IR2020-2.1 Avoidance and mitigation measures for project construction – Fish and fish habitat

Background

In his letter of August 24, 2020, the minister of environment and climate change (the minister) requested additional information regarding project construction avoidance and mitigation measures, including design options, related to fish and fish habitat.[1] The Vancouver Fraser Port Authority (the port authority) had previously proposed the following design-related mitigation measures to avoid or reduce effects on fish and fish habitat:[2]

- Designing the project within the footprint defined in the project construction update[3] (commitment #3), which includes:
  - Placement of the marine terminal in predominantly subtidal waters, thereby reducing direct footprint effects on more productive intertidal habitats such as intertidal marsh and native eelgrass, which provide food and refuge opportunities for fish
  - Reduced footprint for the berth pocket and marine approach area on the terminal's south side to reduce potential effects on fish and fish habitat
  - Optimized footprint of the tug basin to promote drainage during tidal exchanges in order to maintain good water quality in this localized area of the inter-causeway area and reduce potential effects on fish and fish habitat
- Designing the project such that the causeway widening has a reduced footprint (commitment #4), to reduce overlap with intertidal habitat important for fish rearing
- Designing and constructing the project to reduce the effects of channel formation during dyke construction (commitment #5), to reduce overlap with intertidal habitat important for fish rearing
- Designing the terminal with a rounded northwest corner to reduce the potential for seabed scour and associated sediment deposition post-project construction (commitment #6)
- Designing and constructing portions of the terminal's north face and northern side of the causeway with a rocky shoreline to create fish habitat opportunities within the structure (commitment #7)
- Designing the caisson face to include fish refuge habitat (commitment #8)

In addition to prioritizing avoidance of adverse project interactions with fish and fish habitat through careful infrastructure location and design, the port authority will mitigate environmental risks during construction of the project to protect fish and fish habitat (commitments #10, 14, 34, 49, 50, 51, 53). The port authority will verify the effectiveness of measures taken to mitigate adverse environmental effects of the project (commitment #81), and develop a final offsetting plan (commitment #40) to offset effects on fish and fish habitat that remain after the implementation of avoidance and reduction measures.

Based on a comprehensive assessment of the effects of the project on marine fish and fish habitat at Roberts Bank, and considering the proposed avoidance, reduction, and offsetting measures to mitigate adverse project

[1] CIAR Document #2067 From the Minister of Environment and Climate Change to the Vancouver Fraser Port Authority re: Information Request. https://iaac-aeic.gc.ca/050/documents/p80054/135827E.pdf
[2] CIAR Document #2001 From the Vancouver Fraser Port Authority to the Review Panel re: Updated Project Commitments. https://iaac-aeic.gc.ca/050/documents/p80054/130776E.pdf
[3] CIAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update. https://iaac-aeic.gc.ca/050/documents/p80054/122934E.pdf

effects, the assessment concluded the project was unlikely to result in a significant adverse residual effect on the productivity of marine vegetation (fish habitat) or fish and invertebrates.

Guided by ongoing consultation in one-on-one meetings and multi-group workshops with Indigenous groups and engagement with regulators, the port authority has undertaken further work to reduce effects to fish and fish habitat in response to the minister's request.

Since the closing remarks, the port authority has conducted an analysis of terminal and rail operations, and subsequently evaluated options to reduce the project footprint. The outcomes of this work to determine technically and economically feasible project design options and the implications to potential effects on fish and fish habitat are provided in the response below.

Consultation with Indigenous groups on proposed design refinements to reduce potential effects on fish and fish habitat has been completed and feedback received on the port authority's approach to the minister's request that has been incorporated into the response. Ongoing consultation with Tsawwassen First Nation and Musqueam Indian Band have underscored the continued importance to the nations of opportunities to reduce effects on fish and fish habitat through refinements to the design that minimize project interactions with fish, in particular juvenile salmon and crab in the intertidal area. Semiahmoo First Nation and Ts'uubaa-asatx First Nation have noted interest in the potential for design changes to reduce the need for, and effects of, dredging. Ts'uubaa-asatx has also highlighted the importance of introducing protection, restoration, enhancement, and innovative measures to increase fish habitat in the region, as outlined in Ts'uubaa-asatx's Lake Cowichan First Nation Policy: South Arm of the Fraser River and Approaches June 1, 2018.

The port authority has also investigated additional operational mitigation measures and terminal and causeway design options with the objective of reducing the loss of habitat and potential disruption to juvenile salmon migration during project operation (refer to **IR2020-2.2** for more information).

In addition, information on all potential projects being considered by the port authority to offset project-related effects to fish and fish habitat is detailed in **IR2020-1.1**. The port authority also explains in **IR2020-1.2** how effects of the project on fish, including juvenile salmon, and fish habitat that remain after avoidance and reduction measures will be offset.

Response

Minister's request: Describe any technically feasible Project design options (e.g., reduced footprint) that would reduce effects to fish and fish habitat. Describe the effects to fish and fish habitat that would be avoided for each option.

In consultation with Indigenous groups, the port authority evaluated project design options that could avoid or reduce effects to fish and fish habitat. As described for the proposed project reference concept design in the environmental impact statement (EIS)[4] and project construction update, project components were located and configured to reduce effects to fish and fish habitat.

Based on these and other mitigation measures incorporated in the project's design and further review of potential project design options, a technically and economically feasible design-related means of further reducing effects to fish and fish habitat is to optimize the marine terminal and widened causeway footprints. These optimizations are described below, and include a reduction of approximately 14.4 hectares (ha) at the terminal (~10.3 ha) and causeway (~4.1 ha). The extents of area reductions are approximate and will be determined during the detail design stage and in consideration of cargo handling equipment electrification requirements.

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[4] CIAR Document #181 Roberts Bank Terminal 2 Project – Environmental Impact Statement, Volume 1, Sections 4 (Project Description) and 5 (Alternative Means of Carrying out the Project). https://iaac-aeic.gc.ca/050/evaluations/document/114311

The reduction in effects from the implementation of these footprint reduction options to fish and fish habitat are described subsequently. To clarify, effects to fish and fish habitat will be avoided within the footprint reduction area. Considering the biophysical local assessment area (LAA; Figures 11-1, 12-1, and 13-1 in the EIS[5]), overall effects to fish and fish habitat that were assessed in the EIS and the project construction update will be reduced (not avoided) by reducing the project footprint.

Marine terminal footprint reduction

To determine if the marine terminal footprint could be reduced (to reduce potential effects to fish and fish habitat), the port authority evaluated the project's railway operations and overall terminal operations. This work focused on determining efficiency improvements and minimum operating area requirements to achieve the annual terminal design operating capacity of 2.4 million (M) twenty-foot equivalent units (TEUs). In this evaluation, container vessel schedule scenarios, varying cargo volumes, and historic peak cargo handling data for existing container terminals in the Port of Vancouver were taken into account.

From these evaluations, it was determined that the terminal infrastructure layout could be feasibly optimized to reduce the operating area and the overall marine terminal footprint, while maintaining the terminal design capacity. In summary, the following are the key changes to the marine terminal surface infrastructure design layout (compared to the EIS layout) that dictated the extent to which the marine terminal footprint could be reduced:

- Utilizing latest technologies, including rail-mounted gantry cranes with larger spans, to replace the double module (north and south) intermodal yard (IY) with a single module IY
- Adding the IY storage yard for storing and staging railcars
- Optimizing the container yard to reduce the required area, while maintaining separation of automated cargo handling equipment (shuttle carriers, stacking cranes) and manually-operated trucks, and ensuring sufficient operating areas for cargo handling equipment

It is not technically feasible to reduce the terminal length (east-west direction), as an operating requirement for the IY on the north side of the terminal includes minimum 4,000-foot (1,219-m) track lengths for loading and unloading railcars and the full 1,300 m wharf length (on the south side) is required to accommodate anticipated container vessels.

A multidisciplinary analysis demonstrates that the most favourable perimeter of the terminal (north-south direction) to optimize (shift) is the north side. The north terminal perimeter is closest to higher value intertidal fish habitat (e.g., juvenile Chinook salmon habitat), which is also noted for its importance to Indigenous groups; shifting this perimeter southward is therefore more conducive for fish rearing and foraging as a result of calmer conditions (i.e., less exposure to waves and currents) on the north side. The alternative of shifting the south terminal perimeter northward would require less fill and dyke materials due to the shallower depth, but additional dredging for an expanded berth pocket and approach channel would be required. Optimizing the south marine terminal perimeter would increase environmental effects during terminal construction, and that the seaward (south) shift of the north perimeter was preferred with regard to fish and fish habitat.

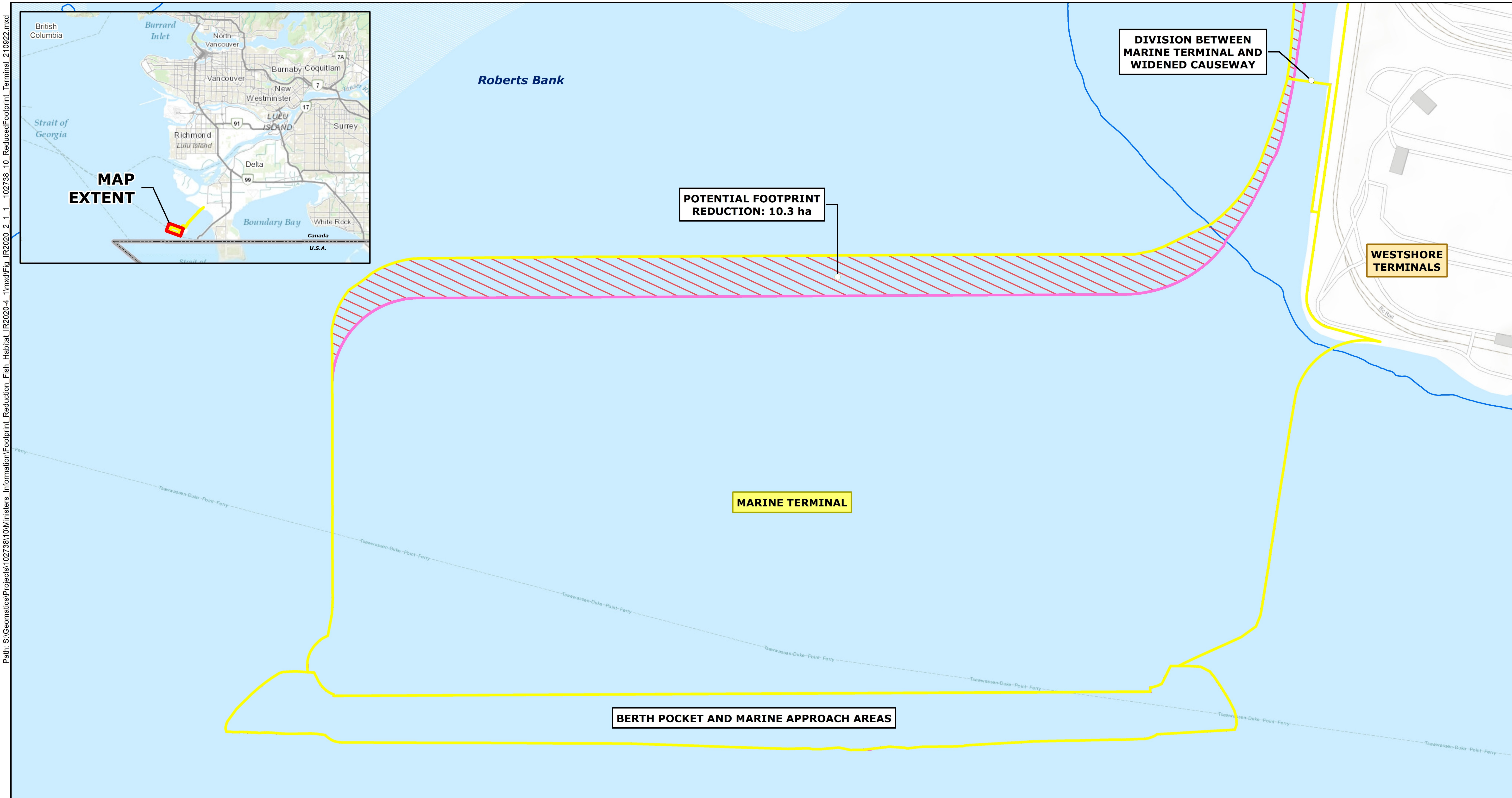
It is feasible to reduce the marine terminal width (north-south direction) by a maximum of up to approximately 67 m by shifting the north perimeter seaward, as shown in **Figure IR2020-2.1-1**. With this potential reduction, the marine terminal footprint can be reduced by up to approximately 10.3 ha. **Figure IR2020-2.1-1** also illustrates the approximate minimum footprint required to sustain terminal operation at its design capacity of 2.4 M TEUs annually, based on the current design assumptions. It is important to note that a reduced terminal footprint may preclude certain design options from being considered in the future; for example, although much of the container handling equipment will likely be zero-emission, including the largest cranes, zero-emission shuttle carriers are not currently available (only prototypes exist). The port authority notes that electrification of the entire terminal to

[5] CIAR Document #181 Roberts Bank Terminal 2 Project – Environmental Impact Statement, Volume 3: Biophysical Effects Assessment, Figures. https://iaac-aeic.gc.ca/050/evaluations/document/114311

accommodate currently available zero-emission cargo handling equipment, including horizontal transport equipment, would have an impact on the size of the terminal footprint, as space would be required to accommodate the electrical infrastructure and equipment operations. If electrification of the entire terminal is required for zero-emission cargo handling equipment, the potential terminal footprint reduction would be limited to approximately 6 ha (instead of the potential for a 10.3 ha reduction identified).

Assuming a maximum reduction of approximately 10.3 ha on the north side of the terminal were to be implemented,[6] the reduction in effects to fish and fish habitat is described below, following a description of a footprint reduction for the widened causeway.

[6] If a reduction in the marine terminal footprint is integrated in the proposed project reference concept design, the effects assessment conclusions for other intermediate and valued components presented in the EIS and project construction update are not expected to change, based on the conservative approach taken in these assessments and the extent of the footprint reduction.



Path: S:\Geomatics\Projects\102738\10\Ministers Information\Footprint Reduction Fish Habitat IR2020-4 1\mxd\Fig IR2020 2 1 1 102738 10 ReducedFootprint Terminal 210922.mxd

Legend

- BOUNDARY OF PROJECT AREA
- REDUCED FOOTPRINT BOUNDARY
- FOOTPRINT REDUCTION AREA
- 0 m (CHART DATUM)
- PROJECT COMPONENT
- EXISTING LANDMARK

0 125 250
Metres
1:6,000
NAD 1983 UTM Zone 10N

N

PORT of vancouver

ROBERTS BANK TERMINAL 2

MARINE TERMINAL POTENTIAL FOOTPRINT REDUCTION AREA

DATE:	FIG No.
22/09/2021	IR2020-2.1-1

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Widened causeway footprint reduction

The port authority also evaluated options to further optimize the footprint of the widened causeway.

These evaluations demonstrate that the infrastructure layout on the widened causeway could be changed to further reduce the footprint, while maintaining the terminal design capacity. In summary, the following are the key changes to the causeway infrastructure concept design (compared to the EIS reference concept design) that dictated the extent to which the widened causeway footprint could be reduced:

- Improving railway operation efficiency through reduction of the distributed power unit locomotive setout yard area by shifting the location for railcar repairs to the T-yard
- Optimizing the area required for the utility corridor as well as emergency access and service roads along the northern side of the widened causeway

Based on these changes, the widened causeway footprint can be reduced by approximately 4.1 ha. As shown in **Figure IR2020-2.1-2**, the shoreward (east) end of the causeway can be reduced by approximately 1.8 ha (top panel) and the seaward (west) end of the causeway by approximately 2.3 ha (bottom panel). If a reduction in the widened causeway footprint is integrated in the proposed project reference concept design, the effects assessment conclusions for other intermediate and valued components presented in the EIS and project construction update are not expected to change, based on the conservative approach taken in these assessments and the extent of the footprint reduction. The reductions in footprint area by project component are summarized in **Table IR2020-2.1-1**. For comparison purposes, project component footprint areas stated in the EIS and project construction update are also provided.[7]

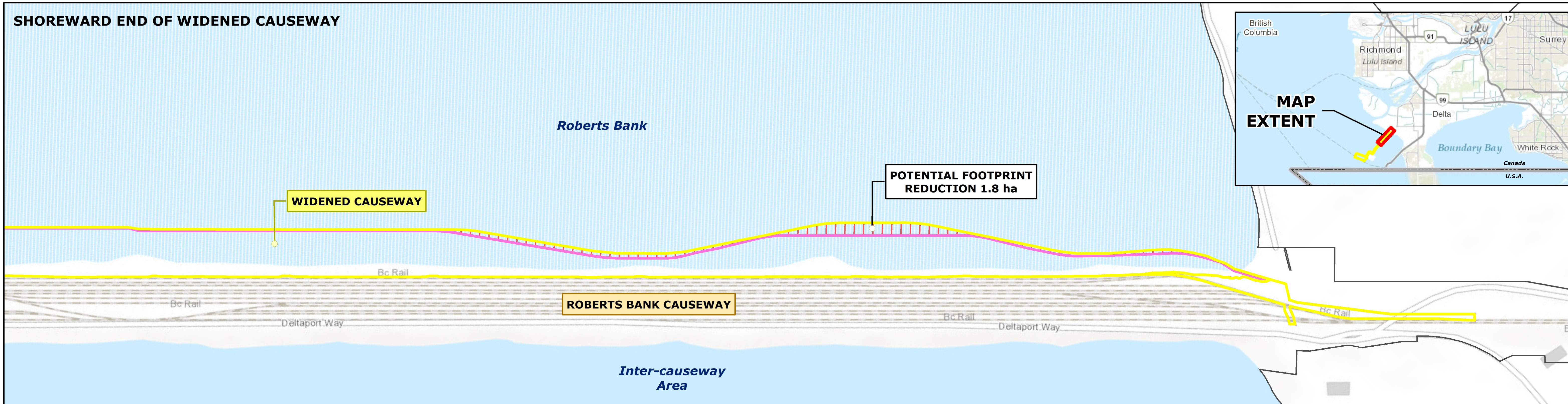
[7] Project areas stated in the EIS and project construction update are summarized in Table UR18-1 in CIAR Document #1872 Undertaking #18: From the Vancouver Fraser Port Authority - Project Area and Navigational Closure Area. https://iaac-aeic.gc.ca/050/documents/p80054/130184E.pdf

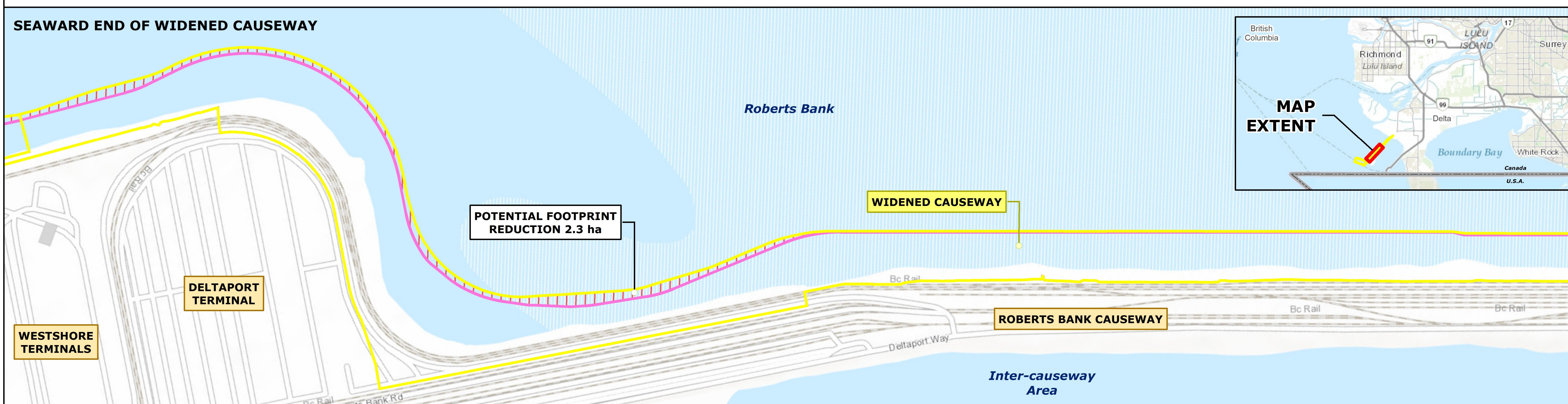
Table IR2020-2.1-1: Roberts Bank Terminal 2 project areas by project component for the project reference concept design presented in EIS and project construction update and considering potential project footprint reduction area

Project component	Project reference concept design areas (ha)		Project areas with potential reductions IR2020-2.1 (ha)
	EIS Table 4-1	PCU Table 2-1	
Marine terminal	**133.5**	**130.0**	**up to 119.7**
Terminal (including slope, toe of slope, and three-berth wharf)	116.1	116.1	up to 105.8
Berth pocket and marine approach areas	17.4	13.9	13.9
Widened causeway	**49.4**	**49.4**	**45.3**
Widened causeway (including slope, toe of slope)	42.4	42.4	38.3
Overpass and road tie-ins on existing causeway*	6.0	6.0	6.0
Rail tie-ins and emergency access roads tie-in on mainland*	1.0	1.0	1.0
Expanded tug basin	**3.1**	**3.1**	**3.1**
Total project area	**186.0**	**182.5**	**up to 168.1**

Notes: All project component areas are approximate and will be finalized during detail design stage.

- EIS – Environmental Impact Statement (CIAR Document #181); PCU – Project Construction Update (CIAR Document #1210)
- * Project components proposed to be located on land and therefore not considered in the calculations of the reduction in project-related losses in fish and fish habitat productivity presented in the responses to **IR2020-1.2** and **IR2020-2.1**





Legend

- BOUNDARY OF PROJECT AREA
- REDUCED FOOTPRINT BOUNDARY
- FOOTPRINT REDUCTION AREA
- PROJECT COMPONENT
- EXISTING LANDMARK

0 125 250
Metres
1:7,000
NAD 1983 UTM Zone 10N

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ROBERTS BANK TERMINAL 2

WIDENED CAUSEWAY
POTENTIAL FOOTPRINT REDUCTION AREA

DATE:	FIG No.
22/09/2021	IR2020-2.1-2

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Reduction in effects to fish and fish habitat

In summary, a total of up to approximately 14.4 ha (or approximately 8% of the current proposed project footprint)[8] of fish and fish habitat would no longer be directly impacted by the project (compared to the footprint assessed in the EIS and the project construction update), if the full footprint reduction were to be implemented. The majority (68%) of the habitat that would be avoided is in the subtidal zone and it is used predominantly by species such as older juvenile and adult Dungeness crab and flatfish, as well as by infaunal invertebrates (e.g., bivalves). The remainder of the habitat that would be avoided comprises intertidal marsh and eelgrass along the causeway and it is used predominantly by species such as juvenile Chinook and chum salmon, Dungeness crab, and forage fish, including Pacific herring and Pacific sand lance. The importance of reducing effects on habitat for fish and invertebrates in all life stages has been emphasized by Indigenous groups, Fisheries and Oceans Canada, and the review panel.

Reductions would be expected in effects to fish and fish habitat that are direct (defined as an effect related to the project footprint, consistent with the EIS) and indirect (defined as a project-related effect that cascades in the food web through predatory-prey interactions or through changes in abiotic/environmental conditions). Direct and indirect effects to fish and fish habitat that would be reduced if the full footprint reduction were to be implemented are summarized in **Table IR2020-2.1-2** and described in greater detail in the response below. Additional technical information on the approach taken to describe the reduction in direct and indirect effects to fish and fish habitat is provided in **Appendix IR2020-2.1-A**.

Table IR2020-2.1-2: Proposed footprint reduction (in hectares; ha) by Roberts Bank Terminal 2 project component and summary description of reduced direct and indirect effects to fish and fish habitat

Project component	Footprint reduction	Description of reduced direct and indirect effect

Marine terminal	Up to 10.3 ha	• Overlap with fish habitat reduced by 0.2 ha of native eelgrass, 9.5 of ha sand/mud (direct)
		• Overlap with predicted suitable Pacific sand lance burying habitat reduced by 9.7 ha (direct)
		• Overlap with predicted suitable Dungeness crab habitat reduced by 9.7 ha (respectively for juvenile, adult, and gravid life stages) (direct)
		• Loss of primary productivity reduced by 0.2 tonnes (t) (direct)
		• Loss of secondary productivity reduced by 9.6 t (direct)
		• Habitats within the footprint reduction area will be available to fish and invertebrate species to perform important life functions (indirect), including:
		  o Pacific sand lance burying, overwintering
		  o Dungeness crab rearing, foraging, burying
		  o Flatfish rearing, foraging, burying

[8] The potential project footprint reduction of 8% (to approximately 161.1 ha) consists of approximate 10.3 ha reduction for the marine terminal and approximate 4.1 ha reduction for the widened causeway, relative to the current proposed total marine footprint of 175.5 ha (outlined in CIAR Document #1872).

Project component	Footprint reduction	Description of reduced direct and indirect effect
Widened causeway	4.1 ha	• Overlap with fish habitat reduced by 1.5 ha of intertidal marsh, 0.5 ha of native eelgrass, 2.4 ha of non-native eelgrass, <0.1 ha of mixed native/non-native eelgrass, <0.1 ha of rock (direct) • Loss of primary productivity reduced by 0.6 t (direct) • Loss of secondary productivity reduced by 14.9 t (direct) • Overlap with predicted suitable Dungeness crab habitat reduced by 1.5 ha (juvenile life stage), 0.2 ha (adult life stage), and 0.1 ha (gravid life stage) (direct) • Habitats within the footprint reduction area will be available to fish and invertebrate species to perform important life functions (indirect), including: o Juvenile Chinook and chum salmon rearing, seeking refuge from predators, adapting physiologically to higher salinities o Dungeness crab rearing, seeking refuge from predators, foraging o Flatfish and forage fish rearing, foraging o Pacific herring rearing, foraging, seeking refuge from predators, spawning
Expanded tug basin	No further footprint changes*	• No reduction in effects to fish and fish habitat assessed in the EIS

Note: * During project planning, the expanded tug basin footprint was previously optimized (2013 Option 1 concept to Option 2 concept) to reduce potential effects to fish and fish habitat (CIAR Document #181, Section 5).

Reduced direct effects on fish habitat

In this part of the response, reduced direct effects to fish habitat that would be achieved with the maximum possible footprint reduction described above are described in terms of areal extent[9] (in ha) and productivity[10] (in tonnes (t)). The potential reduction of the project footprint by up to 14.4 ha would avoid up to 4.7 ha of vegetative habitat and up to 9.7 ha of bare sand/mud and rock (**Table IR2020-2.1-3**). This represents a reduction by 12% and 7%, respectively, in direct project effects to vegetative and bare habitats, assessed in the EIS and updated in 2019 to support the development of the project's application for a *Species at Risk Act*-compliant *Fisheries Act* Authorization.

Vegetative habitats that would be avoided are predominantly in the intertidal zone along the shoreward and seaward ends of the widened causeway. They comprise 1.5 ha of intertidal marsh, 2.4 ha of non-native eelgrass, and 0.5 ha of native eelgrass (**Table IR2020-2.1-3**; **Appendix IR2020-2.1-A**, Figures 1 and 2). A mixed native/non-native eelgrass patch of <0.1 ha along the seaward end of the causeway would also be avoided (**Table IR2020-2.1-3**; **Appendix IR2020-2.1-A**, Figure 2). In the subtidal zone, a reduction of the marine terminal footprint would avoid 0.2 ha of native eelgrass (**Table IR2020-2.1-3**; **Appendix IR2020-2.1-A**, Figure 3). Overall, the maximum possible reduction in the project footprint (i.e., up to 14.4 ha) would result in a reduction by 12%,

[9] Calculations are based on empirical surveys undertaken in 2019 to update the distribution of fish habitats at Roberts Bank to support the development of the project's application for a *Species at Risk Act*-compliant *Fisheries Act* Authorization.
[10] Effects from the project to fish and fish habitat were assessed in the EIS using productivity (in t) as a metric. The numbers presented in this response represent productivity associated with the extent of fish habitats that would no longer be directly impacted by the project due to a potential footprint reduction.

31%, and 12% in direct (footprint; areal extent) effects to marsh, native eelgrass, and non-native eelgrass, respectively, assessed in the EIS and updated in 2019 (**Table IR2020-2.1-3**).

Bare habitats within the maximum possible footprint reduction area consist of 9.7 ha of sand/mud and <0.1 ha of rock (**Table IR2020-2.1-3**; **Appendix IR2020-2.1-A**, Figures 1 to 3). This represents a potential reduction by 7% in direct effects to bare habitats assessed in the EIS and updated in 2019 (**Table IR2020-2.1-3**).

An annualized[11] average of 0.8 t of primary productivity[12] (associated with the vegetative habitats) would no longer be affected should the maximum footprint reduction be implemented. For comparative purposes, this is equivalent to approximately 0.1% of indirect increases in primary productivity forecasted in the LAA after avoidance and reduction measures.[13] Bare habitats (i.e., sand/mud, rock) do not have associated primary productivity values as they are classified by the lack of vegetation and characterized instead by the dominant substrate type.

Each vegetative and bare (except for rock) habitat type, which would be avoided if the maximum possible footprint reduction were to be implemented, also sustains secondary productivity[14] associated with sessile infaunal invertebrate communities consisting of macrofauna, meiofauna, and infaunal bivalves. Secondary productivity within the potential footprint reduction area amounts to 24.6 t (**Table IR2020-2.1-3**). This includes the contribution of 0.002 t of orange sea pen productivity present within 1.8 ha of a sparse orange sea pen bed that overlaps with the potential footprint reduction area at the marine terminal (**Appendix IR2020-2.1-A**, Figure 3). For comparative purposes, secondary productivity that would be avoided if the maximum possible footprint reduction were to be implemented is equivalent to about 5.7% of indirect increases in secondary productivity forecasted in the LAA after avoidance and reduction measures.[15]

Overall, a reduction of the project footprint by 14.4 ha would reduce direct (footprint-related) losses in primary and secondary productivity by a total of 25.4 t (**Table IR2020-2.1-3**), or by 1.5% when compared to combined indirect increases in primary and secondary productivity forecasted in the LAA after avoidance and reduction measures.

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[11] Corrected to account for seasonality, i.e., percentage of the year that the vegetation has seasonal growth. Correction factors for all vegetative habitat types are provided in **Appendix IR2020-2.1-A**.

[12] Primary productivity refers to the rate of organic carbon production by marine vegetation (e.g., eelgrass, marsh) using sunlight through photosynthesis.

[13] For indirect increases in the productivity of intertidal marsh, native and non-native eelgrass after avoidance and reduction measures, see column 'Direct and indirect project effects with avoidance and reduction measures (with – without project; t)' in **Table IR2020-1.2-4**.

[14] Secondary productivity refers to the rate of biomass generation by consumer organisms (e.g., macrofauna, meiofauna, bivalves) via ingestion and assimilation of organic matter. Orange sea pens contribute to secondary productivity of subtidal sand/mud.

[15] For indirect changes in the productivity of infaunal bivalves, macrofauna, meiofauna, and orange sea pens after avoidance and reduction measures, see column 'Direct and indirect project effects with avoidance and reduction measures (with – without project; t)' in **Table IR2020-1.2-4**.

Table IR2020-2.1-3: Potential reduction in direct (footprint-related) loss in primary, secondary, and total productivity by habitat type within the potential footprint reduction area

Habitat type	Zone	Potential footprint reduction (ha)	Potential footprint reduction (%) from EIS updated in 2019[a]	Potential reduction in direct productivity loss (t)		
				Primary productivity[b]	Secondary productivity[c]	Total productivity[d]
Intertidal marsh	Intertidal	1.5	12	0.4	4.9	5.3
Native eelgrass	Intertidal	0.5	31	0.1	1.6	1.7
	Subtidal	0.2		0.2	0.2	0.5
Non-native eelgrass	Intertidal	2.4	12	0.1	7.8	7.9
Native/non-native eelgrass	Intertidal	<0.1	<0.1	<0.1	<0.1	<0.1
Sand/mud	Intertidal	0.2	7	0.0	0.6	0.6
	Subtidal	9.5		0.0	9.4	9.4
Rock	Intertidal	<0.1	<1	0.0	0.0	0.0
Total		**14.4**	**8**	**0.8**	**24.6**	**25.4**

Notes:

a. Per cent (%) reduction in the direct effect to each habitat type is relative to the project footprint assessed in the EIS[16] and updated during empirical surveys undertaken in 2019 to support the development of the project's application for a *Species at Risk Act*-compliant *Fisheries Act* Authorization.
b. Primary productivity refers to the rate of organic carbon production by marine vegetation (e.g., eelgrass, marsh) using sunlight through photosynthesis.
c. Secondary productivity refers to the rate of biomass generation by consumer organisms (e.g., macrofauna, meiofauna, bivalves) via ingestion and assimilation of organic matter. Orange sea pens contribute to secondary productivity of subtidal sand/mud.
d. Total productivity = primary productivity + secondary productivity.
e. t – tonnes; ha – hectares.

Table IR2020-2.1-4 provides the areal extent within the potential footprint reduction area of habitat predicted to be suitable for Pacific sand lance burying and Dungeness crab life stages (i.e., juveniles, adults, gravid females[17]). Suitability in this response is characterized as moderate or high based on outputs of a habitat suitability modelling study[18] undertaken to support the marine invertebrate and marine fish effects assessment presented in the EIS.

A potential reduction in the project footprint by 14.4 ha would avoid 9.7 ha of habitat that is predicted to be suitable for Pacific sand lance burying (**Table IR2020-2.1-4**; **Appendix IR2020-2.1-A**, Figure 4). This represents a reduction by 1.1% in the direct effect on suitable Pacific sand lance habitat assessed in the EIS. With the project, a total of 768 ha of moderately suitable and 490 ha of highly suitable habitat would be available in the LAA for Pacific sand lance burying (based on the potential footprint reduction described above and quantifications provided in Hemmera 2014).

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[16] A breakdown of the habitat types that overlap with the project footprint assessed in the EIS and project construction update can be found in the response to IR11-13 (CIAR Document #1360).
[17] Gravid life stage refers to females carrying eggs or developing young.
[18] CIAR Document #181 Roberts Bank Terminal 2 – Environmental Impact Statement, Volume 3: Biophysical Effects Assessment, Appendix 12-A: Habitat Suitability Modelling. https://iaac-aeic.gc.ca/050/evaluations/document/114311

The maximum potential footprint reduction (i.e., 14.4 ha) would also avoid 11.3 ha, 9.9 ha, and 9.9 ha of habitat predicted to be suitable for Dungeness crab juvenile, adult, and gravid life stages, respectively (**Table IR2020-2.1-4**; **Appendix IR2020-2.1-A**, Figures 5 to 7). The direct effect on suitable crab habitat assessed in the EIS would be reduced by 0.4%, 0.9%, and 0.8% for crab juveniles, adults, and gravid females, respectively. Predicted suitable crab habitat that would be available in the LAA following project construction amounts to a total of 2,877 ha for juveniles, 1,825 ha for adults, and 729 ha for gravid females (based on the potential footprint reduction described above and quantifications provided in Hemmera 2014).

Table IR2020-2.1-4: Areal extent (in hectares) of habitat predicted to be moderately or highly suitable for Pacific sand lance burying and Dungeness crab life stages (juveniles, adults, gravid females) within the potential footprint reduction area

Species	Life stage	Areal extent (ha) of predicted suitable habitat in the potential footprint reduction area		
		Moderately suitable	Highly suitable	Total
Dungeness crab	Juvenile	10.0	1.3	11.3
	Adult	0.0	9.9	9.9
	Gravid	2.6	7.3	9.9
Pacific sand lance	Burying	9.7	<0.1	9.7

Notes:

- Gravid Dungeness crab life stage refers to females carrying eggs or developing young.
- Habitat suitability determined during modelling undertaken for the EIS (Hemmera 2014).

Reduced indirect effects on fish

A reduction in direct effects to fish habitat (described above) would also result in a reduction to indirect effects to fish through the provision of food and refuge associated with fish habitats within the potential footprint reduction area. In summary, the habitats that would be avoided would be available to fish to undertake important life functions (e.g., rearing, foraging, burying, spawning). Vegetative habitats that would be avoided would also provide refuge against predators. Lastly, the amount of productivity associated with habitats that would be avoided will be available as food to fish that comprise the food webs of the habitat types within the potential footprint reduction area.

A reduction in indirect effects to fish and fish habitat from a potential project footprint reduction has been evaluated qualitatively (and not quantitatively using the updated Roberts Bank ecosystem model (RB model)).

Based on the numerical model results, the only predicted appreciable difference that the reduced project footprint has on the physical parameters, as compared to the changes that were predicted to be induced by the footprint of the EIS project reference concept design, is that the depth of scour and sediment deposition in the immediate vicinity of the terminal's rounded northwest corner are both slightly reduced.[19] This relatively minor change is most likely due to the north perimeter of the marine terminal (and northwest corner) being shifted seaward by approximately 67 m (i.e., shift to deeper water would reduce seabed erosional forces resulting from flow being diverted around the terminal during tidal exchanges).

This is a relatively minor change compared to that described in the EIS and incorporated in the updated RB model. No appreciable change (with a potential reduction in the marine terminal footprint) is predicted for other

[19] The area of scour in the immediate vicinity of the terminal's rounded northwest corner, assuming a marine terminal footprint reduction of 10.3 ha, is estimated to be approximately 5 ha, as compared to 5.5 ha that was reported in EIS Section 9.5 based on the project reference concept design footprint.

coastal geomorphic conditions (i.e., bottom current velocity, salinity, wave height) that were also incorporated in the updated RB model.

A potential reduction in the project footprint by up to 14.4 ha would result in a reduction to indirect project effects on fish and fish habitat productivity that are relatively small compared to productivity increases forecasted by the updated RB model (refer to Tables 4-1 and 4-2 in **Appendix IR2020-2.1-A** for potential reduction of primary and secondary annualized productivity loss proportional to the biophysical LAA). Therefore, reduction in the effects to fish and fish habitat productivity if the full footprint reduction were to be implemented has not been taken into account in the overall productivity calculations for fish and fish habitat presented in **IR2020-1.2**, and are thus conservative. A qualitative summary of the reduction in indirect effects to fish is provided below for juvenile Chinook salmon, Dungeness crab, and forage fish, including Pacific herring and Pacific sand lance. Detailed descriptions of the reduction in indirect effects to representative fish species or groups selected for the assessment presented in the EIS are included in **Appendix IR2020-2.1-A**.

The potential project footprint reduction would result in a reduction in indirect effects to juvenile Chinook salmon. Based on literature and empirical information (for a review of literature, see **Appendix IR2020-2.1-A**), intertidal marsh is well understood to provide productive habitat for juvenile Chinook salmon, including opportunities for rearing and estuarine growth, as well as refuge from predation. Intertidal marsh also provides a rearing environment that is less stressful to juvenile Chinook salmon as they physiologically adapt to higher salinities during rearing. Potential footprint reduction along the causeway would avoid 1.5 ha of intertidal marsh, resulting in 12% more marsh habitat that would remain available to juvenile Chinook salmon during and following project construction, compared to what was assessed in the EIS.

The potential project footprint reduction would also result in a reduction in indirect effects to juvenile and adult life stages of Dungeness crab and forage fish, such as herring and sand lance (for a review of literature, see **Appendix IR2020-2.1-A**). Eelgrass is well understood to provide feeding opportunities and vegetative cover for juvenile and sub-adult crabs, as well as juvenile herring and sand lance. At Roberts Bank, including in the footprint reduction area, eelgrass has also been documented to support some adult herring spawn. Potential reduction of the project footprint would avoid 0.7 ha of native eelgrass. This would result in 31% more habitat, compared to what was assessed in the EIS, that would provide food and refuge to juvenile Dungeness crab and forage fish, as well as spawning substrate for adult herring.

In summary, a reduction of the current proposed project footprint would result in a reduction in indirect effects to fish through increased availability of fish habitat for important life functions and the provision of prey through the reduction in direct loss of secondary productivity. A reduction in indirect effects is expected for both adult and juvenile life stages of fish, including Chinook and chum salmon, herring, sand lance, and Dungeness crab, who use the habitats that will be avoided for life functions such as rearing, foraging, predator avoidance, and spawning.

Appendices

Appendix IR2020-2.1-A Hemmera Memo: RBT2 – Potential project footprint reduction and reduced effects to fish and fish habitat