Keystone Environmental
Knowledge-Driven Results

March 25 2025

Woodfibre LNG Limited Partnership
900 – 1185 West Georgia Street
Vancouver, BC V6E 4E6

Attn: Scott Wagner, P. Biol, Permitting Manager

Re: Revision 3 (March 25, 2025)
Detailed Habitat Offsetting Effectiveness Monitoring Plan
Woodfibre LNG, Skwxwú7mesh (Squamish), BC
Project No. 20327-109

We have enclosed the Detailed Habitat Offsetting Effectiveness Monitoring Plan for the Woodfibre LNG Project. As discussed in the FTAC meeting, this revision of the report includes a summary and interpretation of the existing baseline data collected so far for the project.

We trust this report meets your requirements and thank Woodfibre LNG for the opportunity to work on this exciting Project.

If you have any questions, please do not hesitate to contact us.

Sincerely,

Keystone Environmental Ltd.

Afshin Parsamanesh M.Sc., R.P.Bio.
Project Manager/Fisheries Biologist

I:\20300-20399\20327 WLNG\Phase 00109B MFFHMMP Plans and SOPs\Reporting\OEMP\Rev 3\20327 250325 WLNG Detailed OEMP-Rev3.docx

encl.

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Keystone Environmental
Knowledge-Driven Results

REVISION 3 (MARCH 25, 2025)
DETAILED HABITAT OFFSETTING EFFECTIVENESS MONITORING PLAN

Woodfibre LNG
Squamish, BC

Prepared For: Woodfibre LNG Limited Partnership

Project No: 20327-109
March 2025

Detailed Habitat Offsetting Effectiveness Monitoring Plan – Woodfibre LNG Project – Revision Tracking Table

Revision	Author	Review	Company	Change Summary	Revision Date
Draft 1	C. Belz, BIT A. Parsamanesh, RP Bio	D. Clark, RP Bio	Keystone Environmental Ltd	n/a	23-Feb-24
Revision 1	C. Belz, BIT A. Parsamanesh, RP Bio	D. Clark, RP Bio	Keystone Environmental Ltd	-Appendix B – clarification of variables of OKPIs -Appendix D – Modification of standard error calculation -Section 4 – Clarification & modification of offsetting monitoring objective -Section 4.1 – Added clarification on spot water quality monitoring measurements at offsetting areas/reference sites and consideration for permanent data loggers -Throughout document -editorial updates	31-May-24
Revision 2	C. Belz, BIT A. Parsamanesh, RP Bio	D. Clark, RP Bio	Keystone Environmental Ltd	-Addition of revision tracking table -Figure 1-2 - PPIA revised to include wholistic PPIA boundary and inclusion of Mill Creek and Woodfibre Creek -Section 3.2.2 – expected depths of sugar kelp growth -Section 4 – Added statement of roles and responsibilities of TAC in reference to Guiding Principles	05-Jul-24
Revision 3	C. Belz, BIT A. Parsamanesh, RP Bio	D. Clark, RP Bio	Keystone Environmental Ltd	-Section 5 – Added specific timebound language for implementation of adaptive management plan	25-Mar-25

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LIST OF ACRONYMS

AEA	Aquatic Effects Assessment
BC	British Columbia
CD	Chart Datum
CPA	Certified Project Area
CWD	Coarse Woody Debris
DFO	Fisheries and Oceans Canada
EWG	Environmental Working Group
FAA	*Fisheries Act* Authorization
FST	Floating Storage Tank
GD	Geodetic Datum
GPS	Global Positioning System
HADD	Harmful Alteration Disruption or Destruction
HHWL	Higher High-Water Line
KPI	Key Performance Indices
LNG	Liquefied Natural Gas
LPL	Lowest Practicable Level
MFFHMMP	Marine Fish and Fish Habitat Management and Monitoring Plan
MFFH EEMP	Marine Fish and Fish Habitat Environmental Effects Monitoring Plan
MFFH OEMP	Marine Fish and Fish Habitat Offsetting Effectiveness Monitoring Plan
MOF	Materials Offloading Facility
OKPI	Offsetting Key Performance Indices
PPIA	Potential Project Impact Area
Project	Woodfibre LNG Project
QEP	Qualified Environmental Professional
Ro-Ro	Roll-on and Roll-off
SCUBA	Self-Contained Underwater Breathing Apparatus
SNEAA	Squamish Nation Environmental Assessment Agreement

LIST OF ACRONYMS (CONT'D)

TAC	Technical Advisory Committee
TWN	Tsleil-Waututh Nation
Woodfibre LNG	Woodfibre LNG Limited Partnership

PREAMBLE

The Woodfibre Liquified Natural Gas Project (the Project) is a liquefied natural gas export facility being constructed on the former Woodfibre Pulp and Paper Mill site (the Site) in Nexwnéwu7ts Átlḵ'a7tsem (Howe Sound), approximately seven kilometres south of Sḵwx̱wú7mesh (Squamish). The Project is on the historical location of a Skwxwú7mesh Úxwumixw (Squamish Nation) village known as Swiy̓át. Swiy̓át and Nexwnéwu7ts Átlḵ'a7tsem (Howe Sound) are tied to the cultural well-being of Skwxwú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants, and to other Indigenous groups as defined in the Project's Environmental Assessment Certificate. Woodfibre LNG Limited Partnership (Woodfibre LNG) recognizes the importance of these areas to the Skwxwú7mesh stélmexw (Squamish People), and other Indigenous groups. Woodfibre LNG seeks to construct and operate the Project in a manner that is respectful of Indigenous values. This Detailed Habitat Offsetting Effectiveness Monitoring Plan is primarily written in English with important place names, species, phrases, and passages provided in the Skwxwú7mesh (Squamish) language.

Temíxwiy̓iḵw chet wa naantem chet ti temíxw Swiy̓át
Chet wa sméṅhemswit kwis ns7éyx̱nitas chet ti temíxw
We7ú chet kwis t'íchimwit iy íẇas chet eḵ' I tti.

Our ancient ancestors named this place Swiy̓át
We, as their descendants safeguard these temíxw (lands)
We will continue to swim and Sts'úkwi7 (fish) in these clear staḵw (waters).

Tsleil-Waututh Nation - Woodfibre LNG understands that it is operating within the traditional, ancestral, and unceded territory of the səlilwətaɬ (Tsleil-Waututh) Nation.

1. INTRODUCTION

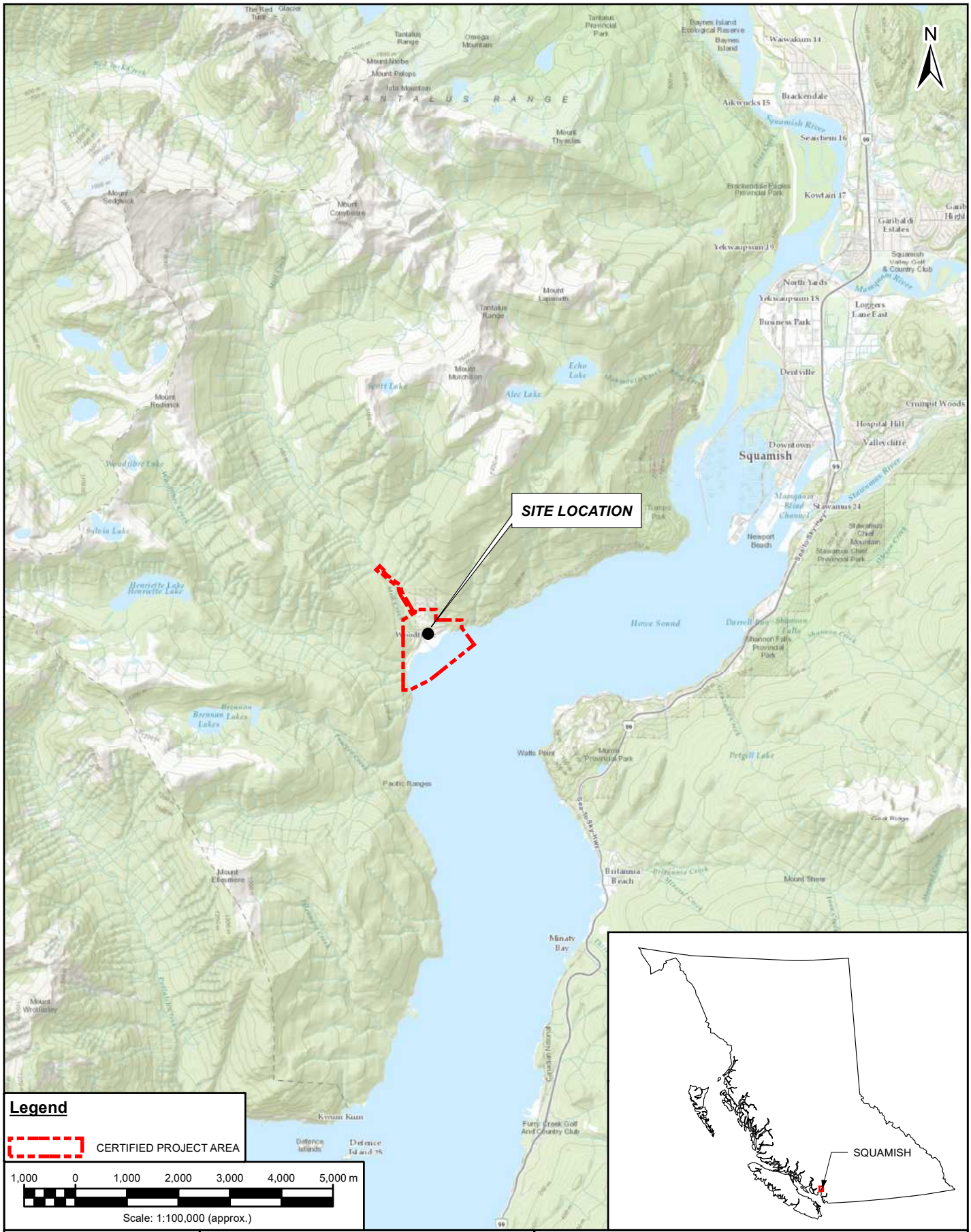
Woodfibre LNG Limited Partnership (Woodfibre LNG) commenced construction of a liquefied natural gas (LNG) export facility (the Project) in November 2023 on the former Woodfibre Pulp Mill site (the Site) in Nexwnéwu7ts Átlḵ'a7tsem (Howe Sound), approximately seven kilometres south of Skwxwú7mesh (Squamish). The Project is on the historical location of a Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) village known as Swiy̓át. Swiy̓át and Nexwnéwu7ts Átlḵ'a7tsem (Howe Sound) are tied to the cultural well-being of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants. Woodfibre LNG recognizes the importance of these areas to the Sḵwx̱wú7mesh stélmexw (Squamish People) and seeks to construct and operate the LNG facility and export terminal in a manner that is respectful of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) values.

The Project area is located at the former Woodfibre pulp mill site; a fee simple, industrially zoned brownfield site with more than 100 years of industrial use and deep-water marine access. The community of Shisháyu7ay (Britannia Beach) is approximately 5.5 km southeast of the Project area; Kwtsá7tsutsin (Darrell Bay) is approximately 6.2 km to the east; and K'íḵ'elxn (Port Mellon) is approximately 22 km southwest. K'emḵ'emeláy (Vancouver) is situated approximately 50 km southeast of the Project area.

The Project location and Certified Project Area (CPA) are shown on **Figure 1-1** and the Project layout is shown on **Figure 1-2**.

This Detailed (Marine Fish and Fish Habitat) Habitat Offsetting Effectiveness ínexwantas (Monitoring) Plan (MFFH-OEMP) is primarily written in English with important place names, species, phrases, and passages provided in Sḵwx̱wú7mesh Sníchim (Squamish language) and English. This Plan is a companion document to the Marine Fish and Fish Habitat Management and Monitoring Plan (MFFHMMP), which required written approval from Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) prior to the start of the construction phase of the Project.

Woodfibre LNG is committed to ongoing engagement and information sharing with Indigenous groups on the development and implementation of the MFFHMMP and associated documents. A Technical Advisory Committee (TAC) has been convened with the Squamish Nation Environmental Working Group (EWG) to collaboratively develop monitoring protocols based on agreed upon objectives, performance indices, and methodologies. In alignment with the objectives and Guiding Principles established in collaboration between Woodfibre LNG and the TAC, the development of this Plan supports the follow-up monitoring program during and after construction within the Project's habitat offsetting areas. Concurrently, this Plan has been prepared to provide a procedure for executing offsetting monitoring that meets the requirements outlined in the Project's *Fisheries Act* Authorization (FAA), which was issued by Fisheries and Oceans Canada (DFO), File No.: 22-HPAC-01346, and intends to meet the requirement for a detailed Offset Effectiveness Monitoring Plan (condition 4.4.4 of the FAA).



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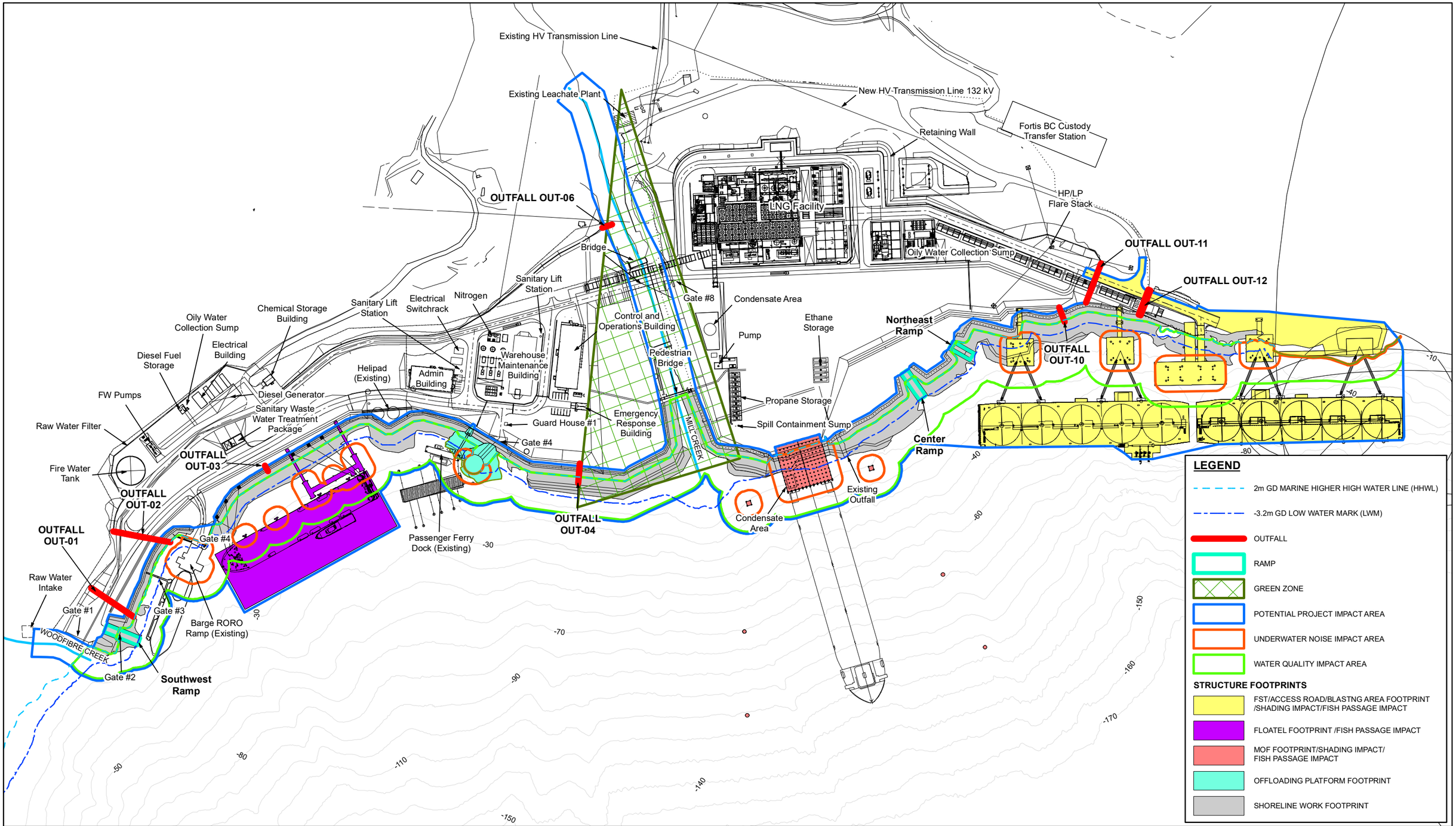
Woodfibre
Squamish, B C
Woodfibre LNG Limited

REVISION No.	DATE	PROJECT No.
00	Jul. 2023	17227-100

Figure 1-1 Project Location

DRAWN BY: CS DOCUMENT PATH: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17227\00100\2022_10Oct_07__DFO_FA_Authorization\Fig1-1-LocationPlan-R0.mxd



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NOTES:
1. *THIS DRAWING IS FOR GENERAL INFORMATION ONLY. LOT BOUNDARIES AND FEATURES ARE APPROXIMATE.*
2. *DATE OF AERIAL PHOTO IS 2016.*
3. *CONTOUR ELEVATION IS IN CHART DATUM (CD).*
4. *SPILLS FROM INDUSTRIAL EQUIPMENT OR CONCRETE IS AN ADDITIONAL POTENTIAL PROJECT IMPACT TO NOT SHOWN. IF THERE IS A SPILL, IT WILL BE INVESTIGATED AND MONITORING SEPARATELY.*

25 0 125 m

SCALE: 1:3,500 (approx.)

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Squamish, B C
Woodfibre LNG Limited

REVISION No.	DATE	PROJECT No.
00	Jul. 2024	18785-109

Figure 1-2

Project Layout and Potential Project Impact Area

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2. PROJECT DESCRIPTION

The Project includes the construction of both upland and marine infrastructure to facilitate the production, storage, loading and offloading, and transport of LNG. The Potential Project Impact Area (PPIA) is shown on **Figure 1-2** and depicts the area(s) of potential project effects due to construction (e.g. underwater noise impacts, water quality impacts, fish passage impacts) and infrastructure footprints (i.e., alteration or loss of fish habitat).

Infrastructure relating to marine fish and fish habitat includes:

1. Construction of a marine terminal with floating storage tanks (FSTs), including upland blasting to create an upland road and concrete foundation for an FST mooring structure;
2. Construction of a materials offloading facility (MOF);
3. Construction of an offloading platform;
4. Construction of temporary floating worker accommodations on Site (the Floatel);
5. Repair and upgrades to shoreline armour, including excavation of existing shoreline materials to key in rock and place new riprap. Includes covering riprap with native beach material in some locations;
6. Repair and upgrades to the roll-on and roll-off facility (Ro-Ro);
7. Installation of two clear span bridges across Mill Creek;
8. Installation of culverts and outfalls within the shoreline of Howe Sound and Mill Creek;
9. East Creek hydraulic modifications;
10. Water withdrawals from an existing instream water intake in Mill Creek and installation of a supplemental intake in Woodfibre Creek including water withdrawals; and
11. Construction and Ínexwantas (monitoring) of Habitat Offsetting.

Minor additional works are anticipated to support the marine construction work. These additional works may include vessel maneuvering and anchoring at the site and the installation of temporary structures for equipment tie-up. Additional details are provided within the MFFHMMP.

3. HABITAT OFFSETTING PLAN

3.1 Habitat Offsetting Requirements

As outlined in the *Fisheries Act* Authorization 22-HPAC-01346 (FAA, Appendix A), the Project is expected to result in the following impacts to sts'úkwi7 (fish) habitat:

- Loss of 7,342 m^2 of marine riparian habitat.
- Loss of 5,133 m^2 of marine intertidal and subtidal habitat.
- Alteration of 2,843 m^2 of marine aquatic habitat.

To offset the harmful alteration, disruption, or destruction (HADD) to fish habitat, Woodfibre LNG is planning to construct the following offsetting areas, as outlined in Section 4.2 of the FAA (**Appendix A, Table 3-1**):

Marine offset construction and enhancement totalling 22,120 m^2, including:

- 1,160 m^2 of cobble blanket.
- 2,463 m^2 of shallow rock reef.
- 10,953 m^2 of sand blanket with rock mounds.
- 7,544 m^2 deep rock reef.
- Riparian area enhancement and planting totalling 16,183 m^2.

In addition to meeting the principle of no-net loss of habitat, Woodfibre LNG considered the following aspects when determining the calculated areas (m^2) of the offsetting habitat:

- Additional habitat offsetting equivalent to a 10% per year to account for the time-lag for the marine aquatic habitat to become established[1], and
- An additional 25% contingency to account for all other aspects (for example, but not limited to, addressing potential uncertainty associated with measuring changes to sts'úkwi7 (fish) behaviour that may be low in nature as presented herein, but could be cumulative and may be difficult to account for).

3.2 Offsetting Approach

The offsetting measures for the Project focus on improving the overall ecological health in the CPA by restoring seabed habitat (i.e., physical quality and biotic activity), promoting sts'úkwi7 (fish) rearing and spawning areas, and enhancing sts'úkwi7 (fish) migration corridors through the CPA. The following are the four main offsetting objectives:

- Expand existing intertidal / shallow subtidal hard substrate to promote marine vegetation growth, thereby increasing areas for slhawt' (herring) spawning and juvenile salmonid rearing, while enhancing their migration route.

[1] For the shallow reef and cobble blanket, a three-year time lag is assumed. For the sand blanket and deep reefs, a one-year time lag is assumed.

- Improve sediment health through the addition of:
  - A sand layer over existing sediments determined to be unproductive or of poor health to enhance the biologically active zone (i.e., upper 0.3 m to 0.5 of sediment), and
  - A sparse surficial cobble blanket to promote kelp and algal growth but spaced to allow infaunal access to the sand layer (bivalves to protrude, invertebrates to migrate).
- Add rock reefs that will:
  - Increase cover/structure for sts'úkwi7 (fish) species such as juvenile salmonids, rockfish and lingcod; spawning areas for sts'úkwi7 (fish) such as slhawt' (herring) and demersal sts'úkwi7 (fish); and
  - Increase marine structure/ cover to enhance invertebrate diversity (e.g., sea cucumbers, sea urchins, crabs). Shallow reefs would be expected to support kelp growth, while deeper reefs would be primarily for sts'úkwi7 (fish) and invertebrate cover.
- Restore degraded riparian areas focussing on the marine shoreline, lower Woodfibre Creek, and lower East Creek (Restoration of the Mill Creek Green Zone will be completed separately in partnership with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) as agreed upon in the Squamish Nation Environmental Assessment Agreement (SNEAA) without additional offsetting credit).

A brief explanation of how the selected offsetting setting habitat components aim to meet the offsetting objectives is provided in the following subheadings (**Section 3.2.1 to 3.2.4)**.

3.2.1 Cobble Blanket

A mix of hard and soft substrates allows for a high degree of biodiversity by supporting numerous target species including kelp that requires hard surfaces for attachment and infauna shellfish that need soft sediments to burrow. Kelp in turn will provide cover for sts'úkwi7 (fish) to rear and substrate to spawn on. Shallow areas of the Project footprint can support this offsetting concept. Encouraging macroalgal growth will also build up nutrients of the sediments over time and increase density and diversity of benthic invertebrates and sts'úkwi7 (fish). Using a mix of hard and soft substrates in restoration will increase diversity in the area by adding habitat complexity.

3.2.2 Shallow and Deep Rock Reefs

Rock reefs have been employed successfully in the Salish Sea region for decades (Naito 2001; Slogan 2015). Shallow rock reefs support kelp beds, shellfish and provide cover for small and large sts'úkwi7 (fish) species. Deeper reefs support sessile invertebrate cover, while providing refuge for numerous sts'úkwi7 (fish), shrimp, and crab species. Rock reefs typically fully colonize in less than three years and are generally very stable over the long-term, making them good candidates for offsetting measures. Since much of the areas proposed for offsetting measures historically have soft sediments, rock reefs will be complimentary in nature to sediment restoration and increase habitat complexity and biodiversity. Riprap within the site is successfully growing sugar kelp between 0 to -3 m CD despite the "glacial flour" deposition from the Sḵwx̱wú7mesh Stak̲w (Squamish River), therefore, we do not expect this to prevent the reefs from functioning as intended.

3.2.3 Sand Blanket with Rock Mounds

Wood waste in the marine benthic environment can be detrimental to marine life as it physically smothers biota on the sediment surface and can lead to the production of toxic by-products during decomposition (e.g., hydrogen sulfide and methane). Areas of thick wood waste deposits can be unfeasible to physically remove and dispose on land, due to issues with salt contamination. In Puget Sound, methods have been proposed to remediate varying thicknesses of wood waste in the marine environment (Breems & Goodman 2009). Restoration design depends on the nature and thickness of the existing wood debris. In the areas of proposed offsetting, a relatively thin (0.2 to 0.3 m) layer of sand can be placed over a thin layer of wood particulate (i.e., less than 0.3 m) to improve the health of surficial sediments, encouraging colonization by benthic macroinvertebrates that act to mix the sand with wood waste and improve overall sediment health. As the wood waste is fine and relatively thinly layered, any decomposition is likely to have little impact on offsetting structural integrity or result in subsidence (pers comm. CMO Consultants). Additionally, gravel mounds under rock reefs may be added to reduce subsidence.

3.2.4 Riparian Areas

The goals for riparian habitat restoration are to support the re-establishment of the following:

- Functional habitat attributes (e.g. water capture and filtration, fine sediment control, litter fall and organic matter input, etc.)
- A suitably diverse plant community that can develop a self-sustaining successional trajectory that is ecologically appropriate to existing and future site conditions, surrounding ecological conditions and land uses.

Riparian habitat offsetting measures will consist of restoring degraded marine, estuarine, and freshwater riparian areas to historic native vegetation communities. Riparian offsetting will target riparian areas disturbed from historical industrial use in areas cleared of vegetation and native soils, and areas covered with permanent or long-lasting covers (e.g., gravel, concrete or asphalt) or non-native species.

3.3 Complementary Measures

Prior to construction, Woodfibre LNG conducted significant Site clean-up and remediation of structures and debris that are described below. Once the construction phase is complete, Woodfibre LNG is committed to restoring a large area on either side of lower Mill Creek referred to as the Green Zone. The Green Zone will be restored in consultation with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation). While Woodfibre LNG acknowledges these complementary measures are additional to the habitat offsetting commitments outlined in this Plan, these substantial actions are important components to improving the overall health of the ecosystem and support the approach within this Plan. Additional information regarding these complementary measures is available in the Aquatic Effects Assessment submitted as part of the application for the FAA (Keystone Environmental 2023).

3.4 Habitat Offsetting Locations

The primary areas for habitat offsetting were selected using the following criteria:

- Expanding existing sts'úkwi7 (fish) use on-Site (e.g., sts'úkwi7 (fish) spawning),
- Improving sts'úkwi7 (fish) passage through the Site (e.g., juvenile salmonids and slhawt' (herring)), and
- Restoring habitats that have been heavily degraded from historic industrial use.

Potential habitat offsetting areas identified from baseline assessments were reviewed by Woodfibre LNG operations to ensure there was no overlap with Project infrastructure or risk for either operations or the long-term physical integrity of the habitat measures. An overview of the proposed habitat offsetting areas is shown on **Figure 3-1**. Marine habitat offsetting southwest, and northeast of Mill Creek is shown on **Figures 3-2A** and **3-3A** respectively. Riparian offsetting is shown on **Figure 3-4**.

A summary of the habitat offsetting areas is provided in Sections 3.5 through 3.6 below. Additional details are available in the AEA submitted as part of the application for the FAA (Keystone Environmental 2023).

3.5 Marine Habitat Offsetting

There are four marine aquatic habitats that will be constructed to offset the residual effects associated with the Project (**Table 3-1**) across five areas (Areas 1 through Area 5). These habitat offsetting areas are shown in **Figures 3-1, 3-2A, and 3-3A** and are summarized below.

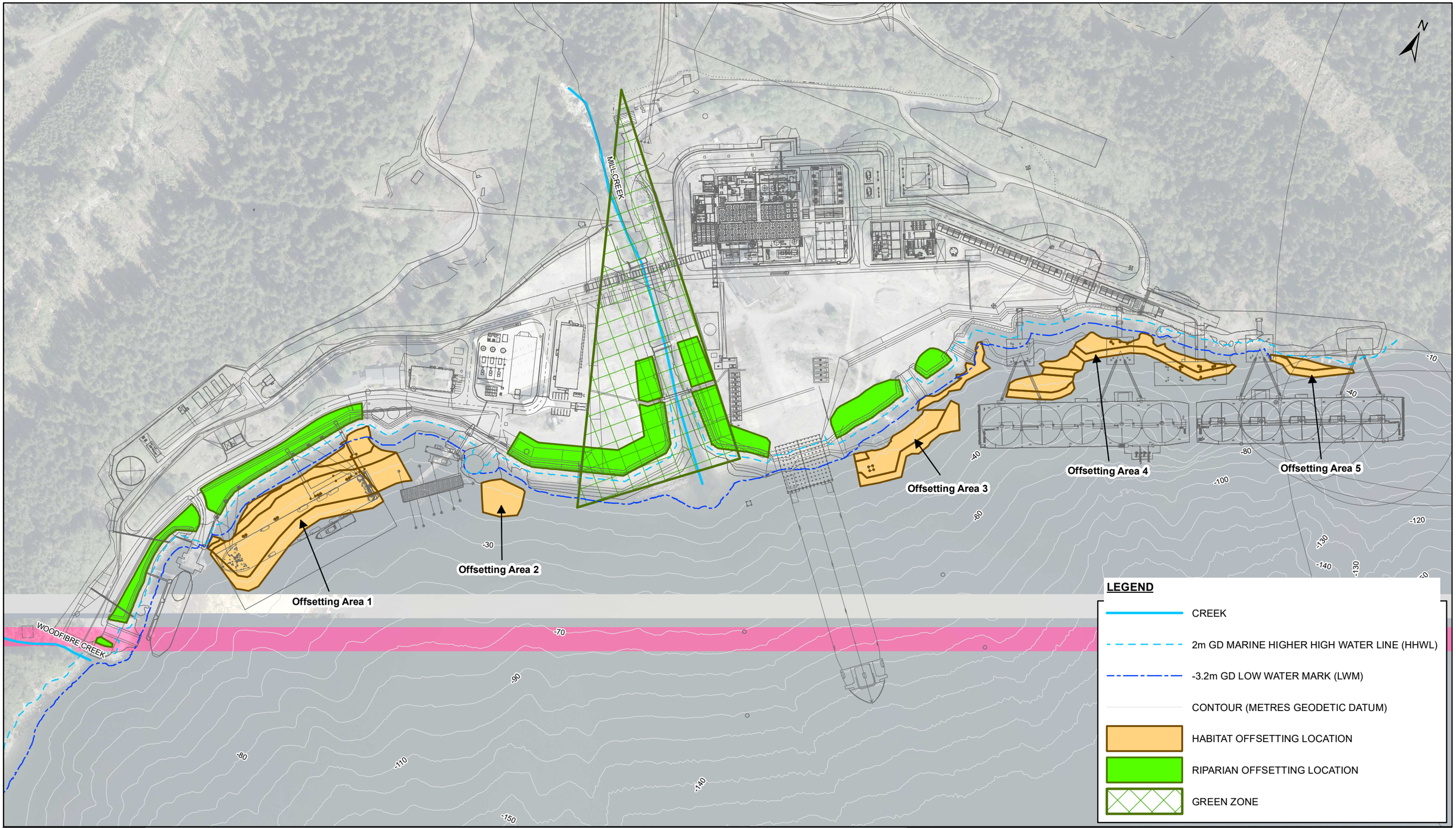
Table 3-1 Habitat Offsetting Measures Including Area, Habitat Types, and Location

Habitat Type	Marine Aquatic Offsetting Areas (m^2)					Total Area (m^2)
	Area 1	Area 2	Area 3	Area 4	Area 5	
Cobble Blanket	1,159.7	0	0	0	0	**1,160**
Shallow Rock Reefs	1,599.0	0	864.3	0	0	**2,463**
Sand Blanket	6,116.9	0	1870.1	2,654.4	311.7	**10,953**
Deep Rock Reefs Deep	2,507	1,274	1,311	1,881	571	**7,544**
Total	**11,383**	**1,274**	**4,045**	**4535**	**883**	**22,120**

3.5.1 Cobble Blanket

Placement of cobble blankets are proposed along the Project shoreline south of Mill Creek in the area of the Floatel (**Figure 3-2A)**. This component is comprised of a band of sand with cobble substrate on top in the shallow subtidal zone to provide habitat for infauna and epifauna and substrate for algae growth and slhawt' (herring) spawning.

A 0.3 m to 0.4 m thick sand cap layer will be placed on the existing substrate totalling 1,160 m^2 from a depth of -1 m to -2 m chart datum (CD, [-4 m to -5 m GD]). A single layer of cobble (or small boulders) with a median diameter (D_{50}) of 0.3 m will be placed on the sand cap to provide attachment substrate for algae and sessile invertebrate species such as sugar kelp and anemones, while allowing bivalves (e.g., clams) access to the sand below.



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NOTES:
1. ALL MAPPED FEATURES ARE APPROXIMATE AND SHOULD BE USED FOR DISCUSSION PURPOSES ONLY. PROJECT FEATURES MAY BE SUBJECT TO CHANGE.
SOURCES:
1. DATE OF AERIAL PHOTO IS 2019, OBTAINED FROM DISTRICT OF SQUAMISH.

20 0 100 m
SCALE: 1:3,500 (approx.)

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00	Mar. 2024	17953-109

Figure 3-1
Habitat Offsetting Overview

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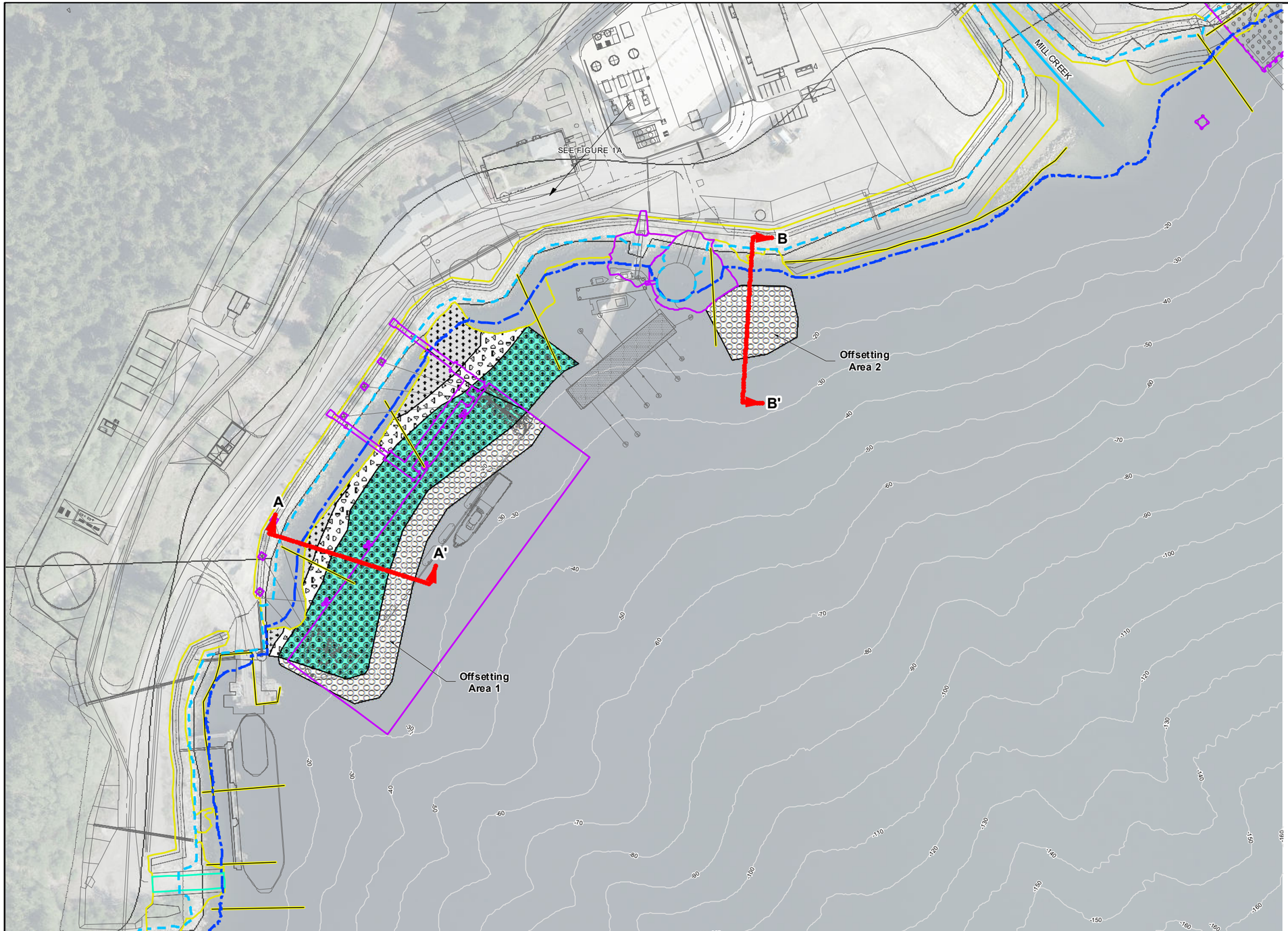

N

LEGEND

- LOT LINES & WATER LOT
- NEW STRUCTURES
- RAMP
- SHORELINE WORK
- COBBLE BLANKET
- DEEP REEF
- SAND BLANKET
- SHALLOW REEF
- 2m GD MARINE HIGHER HIGH WATER LINE (HHWL)
- -3.2m GD LOW WATER MARK (LWM)
- CREEK
- TRANSECT (KEYSTONE ENVIRONMNETAL MAY 2019)
- CONTOUR (METRES GEODETIC DATUM)
- CROSS SECTION

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NOTES:
1. *THIS DRAWING IS FOR GENERAL INFORMATION ONLY. LOT BOUNDARIES AND FEATURES ARE APPROXIMATE.*
2. *DATE OF AERIAL PHOTO IS 2016.*

Data collected from:
- *Keystone Environmental Ltd. 2019 Dive Surveys at Woodfibre, Squamish, BC. Data Collected for Woodfibre. May 2019*
- *Hemmera. 2016. Figure 1 - Benthic Habitat Survey Summary Report. Prepared for Woodfibre LNG. September 2015*
- *Golder Associates Ltd. 2014. Marine Resources Baseline Study. Prepared for Woodfibre LNG. October 2014*

15 0 75 m

SCALE: 1:1,500 (approx.)

Woodfibre
Squamish, BC
Woodfibre LNG Limited

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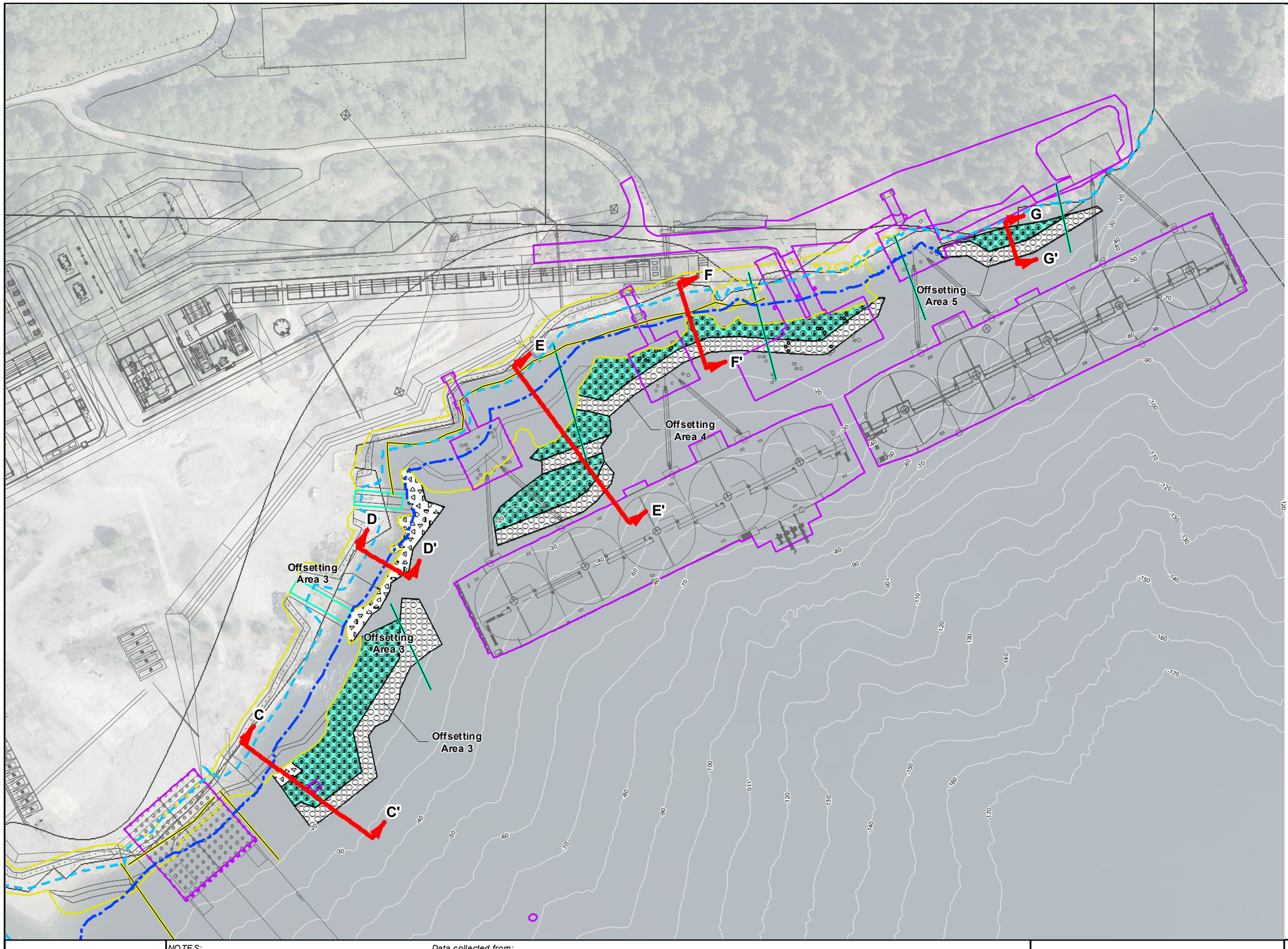
00	Dec. 2023	17953-109

Figure 3-2A

Habitat Offsetting Options
(Southwest of Mill Creek)

DRAWN BY: CS Document Path: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17953\00109\2023_12Dec_18_Offset_Monitoring\Fig3-2A-HabitatOffsettingOptions-Central-R0.mxd



LEGEND

- LOT LINES & WATER LOT
- NEW STRUCTURES
- RAMP
- SHORELINE WORK
- COBBLE BLANKET
- DEEP REEF
- SAND BLANKET
- SHALLOW REEF
- 2m GD MARINE HIGHER HIGH WATER LINE (HHWL)
- -3.2m GD LOW WATER MARK (LWM)
- TRANSECTS (HEMMERA, 2016)
- TRANSECT (KEYSTONE ENVIRONMNETAL MAY 2019)
- CONTOUR (METRES GEODETIC DATUM)
- CROSS SECTION

Keystone Environmental

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15 0 75 m

SCALE: 1:1,500 (approx.)

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00	Dec. 2023	17953-109

Figure 3-3A

Habitat Offsetting Options
(Northeast of Mill Creek)

DRAWN BY: CS Document Path: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17953\00109\2023_12Dec_18_Offset_Monitoring\Fig3-3A-HabitatOffsettingOptions-North-R0.mxd

MR9=645.2 m^2

MR6=991.7 m^2

MR8=1811.2 m^2

MR5=830.9 m^2

MR7=2165.9 m^2

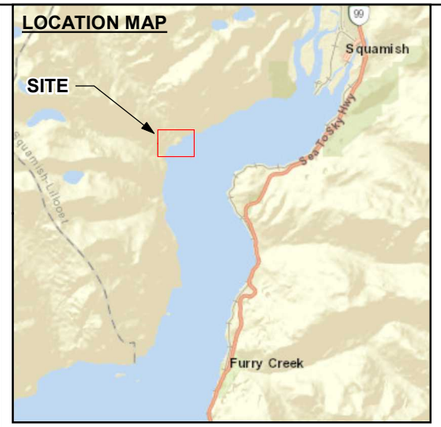
MR4=4629.1 m^2

MR3=3371 m^2

MR2=1646.6 m^2

MR1=91.1 m^2

LOCATION MAP



N

LEGEND

- LNG CERTIFIED PROJECT AREA
- SPEA (PRELIMINARY)
- RIPARIAN OFFSETTING LOCATION
- GREEN ZONE

STREAMS (CHANNEL MIDPOINT) AND DITCHES (CLASSIFIED ACCORDING TO DoS DITCH MATRIX)

- NON FISH HABITAT
- NON PERMANENT NON FISH BEARING
- PERMANENT FISH BEARING
- PERMANENT NON FISH BEARING
- DITCH - MODERATELY PRODUCTIVE
- DITCH - MINIMALLY PRODUCTIVE
- DITCH - NON FISH HABITAT

Keystone Environmental

NOTES:
1. THIS DRAWING IS FOR GENERAL INFORMATION ONLY. LOT BOUNDARIES AND FEATURES ARE APPROXIMATE.
2. DATE OF AERIAL PHOTO IS 2019.

50 0 250 m

SCALE: 1:4,750 (approx.)

Woodfibre
Squamish, B C
Woodfibre LNG Limited

REVISION No.	DATE	PROJECT No.
00	Mar. 2024	17953-109

Figure 3-4

Riparian Offsetting

DRAWN BY: LW Document Path: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17953\00109\2023_12Dec_18_Offset_Monitoring\Fig3-4-RiparianOffsetting-R0.mxd

3.5.2 Shallow Rock Reefs

The proposed area for shallow rock reef is 2,463 m^2 and will be constructed of quarry tailing rock (D_{Max}=0.5 m) at -2 m to -4 m CD (-5 m to -7 m GD. The top of the reef will be generally -2 m CD to provide adequate insolation for kelp growth. The shallow rock reef will act as a stabilizing rock reef to anchor the sand and cobble layers.

3.5.3 Sand Blanket with Rock Mounds

Sand blankets are proposed to be constructed on both sides of Mill Creek (**Figures 3-2A and 3-3A)**. This concept consists of a sand/sparse gravel cap and is designed to improve habitat conditions for benthic infauna (e.g., clams and worms).

The sand blanket consists of 10,953 m^2 of 0.3 to 0.4m thick layer of sand placed over the existing substrate at various elevations between -4 m to -18.5 m CD (-7 m to -21.5 m GD). Material for the sand cap will incorporate gravel (to 38 mm diameter) to provide stability under wave and currents. Throughout the sand blanket, rock mounds with 0.5 m height are also to be constructed and generally spaced greater than 2 m apart in all areas of the sand blanket where feasible. Rocks mounds are expected to cover more than 10% of the sand blanket area (e.g. 10% of 10, 953 m^2), but will vary based on how much the contractor can construct as a result of the steep nature of the seabed. Areas where the existing grade is near or greater than 1.5 horizontal to 1 vertical will not contain rock mounds because it is too steep to construct them. Rock mounds will be constructed from the same material as the deep rock reefs (quarry tailings). The rock mounds will also be evaluated in a similar manner as the deep rock reefs for effectiveness.

3.5.4 Deep Rock Reefs

Deep rock reefs (with an area of 7,544 m^2) will be constructed on top of the sand/ cobble cap at the deep edge between -4 m and -21 m CD (-7 m and -24 m GD) running parallel to the shore (**Figures 3-2A and 3-3A)**.

As mentioned in Section 3.5.3, smaller rock mounds will be placed within the sand blanket area consisting of a deep rock reef. Notably, the area of rock mounds within the sand blanket is in the sand blanket area in Section 3.5.3, and not included in the area provided for the deep rock reefs in Section 3.5.4.

Rock reefs will be constructed of quarry tailing rock of a maximum diameter (D_{Max}) of 0.5 m piled in a stable triangular cross-sectional form.

3.5.5 Offsetting Construction Materials and Methods

Material for sand substrate will be sand that is mixed with fine quarry tailings (provided the silt content is washed out) to incorporate gravel with grain size of up to 38 mm for stability under waves and currents. Cobbles will have median diameter (D50) of 0.3 m and will be evenly graded between 0.2 m and 0.4 m. Reefs and berms/mounds will be constructed of quarry tailings with a maximum rock diameter of 0.5 m and median rock diameter of 0.075 m to 0.35 m. Rock materials will be rough angular blasted quarry rock to provide good filtering and good frictional strength along contact surfaces.

Sand and fine quarry tailings will be placed on the slope starting at the deeper end of each offsetting component and working up the slope. Finer material will be in contact with the seabed and uniformly distributed over the surface of existing substrate being covered. Cobbles will be placed on top of sand/fine quarry tailings on the slope starting at the top of the deep rock reefs/berms and working up the slope to the underside of the rip rap protection, where such exists, slightly overlapping its lower part.

Reef construction will begin with placement of rock material at the deeper end (toe) of each area and continue working up the slope. Rock to be lowered with a clam shell or excavator on a barge or from shore depending on what is feasible and the contractor's preference. Rock shall be lowered in a controlled manner and placed as specified.

Material will be handled, stored and transported in a way that fines are not separated from coarser fractions. Materials will not be dropped through the water column but placed on the seabed with a bucket to prevent separation of finer material from coarser material.

3.6 Riparian Habitat Offsetting

Riparian habitat offsetting measures consist of restoring degraded marine, estuarine, and/or freshwater riparian areas to historic vegetation communities (**Figure 3-4)**. Criteria for marine riparian planting includes the following:

- Riparian planting to be within 30 m of the marine environment (higher high-water line [HHWL]).
- Riparian offsetting will target riparian areas disturbed from industrial use, cleared of vegetation and the native soils covered with permanent or long-lasting covers (e.g., gravel, concrete, or asphalt), and areas colonized by nonnative species.
- Planting will follow restoration specifications based on DFO Riparian Revegetation Guidelines (DFO, 1992) with modification for local Site conditions.
- Species composition and densities will mimic local habitats where possible.

Woodfibre LNG is currently reviewing the operational constraints pertaining to safety and security requirements. These constraints may limit riparian offset planting prescriptions. In this case, field fitting may be required to adjust the riparian planting locations to work around final design infrastructure, roads, fences, and ditches. If warranted, changes to planting specification, species, or plan, will be considered through consultation with a qualified environmental professional (QEP). Green Zone restoration planning by Squamish Nation is in its early stages at this time. The riparian restoration is intended to mimic the outcomes of the Green Zone and will be updated to address overlapping areas to ensure Green Zone commitments are not applied to the final habitat offsetting credits (**Figure 3-4**). A total area of 16,183 m^2 will be planted (**Table 3-2**).

Table 3-2 Proposed Riparian Planting (Figure 3-4).

Polygon	Area of Riparian Planting (m^2)
MR1	91.1
MR2	1,646.6
MR3	3,371.0
MR4	4,629.1
MR5	830.9
MR6	991.7
MR7	2,165.9
MR8	1,811.2
MR9	645.2
	16,183.0

3.7 Riparian Offsetting Considerations

Other offsetting consideration includes installation of coarse woody debris. Coarse woody debris (CWD) in riparian areas and sekw'ekw'inexw (wildlife) corridors will equate to a minimum of one percent of area. CWD can be any tree species and a variety of sizes with a minimum of 3 m length and 0.2 m diameter.

During construction of offsetting areas, sekw'ekw'inexw (wildlife) trees will be preserved wherever possible and where they do not act as a hazard tree. Sekw'ekw'inexw (wildlife) trees installed as an offsetting measure should be 3 to 5 m long, 30% below ground (i.e., 1.5 m in ground and 3 m above ground), and 0.3 m in diameter. Sekw'ekw'inexw (wildlife) trees may occur at a frequency of one per 1,000 square metres.

3.8 Offsetting Construction Schedule

Construction of the offsetting habitat is expected to begin throughout Project's construction phase and is anticipated to commence in 2024. All offsetting areas are estimated to be completed by 2027 **(Table 3-3).** As outlined in the FAA, marine and riparian offset construction shall be completed by January 31, 2028. Placement of the rock reefs, sediments caps, and extension of the shallow hard substrate will be completed within the marine least risk window. Shallow reefs in the northeast will be constructed prior to, or at the same time as the marine terminal to avoid potential future access restrictions. Offsetting measures in Area 1 will be coordinated with the decommissioning of the Floatel.

Upland riparian offsetting areas will also be coordinated near the end of Project works to avoid disturbance and allow for efficiencies. Marine riparian areas will be constructed after shoreline works are complete and upland grading finalized. Offsetting along Woodfibre and Mill Creeks will be completed prior to completion of Construction. Timing of riparian area preparation and planting will be guided by the offsetting plan and specifications (see **Table 3-3**)

Table 3-3 Estimated Construction Schedule for Offsetting Areas

Offsetting Measure	Estimated Start	Estimated Finish	Maintenance Period
Area 1	2026	2027	2028
Area 2	2024	2025	2026
Area 3	2024	2025	2026
Area 4	2024	2025	2026
Area 5	2024	2025	2026
MR[2]1-9	2026	2026	2027–2028

[2] MR: Marine riparian

4. MARINE HABITAT OFFSETTING EFFECTIVENESS MONITORING

The master habitat offsetting key performance indices (KPI) table included in **Appendix B** presents a list of variables and offsetting key performance indices (OKPIs) for the marine habitat offsetting effectiveness monitoring. For each OKPI, a general study approach has been defined in the following sections. In preparation of the list of variables, data collected during the baseline studies and ongoing monitoring programs have been considered. Additionally, it is noteworthy that OKPIs listed here are also relevant to the Environmental Effects Monitoring Plan for the Project and have been developed in collaboration with the TAC.

The objective of habitat offsetting effectiveness monitoring is generally to monitor species abundance, diversity, and richness within the offsetting areas and to demonstrate a sustained net improvement from pre-construction levels, observed over multiple years.

Further description of each variable and the proposed monitoring strategy is presented in the following sections. The Guiding Principles developed collaboratively between Woodfibre LNG and the TAC define the roles and responsibilities of the TAC members relating to the development and execution of this Plan, including production, analysis and reporting data results.

4.1 Marine Habitat Offsetting Effectiveness Monitoring

The following variables (i.e., OKPIs) will be measured at all offsetting areas annually prior to construction, following construction, and at reference sites to determine the effectiveness of habitat offsetting measures. OKPIs presented here are based on the FAA requirements and consider both primary metrics (outlined in FAA section 4.4) and secondary metrics (outlined in FAA section 5.2.2). In addition to the collection of monitoring data related to each OKPI, during all monitoring and sampling at offsetting and reference sites, spot measurements of turbidity, salinity, temperature and Secchi Disk depth will be conducted. Additionally, the potential for the installation of permanent data loggers (for turbidity, temperature and salinity) will be explored, and if feasible, they will be installed at proper locations. **Appendix B** presents detailed description of OKPIs for this monitoring program.

Notably, the functionality of offsetting measures will be deemed successful if OKPIs associated with primary metrics are met. However, measurement of OKPIs associated with secondary metrics will be also required in offset effectiveness monitoring reports (reporting requirements are detailed in **Section 6**) and will provide additional context on the functionality of offsetting measures to aid development of contingency measures if required.

4.1.1 Cobble Blanket

4.1.1.1 OKPI 1: Physical Integrity of Cobble Blanket Offsetting Areas

The physical integrity OKPI reflects the physical aspects of Cobble Blanket Offsetting Areas that are considered an integral part of this offsetting option and include the following:

- Depth of sand of 0.3 to 0.4 m must be present.
- Cobble must be present above the sand layer.

- Areas that revert back to predominantly wood waste (i.e., proposed thin layer of sand is absent) will be deemed non-functional.
- As outlined in the FAA, the cobble blanket will be considered successful if by year 7 the physical integrity of the site, including sand depth and cobble density, is stable and consistent with the design specifications and showing no indications of movement, slumping, or deposition that may affect habitat functionality.

4.1.1.2 OKPI 2: Abundance and Diversity of Macroalgae in Cobble Blanket Offsetting Areas

(a) Hypothesis

Primary metric hypothesis:

- Abundance of marine macroalgae (measured by percent cover) on cobble blanket offsetting areas compared to reference sites is at least 95% of the mean abundance at reference sites by year 7.

Secondary metric hypothesis:

- Species diversity is comparable to that of the reference site.

(b) Sampling Method

Annual SCUBA Dive Surveys in Summer- Dive surveys will be used for recording substrate composition, aquatic vegetation cover, epifaunal invertebrate presence and fish presence within each offsetting area. This will include completing transects within the offsetting areas and reference sites using an underwater quadrat approach to collect the necessary data to assess the various performance metrics associated with each OKPI. If dive surveys are not feasible due to operational and/or safety considerations (e.g. in areas too deep for diving, [greater than 30 m]), an underwater camera will be used following the same procedures as the dive surveys (except using single quadrats instead of paired quadrats). The underwater quadrat approach is explained further within **Section 4.1.1.2(c)**.

Dive surveys will be conducted following a modified version of DFO's Marine Foreshore Environmental Assessment Procedure (DFO 2004). Dives are to be completed by a three-person team of biologists certified to occupational SCUBA standards according to WorkSafeBC safe diving procedures (as outlined in the Occupational Health and Safety Regulation Part 24).

(c) Dive Survey Procedure

The dive survey procedure will consist of the following:

- Divers to establish transects perpendicular to shore beginning at the nearshore side (upper elevation) of the offsetting habitat and extending offshore to the lower extent of the offsetting habitat within each habitat area.
- For reference sites, transects should cover the full depth range equivalent to the proposed offsetting areas.

- Transects will be distributed evenly throughout each offsetting area, spaced approximately every 25 m, with at least 3 transects per reference site.
- Paired quadrats (0.5 m^2) will be placed on either side of the transect.
- Quadrats are to be positioned within each habitat type within the offsetting area (e.g., cobble blanket, shallow rock reef, etc.) along each transect.
- At least five paired quadrats (i.e. 10 quadrats) per habitat type per transect are recommended for comparison between the offsetting site and reference site in order to provide meaningful results. Given the length of the habitat offsetting, we expect this number to be much higher.
- Transects will be marked a minimum of every 5 m and secured (e.g., weighted) at either end.
- The starting points of each transect along the shore will be marked using a handheld GPS. The end point will be determined with GPS or by compass bearing off the start position.
- Along each transect, the divers shall:
  - Measure the location where the habitat feature (e.g. cobble blanket) starts and stops.
  - Measure the distance along the transect where each quadrat pair is located.

Two divers will start each dive survey at inshore (shallow) end of the transect and swim the length of the transect with one diver recording video and the other documenting observations of all fish and mobile invertebrates within two metres of the transect line on a slate with underwater paper. Supplemental observations will be made of the substrate and biota extending to deeper depths. While documenting fish observations, the divers should:

- Remain still at least once every 5m along the transect within the habitat feature of interest (e.g. cobble blanket).
- Document fish presence over a 1-minute period before continuing forward.
- Identify the species and life stage.
- Record comments on how the fish are using the habitat feature.

Divers will then return up the transect line toward shore and record observations within the paired quadrats placed along the transect line.

Within each quadrat, the following will be recorded:

- The location of the quadrat relative to transect distance and depth.
- Substrate type and composition, according to Wentworth (1922) (**Table 4-1**). Substrate types will be recorded cumulatively within each quadrat as a percentage out of 100.
- Total percent aerial coverage of marine vegetation and colonial sessile invertebrates (e.g., barnacles or mussels), and individual percent aerial coverage by species identified to the lowest practicable level (LPL).
- Total counts of motile invertebrates, non-colony forming sessile invertebrates, siphons, and clam holes if visible, and individual counts of species identified to the LPL.
- Document any evidence of spawning.
- Note any anthropogenic debris or materials.

Additional information collected within quadrats following construction of the offsetting areas will include:

- Confirmation that the substrate coverage within the offsetting area (e.g. cobble) is uniform.
- Document any signs of instability within the offsetting habitats.
- Note any anthropogenic debris that is not supposed to be present.
- Describe and measure voids in rocks (for shallow rock reef, deep rock reef, and rock mounds in sand blanket habitats).

Table 4-1 Substrate Classification (Wentworth, 1922)

Substrate Type	Size Range (Diameter)
Bedrock	-
Boulder/ Riprap	>256 mm Rounded/ Angular
Cobble/ Filter rock	64–256 mm Rounded/ Angular
Gravel	2–64 mm
Sand	0.062–2 mm
Silt (Silt/ Mud/ Clay)	<0.062 mm

Results are to be documented with high-definition underwater camera or video, which is to be made available to DFO upon request.

Following the dive surveys, depths will be corrected to metres relative to CD. Abundance estimates of observed biota will be determined using the categories in **Table 4-2.**

Table 4-2 Abundance Categories for Marine Vegetation, Sessile Animals and Mobile Animals

Abundance Category	Percent Aerial Coverage (Marine Vegetation and Colonial Sessile Animals)	Individual Counts per m^2 (Infaunal Holes/ Non-Colonial Sessile Animals)	Individual Counts per Transect[1] (Motile Animals)
Rare	< 5%	1	1
Sparse	5–25%	2–4	2–4
Few	26–50%	5–10	5–10
Common	51–75%	11–30	11–30
Abundant	75–100%	>30	>30

[1] Where animals are too numerous to count individually estimated numbers are recorded.

(d) Sampling Frequency and Timing

Dive surveys and sediment sampling will occur in Years 1, 2, 3, 4, 5, and 7 following the construction of the offsetting areas to meet the monitoring requirements outlined in the FAA. Surveys will be conducted in the summer. Depending on project scheduling, monitoring will occur annually in the offsetting areas prior to construction to collect additional data of pre-construction levels. For offsetting areas where construction is anticipated to commence in 2024 (**Table 3-3)**, it is recommended that at least one dive survey is completed in 2024 prior to construction.

(e) Reference Site Location

Reference sites were selected that consist of established, non-impacted natural habitats having similar habitat conditions (e.g. depth, substrate type, exposure) to the associated offsetting measures and colonized by species representative of the local area.

A single reference location does not contain all the habitat types proposed as part of the habitat offsetting; therefore, two reference locations are required to complete the evaluation. In May 2023, Keystone Environmental considered 13 reference site locations prior to conducting fieldwork to ground-truth their suitability as reference sites (**Figure 4-1)**. Keystone conducted dive surveys at 4 of the 13 locations and determined suitable reference sites at sites 7 and 12. Additional dives were not conducted at sites not examined because suitable reference sites were found in closer proximity to the Site.

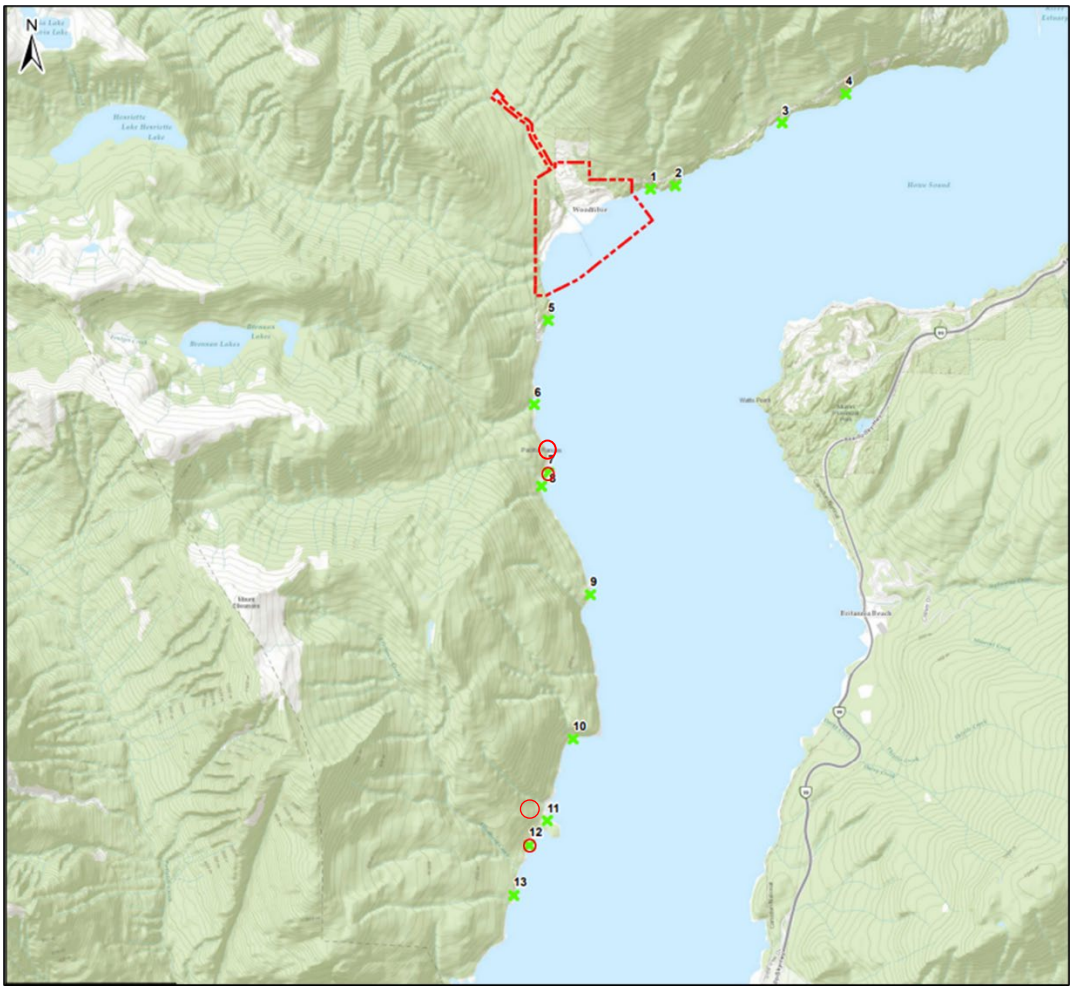


Figure 4-1 Potential Offsetting Reference Site Locations Considered. Selected reference sites 12 (Reference site 1) and 7 (Reference site 2) are circled in red.

The selected reference sites 7 and 12 are located approximately 2.6 km and 7 km southwest of the CPA, respectively. Site 12 has been renamed "Reference site 1" and site 7 has been renamed "Reference site 2" for further offsetting monitoring, including the pilot study described in the following subsection.

(f) Pilot Study Results

As outlined as a requirement in section 4.4.4 of the FAA, pilot data of the selected reference sites was collected.

On October 24 and 25, 2023, Keystone Environmental completed a marine biophysical dive survey within the lower intertidal and subtidal areas of the two predetermined marine habitat offsetting reference sites. Details of the pilot study, including methodology, description of the physical and biological conditions of the habitat offsetting reference sites, and detailed biophysical data is provided in **Appendix C.**

Substrate and Biophysical conditions mapped during the survey are shown on **Figure 1** and **Figure 2 (Appendix C)**.

(g) Sampling Duration

Seven years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of the Offsetting Measures.

(h) Analysis

Descriptive and comparative statistics will be used in annual reporting to compare the abundance of macroalgal cover at the offsetting areas to the abundance at reference sites (e.g., calculation of minimum abundance, maximum abundance, median and mean abundance, graphical representation of results, Shannon's diversity index, species richness).

Comparison of species diversity between the offsetting area and reference sites will be completed using Shannon's diversity index. Species richness, and species identified down to the LPL will be tabulated and compared between the offsetting areas and reference sites. Additionally, professional opinion will be also used for the interpretation of results.

In addition, in years 3, 5 and 7 of reporting, a left-tailed t-test will be conducted to determine if the abundance of macroalgae (measured by percent cover) on cobble blanket offsetting areas is at least 95% of the mean abundance at reference sites. Further detail on this analytical approach is provided in **Appendix D.**

4.1.1.3 OKPI 3: Abundance and Diversity of Invertebrates on Cobble Blanket Offsetting Areas

Details of sampling and analytical approach are presented in Section 4.1.1.2 and Appendix B.

4.1.1.4 OKPI 4: Abundance and Diversity of Fish on Cobble Blanket Offsetting Areas

Details of sampling and analytical approach are presented in Section 4.1.1.2 and Appendix B.

4.1.1.5 OKPI 5: Abundance and Distribution of Pacific Herring Spawn on Cobble Blanket Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B. However, a detailed methodology for SCUBA dives specific to this OKPI is presented below.

Assessment of Herring spawn on shallow rock reef will occur through herring specific SCUBA surveys conducted as required under the project MFFH EEMP.

SCUBA surveys will include two stages:

- Identifying and mapping the presence/ absence and distribution of herring eggs horizontally along the shoreline within the PPIA.
- Detailed data collection within areas where herring spawn is present (using transects and quadrats).

Distribution Mapping

For each survey, distribution mapping will be conducted by a team of two WorkSafeBC-certified SCUBA divers with training in identifying herring spawn, with at least one member of the team being a Registered Professional Biologist. The entire length of shoreline within the PPIA will be surveyed, including up to 20 m upstream of Mill Creek and Woodfibre Creek if accessible by the divers.

During the distribution mapping survey, the divers will swim in a sinuous pattern from the water's surface to a maximum lower depth of approximately-10 m chart datum (CD). The depth range where herring spawn is typically observed in the CPA correlates to the presence of hard substrate (e.g., sheet pile, riprap, bedrock). Note that the depth of the surveys will need to increase in years where habitat offsetting has been constructed, as new hard substrate will be added at deeper depths. Typically, one diver will cover the lower elevation range while the other will cover the upper elevation range, with some overlap between divers to ensure adequate coverage. Distribution mapping will be scheduled during periods of higher tides to ensure intertidal areas can be adequately observed by the divers.

When either diver identifies the presence of herring eggs they will record the general location, elevation, and substrate on an underwater slate. The diver will indicate to the dive tender onboard the dive vessel the presence of either herring spawn or lingcod egg masses (e.g., at the surface through visual communication, at depth via wireless comms, or other suitable methods). The dive tender will map the location of the observation using a handheld Global Positioning System (GPS) unit or relative to permanent infrastructure. In the case of herring spawn, the location of where the eggs were first observed along the shoreline would be mapped. The divers would then continue swimming along the shoreline and notify the dive tender of the end of that section of spawn such that the start and end points of any areas of herring spawn are identified linearly along the shoreline within the PPIA. Once the start and end points have been mapped, the divers would continue swimming throughout the PPIA until the entire length of the shoreline has been surveyed. Along with herring egg mass identification, the divers will also record lingcod egg masses if present.

Detailed Data Collection

Detailed data collection will occur within sections where herring eggs were observed during the distribution mapping stage. For the detailed data collection phase, the divers will install transects perpendicular to the shoreline within areas where eggs are present. The starting point of each transect will be mapped with a handheld GPS or relative to a permanent infrastructure. A haphazard sampling[3] design will be employed to select transect locations within each section, with one to two transects within each section, with a minimum separation of 25 meters between them. The lengths of the transects will cover the full width of eggs from the upper to lower limit of where the eggs are observed.

Along each transect, a minimum of five quadrats (0. 5 m^2 or 1.0 m^2 in size) will be evenly distributed across the width of the Pacific Herring spawn. At each quadrat, the diver will record the time, transect number, position along the transect, depth, substrate type, vegetation percent cover, egg percent cover on both substrate and vegetation (if present), egg layer characteristics and egg viability. Photos will also be taken of quadrats. Substrate categories will be adapted from Wentworth (1922). Substrate types recorded may also include organic material such as wood debris or anthropogenic materials such as sheet pile, timber pile, or steel pile.

(a) Sampling Frequency and Timing

Herring Dive Surveys within the PPIA will be conducted during the Pacific herring spawning season (February to June-July) with a frequency of once every two weeks starting in 2024. Surveys will be conducted every two weeks for the first year. However, the survey range may be reduced gradually should herring spawn consistently not be observed in the later months (e.g., after late April). This proposed approach for gradually decreasing the sampling frequency is expected to assist in identifying the site-specific timing of herring spawning and fine tune the long-term monitoring activities for this OKPI.

Herring eggs take between 14 to 21 days to hatch depending on water temperature (Fort et al. 2013). The date of the first survey annually will either be within 15 days of the first recorded spawn within the PPIA (determined through regional data sources and/or onsite observations of spawning behaviour) or February 15, whichever is earlier.

4.1.1.6 OKPI 6: Abundance and Distribution of Invertebrate Holes and Siphons in Cobble Blanket Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

[3] In haphazard sampling, the researcher selects individuals or items that are easy to reach or readily available, without any systematic or random approach (Statistics Canada, 2021).

4.1.2 Shallow Rock Reef

4.1.2.1 OKPI 7: Physical Integrity of Shallow Rock Reef Offsetting Areas

This OKPI reflects the physical aspects of the shallow rock reef offsetting areas that are considered an integral part of this offsetting option and include the following:

- Voids are present (pass or fail).
- Rocks must be present within elevation range of constructed reef.
- As outlined in the FAA, the shallow rock reef will be considered successful if by year 7 the physical integrity of the site, including sand depth and cobble density, is stable and consistent with the design specifications showing no indications of movement, slumping, or deposition that may affect habitat functionality.

4.1.2.2 OKPI 8: Abundance and Diversity of Macroalgae on Shallow Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.2.3 OKPI 9: Abundance and Diversity of Invertebrates on Shallow Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.2.4 OKPI 10: Abundance and Diversity of Fish on Shallow Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.2.5 OKPI 11: Abundance and Distribution of Pacific Herring Spawn on Shallow Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B. The detailed methodology for SCUBA dives specific to this OKPI is presented in Section 4.1.1.5.

4.1.2.6 OKPI 12: Presence and Dimension of Voids in Shallow Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.3 Sand Blanket with Rock Mounds

4.1.3.1 OKPI 13: Physical Integrity of Sand Blanket with Rock Mounds Offsetting Areas

This OKPI reflects the physical aspects of the sand blanket with rock mounds offsetting areas that are considered an integral part of this offsetting option and include the following:

- Depth of sand is maintained at 0.3 m.

4.1.3.2 OKPI 14: Abundance and Diversity of Infaunal and Epifaunal Invertebrates on Sand Blanket with Rock Mounds

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and **Appendix B**. However, a detailed methodology for SCUBA dives specific to infaunal invertebrates is presented below.

Sediment Grabs and Core Samples – Assessment of infaunal benthic invertebrate assemblages within the sand blanket offsetting component will be evaluated by collecting sediment samples. Sediment samples will be collected by divers from sand blanket habitat within the applicable offsetting areas. The same transects should be used as those established for monitoring of other biophysical features described in the previous subsection.

The same type of sampling equipment should be used between sample locations and sampling events. Samples should be collected using divers and cores. 0.1 diameter x 0.4 m in length to depth of 0.3 m into the substrate (~0.025 m^3). A minimum of two cores should be collected per transect and composited to improve species abundance (~0.05 m^3). This may be substituted with a PONAR grab sampler of equal collection volume.

For sorting and sampling benthic invertebrates, the same mesh sizes must be used amongst sample locations and sampling periods. It is recommended that a 2 mm sieve be used to collect debris and larger invertebrates, followed by 0.5 mm mesh size for greater species resolution. 10% of invertebrate samples should be verified by a re-sort. Sub-sampling may be completed if abundance is high. Sub-sampling should be within 20% of estimated levels based on full counts.

Samples will be analyzed in a biological laboratory for benthic invertebrate taxonomic composition (down to the lowest practical taxonomic level) and abundance. Adult values will be reported separate from juvenile or immature. Benthic community results will be analyzed and interpreted using descriptive and comparative statistics consistent with analysis of other OKPIs (e.g. average abundance across offsetting areas, Shannon's diversity index, etc., Section 4.1.1.2, **Appendix B**).

4.1.3.3 OKPI 15: Abundance and Distribution of Invertebrate Holes and Siphons in Sand Blanket with Rock Mound Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.3.1 OKPI 16: Abundance and Diversity of Fish on Sand Blanket with Rock Mound Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.3.2 OKPI 17: Presence and Dimension of Voids among Rock Mounds in Sand Blanket with Rock Mound Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.4 Deep Rock Reef

4.1.4.1 OKPI 18: Physical Integrity of Deep Rock Reef Offsetting Areas

The physical integrity OKPI reflects the physical aspects of Deep Rock Reef Offsetting Areas that are considered an integral part of this offsetting option and include the following:

- Voids in rock are present (pass or fail).
- Rock must be present within elevation range of constructed reef.
- As outlined in section 4.4 of the FAA, the sand blanket with rock mounds and deep rock reef offset measures will be considered successful if by year 7, the physical integrity of the site is stable and consistent with design specifications, including the presence of voids within the rocks, and showing no indications of movement, slumping, or deposition that may affect habitat functionality.

4.1.4.2 OKPI 19: Abundance and Diversity of Epifaunal Invertebrates on Deep Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.4.1 OKPI 20: Abundance and Diversity of Fish on Deep Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.1.4.2 OKPI 21: Presence and Dimension of Voids Among Deep Rock Reef Offsetting Areas

Details of sampling and analytical approach and other details are presented in Section 4.1.1.2 and Appendix B.

4.2 Riparian Habitat Offsetting Effectiveness Monitoring

The monitoring approach to assess riparian offset measures is designed to meet offsetting effectiveness monitoring requirements outlined in the Project's FAA. Riparian areas will target re-establishment of native riparian plant communities in similar proportions as found at a selected reference site.

4.2.1 Criteria

The riparian offset measures will be considered successful if by year 10 the habitat offsetting measures are functioning according to the criteria below:

- Representative native marine riparian vegetation is established within new or restored riparian habitat areas. The vegetated area will provide a minimum of 90% cover of the new or restored riparian area.
- The planted offset area consists of no more than 5% non-native species by area.

- The habitat is considered stable, showing no indications of movement, slumping, or erosion that may affect habitat functionality.

4.2.2 Methods

A site visit during the summer will be conducted for each ínexwantas (monitoring) period with the Project offsetting locations surveyed by, or under the supervision of, a registered professional biologist. The following methods will be applied:

- 10 m x 10 m plots will be assessed in riparian planting areas to determine plant survivorship and health.
- A minimum of one plot per 500 m^2 will be assessed.
- Plots will be surveyed for substate and erosion, sekw'ekw'inexw (wildlife) tree stability, plant survivorship, percent cover of native ground, shrub and canopy layers, and the presence and percent cover of non-native plant species.
- A reconnaissance survey consisting of systematically walking through non-plot riparian areas will be conducted to identify other plant mortality and non-native plant colonization to allow for maintenance.
- Planted riparian habitat shall exhibit a survival rate of at least 80% for graminoids, forbs and shrubs, and 90% for trees, or additional planting will be required to achieve this threshold after the first year. Survivorship will be compared with the specified planting and documented as-built report for expected results. Changes to plant species used in replanting may be made with approval from the professional biologist to incorporate plants with higher local observed survivor rates.
- The riparian areas will be assessed annually for regrowth and establishment of invasive plants. Plots having greater than five percent cover of targeted non-native species (e.g., Himalayan blackberry, Japanese knotweed) will be actively managed to reduce invasive competition, and regrowth of non-native plant species in areas outside of ínexwantas (monitoring) plots will be marked for maintenance.
- The location of vegetation assessment plots will be chosen using a stratified random method (i.e., randomly within predetermined stratified areas) within the offsetting area, with each plot recorded using a GPS unit (±4 m).
- The physical stability of each riparian habitat will be assessed to confirm that erosional issues or anthropogenic impacts are not occurring.
- GPD coordinates will be taken of the perimeter of the riparian offsetting area(s) to produce polygons of the offsetting areas and confirm that the minimum area required in the FAA is present.

4.2.3 Monitoring Frequency and Duration

Riparian surveys will occur in Years 1, 2, 3, 4, 5, 7 and 10 following the construction of the riparian offsetting area to meet the monitoring requirements outlined in the FAA.

4.2.4 Analysis

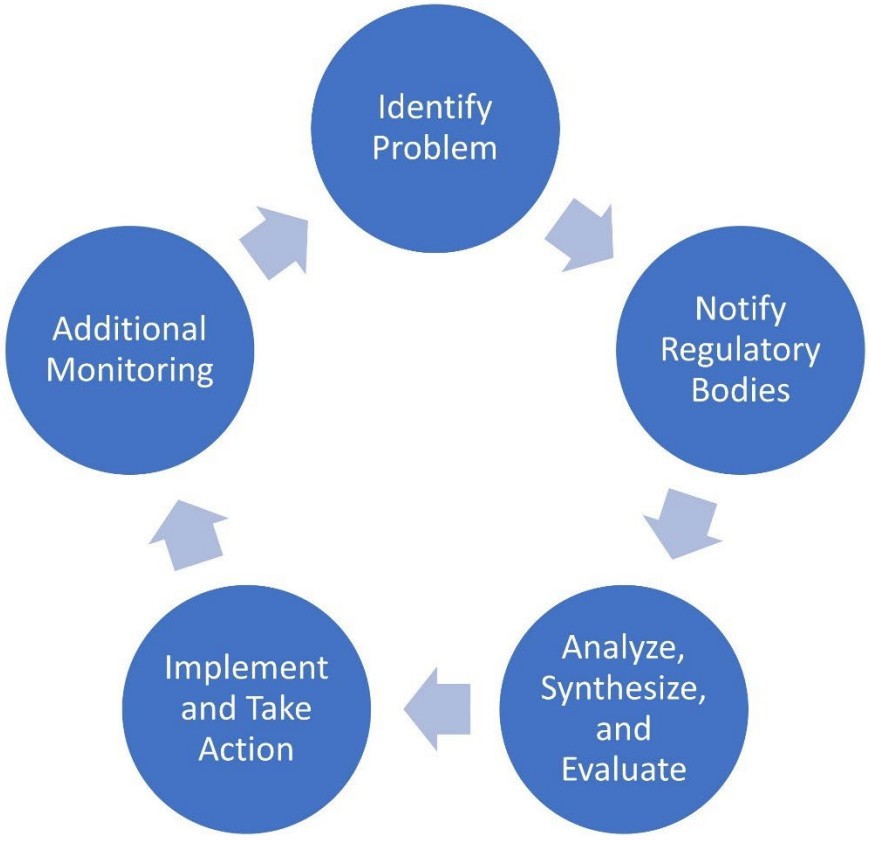
In addition to the performance criteria outlined in Section 4.2.1, the assessment of the functioning of riparian offsetting area(s) will include the following:

- Planting survival and natural recruitment within the riparian offsetting area(s)
- A map identifying polygons for the riparian habitat feature over top of as-built bathymetry. If there is variability in the functionality of the habitat feature, the areas may be divided to show areas of different functionality.
- If applicable, an interpretation should be provided for why areas with lower productivity are not performing as intended and proposed remedies as required.

Assessment details will be included in the offsetting effectiveness monitoring report prepared at the end of each monitoring year (**Section 6**).

5. ADAPTIVE MANAGEMENT PLAN AND CONTINGENCY MEASURES

The habitat offsetting effectiveness monitoring will be implemented following an adaptive management approach, as per condition 8 of the Environmental Assessment Certificate and outlined herein. **Inset A** presents a flowchart that outlines key steps to implement the adaptive management approach. A detailed description of each step is presented below.



Inset A: Adaptive Management Workflow

1. Identify Problem
   - Offsetting objectives are not being met if all or a portion of the habitat offsetting is not completed by the date specified (see **Section 3.8**) and/or are not functioning according to the primary performance metrics as required by Section 4.4 of the FAA (outlined in OKPIs 1 through 21 [**Appendix B**])
   - Analysis and evaluation of the monitoring will be summarised and communicated in offsetting effectiveness monitoring reports in required monitoring years (see **Section 6** for marine habitat reporting requirements, **Section 4.2.4** for riparian habitat reporting requirements). If in any year monitoring identifies any concerns regarding offsetting function, the QEP will be responsible for proposing a corrective action and implementation timeline within 30 days of the concern being identified.

2. Notify Regulatory Bodies
    - Woodfibre LNG will give written notice to DFO that outlines any of the habitat offsetting areas that are not functioning according to the primary performance metrics.
3. Analyze, Synthesize, and Evaluate
    - Woodfibre LNG, in collaboration with the TAC, will review the proposed corrective action and implementation timeline proposed by the QEP and evaluate data collected from existing monitoring to determine the reason for failure(s) associated with the habitat offsetting.
4. Implement and Take Action
    - A contingency plan will be developed to address the failure(s) and corrective action(s) will be implemented within one calendar year of determining the reason for failure.
    - Should contingency measures be implemented, Woodfibre LNG will give written notice to DFO and will provide revised success criteria and an updated Detailed Habitat Offsetting Effectiveness Monitoring Plan, subject to approval from DFO.
5. Additional Monitoring
    - The updated plan will detail additional monitoring measures to verify whether the offsetting measures are functioning as intended, subject to approval from DFO.
    - Notably, should contingency measures be implemented that require additional construction works or riparian planting, the monitoring for that component will restart and begin at year 1.

Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Woodfibre LNG have established a long-term Fish and Fish Habitat TAC with representatives from the Nation, Woodfibre LNG, and various qualified environmental professionals. The function of the TAC is to guide the development of fisheries related monitoring programs and to oversee the implementation of the MFFHMMP for the Project, including the associated FAA requirements.

In the case that specific OKPI tests cannot show a statistically significant improvement relative to the reference sites, one of the critical adaptive steps will be an evaluation of the current available evidence. The lack of statistical evidence for an offsetting objective may be the result of lack of statistical power (i.e., Type II error) rather than necessarily a lack of a biological effect. Insufficient statistical power can result from insufficient sampling or larger than expected variation (e.g., process or sampling error). As part of the adaptive management process, a detailed investigation should be conducted to clarify these aspects.

It is likely that that insufficient time has passed to statistically demonstrate an offsetting effect. In this case, formal power analyses can be conducted to determine the number of additional years may be required to demonstrate offsetting effect assuming currently estimated effects continue in perpetuity. For example, offsetting may be taking place but will need another five years before the desired offsetting effect can be statistically demonstrated.

It is also likely that either process error (i.e., natural variation) or sampling error (e.g., insufficient samples) has caused the lack of an offsetting effect to be statistically demonstrated. In the case of a single objective (or multiple objectives) failing within the context of a larger group of similar OKPI/KPI objectives (e.g., fish abundance) multiple lines of evidence could be used to assess an offsetting effect across the OKPI/KPI

grouping as a whole. For example, in the case of a single OKPI/KPI objective failure, do the other OKPI/KPI objectives in the grouping show a significant offsetting effect? If so, then the failure of a single indicator could be evidence for a statistical issue. Similarly, if we assume that objectives within an objective grouping possess commonalities, then it is also possible that if one objective displays insufficient statistical power, other objectives in that grouping may also show the same deficiency. In this case, it may be pragmatic to pool objectives together to determine whether a pooled offsetting effect can be shown for the larger grouping. Explicitly this could be done estimating a shared offsetting effect that is assumed to occur across the group of objectives, after accounting for baseline and scale differences between objective outcomes. In both cases sharing information across the objective grouping can provide a method to further evaluate offsetting effectiveness. While this approach does not demonstrate that an offsetting effect was achieved for a given objective it does provide further context around the likelihood that offsetting may have been achieved, but not detected.

The TAC will collaboratively prioritize and oversee the development of various deliverables, including refinements to pre-construction baseline conditions reporting, an environmental effects monitoring plan (e.g. follow up program), and this detailed offset effectiveness monitoring plan. The TAC will oversee the implementation of these plans, support the development of annual reporting, and provide recommendations for plan updates and adaptive management. Through the TAC, on-going evaluation of data collected through various assessment and monitoring programs will inform annual reports, plan updates and adaptive management recommendations, including contingency measures where the offsetting measures are not functioning as required. Changes to the structure, function and necessity of the TAC will follow the processes established through the Woodfibre LNG – Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) EWG, as provided by the SNEAA.

6. REPORTING

An offsetting effectiveness monitoring report will be prepared at the end of each monitoring year (Years 1, 2, 3, 5 and 7 following construction of the offsetting) and will be submitted to DFO and the Woodfibre Skwxwú7mesh Úxwumixw (Squamish Nation) TAC. The report will be provided to the TAC for preliminary review prior to submission to DFO by December 15 of each monitoring year.

This report will include:

- Dated photographs of the offsetting areas showing habitat features/values, the physical stability of each of the offsetting measures, fish and invertebrate use of the offsetting, colonization of kelp, and growth of riparian vegetation.
- Maps or figures delineating the extent and area of the offsetting areas presenting locations of photographs and/or mapped locations of key biophysical features, and the location of offsetting monitoring transects.
- Measurements of environmental variables during the surveys, including ambient temperature and water quality metrics (i.e., temperature, salinity and turbidity) in the surface waters and at the depth of the offsetting measures.
- Any concerns regarding the functioning of the offsetting measure, and a description of any remedial measure implemented, and their effectiveness. Remedial measures are to be implemented as soon as feasible and will be developed using the adaptive management approach outlined in **Section 5**.
- An assessment of the functioning of the marine habitat offsetting measures consistent with the standards or criteria (i.e., primary and secondary criteria) outlined in OKPI 1 through OKPI21 (see **Sections 4.1.1 to 4.1.4** and **Appendix B).**
- A description of the recolonization of macroalgae and benthic invertebrates on riprap following shoreline repair activities, as well as a description of colonization and use of pilings as a habitat following piling installation.
- An assessment of the functioning and criteria of the riparian offsetting measures consistent with the standards or criteria outlined in **Section 4.2.1** and **4.2.4**

7. PROFESSIONAL STATEMENT

Keystone Environmental Ltd. confirms that this report titled *Detailed Habitat Offsetting Effectiveness Monitoring Plan* has been prepared in a manner consistent with that level of care and skill normally exercised by other members of the environmental science and engineering profession practising under similar circumstances in the area at the time of the performance of the work.

This report was prepared by Caitlin Belz, B.I.T. and Afshin Parsamanesh, R.P.Bio. and reviewed by Duncan Clarke, R.P.Bio.

Recommendations and guidelines presented in this report have been prepared in a manner consistent with that level of care and skill normally exercised by other members of the environmental science and engineering profession practicing under similar circumstances in the area at the time of the performance of the work and are based upon (i) a review of available documentation and records, (ii) discussions with available personnel and regulatory representatives, (iii) review of the terms and conditions for planned construction, and (iv) observations of the Site and surrounding lands.

This report has been prepared solely for the internal use of the Woodfibre LNG Limited pursuant to the agreement between Keystone Environmental Ltd. and Woodfibre LNG Limited. Any use which other parties make of this report, or any reliance on, or decisions made based on it, are the responsibility of such parties. By using the report, Woodfibre LNG Limited agrees that it will review and use the report in its entirety. Keystone Environmental Ltd. accepts no responsibility for damages, if any, suffered by other parties as a result of decisions made or actions based on this report.

March 25, 2025
Date

Keystone Environmental Ltd.

Afshin Parsamanesh, R.P.Bio.
Project Manager, Senior Biologist

Duncan Clark, R.P.Bio.
Project Manager, Senior Biologist

8. REFERENCES

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APPENDIX A

DFO FISHERIES ACT AUTHORIZATION 22-HPAC-01346

Fisheries and Oceans Canada | Pêches et Océans Canada

Pacific Region
Ecosystem Management Branch
200 – 401 Burrard Street
Vancouver, BC
V6C 3S4

Région du Pacifique
Direction de la gestion des écosystèmes
Pièce 200 – 401 rue Burrard
Vancouver (C.-B.)
V6C 3S4

Paragraphs 34.4(2)(b) and 35(2)(b) *Fisheries Act* Authorization

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Authorization issued to
Woodfibre LNG General Partner Inc., as General Partner on behalf of the Woodfibre LNG Limited Partnership *(hereafter referred to as the "Proponent")*

Attention to: Christine Kennedy
900-1185 Georgia Street W
Vancouver, BC V6E 4E6

Location of Proposed Project

Nearest community (city, town, village): Squamish
Municipality, district, township, county: District of Squamish, Squamish-Lillooet Regional District
Province: British Columbia
Name of watercourse, waterbody: Howe Sound, Pacific Ocean
Longitude and latitude, UTM Coordinates: 10 U 481642 E 5501570 N

Valid Authorization Period

This Authorization remains in force from the **Date of Issuance** until **December 31, 2037.**

Please note that this Authorization may contain more specific timing requirements and limitations. These are set out in the Conditions of Authorization section.

Description of Proposed Project

The proposed project of which the work, undertaking or activity authorized is a part of involves:

- Construction of a liquified natural gas shipping terminal and floating storage;
- Construction of a marine offloading facility (MOF), an offloading platform, repair and upgrades to shoreline armour, repair and upgrades to the roll-on and roll-off facility, installation of two clear span bridges on Mill Creek, installation of culverts and outfalls along marine and Mill Creek shoreline; and
- Water withdrawals from Mill Creek and Woodfibre Creek.

Description of Authorized work(s), undertaking(s) or activity(ies) likely to result in the harmful alteration, disruption or destruction of fish habitat:

The work(s), undertaking(s), or activity(ies) associated with the proposed project described above, that are likely to result in the harmful alteration, disruption or destruction of fish habitat, are:

- Falling, clearing, and grubbing in riparian areas within the facility footprint and access roads;
- Infilling and rip-rap placement in marine areas during construction of facility components, and shoreline repairs and upgrades

The authorized work(s), undertaking(s), or activity(ies) are likely to result in the following impacts to fish and fish habitat:

- Loss of 7,342m^2 marine riparian habitat
- Loss of 5,133m^2 of marine intertidal and subtidal habitat
- Alteration of 2,843m^2 marine aquatic habitat

The works, undertakings, or activities associated with the proposed project described above, are not expected to result in death of fish provided that avoidance and mitigation measures described in the Project Plan and outlined in the Conditions of Authorization below are effectively implemented. Any death of fish resulting from this project should be demonstrated to have been unavoidable or accidental. DFO should be notified immediately in such circumstances via an email to: DFO.PACViolations-InfractionsPAC.MPO@dfompo.gc.ca **and** to Observe, Record, Report at 1-800-465-4336 or DFO.ORR-ONS.MPO@dfo-mpo.gc.ca.

Conditions of Authorization

The above described work, undertaking or activity must be carried on in accordance with the following conditions.

1. **Conditions that relate to the period during which the work, undertaking or activity can be carried on**

   The work, undertaking or activity that is/are authorized to be carried on during the following period:

   FROM: Date of Issuance **TO: January 31, 2026**

   If the Proponent cannot complete the work, undertaking or activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the above time period. An application for amendment, suspension or cancellation of the authorization should be submitted to DFO.

   The periods during which other conditions of this authorization must be complied with are provided in their respective sections below.

2. **Conditions that relate to measures and standards to avoid and mitigate impacts to fish and fish habitat**

   2.1 Sediment and erosion control: Sediment and erosion control measures must be in place and shall be upgraded and maintained, such that release of sediment into freshwater or the marine environment is avoided at the location of the authorized work, undertaking, or activity.

   2.2 List of measures and standards to avoid and mitigate impacts to fish and fish habitat

   2.2.1 Authorized works, undertakings or activities shall be limited to the locations outlined in the Proponent's application document "Aquatic Effects Assessment for Construction Works: Woodfibre LNG Project" (June 2023).

   2.2.2 In-water works and near-shore blasting shall be conducted during the reduced work window of August 16 - January 31.

2.2.3 In-water works shall cease if there is risk of physical harm to any pinniped from direct contact. Activities may only resume once there is no longer risk of injury from direct contact.

2.2.4 In-water works shall cease if there is risk of physical harm to any cetacean from direct contact. To avoid contact with cetaceans from placement or removal of materials in water:

2.2.4.1 shut down procedures shall be initiated if cetacean are observed within 400m of works;

2.2.4.2 works shall cease should a cetacean be observed within 250m of the works;

2.2.4.3 work will only resume once the cetacean has left the exclusion zone or has not been re-sighted for 30 minutes.

2.2.5 Fish salvage and relocation will be conducted in areas where there is potential for finfish to be stranded or entrapped as a result of work activities. Salvage effort will be designed for all fish to be removed from the salvage area and to be relocated beyond the Project's zone of influence and in comparable habitat. Salvage shall be repeated if fish regain access to the isolated area.

2.2.6 Within 24 hours prior to placement or removal of in-water materials (i.e. sand, cobble, rock, or rip-rap) or the removal of piles, a salvage and relocation of crabs, sea cucumbers, sea stars, and sea urchins shall be completed within the footprint of the works and a 3 m buffer around it. The area shall be re-salvaged prior to re-commencement of works in the event of a 7 day or longer period of inactivity.

2.2.7 A vibratory hammer or down-the-hole hammer will be used for pile driving, unless an impact hammer is required to achieve design specifications (i.e. pile installation). If impact hammer pile driving is required, an explanation of why impact hammer pile driving was required will be documented in the environmental monitoring report (Condition 3.1.1).

2.2.8 The following conditions specifically relate to activities with the potential to generate underwater noise, including but not limited to impact pile driving and blasting:

2.2.8.1 Establish separate fish, pinniped and cetacean underwater noise exclusion zones prior to activities with the potential to generate underwater noise.

2.2.8.1.1 The fish exclusion zone shall be the area that is effectively enclosed by the sound attenuation device. The peak sound pressure level shall not exceed 207 dB re: 1 µPa and the SELcum shall not exceed 203 dB re: 1 μPa^2s outside of the sound attenuation device to avoid injury or death of fish.

2.2.8.1.2 The pinniped exclusion zone must be a minimum of 150m or the distance at which sound levels do not exceed 190 dB_{RMS} re: 1µPa outside of the zone, whichever distance is greater. The exclusion zone for blasting must be at least 500m at the start of blasting, until the distance to the 190 dB_{RMS} re: 1µPa threshold is verified.

2.2.8.1.3 The cetacean exclusion zone must be a minimum of 500m or the distance at which sound levels do not exceed 160 dB_{RMS} re: 1µPa outside of the zone, whichever distance is greater. The exclusion must be at least 1000m at the start of each new activity, until the distance to the 160 dB_{RMS} re: 1µPa threshold is verified.

2.2.8.2 Works must be halted immediately if pinnipeds or cetaceans are observed within the respective exclusion zones. Work will only resume once the cetacean has left the exclusion zone or has not been re-sighted for 30 minutes.

2.2.8.3 Works must be halted immediately if sounds levels exceed the established sound level thresholds beyond each respective exclusion zone. Underwater noise exceedances shall be reported to DFO as per Condition 2.3.

2.2.8.4 A notification system (e.g., red, yellow and green light system) must be established prior to activities with the potential to generate underwater noise that may harm fish or marine mammals, to enable quick communication of the sound pressure levels between the environmental monitor and the equipment operator. This will be designed to ensure works are halted immediately if sounds pressure levels are nearing or over the threshold levels identified in Condition 2.2.8.1.

2.2.8.5 An appropriately qualified professional will conduct a survey of the area in the vicinity of the work using appropriate methods for underwater detection of fish or schools of fish prior to the initiation of pile driving or blasting activities for that day and prior to subsequent work if activity has been halted for more than 30 minutes. The surveyed

area must include a minimum radius of 10 m around the sound source. If fish are detected, works will not commence until fish have left the area.

2.2.8.6 An effective sound attenuation device (e.g. bubble curtain) must be installed and functioning prior to and during underwater noise generating activities to attenuate underwater noise unless an appropriately qualified professional has determined that;

- The use of the bubble curtain will result in unavoidable generation of harmful levels of suspended sediment; and
- The specific works or activities can be carried out without risk of exceeding the acoustic thresholds specified by this authorization.

2.2.8.7 A soft start up procedure shall be employed for impact pile driving where the impact energy and frequency are gradually increased. The soft start procedure is to be employed anytime there is a break of 30 minutes or more in impact pile driving. If, during the soft start up, monitoring indicates that noise levels may exceed noise thresholds, the work will be halted and additional mitigation will be implemented according to the direction of an appropriately qualified professional.

2.2.8.8 A soft start up procedure shall be employed for near-shore blasting, where the blasts furthest from shore are conducted first, and when the tide is lower than 2m chart datum. Monitoring of underwater noise during soft start will inform subsequent implementation of mitigation.

2.2.8.9 Activities with the potential to generate underwater noise that may harm fish or marine mammals shall be carried out when environmental conditions enable effective visual monitoring of the pinniped and cetacean exclusion zones.

2.2.8.10 Underwater noise monitoring and mitigations, as per Condition 2.2.8, may be discontinued for an in-water work activity (excluding impact pile driving or blasting) if hydroacoustic monitoring provides verification that the activity does not have potential to generate underwater noise that may harm fish or marine mammals.

2.2.9 If injured or dead fish are observed, works will cease immediately and a notification issued to DFO as per Condition 2.3 of this Authorization. Works will only resume after additional mitigation measures are implemented to avoid and mitigate further impacts to fish.

2.2.10 In-water works will cease if herring spawn occurs within 100m of the authorized project footprint or offsetting footprints during construction. In-water works, undertakings or activities will only resume once an appropriately qualified professional has identified and implemented necessary measures to avoid impacts to herring adults, spawn, or larvae. If herring spawn occurs it shall be reported to DFO at ReferralsPacific@dfo-mpo.gc.ca within 24 hours.

2.2.11 Vessels and barges will be operated and positioned in a manner that prevents damage to the seafloor or shoreline.

2.2.12 All vegetation clearing, site layout, access construction and material placement shall be planned and conducted in a way to minimize disturbance such that impacts are limited to what is authorized.

2.2.13 All new road crossings over fish-bearing streams will be clear-span bridges, constructed according to the DFO code of practice for clear-span bridges (Appendix B)

2.2.14 Pump intakes will be constructed and operated to avoid entrainment and impingement of fish by applying the interim DFO code of practice for end-of-pipe fish protection screens for small water intakes in freshwater (Appendix B) where applicable.

2.2.15 Water withdrawals from Mill Creek will not exceed $0.1 m^3/s$. No water will be withdrawn if discharge at the hydrometric station is less than $0.81 m^3/s$.

2.2.16 Water withdrawals from Woodfibre Creek will not exceed $0.1 m^3/s$. No water will be withdrawn if discharge at the hydrometric station is less than $0.47 m^3/s$.

2.3 Contingency measures: If monitoring required in Section 3 and Condition 5.2.1 below indicates that the measures and standards to avoid and mitigate impacts to fish and fish habitat are not successful the Proponent shall:

2.3.1 Immediately cease those works, undertakings, or activities and notify DFO through DFO's Observe, Record, and Report Line 1-800-465-4336 or DFO.ORR-ONS.MPO@dfo-mpo.gc.ca;

2.3.2 Submit an incident report within 24 hours to DFO through ReferralsPacific@dfo-mpo.gc.ca, referencing DFO File No. 22-HPAC-01346;

2.3.3 Only recommence those works, undertakings, or activities after the Proponent has determined the reasons for the failure of measures and standards, and upon the advice of a qualified environmental professional, implemented additional measures to avoid and mitigate harmful alteration, disruption or destruction of fish habitat and/or death of fish;

2.3.4 Continue monitoring to determine the effectiveness of all mitigation measures and standards and contingency measures.

2.4 Measures and standards to avoid and mitigate harmful alteration, disruption or destruction of fish habitat and/or death of fish shall be implemented, as necessary, prior to, during, and after construction activities related to the authorized works, undertakings, or activities, and offsetting measures.

3. **Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate impacts to fish and fish habitat,**

3.1 Monitoring of avoidance and mitigation measures: The Proponent must submit construction monitoring reports to DFO, for each month (or part) that works, undertakings, or activities associated with the Authorization are conducted. Monitoring reports are to submitted no later than 20 days from the last day of the month being reported on. The construction monitoring reports will indicate whether the measures and standards to avoid and mitigate impacts to fish were conducted according to the conditions of this authorization. This shall be done by providing the following for that reporting period:

3.1.1 Demonstration of effective implementation and functioning: Providing a concise summary of the works, undertakings, or activities carried out during the reporting period, dated photographs and inspection reports to demonstrate effective implementation and functioning of mitigation measures and standards described above to limit the impacts to fish and fish habitat to what is covered by this authorization.

3.1.1.1 A summary of fish and marine mammals observed;

3.1.1.2 A summary of the fish salvaged, including dates, number of individuals salvaged (by species) and locations of salvage and relocation;

3.1.1.3 A summary of the need for impact pile driving, including rationale;

3.1.1.4 A summary of the results of hydroacoustic monitoring;

3.1.1.5 A summary of Mill Creek and Woodfibre Creek flow rates during the reporting period.

3.1.2 Contingency measures: Providing details of any contingency measures that were followed, in the event that initial mitigation measures did not function as described.

3.2 Other monitoring and reporting conditions:

3.2.1 The Proponent shall employ an appropriately qualified professional(s) to monitor the implementation of avoidance and mitigation measures referred to in section 2 of this authorization. The qualified professional(s) must be onsite during the carrying on of in-water works, undertakings and activities and shall monitor the works, undertakings, and activities to ensure that the measures to avoid impacts to fish and fish habitat are effective, and that unauthorized impacts are avoided.

3.2.2 During activities with the potential to generate underwater noise with the potential to harm fish or marine mammals, hydroacoustic monitoring must be conducted continuously to verify that underwater noise levels are consistent with requirements of Condition 2.2.8.1 to prevent injury or death of fish.

3.2.3 For activities with the potential to generate underwater noise that may harm fish or marine mammals, at minimum, a two hydrophone configuration must be used to monitor hydroacoustic sound levels. This should be achieved by positioning one hydrophone at the mid-point of the water column (e.g., equal distance between the surface and ocean floor) and another hydrophone within 2 m of the ocean floor. The hydrophones should be located 10 m from the source, where possible and the environmental monitor shall extrapolate the peak and cumulative sound pressure to confirm that the peak and cumulative sound pressure level

thresholds are not exceeded outside of the sound attenuation device (which may be less than 10 m from the pile).

3.2.4 When bubble curtains are used, frequent inspections of the bubble curtain system must confirm that it is fully connected and functioning (i.e. continuous bubble distribution around the sound source at the water surface).

3.2.5 An experience and qualified marine mammal observer(s) shall be present at all times during activities with the potential to generate underwater noise that may harm marine mammals, and shall monitor for cetaceans and pinnipeds within the respective cetacean and pinniped underwater noise exclusion zones for at least 30 minutes prior to the start the works.

3.2.6 All construction monitoring reports are to be submitted to ReferralsPacific@dfo-mpo.gc.ca referencing DFO file: **22-HPAC-01346**.

3.3 Post-construction reporting conditions: The proponent shall provide a post-construction monitoring report to DFO, 90 days following the completion of works, undertakings or activities, and indicate whether the works, undertakings, or activities were conducted according to the conditions of this authorization. This shall be done by providing;

3.3.1 A description of the completed authorized works including dimensions (e.g., area, elevation, slope, volume, etc.) and materials used.

3.3.2 A comparison of the completed authorized works with the design dimensions.

3.3.3 A geospatial polygon that accurately represents the completed HADD footprint(s). Geospatial polygon data should be collected using WGS 1984 to four (4) decimal places (e.g., 28.5234ºN, 80.6830ºW). Geospatial polygon data must be supplied in Shape File (.shp) format. In addition to the geospatial polygon, the following data must also be supplied in an Excel file (i.e., metadata):

- HADD area per habitat type (based on depth during high and low water seasons, high water mark, or high tide line);
- Date when HADD completed;
- Brand name and model of GPS unit, the coordinate system used, and guaranteed accuracy of GPS unit.

Geospatial polygons (.shp files) are to be submitted to ReferralsPacific@dfo-mpo.gc.ca with reference to DFO file: 22-HPAC-01346).

3.3.4 A summary of the effectiveness of implementation and function of mitigation measures and standards descried above.

3.3.5 A summary of the fish salvage, including dates, number and species of individuals salvaged, holding and handling time, water temperature (watercourse and any fish holding containers), the location of salvage and relocation, and the nature of any effects on salvaged fish (death, sub-lethal harm, etc.).

3.3.6 A summary of any contingency measures that were employed in the event that initial mitigation measures did not function as described.

3.3.7 The post-construction monitoring report is to be submitted to ReferralsPacific@dfo-mpo.gc.ca referencing DFO file: 22-HPAC-01346.

4. Conditions that relate to offsetting

4.1 Letter of credit DFO may draw upon funds available to DFO as the beneficiary of the letter of credit provided to DFO as part of the application for this authorization, Letter of Credit Number 10014350, to cover the costs of implementing and maintaining the offsetting measures required to be implemented under this authorization, including the associated monitoring measures included in section 5 of this authorization, in instances where the Proponent fails to implement these required measures.

4.2 Scale and description of offsetting measures: Marine and riparian habitat offsetting measures shall be carried out in accordance with the measures set out in the Proponent's offsetting plan within the report titled “Aquatic Effects Assessment For Construction Works, Woodfibre LNG” dated June 2023. The offset measures will be located as indicated in Appendix A (Figure 1 and Figure 2). Offsetting will consist of no less than:

4.2.1 Marine offset construction and enhancement totalling 22,120m^2, including;
- 1,160m^2 cobble blanket;
- 2,463m^2 shallow rock reef;
- 10,953m^2 sand blanket with rock mounds;
- 7,544m^2 deep rock reef.

4.2.2 Riparian area enhancement and planting totalling 16,183m^2.

4.3 Schedule: Marine and riparian offset construction shall be completed by January 31, 2028.

4.4 Offsetting criteria to assess the implementation and effectiveness of the offsetting measures: All fish habitat offsetting measures shall be completed and functioning according to the criteria below:

4.4.1 The cobble blanket and shallow rock reef offset measures will be considered successful if, by year 7, the habitat offsetting measures are functioning according to the criteria below:

4.4.1.1 Abundance of marine macroalgae is at least 95% of mean percent coverage at reference site(s).

4.4.1.2 Abundance of invertebrates on rock surfaces is at least 95% of mean abundance at reference site(s).

4.4.1.3 The physical integrity of the site, including sand depth and cobble density, is stable and consistent with the design specifications showing no indications of movement, slumping or deposition that may affect habitat functionality.

4.4.2 The sand blanket with rock mounds and the deep rock reef offset measures will be considered successful if, by year 7, the habitat offsetting measures are functioning according to the criteria below:

4.4.2.1 In the sand blanket offset area, abundance of infaunal invertebrates is at least 95% of mean abundance observed at reference site.

4.4.2.2 On rock mounds and deep rock reef, abundance of epifaunal invertebrates is at least 95% of the mean abundance observed at reference site(s).

4.4.2.3 The physical integrity of the site is stable and consistent with the design specifications, including the presence of voids within the rocks, and showing no indications of movement, slumping or deposition that may affect habitat functionality.

4.4.3 The riparian offset measures will be considered successful if by year 10 the habitat offsetting measures are functioning according to the criteria below:

4.4.3.1 Representative native marine riparian vegetation is established within new or restored riparian areas. The vegetated area will provide a minimum of 90% cover of the new or restored riparian area.

4.4.3.2 The planted offset area consists of no more than 5% non-native species by area.

4.4.3.3 The habitat is considered stable, showing no indications of movement, slumping, or erosion that may affect habitat functionality.

4.4.4 The proponent shall prepare a detailed Offset Effectiveness Monitoring Plan, by March 15, 2024 including:

4.4.4.1 A detailed description of the implementation plan and approach to monitoring effectiveness of the offset habitats. The plan will consider the success criteria of Condition 4.4 and the additional requirements of Section 5.

4.4.4.2 Reference site selection including a description of how the sites are suitable for references, and pilot data at these locations. The reference sites shall consist of established, non-impacted natural habitats having similar habitat conditions (e.g., depth, substrate type, exposure) to the associated offsetting measures and colonized by species representative of the local area.

4.5 Contingency measures: If the results of monitoring as required in section 5 indicate that the offsetting measures are not completed by the date specified and/or are not functioning according to the above criteria in 4.4, the Proponent shall give written notice to DFO, and shall implement contingency measures and associated monitoring measures to ensure the implementation of the offsetting measures is completed and/or functioning as required by this Authorization.

4.5.1 Scale and description of contingency measures:

4.5.1.1 In the event that the offsetting does not meet the target criteria described in Condition 4.4, the proponent will determine the reason for the failure(s), develop a contingency

plan to address the failure(s) and implement corrective action(s) within one calendar year of determining the reason for the failure. If corrective action requires additional construction works or riparian planting, the monitoring for that component will restart and begin at year 1.

4.5.1.2 If, in any year, the monitoring required in Section 5 identifies any concerns regarding the functioning of the offset measure, remedial measures will be implemented as soon as feasible. These measures will be described in the effectiveness monitoring report as required in condition 5.2.2.4.

4.5.2 Monitoring measures to ensure offsetting contingency is completed and/or functioning as required: Should contingency measures be implemented, the Proponent will provide revised success criteria and an updated monitoring plan. The Proponent will implement additional monitoring measures to verify whether the offsetting measures are functioning as intended, subject to approval by DFO.

4.6 The Proponent shall not carry on any work, undertaking or activity that will adversely impact the offsetting measures.

5. **Conditions that relate to monitoring and reporting of implementation of offsetting measures (described in section 4):**

5.1 Schedule(s) and criteria: The Proponent shall conduct monitoring of the construction and implementation of offsetting measures in accordance with monitoring conditions described in Section 3 of this authorization.

5.2 Reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures (described in Condition 4.2) were conducted according to the conditions of this authorization, by providing the following:

5.2.1 A Post-Construction Monitoring Report shall be provided to DFO, 90 days following the completion of construction of each offset area and indicate whether the works were conducted according to the conditions of this authorization. The post-construction monitoring report must include the following:

5.2.1.1 A description of the completed authorized works including dimensions (e.g. area, bathymetry, elevation, slope, etc.) and materials specifications used.

5.2.1.2 Dated photographs of the constructed offsetting measures, pre-construction, during construction, and post-construction.

5.2.1.3 A comparison of the completed offset with the design dimensions

5.2.1.4 A summary of the effectiveness of construction mitigation measures and standards implemented.

5.2.1.5 An inventory of the riparian plants (by species) planted as offsetting.

5.2.1.6 A geospatial polygon that accurately represents the completed offset footprint(s). Geospatial polygon data should be collected using WGS 1984 to four (4) decimal places (e.g., 28.5234oN, 80.6830oW). Geospatial polygon data must be supplied in Shape File (.shp) format.

In addition to the geospatial polygon, the following data must also be supplied in an Excel file (i.e., metadata):

- Area of offset per habitat type (based on depth during high and low water seasons, high water mark, or high tide line);
- Target species;
- Date offsetting completed, date of maintenance, and date monitored;
- Brand name and model of GPS unit, the coordinate system used, and guaranteed accuracy of GPS unit.

5.2.2 An Offset Effectiveness Monitoring Report, will be provided in Years 1, 2, 3, 4, 5, and 7 following construction of the offsetting. An additional report will be provided in Year 10, for the riparian offset areas. The report will be provided to DFO by December 15 of each year and report on whether the offsetting measures were conducted according to the

conditions of the authorization by providing effectiveness monitoring reports that will describe, at minimum, the information listed below, collected during the year:

5.2.2.1 Geo-referenced and dated photographs of the offsetting showing habitat features/values, the physical stability of each of the offsetting measures, fish and invertebrate use of the offsets, colonization of kelp on the cobble blanket and shallow reefs, and growth of the riparian vegetation.

5.2.2.2 Maps or figures delineating the extent and area of the offsets, the location of provided photographs, and the location of offset monitoring transects and assessments.

5.2.2.3 Measurements of environmental variables during surveys, including ambient temperature and water quality metrics (i.e. temperature, salinity, and turbidity) in the surface waters and at the depth of the offsetting measures.

5.2.2.4 Any concerns regarding the functioning of the offset measure, and a description of any remedial measures implemented, and their effectiveness.

5.2.2.5 Assessment of the functioning of the offsetting measures consistent with the Offset Effectiveness Monitoring Plan defined in Condition 4.4.4.

5.2.2.6 An assessment of the functioning of the cobble blanket offset consistent with the standards or criteria described in Condition 4.4.1, and including the following:

- Abundance and diversity of macroalgae, epifaunal invertebrates, and fish compared to reference site(s);
- Abundance and distribution of herring spawn;
- Abundance and distribution of invertebrate holes and siphons.

5.2.2.7 An assessment of the functioning of the shallow rock reef offset consistent with the standards or criteria described in Condition 4.4.1, and including the following:

- Abundance and diversity of macroalgae, epifaunal invertebrates, and fish compared to reference site(s);
- Abundance and distribution of herring spawn;
- Presence and dimensions of voids among the rock reef.

5.2.2.8 An assessment of the functioning of the sand blanket offset consistent with the standards or criteria described in Condition 4.4.2, and including the following:

- Abundance and diversity of fish compared to a reference site(s);
- Abundance and distribution of invertebrate holes and siphons;
- Abundance and diversity of epifaunal and infaunal invertebrates compared to a reference site.

5.2.2.9 An assessment of the functioning of rock mounds and deep rock reef consistent with the standards or criteria described in Condition 4.4.2, and including the following:

- Abundance and diversity of fish compared to a reference site(s);
- Abundance and diversity of epifaunal invertebrates compared to a reference site(s);
- Presence and dimensions of voids among the rock reef.

5.2.2.10 An assessment of the functioning of riparian consistent with the standards or criteria described in Condition 4.4.3, and including the following:

- Planting survival and natural recruitment;
- Abundance and diversity of vegetation compared to reference site(s).

5.2.2.11 A description of the recolonization of macroalgae and benthic invertebrates on riprap following shoreline repair activities, as well as a description of colonization and use of the pilings as a habitat following piling installation.

6. **Conditions that relate to reporting and engagement with Indigenous Nations**

6.1 All reports and/or notifications submitted by the Proponent to DFO under the conditions of this authorization shall be shared concurrently with DFO and the Indigenous Nations consulted on this Authorization. Reporting and/or notifications may be discontinued at the request of the Nation.

6.2 All environmental management plans and procedures pertaining to fish and fish habitat that are developed or updated following Authorization will be distributed to the Indigenous Nations consulted on this Authorization. This includes fish salvage plans, erosion and sediment control plans, or any other monitoring plans or procedures. Submissions may be discontinued at the request of the Nation.

6.3 Within 60 days of the issuance of this authorization and then annually by December 31 of each year, the Proponent shall provide a schedule of expected construction milestones and report submissions as required by this Authorization. The schedule will be distributed to DFO and the Indigenous Nations consulted on this Authorization. Submissions to Indigenous Nations may be discontinued at the request of the Nation.

6.4 In recognition of the importance of engaging with Indigenous Nations for adaptive management, the Proponent is to convene an annual meeting related to the content of the required documents (i.e., monitoring reports, notifications, contingency plans) described in this authorization with a Collaborative Technical Working Group.

6.4.1 The Collaborative Technical Working Group is to consist of the Proponent, DFO, and a technical representative of each of the Indigenous Nations unless the Nation declines to participate.

6.4.2 An annual Collaborative Technical Working Group meeting is to be convened between February and May of each year from 2024 until the final year of offsetting effectiveness monitoring, unless otherwise specified by DFO.

6.4.3 The Proponent will undertake a full and impartial consideration of views and other information provided by Indigenous Nations and provide a written explanation detailing how the views and information provided have been considered and addressed, or why such views and information have not been addressed.

6.4.4 The Proponent will submit a summary report to DFO describing compliance with the conditions of Section 6. The report will be provided to DFO by June 30 following each annual meeting of the Collaborative Technical Working Group.

Authorization Limitations and Application Conditions

The Proponent is solely responsible for plans and specifications relating to this authorization and for all design, safety and workmanship aspects of all the works associated with this authorization.

The holder of this authorization is hereby authorized under the authority of Paragraphs 34.4(2)(b) and 35(2)(b) of the *Fisheries Act*. R.S.C., 1985, c.F-14, to carry on the work(s), undertaking(s) and/or activity(ies) that are likely to result in impacts to fish and fish habitat as described herein.

This authorization does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

This authorization does not permit the deposit of a deleterious substance in water frequented by fish. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of any deleterious substances into waters frequented by fish unless authorized by regulations made by Governor in Council.

This authorization does not permit the killing, harming, harassment, capture or taking of individuals of any aquatic species listed under the *Species at Risk Act* (SARA) (s. 32 of the SARA), or the damage or destruction of residence of individuals of such species (s. 33 of the SARA) or the destruction of the critical habitat of any such species (s. 58 of the SARA).

At the date of issuance of this authorization, no individuals of aquatic species listed under the *Species at Risk Act* (SARA) were identified in the vicinity of the authorized works, undertakings or activities.]

It is also your *Duty to Notify* DFO if you have caused, or are about to cause, the unauthorized death of fish by means other than fishing and/or the harmful alteration, disruption or destruction of fish habitat. Such notifications should be directed to DFO.PACViolations-InfractionsPAC.MPO@dfo-mpo.gc.ca **and** to Observe, Record, Report at 1-800-465-4336 or DFO.ORR-ONS.MPO@dfo-mpo.gc.ca.

The failure to comply with any condition of this authorization constitutes an offence under Paragraph40(3)(a) of the *Fisheries Act*, and may result in charges being laid under said Act.

A copy of this authorization should be kept on site while the work is in progress and upon request be provided to relevant federal or provincial officials. The authorization holder is responsible for ensuring work crews are familiar with, and able to adhere to, the conditions.

This authorization cannot be transferred or assigned to another party. If the work(s), undertaking(s) or activity(ies) authorized to be conducted pursuant to this authorization are expected to be sold or transferred, or other circumstances arise that are expected to result in a new Proponent taking over the work(s), undertaking(s) or activity(ies), the Proponent named in this authorization shall advise DFO in advance.

Date of Issuance:

Chambers, Susan
Digitally signed by Chambers, Susan
Date: 2023.10.06 09:35:52 -07'00'

Approved by: _____

Susan Chambers
Regional Director General
Pacific Region
Fisheries and Oceans Canada

Summary of key activities and timelines associated with this authorization

Activity	Condition	Date
Period of authorized work, undertaking or activity	1	January 31, 2026
Monthly Project Construction Monitoring Reports	3.1	Within 20 days from the last day of the month being reported on
Project Post Construction Monitoring Report	3.3	Within 90 days following the completion of authorized works
Monthly Offset Construction Monitoring Reports	5.1	Within 20 days from the last day of the month being reported on
Post Construction Monitoring of Offsetting Measures	5.2.1	Within 90 days of the completion of construction of offset measures
Offsetting Effectiveness Monitoring Reports	5.2.2	Marine: December 15 of years 1, 2, 3, 5, and 7 following completion of construction Riparian: December 15 of years 1, 2, 3, 5, 7, and 10 following completion of construction
Annual Collaborative Technical Working Group Meeting	6.4	Between February and May following each year of project construction or offset effectiveness monitoring

APPENDIX B

MASTER HABITAT OFFSETTING KEY PERFORMANCE INDICES TABLE

Metric (from FAA and EEM)	KPI/Variable		Objective	Hypotheses Tested	Sampling/Study Approach	FAA or EEM Reporting Requirement Filled	Survey Locations	Sampling/Study Duration	Sampling Frequency	Analysis Approach
Habitat Offsetting - Cobble Blanket										
Primary Metric										
Plan View Area	N/A	Minimum area required by the *Fisheries Act* Authorization must be present	Confirm meeting or beating minimum requirement for the Cobble Blanket offsetting concept	N/A	Underwater survey of cobble blanket placed in offsetting area	FAA 5.2.2.2	Cobble blanket offsetting area	One time survey	Once, after the installation of cobble blanket	N/A
Physical Integrity of cobble blanket offsetting Areas	OKPI 1	Physical Integrity of Cobble Blanket Offsetting Areas	The physical integrity of the site, including sand depth and cobble density, is stable andconsistent with the design specifications showing no indications of movement, slumping or deposition that may affect habitat functionality.	Cobble blanket layer installed is stable.	SCUBA Surveys in summer - Presence within quadrats and belt transects as observed by divers or other methods such as underwater camera	FAA 4.4.1.3	Cobble blanket offsetting and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Description of stability
Abundance and Diversity of Macroalgae in Cobble Blanket Offsetting Areas	OKPI 2	Mean aquatic vegetation % coverage (e.g., algae) - average quadrat percent coverage (mean across offsetting habitat type) Shannon's diversity index calculation (mean across offsetting habitat type) and descriptive assessment of the macroalgal community	Confirm and measure (in percent coverage) marine macroalgae abundance and species diversity within the cobble blanket offsetting area	By year 7, abundance of marine macroalgae on cobble blanket rock surfaces is at least 95% of mean percent coverage at reference site(s). Species diversity is comparable to that of reference site(s).	SCUBA Surveys in summer - Presence within quadrats and belt transects as observed by divers or other methods such as underwater camera	FAA 4.4.1.1 FAA 5.2.2.6	Cobble blanket offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance, diversity, and species richness in the Applicable Offset Area compared to Reference Site(s); Repeat test of hypothesis in Years 5 and 7 post-construction of the applicable offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Abundance and Diversity of Invertebrates on Cobble Blanket Offsetting Areas	OPKI 3	Mean abundance of mobile invertebrates on cobble blanket surfaces, either by: Abundance of mobile invertebrates (mean # of invertebrates observed within belt transects within OA,) (e.g., crab, seastar) OR sessile invertebrate percent coverage (average quadrat percent coverage (mean across OA) Shannon's diversity index calculation (mean across offsetting habitat types) and descriptive assessment of the invertebrate community	Confirm the abundance and diversity of invertebrates on cobble blanket	By year 7, abundance of invertebrates on cobble blanket rock surfaces is at least 95% of mean abundance at reference site(s). Species diversity is comparable to that of reference site(s).	Annual SCUBA Surveys in summer-Presence within quadrats and belt transects as observed by divers or other methods such as underwater camera	FAA 4.4.1.2 FAA 5.2.2.6	Cobble blanket offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance, diversity, and species richness in the Applicable Offset Area compared to Reference Site(s); Repeat test of hypothesis in Years 5 and 7 post-construction of the applicable offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Secondary Metric										
Abundance and Diversity of Fish on Cobble Blanket Offsetting Areas	OKPI 4	Abundance and diversity of fish in cobble blanket offsetting areas: # of individual fish by species (e.g., flatfish, rockfish, lingcod)	Assess habitat use by demersal fish species.	Abundance and diversity of fish is comparable to that of the reference site	Annual SCUBA Surveys in summer	FAA 5.2.2.6	Cobble blanket offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Abundance and Distribution of Pacific Herring Spawn on Cobble Blanket Offsetting Areas	OKPI 5	Pacific herring spawn intensity - Spawn area spatial distribution, Pacific Herring spawn intensity - Average quadrat spawn percent coverage (mean across PPIA) - with qualitative layer metric included, Pacific Herring spawn intensity - spawn vertical distribution	Assess potential changes in Pacific Herring habitat use for spawning and identify trends (if any) in PPIA from pre-construction, construction and into operational phases.	Herring spawning in cobble blanket offsetting area is comparable to that of the reference sites	SCUBA surveys during peak spawning period for Pacific herring (between February and April) May be conducted concurrently with KPI1 surveys	FAA 5.2.2.6 and EEM KPI1	Transects in offsetting and and reference site(s)	Throughout the life of the Project.	Initially every 2 weeks in first year and gradually reducing frequency as information on spawning timing gained.	Descriptive statistics Professional opinion
Abundance and Diversity of Invertebrate Holes and Siphons on Cobble Blanket Offsetting Areas	OKPI 6	Presence of invertebrate holes and siphons within quadrats or as observed by divers or other methods such as underwater camera.	Assess habitat use by invertebrates	Abundance and distribution of invertebrate holes and siphons is comparable to that of the reference sites	Annual SCUBA Surveys in summer	FAA 5.2.2.6	Cobble blanket offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Shallow Rock Reef										
Primary Metric										
Surface Area	N/A	Minimum area required by the *Fisheries Act* Authorization must be present	Confirm meeting or beating minimum requirement for the shallow rock reef offsetting option	N/A	Underwater survey of shallow rock reef	FAA 5.2.2.2	Shallow rock reef offsetting area	One time survey	Once, after the installation of shallow rock reef	N/A
Physical Integrity of shallow rock reef offsetting Areas	OKPI 7	Physical stability of shallow rock reef material placed	The physical integrity of the site is stable and consistent with the design specifications showing no indications of movement, slumping or deposition that may affect habitat functionality.	Shallow rock reef is stable	Annual SCUBA Surveys in summer	FAA 4.4.1.3	Shallow rock reef offsetting area	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Description of stability
Abundance and Diversity of macroalgae on Shallow Rock Reef Offsetting Areas	OKPI 8	Mean aquatic vegetation % coverage (e.g., algae) - Average quadrat percent coverage (mean across OA) Shannon's diversity index calculation (mean across offsetting area) and descriptive assessment of the macroalgal community.	Confirm and measure (in percent coverage) macroalage abundance and species within the shallow rock reef offsetting area	By year 7, abundance of marine macroalgae on shallow rock reef is at least 95% of the mean percent coverage at reference site(s). Species diversity is comparable to that of reference site(s).	Annual SCUBA Surveys in summer	FAA 4.4.1.1	Shallow rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance. Repeat test of hypothesis in Years 5 and 7 post-construction of the Applicable Offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Abundance and Diversity of Invertebrates on Shallow Rock Reef Offsetting Areas	OKPI 9	Abundance of invertebrates (with exception to infauna) on shallow rock reef compared to reference sites is at least 95% of the mean abundance at reference sites by year 7. Shannon's diversity index calculation and descriptive assessment of the invertebrate community	Confirm the establishment of invertebrates on shallow rock reef offsetting areas.	By year 7, abundance of invertebrates (with exception to infauna) on shallow rock reef compared to reference sites is at least 95% of the mean abundance at reference sites. Species diversity is comparable to that of reference site(s).	Annual SCUBA Surveys in summer	FAA 4.4.1.2 FAA 5.2.2.7	Shallow rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance. Repeat test of hypothesis in Years 5 and 7 post-construction of the Applicable Offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Secondary Metric										
Abundance and Diversity of Fish on Shallow Rock Reef offsetting Areas	OKPI 10	Abundance and diversity of fish in shallow rock reef offsetting areas: # of individual fish by species (e.g., flatfish, rockfish, lingcod)	Assess habitat use by demersal fish species (e.g., flatfish, rockfish , lingcod, etc.)	Abundance and diversity of fish is comparable to that of the reference site.	Annual SCUBA Surveys in summer	FAA 5.2.2.7	Shallow rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Abundance and Distribution of Pacific Herring Spawn on shallow rock reef Offsetting Areas	OKPI 11	Pacific Herring spawn intensity - Spawn area spatial distribution, Pacific Herring spawn intensity - Average quadrat spawn percent coverage (mean across PPIA) - with qualitative layer metric included, Pacific Herring spawn intensity - Spawn vertical distribution	Assess potential changes in Pacific Herring habitat use for spawning and identify trends (if any) in PPIA from pre-construction, construction and into operational phases.	Herring spawn intensity in shallow rock reef is comparable to that of the reference site.	SCUBA surveys during peak spawning period for Pacific herring (between February and April) May be conducted concurrently with KPI1 surveys	FAA 5.2.2.7	Shallow rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Initially every 2 weeks in first year and gradually reducing frequency as information on spawning timing gained.	Descriptive statistics Professional opinion
Presence and Dimension of Voids in Shallow Rock Reef Offsetting Areas	OKP I2	Voids are present (pass or fail) within the shallow rock reef area	Integrity of Rock Reefs is maintained	Voids among shallow rock reef offsetting are present at the dimensions consistent with design specifications (pass or fail).	Annual SCUBA Surveys in summer	FAA 5.2.2.7	Shallow rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Pass or fail test Professional Opinion

Metric (from FAA and EEM)	KPI/Variable		Objective	Hypotheses Tested	Sampling/Study Approach	FAA or EEM Reporting Requirement Filled	Survey Locations	Sampling/Study Duration	Sampling Frequency	Analysis Approach
Sand Blanket with Rock Mounds										
Primary Metric										
Surface Area	N/A	Minimum area required by the Fisheries Act Authorization must be present	Confirm meeting or beating minimum requirement for the shallow rock reef offsetting option	N/A	Underwater survey of shallow rock reef	FAA 5.2.2.2	Sand blanket with rock mounds offsetting area	One time survey	Once, after the construction of the habitat	N/A
Physical Integrity of Sand Blanket with Rock Mounds Offsetting Areas	OKP I3	Physical stability of sand blanket material placed	The physical integrity of the site, including sand depth is stable and consistent with the design specifications showing no indications of movement, slumping or deposition that may affect habitat functionality. Rock mounds to be assessed similar to deep rock reefs.	Sand blanket layer installed is stable.	Annual SCUBA Surveys in summer	FAA 4.4.2.3	Sand blanket with rock mounds offsetting area	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Description of stability
Abundance and Diversity of Infaunal and Epifaunal Invertebrates on Sand Blanket with Rock Mounds	OKP I4	Abundance of infaunal invertabrates on sand blanket and epifaunal invertebrates on rock mounds within offsetting area. Shannon's diversity index calculation and descriptive assessment of the infauna and epifauna invertabrate community	Assess the use of the offsetting option by infaunal and epifaunal invertebrates	Abundance of infaunal invertebrates on sand blanket and epifaunal invertebrates on rock mounds compared to reference sites is at least 95% of the mean abundance at reference sites by year 7. Species diversity is comparable to that of reference site(s).	Epifauna - Annual SCUBA Surveys in summer Infauna - Sediment grabs and/or core samples	FAA 4.2.2.1 and 4.4.2.2 FAA 5.2.2.8	Sand Blanket with rock mounds offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance, d Repeat test of hypothesis in Years 5 and 7 post-construction of the Applicable Offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Secondary Metric										
Abundance and Distribution of Invertabrate Holes and Siphons in Sand Blanket with Rock Mound Offsetting Areas	OKPI15	Presence of invertebrate holes and siphons within quadrats or as observed by divers or other methods such as underwater camera	Assess habitat use by invertebrates	Abundance and distribution of invertebrate holes and siphons comparable to the reference sites	Annual SCUBA Surveys in summer	FAA 5.2.2.8	Sand Blanket with rock mounds offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Abundance and Diversity of Fish on Sand Blanket with Rock Mound Offsetting Areas	OKPI I6	Abundance and diversity of fish in sand blanket with rock mound offsetting areas: # of individual fish by species (e.g., flatfish, rockfish, lingcod)	Assess habitat use by demersal fish species (e.g., flatfish, rockfish , lingcod, etc.)	Abundance and Diversity of fish is comparable to that of the reference sites	Annual SCUBA Surveys in summer	FAA 5.2.2.8	Sand Blanket with rock mounds offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Presence and Dimension of Voids among Rock Mounds in Sand Blanket with Rock Mound Offsetting Areas	OKP I7	Voids are present (pass or fail) within the rock mound offsetting area	Integrity of the offsetting option is maintained.	Voids among rocks, mounds are present at the dimensions consistent with design specifications (pass or fail)	Annual SCUBA Surveys in summer	FAA 5.2.2.9	Sand Blanket with rock mounds offsetting area	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Pass or fail test Professional Opinion
Deep Rock Reef										
Primary Metric										
Area	N/A	Minimum area required by the *Fisheries Act* Authorization must be present	Confirm meeting or beating minimum requirement for the deep rock reef offsetting option	N/A	Underwater survey of deep rock reef	FAA 5.2.2.2	Deep rock reef offsetting area	One time survey	Once, after the installation of shallow rock reef	N/A
Physical Integrity of deep rock reef Offsetting Areas	OKP I8	Physical stability of deep rock reef material placed	The physical integrity of deep rock reef site is stable and consistent with the design specifications.	Deep rock reef is stable	Annual SCUBA Surveys in summer	FAA 4.4.2.3	Deep rock reef offsetting area	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Description of stability
Abundance and Diversity of Epifaunal Invertebrates on Deep Rock Reef Offsetting Areas	OKP I9	Abundance of epifaunal invertebrates on deep rock reef offsetting areas. Shannon's diversity index calculation and descriptive assessment	Assess the use of the offsetting option by epifaunal invertebrates	Abundance of epifaunal invertebrates on deep rock reef offsetting areas compared reference sites is at least 95% of the mean abundance at reference sites by year 7 Species diversity is comparable to that of reference site(s).	Annual SCUBA Surveys in summer	FAA 4.4.2.2 FAA 5.2.2.9	Deep rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Three years after construction of the Applicable Offset, test hypothesis by statistically comparing abundance. Repeat test of hypothesis in Years 5 and 7 post-construction of the Applicable Offset area. Descriptive statistics for diversity (shannon's diversity, species richness)
Secondary Metric										
Abundance and Diversity of Fish on Deep Rock Reef Offsetting Areas	OKP 20	Abundance and diversity of fish in deep rock reef offsetting areas: # of individual fish by species (e.g., flatfish, rockfish, lingcod)	Assess habitat use by demersal fish species (e.g., flatfish, rockfish , lingcod, etc.)	Abundance and diversity of fish is comparable to that of reference site.	Annual SCUBA Surveys in summer	FAA 5.2.2.9	Deep rock reef offsetting area and reference sites	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Descriptive statistics Professional opinion
Presence and Dimension of Voids Among Deep Rock Reef Offsetting Areas	OKP 21	Voids are present (pass or fail) within the deep rock reef offsetting area	Integrity of deep rock reef offsetting area	Voids among deep rock reef offsetting areas are present at the dimensions consistent with design specifications (pass or fail).	Annual SCUBA Surveys in summer	FAA 5.2.2.9	Deep rock reef offsetting area	7 years, with reporting in years 1, 2, 3, 4, 5, and 7 following construction of Offsetting Measures.	Once annually in summer	Pass or fail test Professional Opinion

APPENDIX C

2023 MARINE BIOPHYSICAL PILOT STUDY OF HABITAT OFFSETTING REFERENCE SITES

2023 MARINE BIOPHYSICAL PILOT STUDY OF HABITAT OFFSETTING REFERENCE SITES

1. INTRODUCTION

In October 2023, Woodfibre LNG General Partner Inc. (Woodfibre LNG) received a *Fisheries Act* Authorization (File No.: 22-HPAC-01346) from Fisheries and Oceans Canada (DFO) for the Woodfibre LNG project (the Project), located in Squamish, British Columbia. The components of the Project that are covered in the *Fisheries Act* Authorization (FAA) include:

- the construction of a liquified natural gas shipping terminal and floating storage;
- construction of a marine offloading facility, an offloading platform and a floating hotel (Floatel);
- shoreline works (including the installation of culverts and outfalls);
- repair and upgrades to existing marine infrastructure;
- installation of clear span bridges over Mill Creek; and
- water withdrawals from Mill Creek and Woodfibre Creek.

As the authorized works were likely to result in loss and alteration of fish habitat, Woodfire LNG will be creating marine habitat offsetting within the certified project area (CPA) of the Project including:

- 1,160 m^2 of cobble blanket;
- 2,463 m^2 of shallow rock reef;
- 10,953 m^2 of sand blanket with rock mounds;
- 7,544 m^2 of deep rock reef; and
- 16,183 m^2 of riparian area enhancement.

Condition 4.4.4 of the FAA requires that Woodfibre LNG prepare a detailed Offset Effectiveness Monitoring Plan including a description of how habitat offsetting reference sites were suitable for references and pilot data at the habitat offsetting reference site locations. This report (Appendix C of the Detailed Habitat Offsetting Effectiveness Monitoring Plan) describes how the reference sites were selected and includes pilot biophysical data collected during a SCUBA dive assessment of the reference sites.

As described in the Detailed Habitat Offsetting Effectiveness Monitoring Plan (the Plan), thirteen potential reference sites were initially considered before two sites were found that together were suitable as references for the proposed offsetting habitat. Reference Site 1 (RS1) and Reference Site 2 (RS2) are located 7 km southwest and 2.6 km southwest of the CPA respectively. An initial assessment at RS1 found shallow cobble mixed with sand (suitable reference for cobble blanket) that transitioned to sand continuing to deeper depths (suitable reference for sand blanket). RS2 was composed of composed of a mixture of bedrock and boulder at shallow depths (suitable reference for shallow rock reef), with bedrock continuing to deeper depths (suitable reference for deep rock reefs and rock mounds on sand blanket).

An initial biophysical survey was conducted on October 24 and 25, 2023 to collect pilot data as required by the FAA. The surveys will be completed on an annual basis in the summer months, when the abundance of photosensitive organisms (e.g., macroalgae) is anticipated to be higher than late fall.

2. METHODS

On October 24 and 25, 2023, Keystone Environmental Ltd. (Keystone Environmental) completed a marine biophysical survey within lower intertidal and subtidal areas of RS1 and RS2. The survey was conducted following a modified version of Fisheries and Oceans Canada's Marine Foreshore Environmental Assessment Procedures (DFO 2004).

The dive surveys were completed between 9:00 am and 2:00 pm on October 24 and 25, 2023. Tide levels during the surveys were as follows:

- RS 1 transect T1: 2.9 m to 3.3 m CD.
- RS 1 transect T2: 2.3 m to 2.5 m CD.
- RS 1 transect T3: 4.0 m to 4.3 m CD.
- RS 2 transect T1: 1.7 m CD.
- RS 2 transect T2: 2.2 m CD.
- RS 2 transect T3: 2.4m CD.

Water conditions were calm to light wind with a maximum 0.4 m chop on October 24. Conditions on October 25 were choppy with winds of 70 km/h with a maximum chop of 1.5 m. Underwater visibility was approximately two metres, with reduced visibility at times due to mixing at the interface between saltwater and the freshwater surface layer (halocline), due to inputs from Squamish River. Water temperature ranged from 8°C at the surface to 10°C at depth.

The survey was conducted by a three-person team of Registered Professional Biologists certified to occupational SCUBA standards according to WorkSafeBC safe diving procedures. The following approach was used to collect the survey data at each of the reference sites:

- Three rope transects, approximately 12 m to 63 m in length were deployed perpendicular to shore from a dive boat to depths of approximately -15 m. The transects were distributed evenly throughout the survey area, approximately 25 m apart. Transects were marked every 5 m and weighted at either end with half cinder blocks and/or shackles.
- A pair of divers began each dive survey at the surface, near the water line at the time of the survey and swam the length of the transect with one diver recording video, and the other documenting observations of all fish and mobile invertebrates (e.g., crabs and seastars) within two metres of the transect line on a slate with underwater paper to a depth of approximately -15 m. Visual observations were made of the substrate and biota extending to deeper depths, which appeared consistent to the areas covered by the transects.
- Next, the divers returned up the transect line towards shore, recording substrate type (according to classifications in **Table 2-1**), depth, percent cover of marine vegetation and sessile invertebrates (e.g., algae, barnacles) and mobile species within a one square metre quadrat at five metre intervals along the marked transect line. Divers also noted nearby biota and substrate transitions along the transects, outside of quadrat locations. Underwater photos were collected on the return path along each transect. Above water photographs were also taken of the intertidal foreshore above the location of the transects.

Following the dive surveys, depths were corrected to metres relative to chart datum (CD)[1] using the Squamish inner tide station. Abundance estimates of observed biota were determined using the categories in **Table 2-2**.

Table 2-1 Substrate Classification

Substrate Type	Size Range (Diameter)
Bedrock	-
Boulder/ Riprap	>256 mm Rounded/ Angular
Cobble	64–256 mm
Gravel	2–64 mm
Sand	0.062–2 mm
Fines (Silt/ Mud/ Clay)	<0.062 mm

Table 2-2 Abundance Categories for Marine Plants, Sessile Animals and Mobile Animals

Abundance Category	Percent Aerial Coverage (Marine Plants and Sessile Animals)	Individual Counts per m^2 (Infauna Holes)	Individual Counts per Transect[1] (Motile Animals)
Rare	< 5%	1	1
Sparse	5–25%	2–4	2–4
Few	26–50%	5–10	5–10
Common	51–75%	11–30	11–30
Abundant	75–100%	>30	>30

[1] Where animals are too numerous to count individually estimated numbers are recorded.

3. EXISTING CONDITIONS

Biophysical conditions at RS1 and RS2 are shown on **Figure 1** and **Figure 2** (**Appendix 1**) respectively and transect/ quadrat data is available in **Appendix 2**. Biophysical conditions are summarized in Sections 3.1 and 3.2.

3.1 Physical Conditions

3.1.1 Reference Site 1

The upper intertidal shoreline above RS1 was comprised of a cobble bed with boulders interspersed (**Photograph 1**). For transect 1 from the water level during the survey to middle intertidal (2.3 m to 0.2 m CD) consisted of a cobble bed with interspersed sand and gravel, while transitioning to a gravel and sand dominant substrate a sand blanket comprised the substrate the entire subtidal area that was surveyed (-1.1 m to -7.4 m CD) (**Photograph 2**). Transect 2 also consisted of cobble bed with gravel and sand interspersed within the substrate beginning at the start of the transect and extending into the shallow

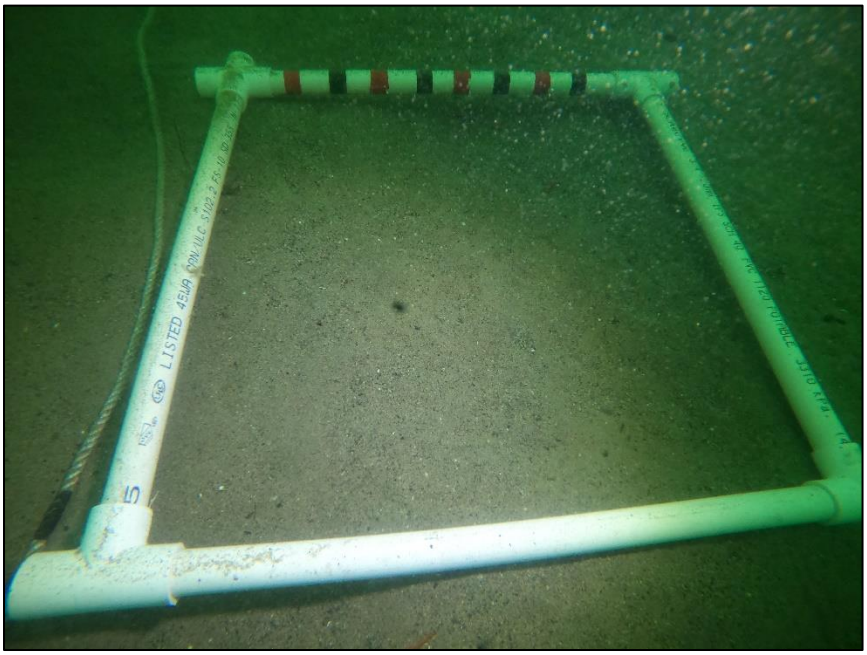
[1] *Depths below chart datum are shown as negative.*

subtidal (-3.2 m CD) (**Photograph 3),** with the remaining section of surveyed subtidal area dominated by sand blanket. Transect 3 consisted of cobble blanket with small amounts of sand interspersed from the start of the transect to the shallow subtidal zone (2.7 m to -2.7 m CD). Below -2.7 m CD, the remainder of the subtidal zone was dominated by sand.

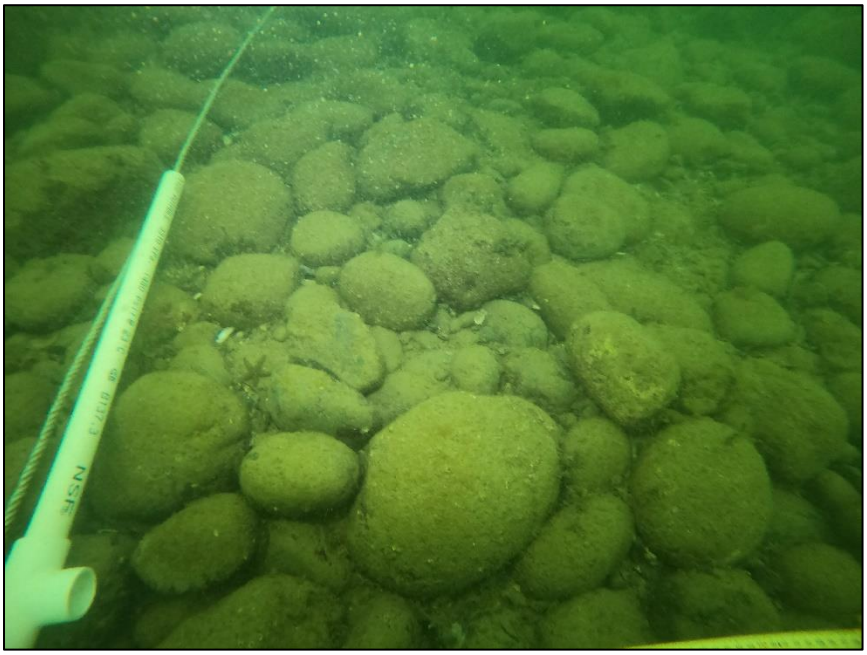
3.1.2 Reference Site 2

The upper intertidal shoreline above RS 2 was composed of fractured bedrock for all transects (**Photograph 4**). The shallow subtidal zone for transect 1 was composed of boulders with a 1 to 2 mm thick layer of silt (-2.3m to -2.5 m CD) (**Photograph 5**), with the remainder of the subtidal survey area consisting of bedrock covered with a 1 to 2 mm thick layer of silt. Substrate observed along Transect 2 subtidal substrate was composed of bedrock with a 1 to 2 mm thick layer of silt (**Photograph 6**), except for at -3.7m to -4.5m CD where a boulder cobble substrate was observed. Boulder crevices ranged from 15 cm x 11cm to 30 cm x 60 cm. Transect 3 consisted entirely of bedrock with a 1 to 2 mm thick silt layer.

Photograph 1: Upper intertidal zone above RS 1, comprised of a cobble bed with boulders interspersed; October 24, 2023

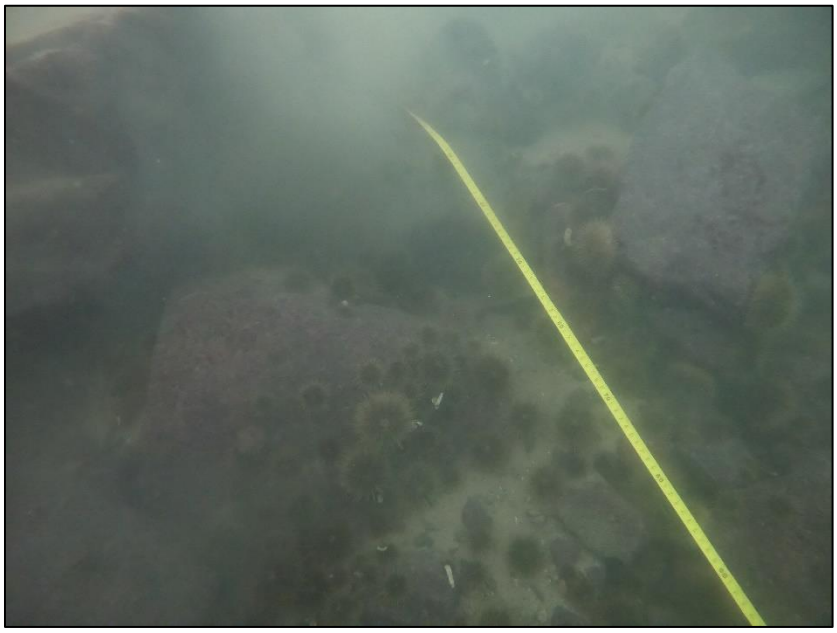


Photograph 2: Sand blanket comprising the substrate of the subtidal zone for Transect 1; this is representative of the sand blankets also observed within Transects 2 and 3. October 24, 2023.

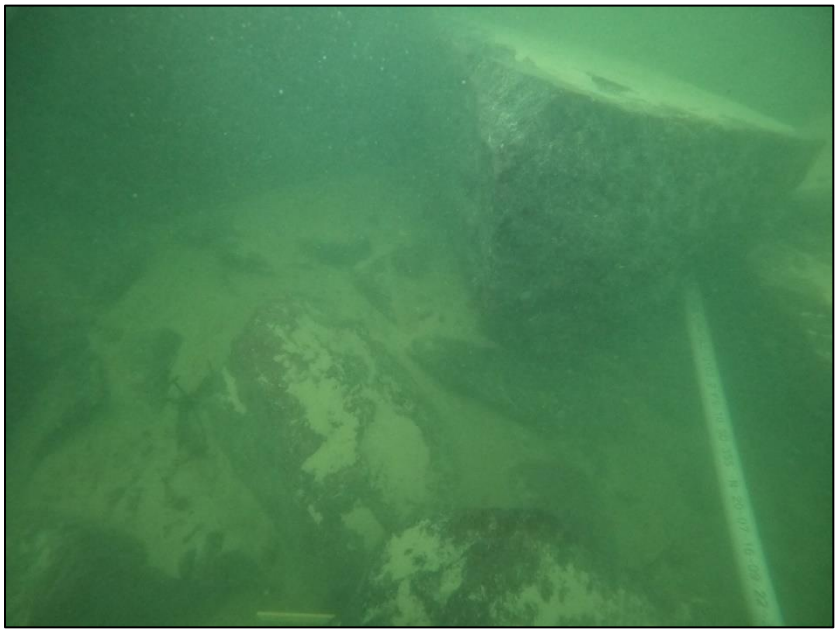


Photograph 3: Cobble blanket with sand interspersed observed within the subtidal area of RS 1 Transect 2; October 24, 2023.

Photograph 4: Fractured bedrock observed in the intertidal zone of RS 2; October 25, 2023.



Photograph 5: Boulders observed on bedrock in the shallow subtidal zone of RS 2 Transect 1; October 25, 2023.



Photograph 6: Bedrock covered with a 1-2 mm thick layer of silt that was observed on Transect 2 at RS 2; photo is representative of all three transects. October 25, 2023

3.2 Biological Conditions

3.2.1 Reference Site 1

Sparse to few rockweed (*Fucus distichus*) was observed growing on cobble substrate in the intertidal zone (2.4 m to 1.2 m CD) of all three transects within RS 1 (**Photograph 7**). Sparse amounts of green algae (*Ulva intestinalis*) was observed between 2.3 m and 1.8 m CD attached to cobble on Transect 1 and Transect 3. Diatoms were present in the lower intertidal and upper subtidal zones (1.5 m to -0.4 m CD) of all three transects and ranged from sparse to abundant in abundance. Sugar wrack kelp (*Saccharina latissimi*) was rare on transect 1 at a depth of 1.2 m CD , changing to few abundance on Transect 2 between -0.4 m and -3.2 m CD (**Photograph 8**). In the lower intertidal and upper subtidal zones (0.2 m to -1.1 m CD) of Transect 1, sea lettuce (*Ulva lactuca*) was sparse. Additional biota observed in the intertidal and upper subtidal zones of RS 1 included acorn barnacles (*Balanus glandula c.f.*), which were observed in the intertidal zones of all three transects between the depths of 2.7 m to 0.4 m CD and located in the upper subtidal zone of Transect 2 at a depth of -0.7 m CD. A sparse number of blue mussels (*Mytilus trossulus*) were observed in the middle intertidal zone of Transect 3 at a depth of 2.7 m to 1.8 m CD. Blue mussel shell hash was observed in the intertidal zone of all three transects ranging from rare to few in abundance (**Photograph 9**). Mottled stars (*Evasterias troschelii)* were present in abundances of rare to few in the lower intertidal and upper subtidal zones of Transect 1 and Transect 3 (0.9 m to -1.1 m CD).

Speckled sanddab (*Citharichthys stigmaeus*) was present in few to sparse abundances in Transect 1 through 3 in the subtidal zone at depths from -10.6 m to -1.9m CD. In addition, an abundant number of speckled sanddabs were observed within the belt transects throughout the duration of the dives in the

sandy substrate (**Photograph 10**). Hermit crabs were rare in the upper subtidal zones of Transect 1 and Transect 2 (-1.1 m to -3.9 m CD), and few hermit crabs were identified outside of the quadrats on Transect 1 and Transect 2 (**Photograph 11**). Few abundance of red rock crabs (*Cancer productus*) were present throughout the subtidal zone of the belt of Transect 1. Dungeness crab (*Metacarcinus magister*) were observed in few abundance along Transect 1 and sparse abundance along Transect 2. A few abundance of limpets (*lottia spp.*) were observed along Transect 3 attached to cobble and a rare abundance of giant plumose anemone (*Metridium farcimen*) was observed in the subtidal zone of Transect 2 at a depth of -4.7 m CD. Bay goby (*Lepidogobius* Lepidus) was rare on the belt of Transect 2. English sole (*Parophrys vetulus*) was rare and present on Transect 1. Benthic infaunal holes ranged from rare to few abundance on Transect 1 through 3 at depths of -3.5 m to -9.0 m CD.

3.2.2 Reference Site 2

No macro algae were observed in the subtidal zones of all three transects of RS 2. Green Urchins (*Strongylocentrotus droebachiensis*) were common to abundant in the subtidal zones of Transect 1 and Transect 3 at depths from -4.3 m to -0.9 m CD (**Photograph 12**). In addition, an abundant number of green urchins were observed between quadrats along Transects 1 and 2. Coonstripe shrimp (*Pandalus danae*) were present on the bedrock in rare to few abundances at Transect 2 and Transect 3 at depths of -4.3 m to -11.1 mm CD, and in abundant numbers outside of the quadrats along the belt of transects 2 and 3. Smooth pink scallops (*Chlamys rubida*) were present in sparse abundance on Transect 3 at a depth of -8.9 m CD. A rare abundance of squat lobster (*Munida quadrispina*) were observed along Transect 1 (**Photograph 13**), along with mottled stars at a depth of -2.5 m CD. In addition, rare to sparse abundance of calcareous tubeworm castings were present on Transect 3 at depths of -4.3 m to -0.9 m CD.

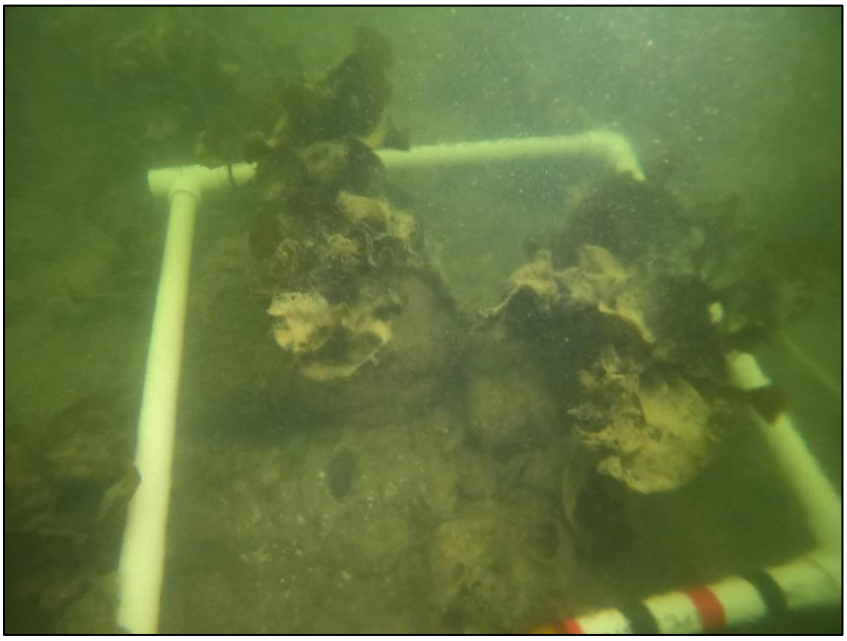
A summary list of observed species is provided in **Table 3-1.**

Table 3-1 Summary of Observed Species

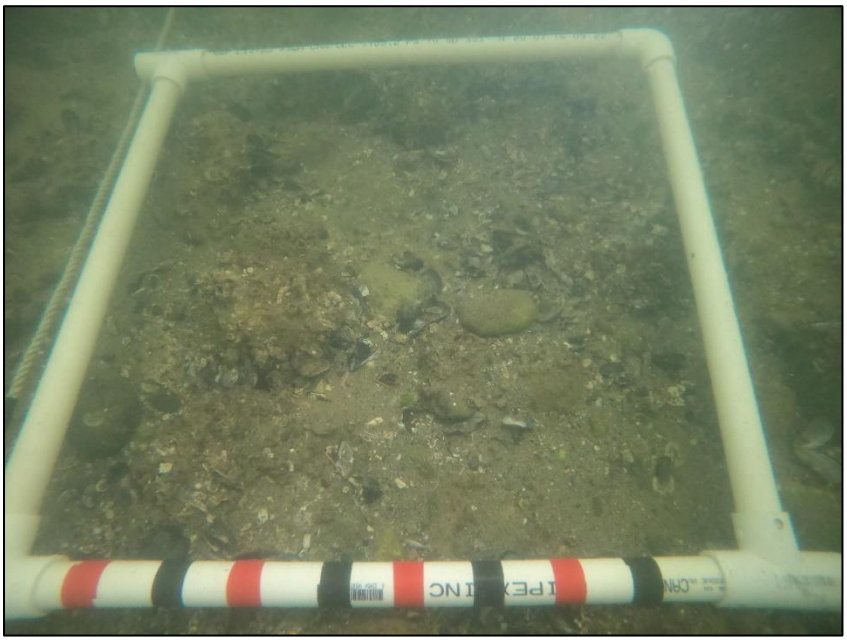
Common name	Scientific name	Average Abundance	Upper (m CD)	Lower (m CD)
Acorn barnacle	*Balanus glandula c.f.*	sparse	2.7	0.4
Bay goby	*Lepidogobius lepidus*	rare	-5.5	-5.5
Rockweed	*Fucus distichus*	sparse	2.4	1.2
Blue mussel	*Mytilus trossulus*	sparse	2.7	1.8
Coonstripe shrimp	*Pandalus danae*	abundant	-4.3	-11.1
Calcareous tubeworm casting	*Serpula sp*	rare	-0.9	-4.3
Diatom	*Class Bacillariophyceae*	common	1.5	-0.4
Dungeness Crab	*Metacarcinus magister*	rare	-1.1	-1.1
English sole	*Parophrys vetulus*	rare	-4.5	-4.5
Giant plumose anemone	*Metridium farcimen*	rare	-4.7	-4.7
Green urchin	*Strongylocentrotus droebachiensis*	abundant	-0.9	-4.3
Hermit crabs	*Pagurus spp*	rare	-1.1	-3.9

Common name	Scientific name	Average Abundance	Upper (m CD)	Lower (m CD)
Infauna holes		sparse	-3.5	-9.0
Limpets	*Lottia spp.*	few	-0.9	5.2
Mottled sea star	*Evasterias troschelii*	rare	0.9	-6.8
Sea lettuce	*Ulva lactuca*	sparse	0.2	-1.1
Smooth pink scallop	*Chlamys rubida*	common	-8.9	-8.9
Speckled sanddab	*Citharichthys stigmaeus*	abundant	-2.6	-10.8
Sugar wrack kelp	*Saccharina latissima*	few	1.2	-3.2
Sea lettuce	*Ulva lactuca*	sparse	0.2	-1.1
Green String Lettuce	*Ulva intestinalis*	sparse	2.3	1.8

Photograph 7: View of rockweed and Ulva intestinalis anchored to cobble on Transect 1 of RS1; October 24, 2023.



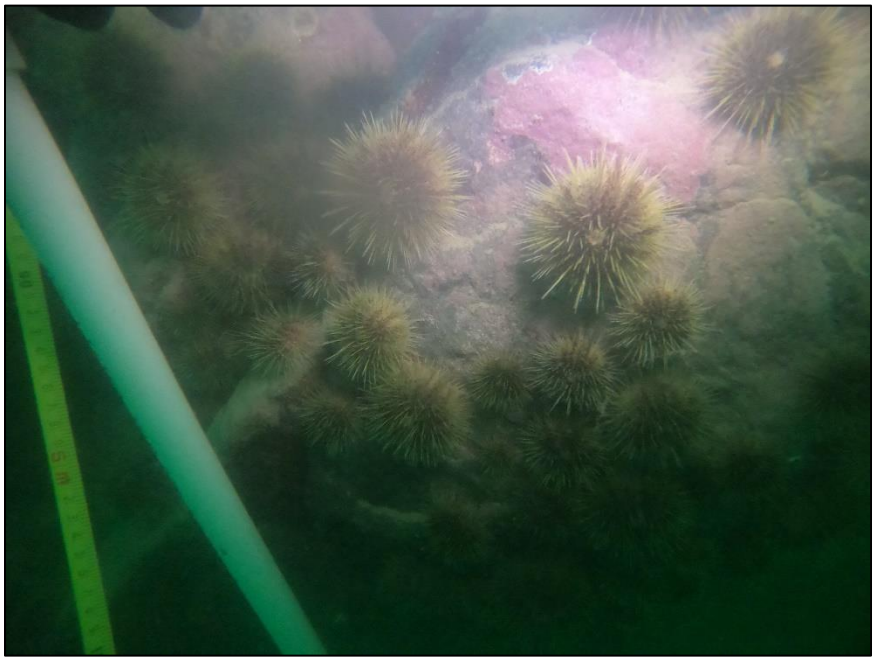
Photograph 8: View of sugar wrack kelp on Transect 2 of RS1; October 24, 2023.



Photograph 9: View of acorn barnacles and blue mussel shell hash observed in the intertidal zone of Transect 2 in RS1; October 24, 2023.

Photograph 10: View of a speckled sanddab along belt Transect 2 at RS 1; October 24, 2023.

Photograph 11: View of a hermit crab on sandy substrate on Transect 3 of RS 1; October 24, 2023.



Photograph 12: View of green urchins attached to bedrock on Transect 3 of the RS2; October 25, 2023.

Photograph 13: View of a Squat lobster along the belt of Transect 1 at RS 2; October 25, 2023.

4. SUMMARY

A marine biophysical completed by biologists using SCUBA was performed on October 24 and 25, 2023. RS 1 is comprised of a cobble dominant substrate with sand, which extends past the intertidal zone down to the upper subtidal zone, transitioning to sand in the middle subtidal zone. In general, the lower intertidal and upper subtidal zone contained a low diversity and abundance of benthic invertebrates and algae, with the exception of a narrow band of diatoms, which was abundant along the lower intertidal and upper subtidal zone of Transect 3. Speckled sanddabs were commonly observed in the subtidal zones with sand substrates, with benthic infaunal invertebrate holes sparse and located only within the sand blanket.

RS 2 was composed of hard substrates consisting of bedrock, boulders, and gravel covered with a 1 to 2 mm thick layer of silt; no macro algae were present during the dive survey. Green urchins and Coonstripe shrimp were present in abundant concentrations within Transect 1 and Transect 3. Other observed species were mottled stars, squat lobster and smooth pink scallops with rare to sparse abundances.

A small kelp bed consisting of sugar wrack kelp was observed on Transect 2 of the RS 1; no species at risk were observed within the surveyed areas.

It is possible that the abundance of macroalgae observed at the reference sites could be reduced due to the survey being conducted outside of the growing season. Pilot surveys are planned to be conducted annually within the summer months, when a higher abundance of macroalgae is anticipated.

5. REFERENCES

DFO, Fisheries and Oceans Canada. 2004. Marine Foreshore Environmental Assessment Procedures. Working Draft. Fisheries and Oceans Canada. Nanaimo, BC.

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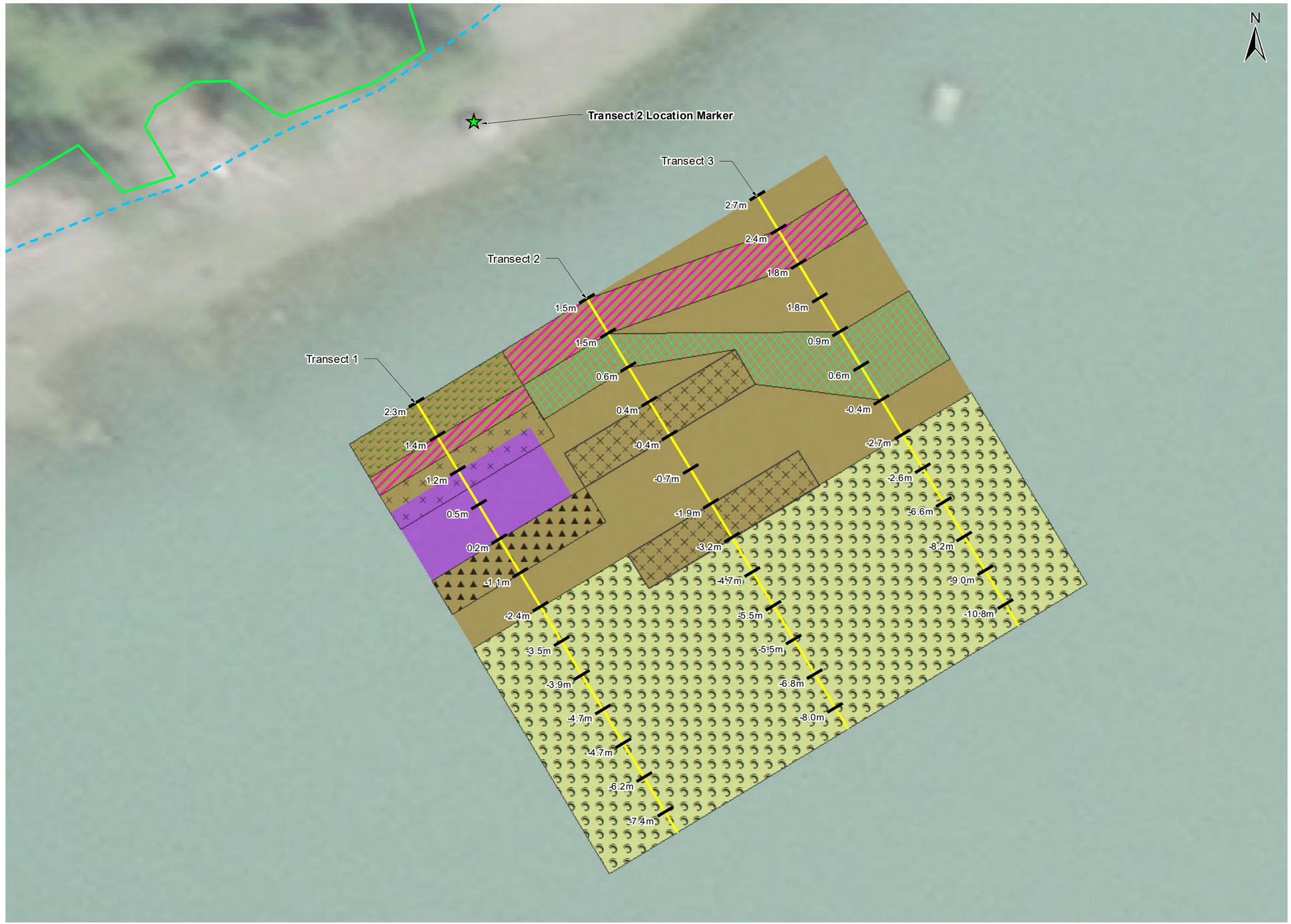
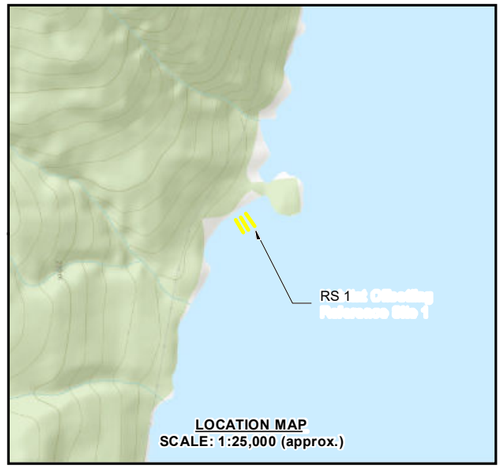
Hemmera, an Ausenco Company (Hemmera). 2019b. Woodfibre LNG Worker Accommodation, Application to Amend Environmental Assessment Approvals. Prepared for Woodfibre LNG Limited. Project No. 989232-05. October 2019.

APPENDIX 1

FIGURES





LEGEND

- TRANSECT_LM
- TRANSECT 5m MARKER
- HIGH WATER MARK
- Treeline

Substrate

- COBBLE BLANKET WITH SAND/COBBLE
- GRAVEL DOMINANT WITH SAND/COBBLE
- SAND BLANKET

Biophysical

- BENTHIC INVERTEBRATES (SPARSE)
- ROCKWEED (SPARSE)
- DIATOMS (ABUNDANT)
- SEA LETTUCE (SPARSE)
- SUGARWRACK (RARE)
- SUGARWRACK (SPARSE)
- ULVA INTESTINALIS (SPARSE)

Keystone Environmental

NOTES:
1. THIS DRAWING IS FOR GENERAL INFORMATION ONLY. LOT BOUNDARIES AND FEATURES ARE APPROXIMATE.
2. DATE OF AERIAL PHOTO IS 2020.

5 0 25 m

SCALE: 1:500 (approx.)

Woodfibre
Squamish, BC
Woodfibre LNG Limited

REVISION No.	DATE	PROJECT No.
00	Dec. 2023	17953-109

Figure 1

Biophysical Conditions at Reference Site 1

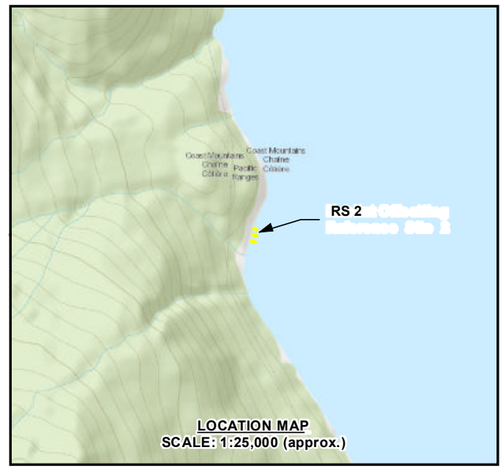
DRAWN BY: CS Document Path: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17953\00109\2023_12Dec_18_Offset_Monitoring\Fig4-2-HabitatOffsetting_RefSite1-R0.mxd

N

Transect 3
-0.9m
-4.3m
-9.0m

Transect 2
-1.0m
-4.0m
-6.3m
-11.1m

Transect 1
-2.3m
-2.5m
-5.7m
-8.6m
-11.3m



LEGEND

- TRANSECT
- BEDROCK
- BOULDER
- BOULDER DOMINANT WITH COBBLE
- GREEN URCHIN (ABUNDANT)
- HIGH WATER MARK

Keystone Environmental

NOTES:
1. THIS DRAWING IS FOR GENERAL INFORMATION ONLY. LOT BOUNDARIES AND FEATURES ARE APPROXIMATE.
2. DATE OF AERIAL PHOTO IS 2020.

5 0 25 m
SCALE: 1:500 (approx.)

Woodfibre
Squamish, BC
Woodfibre LNG Limited

REVISION No.	DATE	PROJECT No.
A	Dec. 2023	17953-109

Figure 2
Biophysical Conditions at Reference Site 2

DRAWN BY: CS Document Path: I:\0-GIS\1-Projects\1-WLNG\GIS_CADD\17953\00109\2023_12Dec_18_Offset_Monitoring\Fig4-3-HabitatOffsetting_RefSite2-R0.mxd

APPENDIX 2

TRANSECT/ QUADRAT DATA

Date		2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24
Dive		T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1
Location		Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1
Tape Distance (m)		**63**	**58**	**53**	**48**	**43**	**40**	**35**	**30**	**25**	**20**	**15**	**10**	**5**	**0**
Time		**11:38**	**11:37**	**11:46**	**11:46**	**11:51**	**11:51**	**11:56**	**11:56**	**12:00**	**12:00**	**12:05**	**12:05**	**12:09**	**12:11**
Depth (m)		**10.3**	**9.1**	**7.8**	**7.8**	**7.0**	**6.6**	**5.5**	**4.2**	**3.1**	**2.8**	**2.1**	**1.9**	**1.0**	**1.0**
CD m		**-7.4**	**-6.2**	**-4.7**	**-4.7**	**-3.9**	**-3.5**	**-2.4**	**-1.1**	**0.2**	**0.5**	**1.2**	**1.4**	**2.3**	**2.3**
	Scientific Name														
Vegetation															
diatoms											20%				
Rockweed	*Fucus distichus*											10%	10%		
sugar wrack kelp	*Saccharina latissima*											5%			
Ulva intest	*Ulva intestinalis*													10%	
sea lettuce	*Ulva lactuca*								15%	10%					
Sessile Invertebrates															
giant plumose anemone	*Metridium farcimen*				1										
blue mussels	*Mytilus trossulus*														
acorn barnacles	*Balanus glandula c.f.*											10%			
benthic invertebrate holes		10	4			1	2								
limpet															
Calcarus tubeworm casting															
Mobile Invertebrates															
hermit crab						1			1						
green urchin	*Strongylocentrotus droebachiensis*														
red rock crab	*Cancer productus*														
mottled star	*Pachycerianthus fimbriatus*								1	1					
dungeness crab	*Metacarcinus magister*														
Smooth Pink Scallop	*Chlamys rubida*														
Coon stripe Shrimp	*Pandalus danae*														
Fish															
Speckled sanddab	*Citharichthys stigmaeus*		1			1	2								
English Sole	*Parophrys vetulus*														
Bay goby	*Lepidogobius lepidus*														
Substrate															
Boulder	Boulder														
Cobble	Cobble									80%	50%	20%	20%	50%	90%
Gravel										10%	15%	60%	60%	40%	10%
Sand		100%	100%	100%	100%	100%	100%	100%	100%	10%	35%	20%	20%	10%	
Bedrock															
Substrate total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
shell hash									1%		1%	10%			40%
Notes			multiple sandabs swimming in close proximity to quadrat					Dungeness Crabs (outside of quadrats)	mottled sea stars outside of quadrat			Juvenile Red Rock Crabs (outside of quadrats)			

Date		2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24
Dive		T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2
Location		Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1
Tape Distance (m)		**63**	**58**	**53**	**48**	**43**	**35**	**30**	**25**	**20**	**15**	**10**	**5**	**0**
Time		**10:28**	**10:28**	**10:33**	**10:33**	**10:37**	**10:42**	**10:42**	**10:46**	**10:46**	**10:48**	**10:48**	**10:54**	**10:54**
Depth (m)		**10.3**	**9.1**	**7.8**	**7.8**	**7.0**	**5.5**	**4.2**	**3.1**	**2.8**	**2.1**	**1.9**	**1.0**	**1.0**
CD m		**-8.0**	**-6.8**	**-5.5**	**-5.5**	**-4.7**	**-3.2**	**-1.9**	**-0.7**	**-0.4**	**0.4**	**0.6**	**1.5**	**1.5**
	Scientific Name													
Vegetation														
diatoms												100%	60%	
Rockweed	*Fucus distichus*												15%	15%
sugar wrack kelp	*Saccharina latissima*						20%			50%				
Ulva intest	*Ulva intestinalis*													
sea lettuce	*Ulva lactuca*													
Sessile Invertebrates														
giant plumose anemone	*Metridium farcimen*													
blue mussels	*Mytilus trossulus*													
acorn barnacles	*Balanus glandula c.f.*								20%		15%	10%	25%	
benthic invertebrate holes				1	6	1								
limpet														
Calcarus tubeworm casting														
Mobile Invertebrates														
hermit crab			2					2						
green urchin	*Strongylocentrotus droebachiensis*													
red rock crab	*Cancer productus*													
mottled star	*Pachycerianthus fimbriatus*		1											
dungeness crab	*Metacarcinus magister*													
Smooth Pink Scallop	*Chlamys rubida*													
Coon stripe Shrimp	*Pandalus danae*													
Fish														
Speckled sanddab	*Citharichthys stigmaeus*		1			5		2						
English Sole	*Parophrys vetulus*													
Bay goby	*Lepidogobius lepidus*													
Substrate														
Boulder	Boulder													
Cobble	Cobble						20%		55%	80%	30%	90%	75%	80%
Gravel									45%	5%	10%		15%	10%
Sand		100%	100%	100%	100%	100%	80%	100%	10%	15%	60%	10%	10%	10%
Bedrock														
Substrate total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**110%**	**100%**	**100%**	**100%**	**100%**	**100%**
shell hash									10%			15%	10%	15%
Notes									Dungeness Crab					

Date		2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-24	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25	2023-10-25
Dive		T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T1	T1	T1	T1	T1	T2	T2	T2	T2	T3	T3	T3
Location		Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 1	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2	Habitat Offsetting reference site 2
Tape Distance (m)		**60**	**55**	**50**	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**10**	**5**	**0**	**20**	**15**	**10**	**5**	**0**	**17**	**10**	**5**	**0**	**12**	**6**	**0**
Time		**13:20**	**13:20**	**13:23**	**13:23**	**13:26**	**13:26**	**13:32**	**13:32**	**13:36**	**13:36**	**13:40**	**13:40**	**13:46**	**9:51**	**9:51**	**9:57**	**9:57**	**9:58**	**10:11**	**10:13**	**10:18**	**10:21**	**11:13**	**11:15**	**11:22**
Depth (m)		**14.8**	**13**	**12.2**	**10.6**	**6.6**	**6.7**	**4.6**	**3.6**	**3.3**	**2.4**	**2.4**	**1.8**	**1.6**	**13**	**10.3**	**7.4**	**4.2**	**4**	**13.3**	**8.5**	**6.2**	**3.2**	**11.3**	**6.7**	**3.3**
CD m		**-10.8**	**-9.0**	**-8.2**	**-6.6**	**-2.6**	**-2.7**	**-0.4**	**0.6**	**0.9**	**1.8**	**1.8**	**2.4**	**2.7**	**-11.3**	**-8.6**	**-5.7**	**-2.5**	**-2.3**	**-11.1**	**-6.3**	**-4.0**	**-1.0**	**-8.94**	**-4.34**	**-0.94**
	Scientific Name																									
Vegetation																										
diatoms								100%	85%	90%																
Rockweed	*Fucus distichus*											40%	5%													
sugar wrack kelp	*Saccharina latissima*																									
Ulva intest	*Ulva intestinalis*										5%															
sea lettuce	*Ulva lactuca*																									
Sessile Invertebrates																										
giant plumose anemone	*Metridium farcimen*																									
blue mussels	*Mytilus trossulus*											15%		5%												
acorn barnacles	*Balanus glandula c.f.*								50%		5%		5%	5%												
benthic invertebrate holes			1	1	1																					
limpet																										
Calcarus tubeworm casting																									1	2
Mobile Invertebrates																										
hermit crab																										
green urchin	*Strongylocentrotus droebachiensis*																49								68	11
red rock crab	*Cancer productus*																									
mottled star	*Pachycerianthus fimbriatus*							2		10							1									
dungeness crab	*Metacarcinus magister*																									
Smooth Pink Scallop	*Chlamys rubida*																							4		
Coon stripe Shrimp	*Pandalus danae*																			10	1				1	
Fish																										
Speckled sanddab	*Citharichthys stigmaeus*	1			2	1																				
English Sole	*Parophrys vetulus*																									
Bay goby	*Lepidogobius lepidus*																									
Substrate																										
Boulder	Boulder															10%	100%	100%				80%				
Cobble	Cobble						10%	90%	90%	90%	100%	85%	95%	100%								20%				
Gravel										10%		15%														
Sand		100%	100%	100%	100%	100%	90%	10%	10%				5%													
Bedrock															100%	100%	90%			100%	100%		100%	100%	100%	100%
Substrate total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
shell hash									40%	20%	5%	45%	5%	5%												
Notes						Limpets (outside of quadrats)	Bay Gobies (outside of quadrats)	Mottle Stars (outside of quadrats)							1-2mm thick layer of silt	1-2mm thick layer of silt	1-2mm thick layer of silt			1-2mm thick layer of silt	1-2mm thick layer of silt			1-2mm thick layer of silt	Crevice in rocks large enough for rock fish	Crevice in rocks large enough for rock fish

APPENDIX D

STATISTICAL APPROACH FOR OFFSETTING KEY PERFORMANCE INDICES

STATISTICAL APPROACH – ASSESSMENT OF OFFSETTING CRITERIA USING LEFT-TAILED T-TEST

1. INTRODUCTION

The offsetting criteria outlined in the FAA (and summarised as offsetting key performance indicators [OKPIs] in this Detailed Habitat Offsetting Effectiveness Monitoring Plan [OEMP]) involves comparison of mean abundance of several metrics (e.g., abundance of macroalgae, abundance of epifaunal or infaunal invertebrates, etc.) between the constructed offsetting areas and reference sites. This comparison of abundance will be assessed using a left tailed t-test. In the sections following, the general approach is described for OKPI2: *Abundance and Diversity of Macroalgae in Cobble Blanket Areas* as an example. This general approach can be applied to all OKPIs for which a comparison of averages is required according to the FAA. Note that p-values may be adjusted to control for experimental wise error that results from conducting the tests.

2. INPUT DATA

The input data for OKPI2 will be collected from SCUBA surveys as described in Section 4.1.2.2 (f) of the OEMP.

- Macroalgae abundance is represented as percent aerial coverage of marine macroalgae on rock surfaces. Percent aerial coverage of marine macroalgae (X) will be determined within each quadrat along each transect assessed within the offsetting areas and reference sites.
- The mean macroalgae abundance (X_2) will be calculated for the cobble blanket offsetting area(s):

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

where:

- All quadrat measurements within the cobble blanket offsetting area(s) (X_i) from the first quadrat (X_1) to the last (X_n) are summed and divided by the number of measurements made (n).
  - The calculation of X_2 considers measurements collected in *year 7 following construction of the offsetting area(s)*.
- The mean macroalgae abundance at reference sites (X_1) will be calculated in the same manner, with the following exception:
  - Percent aerial coverage within the offsetting area at year 7 will be compared to the natural range at the reference site(s). Therefore, calculation of X_1 considers all measurements collected at reference sites from **initial pilot data collection up until year 7 following construction of the offsetting areas.**

To perform a t-test, the difference in the two group means (i.e., the offsetting area and reference site means, X_1 and X_2) must be scaled by the within-group variation. The appropriate measure of variation is the standard error of the mean (SE). With two sample groups, a "pooled" standard error of the means is calculated as:

$$SS_1 = \sum_{i=1}^{n_1} \left(X_i - \overline{X_1}\right)^2 \qquad SS_2 = \sum_{i=1}^{n_2} \left(X_i - \overline{X_2}\right)^2$$

$$S_p^2 = \frac{SS_1 + SS_2}{(n_1 - 1) + (n_2 - 1)}$$

$$SE = \sqrt{\frac{S_p^2}{n_1} + \frac{S_p^2}{n_2}}$$

Where:

- SS_1= sum of squares at X_1
- SS_2= sum of squares for X_2
- n_1=number of measurements (i.e., number of quadrats measured) for X_1
- n_2=number of measurements (i.e., number of quadrats measured) for X_2
- S^2_p= the "pooled variance"
- SE=the "pooled" standard error of the two means

3. ANALYSIS

3.1 Hypothesis

The null hypothesis (H_o) for OKPI2 is that the mean abundance of macroalgae on cobble blanket offsetting areas compared to reference sites is equal to 95% of the mean abundance at reference sites by year 7.

$$H_o : \mu_1 * 0.95 = \mu_2 ,$$

Where:

- μ_1 =mean macroalgae abundance at reference sites
- μ_2= mean macroalgae at cobble blanket offsetting areas

The alternative hypothesis (H_1) for OKPI 2 is that the mean abundance of macroalgae on cobble blanket offsetting areas compared to reference sites is *at least* 95% of the mean abundance at reference sites by year 7.

$$H_1 = \mu_1 * 0.95 < \mu_2$$

3.2 Significance Level (α)

Alpha (α) is defined as the probability of falsely identifying a difference in abundance while no difference has occurred in reality. In other words, it is the uncertainty that is accepted when rejecting the null hypothesis. For example, if this value is 0.05, there is a 5% probability of falsely identifying a difference in abundance while in reality no difference has occurred.

An *a-prior* power analysis should be performed to confirm what the reasonable significance level is for the statistical analysis, which will be based on the number of samples/variability of data collected at the time of analysis.

Test Statistic

The test statistic (ts) will be used to determine the outcome of the hypothesis, which is calculated by the following formula:

$$ts = (\mu_2 - \mu_1 * 0.95) / SE$$

where:

- SE= the "pooled" standard error of the two means (see Section 2)
- n=sample size (i.e., number of quadrats assessed within offsetting area)

3.3 P-value

The P-value of the test statistic will determine the outcome of the hypothesis. If the P-value is **smaller than** the **significance level (α**), the null hypothesis (H_o) will be rejected.

To complete a left-tailed t-test, we must find the P-value of a t-value *smaller* than the calculated test statistic (ts).

The t-value varies with sample size. The degrees of freedom (df) is used to take into account this variation, and is calculated by the following formula:

$$df = (n_1 - 1) + (n_2 - 1)$$

A programming language (e.g. R) will be used to find the P-Value for a t-value **less than** the **calculated ts,** at the **calculated degrees of freedom (df).**

3.4 Conclusion

If the P-value is smaller than the significance level (α) then the null hypothesis (H_o) will be rejected, and the conclusion may be summarized as:

The sample data **supports** the claim that "The mean abundance of macroalgae on cobble blanket offsetting areas compared to reference sites is *at least* 95% of the mean abundance at reference sites by year 7 at a [e.g. 5% or 10%] significance level**.**

If the *P*-value is greater than the significance level (α) then the null hypothesis (H_o) will be accepted and the conclusion may be summarized as:

The data **does not support** the claim that "The mean abundance of macroalgae on cobble blanket offsetting areas compared to reference sites is *at least* 95% of the mean abundance at reference sites by year 7 at a [e.g**.** 5% or 10%] significance level**.**