Northwest Hydraulic Consultants Ltd.
30 Gostick Place
North Vancouver, BC V7M 3G3
Tel: (604) 980-6011
www.nhcweb.com

3007864

July 14, 2023

Neptune Bulk (Canada) Terminals Ltd.
1001 Low Level Road
North Vancouver, BC
V7L 4K6

Attention: Victoria Burdett-Coutts
vburdett-coutts@neptuneterminals.com

Re: **Lynn Creek Estuary Offset Project to Support the B2 FAA Design Basis Report Final, Rev. 3**

The following letter report summaries the design basis prepared by Northwest Hydraulic Consultants Ltd. (NHC) for fish habitat offsetting work within the Lynn Creek Estuary (LCE) to support a *Fisheries Act Authorization* (FAA) for the NBT B2 Project. The enclosed letter report has been prepared exclusively for Neptune Bulk (Canada) Terminals Ltd (NBT).

1 Introduction

1.1 Background

Lynn Creek originates in Lynn Headwaters Regional Park in North Vancouver, BC. The creek generally flows southeast and south for about 18 km before draining into Burrard Inlet. The main tributaries are Kennedy, Wickenden, Hanes, and Coliseum Creeks. The watershed is bordered by Mosquito Creek and Seymour River watersheds. The upper area is forested while lower Lynn Creek is mainly residential and industrial. The watershed has an overall drainage area of approximately 56.5 km^2.

Lower Lynn Creek and its estuary have been largely impacted by development and encroachment, dredging, flood protection works and ongoing infrastructure development. This has resulted in a direct loss of tidal and riparian area, as well as adjacent relic flood channels that provided valuable subtidal and intertidal habitat. The lower LCE is lacking in habitat availability and diversity, and does not currently provide substantial refuge habitat for juvenile salmonids and forage fish species. Ideally, both riparian and structural habitat would provide transition habitats from freshwater to marine habitat during smoltification undertaken by Coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Oncorhynchus tshawytscha*) and Steelhead trout (*Oncorhynchus mykiss*). Shallow estuarine areas also provide ideal feeding and transition habitat for Coastal Cutthroat trout (*Oncorhynchus clarkii*) and Chum salmon (*Oncorhynchus keta*), as well as critical wildlife habitat.

Interest in fish habitat restoration work in the LCE is relatively recent with some habitat offsetting and compensation work completed in subtidal area at the creek mouth. As shown in Figure 1, some previous restoration work completed by NHC and others has been implemented upstream through placement of Large Woody Debris (LWD) designed to provide channel complexity and instream cover for out-migrating and resident fish species. The option to add (described in Section 1.8.1 of NBT (2023a)) the LCE Offset Project site for the marine rocky reef boulder habitat is located at the estuary terminus (Figure 1).

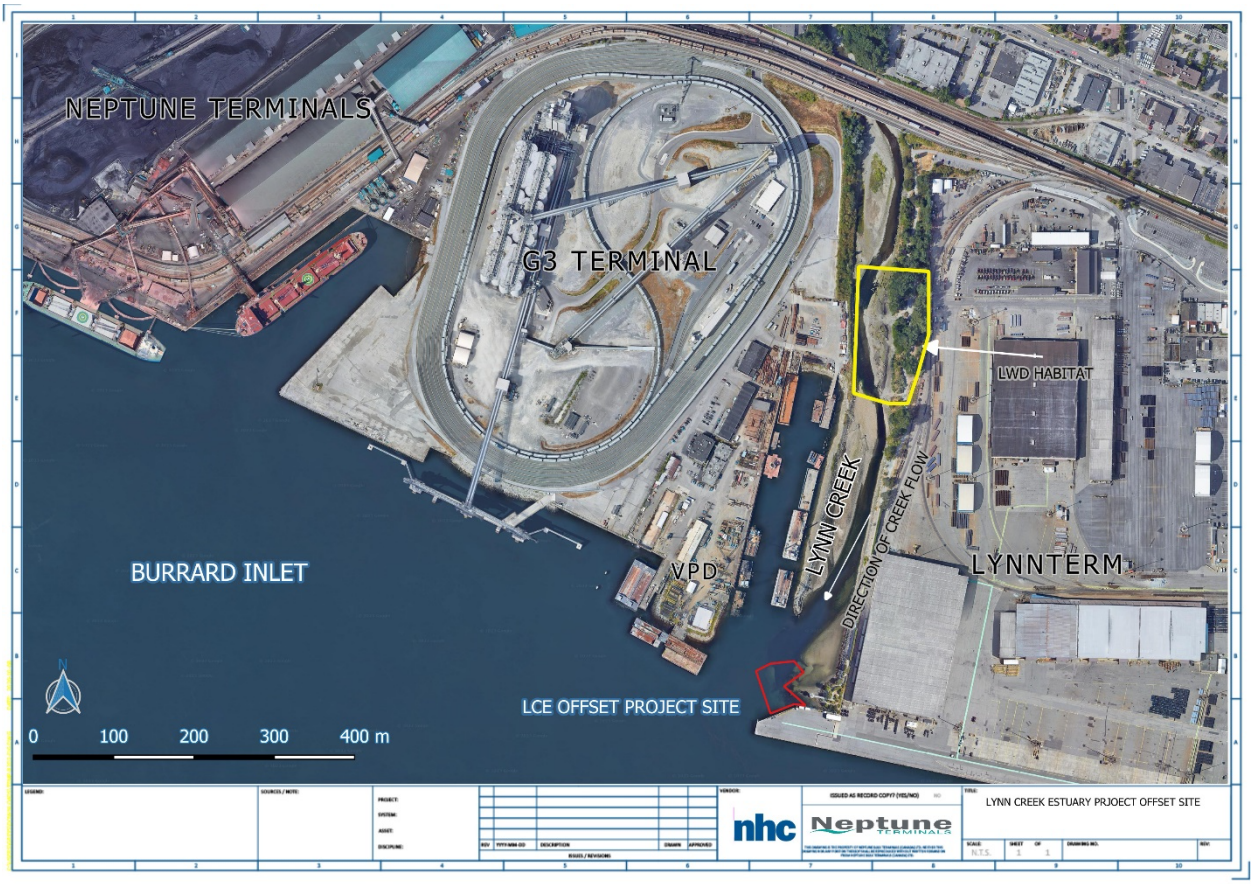


Figure 1. Proposed Lynn Creek Estuary Offset Project Site (red line)

1.2 Site Description

The LCE is located immediately downstream of the rail bridge, (Main Street bridge is 100 m further upstream) and extends 500 m south into Burrard Inlet. At the site itself the creek has a sinuous form, with an average slope of 0.5%. At low flows the creek meanders through the channel-way, and gravel bars have been formed along the channel edges. The channel bed is formed of rounded gravel and cobble although these become progressively smaller towards the mouth.

The estuary channel is approximately 55 m wide at the top-of-bank, with the wetted channel substantially narrower at low flows and low tides. The banks are generally 3 m to 5 m high and are for the most part riprapped with 600 to 900 mm angular rock. The riprap tends to be loosely interlocked and thin is some areas which indicates ravelled material or poor placement.

Some sections of the channel bank are unprotected, however further downstream towards the estuary terminus (Photo 1) the quality of the riprap on the left bank improves and the bank height increases. There is some vegetation on the left top-of-bank; mostly scrub and some trees. The right bank has minimal vegetation, with some scrub. The river bed consists of cobble, gravel, and sands. Exposed bars have coarser lag deposits and looser sand and finer gravels have deposited lower down near the project site.

Photo 1. Lower Lynn Creek channel looking south towards the LCE Offset Project Site.

1.3 Site Inspection

A site inspection was conducted by the NHC project team during the low tide on January 21, 2023 to investigate the current site conditions. The low tide elevation was at approximately El. -3.0 m CGVD28 (0 m CD) at 23:38 PST. The exposed beach was gently sloping and composed primarily of both fine grained sands and silts with defined cobble benches on the upper slopes. The previously placed pilot study boulder clusters on the lower beach slope were visible and appear to be functioning as intended. It was noted that the larger material (approx. 1.0 m in diameter) was settling slightly into the underlying fine bed material (Photo 2).

Photo 2. View of LCE Project Site location looking east towards observation tower on upper beach (Image taken 23:27 on January 21, 2023)

2 Basis of Design

2.1 Objective

The objective of the work is to develop technical documentation, engineered plans and specifications for a habitat offset, which is required as part of a FAA for the NBT B2 Project . Due to the HADD footprint, 1,400 m^2 of offsetting habitat is required, and the total proposed offset area is approximately 1,710 m^2. The offset area consists of complexed marine and intertidal rock reef habitat at the terminus of the LCE.

2.2 Design Parameters

The offsetting design is to establish stable marine and intertidal rock reef habitat in an area that has little existing habitat complexity. The constructed rock reef slopes and top surface will be designed to withstand tidal current and orbital wave velocities and promote macroalgal growth for species specific ideal growth elevation ranges (El. -8.0 m to -2.0 m CGVD28 or approximately El. -5.0 m to 1.0 m CD). The rock reef habitat and boulder clusters will be positioned so that it does not impede the operations and maintenance dredging of the neighbouring tenant(s).

The design hydraulics for the LCE are dominated by wind generated waves with the maximum fetch distance from the west, and the combined tidal current velocity from large winter tides. The hydraulic generated by Lynn Creek flood discharges was determined to have no impact on the design hydraulics, however sediments carried by Lynn Creek may influence the character and performance of the offset. These issues are discussed later in this report.

2.2.1 Design Standards and Codes

The following design standards and codes were considered to meet the objectives of providing stable rocky reef material to the Lynn Creek Estuary in Burrard Inlet:

1. U.S. Army Coastal Engineering Research Centre (1984) – Shore Protection Manual
2. US Army Corps of Engineers Coastal and Hydraulics Engineering (2003) - Technical Note
3. US Army Corps of Engineers Coastal and Hydraulics Engineering (2005) - Technical Note
4. Engineers and Geoscientists British Columbia (2021) – Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work.

In addition to the above, the following design references were applied:

1. Estimate of Tidal Current Velocities using the Telemac3D Hydraulic Model.

2.3 Offsetting Objectives

The offsetting objectives and design were developed based on DFO's Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat under the recent revisions to the *Fisheries Act* (Nov 2019), and through engagement with Indigenous Groups, and other project stakeholders.

As per DFO's Policy of restoration of degraded habitat, this offset has been demonstrated to achieve habitat equivalency, based on the area and expected productivity of the habitat, and is consistent with the preference for in-kind offsetting, i.e., it is the same habitat type and within the same waterbody as the HADD that will result from B2 Project. For further details on offsetting objectives, see Section 2.1 of the LCE Offsetting Plan (NBT, 2023b).

At present, there is only a very limited amount of marine refuge habitat for juvenile salmonids at the mouth of Lynn Creek. Restoration and development of this and similar refuge habitats are intended to increase the survival of out-migrating salmonid smolts by providing refuge from predators, such as piscivorous birds, carnivorous marine fish species, and marine mammals. In addition, promoting a perennial macroalgal community will increase the biological productivity and diversity of the area.

The proposed offset rock reef is a key project to support these regional objectives and provides another link in the goal of developing this marine migration corridor along the north shore of Burrard Inlet.

The LCE Existing Conditions identified several marine algal species that naturally occur in the LCE intertidal and subtidal zone; the species include sea lettuce (*Ulva spp*.), sugar kelp (*Saccharina latissimi*), rock weed (*Ascophyllum nodosum*) and red bladed algae (NBT, 2023a). Although five kelp species are known to grow in Vancouver Harbour, Sea lettuce, sugar kelp, and rockweed are believed to be the most suitable macroalgal species for colonizing the project location (NHC, 2019).

2.4 Tidal Currents

Tidal currents in Burrard Inlet peak annually during king tides around new and full moons in December and January. The Central Harbour that makes up Burrard Inlet is bounded by the First and Second Narrows. Tidal current velocities are stronger within these constriction points compared to the Central Harbour. A three-dimensional hydrodynamic model used a bathymetric surface and computational nodes to simulate hourly tidal currents in Burrard Inlet. The model results are shown in Figure 2.

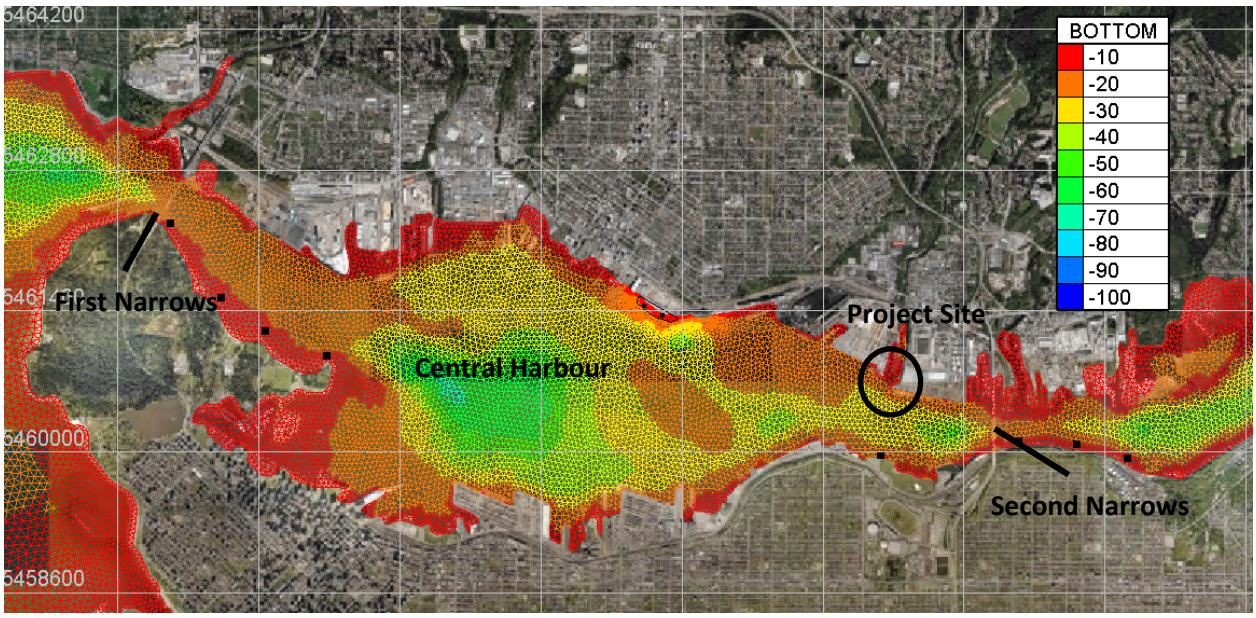


Figure 2. Bathymetry and computational nodes used to predict tidal current velocities in Burrard Inlet using the Telemac3D mode

The simulations were conducted using the Telemac3D model and the following key configurations:

- The density of computational nodes was increased near the proposed reef location to a spacing of approximately 25 m
- The model consisted of 20 vertical layers for the flow calculations
- Only the Fraser River inflow was considered and no other tributary inflows to Burrard Inlet were modelled (e.g., Capilano River, Seymour River, etc.)
- The simulation period was from November 20th to December 31st, 2012
- Hourly data from the December period was used as input data to initialize the model.

The model results indicate that the current velocity adjacent to the LCE Project Site are between 0.2 and 0.3 m/s during a typical period with large tide cycles in December. The current velocity reached a maximum of 0.7 m/s near the shoreline and 0.9 m/s offshore beyond the project area boundary. The project site is located at the estuary terminus before the water depths increase into the Central Harbour. Tidal, wind, and wave hydraulics are dominant compared to fluvial river processes and will influence sediment deposition, transport, and erosion within the project footprint.

2.5 Wind Waves

Over 10 years of wind data measured in Vancouver Harbour was used to estimate the wind-driven wave height at the project location. Based on the data, the 10-year, 20-year, 50-year and 100-year return period for westerly wind events is 15.8 m/s, 16.6 m/s, 17.6 m/s and 18.4 m/s, respectively. These wind speeds were used to calculate the height of a wind-driven wave generated over a fetch of 7 km, which represents the maximum exposure distance to the west of the proposed reef location.

This relatively limited exposure distance causes the wave heights at the project site to be fetch-limited, where the maximum height of a wind-driven wave is less than that of a fully developed wave under identical wind conditions. The results of the wind-wave analysis indicate that the maximum wave height at the project location generated by a westerly wind event with a 100-year return period is approximately 1.1 to 1.4 m.

2.6 Design Criteria

2.6.1 Substrate Type

The intertidal rocky reefs are composed of a deeper perimeter of rock mounds composed of larger Type 1 rock material with a B-Axis nominal diameter of 900 mm and a gradation ranging from 600 to 1,200 mm (modified MoTI Class 500 kg). On the interior surface of the reef, three different structures are provided: large single rock, large cluster and small clusters. Large single rocks consist of a 1,200 to 1,500 mm single rock placed on the bed. The large cluster is 3-5 pieces of Type 1 materials placed together. The small cluster is a single piece of Type 1 with 4-5 pieces of the Type 2 material placed around it. The interior of the reef and surrounding the structured rock placements is filled with Type 2 material with a B-Axis nominal diameter of 300 mm and a gradation ranging from 200 to 400 mm (modified MoTI Class 25 kg).

2.6.2 Structure

The proposed structure of the reef is intended to maximize the area and make best use of the elevations and slopes to generate the desired structure and tidal elevation bands. The open central part of the reef has columnar rock structures and a “flow through” design to ensure flows sweep through the reef and minimize sedimentation. The surrounding Type 2 rock provides a stable base the structure and resulting macroalgal growth provide cover habitat elements.

The reef edge consists of irregular mounds of Type 1 rock which are open and gapped to provide current variability within the structure. On the outside edge, an exterior apron of Type 1 material drapes downslope to depths of El. -1.0 to -2.0 m CD. Where the existing boundary of the conservation area allows, the apron extends deeper to El. -3.0 m CD and has 8 to 10 placements of single large Type 1 material on the surface.

2.6.3 Reef Elevation

The depth of the rock reef surface below lowest tide is a critical design criterion that must be optimized for macroalgal growth. Stable substrate placed at shallower intertidal depths between El. 0 m and 1.5 m CD are more suitable for sugar kelp and sea lettuce species (Hemmera, 2018). A large proportion of the constructed rocky reef surface area will target this elevation as sugar kelp, sea lettuce, and rockweed are more likely to successfully establish at this location. Extending individual rock clusters upstream into shallower depths will also provide a sequence of cover points for out-migrating salmonid species as they transition from Lynn Creek to the marine environment.

Based on surveys of existing kelp beds done for Tsleil-Waututh Nation (Schroeder, 2018), kelp species in Burrard Inlet appear to grow at subtidal elevations between 0 m and -5 m CD, with a mean elevation of -2.18 m CD (90^{th} and 10^{th} percentiles are -0.80 m CD and -3.42 m CD, respectively). These deeper target elevations were considered in developing the reef designs by including stable rock substrate surface area at depths within that range. This elevation range is also able to support the growth of other macroalgal species including sugar kelp, thereby providing opportunities for diverse and vertically stratified habitat for juvenile fish within coexisting kelp species.

2.6.4 Tidal Current Velocity

Results obtained from a 3-dimensional hydrodynamic model of Burrard Inlet indicate that flow velocities around the proposed reef location are 0.2 to 0.3 m/s during a typical period of large tidal cycles in December, reaching a maximum of 0.7 m/s near the shoreline and 0.9 m/s further offshore. The tidal current and water velocities are expected are nominal and accommodated in wind wave design basis of the rock reef. Tidal currents do play an important role in flushing and sediment transport in the area, and this issue is discussed below in Sedimentation and Project Risks and Mitigation.

2.6.5 Sedimentation

A video analysis of the LCE indicated that the substrate in the study area is dominated by finer sediments such as sand, gravel, cobbles (NBT, 2023a). The LCE Offset Project site is within the LCE, so some fine sediment deposition is expected to continue around and in between the proposed inter-tidal rocky reef structures.

NHC field observations of the subtidal and intertidal areas indicate that fine sediment deposition is occurring but is not overwhelming the placed rocky reef substrate. The design will incorporate areas for fine sediment transport by incorporating pockets of open native bed between rocky reef clusters. This will allow for sediment deposition and transport to continue while promoting nutrient exchange between the existing underlying bed material and newly established macroalgal canopy community.

The risk of sedimentation at the project location is believed to be low because current velocities are typically high enough to mobilize deposition of fine sediments and low enough to retain coarser sediments.

2.6.6 Settlement

Risk of excess rock settled and loss of material was reviewed as part of this study. Based on professional judgment and on available bathymetric and site review, NHC suspects that there is a fairly dense layers of sand and gravel underlying the soft sand and silt layer that was present during the site inspection. A loss facto of 25% was added when calculating the rock tonnage of fill materials required to construct the reef design, which is considered to be a conservative estimate.

2.7 Project Risks and Mitigation

The governing project risk for implementing intertidal and subtidal rocky reef habitat is associated with preserving form and function of the constructed offset habitat once it has been constructed and established. The primary risk is associated with sedimentation – physically covering the rocky reef substrate with fine grained sediments – and impaired function of the constructed habitat. Other hazards exist from maintenance activities of the neighbouring tenures including channel dredging and direct loss or destabilization of the foundation of the reef substrate. Offsite hazards also exist from ongoing operations within the Lynnterm area, spills and the release of degraded stormwater water quality inhibiting fish, fauna and macroalgal growth.

The quantitative risk assessment is based on a rating for the severity of consequence and the likelihood of consequence. Based off of the Engineers and Geoscientists British Columbia (EGBC) Risk Matrix it is believed that implementing the intertidal and subtidal rocky reef offset habitat carries a low overall risk rating (EGBC, 2021).

Risk mitigation for the LCE Offset Project will include design elements that allow for sediment deposition between rock clusters and the perimeter reef material. Additional numerical modelling during detailed design will examine tidal flushing through the reef structure and will determine if sediment transport processes will be affected and whether they are sufficient to ensure sediment remobilization. The position of the reef is set back from the neighbouring tenures lease area where maintenance dredging is expected to occur and is positioned withing the designated conservation area with a greater marine influence so will be less influenced by alluvial sediment transport processes.

3 Offset Reef Construction

3.1 Constructability

The NHC project team has discussed some of the constructability issues related to the LCE Offset Project. These discussions were held at a conceptual level to identify issues that could greatly increase construction costs or prove to be problematic due to logistical or practical complexity. The results of these discussions are summarised below.

3.1.1 Constructability

There are no major concerns for constructability issues, but there is some precautionary advice to consider:

- Based on the nature of the project and desired location of the placed rock, the project would be approached using marine-based equipment; e.g., material would arrive and be placed by barge.
- Placement of material would be conducted using a clamshell bucket controlled by crane and derrick. Material is to be placed as close to the bed as possible and no end dumping or release from the water surface will be permitted.
- Environmental considerations, such as the requirement for use of silt curtains will increase costs. If there is flexibility in meeting the environmental considerations through other measures suitable for marine construction, then risks are less, and costs will be lower.
- Related to constructability is the availability of materials. Given the volumes of material that are anticipated to be needed, it was advised that a minimum of six to eight week notice would be required for a quarry to produce the volume of rock specified by the design.
- Related to the need for sufficient lead-time to procure materials is the likelihood of other large marine construction projects proceeding in the next year and the need to provide sufficient advance notice to the contractor in order to ensure suitable equipment is available.
- Placement of materials shall be primarily within the Port Authority conservation area.

3.2 Materials

It is understood from project team meetings that Vancouver Pile and Dredge (VanPile) has an existing relationship with NBT given that they are part of the neighboring lease. VanPile has provided constructability recommendations and proposed material types and gradations that were reviewed as a part of this preliminary design (NHC email dated January 14, 2023).

For the reef design, the rock size and gradation were constrained by the following criteria:

- The rock is to be blocky in shape, and roughly equidimensional. It should not have a length more than 2.4 times the width or thickness measured at the middle of the stone. The rock is to be hard, durable and abrasive resistant.
- Rock source is to be approved by the engineer greater than 2 weeks prior to loading.
- Specific gravity is to be greater or equal to 2.65.
- Fractured rock classes should be tested for acid rock drainage (ARD) in accordance with BC MoTI Metal Leaching / Acid Rock Drainage Technical Circular T-04/13. Materials that are suspected to be potentially acid generating rock (PAG) will not be accepted.
- The rock shall be free from debris, litter, fine sediments, pollutants and/or deleterious substances.

Based on these requirements, two general rock types were specified:

- Type 1 material: Rock riprap with a B-Axis nominal diameter of 900 mm and a gradation ranging from 600 to 1,200 mm (modified MoTI Class 500 kg).
- Type 2 material: Rock riprap with a B-Axis nominal diameter of 300 mm and a gradation ranging from 200 to 400 mm (modified MoTI Class 25 kg).
- Select Type 1 : 20 to 30 select 1,200 to 1,500 mm boulders for individual placements in the reef structure.

Quantities of materials are included on the preliminary design drawings.

4 Preliminary Reef Designs

The preliminary design drawings to support the permit package are located in Appendix A. The design basis and areal extent is designed to provide approximately 1,710 m^2 of long-term, effective intertidal and subtidal fish habitat meeting the proposed FAA habitat offsetting objectives.

5 Summary

Currently, the existing intertidal and subtidal area at the estuary is insufficient with little to no productive habitat areas, no substrates and no structure within the optimal range for macroalgae colonization - which is a keystone element of shallow subtidal habitat restoration. Aside from a small pilot study of approximately 70 m^2, it lacks stable structural features and is composed predominantly of fine sediments overlying alluvial cobble material.

The habitat offsetting design as proposed in this design basis report and drawings are expected to satisfy the design criteria and requirements set out in the project objectives. The designs were developed based on biological data and assessment provided by NBT (2023), hydrodynamic modelling and discussions with stakeholders, technical experts, coastal engineers and contractors.

The construction of a shallow intertidal and subtidal rock reef at this location is warranted to increase the biological productivity of the area and to provide critical refuge habitat for out-migrating juvenile salmonids from Lynn Creek and forage fish species in Burrard Inlet. A structurally varied, intertidal and subtidal reef design has been developed to provide refuge habitat for both forage fish and rearing juvenile salmonids by increasing habitat complexity and by supporting the growth of native macroalgal species.

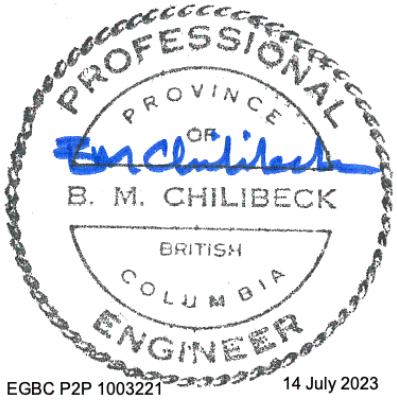
6 Closure

Report prepared by:

Alicia Van Boven, E.I.T.
Project Engineer

Greg Grzybowski, P.Eng., BIT.
Hydrotechnical Engineer

Report reviewed by:



Barry Chilibeck, P.Eng.
Principal Engineer

DISCLAIMER

This report has been prepared by Northwest Hydraulic Consultants Ltd. for the benefit of Neptune Bulk (Canada) Terminals Ltd. for specific application to the Lynn Creek Estuary Offset Project to Support the B2 FAA. The information and data contained herein represent Northwest Hydraulic Consultants Ltd. best professional judgment in light of the knowledge and information available to Northwest Hydraulic Consultants Ltd. at the time of preparation and was prepared in accordance with generally accepted engineering and geoscience practices.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by Neptune Bulk (Canada) Terminals Ltd., its officers and employees. Northwest Hydraulic Consultants Ltd. denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

7 References

EGBC (2021). *Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work* (Version 1.0). Engineers and Geoscientists British Columbia. Quality Managment Guides.

Hemmera (2018). *Existing Ecological Conditions: Maplewood Marine Restoration Project*. Report prepared by Hemmera Envirochem Inc. for Vancouver Fraser Port Authority. 28 pp.

NBT (2023a). *Lynn Creek Estuary Fish and Fish Habitat Existing Conditions Report. B2D2 Project* (REP-B2D2-0002 R0). Prepared by Hatfield Consultants. 22 pp.

NBT (2023b). *Lynn Creek Estuary Offsetting Plan. B2D2 Project. Doc No.: PLAN-B2D2-0006.* Rev. 0.

NHC (2019). *300 Low Level Road Rock Reef Conceptual Design*. Conceptual-Level Design Final Report. Prepared for Vancouver Fraser Port Authority, North Vancouver, BC. 36 pp.

Schroeder, S. (2018). *Burrard Inlet Bull Kelp Survey 2018*. Prepared for the Tsleil-Waututh Nation. 11 pp.

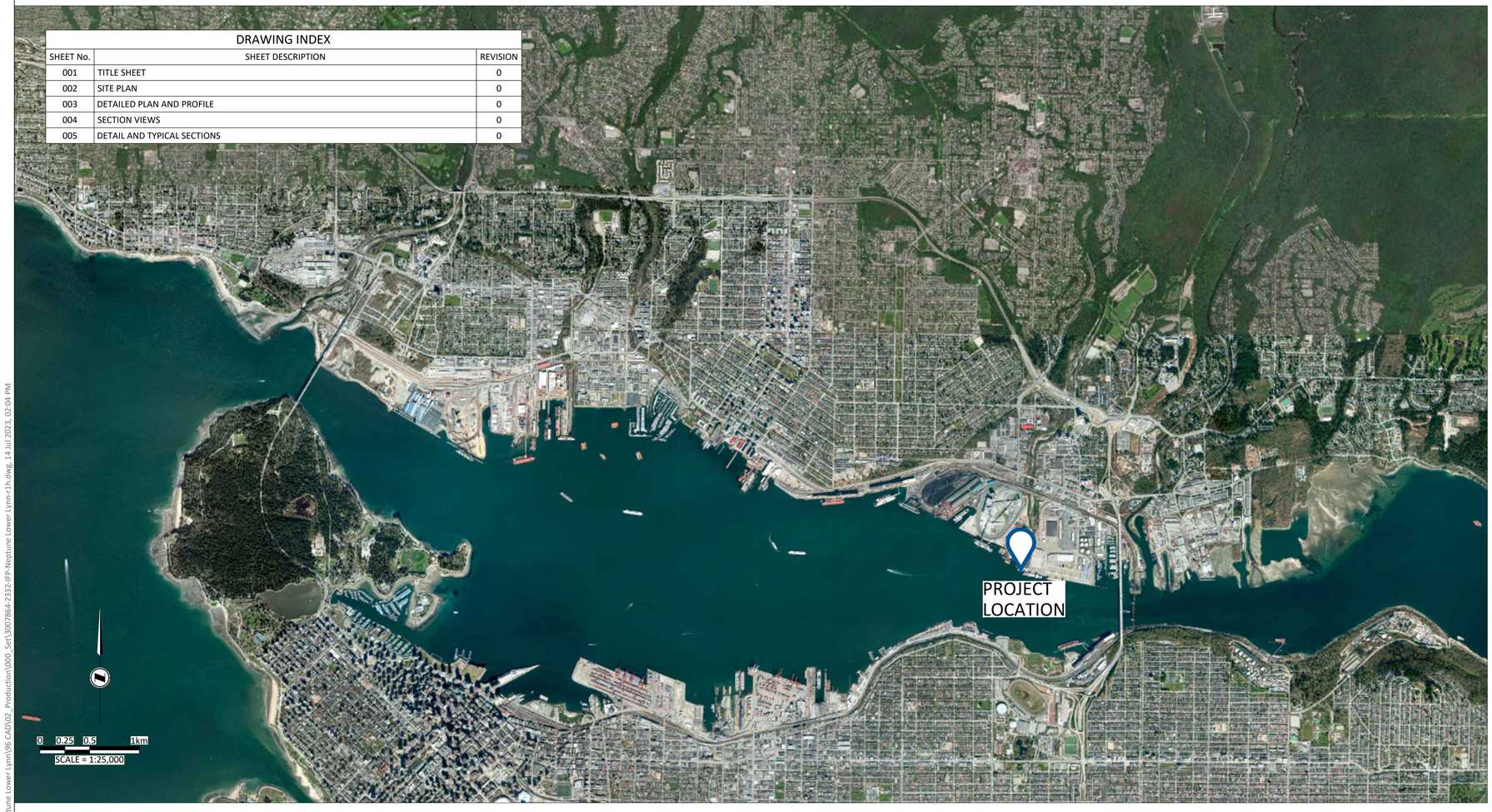
APPENDIX A

PRELIMIARY DESIGN DRAWINGS

LOWER LYNN CREEK HABITAT OFFSETTING ROCKY REEF CONCEPTUAL DESIGN

ISSUED FOR PERMITTING, JULY, 2023

DRAWING INDEX		
SHEET No.	SHEET DESCRIPTION	REVISION
001	TITLE SHEET	0
002	SITE PLAN	0
003	DETAILED PLAN AND PROFILE	0
004	SECTION VIEWS	0
005	DETAIL AND TYPICAL SECTIONS	0



NOTES

1. GENERAL INFORMATION
   - 1.1. BASE IMAGERY SITE DETAIL: NHC 10cm DRONE ORTHO, 2022/12/14.
   - 1.2. BASE IMAGERY OUTSIDE SITE DETAIL: WORLD IMAGERY
   - 1.3. PROPERTY BOUNDARIES FROM VFPA
2. SURVEY AND DIMENSIONS
   - 2.1. ALL DIMENSIONS ARE EXPRESSED IN METRES; ELEVATIONS ARE EXPRESSED IN METRES ABOVE MEAN SEA LEVEL
   - 2.2. RTK TOPOGRAPHIC GPS SURVEY CONDUCTED BY NHC, 2022/12/14.
   - 2.3. BATHYMETRIC SURVEY CONDUCTED BY VPD, 2022/12/01 AND 2022/06/15.
   - 2.4. SURVEY DATUM
     HORIZTONTAL DATUM NAD83 (CSRC)
     VERTICAL DATUM: CGVD2013, GEOID: CGG2013a
3. MATERIALS
   - 3.1. REFER TO TABLE 1. FOR ESTIMATED QUANTITIES AND TABLE 2. FOR MATERIAL SIZE GRADATION.
   - 3.2. ESTIMATED QUANTITIES. VOLUMES ARE CLEAN-LINE APPROXIMATES CALCULTED FROM AUTOCAD CIVIL 3D SURFACES AND DO NOT INCLUDE SWELLING OR SHRINKAGE. NEPTUNE DOES NOT ACCEPT RESPONSIBILITY FOR VARIANCES FROM ESTIMATES TO IN-PLACE VOLUMES.
   - 3.3. ROCK IS TO BE BLOCKY IN SHAPE AND EQUIDIMENSIONAL. ROCK LENGTH SHOULD NOT BE MORE THAN 2.4 TIMES THE WIDTH OF THICKNESS MEASURED AT THE MIDDLE OF THE STONE
   - 3.4. ROCK IS TO BE HARD, DURABLE AND ABRASIVE RESISTANT.
   - 3.5. FRACTURED ROCK CLASSES SHOULD BE TESTED FOR ACID ROCK DRAINAGE.
   - 3.6. ROCK SHALL BE FREE FROM DEBRIS, LITTER, FINE SEDIMENTS, POLLUTATNS AND/OR DELETERIOUS SUBSTANCES.
4. GENERAL INSTRUCTIONS
   - 4.1. A COPY OF THESE DRAWINGS MUST BE REVIEWED BY ALL CREW SUPERVISOR(S) AND CONTRACTOR(S), AND MUST BE PRESENT ON THE SITE WHILE WORK IS PROCEEDING.
   - 4.2. ALL ELEVATIONS, DIMENSIONS AND STATIONING SHALL BE VERIFIED BEFORE CONSTRUCTION.
   - 4.3. THE LOCATION OF THE UTILITIES IS APPROXIMATE ONLY, AND THE EXACT LOCATION SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED. THE CONTRACTOR SHALL ALSO VERIFY THE EXACT LOCATION AND INVERT ELEVATION BY HAND EXCAVATION BEFORE CONSTRUCTION OF THE UTILITY CROSSING AND SHALL BE RESPONSIBLE FOR ADEQUATE PROTECTION FROM DAMAGE.

TABLE 1. QUANTITIES	
ITEM	QUANTITY
TYPE 1 FILL	545 m^3
TYPE 2 FILL	335 m^3
TOTAL FOOTPRINT	1710 m^2

TABLE 2. ROCK MATERIAL SIZE SPECIFICATIONS (mm)			
		PERCENTAGE LESS THAN	
MATERIAL	D_{50}	LOWER	UPPER
TYPE 1 FILL	900	600	1200
TYPE 2 FILL	300	200	400

CLIENT:

Neptune TERMINALS

NEPTUNE TERMINALS
SUITE 100 - 340 BROOKSBANK AVE
NORTH VANCVOUER, BC
V7J 2C1

REV.	DATE	DESCRIPTION
0	13 01 2023	ISSUED FOR PERMITTING
1	14 07 2023	ISSUED FOR PERMITTING

nhc northwest hydraulic consultants

SEAL:

LOWER LYNN CREEK HABITAT OFFSETING ROCKY REEF CONCEPTUAL DESIGN

TITLE AND NOTES

DESIGNED: GMG	SHEET ID: 3007864-2332-IFP-NEPTUNE LOWER LYNN-R1H-001 R1	SHEET No:	001
DRAFTED: CZZ	STATUS: ISSUED FOR PERMITTING		
CHECKED: BMC	SCALE: AS SHOWN WHEN PLOTTED D SIZE		
APPROVED: ----	DATE: 14 JUL 2023	REV No: R1	

SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING

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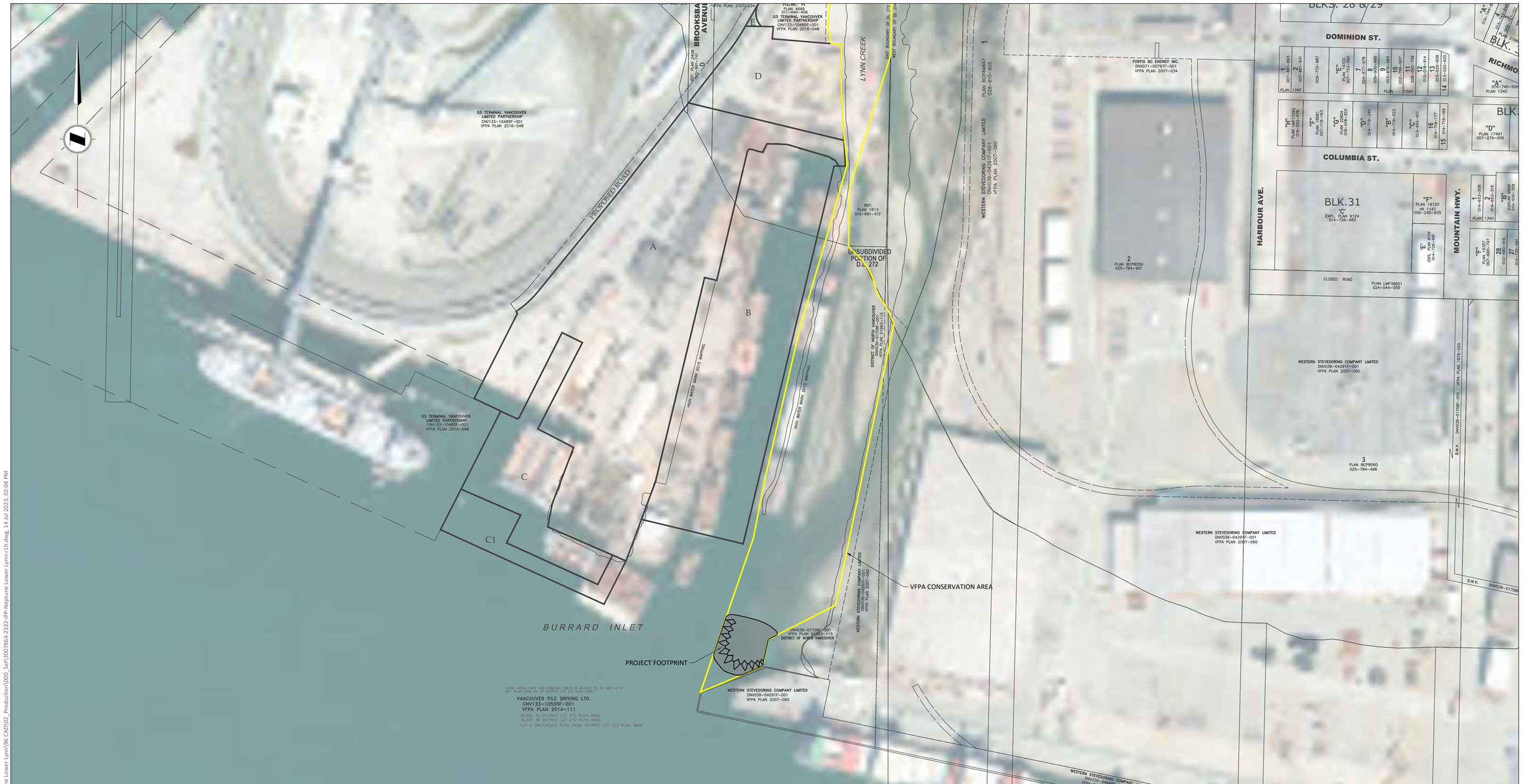

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PLAN VIEW

1:5000

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CLIENT:

Neptune TERMINALS

NEPTUNE TERMINALS
SUITE 100 - 340 BROOKSBANK AVE
NORTH VANCVOUER, BC
V7J 2C1

REV.	DATE	DESCRIPTION
0	13 01 2023	ISSUED FOR PERMITTING
1	14 07 2023	ISSUED FOR PERMITTING

nhc northwest hydraulic consultants

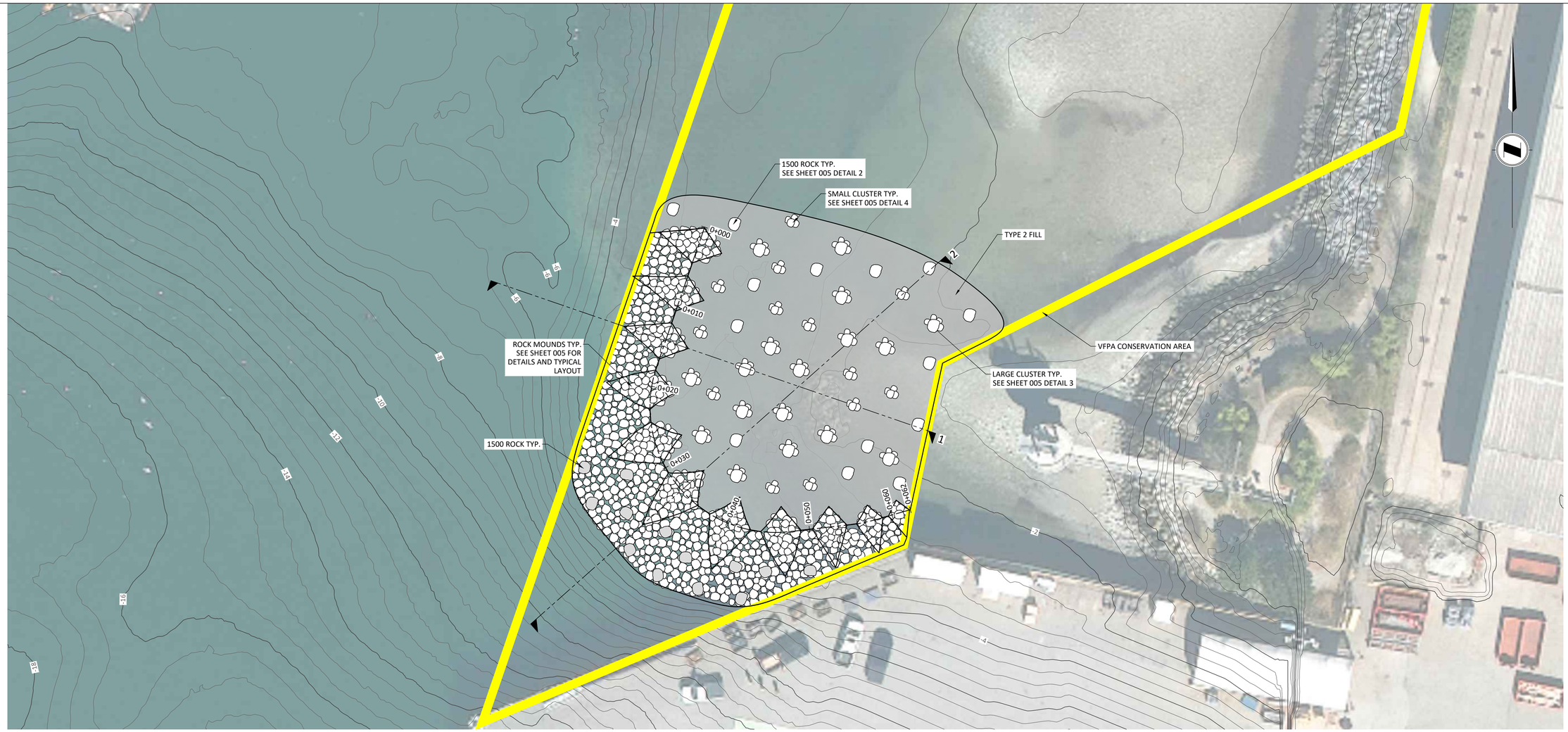
SEAL:

LOWER LYNN CREEK HABITAT OFFSETING
ROCKY REEF CONCEPTUAL DESIGN

TENURE BOUNDARY PLAN

DESIGNED:	GMG	SHEET ID: 3007864-2332-IFP-NEPTUNE LOWER LYNN-R1H-002 R1	SHEET No: 002
DRAFTED:	CZZ	STATUS: ISSUED FOR PERMITTING	
CHECKED:	BMC	SCALE: AS SHOWN WHEN PLOTTED D SIZE	
APPROVED:	----	DATE: 14 JUL 2023	REV No: R1

SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING



0 5 10m
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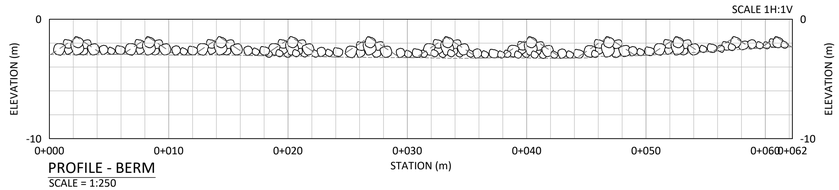
PLAN VIEW
1:250



PROFILE - BERM
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CLIENT:

Neptune TERMINALS

NEPTUNE TERMINALS
SUITE 100 - 340 BROOKSBANK AVE
NORTH VANCVOUER, BC
V7J 2C1

REV.	DATE	DESCRIPTION
0	13 01 2023	ISSUED FOR PERMITTING
1	14 07 2023	ISSUED FOR PERMITTING

nhc northwest hydraulic consultants

SEAL:

LOWER LYNN CREEK HABITAT OFFSETING
ROCKY REEF CONCEPTUAL DESIGN

PLAN AND PROFILE

DESIGNED:	GMG	SHEET ID: 3007864-2332-IFP-NEPTUNE LOWER LYNN-R1H-003 R1	SHEET No: 003
DRAFTED:	CZZ	STATUS: ISSUED FOR PERMITTING	
CHECKED:	BMC	SCALE: AS SHOWN WHEN PLOTTED D SIZE	
APPROVED:	----	DATE: 14 JUL 2023	REV No: R1

SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING

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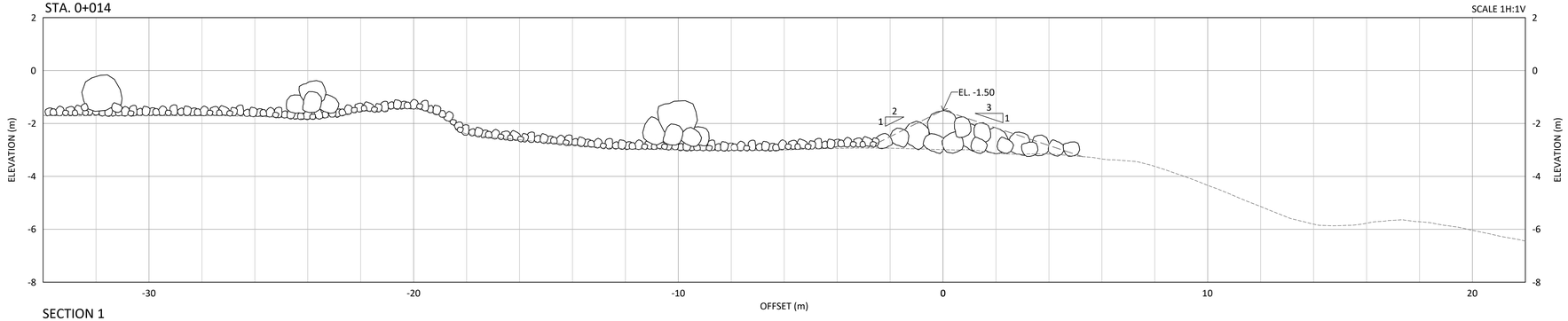
STA. 0+014

SCALE 1H:1V



SECTION 1
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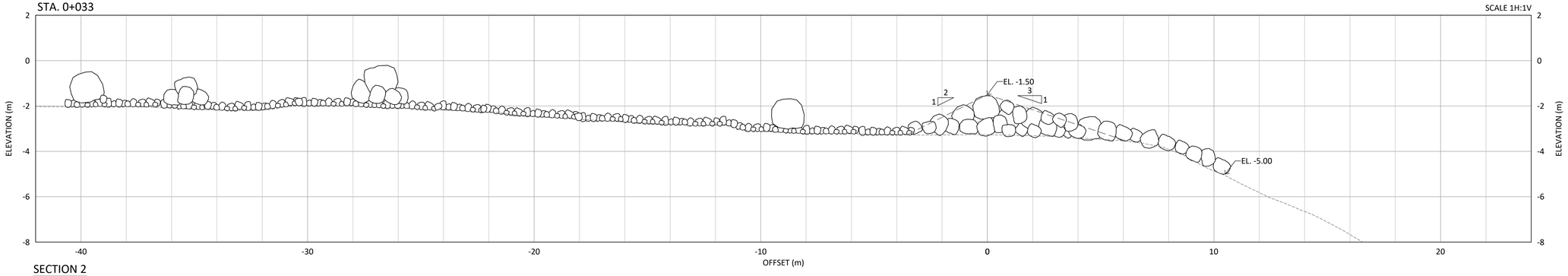
STA. 0+033

SCALE 1H:1V



SECTION 2
SCALE = 1:200

CLIENT:

Neptune TERMINALS

NEPTUNE TERMINALS
SUITE 100 - 340 BROOKSBANK AVE
NORTH VANCVOUER, BC
V7J 2C1

REV.	DATE	DESCRIPTION
0	13 01 2023	ISSUED FOR PERMITTING
1	14 07 2023	ISSUED FOR PERMITTING

nhc northwest hydraulic consultants

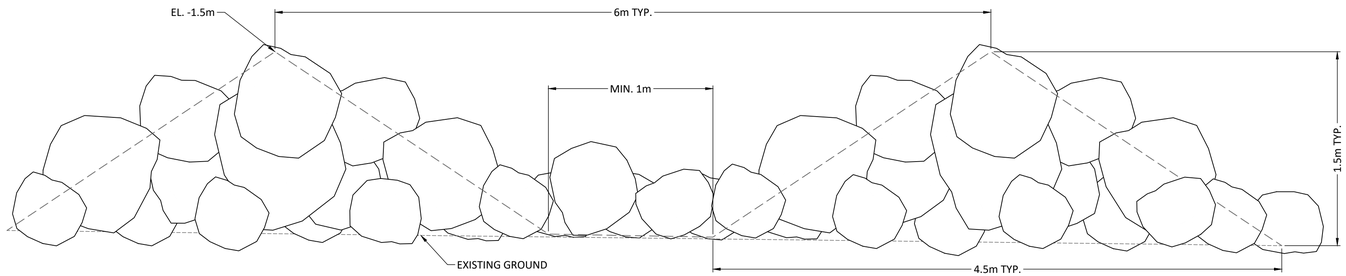
SEAL:

LOWER LYNN CREEK HABITAT OFFSETING
ROCKY REEF CONCEPTUAL DESIGN

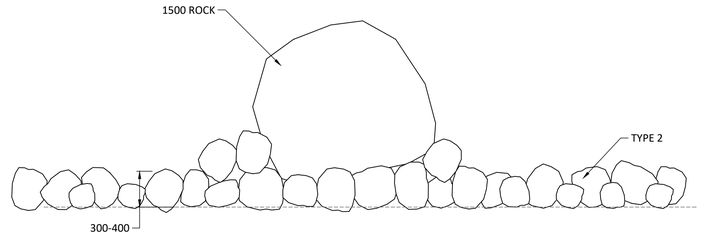
SECTIONS

DESIGNED: GMG	SHEET ID: 3007864-2332-IFP-NEPTUNE LOWER LYNN-R1H-004 R1	SHEET No:	004
DRAFTED: CZZ	STATUS: ISSUED FOR PERMITTING		
CHECKED: BMC	SCALE: AS SHOWN WHEN PLOTTED D SIZE		
APPROVED: ----	DATE: 14 JUL 2023	REV No:	R1

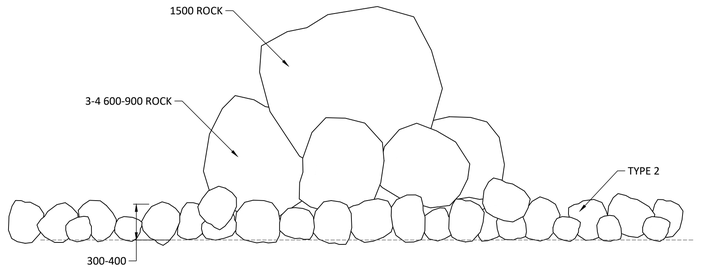
SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING



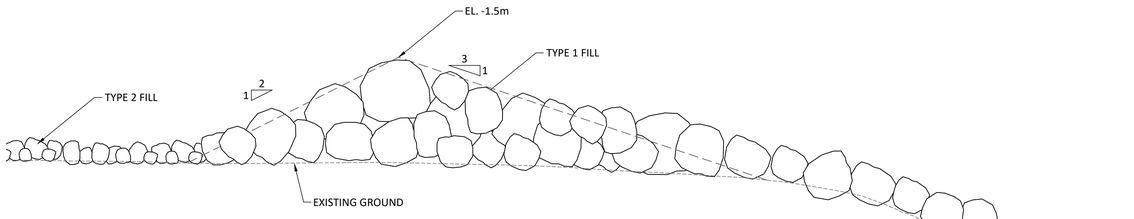
TYPICAL PROFILE VIEW - MOUNDS
1:25



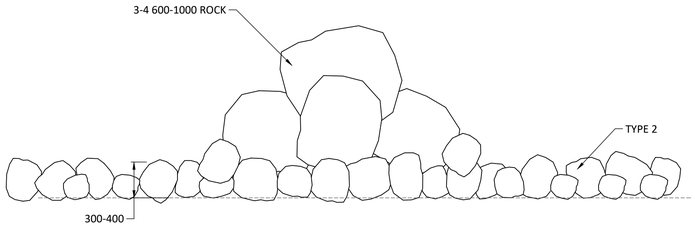
DETAIL 2 - LARGE SINGLE ROCK
1:25



DETAIL 3 - LARGE CLUSTER
1:25



DETAIL 1 - TYPE 1 ROCK
1:50



DETAIL 4 - SMALL CLUSTER
1:25

EL. -5m

CLIENT:

Neptune TERMINALS

NEPTUNE TERMINALS
SUITE 100 - 340 BROOKSBANK AVE
NORTH VANCVOUER, BC
V7J 2C1

REV.	DATE	DESCRIPTION
0	13 01 2023	ISSUED FOR PERMITTING
1	14 07 2023	ISSUED FOR PERMITTING

nhc northwest hydraulic consultants

SEAL:

LOWER LYNN CREEK HABITAT OFFSETING
ROCKY REEF CONCEPTUAL DESIGN

TYPICAL SECTION AND DETAIL

DESIGNED: GMG	SHEET ID: 3007864-2332-IFP-NEPTUNE LOWER LYNN-R1H-005 R1	SHEET No:	005
DRAFTED: CZZ	STATUS: ISSUED FOR PERMITTING		
CHECKED: BMC	SCALE: AS SHOWN WHEN PLOTTED D SIZE		
APPROVED: ----	DATE: 14 JUL 2023	REV No:	R1

SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING

FILENAME: \\mainfile-van\Projects\Active\3007864.01 Neptune Lower Lynn\96 CAD\02_Production\000_Set\3007864-2332-IFP-Neptune Lower Lynn-r1h.dwg, 14 Jul 2023, 02:04 PM