



# B2D2 Project

## Lynn Creek Estuary Complementary Measures Report

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## ACRONYMS AND DEFINITIONS

ACRONYM	DEFINITION
AFA	Application for Authorization
AH	Autonomous Hydrophone
AIMMD	Artificial Intelligence Marine Mammal Detection
B2	Berth 2
BC	British Columbia
BKR	Bull Kelp Restoration
Cargill	Cargill Terminals
CD	chart datum
DFO	Fisheries and Oceans Canada
Dynamic Ocean	Dynamic Ocean Consulting Ltd.
EZ	Exclusion Zone
FAA	Fisheries Act Authorization
FFHPP	Fish and Fish Habitat Protection Program
FMO	Fisheries Management Objectives
HADD	Harmful alteration, disruption, or destruction
Hatfield	Hatfield Consultants LLP
LCE	Lynn Creek Estuary
Musqueam	Musqueam Indian Band
NBT	Neptune Bulk Terminals (Canada) Ltd.
NHC	Northwest Hydraulic Consultants Ltd
NSSK	North Shore Streamkeepers
P1, P2, P3	Phase 1, Phase 2, Phase 2
PER	Project and Environmental Review
PIs	Principle Investigators
Port Authority	Vancouver Fraser Port Authority
RA	Regulatory Authority
ROV	Remotely Operated Vehicle
SCUBA	Self Contained Underwater Breathing Apparatus
Squamish	Squamish First Nation
Tsleil-Waututh	Tsleil-Waututh Nation
UBC	University of British Columbia
USA	United States of America
UVic	University of Victoria



ACRONYM	DEFINITION
VanPile	Vancouver Pile Driving Ltd.
WWL	Western Water Lot

# 1 INTRODUCTION

## 1.1 Background

Fisheries and Oceans Canada (DFO) – Fish and Fish Habitat Protection Program (FFHPP) have determined that a Fisheries Act Authorization (FAA) is required for the Neptune Bulk Terminals (CANADA) Ltd. (NBT) Berth 2 (B2) Shiploader Replacement Project (B2 Project). The FAA is required due to the harmful alteration, disruption, or destruction (HADD) of fish habitat associated with the B2 Project seabed footprint. To support the Offsetting Plan, NBT is proposing both physical and complementary offsetting measures.

- The physical measures will comprise 90% of the offsetting requirements and will be the Lynn Creek Estuary (LCE) Offset Project (the LCE Offset Project). The intention of the LCE Offset Project is to implement a habitat enhancement project in an important Burrard Inlet estuary that targets juvenile salmonid habitat. Justification for the selection of the LCE Offset Project relative to B2 Project effects is provided in the report titled ‘the Lynn Creek Estuary Offsetting Plan’ (NBT, 2023i).
- The complementary measures will comprise 10% of the offsetting requirements and will be the LCE Bull Kelp Restoration (BKR) Program. The intention of the LCE BKR Program is to assess the efficacy of bull kelp restoration in the LCE. The LCE BKR Program is an extension of the existing NBT BKR Program at the Terminal. Justification for the complementary measures component is described in this report.

The determination of the proportional breakdown between the physical and complementary measures components is based on the DFO-FFHPP guidance document titled ‘Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act’ (DFO, 2021), which stipulates that a maximum of 10% of an Offsetting Plan can be supported through complementary measures. Thus, complementary measures for the inclusion of research or innovative offsetting strategies are only allowed as supplementary to physical measures offsetting. The justification is due to difficulty in determining measurable metrics for ‘equivalency’. However, complementary measures can be considered measurable in ways that lead to positive outcomes for marine ecosystems, through:

- Advancing the scientific knowledge for unique restoration techniques for high quality habitat such as bull kelp and eelgrass.
- Allows for the inclusion of Indigenous Knowledge into determining pertinent research programs.
- Scientific information for research outcomes is a driver of policy directives (Soomai, 2017).
- Forms the foundation for meaningful development of microhabitats in impacted areas such as Burrard Inlet and provide the potential to be considered as physical measures offsetting once there is more confidence in successful recruitment. Thus, providing the ability to develop ‘equivalency metrics’ based on predictable survival of bull kelp through restoration initiatives.

A description of the offsetting requirements and each of the physical and complementary measures components constitute the Offsetting Plan is provided in Section 2.1.

A detailed summary of the physical offsetting component (the LCE Offset Project) for the B2 Project is provided in NBT (2023i), while this report focuses exclusively on the complementary measures component.

## 1.2 Neptune Terminals Ecosystem Programs

NBT has a high standard around understanding our localized ecosystems and has developed several innovative research programs to contribute to a deeper and more meaningful understanding of the existing conditions of marine habitats in the Inner Harbour of Burrard Inlet. All of these programs have elements of collaboration with Indigenous Groups either through Traditional Knowledge, opportunities for capacity building or opportunities for data sharing. One of these programs, the NBT BKR Program, will be expanded to include the complementary measures aspect for the Offsetting Plan. A summary of the three programs is provided in this section.

### 1.2.1 Bull Kelp Restoration Program

Existing conditions studies within the NBT water lot in 2022 showed that bull kelp is present in both the B2 footprint and an area north of Berth 1 termed 'the Western Water Lot' (WWL) (Appendix A, Figure A-1). The intention of the NBT BKR Program is to assess the efficacy of bull kelp planting within NBT's own water lots. The NBT BKR Program is being supported by Dynamic Ocean Consulting Ltd (Dynamic Ocean), who are working closely with the University of British Columbia (UBC).

Planting will occur through two methodological processes:

- Relocation: transplanting of bull kelp plants between the NBT water lots.
- Outplanting: laboratory-reared and genetically identical to NBT bull kelp.

Northwest Hydraulic Consultants Ltd (NHC) has been contracted to undertake a feasibility study of the hydrodynamic conditions within the existing B2 quadrant beams where bull kelp is known to exist, and the potential area in the new B2 footprint that has been identified for bull kelp restoration.

If the NBT BKR Program is successful, NBT may consider a bull kelp planting program within the rip rap areas of the new B2 infrastructure. This would be considered through the habitat banking program with DFO-FFHPP.

### 1.2.2 Autonomous Hydrophone Program

In advance of the B2 Project, NBT is interested in conducting underwater noise monitoring at the Terminal to understand the existing underwater sound levels and understand how ships in Burrard Inlet also contribute to the underwater soundscape. The goal of the NBT Autonomous Hydrophone (AH) Program is to understand the typical background ambient sound levels, occurrence and distribution of marine mammals in the vicinity of the Terminal, and levels of anthropogenic noise.

This information will inform planning for pile driving in two ways:

- To understand local patterns in marine mammal presence and assess the likelihood that marine mammals will be present during pile driving activity.
- To understand local contributions to underwater sound levels, which is key when estimating the natural cumulative sound levels that the noise from pile driving activity will add to. Underwater sound levels are naturally driven by tide, wind and waves. If enough marine mammals are in an area, marine mammals can also cause sound levels to elevate. Noise from vessel traffic and other construction activity in Burrard Inlet will likely be the largest contributors to underwater sound levels.

This existing condition study will support an understanding of the types of marine mammals present within proximity to the Terminal, which will support NBT to understand and predict marine mammals that may be in proximity to B2 during the out of window impact pile driving. The AH Program is being supported by Dynamic Ocean, who are working closely with the University of Victoria (UVic). The NBT AH Program is being permitted through the Vancouver Fraser Port Authority (the Port Authority) Project and Environmental Review (PER) process as a Category A (PER 22-125) approval.

### 1.2.3 Artificial Intelligence Marine Mammal Detection Program

The Artificial Intelligence Marine Mammal Detection (AIMMD) Program seeks to develop AI technology to automatically detect, document, and recognize marine mammals in coastal British Columbia (BC) waters, specifically in Burrard inlet. The objective of this work is to develop AI technology to support the monitoring and management of Exclusion Zones (EZ) during marine construction activities. The use of AI technology to support the MMO allows for more effective and efficient management of EZs. Development of this technology will also advance academic research and citizen science objectives and provide better understanding for the application of AI to analyze stationary camera images.

Successful implementation for AI technology to support EZ management will require a three-phased study design, where the AIMMD Program is Phase 1:

- Phase 1 (P1, Feasibility Phase): Installation of digital cameras and collection of extensive data (i.e., images) to ‘train’ and develop an AI Model prototype. The feasibility report will outline a ‘go-no-go model’ where future phases can continue to P2, or if additional P1 ‘training’ is required.
- Phase 2 (P2, Implementation Phase): Continued training of the AI Model to improve and advance ‘recognition’ capability. Phase 2 would work towards a ‘live’ AI Model and alert system, where ‘testing’ would be undertaken for the system to send ‘alerts’ based on set parameters (e.g., detection of marine mammal within a 300 m EZ).

- Phase 3 (P3, Operational Phase): Continued re-training and implementation of the 'live' AI model and alert system. Integration of this digital camera system and a hydrophone program for even more reliable and accurate monitoring outcomes will be investigated.

The NBT AIMMD Program is being supported by Dynamic Ocean, who are working closely with the Hatfield Consultants LLP (Hatfield).

### 1.3 Guidance Documents

The Application for Authorization (AFA) application, and both components of the Offsetting Plan (physical, complementary), were developed with the following guidance documents:

- DFO: Applicant's Guide Supporting the "Authorizations Concerning Fish and Fish Habitat Protection Regulations" (Government of Canada, 2021).
- DFO: Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the *Fisheries Act* (DFO, 2021).
- DFO: Measures to Protect Fish and Fish Habitat (DFO, 2022).
- DFO: Fish and Fish Habitat Protection Policy Statement (DFO, 2019).
- DFO: Aquatic species at risk map (DFO, 2023).
- Burrard Inlet Action Plan (KWL, 2017).
- Tsleil-Waututh Nation Stewardship Policy (Tsleil-Waututh, 2019).
- Tsleil-Waututh Nation Construction Environmental Management Plan Requirements (Tsleil-Waututh, 2022).

### 1.4 Document Scope

This document has been developed to describe the Complementary Measures component of Offsetting Plan and is a component of the AFA documentation. This document will describe:

- The research objectives of the LCE BKR Program.
- The LCE BKR Program team and their qualifications.
- The alignment of the LCE BKR Program the DFO-FFHPP Fishery Management Objectives (FMO).
- Expected outcomes subsequent to the execution of the LCE BKR Program.
- Description of Milestones and Deliverables.

### 1.5 Supporting Documents

Several documents have been developed to support the AFA, inclusive of the Offsetting Plan (see Appendix B, Table B-1). Each document was developed to consider pertinent guidance when available which is described in the Document Scope section of each report.

## 1.6 Indigenous Engagement

NBT conducted early engagement with Indigenous Groups and has provided the opportunity to discuss the LCE BKR Program with the Tsleil-Waututh Nation (Tsleil-Waututh), Musqueam Indian Band (Musqueam) and Squamish First Nation (Squamish) (NBT, 2023d, 2023e, 2023f).

The LCE BKR Program strategy will continue to maintain an open dialogue with these Indigenous Groups through all stages of project planning and execution. The Tsleil-Waututh, Musqueam and Squamish will be further engaged to confirm their interest to support the LCE BKR Program through the inclusion of traditional knowledge (see Section 5.3). Indigenous Groups who request it will be provided with all notifications and reports that are provided to Regulatory Authority (RAs). NBT will also support DFO-FHPP and the Port Authority through their respective consultation processes as required.

Further details on the status of engagement with Indigenous Groups are provided in the Indigenous Consultation and Stakeholder Engagement Report (NBT, 2023c).

## 1.7 Stakeholder Communication

Several stakeholders have been engaged by NBT either due to their interest in habitat restoration initiatives or due to their proximity to the LCE Offset Project. Stakeholders that have been engaged include Vancouver Pile Driving Ltd (VanPile) and North Shore Streamkeepers (NSSK). Further details on the status of these discussions are provided in the Indigenous Consultation and Stakeholder Engagement Report (NBT, 2023c).

## 1.8 Existing Conditions

Details on the existing conditions in the B2 Project footprint and the LCE are described in NBT (2023b) and NBT (2023h), respectively. Habitat maps for the B2 and LCE Offset Project footprints is provided in Appendix A, Figure A-2 and Figure A-3.

# 2 OFFSETTING PLAN

## 2.1 Justification

NBT has been supported by Hatfield, NHC and Dynamic Ocean for the development of the B2 Offsetting Plan, with a high-level summary of support as below:

- Hatfield: Lead for the selection of the LCE as the offsetting site, and development of the LCE Offset Project (physical measures) justification and documentation.
- NHC: Engineer for design of the LCE Offset Project (physical measures) and supporting Dynamic Ocean to consider potential locations within the LCE Offset Project footprint for bull kelp planting.
- Dynamic Ocean: Lead for the LCE BKR Program and support to Hatfield for the development of the LCE Offset Project justification.

Hatfield's selected the LCE as the most suitable location for NBT's offsetting commitments. The justification for this section was:

- The LCE is close to the Terminal (~ 1 km) and therefore closely aligns with DFO-FFHPP's preference for like for like.
- The LCE is an important estuary for Burrard Inlet fish species and has been highly impacted by industrial development.
- The NSSK is very interested to support restoration efforts in the LCE and has provided a letter of support for the LCE Offset Project (see Appendix B, NBT (NBT, 2023i)). NSSK and other interested stakeholders will be able to develop offshoot restoration initiatives.

In the development of equivalency metrics, sugar kelp was selected as the metric for the success determination. NBT was hesitant to commit to 'equivalency' metrics which were inclusive of bull kelp as the survivability of this species in the LCE is unknown. While it was appreciated that bull kelp is in the HADD footprint, there was uncertainty over the ability for bull kelp to be successful in this estuarine environment, where existing conditions are unlikely to be similar to those at within the NBT water lots. However, restoration efforts at the LCE were always on the agenda for a second phase of the NBT BKR Program. With the request by DFO-FFHPP for the Offsetting Plan to be inclusive of complementary measures, the decision was taken to expand the NBT BKR Program, and develop the LCE BKR Program.

The LCE Offset Project meets the full requirements for offsetting the NBT HADD as measured in Relative Productivity Value (RPV) (see Table 7-1 (NBT, 2023i)).

Based on DFO-FFHPP guidance, NBT interprets the 10% complementary measures component will be met by a proportional breakdown to be based on the estimated cost of the physical measures component (DFO, 2021).

NBT is excited to expand the NBT BKR Program to the LCE through the LCE BKR Program as bull kelp is a high quality habitat and the opportunity to develop microhabitats in Burrard Inlet is a novel initiative. Creating microhabitats in a region can facilitate habitat connectivity in the broader marine environment and provide valuable refuge for marine life in developed coastal environments such as Burrard Inlet. Further, if successful BKR Programs within Burrard Inlet and other developed waterbodies, has the potential to constitute physical offsetting measures, as once success criteria can be defined with more confidence there would be the opportunity to identify equivalency metrics.

## 2.2 Objectives

The offsetting objective of the LCE BKR Program is to assess the opportunity for bull kelp restoration in estuarine environments so as to advance our knowledge for increasing high quality habitat for fish species in Burrard Inlet.

As with many areas of coastal BC, bull kelp has experienced declines in Burrard Inlet. Rising sea surface temperatures, grazing from herbivorous invertebrates and disturbance from nearby development can all act to limit the growth and extent of kelp forests.

Enhancement of kelp forests can increase the productivity of nearby fisheries and other ecosystems. Bull kelp forests create complex and diverse ecosystems which provide important habitat for many species of juvenile fishes, including salmon and rockfish (Siddon *et al.*, 2008; Springer *et al.*, 2010). Through establishment of bull kelp microhabitat, the proposed LCE BKR

Program has the potential to increase sheltering habitat for juvenile salmon during outmigration, in addition to potentially providing juvenile habitat for Dungeness crab (*Matacarcinus magister*).

Furthermore, if the LCE BKR Program determines that bull kelp can successfully establish within estuarine environments like the LCE, there is potential for new avenues for increasing bull kelp habitat throughout Burrard Inlet. Thus, the LCE BKR Program has the potential to improve and support innovative restoration of important salmon habitat in estuarine environments.

## 3 BULL KELP

### 3.1 Biogeographic Distribution

Bull kelp is a widely distributed kelp ranging from Central California, United States of America (USA), north to the Aleutian Islands. Bull kelp inhabits shallow, high current coastal areas (Springer et al., 2007) in up to 20 m depth, where its abundance depends largely on substrate suitability, temperature and flow rates (Dayton, 1985) (see Section 3.3 for habitat requirements). Salinity also affects kelp abundance. Under low salinity conditions bull kelp shows decreased recruitment and growth rates as well as increased instances of physiological stress (Hollarsmith *et al.*, 2022).

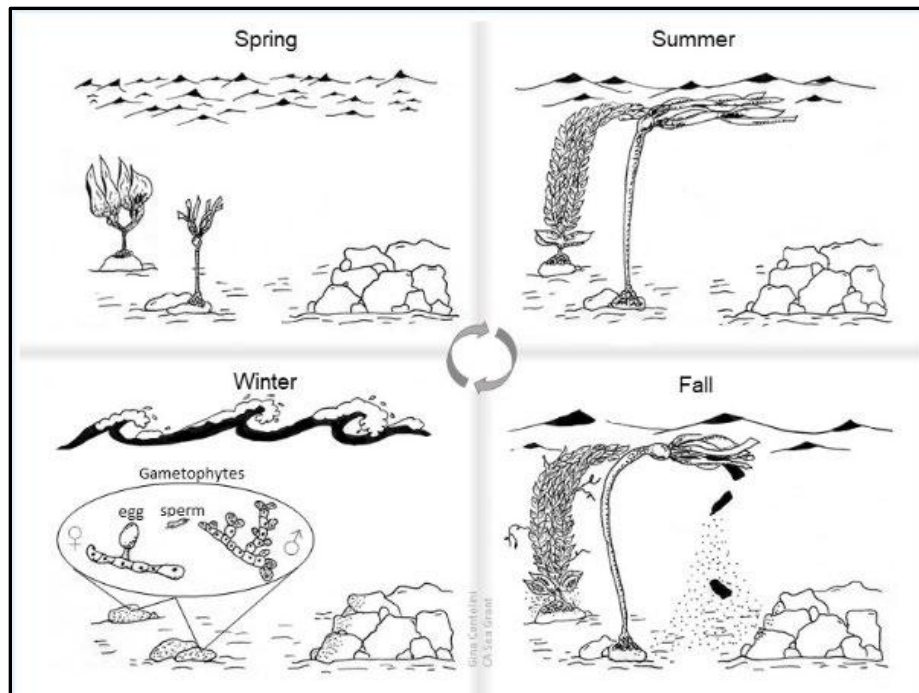
Bull kelp is present in Burrard Inlet (Lamb et al., 2011) with multiple distinct beds between along the northeastern edge of Stanley Park (PSF, 2022; Schroeder, 2018), between Second Narrows Bridge and Westridge Terminal (Stantec, 2017), off of New Brighton Park (Project Noah, 2014) and along between Point Atkinson and Dundarave (Schroeder, 2018).

### 3.2 Life History

Bull kelp is an annual, large-bodied brown kelp (Laminariales). Bull kelp have a single long stipe connecting the holdfast to the pneumatocyst (float) and up to one hundred blades (CDFW, 2021). As an annual species, bull kelp grows, reproduces, and senesces each year.

Bull kelp has a biphasic life cycle, comprised of a gametophyte and sporophyte stage (CDFW, 2021) (see Figure 3-1). From May to November, mature sporophytes develop sorus tissue (reproductive tissue) on the blade, which falls out of the sporophyte blade and releases spores into the water column (Maxell & Miller, 1996).

These spores disperse and settle to the sea floor and develop into male and female gametophytes. If the density of spores is high enough and conditions are suitable (e.g., temperature, flow) (CDFW, 2021), female gametophytes are fertilized and, develop into small sporophytes in the spring. Sporophytes grow quickly through spring and summer, with blades reaching the surface and forming the canopy of dense kelp forests.



**Figure 3-1: Bull Kelp Life History**

Source: Figure 1-4 in [California Department of Fish and Wildlife] CDFW (2021)

### 3.3 Ecological Role

Bull kelp is an ecosystem engineer that plays an important role in coastal productivity (Springer *et al.*, 2006) and acts as a physical buffer from ocean wave energy, reducing erosion along coastlines (Springer *et al.*, 2007). Bull kelp is considered a foundational species in coastal BC because of the diversity of organisms that use this habitat for various stages of their life history (e.g., nursery habitat, feeding, predator refuge). Bull kelp forests create foraging habitat for many marine macro-organisms, including fish, otters, seabirds, and pinnipeds (Carr & Syms, 2006). Individual kelps also serve as habitat for many crustaceans, and protists, such as bryozoans and other algae (CDFW, 2021) and when individual bull kelp detach from the sea floor, they serve as rafts that facilitate long-range dispersal for many of these species (Saunders, 2014). Bull kelp are a food source for numerous species of fish, including commercially valuable rockfish (Duggins *et al.*, 1989), and are also heavily grazed by invertebrates such as sea urchins and abalone (CDFW, 2021).

In order to grow, bull kelp requires hard substrate (e.g., cobble, boulder), high flow, nutrients, and light. Bull kelp tend to occur where nutrient availability is high and temperatures are less

than 14-16°C (Hamilton *et al.*, 2020). Light availability is a key component for kelp growth and reproduction, with lab culture experiments suggesting a threshold of  $\sim 2 \mu\text{mol m}^{-2} \text{s}^{-1}$  for gametophyte maturation (Vadas, 1972).

### 3.4 Presence at Neptune Terminals

Bull kelp has been observed at NBT for several years in both the B2 Quadrant and the WWL. Though not extensive forests, the NBT bull kelp creates specialized microhabitats (small areas of unique habitat compared to the surrounding environment) for fish and invertebrates. Bull kelp within the B2 footprint and the WWL were observed in August 2022 with a Remotely Operated Vehicle (ROV). Additional surveys have been undertaken with ROV and by Self Contained Underwater Breathing Apparatus (SCUBA) over three events from April to July of 2024. Observations as summarized below are from the August 2022 field program.

Details of bull kelp within the NBT water lot are provided as below:

- Overview map which depicts locations of bull kelp in the B2 quadrant beams and the WWL: Appendix A, Figure A-1.
- Habitat map which depicts bull kelp: Appendix A, Figure A-2.
- Details of bull kelp presence: Table 3-1.
- Underwater Photos: Appendix C, Photo C-1 (B2), Photo C-2 (WWL).

#### 3.4.1 Berth 2

Within the B2 Quadrant, distinct patches of bull kelp were observed during existing conditions subtidal surveys in 2022 (NBT, 2023b). Two distinct patches of bull kelp observed in each of the western and eastern quadrant beam areas. The bull kelp beds in the western and eastern B2 Quadrant were approximately 26.0 m x 6.0 m (156 m<sup>2</sup>, density estimated at 0.25 individuals/m<sup>2</sup>) and 39.0 m x 2.4 m (93.6 m<sup>2</sup>, density estimated at 0.17 individuals/m<sup>2</sup>) for a total footprint of 249 m<sup>2</sup>. Bull kelp was observed in approximately 0.6 m to 5.3 m chart datum (CD) depth, with hard substrates (gravel, cobble, and boulder). Bull kelp within the B2 water lot is not considered ephemeral it has been observed within this area annually within the past five years (pers. comms. Matt Simmons), including observations of juvenile bull kelp in spring 2023 during initial NBT BKR Program surveys.

#### 3.4.2 Western Water Lot

Within the WWL, distinct patches of bull kelp were observed during the same field program as for B2 (August 2022). Bull kelp was observed north of the walkway to Cargill Terminals (Cargill), in the southeast portion of the water lot. The bull kelp bed was approximately 11.6 m x 23.5 m (272.6 m<sup>2</sup>, density estimated at 0.5 individuals/m<sup>2</sup>). Bull kelp was observed in approximately 0.5 – 4.0 m CD depth. Substrate for bull kelp was variable and consisted of hard substrates available such as gravel and cobble. During the 2023 June field program, bull kelp was also observed to be growing on the piles that support the Cargill walkway.

**Table 3-1: Bull Kelp Presence within Neptune Terminals Water Lots**

LOCATION	BED SIZE			CHART DATUM DEPTH (M)
	(m x m)	(m <sup>2</sup> )	Approximate Density (individuals/m <sup>2</sup> )	
B2 Quadrant Beams (Western)	26.0 m x 6.0 m	156.0	0.25	0.6 to 5.3
B2 Quadrant Beams (Eastern)	39.0 m x 2.4 m	93.6	0.17	
WWL	23.5 m x 11.6 m	272.6	0.5	0.5 – 4.0

### 3.5 Presence in Burrard Inlet

Bull kelp has long history in Burrard Inlet with several notable beds present along the southern shores of Burrard Inlet between Stanley Park and the Second Narrows Bridge (see Section 3.1). However, details on bed density and size are not publicly available.

Based on surveys of existing kelp beds in Burrard Inlet undertaken by the Tsleil-Waututh, bull kelp (*Nereocystis luetkeana*) grows at elevations between 0 and -5 m CD in Burrard Inlet, with a mean elevation of -2.2 m CD (NHC, 2019). The depth of the hard substrates (cobbles and boulders) within the B2 Project footprint is suitable for bull kelp to adhere to.

## 4 COMPLEMENTARY MEASURES PROGRAM

### 4.1 Project Title

The LCE BKR Program.

### 4.2 Schedule

The LCE BKR Program will run for a period of 18 to 24 months and will consist of pilot program and a post-construction program. The post-construction program will be subsequent to the construction of the LCE Offset Project. The LCE Offset Project will be constructed before February 28, 2024, and prior to the end of the Fisheries and Oceans Canada (DFO) recommended least-risk window (Area 28 – Burrard Inlet: August 16 to February 28) (DFO, 2014).

The pilot program will be undertaken from July to December of 2023, and the post-construction program will be undertaken from March to October of 2024. The post-construction program is dependent on the LCE Offset Project being in place.

Depending on the success of the LCE BKR Program in October of 2024, a decision will be taken by NBT as below:

1. Continue to reseed bull kelp within the LCE Offset Project footprint.
2. Determine bull kelp is self sustaining and does not need further support.
3. Determine that the LCE BKR Program was not successful and the LCE is not a viable environment for bull kelp.

Options 1 and 2 will allow for bull kelp to contribute to the equivalency metrics of the LCE Offset Project through the Y3 and Y5 monitoring events.

### 4.3 Rationale for Use of Complementary Measures Program

NBT has decided to include complementary measures as component of the Offsetting Plan for the following reasons:

- The inclusion of complementary measures was requested by DFO-FFHPP.
- Bull kelp is naturally present within the NBT water lots.
- Through independent initiatives, NBT already has the NBT BKR Program in place out of interest to support restoration initiatives of this important species.
- The Terminal is in close proximity (approximately 1 km) to the LCE and has a healthy bed of bull kelp which will serve as a donor site for bull kelp transplant. Due to proximity of the Terminal population of bull kelp, transplant it not expected to result in concerns for genetic stocks.
- The presence of the LCE Offset Project will provide substrate that would support bull kelp presence.

- The opportunity to be inclusive of Traditional Knowledge and western science to test for the ability to bull kelp to grow in estuarine environments and understand this occurrence historically is exciting.
- Bull kelp is an important canopy kelp species in BC and forms an integral part of coastal ecosystems. Increasing bull kelp habitat in Burrard Inlet provide more opportunity for the creation of microhabitats, increasing habitat connectivity.

#### 4.4 Principal Investigators and Research Team

The principal investigators (PIs) and research team that are supporting the LCE BKR Program and described in Appendix B, Table B-2.

## 5 PROJECT DESCRIPTION

### 5.1 Objectives

The objectives of the LCE BKR Program are as follows:

1. Engage with Indigenous Groups to gather traditional knowledge to understand where bull kelp has historically and currently occurred in estuarine environments.
2. Relocate a subset of existing B2 Quadrant bull kelp to the LCE offsetting site prior to demolition of B2 and monitor it for survival success.
3. Undertake a collaboration with UBC to grow genetically identical kelp to the NBT bull kelp and undertake outplanting of bull kelp to the LCE and monitor for survival success.
4. Undertake experimental planting of bull kelp within the LCE Offset Project footprint. This will not necessarily consist of a single plot area. Dynamic Ocean will work with NHC to confirm the areas that are the most suitable for bull kelp planting (e.g. substrates, minimum of 0.5 m CD).
5. Understand the efficacy of bull kelp survival in the LCE.

### 5.2 Western Science

As this is an exploratory program, the methodology will evolve based on the outcome of both the NBT and LCE BKR Programs, and through engagement with academic collaborators and engagement with Indigenous Groups. Methodology will be refined for work being undertaken for the NBT BKR Program. An updated methodology document will be developed prior to the initiation of the LCE BKR Post-Construction Phase.

Monitoring of bull kelp survival for both outplanted and relocated individuals will be undertaken using a combination of subtidal survey techniques (SCUBA, ROV). Exact metrics for quantifying survival will be confirmed during the NBT BKR Program but is likely to include:

- Number of surviving individuals.
- Presence of reproductive blade tissue.
- Bull kelp size (length of stipe, length of blades).
- Condition of holdfast.

Loggers will be deployed in the LCE to document temperature, light and salinity and to align with loggers already deployed in the B2 quadrant beams and the WWL. This will allow for a comparison of existing conditions of these metrics in areas where bull kelp is known to exist and those of the LCE. Temperature, light and salinity data will also support the laboratory selection experiments to test for bull kelp tolerance in conditions similar to the LCE.

### 5.2.1 Laboratory

Laboratory cultivation of bull kelp will be undertaken by UBC using existing culture material derived from collection of reproductive bull kelp tissues from NBT. The Dynamic Ocean team are opportunistically collecting sori through field programs undertaken for the NBT BKR Program. Cultivation will be ongoing for the duration of the NBT and LCE BKR Programs (October 2022 to November 2024).

Laboratory cultivation of bull kelp requires three general steps, where temperature, light, pH, and nutrients are important factors in successful lab culture (Flavin *et al.*, 2013).

1. Acquisition of reproductive kelp tissue (i.e., sori).
2. Release and fertilization of gametophytes.
3. Inoculation and maintenance of developing sporophytes to the desired size for outplanting.

Further to cultivation of bull kelp individuals, UBC will undertake experimental manipulations to select for strains that are 'climate resilient' and thus tolerant to temperature (higher) and salinity (lower) variability. Strain selection will be based exclusively on magnifying naturally occurring genotypes within the NBT population (Coleman & Goold, 2019). These experiments will increase survival probability of the bull kelp plants in the field. Bull kelp will be seeded on tiles (or other suitable material) at a density of approximately 1000-3000 spores per ml with an expected recruitment of hundreds to thousands of sporophytes initially and an ultimate yield of 1-2 mature sporophytes per tile.

### 5.2.2 Field Programs

Bull kelp planting will be undertaken during the Pilot Phase (2023) and Post-Construction Phase (2024) of the LCE BKR Program. Bull kelp relocation and outplanting will be undertaken by SCUBA divers who are appropriately qualified. The field team will travel to the LCE by boat from the Terminal. When bull kelp is being retrieved (relocation) or deposited (relocation, outplanting) to the seabed, bull kelp will be placed in collection trays. For lowering the collection trays, a SCUBA diver and the surface support will each have a length of rope attached to the collection tray and will communicate by hand pulls for the collection trays to be raised or lowered. When planting bull kelp there may need to be several exchanges of the collection tray between the surface and dive team depending on the number of bull kelp plants being planted. When sending bull kelp to the surface (relocation), methodology will either follow the same technique, or divers will deploy a lift bag. When sending a collection

tray to the surface with a lift bag, the diver will keep a rope attached as the collection tray surfaces.

Prior to deployment of bull kelp in the LCE, individuals will be tagged and labelled to identify the source population (B2, WWL, Laboratory) and date. For relocated bull kelp, the tag will further indicate whether the individual was attached or detached from its substrate (see Photo C-3).

#### 5.2.2.1 Bull Kelp Relocation

For bull kelp relocation, individual bull kelp will be hand-collected by SCUBA divers from the NBT water lot (B2, WWL). Where possible, bull kelp will be collected attached to its substrate, and will otherwise be removed from its substrate gently with the blunt end of a dive knife. SCUBA divers will move substrate that is smaller than the size of a basketball. Once at the surface, the surface field team will wrap bull kelp plants individually in wet pillowcases and carefully place in a cooler. Detached individuals will be reattached to similarly sized cobbles using rubber bands or zip ties.

#### 5.2.2.2 Bull Kelp Outplanting

Tiles will be outplanted to the LCE by SCUBA divers and will be attached to boulders with z-spar or with bolts and wall-anchors. For the Pilot Phase, the boulders that are a component of the NSSK Boulder Habitat Augmentation (see Section 1.8.2 of NBT (2023h)), will be used. For the Post-Construction Phase, the boulders that are a component of the LCE Offset Project will be used for attachment of tiles.

### 5.3 Traditional Knowledge

Within the context of the LCE BKR Program, NBT is interested in understanding historical occurrences of bull kelp in estuarine environments and to integrate extensive first-hand knowledge with scientific research. Traditional Knowledge studies, through engagement with Indigenous Groups, is vital to the success of bull kelp restoration and ecosystem management in Burrard Inlet. Further, the success of a Traditional Knowledge study is dependent on respectful and reciprocal relationships and engagement with the Tsleil-Waututh, Squamish and Musqueam.

The Tsleil-Waututh, Squamish and Musqueam have been contacted to discuss their interests and capacity to participate in a Traditional Knowledge study (NBT, 2023j, 2023k, 2023l). If interest is present, community representatives will be engaged to identify key knowledge holders and elders who may be contacted to determine their interest in participation. Ongoing communication will take place with participating Indigenous Groups to ensure reciprocal engagement. Flexibility will be built into the engagement structure to ensure that community relationships, goals and needs are being respected. Engagement methods and study focuses may evolve as relationship building takes place with Indigenous Groups. Potential methods of engagement are included but until in depth discussions have taken place with the Tsleil-Waututh, Squamish and Musqueam the methods of this study cannot be confirmed. Potential options for community engagement methods are further described in Section 5.3.1.

Options for engagement methods are summarized in Table 5-1. All methods of engagement will be decided upon collectively with participating Indigenous Groups and will be informed by the best practices and protocols of the respective communities. The engagement methods will be subject to community input and alternate methods may be used if desired by community partners.

Knowledge holders providing their consent will have the information contribute to the LCE BKR Program and all information documented will be considered intellectual property of the knowledge holders with data to be owned and stewarded by the respective Indigenous Groups upon completion of the LCE BKR Program.

A consultation log will be developed following any workshops to document discussions and ensure that knowledge being shared is respected and reflected accurately. Consultation logs will be shared with partnering Indigenous Groups following workshops.

**Table 5-1: Potential Methods of Engagement with Indigenous Groups**

TYPE	DETAILS
Relationship building	Focus on relationship building with community representatives to ensure that community needs and concerns are being addressed within the scope of the LCE BKR Program. This will include discussing best practices for engagement with each Indigenous Group, adapting engagement methods to meet community needs, and building community goals/interests into the Traditional Knowledge study.
Education	The provision of educational materials regarding the LCE BKR Program and the relevance and opportunities to ensure Indigenous Groups are well informed about the LCE BKR Program and have an opportunity to provide feedback. These educational materials may be delivered in the format of in person/online engagement sessions and/or they may be delivered in the format of educational documents with contact information for LCE BKR Program representatives. Flexibility will be built into the provision of educational materials to ensure it is representative of the needs and interests of the communities involved.
Interviews	Individual interviews or small focus group interviews with key knowledge holders or community members may be used to increase opportunities for engagement with community members and address potential barriers for individual participation in workshops. These interviews may be useful to ask questions about historical presence of bull kelp and its traditional uses, and management interests within the community. Participants in interviews will be given appropriate honoraria for their contributions to the Traditional Knowledge study.
Workshop 1	Workshop 1 will provide educational information about the LCE BKR Program and ask questions about historical presence of bull kelp, its traditional usage, and management interests within the community. Maps will be used to help participants identify areas where bull kelp has historically occurred in estuarine environments and identify any current areas of interest. If alternative priorities or interests are communicated by participants, the structure and contents of the workshop will be adapted to fit these priorities and interests.
Workshop 2	Workshop 2 will be used to verify that the information gathered is interpreted and presented in a manner intended by the knowledge holders and request their feedback on any changes as needed. Any deliverables or fulfillable requests of the

TYPE	DETAILS
	community will be given to community representatives at this time and an opportunity for discussion about the successes and challenges of the study will be created. Any further changes or requests will be addressed as needed.

#### 5.4 Work Plan

The proposed work plan for the LCE BKR Program is detailed in Table 5-2.

**Table 5-2: Lynn Creek Estuary Bull Kelp Restoration Program Work Plan**

PROGRAM DELIVERABLE	MILESTONES
<b>Pilot Phase</b>	
Deployment of loggers (temperature, light, salinity).	August 2023
Pilot Program to confirm relocation and outplanting technique.  Field assessment of bull kelp survivability.  Two field programs expected.	August to November 2023
Laboratory growth of bull kelp	August to December 2023
Harvesting of bull kelp sori from NBT water lot	August to November 2023
Indigenous Groups Engagement and Traditional Knowledge Study	August to December 2023
Summary Report on Pilot Program	December 2023
Development of Consultation log	December 2023
<b>Construction of LCE Offset Project</b>	
Physical Measures Component – Critical Path Activity for Post-Construction Phase	January – February 2024
<b>Post Construction Phase</b>	
Pilot Program to confirm relocation and outplanting technique, including planting of including temperature and salinity tolerant strains (laboratory grown).  Two to three field programs expected.	March – June 2024
Indigenous Groups Engagement and Traditional Knowledge Study	January to October 2024
Summary Report on Post Construction Program	November 2024
Development of Consultation log	November 2024
<b>Decision Phase</b>	
NBT decision to continue BKR Program	January 2025

## 5.5 Program Deliverables

The primary outcomes of the LCE BKR Program will be:

6. Final report on the efficacy of bull kelp establishment and survival in the LCE.
7. Quantitative assessment of bull kelp survivability for relocation and outplanting (see Section 5.2 for quantitative metrics).
8. Consultation log from Indigenous Groups workshops.
9. Potential to define measurable metrics for BKR Programs to be considered as physical measures offsetting.
10. Advancement of an understanding of the techniques that contribute to bull kelp restoration which will lead to global recognition.
11. Further understanding of the ability of bull kelp to survive in estuarine environments through western science and traditional knowledge.
12. Support to determine other variables that need to be considered in 'climate resiliency' (e.g., turbidity).

## 5.6 Risks and Constraints

Risks and constraints for the LCE BKR Program are summarized in Table 5-3.

**Table 5-3: Potential Risks that will Impact the LCE BKR Program**

ID #	RISK	MITIGATION	CONSEQUENCE
1	Bull kelp may not remain attached to rock/tile/substrate.	Boulder/tile will be marked by date of planting and numbered and several methods for attachment will be tested during the pilot phase (e.g., zspar, bolts and wall anchors) to determine the best approach for attachment of bull kelp and tiles.	Additional outplanting may be needed and other methods of attachment may require testing. This would require additional field days and laboratory sample preparation.
2	Bull kelp may not survive at LCE site.	The pilot phase of the LCE BRK Program will provide preliminary information on if the LCE is a hospitable environment for bull kelp. Further, the laboratory component to test for 'salinity' tolerant strains will increase survival probability.	If bull kelp is unable to survive in the LCE, further outplanting will not be undertaken.
3	Hydrodynamics at the LCE may not be conducive to bull kelp survivability.	<p>Bull kelp will be placed on boulders large enough to withstand expected water movement at site.</p> <p>Dynamic Ocean will work with NHC to confirm areas within the LCE Offset Footprint during the post-construction phase that are the most conducive to desirable water characteristics.</p>	If kelp is being moved around by water movement, it is likely individuals will become detached and not survive. Additional outplanting may then be required to ensure suitable sample size for quantitative assessment of survivability.
4	Site access issues due to industry activity and weather issues.	Clear communication with NBT will be implemented for the days field work is planned to ensure access. Weather will be checked prior to field work and the morning of the field day to ensure site access and work will be possible.	Additional field days will be added to the LCE BKR Program in the event of a cancellation due to weather.



ID #	RISK	MITIGATION	CONSEQUENCE
5	Catastrophic laboratory culture failure.	Maintain backup cultures of samples in different storage locations to prevent total loss in the event of a power failure.	If all laboratory cultures are lost, additional collections of reproductive tissue from NBT bull kelp would be required. Collection of tissue would be based on reproductive status of the bull kelp and additional time would be required to establish new laboratory cultures.

## 6 CLOSURE

Regulatory professionals from Dynamic Ocean, UBC and NBT have contributed to development of this Complementary Measures program. If you have any questions, please contact the undersigned, Victoria Burdett-Coutts.



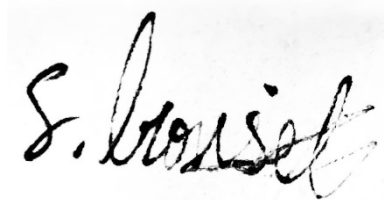
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Senior Marine Scientist  
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## APPENDIX A: SUPPORTING FIGURES



**LEGEND:**

- DNV / CNV Jurisdictional Boundary
- B2 Project Location / LCE offset location
- VFPA Jurisdictional Boundary

**SOURCES / NOTE:**  
 NAD1983 CORS96 UTM 10N  
 Scale 1:5000  
 Units: meters  
 Static (relies on a datum which is plate-fixed)  
 Celestial body: Earth  
 Method: Universal Transverse Mercator (UTM)

**PROJECT:** Neptune Terminals B2D2  
**SYSTEM:**  
**ASSET:**  
**DISCIPLINE:** Regulatory

REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED	VENDOR:
A	2023-03-04	Neptune Terminals Environmental Regulatory	C. Knight		Dynamic Ocean Consulting Ltd.
	2023-03-28	Neptune Terminals Environmental Regulatory	C. Knight		
ISSUES / REVISIONS					

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**TITLE:** Berth 2 and Lynn Creek Estuary Project Location and Footprint Including Federal and Municipal Boundaries

**Figure A-1**

**SCALE:** As Shown    **SHEET** 1 OF 1    **DRAWING NO.** 20230328-002    **REV:** A

496,200

496,400

5,461,200

5,461,200

5,461,100

5,461,100



**LEGEND:**

- Sargassum
- Sugar kelp
- Bull kelp
- Infill area
- Piles to be installed (permanent)
- Piles to be installed (temporary)
- Water lot boundary
- Pony wall and Chain link
- Contour
- Habitat Substrates**
- Cobble and boulders >50% covered by Silt/Sand
- Silt/Sand

**SOURCE / NOTE:**

- a) Habitat areas, digitized by Hatfield (2022) using Figure 3 (Appendix A), "Berth 2 Marine Fish and Fish Habitat Existing Conditions Report", Neptune Bulk Terminals, August 2022.
- b) Water lot, digitized by Hatfield (2022) using Figure 1 (Appendix A), "Site Location and Marine Survey Area", Neptune Bulk Terminals, January 2022.
- c) Infill area and piles, digitized by Hatfield (2022) using Seabed Footprint Modifications Demolition and Construction Works Plan Map, Neptune Bulk Terminals, January 2022.
- d) Contours, Neptune Bulk Terminals, January 2022.
- e) Bull Kelp, Sugar Kelp, Sargassum Pony wall and Chain link, Hatfield, August 2022.
- f) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

PROJECT:				
SYSTEM:				
ASSET:				
DISCIPLINE:				
REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED
ISSUES/REVISIONS				

VENDOR:

ISSUED AS RECORD COPY (YES/NO) NO

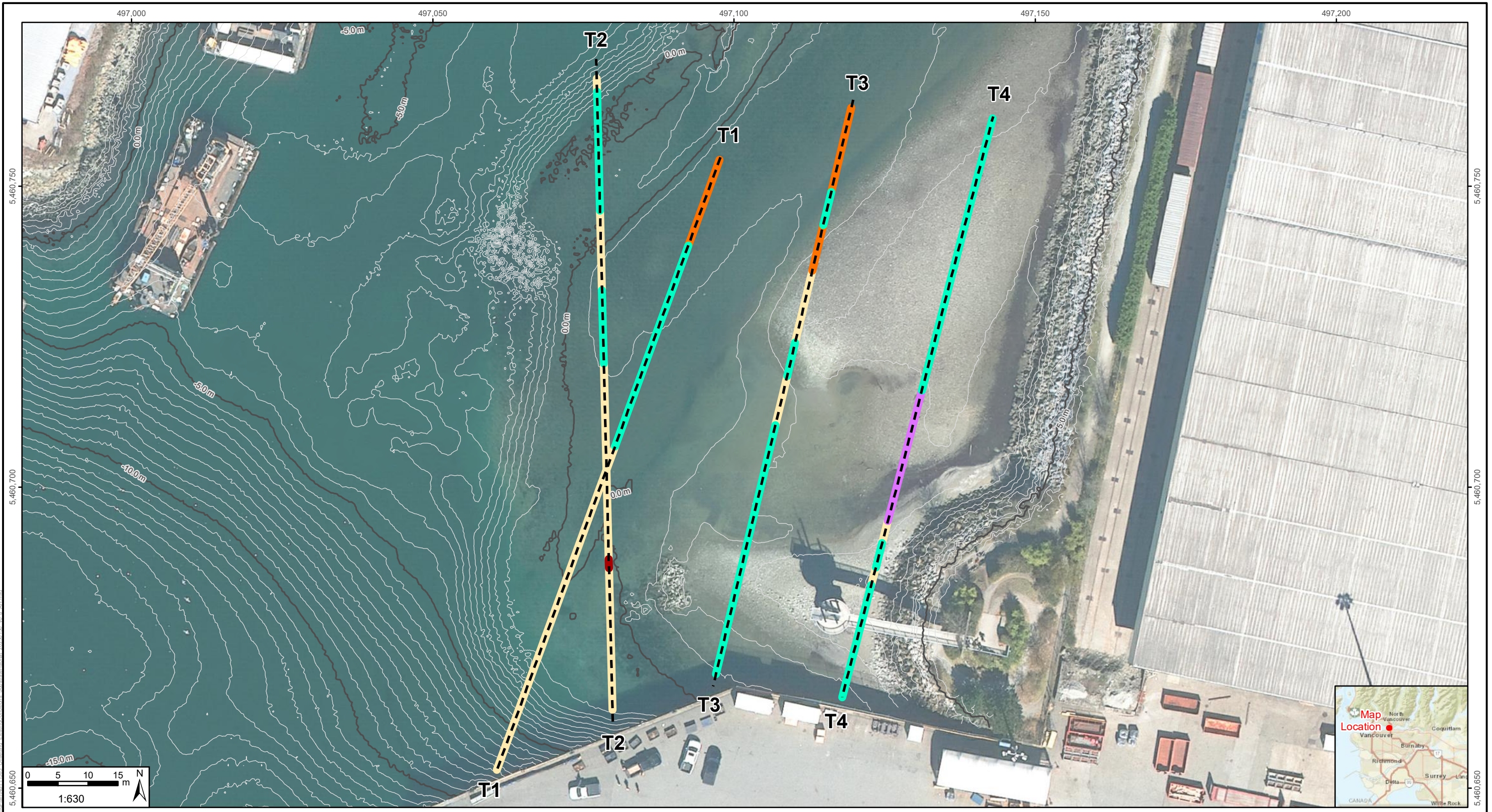
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TITLE: Berth 2 Habitat Map

SCALE: SHEET 1 OF 1 DRAWING NO. REV: A

**Figure A-2**

K:\Data\Project\NBT11583-NVA\_MXD\NBT11583\_Habitat\_Map\_20230313\_v1\_5\_AH.mxd



**LEGEND:**

**Transect**  
 - - - - -

**Substrate**

- Cobble
- Plant Debris
- Gravel
- Sand
- Boulder

**Depth**

- 5.0 m Contour
- 0.5 m Contour

**SOURCE / NOTE:**  
 a) Transects, substrates, Hatfield 2022.  
 b) Contours generated using depth points provided by Neptune Terminals in December 2022, Hatfield 2022. Contours have been adjusted to chart datum using a +3.0 m offset.  
 c) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED
ISSUES/REVISIONS				

VENDOR:

ISSUED AS RECORD COPY (YES/NO) NO

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Title: Lynn Creek Estuary Project Footprint Substrate Conditions

Figure A-3

SCALE:	SHEET	OF	DRAWING NO.	REV:
	1	1		A



## APPENDIX B: SUPPORTING TABLES

**Table B-1: Supporting Documents for the Application for Authorization**

DOCUMENT TITLE	DESCRIPTION
Lynn Creek Estuary Offsetting Plan (NBT, 2023i)	The LCE Offsetting Plan describes the pertinent legislation and justification for the use of physical offsetting to meet the offsetting requirements for the B2 Project. This document details the methodology and workplan for the design and implementation of a shallow rock reef in the LCE. The reef is designed to increase macroalgae habitat for out-migrating juvenile salmon.
Lynn Creek Estuary Construction Environmental Management Plan (NBT, 2023g)	The LCE Construction Environmental Management Plan (CEMP) describes the mandates of pertinent regulatory authorities, associated legislation to confirm permit approvals, and relevant compliance requirements for the construction of the offset project. This document details and outlines commitments and adherence to relevant Best Management Practices (BMPs), the potential environmental effects, and project-specific mitigation and monitoring measures to be implemented during construction to minimize negative effects to physical, biological, and socio-economic features associated with construction.
Lynn Creek Estuary Fish and Fish Habitat Existing Conditions Report (NBT, 2023h)	The existing conditions report was developed to summarize the fish (including marine mammals) and fish habitat existing conditions within the LCE location. Study areas were defined for the LCE which is described in Section 1.1 of the report. Field programs were conducted to assess the subtidal, intertidal, and terrestrial habitats available.
Application for Authorization Supplementary Report (NBT, 2023a)	This document summarizes the requirements for the Application for Authorization (AFA) for the B2 Project and details where pertinent information is provided in supporting documents. A table of concordance based on DFO-FFHPP criteria has been developed to support clear communication on application content.
Lynn Creek Estuary Offsetting Basis of Design and Drawing Report (NHC, 2023b)	The Lynn Creek Estuary Offsetting Design Basis and Drawing Report consists of a design basis memo and preliminary engineering drawings. The design basis memorandum outlines the technical basis of design supporting the habitat offset requirements outlined in the AFA. It includes environmental and engineering design criteria, operating conditions, user requirements, codes, safety, materials, and constructability. The design drawings provide geodetic location of the structure, plans, sections, and details of the proposed habitat offset, including elevation and areas of specific features, types and volumes of materials.
Lynn Creek Estuary Offset Preliminary Hydraulic Assessment Memorandum (NHC, 2023a)	Preliminary results of the hydraulic model Northwest Hydraulic Consultants is developing will be presented in the Lynn Creek Estuary Preliminary Hydraulic Assessment Memorandum. The model will be used to inform potential for localized sedimentation in the vicinity of the LCE Offset Project and will include wind-wave and tidal functions in Burrard Inlet, as well as freshwater inputs from Lynn Creek. The assessment will be part of the Detailed Design Report.
Lynn Creek Estuary Contractor Construction Environmental Management Plan (LCE CCEMP)	<p>The Contractor will be responsible for the development of a CCEMP (Contractor Construction Environmental Management Plan) which will at a minimum meet the requirements stipulated in this LCE CEMP (Lynn Creek Estuary Construction Environmental Management Plan) and the commitments identified in any issued permits or approvals, including, but not limited to, the following:</p> <ul style="list-style-type: none"> <li>• Spill response and clean-up procedures in the form of a Spill and Emergency Response Plan.</li> <li>• Fuel management procedures.</li> <li>• Any site staging/access information.</li> </ul>

**Table B-2: Lynn Creek Estuary Bull Kelp Restoration Program Team**

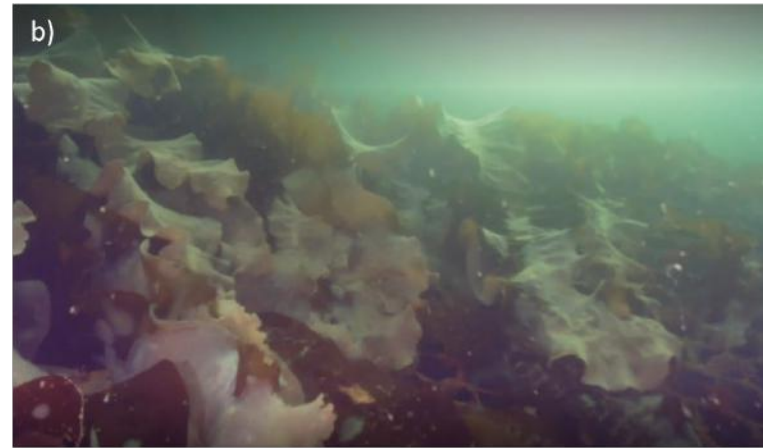
NAME	TITLE	DESCRIPTION
<b>Neptune Terminals</b>		
<b>Victoria Burdett-Coutts</b>	Project Coordinator	Project coordinator for liaison between Indigenous Groups, consultant and academic partners. Technical advisor and lead for the LCE BKR Program.
<b>Nelly Francois</b>	Project Manager	Neptune Project Manager for liaising between the LCE BKR Program Team and Neptune B2 Project Manager.
<b>University of British Columbia</b>		
<b>Dr. Patrick Martone</b>	Principal Investigator	Lead investigator and subject matter expert. Responsible for overseeing a laboratory technician and graduate student in the cultivation and experimentation to address objectives and questions for the LCE BKR Program. General support and guidance for the design of strain selection experiments and outplanting techniques.
<b>Dr. Mary O'Connor</b>	Supporting Investigator	Supporting investigator to provide guidance if there is interest to expand the LCE BKR Program to study epiphytic relationships of bull kelp and invertebrates. Mary will also provide guidance if there is interest to consider Dungeness crab settlement enhancement programs.
<b>Dynamic Ocean Consulting Ltd</b>		
<b>Laura Borden</b>	LCE BKR Program Coordinator	LCE BKR Program coordinator, including liaising with UBC regarding technical aspects of the LCE BKR Program. Responsible for supporting experimental design, field program execution and overseeing development of the final LCE BKR Report.



NAME	TITLE	DESCRIPTION
<b>Emily Adamczyk</b>	Marine Vegetation QP	Marine vegetation specialist supporting the experimental design and implementation of the field program.
<b>Varoon P Supratya</b>	Bull Kelp specialist	Bull kelp specialist overseeing the experimental design and laboratory cultivation.
<b>Brian Timmer</b>	Bull Kelp specialist	Bull kelp specialist supporting experimental design and implementation of the field program.
<b>Cameron Knight</b>	Field technician	Dive Safety Officer and ROV pilot for field programs. Technical support for diving operations and implementation of field program.
<b>Colleen Parker</b>	Indigenous Engagement Lead	Lead for engagement with Indigenous Groups including preparation of workshop materials, implementation of workshops and development of the consultation log.
<b>Samara Ironside</b>	Indigenous Engagement Support	Support for Indigenous engagement program including preparation of workshop material, implementation of workshops and development of the consultation log.



## APPENDIX C: SUPPORTING PHOTOS



**Photo C-1: Berth 2 Kelp (Sugar, Bull)**



**Photo C-2: Western Water Lot Kelp (Sugar, Bull)**



**Photo C-3: Labelling of Berth 2 Relocated Bull Kelp Plants from the Neptune Bull Kelp Restoration Program**