2	-	2.10	-
W3	-	1.61	-
W4	-	1.14	-
S1	-	-	1.10
E1	-	1.93	-
E2	-	-	0.24
E3	-	-	0.13
E4	-	-	0.71
E5	-	2.01	-
E6	-	0.99	-
TOTALS	0.69 Ha	9.78 Ha	1.47 Ha

CHART DATUM ELEVATIONS (m)	LOCATIONS (Ha)											
	W1	W2	W3	W4	E1	E2	E3	E4	E5	E6	S1	Nav
+5.0m TO +3.8m (UPPER INTERTIDAL ZONE)	0.21	-	-	-	-	-	-	-	-	-	-	-
+3.8m TO -1.0m (MID INTERTIDAL ZONE TO SHALLOW SUBTIDAL)	0.01	-	-	-	-	0.24	0.13	-	-	-	1.1	-
-1.0m TO -5.0m (SHALLOW SUBTIDAL TO SUBTIDAL)	0.12	-	-	-	0.05				-	-		-
-5.0m TO -10.0m (SUBTIDAL TO DEEP WATER)	0.24	0.03	0.01	-	0.87				0.05	-		0.33
-10.0m TO -30.0m (DEEP WATER)	0.11	2.07	1.59	1.14	1.02				1.95	0.99		-
TOTAL	0.69	2.1	1.61	1.14	1.94	0.24	0.13	0.71	2	0.99	1.1	0.33

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CENTERM EXPANSION PROJECT
ENVIRONMENTAL ASSESSMENT
HABITAT IMPACTS

Figure 8-5

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8.5.1.3 Species of Conservation Concern

Rockfish are the most likely species of conservation concern to occur in Burrard Inlet. These include canary rockfish (*Sebastes pinniger*), bocaccio (*S. paucispinis*), yelloweye rockfish (*S. ruberrimus*), and rougheye rockfish (*S. aleutianus*) as identified on the website www.speciesatriskbc.ca. However, these rockfish species are unlikely to be found in the vicinity of the Centerm terminal as they prefer habitats at depths of 50 m or more, while the waters around Centerm are less than 40 m deep. A search of the DFO website dedicated to aquatic Species of Conservation Concern (http://www.dfo-mpo.gc.ca/species-especes/listing-eng.htm) did not reveal any recent reports of these rockfish fish being found in the Inner Harbour.

The eulachon (*Thaleichthys pacificus*) population that spawns in the Fraser River has been identified as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); however, this fish is common in Georgia Strait only during its spawning migration into the Fraser River. No records of eulachon being present in Burrard Inlet were found.

No SARA-listed fish species were recorded during the dive surveys around Centerm.

8.5.2 Marine Birds

Burrard Inlet is designated as an internationally Important Bird Area (IBA) (IBA Canada 2016). Burrard Inlet was given IBA status because it provides habitat for globally significant populations of western grebe, Barrow's goldeneye, and surf scoter and supports a nationally significant population of great blue heron. Most birds using Burrard Inlet are marine bird species such as loons, grebes, cormorants, geese, ducks, gulls, coots, and alcids.

Butler et al. (2015) completed an extensive survey of marine birds in Burrard Inlet in 2011, 2012, and 2013. During the course of the study 48 marine bird species and three listed on Schedule 1 of the *Species at Risk Act* including marbled murrelet, peregrine falcon, and great blue heron were identified. The most common birds were the glaucous-winged gull and the surf scoter.

Using spatial clustering analysis of the data, Butler et al. (2015) identified three types of areas, primary, secondary, and tertiary, representing areas where different birds were most often seen. Of the 48 species, 5 showed significant groupings around Centerm. These include:

- glaucous-winged gull (*Larus glaucescens*) with Centerm showing as a primary area
- western grebe (*Aechmophorous occidentalis*) with Centerm showing as a secondary area
- Canada goose (*Branta Canadensis*) with Centerm showing as a secondary area
- pelagic cormorant (*Phalacrocorax pelagcius*) with Centerm showing as a tertiary area
- double crested cormorant (*P. auritus auritus*) with Centerm showing as a tertiary area

Butler et al. (2015) also looked at groupings of birds by their feeding behaviour. The Centerm area is shown as a tertiary area for rocky shore specialists that included birds that specialize in eating mussels and other marine invertebrates, including sea ducks and shore birds. Examples include glaucous-winged gull, surf scoter, and Barrow's goldeneye.

8.5.3 Marine Mammals

The most common marine mammal in Burrard Inlet is the harbour seal (*Phoca vitulina*) with an estimated population of 300 animals (TWN 2005). The nearest known congregation of harbour seals is on log booms near Port Moody approximately 15 km east of Centerm (Butler et al. 2015); however, these animals were also observed along the north shore of the Inner Harbour.

Sightings of marine mammals in the harbour also include false killer whales (*Pseudorca crassidens*), killer whale (*Orcinus orca*), grey whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), harbour porpoise (*Phocoena phocoena*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), Steller sea lions (*Eumetopias jubatus*), and California sea lions (*Zalophus californianus*) (BCCSN 2013). From 1990 to 2014, the BC Cetacean Sightings Network reported 65 observations of larger marine mammals in the Outer Harbour and 6 sightings (3 grey whales, 2 killer whales, and 1 harbour porpoise) in the Inner Harbour (KWL 2015). Butler et al. (2015) reported four sightings of harbour porpoise in 2013 during their 2011 to 2013 sea bird survey of Burrard Inlet. All sightings were in the Outer Harbour.

A search of local news stories found five reports of killer whales entering Burrard Inlet, including on: May 11, 2011; June 19, 2013; March 12, 2015; June 22, 2015; and June 26, 2016. The 2013, 2015 and 2016 sightings were identified as Bigg's or transient killer whales. The pods ranged in number from 4 to 10 animals and on each occasion, the killer whales travelled various distances into Burrard Inlet, including into Indian Arm, and then exited the Inlet generally in less than a day.

DFO has recently amended its "Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada" (DFO 2016b), which included a revision to the distribution of critical habitat to include all nearshore marine waters within 3 nautical miles (5.56 km) of land along the entire BC coast, which includes Burrard Inlet. The report indicates that not all habitats within this area provide critical habitat, only those areas that contain the necessary functions, features, and attributes identified as important for transient killer whales. Though DFO 2016a provides no specific criteria or thresholds for many of the attributes, Table 8-3 summarizes the conditions within the study area and an assessment of the attributes in relation to providing critical habitat for the transient killer whale.

Table 8-3 Attributes of Critical Habitat Features for Transient Killer Whales found in Burrard Inlet (modified from DFO 2016a)

Habitat Feature	Attributes in Burrard Inlet
Prey abundance and distribution	Harbour seals locally abundant in Indian Arm but not abundant around Centerm
Water quality	Not defined in DFO 2016b. However, water in the Inlet is within CCME *Water Quality Guidelines for the Protection of Aquatic Life*, except for copper and nickel in marine water, and PAHs and PCBs in sediment (Tsleil-Waututh 2016)
Acoustic environment	Chronic noise related to shipping: thresholds not defined in DFO 2016b; however, the U.S. National Marine Fisheries Service (NMFS) defines a disturbance threshold for continuous noise of 120 dB re 1 µPa rms SPL, for both pinnipeds and cetaceans (NMFS 2014). Underwater noise data are not available for the area around Centerm but vessels such as SeaBus regularly cross the area.
Physical space	No impediments to movement (restrictions <100m), although the First Narrows is slightly less than 500 m in width.

The southern resident population of killer whales, transient (Bigg's) killer whale, Steller sea lion, grey whale, humpback whale, and harbour porpoise are listed on Schedule 1 of SARA and are sometimes observed in Burrard Inlet. Of these SARA listed species, DFO has identified that there is potential critical habitat for the transient killer whale within Burrard Inlet; however, the area around Centerm may not provide all the necessary characteristics of critical habitat as shown in Table 8-3. DFO's report on the southern resident population of killer whales indicates that the area of potential critical habitat for this animal extends to a point south of Point Grey which is the southwestern extent of the marine mammal study area (DFO 2011).

8.6 Potential Project Effects

8.6.1 Description of Potential Project Effects on Fish and Fish Habitat

The marine environment around the existing Centerm terminal is diverse. The marine habitats range from mud/silt substrates with a low diversity of plants and animals to areas of boulder and cobble that support diverse assemblages of algae, invertebrates, and fishes. Fish, such as lingcod, and invertebrates, such as Dungeness crab and sea cucumbers, were observed in the area and they are also support a CRA fisheries. Salmon smolts also pass through the Centerm area and they are also part of a CRA fishery. Without appropriate mitigation or habitat offsetting, Project construction would displace and alter habitat that support a diverse biota and would decrease the overall productivity of the local habitat. The following is a list of the Project activities to affect fish and fish habitat:

- dredging areas of soft unconsolidated mud at the east and west end of Centerm
- dredging cobble, gravel, mud substrate to provide sufficient area of adequate depth to enable cruise ships to dock
- demolishing the old pile-supported dock at the east end and infilling with structural fill
- creating rock dykes to contain the structural fill
- installing caissons at the west end of the berth extension to the Terminal
- using structural fill to infill areas to the east and west of the Centerm dock
- discharging stormwater to marine waters

The associated effects on fish and fish habitat include the following:

- short-term loss of the riprap, boulder, and cobble substrates that support the diversity of plants and animals along the western edge of the Terminal, to be replaced by similar habitat around the fringe of the new Terminal expansion
- loss of soft bottom/mud substrate habitat as a result of infilling sections of the seabed to create additional land at the west and east ends of the Terminal along with the containment dykes
- harm to aquatic organisms due to infilling with sand behind the dykes
- changes in fish behaviour caused by lighting (construction or operation) from the Terminal
- physical and behavioural changes to fish or marine mammals from noise created by construction and operation activities
- fish health and survival affected by degraded water quality caused by:
  - dredging (including increased turbidity and resuspension and dispersion of contaminated sediments)
  - deposition of sand to infill behind the dykes
  - demolition of the eastern end of the Terminal
  - release of contaminated stormwater during construction and future operation
- dredging related changes to the quality of fish habitat through the resuspension and redistribution of contaminated sediments settling on fish habitat

8.6.1.1 Change in Habitat

The habitat in the Project area ranges from areas of mud flat with low diversity of habitat and biota to rip rap/cobble slopes providing diverse habitat and supporting a diverse mix of biota. Often a direct measure of area is often used to quantify project effects however, at this site, due to the mix of habitat types and the associated range of productivity, area does not properly measure the value of the different habitats affected. Therefore, a method of standardizing the various habitat types was applied in order to compare the habitat types affected by the proposed Project and the habitat types that will be provided after the project is built. In order to do this an estimate of the total

habitat area and the observed productivity of different habitats were used to provide a qualitative measure of each habitat type. The following components of the habitat were used:

1) Relief or roughness of the substrate. The larger the substrate the greater the surface area available for organisms to attach and voids in the substrate for animals to use for cover. The relief factor (RF) applied as follows:

Substrate	***RF Value***
Rip Rap	*1.2 to 2.5*
Cobble	*1.2*
Pebble	*1.1*
Sand	*1.0*
Mud	*1.0*

   The surface area of a substrate type multiplied by the RF provides an estimate of the total area available for marine plants and animals to use.

2) Habitat Factor (HF), a qualitative assessment of the productivity of the habitat. A number of aspects of the existing habitat were used to determine its HF. These aspects include the species that are colonizing a particular substrate, stability of the substrate, diversity of biota, abundance, and water depth. The HF was determined by the marine biologists involved in the study of Centerm and ratings between 0.1 and 2.5 were assigned to the different habitat types observed in the study areas.

   The highest HF of 2.5 was assigned to shallow (-1 to -10 m deep) areas with stable substrate showing over 70 percent cover with brown algae, kelp, attaching invertebrates and the presence of fish, sea cucumbers, and crabs. Depth is an important component in determining the HF value as deeper habitats receive less sunlight and are therefore less productive. Areas assigned low HF values were characterized by unstable substrates with limited colonization by algae or invertebrate species or have stable substrates but colonization is limited due to factors such as limited exchange of water, poor exposure to light, or existing contamination. The lowest HF of 0.1 was assigned to the areas of deeper mud substrate with a low diversity of biota.

The RF and HF were combined to determine the Habitat Units (HU) provided by the different areas within the project, specifically:

$$HU = SA*RF*HF$$

Where: HU is has no dimension but provides a qualitative measure of the value of the habitat; SA = plan surface area (m^2).

Figure 8-5 shows the locations and area of the different habitats that would be affected by the proposed Project and Table 8-4 provides the RF, HF, and HU values for each of the different habitat types identified in the Project area. Construction of the proposed Project will impact an estimated 125,543 m^2 of useable surface area (applying the RF values to a plan area of 108,163 m^2) ranging from riprap in the high intertidal to fine mud in the deep subtidal area. Table 8-4 provides the HU for each of the different habitat types based on the formula above. The existing habitat that would be affected by Centerm construction represents 72,070 HUs. The majority of the habitat affected by the expansion of Centerm is mud or sand habitat, areas with low relief and low HF values due to low diversity of biota present.

Areas W4, E6, and the navigational dredge areas identified on Figure 8-5 were not included in the calculation of habitat affected by the proposed Project in Table 8-4. The soft sediments in W4 and E6 covering an area of 17,000 m^2 will be removed and the area infilled with sand to provide the structural support for the 78 m long caisson at the west end of the berth and to the toe of the containment dykes. This initially results in the loss of habitat from the placement of the caissons (included in the calculation of lost habitat) but for the area outside the caissons the effect is regarded as a temporary alteration. The area of clean sand outside the caisson footprint results in a

potential improvement in the nature and function of the habitat in this dredge area as potentially contaminated sediment is replaced with clean fill.

The use of HUs provides a framework for developing habitat balance calculations to compare pre and post construction habitat conditions at Centerm. Construction requires the establishment of new dykes at both the east and west ends to contain the fill material required to expand the land area of the Terminal. The face of the new containment dykes would be finished with large riprap, boulders, and cobble similar to the substrate currently present along the western edge of the terminal (i.e., mix of sizes from 255 mm to greater than 1,500 mm).

Figure 8-6 illustrates the habitat areas that could be achieved with the use of boulder and large riprap along the containment dyke at both the east and west ends of the Project. It is anticipated that this will create habitat with similar values to what currently exists along the west edge of Centerm.

Table 8-4 contains a breakdown by depth, the HUs that are expected to be established as a result of the project and the new rock dykes. In addition to the rock dykes, the 78 m long caisson will be added to the west end of Berth 6, which would provide a surface for barnacles, anemones, and sea stars to attach to. The habitat area created by the expansion project is 67,454 m^2 (RF value applied) which is estimated to produce 146,200 HUs. While there is a net loss of habitat on an aerial basis from the infilling of marine areas, there will be a net gain in HUs around Centerm because of the conversion of low value mud substrate to higher value, coarser rip rap substrate. The net increase is 74,000 HUs once the project is completed and the area is recolonized.

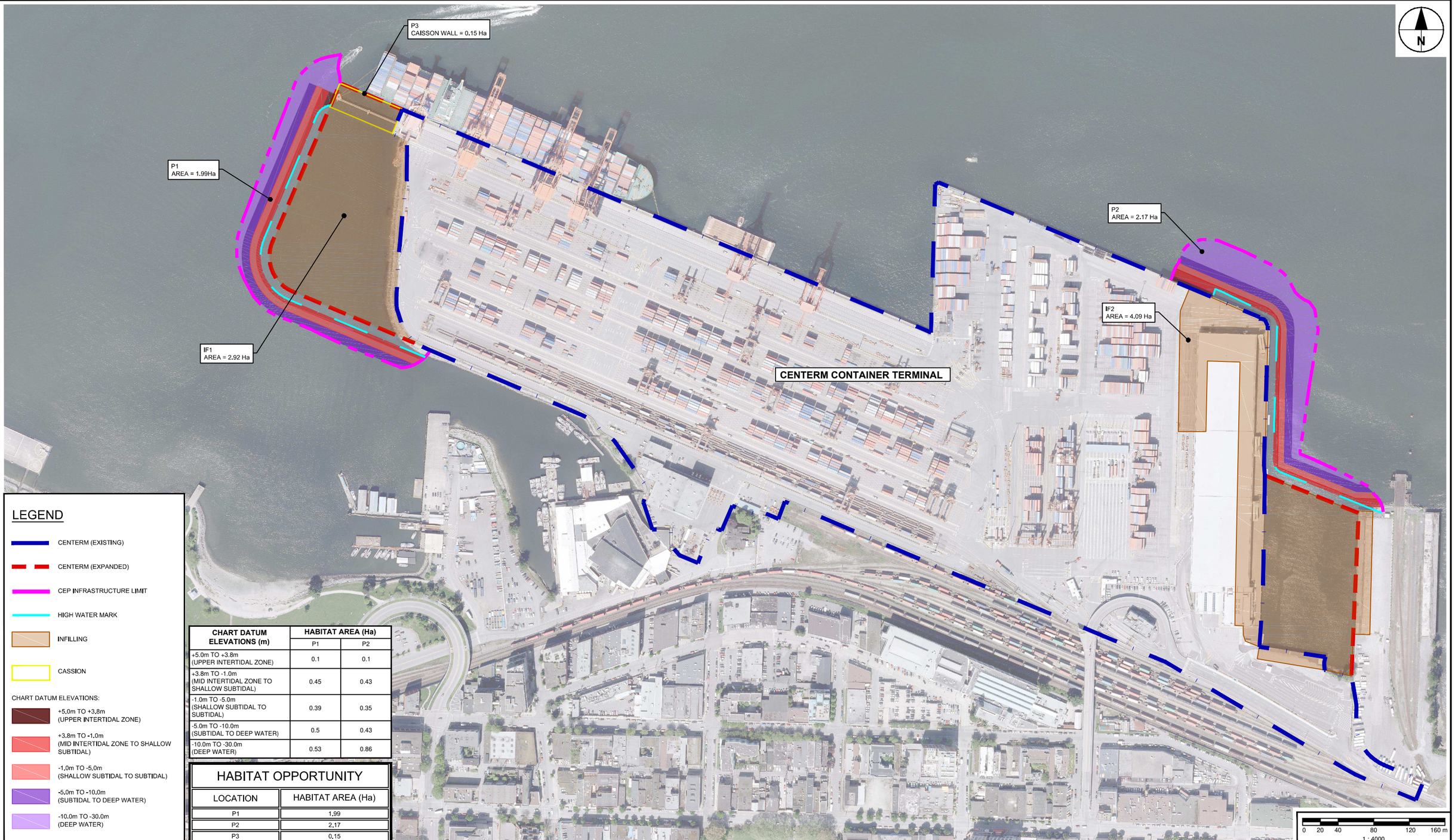
The dredging required to maintain navigation for cruise ships docking on the east side of Canada Place is not expected to result in a long-term disruption of fish habitat. The dredging consists of removing approximately 6,800 m^3 form an area of 3,300 m^2 to reduce seabed elevation from -8 m to -10 m deep. This area consists of granular material of pebbles and cobbles and mud substrate and is sparsely colonized by crabs, sea stars and anemones. Note that the biophysical survey report (Appendix G) details conditions for a larger area than is currently proposed to be dredged to provide the necessary depth for navigation. This change has resulted in excluding the area of more diverse substrate (cobble and boulder) and biota at the south end, closest to the SeaBus terminal. The existing dredge layout is expected to cause a temporary disruption to habitat values which should return to existing conditions once the area recolonizes after the initial dredging. Evidence indicates that this area will not need ongoing dredging to maintain the required depth.

Organisms are anticipated to colonize newly placed rock habitat quickly (Naito 2001; Bohnsack et al. 1994). The habitat features on the new dyke faces would almost double the HU units that would be lost and are expected to be fully functional in 1 to 3 years.

8.6.1.2 Risk of Mortality, Injury, or Physical Disturbance

Infilling would result in the mortality of slow moving and sessile invertebrates. Sessile organisms (i.e., barnacles, tube worms, sea pens, etc.) would be most susceptible to harm. Dredging would also harm sessile invertebrates within the dredge footprint and potentially those outside the dredge area that could be smothered by the deposition of sediment outside the dredge footprint. The replacement habitat for areas that would be infilled is described above. Some of the dredged areas would be infilled with clean sand and would be available for recolonization.

Other physical disturbances to fish would include noise and light during construction and operation, both of which can negatively affect behaviour, resulting in decreased survival. During dredging and infilling work, barges on water and on land and activities next to the water could increase the amount of light shining on the water if it is necessary to work long hours to meet the project schedule. Underwater noise from construction is expected to be limited to dredging and fill placement and the associated process of vibro-densification to compact the new fill. Noise associated with dredging and the dumping of sand fill is not known to create noise levels damaging to fish. Similarly, vibro densification does not create the shock waves that can damage fish. The current plan does not include any pile driving or blasting.



LEGEND

- CENTERM (EXISTING)
- CENTERM (EXPANDED)
- CEP INFRASTRUCTURE LIMIT
- HIGH WATER MARK
- INFILLING
- CASSION

CHART DATUM ELEVATIONS:

- +5.0m TO +3.8m (UPPER INTERTIDAL ZONE)
- +3.8m TO -1.0m (MID INTERTIDAL ZONE TO SHALLOW SUBTIDAL)
- -1.0m TO -5.0m (SHALLOW SUBTIDAL TO SUBTIDAL)
- -5.0m TO -10.0m (SUBTIDAL TO DEEP WATER)
- -10.0m TO -30.0m (DEEP WATER)

CHART DATUM ELEVATIONS (m)	HABITAT AREA (Ha)	
	P1	P2
+5.0m TO +3.8m (UPPER INTERTIDAL ZONE)	0.1	0.1
+3.8m TO -1.0m (MID INTERTIDAL ZONE TO SHALLOW SUBTIDAL)	0.45	0.43
-1.0m TO -5.0m (SHALLOW SUBTIDAL TO SUBTIDAL)	0.39	0.35
-5.0m TO -10.0m (SUBTIDAL TO DEEP WATER)	0.5	0.43
-10.0m TO -30.0m (DEEP WATER)	0.53	0.86

HABITAT OPPORTUNITY

LOCATION	HABITAT AREA (Ha)
P1	1.99
P2	2.17
P3	0.15

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No.	Date	REVISION	Dr'n	Ch'd
C	2016-07-25	TERMINAL UPDATES	FY	NB
B	2016-07-19	TERMINAL UPDATES	FY	NB
A	2016-05-08	TERMINAL UPDATES	FY	NB

FOR INFORMATION AND REVIEW
2016 / 04 / 01

Klohn Crippen Berger
PBX ENGINEERING

LEAD CONSULTANT
AECOM

DP WORLD Vancouver

PORT of vancouver

DESIGN BY	NB
DRAWN BY	AY
APPROVED	NB
DATE	2016-04-01
SCALE	1:4000
PMV SITE	

CENTERM EXPANSION PROJECT
ENVIRONMENTAL ASSESSMENT
TERMINAL EXPANSION FOOTPRINT
AND HABITAT OPPORTUNITY

Figure 8-6

SIZE	DWG.	SHEET	REV.
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Table 8-4: Fish Habitat Balance Sheet for Terminal Expansion

Project Footprint

SUBSTRATE CHARACTERISTICS							BIOTA CHARACTERISTICS					
Location	Type and Percent Cover	Size (mm)		RF [1]	Plan Area	Surface Area	Habitat Indicators	Percent Cover	Elev. (m) CD		HF [2]	Habitat Units
		Low.	Upp.		m^2	m^2			Low.	Upp.		
West End of Centerm (W1)[3]	Angular Rock (100%)	600	> 1500	2.0	1,700	3,400	Limited or no Biota - some Barnacles	0.0	3.8	5.0	0.1	340.0
West End of Centerm (W1)	Angular Rock (100%)	600	>1500	2.0	2,100	4,200	Barnacle, Rockweed, Mussels, Red and Green Algae	>70	-1.0	3.8	2.3	9,660
West End of Centerm (W1)	Angular Rock (100%)	255	>1500	2.0	2,200	4,400	Sargassum, Broad Bladed Kelps, Bull Kelp, Seastars	>70	-5.0	-1.0	2.5	11,000
West End of Centerm (W1)	Angular Rock (100%)	255	>1500	2.0	2,800	5,600	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	>50	-10.0	-5.0	2.3	12,880
West End of Centerm (W1)	Angular Rock (100%)	255	600	1.5	1,100	1,650	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	>50	-30.0	-10.0	2.0	3,300
West End of Centerm (W2 and W3)	Mud (100%)	<0.063		1.0	37,063	37,063	Dungeness,	<1	-30.0	-10.0	0.5	18,532
East End of Centerm (E5)	Mud (>95), Boulder, Cobble Wood Debris (<5)	0.063	1000	1.1	20,100	22,110	Anemones, Dungeness	<1	-30.0	-5.0	0.2	4,422
East End of Centerm (E1)	Mud (85), Boulder (<2), Cobble (<10)	0.063	1000	1.2	19,300	23,160	Anemones, Dungeness	<1	-30.0	-1.0	0.3	6,948
Under Balantyne Pier (S1)	Mud (100%)	<0.063		1.0	11,000	11,000	Dungeness,	<5	-10.0	3.8	0.1	1,100
Under Balantyne Pier (E2, E3, E4)	Anthropogenic Materials	Varies		1.2	10,800	12,960	Barnacles, Shrimp	<5	-10.0	3.8	0.3	3,888
				Total Areas	**108,163**	**125,543**					**Total Habitat Units**	**72,070**

Notes: 1 - Relief Factor (RF) is a relative measure of the stability and relief associated with different substrate types. 2 - Habitat Factor (HF) is a relative measure of Habitat opportunity represented by the substrate for the species normally anticipated to be present in the area. 3 - W1, E1, etc., correspond to areas identified on Figure 8-5.

Habitat Created

SUBSTRATE CHARACTERISTICS							BIOTA CHARACTERISTICS					
Location	Type and Percent Cover	Size (mm)		RF [1]	Plan Area	Surface Area	Habitat Indicators	Percent Cover	Elev. (m) CD		HF [2]	Habitat Units
		Low.	Upp.		m^2	m^2			Low.	Upp.		
West End of Centerm - new dyke (P1)	Angular Rock (100%)	600	> 1500	2.0	1,084	2,168	Limited or no Biota - some Barnacles	0.0	3.8	5.0	0.1	2,168
West End of Centerm - new dyke (P1)	Angular Rock (100%)	600	>1500	2.0	4,472	8,944	Barnacle, Rockweed, Mussels, Red and Green Algae	>70	-1.0	3.8	2.3	20,571
West End of Centerm - new dyke (P1)	Angular Rock (100%)	250	>1500	2.0	3,892	7,784	Sargassum, Broad Bladed Kelps, Bull Kelp, Seastars	>70	-5.0	-1.0	2.5	19,460
West End of Centerm - new dyke (P1)	Angular Rock (100%)	250	>1500	2.0	5,062	10,124	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	>50	-10.0	-5.0	2.3	23,285
West End of Centerm - new dyke (P1)	Angular Rock (100%)	250	>1500	2.0	5,347	10,694	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	>50	-30.0	-10.0	2.0	21,388
West End Extension of Caisson (P3)	Concrete - smooth surface	NA		1.0	1,466	1,466	Barnacles, Shrimp, Anemones, Seastars	>70	-30.0	3.8	1.5	2,199
East End of Centerm - new dyke (P2)	Angular Rock (100%)	250	> 1500	2.0	1,069	2,138	Limited or no Biota - some Barnacles	0.0	3.8	5.0	0.1	214
East End of Centerm - new dyke (P2)	Angular Rock (100%)	250	>1500	2.0	4,249	8,498	Barnacle, Rockweed, Mussels, Red and Green Algae	>70	-1.0	3.8	2.3	19,545
East End of Centerm - new dyke (P2)	Angular Rock (100%)	600	>1500	2.0	3,508	7,016	Sargassum, Broad Bladed Kelps, Bull Kelp, Seastars	>50	-5.0	-1.0	2.5	17,540
West End of Centerm - new dyke (P2)	Angular Rock (100%)	250	>1500	2.0	4,311	8,622	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	>50	-10.0	-5.0	2.3	19,831
East End of Centerm - new dyke (P2)	Angular Rock (100%)	250	>1500	2.0	8,606	17,212	Laminarian, Bull Kelp red algae, Dungeness, Shrimp	<1	-30.0	-10.0	0.5	8,606
				Total Areas	**43,066**	**67,454**					**Total Habitat Units**	**146,200**

Notes: 1 - Relief Factor (RF) is a relative measure of the stability and relief associated with different substrate types. 2 - Habitat Factor (HF) is a relative measure of Habitat opportunity based on the diversity of animals present and the depth range. 3 - P1, P2, etc., correspond to areas identified on Figure 8-6.

Once the proposed Project is built, the operational aspects would be similar to pre-construction conditions. There is expected to be a minor increase in the amount of light on the water during nighttime operations. Centerm has always operated on a 24 hour basis and DPWV is currently changing existing site lighting to LED and the expanded areas will also have LED lights, which will be more focused on work areas with less light on the water. The number of vessel calls to Centerm is projected to increase by one ship per week, which would result in a minor increase in vessel movement in the inner and outer harbour posing little additional risk of marine mammals interacting with vessels. In addition, the rate of travel of ships in the harbour is restricted and is slow enough that these animals should be able to avoid direct contact with ships. Also, the amount of light and noise associated with ship movement and loading would be a minor increase in existing conditions. Overall, the anticipated underwater noise and lighting effects related to the proposed construction and operation of the Project are not expected to change appreciably from the existing noise and light levels currently present in Vancouver Harbour.

8.6.1.3 Change in Water Quality

Construction activities including dredging, rock placement, infilling, and demolition works can affect water quality. Chapter 7 identifies the potential for a residual effect on water quality, including elevated sediment levels within the dredge area and potentially moving beyond the dredge area. This effect could affect fish and fish habitat. Elevated TSS levels are known to have physiological and behavioural effects on fish. These effects would be greatest in the immediate work area; however, fish would move from areas of active construction. Another effect of dredging is the resuspension of contaminated sediments, which can migrate from the dredge area and settle on substrates. The analysis of the existing bottom sediments within and outside the dredge area indicated that the contamination levels are fairly similar, so the movement of sediments from the construction site to surrounding areas is not expected to affect habitat quality. Furthermore, the contaminants are not expected to be available for biological uptake (see Chapter 7 for discussion). Finally, infilling would cause expulsion of pore water; however, analysis in Chapter 7 indicated no residual effect on water quality and therefore this effect is unlikely to affect fish and fish habitat.

Fish and fish habitat could also be affected by the release of contaminated stormwater during the construction and the operation phases of the proposed Project. Centerm has an established stormwater management system that includes remote-controlled outfalls on each side of the Terminal (north, east, south, and west) with oil/water separators to prevent any contaminated runoff from entering the marine environment. The existing systems would be maintained and would be expanded during construction to handle the surface flow from all new land surfaces. The stormwater system would remain functional during all periods of construction and an updated Stormwater Pollution Prevention Plan (AECOM 2016d) will be developed and implemented for the operation of the upgraded Terminal. With these measures in place, the assessment of impacts on water quality in Chapter 7 concluded that any discharges to the marine environment will meet CCME *Water Quality Guidelines for the Protection of Aquatic Life*, and therefore, fish and fish habitat would not be affected.

8.6.2 Summary of Fish and Fish Habitat Mitigation Measures

Mitigation measures for fish and fish habitat include the following:

- The productivity of fish and fish habitat will be maintained around Centerm by finishing the rock dykes with a range of rock sizes similar to what currently exists on the existing dykes of 255 mm to 1,500 mm diameter.
- The potential for physical harm to fish during dredging, infilling, and demolition will be reduced by:
  - conducting a salvage of Dungeness crab prior to the start of dredging or deposition of sand for infilling
  - starting work at a slow pace to provide mobile species the time to move from the construction area
  - using clean fill that has limited potential for distribution outside the construction area and causing elevated turbidity and TSS
- The demolition of the pile supported structures will be managed so that debris does not enter the water. For example, booms may be used to contain floating debris.

- An Erosion and Sediment Control Plan will be developed by the DB Contractor prior to the start of construction and implemented for the site that minimizes risk of sedimentation during all the construction phases of the proposed Project. The plan will, where applicable, include the following:
  - installation of effective and maintained erosion and sediment control measures
  - site isolation measures such as silt curtains or silt booms for containing and managing suspended sediment where in-water work such as dredging is required
- Machinery will be washed, refueled, and serviced and fuels and other materials will be stored at a sufficient distance from the water to prevent any deleterious substances from entering the water.
- Lighting effects will be reduced by adopting BMPs for lighting as listed in the CEMP (AECOM 2016a).
- The gradual start-up of underwater activities will give mobile fish an opportunity to leave the area. The increase in underwater noise during construction and operation are expected to be limited. Pile driving and blasting is not anticipated for this project. Mitigation measures to protect fish are proposed for underwater noise effects related to the proposed construction and operation of the Project as the increased levels are expected to be in keeping with the existing noise levels in Vancouver Harbour.
- The existing Stormwater Pollution Prevention Plan and related infrastructure will be expanded to control on-site runoff during construction and operation so that any discharges to the marine environment meet CCME water quality guidelines.
- Additional mitigation measures listed in the CEMP (AECOM 2016a) will also be implemented to reduce effects of construction activities on fish and fish habitat.

8.6.3 Description of Potential Project Effects on Marine Birds

The area where construction activities would take place is currently affected by vessel movement and noise and light effects from the existing Centerm operations. Also, nearby facilities, including the cruise ship terminal and Vanterm, create disturbance on the water. The increased marine activity during construction and operation could alter current use of the area for activities such as feeding. During construction, the main disruptive behaviour will be the in-water works (dredging and infilling). The published in-water work windows set by DFO for Burrard Inlet to protect marine species are from August 16 to February 28. The construction schedule for in-water works will comply with timing restrictions that will be established by DFO in the *Fisheries Act* Authorization for the proposed Project. This will mitigate the effect on marine birds that feed on juvenile fishes such as the out migrating salmonids. During the operational phase, the increased vessel activity would be minor in relation to the existing vessel traffic in the Inner Harbour. The additional activities associated with the construction and operation of the proposed Project are unlikely to have a noticeable effect on the marine birds that use the Inner Harbour. The ongoing management of lighting on the Terminal will result in more focused lighting, which will reduce the amount of fugitive light that might affect the feeding behaviour of marine birds. Butler et al. (2015) reported that various species are regularly observed in the area of Centerm; however, the area was not a primary area for any bird except for the glaucous-winged gull, which is well known to tolerate human activity. Therefore, no mitigation measures are recommended for marine birds.

8.6.4 Description of Potential Project Effects on Marine Mammals

The on- and in-water activity associated with construction of the proposed Project could affect marine mammals through interaction with vessels and noise from construction. During the operational phase, the increased vessel traffic could lead to an increase of marine mammal/vessel interactions.

The Project plan currently anticipates in-water works to be restricted to dredging, vibro-densification, and wharf demolition. While these activities would generate underwater noise, the associated noise levels are lower than other in-water activities such as blasting and pile driving with an impact hammer. Dredging and densification activities are expected to occur over six months (Figure 8-5).

The proposed Project is located in a very active harbour with constant vessel activity, including small pleasure craft, the public transit ferry (SeaBus), tugboats, and large ocean-going vessels. The Environmental Impact Statement recently submitted for the port authority's proposed Roberts Bank Terminal 2 project (PMV 2015i) considered the effects of similar underwater activities, including vibratory pile driving, vibro-densification, and dredging, and concluded that:

> *Overall, average underwater noise predicted for the future, with the addition of project construction and operation activities, is expected to be comparable to average existing levels of underwater noise due to existing high levels, but will at times exceed existing conditions.*

Similar conclusions are applicable to this Project with the potential for occasional exceedances of the current underwater noise levels within Burrard Inlet. The activities currently proposed for the construction or operational phases do not produce intense underwater noises that would cause physical harm to marine mammals, however, construction related noises may be sufficient that marine mammals would avoid the area.

In 2012, the large vessel traffic (cargo vessels, passenger vessels, and other merchant vessels) transiting Burrard Inlet was reported to be 336 vessels per month (Kinder Morgan 2013). During operation of the proposed Project, the additional ship activity of one extra vessel per week represents a 1 percent increase in vessel activity, which is unlikely to cause additional disturbance to the marine mammals or increase the probability of vessel strikes for the marine mammals that occasionally enter Burrard Inlet. Also, vessels are required to travel at a safe speed while in Port of Vancouver waters (PMV 2016b), which benefits marine life and provides navigational safety.

DFO's recent amendment to the recovery strategy for the transient population of killer whales (DFO 2016b) indicates that all the waters of Burrard Inlet are potential critical habitat. While the criteria for defining specific areas of critical habitat have not been clearly defined (i.e., water quality criteria, under water noise levels), under current conditions the area probably does not meet the requirements for critical habitat. Currently the area experiences high levels of boat traffic including the SeaBus travelling past the west end of Centerm on a regular and frequent basis for up to 19 hours a day along with regular vessel activity around Centerm. Also, one of the main prey species for transient killer whales, harbour seals, congregate in greatest numbers near Port Moody with the closest area with regular sightings of seals being along the north shore of Vancouver Harbour, opposite Centerm (Butler et al. 2015).

8.6.5 Summary of Marine Mammal Mitigation Measures

The following mitigation measure will be implemented to reduce potential effects of construction noise on marine mammals:

- Slow start-up procedures will be implemented for dredging, infilling, and vibro-densification in-water work. This will allow marine mammals in the vicinity of the activity to leave the area.

The increased vessel traffic calling at Centerm during the operational phase is not expected to affect marine mammals.

8.6.6 Summary of Potential Residual Effects

Table 8-5 summarizes the potential residual adverse effects on marine resources and associated mitigation measures and indicates whether there is a residual adverse effect from the proposed Project.

Table 8-5: Summary of Potential Residual Effects on Marine Resources

Potential Adverse Effects and Project Components	Mitigation Measures	Potential Residual Effects
Loss of fish habitat and reduced productivity from dredging and infilling for Terminal extension, removing and rehabilitating Ballantyne Pier, and discharging stormwater to marine waters. See Table 8-4 for areas and habitat values affected by the Project.	▪ Placement of suitably sized cobble, boulders, and riprap (255 mm to 1,500 mm) on the surface of the containment dykes to provide habitat that can be colonized by invertebrates, algae, and fish ▪ See Chapter 7 for stormwater mitigation measures	Proposed mitigation measures are expected to fully offset the anticipated impact; however, there could be a temporal loss of overall productivity as it could take up to 3 years for new habitat to be as productive as the existing habitat.
Harm to fish and fish habitat from dredging and infilling	▪ Conduct crab salvage before dredging or infilling ▪ Sediment containment measures to confine the sediment plume during dredging as described in Chapter 7 ▪ Gradual start-up of dredging and infilling activities to allow animals time to move from the area	Loss of sessile marine invertebrates within the dredge areas and potentially outside the dredge area from deposition of sediment released to the water column. Minor loss of Dungeness crabs as it is unlikely that the salvage will collect all crabs in the area.
Dredging and infilling effects on water quality (i.e., increase in TSS) affecting fish health or behaviour	See Chapter 7	Residual effect confined to construction area; water quality criteria protective of aquatic life would be met outside the work area.
Dredging causing redistribution of contaminated sediment causing degraded habitat in areas where the sediment settles	See Chapter 7	No residual effect expected as the sediment that could be redistributed is similar in contaminant loading as the nearby areas where the sediment may settle; therefore, no additional degradation of fish habitat quality.
Deterioration of marine water quality from pore water expulsion	No mitigation warranted; see Chapter 7 for details	No residual effect
Lighting affecting aquatic species during construction and operation	BMPs built into the Lighting Management Plan (i.e., focus lighting on work areas not over the water, use lights when necessary, etc.)	Mitigation measures are anticipated to avoid any residual effect
Noise affecting aquatic species during construction and operation	▪ Gradual start-up of noisy in-water activities to allow animals an opportunity to move away from the activity ▪ Marine mammal sightings in the area are rare and the anticipated noise levels are low; therefore, additional mitigation measures such as observers are not suggested	No residual effect anticipated
Increased vessel traffic interacting with marine mammals	Existing requirements for vessels to move at a safe speed within Vancouver Harbour (PMV 2016b)	No residual effect anticipated due to limited interaction between marine mammals and vessels travelling to Centerm
Demolition of wharf structures effect on fish and fish habitat	▪ Avoid any products of demolition from entering the water by working at an appropriate pace ▪ Place booms around the demolition area to contain any floatable materials that fall into the water	No residual effect anticipated

Potential Adverse Effects and Project Components	Mitigation Measures	Potential Residual Effects
Stormwater discharge causing degraded water quality during construction	▪ Develop an appropriate Erosion and Sediment Control Plan ▪ Stormwater system on-site to capture and direct stormwater through outfalls equipped with oil/water separators and control valves	No residual effect anticipated
Stormwater discharge causing degraded water quality during operation	Expand the existing storm sewer system to include the expanded surface area including oil/water separators and control valves	No residual effect anticipated

While the proposed mitigation measures are expected to minimize serious harm to fish and fish habitat in the vicinity of Centerm, the overall area affected and the time line for new habitat to become productive may exceed thresholds established by DFO. Therefore, a request for review has been submitted to DFO that describes the project and the potential impacts to fish and fish habitat and the proposed mitigation measures. DFO could determine that the project does constitute a serious harm and that an authorization will be required. An Application for an Authorization will be developed following the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations* and the associated guidelines provided by DFO. An important component of an application is the offsetting plan to offset the residual serious harm. Opportunities for offsets will be developed and shared with Aboriginal groups. After consultation on the opportunities a preferred offset plan will be developed and submitted to DFO.

8.6.7 Characterization of Significance of Residual Effects

The following provides a summary of the overall residual effect to marine resources based on the summary provided in Table 8-5.

8.6.7.1 Fish and Fish Habitat

The main residual effects for fish and fish habitat include:

- loss of productive habitat and harm to fish or fish habitat from the dredging and placement of fill
- potential effects of degraded water quality on fish health.

The following summary characterizes those residual effects.

<u>*Habitat Loss*</u>

Magnitude: Habitat lost due to the new Project footprint of 72,070 HUs would be replaced with an estimated 146,200 HUs. The new habitat is expected to avoid effects on fish that are part of a commercial, recreational, or aboriginal fishery or fish or habitat that support such a fishery.

Geographic extent: Residual effects on fish habitat are expected to be confined to the Project footprint and the immediate area around the construction work area.

Duration: The loss of the 72,070 HUs would be permanent. However, the lost habitat would be replaced by new habitat within three years.

Reversibility: The measures to create new fish habitat would take up to three years to achieve similar productivity to the habitat that would be lost.

Frequency: Impacts on habitat would occur once, during the construction phase.

Water Quality Effects

Magnitude: Exceedance of CCME *Water Quality Criteria for the Protection of Aquatic Life* would occur within the construction mixing zone.

Geographic extent: During construction, mitigation measures will limit water and sediment quality effects on the construction area, which will also limit serious harm to fish.

Duration: Construction effects on water and sediment quality affecting fish would be temporary and intermittent during the six months of in-water construction.

Reversibility: Water quality effects related to release of sediment would be short term and fully reversible.

Frequency: Dredging effects would be intermittent to daily.

8.6.7.2 Marine Mammals

The marine mammals study indicates that where the project activities are concentrated receives limited use by marine mammals and the project represents a 1 percent increase in vessel traffic; therefore, the construction and operational phases of the proposed Project are unlikely to have any residual effects.

8.7 Monitoring and Follow-up

A construction monitoring program will be implemented that reports on the effectiveness of the mitigation measures, and if necessary, mitigation measures will be modified or new ones applied. The CEMP (AECOM 2016a) provides the basis for water quality and fish and fish habitat protection. This plan will include requirements to monitor the effects of potentially impacting activities, such as dredging and infilling and, if necessary, identify changes in the way work is carried out or the need for additional mitigation measures to lessen impacts. Additional surveys of fish habitat will be conducted prior to in-water construction if the Project layout is changed. The CEMP will also provide guidance on when fish salvages, including Dungeness crab, and/or exclusion measures may be required.

A follow-up program will be developed that will:

- Post construction, assess the footprint of the actual development to confirm that the final areas affected are consistent with the areas described in Section 1.1 or any modifications made during the final design for and approved prior to the start of construction.
- Track the progress of fish habitat development for three to five years or until it appears to have achieved full potential. This will involve conducting dive surveys of the habitat created to assess recolonization. This will include surveys of algal and invertebrate recolonization, habitat stability, and fish utilization.