Appendix G.10
Habitat Offsetting Plan

Pacific NorthWest LNG - Addendum to the Environmental Impact Statement Preliminary Habitat Offsetting Plan

Draft

Prepared for:
Canadian Environmental Assessment Agency
Pacific and Yukon Regional Office
410-701 Georgia Street West
Vancouver, BC V7Y 1C6

Prepared by:
Pacific NorthWest LNG Limited Partnership
Oceanic Plaza, Suite 1900 – 1066 West Hastings Street
Vancouver, BC V6E 3X1

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Executive Summary

Pacific NorthWest LNG Limited Partnership (PNW LNG) is proposing to construct and operate a liquefied natural gas (LNG) facility within the District of Port Edward, British Columbic (BC). The Pacific NorthWest LNG Project (the Project) is located on federal land and in water subject to federal jurisdiction. The following fish habitat offsetting plan is prepared based on the updated Project design described in the Environmental Impact Statement (EIS) Addendum.

PNW LNG has asked for, and received, guidance from Fisheries and Oceans Canada (DFO) to clarify the recent changes and policy updates under the 2012 *Fisheries Act*. DFO has clarified that a project related *Fisheries Act* authorization and offsetting will be required for permanent serious harm to fish habitat used for dependent life processes by fish that are part of commercial, recreational and Aboriginal (CRA) fisheries and forage fish that support these fisheries. Based on the siting of the marine infrastructure and recent discussions with DFO, the predicted area of the project related habitat impacts (permanent alteration or destruction) being considered as serious harm to marine fish habitat and requiring habitat offsetting is approximately 23,026 m^2 and includes:

- Approximately 1,830 m^2 of intertidal eelgrass areas used as nursery and foraging habitats by juvenile salmonids, herring, surf smelt, sandlance and crab within the dredge area planned for the materials offloading facility (MOF)
- Approximately 6,800 m^2 of intertidal and subtidal hard bottom substrate with brown algae, used as nursery and foraging habitat by juvenile salmonids, herring, surf smelt, sandlance and crab within the dredge area planned for the MOF
- Approximately 2,384 m^2 of open water / soft substrate area used as benthic habitat by Dungeness crab and local flatfish species around the southwest tower platform (infrastructure and scour armouring) for the marine terminal suspension bridge
- Approximately 5,730 m^2 of open water / soft substrate area used as benthic habitat by Dungeness crab and local flatfish species around the southwest anchor block platform (infrastructure and scour armouring) for the marine terminal suspension bridge
- Approximately 6,282 m^2 of open water / soft substrate areas used as benthic habitat by Dungeness crab, coonstripe shrimp and local flatfish species around individual and grouped piles (pile infrastructure and scour armouring) for the marine terminal jetty and berth.

The habitat offset measures are identified to counterbalance the loss of specific marine habitat types with enhancement of existing habitats, and to avoid and limit potential destruction of existing fish habitats during planning and construction of these offset habitats. Offset habitats will be carefully sited and fully designed with input from DFO and First Nations to maintain local fisheries productivity. The final offset detailed designs will be presented in a Request for Authorization under Section 35(2) of the *Fisheries Act* and will incorporate rationale for serious harm and preferred offset plans refined for location, size, design feasibility, effectiveness and follow-up monitoring. The Project preference will be to construct offset habitats in advance or parallel to project construction works, if feasible, to limit lag time between loss and development of productive habitats.

The currently habitat offsets include approximately 24,080 m^2 of constructed eelgrass and algae habitats comprising five sites constructed as benched raised beds and sloping intertidal reefs, both planted using donor stock (eelgrass and algae) including stock salvaged from the MOF intertidal dredge area if possible. Habitat offsets are conceptually sited at existing rocky intertidal bays on Lelu Island south and west of the MOF. Planned eelgrass/algae beds will be planted on constructed benched and sloping shoreline areas using appropriate sediment types and texture as a growth medium for eelgrass and algae.

As discussed with DFO, the potential offset habitat sites selected on Lelu Island presently comprise widely distributed rocky subtidal and intertidal shorelines with some areas of soft sand substrate. These habitats have been previously surveyed for baseline conditions, and will be revisited in early 2015 to develop detailed habitat construction designs. Present baseline survey results indicate the sites selected for offsetting have little or no complex habitats and have limited or no habitat use by crab, salmon or forage fish species. One of the five sites selected has abandoned vessels and debris in the intertidal area. This debris will be removed and the area restored to its natural function. The five conceptual sites selected will be refined through further field investigations to maximize success of the constructed offset habitats and maintain habitat productivity. No life process dependent habitats have been observed in these potential offset sites.

Abbreviations

BC ..... British Columbia

CCME ..... Canadian Council of Ministers of the Environment

CD ..... chart datum

COSEWIC ..... Committee on the Status of Endangered Wildlife in Canada

CRA ..... commercial, recreational, and Aboriginal

DFO ..... Fisheries and Oceans Canada

EIS ..... Environmental Impact Statement

HHWM ..... highest high-water mark

LNG ..... liquefied natural gas

MOF ..... materials off loading facility

NCD ..... non-classified drainage

PDA ..... project development area

PNW LNG ..... Pacific NorthWest LNG Limited Partnership

ppt ..... parts per thousand

PRPA ..... Prince Rupert Port Authority

ROV ..... remotely operated vehicle

SARA ..... *Species at Risk Act*

the Project ..... Pacific NorthWest LNG Project

1.0 INTRODUCTION

This Preliminary Habitat Offsetting Plan has been prepared for the Pacific NorthWest LNG Limited Partnership (PNW LNG) as part of the construction and operations of a liquefied natural gas (LNG) facility within the District of Port Edward, British Columbia (BC). This plan is consistent with PNW LNG's Environmental Impact Statement (EIS) Addendum and is based on review and input through meetings and discussions with Fisheries and Oceans Canada (DFO), First Nations, and the public.

The Pacific NorthWest LNG Project (the Project) is located in northwestern BC, on Lelu Island, which is federal Crown land and waters within the jurisdiction of the Prince Rupert Port Authority (PRPA) (Figure 1). The construction and operations of the PNW LNG facility at Lelu Island will require both marine and land-based construction that are predicted to result in serious harm to marine fish and fish habitats that presently support dependent life processes for juvenile salmonids and herring, juvenile and adult crab, and various forage fish species. Habitat offsets will counterbalance serious harm to fish and fish habitats to maintain productivity of local commercial, recreational and Aboriginal (CRA) fisheries as protected under the federal *Fisheries Act*.

The Project habitat offsets are planned for marine fish and fish habitat impacts resulting in serious harm from construction and operations of the marine terminal and facilities. Project construction will result in residual effects, or impacts, which will cause serious harm to fish habitats that cannot be avoided by feasible mitigation measures (Section 13 of the EIS Addendum). Serious harm to marine fish and fish habitats is defined as permanent alteration to, or destruction of habitats, which will limit or diminish the ability of juvenile salmonids, herring, crab, and forage fish to use these habitats for life history dependent processes. These fish habitats will include important nursery, foraging, staging habitat areas.

Land based construction and operations of the LNG production facility and associated utilities, storage tanks, and non-manufacturing facilities is not expected to cause serious harm to freshwater streams on Lelu Island. The Lelu Island watercourses are considered ephemeral, sourced from bogs (acidic) on the Island, and not permanently connected to marine waters. The freshwater channels identified on Lelu Island have been assessed to not support any permanent resident or anadromous fish populations based on physical characteristics of these streams (Section 10.0 and 12.0 of the EIS (Stantec 2014a)).

2.0 REGULATORY CONTEXT

This Preliminary Habitat Offsetting Plan has been prepared based on the updated 2012 *Fisheries Act* and is consistent with the federal *Fisheries Protection Policy Statement* (DFO 2013a) and the *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013b). The 2012 *Fisheries Act* provides protection for fish and fish habitats that support a CRA fishery, or fish (forage fish) that support such a fishery, from serious harm.

The *Fisheries Act* defines **fish** as:

- parts of a fish,
- shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and
- the eggs, sperm, spawn larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals

The *Fisheries Protection Policy Statement* (DFO 2013a) defines serious harm to fish as:

- the **death of fish**
- a **permanent alteration** to fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes;
- the **destruction of fish habitat** of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

The *Fisheries Protection Policy Statement* (DFO 2013a) and *Fisheries Productivity Investment Policy* (DFO 2013b) outline DFO's policy for maintaining productivity and sustainability of CRA fisheries or fish and fish habitats that support such fisheries through habitat enhancement. Under this policy, DFO works with proponents and government agencies to design projects to maintain fish habitat while recognizing the potential or existing land use value. Under this policy, DFO states that in cases where residual losses of fish habitat cannot be avoided through mitigation measures, habitat replacement or enhancement, on a case by case basis, may be accepted as offsetting measures. Offsetting through habitat enhancement is planned for the PNW LNG Project to counterbalance the unavoidable serious harm to marine fish habitats resulting from Project construction.

3.0 PROJECT DESCRIPTION

PNW LNG proposes to construct and operate the Project on Lelu Island (Figure 2). The facility will convert natural gas to LNG for export to international markets. The land-based portion of the Project (the LNG facility) is sited entirely on undeveloped land on Lelu Island within the Prince Rupert Port Authority. Lelu Island is federal Crown land, located 15 km southwest of the City of Prince Rupert, BC (Figure 1). Lelu Island is low elevation and covered with lowlands and bog wetlands (Section 10.0 and 12.0 of the EIS (Stantec 2014a)) within very wet coastal conditions (Pojar et al. 1991). Lelu Island is separated from the mainland area of Port Edward by a shallow foreshore and intertidal slough area. The slough comprises of soft sediments that have accumulated from Skeena River discharge and a small channel that is wetted during higher tide events. Lelu Island and the surrounding marine area are subject to large tidal fluctuations (7.4 m range) (Hatch 2014).

The Project components within the marine environment include a pioneer dock, materials offloading facility (MOF), an access bridge from Lelu Island to the mainland, and a marine terminal.

The marine terminal includes a 2.7 km jetty that consists of a 1.6 km clear-span suspension bridge over Flora Bank from Lelu Island to Agnew Bank, and a 1.1 km conventional pipe pile trestle from the suspension bridge to the LNG carrier berth which form the final section of the marine terminal. The east bridge abutment will be on Lelu Island. The west bridge abutment will be just north of Flora Bank (on Agnew Bank). Contact with Flora Bank will be limited to installation of scour protection in one location on the margin of the Bank, which is still a minimum distance of approximately 250 m away from existing eelgrass (Hatch 2014).

Key elements of the marine terminal include:

- No project infrastructure (i.e., piles) will be constructed on Flora Bank (scour armouring for one bridge tower will impinge on the margin of Flora Bank)
- Construction activities directly contacting Flora Bank will be limited to installation of scour protection in one location on the margin of the Bank
- A minimum clearance height of 11.3 m above highest high water mark (HHWM) to allow local vessels (e.g., gill netters) to transit Flora Bank via the use of the passage west of Lelu Island
- No dredging will be conducted at the LNG carrier berth.

The original project marine infrastructure is described in Section 2 of the EIS and the updated project changes are outlined in Section 2 of the EIS Addendum.

Appendix G.20 of the EIS Addendum provides a description of examples of the methods that may be used for construction of the marine infrastructure. The design completed to date is considered preliminary. Although the marine infrastructure design has been advanced to a sufficient level for planning and permitting, considerable engineering effort is still required to complete the design and finalize the design details to a stage that is appropriate for construction.

The final engineering design is subject to change pending the results of further geotechnical studies and other site investigations. The design of the marine foundations especially, is highly dependent on the results obtained from any further geotechnical and geophysical work. As detailed design is completed; various design and construction details may change from the current designs that are described in Appendix G.20.

4.0 EXSITING PROJECT AREA FISH HABITAT AND USE

The following sections will describe fish habitat use in both the freshwater and marine environments at the local scale as assessed through both technical/academic studies and Project related surveys within the PDA and surrounding waters.

4.1 FRESHWATER STREAMS

Surveys identified seventeen ephemeral freshwater watercourses on Lelu Island with potential overlap with the Project area. Fifteen of the seventeen stream channels were considered marginal watercourses due to the lack of a defined channel and were therefore categorized as non-classified drainages (NCD) (BC MOF 1998). Two unnamed watercourses (WC 8/9 and WC 11, Section 10.0 and 12.0 of the EIS (Stantec 2014a)) were surveyed and rated as marginal and unlikely to support resident or anadromous fish populations due to their low water quality, high acidic conditions, lack of connection to the marine environment, and intermittent water flow within the channel.

Based on these observations, no serious harm was determined for freshwater fish habitats on Lelu Island and no offset measures are proposed for freshwater streams. Construction and operations mitigation measures will be implemented to avoid and limit potential effects on flows or runoff from Lelu Island into the marine environment.

4.2 MARINE HABITATS AND FISH HABITAT USE

Marine areas were surveyed and mapped around Lelu Island and comprise the following intertidal and subtidal habitats (Figure 3, Figure 4, Figure 5 and Figure 7, and Appendices L and M of the EIS (Stantec 2014a)):

- Rocky exposed intertidal shorelines
- Subtidal boulder and bedrock
- Intertidal soft silt – clay sediments in sheltered bays, sloughs, channels and on less exposed subtidal areas of Flora and Agnew Banks
- Subtidal soft silt – clay sediment areas, high turbidity and tidal currents on interface areas of Flora, Agnew and Horsey Banks
- Intertidal soft silt – sand sediment on exposed areas of Flora Bank.

Marine areas around the project site at the interface of Flora and Agnew Banks are exposed and physically turbulent (tidal currents, storm events, wave action, and high turbidity) (Faggetter 2009, 2013). These areas are influenced by large tidal fluctuations ranging up to 7.4 m between low and high tide cycles, ebb and flood currents often greater than 1 m /second (Hatch 2014), high concentrations of total suspended solids ranging from 12 mg/L (June freshest) to 4 mg/L (late summer) and low light transparency ranging from 0.25 m (Secchi depth - June freshet) to 1.0 m (Secchi depth - late summer) (Appendix L of the EIS (Stantec 2014a), Prince Rupert Port Authority 2013, 2014).

Multiple fish species found in the project development area (PDA) and their habitats are considered important contributions to local CRA fisheries and are locally supported by forage fish species (Hart 1988, Appendix M of the EIS/Application (Stantec 2014a)). Marine fish and invertebrate species observed seasonally within the PDA include: anadromous salmonids, Pacific herring, eulachon, surf smelt, sandlance, rockfish species, eelpout, prickleback, tubesnout, flatfish species, Dungeness crab and shrimp species (Appendix M of the EIS/Application (Stantec 2014a)). Pacific halibut, lingcod and Pacific cod typically occur at greater depths and have not been caught or observed during historical or recent surveys that have been conducted within the PDA.

Observations of marine habitat types and marine fish distribution are similar among recent project studies conducted in 2013 and 2014, and previous technical/academic studies (Higgins and Schouwenburg 1973, Anderson 1986, Community Fisheries Development Center 2001, Gottesfeld et al. 2008, Faggetter 2009 and 2013, Carr-Harris and Moore 2013, Dunham, DFO Science Branch, personal communication, 2014) conducted around Lelu Island and in Chatham Sound (Figure 4).

Specific marine fish and fish habitat field work in the PDA has been conducted in 2013 (Appendix M of the EIS (Stantec 2014a) and 2014 (October, November and December 2014 Prince Rupert Gas Transmission fisheries surveys) (Figure 4). Additional technical and academic studies have been conducted in the project area and at sites around Chatham Sound in 1972 (Higgins and Schouwenburg 1973), 1986 (Anderson 1986), 2001 (Community Development Centre 2001), 2007 (Gottesfeld et al. 2008), 2009 (Faggetter2009), and 2013 (Carr-Harris and Moore 2013, Ocean Ecology 2013) (Figure 4). The combination of studies conducted allows for sampling coverage on both a yearly and monthly temporal scale that ranges from April to December and includes sampling for fish species presence, distribution, estimated density (relative), and biological characteristics with a variety of methodologies (Figure 4, Table 1).

Specific marine fish and crab surveys in the PDA will continue through December 2014 and into 2015 to confirm species presence and habitat use.

Table 1 Past and Recent Fish and Fish Habitat Surveys within the PDA

Study	Field Year	Methods Used	Duration (months)											
			J	F	M	A	M	J	J	A	S	O	N	D
Higgins and Schouwenburg 1973	1972	Beach seine				x	x	x	x	x				
Anderson 1986	1986	Beach seine				x	x	x	x	x				
Gottesfeld et al. 2008	2007	Mid-water trawl					x	x	x					
Community Fisheries Development Centre 2001	2001	Beach seine				x	x	x	x					
Faggetter 2009	2008	Towed underwater video					x							

Study	Field Year	Methods Used	Duration (months)											
			J	F	M	A	M	J	J	A	S	O	N	D
Faggetter 2013	2012	Towed underwater video							x	x	x			
Carr-Harris and Moore 2013	2013	Beach seine and mid-water trawl				x	x	x	x					
DFO 2014	2013, 2014	Area A and B, Crab Biological Sampling				x	x				x			
Stantec 2014	2013	Underwater video using a Remotely Operated Vehicle (ROV)					x	x						
Stantec 2014	2014	Beach seine, crab trapping, hydroacoustics, and mid-water trawl											x	x
Stantec 2014	2014/ 2015	Beach seine, crab trapping, hydroacoustics, and mid-water trawl	x											x
Stantec 2014	2013	Underwater video using a Remotely Operated Vehicle (ROV)									x	x		

Observations of fish and invertebrate habitat use demonstrate the presence of small benthic fish species (e.g., sculpins, eelpout, tubesnout, flatfish) and low numbers of juvenile crab and shrimp in soft silt-clay sediment habitats on the northwestern perimeter of Flora Bank and into deeper subtidal areas of Agnew Bank, north of Kitson Island. No patches or areas of eelgrass, algae or bull kelp were observed in these areas (Appendix M of the EIS (Stantec 2014a), Faggetter 2009, 2013). Recent and past surveys along this northwestern edge of Flora and Agnew Banks note that this area is highly turbid, has high concentrations of TSS, shows considerable variation in tidal current velocities, and supports mobile silty-clay soft sediments (Appendix M of the EIS (Stantec 2014a), Faggetter 2009, 2013).

Crabs have been commonly observed immediately north of Flora Bank and east of Agnew Bank, in areas of soft sand sediments (DFO 2014a). Through specific marine fish and fish habitat field work in the PDA, shrimp were observed in areas of soft silt-clay sediment on Agnew Bank west of Flora Bank and at depths greater than 5 meters, but well outside the turbulent interface area beyond the outer edge of Flora Bank.

Soft shelled (moulting) Dungeness crabs were not observed in soft silt-clay sediment areas in shallow subtidal areas adjacent to Flora Bank or in shallow depths on Agnew Bank (Appendix M of the EIS/Application (Stantec 2014a), Dunham, DFO Science Branch, personal communication, 2014, DFO 2014a). Male crabs are expected to moult at depths greater than 10 m (high tide) and in sheltered areas of low turbulence on soft sediment substrate characteristic of Agnew and Horsey Banks (Dunham, DFO Science Branch, personal communication). Moulting areas have been observed outside of the very soft silt-clay sediment areas and within the more stable sandy sediment on Agnew Bank consistent with biological crab survey results and commercial fishery soft shell trapping

reference sites in DFO Crab Area A and Area B (DFO 2014a, b). Crab moulting areas will be further confirmed against 2015 DFO Dungeness Crab Coastal Fisheries License Area B (North Coast) biological survey results (Dunham, DFO Science Branch, personal communication, 2014) and with project related seasonal marine fish and crab surveys in the PDA initiated in October, November and December 2014 and continuing in 2015.

In previous studies, peaks of juvenile salmonids have been observed for 2 – 3 week periods during spring smolt migration (May – June) at sites on Flora, Agnew and Horsey Banks and in tidal channels immediately adjacent to Lelu Island and outer Kitson Island (Higgins and Schouwenburg 1973, Anderson 1986, Community Fisheries Development Center 2001, Gottesfeld et al. 2008, Carr-Harris and Moore 2013). Salmonids were observed in largest numbers in complex nearshore habitats of Chatham Sound islands, particularly in habitats with complex vegetated habitats and tidal current channels (Higgins and Schouwenburg 1973, Anderson 1986, Community Fisheries Development Center 2001, Carr-Harris and Moore 2013, Appendix M of the EIS/Application (Stantec 2014a)). Eelgrass beds and algae habitats have a role in supporting coastal ecosystems and providing physical stability, sediment stabilization and shelter for many coastal species of CRA importance (Ward et al., 1984, Fonseca et al. 1998, Lucas et al., 2007, Faggetter 2009, 2013).

Plankton feeding sockeye (*Oncorhynchus nerka*) and pink (*O. gorbuscha*) salmon were observed in higher densities outside Kitson Island and on the southern edge of Flora Bank in areas of tidal currents consistent with their documented use of offshore areas within the water column for plankton feeding (Manzer 1969, Gottesfeld et al. 2008, Faggetter 2013) and energetic swimming benefits (Welch et al. 2009). Sockeye and pink salmon were noted to have limited abundance in the local assessment area (LAA) throughout the year with the exception of periods of spring smolt migration (Higgins and Schouwenburg 1973, Anderson 1986, Gottesfeld et al. 2008, Carr-Harris and Moore 2013) consistent with observations of smolt habitat use in the Fraser River (Johannes et al. 2012). During project related surveys, salmonids were not observed in soft sediment areas of Agnew Bank along the northern edge of Flora Bank (Appendix M of the EIS/Application (Stantec 2014a)).

Chinook (*O. tshawytscha*), coho (*O. kisutch*) and chum salmon (*O. keta*) were observed at low density in catches within complex habitats found in bays and eelgrass beds in the PDA and throughout Chatham Sound (Higgins and Schouwenburg 1973, Anderson 1986, Community Fisheries Development Center 2001, Carr-Harris and Moore 2013). Juvenile coho salmon were caught in areas of higher amphipod density near eelgrass throughout the growing season (Manzer 1969, Higgins and Schouwenburg 1973, Anderson 1986, Carr-Harris and Moore 2013).

Five fish species listed under the *Species at Risk Act (SARA)* have potential to occur in the LAA/RAA including: bluntnose sixgill shark (Special Concern: *Hexanchus griseus*), green sturgeon (Special Concern: *Acipenser medirostris*), northern abalone (Endangered: *Haliotis kamtschatkana*), and two species of rockfish (Special Concern: *Sebastes aleutianus; S. ruberrimus*) (BC CDC 2014, COSEWIC 2014). Six additional species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) also have the potential to occur within the LAA/RAA including: eulachon (Special Concern: *Thaleichthys pacificus*), Northern Pacific spiny dogfish (Special Concern: *Squalus suckleyi*), and four species of rockfish (Special Concern: *S. crameri*, Threatened: *S.pinniger, S. maliger*, and Endangered: *S. paucispinis*) (BC CDC 2014, COSEWIC 2014).

General baseline surveys have been conducted at the offsetting sites which identified they were mainly composed of widely available rocky shoreline of bedrock dominated by *Fucus spp*. Benthic invertebrate density was low and no clam (infauna) beds were identified in the habitat offset locations. The habitat offsetting locations are not expected to be important areas for fish or forage fish that support a CRA fishery.

5.0 EFFECTS ON FISH AND FISH HABITATS

The project infrastructure and footprint was compared with observations of fish habitat use summarized from both independent historical surveys and more recent project related surveys detailed in Section 4.0 and in Figure 4. Predicted effects of project construction and the resultant infrastructure on existing fish habitat are presented in Table 2.

Table 2 Summary of existing conditions, fish habitats and expected effects on these habitats in areas of Project infrastructure.

Access Bridge to the Mainland
Existing Conditions and Fish Habitats: • The slough between Lelu Island and the mainland and between Lelu Island and Stapleton Island is dry during low to mid tide level events (Figure 3) with the exception of a small center channel • Ebb and flood tides create tidal currents that maintain center scour channel in slough • Slough channel width only wetted during high tide events • Intertidal silt / clay mud substrate • Low infauna / epifauna invertebrate density • No eelgrass habitat at bridge site • Potential use as juvenile fish and salmonid passage corridor with tidal currents during high tides • Limited observations of fish use • No life process dependent fish habitats identified in slough area
Expected Effects to Fish Habitats Used by CRA Fish Species: • 8 m^2 marine pile footprints
Pioneer Dock / Roll-on, Roll-off Barge Ramp
Existing Conditions and Fish Habitats: • Large intertidal mud (silt-clay) flats outside project area, wetted during high tide events (Figure 3) • Low infauna / epifauna invertebrate density • No eelgrass habitat overlapping infrastructure • Limited observations of fish use • No life process dependent fish habitats identified in pioneer dock area
Expected Effects to Fish Habitats Used by CRA Fish Species: • 8 m^2 marine pile footprint

Materials Offloading Facility
Existing Conditions and Fish Habitats: • Project area comprises soft silt-clay sediment overlain on bedrock and boulder/cobble shoreline (Figure 3) • Low infauna / epifauna invertebrate density outside eelgrass and algae habitat areas • No life process dependent fish habitats identified in soft sediment intertidal areas outside of eelgrass and hard bottom brown algae • Life process dependent habitats identified in intertidal eelgrass and hard bottom brown algae habitat areas • Expected habitat use of eelgrass and brown algae areas by juvenile fish (herring, salmonids, crab and flatfish species) as foraging and nursery habitats
Expected Effects to Fish Habitats Used by CRA Fish Species: • 51 m^2 marine pile footprint • 31,569 m^2 soft substrate area within dredge footprint (not including hard bottom brown algae and eelgrass habitats) • 6,800 m^2 hard bottom brown algae area • 1,830 m^2 soft bottom eelgrass area
Marine Terminal: Suspension Bridge, Trestle, Bridge Deck, and Carrier Berth
Existing Conditions and Fish Habitats: • Jetty and LNG carrier berth area substrate comprises subtidal soft silt-clay sediment • SW tower area substrate comprises subtidal soft silt-clay sediments in the turbulent (high currents, turbidity) outer edge beyond Flora Bank • Low infauna / epifauna invertebrate density • Area of high tidal current (>1m/sec) and mixing associated with Porpoise Channel currents and tidal current from Flora and Agnew Banks • Low density fish, limited habitat use, including shrimp, crab, eelpout, and flatfishes and species in soft sediment and resilient to tidal perturbation and high turbidity • Potential life process dependent habitats identified in the subtidal area, open areas used as foraging habitats by benthic invertebrates, including shrimp and crab, and benthic fish, including flatfish • Expected habitat use at low density by juvenile fish and crab • Areas not considered preferred habitats for crab moulting. No soft shell crab observed in spring – early summer sampling. Crab moulting habitats identified in stable, less turbulent deeper, flat soft sediment areas north of Agnew Bank • Crab not regularly observed in areas along the jetty and LNG carrier berth alignment. Areas not considered preferred habitats for crab moulting. Crab moulting habitats identified in stable, less turbulent deeper, flat soft sediment areas north of Agnew Bank • Coonstipe shrimp observed at low density in area • No eelgrass beds or subtidal vegetation
Expected Effects to Fish Habitats Used by CRA Fish Species: • 430 m^2 marine jetty and LNG carrier berth pile footprint (380 piles with a 1.22 m diameter) • 3,712 m^2 marine jetty and LNG carrier berth individual pile and scour protection footprint • 2,140 m^2 marine vessel berthing platform with grouped pile scour protection footprint 2,700 m^2 marine suspension bridge: southwest tower (720 m^2) and anchor (1980 m^2) platforms and pilings footprint • 5,414 m^2 marine suspension bridge: southwest tower (1664 m^2) and anchor (3750 m^2) platforms and pilings scour protection footprints • Approximately 50,000 m^2 of sediment deposition resulting from marine infrastructure accretion processes

Lelu Island LNG Facility
Existing Conditions and Fish Habitats: • Fifteen of the seventeen stream channels were considered marginal watercourses due to the lack of a defined channel and were therefore categorized as non-classified drainages (NCD) • Remaining two streams were rated unlikely to support resident or anadromous fish populations due to their low water quality, high acidic conditions, lack of connection to the marine environment, and intermittent water flow within the channel.
Expected Effects to Fish Habitats Used by CRA Fish Species: • 740 m^2 of freshwater channel infilling
Habitat Offsetting Sites
Existing Conditions and Fish Habitats: • Widely available rocky coastline • Bedrock interspersed with isolated soft sand/mud foreshore • Low infauna / epifauna invertebrate density • Limited observations of fish use
Expected Effects to Fish Habitats Used by CRA Fish Species: • 24,080 m^2 of intertidal area being enhanced for habitat offsetting

Observations of habitat characteristics and fish distribution along the marine terminal, MOF, pioneer dock and access bridge sites indicate there is limited expectation of large scale spatial and temporal construction effects on existing spawning, nursery, foraging and migratory habitats (Table 2).

SARA and COSEWIC listed species have the potential to occur in the LAA/RAA, some of which have the potential to use fish habitats within the PDA that are expected to be permanently altered or destroyed by project construction. The loss of these habitats is not expected to affect *SARA* and COSEWIC listed species use of similar habitats in the area or diminish their ability to use local habitats for a critical life process. Change in fish habitat for *SARA* and COSEWIC listed species are predicted to be not significant given that habitat offsetting features will be designed to maintain productivity of CRA fisheries within the LAA (Appendix M of the EIS (Stantec 2014a)).

6.0 POTENTIAL CONSTRUCTION APPROACHES TO AVOID OR LIMIT SERIOUS HARM TO FISH

The Project overlaps with marine resources and fish habitats within the PDA. Table 3 presents a summary of potential construction approaches and methods, and resulting serious harm to fish habitats including:

- Site-specific construction approaches applied to avoid and limit potential effects on observed marine fish and fish habitats and,
- Site-specific expected project related serious harm to CRA fish and forage fish resulting from permanent alteration to, or destruction of, life process dependent fish habitats from project components.

Life process dependent fish habitats are defined as local habitats which fish use and are dependent upon as spawning grounds, nursery, rearing or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

Table 3 Potential construction approaches and expected serious harm to CRA fish habitats

Access Bridge to the Mainland
Construction Approaches : • Temporary access and piling work - short construction window • Initial intertidal piles constructed in slough near centre channel, including activities during low tides • No blasting to occur in areas for the access bridge to the mainland • Low noise piling techniques (vibratory hammers) used for pile installation • Use of EMPs during construction (e.g., sediment and erosion control)
Expected Serious Harm to Fish Habitats Used by CRA Fish Species: • No life process dependent fish habitats observed • No serious harm to fish habitats in slough area
Pioneer Dock / Roll-on, Roll-off Barge Ramp
Construction Approaches: • Floating dock and barge ramp developed on pilings or shoreline for temporary off-loading of construction equipment prior to MOF construction and decommissioned after construction of the MOF and bridge is complete • Low noise piling techniques (vibratory hammers) used for pile installation • Construction is expected to occur within a short time period
Expected Residual Serious Harm to Fish Habitats Used by CRA Fish Species: • No life process dependent fish habitats observed • No serious harm to fish habitats in pioneer dock area
Materials Offloading Facility
Construction Approaches: • Subtidal perimeter of MOF construction area delineated by silt and bubble curtains (checked and maintained) • Blasting activities proposed as concise, short duration events at approximately weekly intervals within limited time period potentially during least risk fisheries work window and during low tides where possible. Exact dates to be refined to reflect local conditions, based on pre-construction field surveys and in consultation with DFO • Dredging activities are not planned to overlap with pile installation at the marine terminal which will reduce combined TSS and combined underwater noise • Use of EMPs during construction (e.g., sediment and erosion control, blasting management plan, marine pile installation plan etc.) • Low noise piling techniques (vibratory hammers) used for pile installation • Dredging conducted using methods and/or equipment that reduce sediment spill • The use of dredged rock for construction on land and potential use of some rock for habitat offsetting work considered as a construction option • Turbidity monitored in real time during in-water construction activities (i.e., blasting, dredging, and ocean disposal) and compared to predicted TSS levels (through use of a turbidity-TSS calibration curve) and WQG. • If TSS levels exceed modelled predictions outside of the active work area (defined as the immediate area surrounding operating construction equipment) or disposal site, the rate of the activity to be adjusted (e.g., slowed), or additional mitigation measures implemented (e.g., silt curtains) to minimize the spatial extent of elevated TSS • Silt curtains installed around dredging and blasting activities and are expected to be most effective in the inner, sheltered areas of the MOF

Potential CONSTRUCTION APPROACHES to avoid OR limit serious harm to fish
December 12, 2014

Expected Residual Serious Harm to Fish Habitats Used by CRA Fish Species:

- Expected serious harm through destruction by dredging of hard substrate intertidal habitat covered by brown algae (6,800 m^2) and soft sediment eelgrass habitat (1,830 m^2) (Figure 5)
- No serious harm to fish habitats within intertidal soft sediment areas or subtidal areas (no life process dependent fish habitats observed)
- Existing eelgrass and potentially brown algae will be used as donor stock for planting (if possible)

Marine Terminal: Suspension Bridge, Trestle, Bridge Deck, and Carrier Berth

Construction Approaches:

- Bridge, deck and loading lines constructed above marine waters
- Suspension bridge northeast tower located on Lelu Island outside marine waters
- Use of EMPs during construction (e.g., sediment and erosion control, marine pile installation)
- Trestle will be located on Agnew Bank in subtidal water outside Flora Bank
- Suspension bridge southwest tower platform and southwest anchor block platform are located on Agnew Bank in subtidal waters outside Flora Bank
- LNG carrier berth located outside Agnew Bank in at least 15 m of water
- No blasting is required for the LNG carrier berth
- Dungeness crab, if present, will be relocated from construction zones using proper handling
- Low noise piling techniques (vibratory hammers) used for pile installation
- Pile scour protection installed around individual piles during construction
- All superstructure for jetty to be constructed above high water
- All superstructure for bridge tower and anchor block to be constructed in dry sealed environment above high water
- Coffer dam approach installed above highest high water mark around work site for the southwest tower and anchor block for the suspension bridge
- Initial piles installed from spud barge above high water
- Turbidity will be monitored in real time during in-water construction activities (i.e., blasting, dredging, and ocean disposal) and compared to predicted TSS levels (through use of a turbidity-TSS calibration curve) and WQG.
- If TSS levels exceed modelled predictions outside of the active work area (defined as the immediate area surrounding operating construction equipment) or disposal site, the rate of the activity to be adjusted (e.g., slowed), or additional mitigation measures implemented (e.g., silt curtains) to minimize the spatial extent of elevated TSS

Expected Residual Serious Harm to Fish Habitats Used by CRA Fish Species:

- Expected serious harm to fish habitats in subtidal area permanently covered by individual piles and scour protection footprints (4,142 m^2)
- Expected serious harm to fish habitats in subtidal area permanently covered by marine vessel berthing platform grouped piles and pile scour protection (2,140 m^2)
- No expected serious harm to areas from potential sediment deposition from the marine terminal infrastructure or from berth propeller scour, given existing annual fluctuations and rates of sediment deposition from the Skeena River and applied mitigation measures. Sediment is expected to move in the PDA related to natural events enhanced by local tidal currents. Additional sediments from deposition around the constructed marine infrastructure and from potential propeller scour, are not predicted to cause mortality to existing eelgrass. No life process dependent fish habitats observed in areas directly around the LNG carrier berth and the southwest anchor and tower blocks where additional sediment may be deposited.
- Expected serious harm to fish habitats in subtidal area permanently covered by tower platform 36 m x 20 m (720 m^2) (Figure 5)
- Expected serious harm to fish habitats in subtidal area through permanent addition of rip rap scour protection at approximately 15 m perimeter outside tower platform (1,664 m^2)
- Expected serious harm to fish habitats in subtidal area permanently covered by anchor block platform 45 m x 45 m (1,980 m^2) (Figure 5)
- Expected serious harm to fish habitats in subtidal area through permanent addition of rip rap scour protection at approximately 15 m perimeter outside anchor block platform (3,750 m^2)
- No expected serious harm to areas from potential sediment deposition given existing annual fluctuations and rates of sediment deposition from the Skeena River. Sediment is expected to move in the PDA related to natural events which enhance local tidal currents. No life process dependent fish habitats observed.

Lelu Island LNG Facility
Construction Approaches: • Construction footprint outside sensitive ecosystems and identified habitats. • No identified freshwater fish habitats on Lelu Island • A 30 m vegetation buffer will be retained around the perimeter of Lelu Island, except at access points • Use of EMPs during construction (e.g., sediment and erosion control)
Expected Residual Serious Harm to Fish Habitats Used by CRA Fish Species: • No life process dependent fish habitats observed • No serious harm to fish habitats
Habitat Offsetting Sites
• Delineation of project site boundaries and marine sensitive areas • Pre-construction surveys and if possible, salvage of any marine species (flora / fauna) in the planned project area • Sediment and erosion control • Material management • Development of an Erosion and Sediment Control Plan • Spill Prevention and Emergency Response Planning • Compliance monitoring of construction methods
Expected Residual Serious Harm to Fish Habitats Used by CRA Fish Species: • No life process dependent fish habitats observed in offset sites • No serious harm to fish habitats

7.0 SERIOUS HARM TO FISH AND FISH HABITAT

Construction methods, presented in Table 3, reflect approaches being proposed to avoid and limit potential habitat effects. The expected residual habitat effects will result in serious harm to fish habitats. Construction activities are expected to permanently alter or destroy habitats at a spatial scale, duration, and intensity that will limit or diminish the ability of fish to use these habitats in the three project areas listed below (Table 4; Figure 5). Serious harm to fish habitats in the PDA is expected to include:

- Algae habitats and eelgrass habitats in the materials off-loading facility
- Soft sediment habitats at the southwest tower and southwest anchor platforms and areas of scour protection
- Soft sediment habitats at individual piles at the marine jetty and LNG carrier berth.

The rationale and approach to characterizing predicted serious harm to fish habitats is described in Section 7.1 and 7.2 for freshwater and marine environments respectively. Those habitats where serious harm is expected as a result of project activities will be offset.

7.1 FRESHWATER AREAS

The project related effects on Lelu Island freshwater watercourses are not considered serious harm to fish and fish habitats; therefore, no offset measures are presented for freshwater streams (Section 10.0 and 12.0 of the EIS (Stantec 2014a)). Construction and operations mitigation measures will be implemented to avoid and limit potential runoff or changes to drainage from Lelu Island into the marine environment. Because the freshwater streams are believed to be connected to nearshore waters during high tide or rain events, they are accessible to fish and fish may be present at times, especially in lower sections. As such, freshwater streams will be surveyed prior to clearing and construction activities through a fish salvage program using standard collection techniques (such as electrofishing, minnow trapping or dip netting) to protect any potential freshwater resources.

7.2 MARINE HABITATS

Three project locations and construction footprints are expected to result in serious harm to fish and fish habitats (Table 2 and Table 4, Figure 5). The Project is predicted to cause serious harm to approximately 23,026 m^2 of marine habitats used by juvenile salmonids, crab, herring and forage fish as nursery, foraging and shelter areas.

Table 4 Habitat Areas Expected as Serious Harm Following Implementation of Mitigation Measures

Project Footprint (m^2) and Area	Serious Harm to Habitats (m^2)	No Serious Harm to Habitats (m^2)
Access Bridge to the Mainland | Total Footprint: 3,330 m^2		
3,322 m^2 [A] Riparian area infilling and/or vegetation removal on Lelu Island	0 m^2	3,322 m^2 No serious harm predicted on marine riparian areas. Riparian areas have been assessed as not supporting life process dependent habitats for salmonids and forage fish species (sandlance and surf smelt); intertidal habitats at Lelu Island comprise mud or rock shoreline. No riparian shaded beach spawning habitats were observed in the PDA.
8 m^2 Marine pile footprint	0 m^2	8 m^2 No serious harm predicted from Lelu Island bridge piling footprint. Slough areas are predominantly dry during high to low tide cycles with the exception of a centre wetted channel. The slough is comprised of fine silt-clay mud areas and is used by fish as tidal passage between ebb and flood periods. No habitats were identified in the slough as dependent for life process for fish species .
Pioneer Dock / Roll-on roll-off barge ramp| Total Footprint: 545 m^2		
537 m^2 [A] Riparian area infilling and/or vegetation removal on Lelu Island	0 m^2	537 m^2 No serious harm predicted on marine riparian areas. Riparian areas have been assessed as not supporting life process dependent habitats for salmonids and forage fish species (sandlance and surf smelt); intertidal habitats at Lelu Island comprise mud or rock shoreline. No riparian shaded beach spawning habitats were observed in the PDA.

Project Footprint (m^2) and Area	Serious Harm to Habitats (m^2)	No Serious Harm to Habitats (m^2)
8 m^2 Marine pile footprint	0 m^2	8 m^2 No serious harm predicted from piling footprint. No soft sediment habitats in the pioneer dock areas were identified as dependent for fish life processes.
Materials Offloading Facility | Total Footprint: 60,075 m^2		
1,830 m^2 Soft bottom eelgrass area	1,830 m^2 Destruction of intertidal eelgrass used as foraging and nursery habitats by juvenile salmonids, herring, surf smelt, sandlance and crab.	0 m^2
19,825 m^2 [A] Riparian area infilling and/or vegetation removal on Lelu Island	0 m^2	19,825 m^2 No serious harm predicted on marine riparian areas. Riparian areas have been assessed as not supporting life process dependent habitats for salmonids and forage fish species (sandlance and surf smelt); intertidal habitats at Lelu Island comprise mud or rock shoreline. No riparian shaded beach spawning habitats were observed in the PDA.
51 m^2 Marine pile footprints	0 m^2	51 m^2 No serious harm predicted from piling footprint. Piles will be placed in dredged MOF footprint.
31,569 m^2 Soft substrate area within dredge footprint (not including hard bottom algae and eelgrass habitats)	0 m^2	31,569 m^2 No serious harm predicted in intertidal soft mud habitats within the MOF area. Intertidal mud areas are widely distributed around Lelu Island and the outer Skeena River estuary. These are sloping mud intertidal areas and predominantly in a low water or dry state. The habitats have been assessed as not supporting life process dependent habitats for juvenile salmonids, crab, and forage fish species.
6,800 m^2 Hard bottom algae area	6,800 m^2 Destruction of intertidal hard bottom brown algae area, used as foraging and nursery habitat by juvenile salmonids, herring, surf smelt, sandlance and crab	0 m^2

Project Footprint (m^2) and Area	Serious Harm to Habitats (m^2)	No Serious Harm to Habitats (m^2)
Marine Terminal (Suspension Bridge, Trestle and LNG Carrier Berth) | Total Footprint: 69,968 m^2		
54,000 m^2 Sediment deposition associated with marine construction	0 m^2	54,000 m^2 Sediment deposition rates and patterns of distribution resulting from placement of marine terminal structures fall within normal variation and ranges of annual sediment deposition onto Agnew and Flora Bank. Sediment deposition around marine structures is expected to be localized, predominately during storm periods in the fall and winter outside the summer growing season. Changes in sediment re-suspension and deposition patters are not expected cause serious harm to fish or fish habitats
1,572 m^2 [A] Riparian area infilling and/or vegetation removal on Lelu Island	0 m^2	1,572 m^2 No serious harm predicted on marine riparian areas. Riparian areas have been assessed as not supporting life process dependent habitats for salmonids and forage fish species (sandlance and surf smelt); intertidal habitats at Lelu Island comprise mud or rock shoreline. No riparian shaded beach spawning habitats were observed in the PDA.
430 m^2 Marine jetty and vessel berth pile footprint (380 piles with a 1.22 m diameter)	430 m^2 Permanent alteration of soft silt – clay subtidal substrate. Added rip rap scour protection around individual piles. Foraging habitats used by shrimp, Dungeness crab and local flatfish species.	0 m^2 No additional serious harm predicted from marine terminal individual pile footprint. Habitats presently used at low density by shrimp and flatfish in depths greater 5 m, and by flatfish and crab in shallower depths. Scour and accretion will not prevent shrimp, Dungeness crab or flatfish from using existing soft substrate habitats to carry out life processes.
3,712 m^2 Marine jetty and vessel berth individual pile and scour protection footprint	3,712 m^2 Permanent alteration of soft silt – clay subtidal substrate. Added rip rap scour protection around individual piles. Foraging habitats used by shrimp, Dungeness crab and local flatfish species.	0 m^2 No additional serious harm predicted from marine terminal piling scour protection armouring footprint. This protective armouring will be applied during construction to avoid and limit pile scour in widely distribution soft substrate at Agnew Bank and outside the bank. Habitats presently used at low density by shrimp and flatfish in depths greater 5 m, and by flatfish and crab in shallower depths. Scour and accretion will not prevent shrimp, Dungeness crab or flatfish from using existing soft substrate habitats to carry out life processes.
2,140 m^2 Marine vessel berthing platform with grouped pile scour protection footprint	2,140 m^2 Permanent alteration of soft silt – clay subtidal substrate. Added rip rap scour protection around grouped piles. Foraging habitats used by shrimp, Dungeness crab and local flatfish species	0 m^2 No additional serious harm predicted from marine vessel berthing platform piling footprint and grouped scour protection (armouring) footprint. Scour protection (rip rap armouring) will be applied during construction to avoid and limit pile scour in widely distribution soft substrate at Agnew Bank and outside the bank. Habitats presently used at low density by shrimp and flatfish in depths greater 5 m, and by flatfish and crab in shallower depths. Scour and accretion will not prevent shrimp, Dungeness crab or flatfish from using existing soft substrate habitats to carry out life processes.

Project Footprint (m^2) and Area	Serious Harm to Habitats (m^2)	No Serious Harm to Habitats (m^2)
2,700 m^2 Marine suspension bridge: Southwest tower (720 m2) and anchor (1980 m2) platforms and pilings footprint	2,700 m^2 Permanent alteration of soft silt – clay subtidal substrate habitat through southwest tower and anchor platforms and pilings. Existing habitats used for foraging by Dungeness crab and local flatfish species.	0 m^2 No additional serious harm predicted from southwest tower and anchor platforms and pilings footprints. Habitats presently used at low density by shrimp and flatfish in depths greater 5 m, and by flatfish and crab in shallower depths. Scour and accretion will not prevent Dungeness crab or flatfish from using existing soft substrate habitats to carry out life processes.
5,414 m^2 Marine suspension bridge: Southwest tower (1664 m2) and anchor (3750 m2) platforms and pilings scour protection footprint	5,414 m^2 Permanent alteration of soft silt – clay subtidal substrate through addition of rip rap scour protection around platforms and piles. Foraging habitats used by Dungeness crab and local flatfish species	0 m^2 No additional serious harm predicted from additional scour protection (armouring) footprint. Scour protection (rip rap armouring) will be applied during construction to avoid and limit pile scour in widely distribution soft substrate at Agnew Bank and outside the bank. Habitats presently used at low density by shrimp and flatfish in depths greater 5 m, and by flatfish and crab in shallower depths. Scour and accretion will not prevent Dungeness crab or flatfish from using existing soft substrate habitats to carry out life processes.
LNG Facility on Lelu Island | Total Footprint: 19,220 m^2		
18,480 m^2 [B] Riparian area infilling and/or vegetation removal on Lelu Island	0 m^2	18,480 m^2 No serious harm predicted on freshwater riparian areas. Riparian areas have been assessed as not supporting life process dependent habitats.
740 m^2 Freshwater channels	0 m^2	740 m^2 No serious harm predicted from Lelu Island around freshwater channels.
Habitat Offsetting | Total Footprint: 24,080 m^2		
24,080 m^2	0 m^2	24,080 m^2 No serious harm predicted from habitat offsetting. Habitat offsets will be designed to limit the destruction of any existing high quality habitats and will focus on the enhancement of physical and biological habitats that support CRA fish and forage fish species consistent with those habitats altered or destroyed by the Project.
Totals		
177,218 m^2	**23,026 m^2**	**154,192 m^2**

NOTES:
[A] marine riparian zone was defined around Lelu Island based on 30 m inland from the HHWM
[B] freshwater riparian zone was defined around freshwater channels based on a 15 m buffer area from top of bank

8.0 HABITAT OFFSETTING

Habitat offsetting is planned for the Project to counterbalance the serious harm to marine fish habitats used for life dependent processes by fish that are part of, or support, CRA fisheries. The habitat offsetting plans are designed to offset project related destruction of eelgrass, algae and soft sediment habitats used by juvenile salmonids, herring, crab and forage fish species during sensitive life history stages.

The habitat offsets are planned across five sites in marine intertidal and subtidal locations around Lelu Island (Figure 7). Through investigative field visits, the offsetting sites have been located within areas which have industrial debris (abandoned vessels, logging debris), have limited existing habitat complexity or diversity (existing mud, silt-clay habitats) and are widely available habitat types (coastal rocky areas, isolated mud foreshores) (Figure 6). The creation of habitat offsets will be designed to limit destruction of any existing high quality habitats and will focus on the creation and enhancement of physical and biological habitats that support CRA fish and forage fish species. Habitat offset locations were selected to provide enhancement of existing habitats through the creation of new habitat features. As offset locations have been previously determined to be widely available rocky coastline with low infauna / epifauna density and have limited fish usage, the constructed habitat offsets are not expected to result in the loss of existing habitat for any CRA fish species or fish that support such a fish species (forage fish).

Offset habitats will be sited and fully designed with input from DFO and First Nations to maintain productivity in the LAA. The final habitat offset designs will be presented in a detailed Request for Authorization under Section 35(2) of the *Fisheries Act.* Habitat offset designs will be defined for location, size, design feasibility, effectiveness and follow-up monitoring. The Project preference will be to create offset habitats in advance or parallel to project construction works to limit lag time between loss of marine fish habitat from construction and development of offsets through habitat enhancement. Habitat offset locations will be accessed from the marine environment.

The habitat offsets include:

- Five sites located around Lelu Island with an approximate total area of 24,080 m^2.
- Benched and sloping platforms at each site designed to support subtidal, intertidal and backshore habitats.
- Habitats planted for algae and kelp, intertidal eelgrass and foreshore salt marsh species (sedges, forbes and salt tolerant shrubs and trees).
- Habitats designed to enhance local productivity, diversity and complexity of habitats available for marine fish and invertebrates, including nursery, foraging and shelter habitats used by juvenile salmonids, herring, crab, and forage fish species.
- Habitats designed to support diverse and complex subtidal, intertidal and foreshore habitats for marine mammals, marine birds and wildlife species.

8.1 HABITAT ENHANCEMENT

Habitat enhancement is focused on future use by CRA fish species including salmonids, crab, herring and forage fish species. Offsetting options will be designed and managed consistent with successful habitat restoration and enhancement programs in BC and around the world (Levings 2003, Wright 2005, Leschen et al. 2010, Fonseca et al. 1998).

Small, patchy sections of eelgrass and hard-bottom brown algae areas used by juvenile salmonids, herring, crab and forage fish are expected to be permanently altered and / or destroyed in the intertidal zone of the MOF area during construction (Figure 5). As a measure for offsetting serious harm to habitats, PNW LNG is proposing the creation of a series of benched and sloping habitats that will include the following components:

- Creation of eelgrass and algae/kelp habitat
- Creation of rocky intertidal shoreline habitat and subtidal rocky reef habitat
- Maintenance and creation of marine foreshore and riparian vegetation

Habitat enhancement will occur in local sites around Lelu Island selected for their existing widely distributed rocky habitat and potential site suitability to support eelgrass, brown algae and bull kelp after offset construction. Suitable offset locations have been defined based on remote sensing assessments and field survey observations. Offset sites will be designed further through engineering and biological surveys as components of detailed habitat designs. Final sites will be reviewed with input from DFO and First Nations.

The offset locations identified in this habitat offsetting plan do not presently contain significant intertidal or subtidal vegetation and are presently assessed as areas with limited complexity and diversity of habitats (Figure 7).

8.1.1 Benched and Sloping Habitats

PNW LNG is proposing to construct approximately 24,080 m^2 of benched and sloping intertidal/subtidal habitats (Figure 7 through Figure 12). The habitat offset sites will be constructed with eelgrass, rocky reef, and foreshore habitats and will be planted with donor stock from local sources as available. Mature donor planting stock will be used from existing eelgrass beds in proximity to the offsetting sites. Design planning for suitable eelgrass and algae / kelp growing conditions will include; light availability, currents, wave action, substrate and salinity to help improve the chances of transplant success (Wright 2005 and Tanner et al. 2010).

Planned eelgrass / algae beds will be planted on constructed benched shoreline areas filled with sediments sourced to provide a growing medium for intertidal eelgrass and potentially for foreshore sedge and forb habitat areas. Habitats are initially planned to incorporate three platforms of benched or sloping design separated by rock berms (Figure 8 through Figure 12). The benched design will create a series of stable habitats wetted throughout the tidal cycle to support intertidal eelgrass and deeper algae beds and rocky intertidal shoreline protected from exposure and harsh wave action. Reference sites from Inverness Passage and Smith Island may also be assessed and used as potential templates to create new benched habitats on Lelu Island.

8.1.2 Detailed Designs

The benched habitats will be identified, situated, designed, constructed, monitored and maintained for long-term success as offset habitats. Each of the five offset sites will consist of separated benched platforms that incorporate both soft sediment intertidal eelgrass and intertidal / subtidal rocky reef habitat. Each site will be designed to construction standards by a team of coastal engineers, biologists and First Nations experts. Elevation, coastal geomorphology, and biological surveys will be undertaken in early 2015 to develop detailed designs for construction.

These offset habitats will be constructed in areas that presently contain widely distributed rocky shoreline habitat that currently exists on Lelu Island. Foreshore sedge and forb plant communities will be maintained at sites where they exist.

Successful eelgrass transplanting will include the placement of intertidal soft sediments as a stable substrate for root systems, nutrients and available light (Figure 7 through Figure 12). The majority of eelgrass beds are found between 0 and – 6 m chart datum (CD). Offsetting eelgrass planting in the benched platforms will take place in water depths between -1 to +1 m CD to remain consistent with known eelgrass depths and those characteristic of the area. Bench and sediment elevations will be planned to support viable intertidal eelgrass habitats to provide stability and limit erosion or exposure through the use of rock berms. These berms will be designed to specific heights to provide protection from wave energy. Characteristic of the area, eelgrass is typically found near mouths of freshwater streams indicating they are tolerant to changes in salinity. Offset habitats will be placed at areas of appropriate salinity for eelgrass, typically between 10 to 30 ppt (parts per thousand) (Phillips 1984). Planting techniques will be developed and detailed in the Request for Authorization under Section 35(2) of the *Fisheries Act* and will include techniques based on efficiency and cross-training opportunities to involve local First Nations participants.

The habitat designs will incorporate a series of sloped rock berms and rip rap shelves surrounding the eelgrass platform described in Section 8.1.1 (Figure 7 through Figure 12). Constructed rock reefs will be placed at water depths suitable to plant and establish brown algae (Hueckel et al. 1989). Habitats will include areas of rock and hard substrates to secure algae to the seafloor, moderate water currents, and allow sufficient light penetration to support photosynthesis. Reef habitat construction will involve the placement of rock in parallel shelves to a depth of approximately -5 m CD.

The ecological benefits of these types of intertidal / subtidal platform habitats are documented in the lower Fraser estuary (Levings and Nishimura 1997, Adams and Williams 2003, Levings 2003, c.f. Johannes et al. 2012), and around the Skeena River area (observed project sites along the Yellowhead Highway). The combination of the offset sites will promote the establishment of a variety of habitats used by salmon, forage fish and invertebrates around Lelu Island. The sites will be designed to establish stable habitats wetted throughout the tidal cycle onto benched rock platforms (Figure 7 through Figure 12).

9.0 MONITORING AND REPORTING

PNW LNG will implement a management, monitoring and reporting program to:

(a) Monitor environmental protection during construction, and

(b) Confirm that habitat offsetting measures meet their intended design objectives through an initial as-built design compliance monitoring, and follow-up habitat performance effectiveness monitoring.

Section 30 of the EIS Addendum provides an overview of the planned monitoring and reporting.

9.1.1 Construction Monitoring

A specific habitat offsetting environmental management plan (EMP) will be submitted as part of Request for Authorization under the *Fisheries Act* for construction of the offset habitats. The construction EMP will define site specific environmental best practices, guidance, mitigation measures and regulatory compliance, to avoid and limit potential impacts on terrestrial, freshwater and marine resources which may overlap the habitat offsets. As a component of the EMP, a specific construction monitoring protocol will be outlined for compliance and guide best practices and implementation of mitigation measures. The EMP will be developed and finalized by a qualified environmental professional in accordance with guidelines and best management practices and may include:

- Delineation of project site boundaries and marine sensitive areas
- Pre-construction surveys and if possible, salvage of any marine species (flora / fauna) in the planned project area
- Sediment and erosion control
- Material management
- Development of an Erosion and Sediment Control Plan
- Spill Prevention and Emergency Response Planning
- Construction methodology

9.1.2 Compliance Monitoring

Compliance monitoring will be planned as a component of offset habitat construction activities. Monitoring will be used to confirm that offset habitats are constructed in accordance with habitat offset as-built designs and meet all requirements defined by DFO under the Project's *Fisheries Act* authorization for habitat offsets (DFO 2014b). Compliance monitoring will take place throughout and soon after completion of constructed habitats. Information to be documented during and with completion of construction will include:

- Written and photo-documented sequence of events during construction of offsetting habitats
- Any changes in the design that are necessary to adapt to unanticipated conditions (these changes must be discussed with DFO before proceeding)
- Technical issues that arise during construction and how they were addressed
- Confirmation that all habitat offsetting components meet design requirements
- Confirmation that all terms and conditions of the *Fisheries Act* authorization are met.

Results of construction and compliance monitoring will be submitted as an as-built report to DFO within 90 days of offsetting habitat construction.

9.1.3 Effectiveness Monitoring

Effectiveness monitoring will be undertaken to confirm the offsetting habitats are functioning as intended following construction. Specific habitat performance criteria, monitoring methods, and measureable parameters will be defined in the Request for *Fisheries Act* authorization and in the authorization requirements from DFO (DFO 2014b). Monitoring will focus on the physical habitat stability, habitat quality and productivity of the offset

habitat. Monitoring will assess a number of quantitative and qualitative habitat metrics including: eelgrass / algae bed extent, percent survival of species planted, eelgrass density (shoot density and percent cover) and CRA fish density and distribution. Wherever possible, survey designs will be implemented using multiple references habitat sites to compare and contrast constructed offset habitats and assess natural variability in the region.

Additional planting and structural maintenance may be completed at habitat offset sites based on surveys and assessed performance of sites over time. Habitat performance criteria will be detailed in the environmental monitoring plans as part of the requirements under the *Fisheries Act* authorization from DFO. A schedule for habitat effectiveness monitoring of all offset sites will be determined across consistent annual or semi-annual time intervals over a set period of years (5 or 10) to be determined by requirements under the *Fisheries Act* authorization. It is typical to monitor survival rates of eelgrass beds at a quarterly frequency for the first year after creation and subsequent annual visits for four additional years (a minimum total of five years) (Fonseca et al. 1998). If habitat performance criteria are not met by year five, a work plan will be developed and additional offsetting measures will be undertaken in consultation with DFO, First Nations and stakeholders. Monitoring will continue until performance criteria have been met and the habitat offsets have been determined as established and successful in terms of enhanced local productivity and fish use and distribution. Results of the effectiveness monitoring program will be reported annually and summarized after five years.

10.0 CLOSURE

This Preliminary Habitat Offsetting Plan was prepared to support the environmental assessment for the Project to support the issuance of a Section 35(2) (b) *Fisheries Act* authorization for the Project. The information presented in this report uses the best available information at the time of preparation.

11.0 REFERENCES

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12.0 FIGURES

Please see the following pages.

- Airport
- City or Town
- Contour (m)
- Electrical Power Transmission Line
- Ferry Route
- Highway
- Railway
- Secondary Road
- Watercourse
- Prince Rupert Port Authority Boundary
- Archaeological Site
- Indian Reserve
- Protected Area
- Waterbody

Shoals

- Agnew Bank
- Flora Bank
- Horsey Bank

Pacific NorthWest LNG

Project Location

HABITAT OFFSET PLAN

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd.; Canadian Hydrological Service (CHS), 1995.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

DATE: 27-NOV-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-851	DATUM: NAD 83
DRAWN BY: N. PUREWAL	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **1**

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N

Ridley Island

Access Bridge

Pioneer Dock

Marine Off-Loading Facility

Porpoise Channel

Skeena Dr

Stapledon Island

NE Bridge Tower on Lelu Island

Agnew Bank

Suspension Bridge

SW Bridge Tower Platform

SW Bridge Tower Anchor

Marine Terminal Jetty

Lelu Island

Flora Bank

Horsey Bank

Vessel Berth

0 250 500 750 m

1:17,500

Project Component
Contour (m)
Railway
Secondary Road
Watercourse
Bathymetric Contour 5m Interval (Chart Datum)

Waterbody
Agnew Bank
Flora Bank
Horsey Bank

***Total Marine Infrastructure and Dredge Area: 57461 m²**

Pacific NorthWest LNG

Planned Project Infrastructure

HABITAT OFFSET PLAN

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd; WorldView-2 Imagery. Imagery date: 2011.

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DATE: 27-NOV-14
FIGURE ID: 123110537-852

PROJECTION: UTM - ZONE 9
DATUM: NAD 83

DRAWN BY: N. PUREWAL
CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

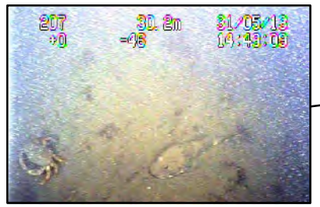
PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **2**

11/27/2014 - 11:19:47 AM \\cd1186-f04\Workgroup\active\123110537\gis\figures\habitat_offset_plan\fig_10537_hab_offset_02_Planned Project Infrastructure.mxd

Inset 6: Soft bottom subtidal habitat

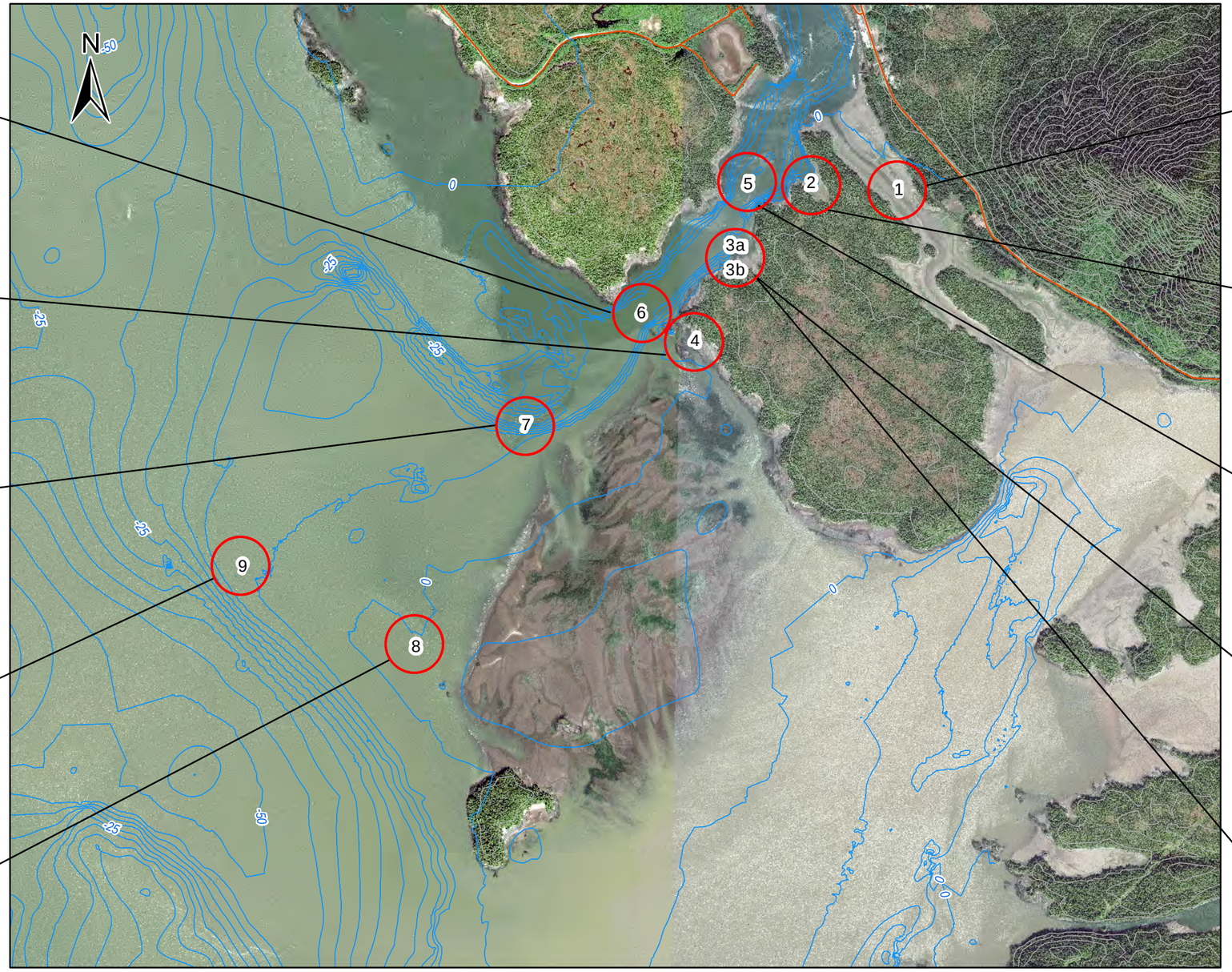
Inset 4: Rocky and soft bottom intertidal habitat



Inset 7: Soft bottom subtidal habitat

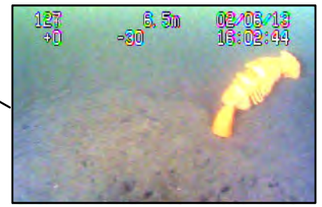
Inset 9: Soft bottom subtidal habitat

Inset 8: Soft bottom subtidal habitat



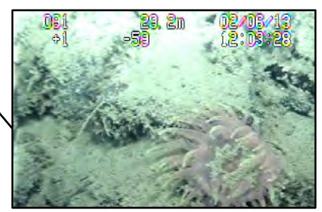
Inset 1: Soft bottom intertidal habitat

Inset 2: Soft bottom intertidal habitat



Inset 5: Soft bottom subtidal habitat

Inset 3a: Rocky and soft bottom intertidal habitat



Inset 3b: Soft bottom with cobble subtidal habitat

Railway
Road
Contour (m)
Bathymetric Contour
5m Interval (Chart Datum)

Pacific NorthWest LNG

Existing Habitats

HABITAT OFFSET PLAN

Sources: Government of Canada; Government of British Columbia. Natural Resources Canada, Centre for Topographic Information; Canadian Hydrological Service (CHS), 1995.

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FIGURE ID: 123110537	DATUM: NAD 83	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **3**

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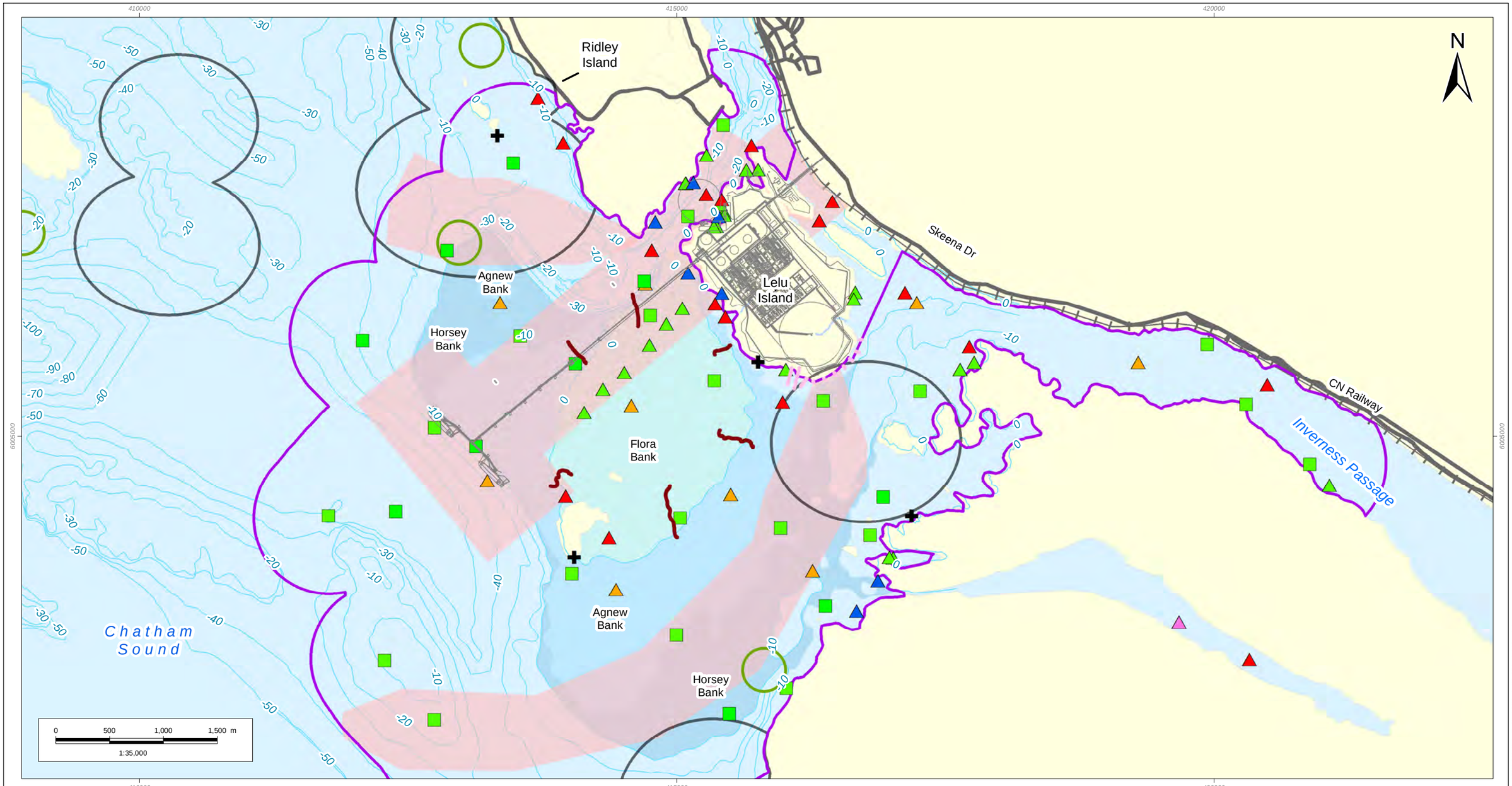

Bathymetric Contour (10 m)
Project Component
Railway
Secondary Road

Shoals

Agnew Bank
Flora Bank
Horsey Bank

Independant/Historical Studies

Beach Seine Site (Anderson 1986)
Beach Seine Site (Carr-Harris and Moore 2013)
Eelgrass Survey (Faggetter 2009)
Beach Seine Site (Community Fisheries Development Center 2001)
Purse Seine Site (Higgens & Schowenburg 1973)
Transects (Faggetter 2009)
Trawl (Carr-Harris and Moore 2013)
Trawl (Gottesfeld et al 2008)

Project-Related Studies

Beach Seine Site
Crab Trap
Foreshore Transects
Hydroacoustic and Trawl Survey Area
ROV Transect Area

Pacific NorthWest LNG

Sampling Extent of Fish and Fish Habitat Studies

EIS ADDENDUM

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd; WorldView-2 Imagery. Imagery date: 2011.

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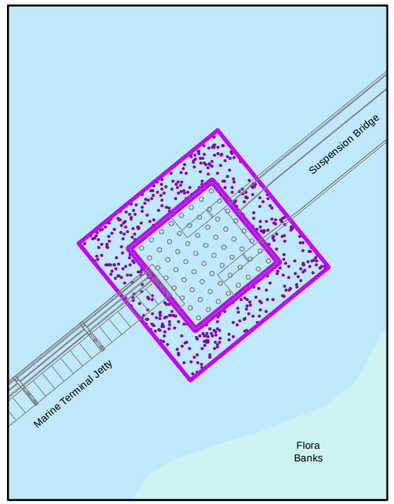
FIGURE ID: 123110537-851	DATUM: NAD 83	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

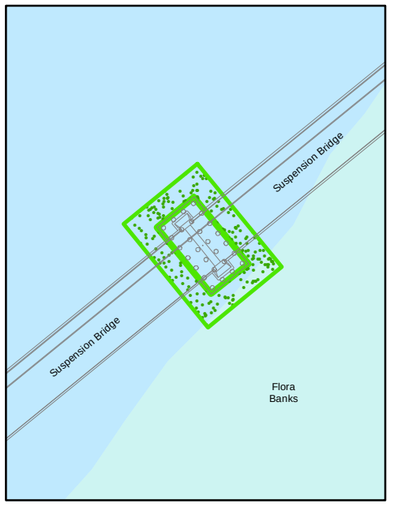
PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **4**

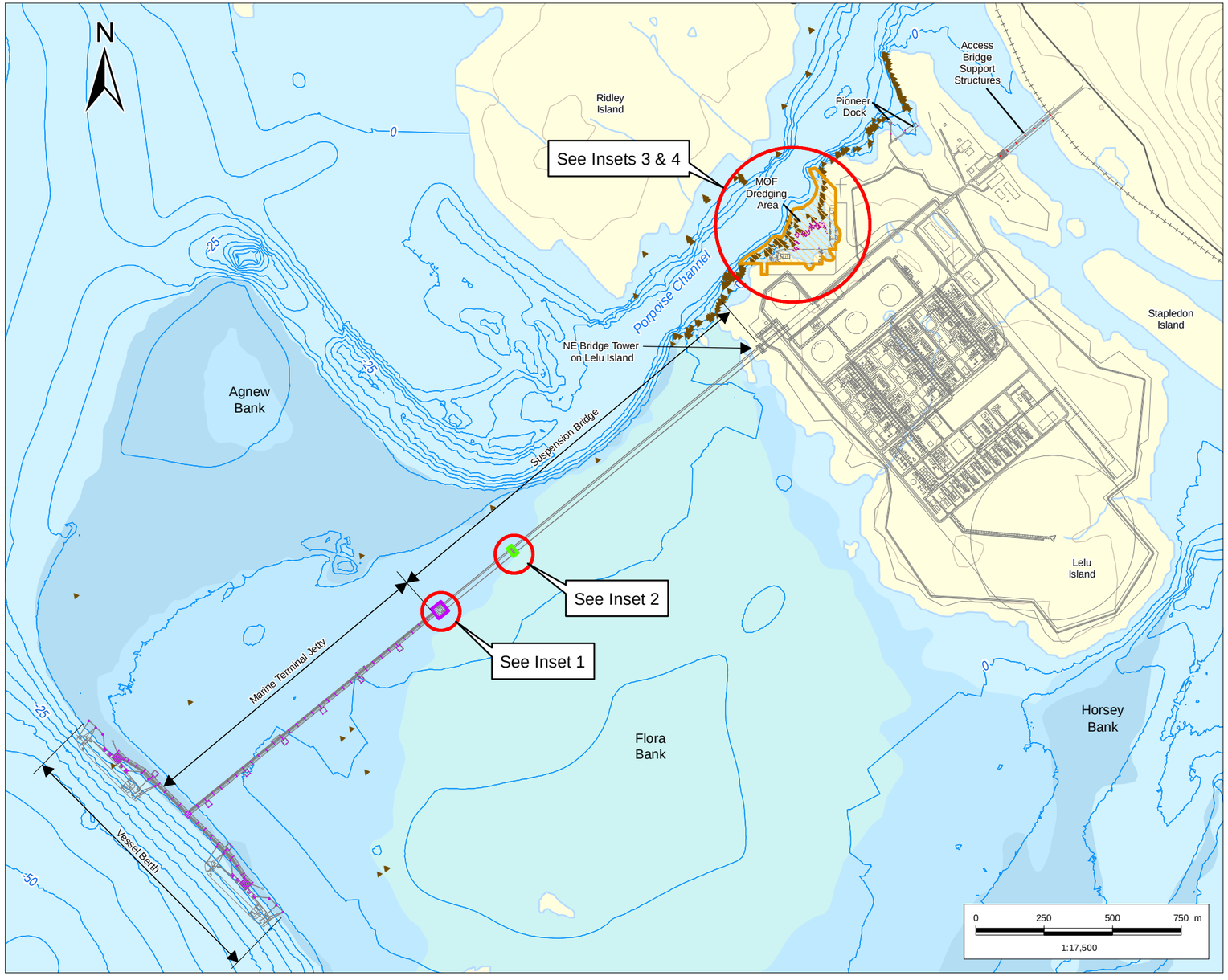
12/9/2014 - 12:21:36 PM V:\active\123110537\gis\figures\habitat_offset_plan\fig_10537_hab_offset_04_all_sampling_in_the_PDA_zoomed_in.mxd

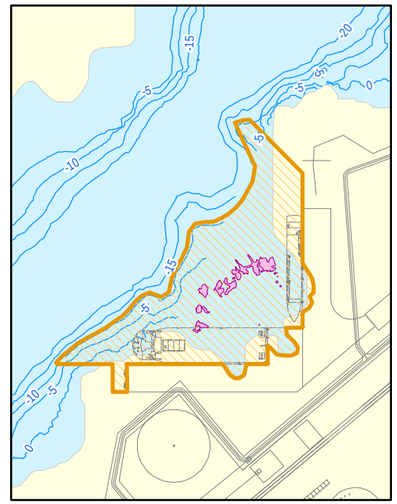


Inset 1: SW Bridge Anchor Block (1980 m²)
Scour Protection (3750 m²)

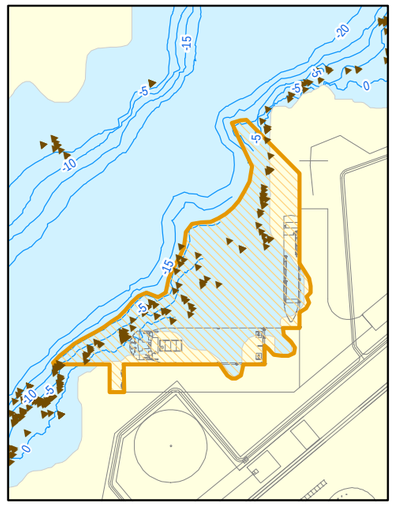


Inset 2: SW Bridge Tower Platform (720 m²)
Scour Protection (1664 m²)





Inset 3: MOF - Eelgrass (1,830 m²)



Inset 4: MOF - Hardbottom Subtrate with Brown Algae (6,800 m²)

Project Component
Contour (m)
Railway
Road
Secondary Road
Watercourse
Bathymetric Contour
5m Interval (Chart Datum)

Waterbody
Agnew Bank
Flora Bank
Horsey Bank

Algae Type
Brown Algae
2014 Observation
Eelgrass Bed (*Zostera marina*)*
MOF Dredge Boundary (60,000 m²)

SW Bridge Anchor Block (45m x 44m)
SW Bridge Tower Platform Scour Protection
SW Bridge Tower Platform (36m x 20m)
SW Bridge Anchor Block Scour Protection

Piles
Jetty / Trestle
Access Bridge Piles
Pioneer Dock Piles

Pacific NorthWest LNG

Predicted Habitat Impact

HABITAT OFFSET PLAN

Sources: Government of British Columbia; Government of Canada, Natural Resources Canada, Centre for Topographic Information; Progress Energy Canada Ltd; WorldView-2 Imagery. Imagery date: 2011.

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DATE: 08-DEC-14
FIGURE ID: 123110537-847
PROJECTION: UTM - ZONE 9
DATUM: NAD 83
DRAWN BY: N. PUREWAL
CHECKED BY: M. JOHANNES

PREPARED BY: Stantec
PREPARED FOR: Pacific NorthWest LNG
FIGURE NO: **5**

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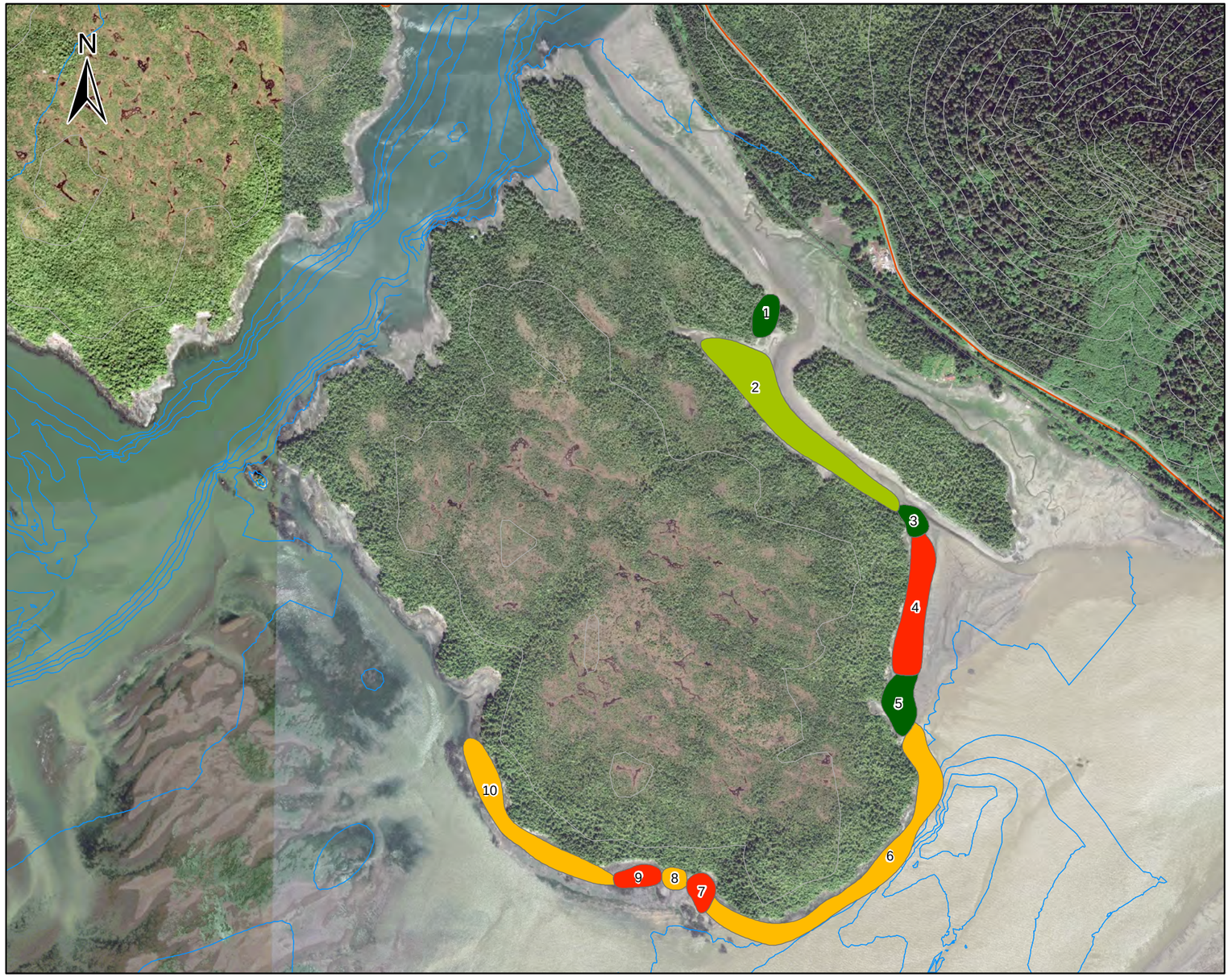
Intertial Habitat 1: Cobble Field

Intertial Habitat 2: Mudflat

Intertial Habitat 3: Cobble Field

Intertial Habitat 4: Sandy Soft Substrate

Intertial Habitat 5: Cobble Field



Intertial Habitat 6: Rocky Substrate

Intertial Habitat 7: Sandy Soft Substrate

Intertial Habitat 8: Rocky Substrate

Intertial Habitat 9: Sandy Soft Substrate

Intertial Habitat 10: Rocky Substrate

Railway
Road
Contour (m)
Bathymetric Contour
5m Interval (Chart Datum)

Intertidal Habitats

- Cobble Field
- Mudflat
- Rocky Substrate
- Sandy Soft Substrate

Pacific NorthWest LNG

Existing Intertidal Habitats around Lelu Island

HABITAT OFFSET PLAN

Sources: Government of Canada; Government of British Columbia. Natural Resources Canada, Centre for Topographic Information; Canadian Hydrological Service (CHS), 1995.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

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FIGURE ID: 123110537	DATUM: NAD 83	CHECKED BY: M. JOHANNES

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: **6**

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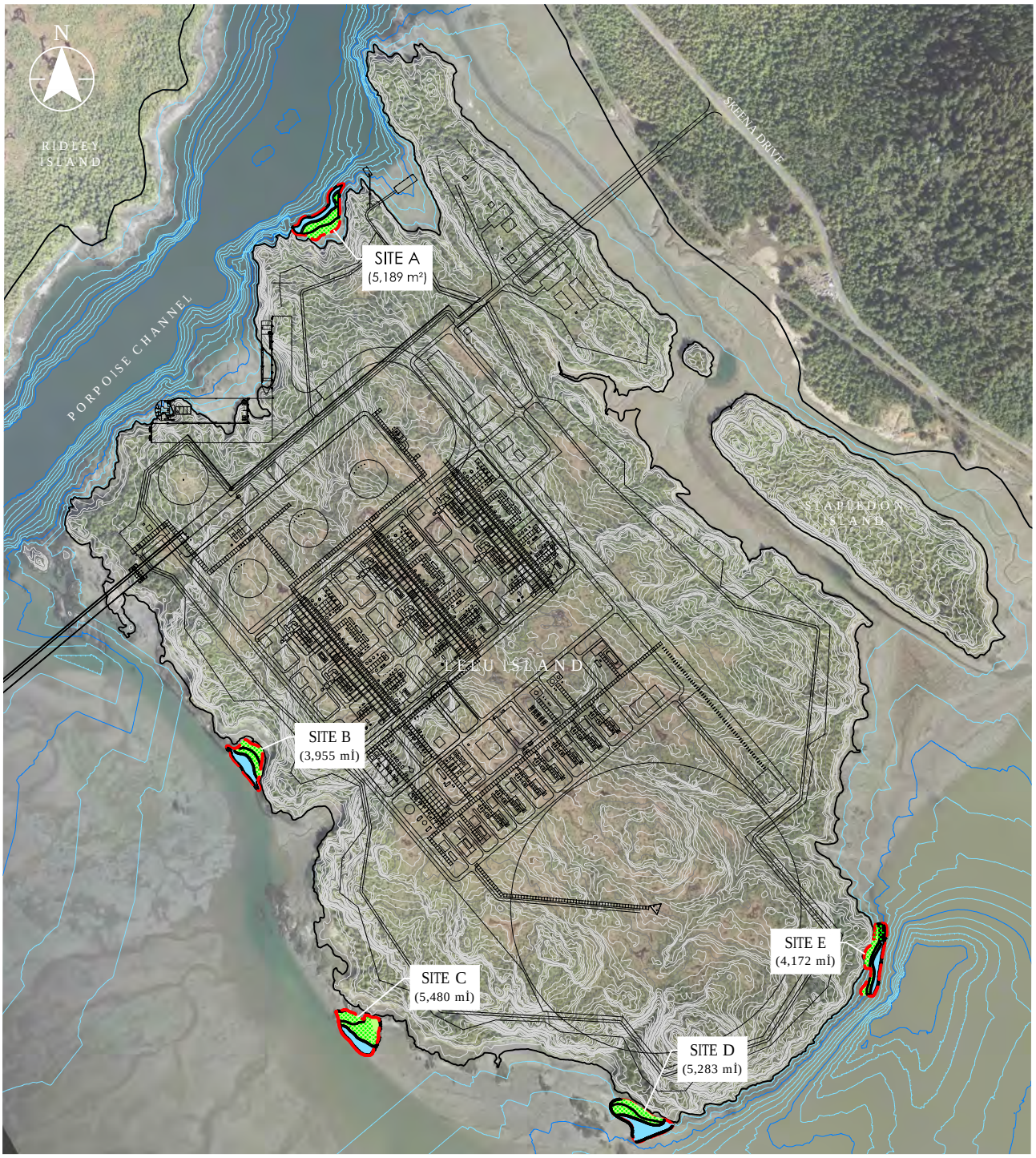

Legend

Proposed Marine Habitat Compensation Site

Total Proposed Marine Habitat Offsets: 24,080 mİ

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NOT FOR CONSTRUCTION

Pacific NorthWest LNG

Marine Habitat Offsetting Proposed Site Locations

Sources: Base map provided by Microsoft Bing Imagery

DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 7

ORIGINAL SHEET - ANSI A

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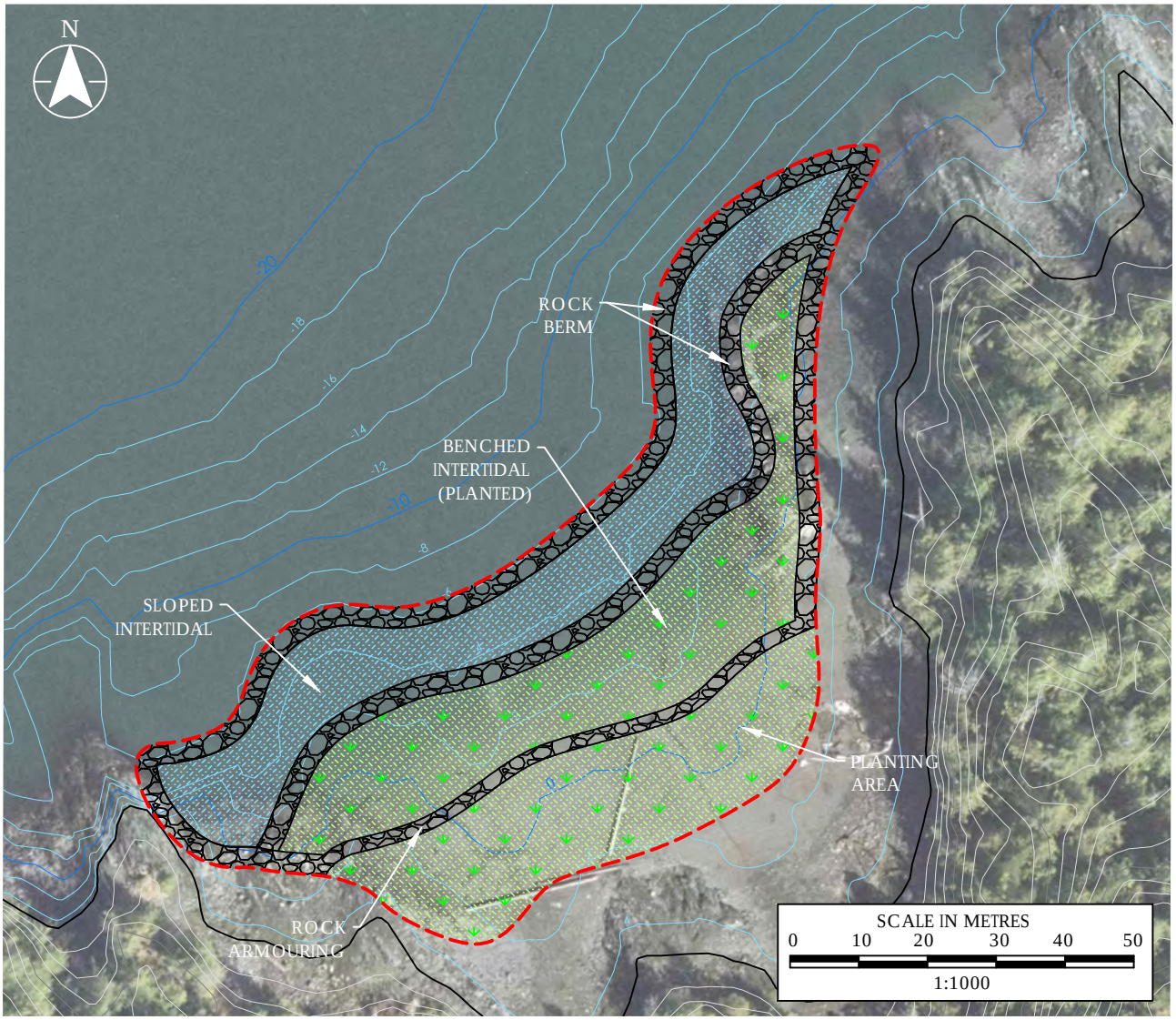
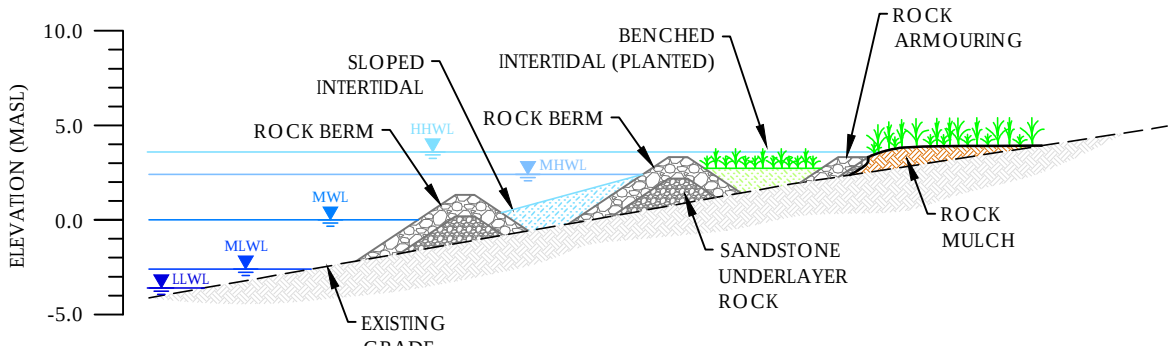




PROPOSED BENCHED SHORELINE HABITAT

SCALE: NOT TO SCALE

Legend

Proposed Marine Habitat Compensation Site

DRAFT
NOT FOR CONSTRUCTION

Pacific NorthWest LNG

Marine Habitat Offsetting
Site A

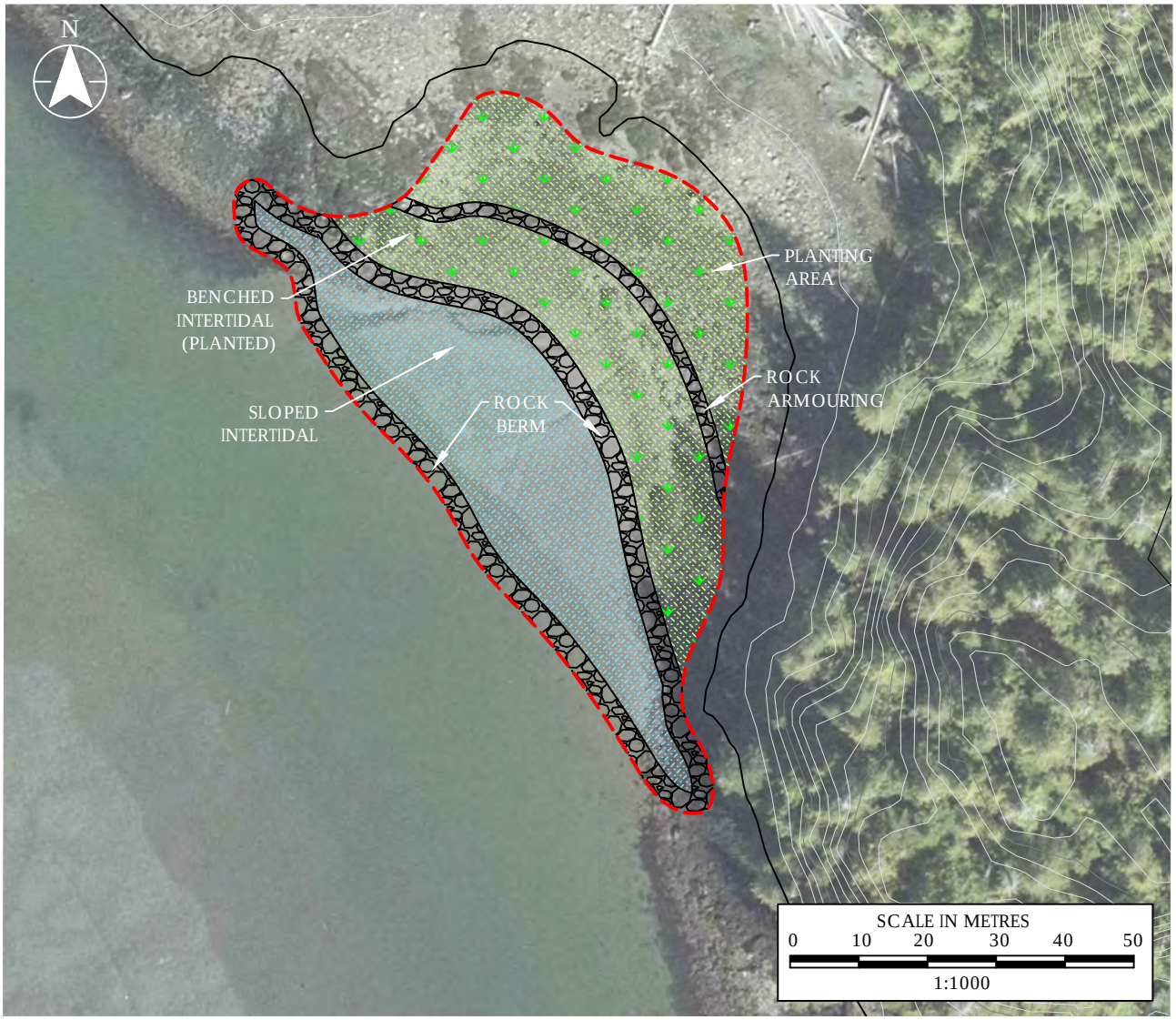
Sources: Base map provided by Microsoft Bing Imagery

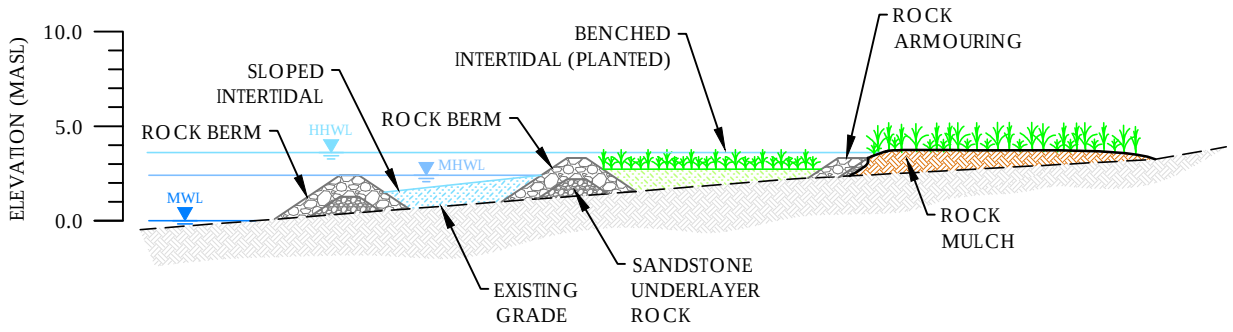
DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-855	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 8





PROPOSED BENCHED SHORELINE HABITAT

SCALE: NOT TO SCALE

Legend

Proposed Marine Habitat Compensation Site

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Pacific NorthWest LNG

Marine Habitat Offsetting
Site B

Sources: Base map provided by Microsoft Bing Imagery

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DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-857	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 9

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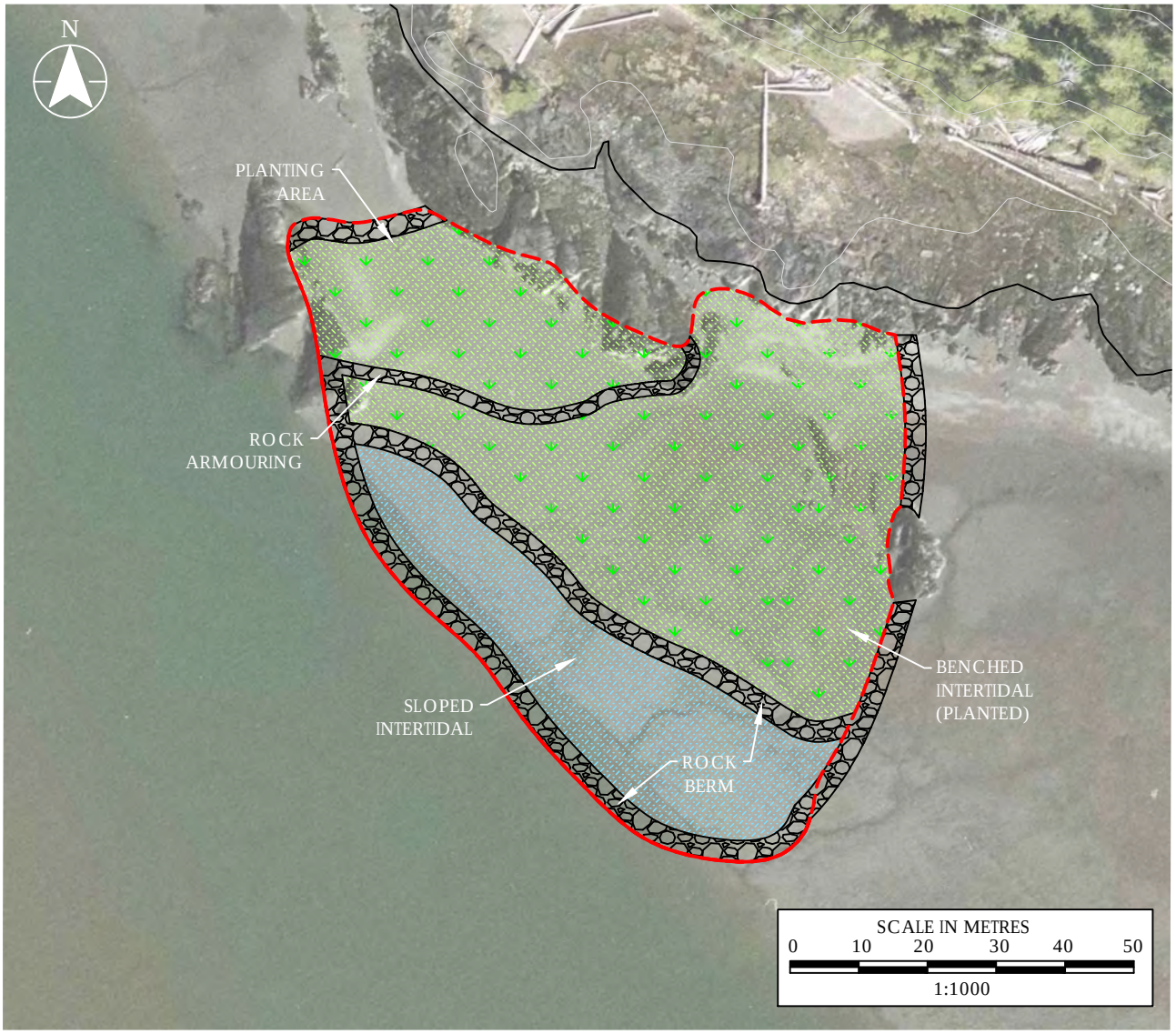

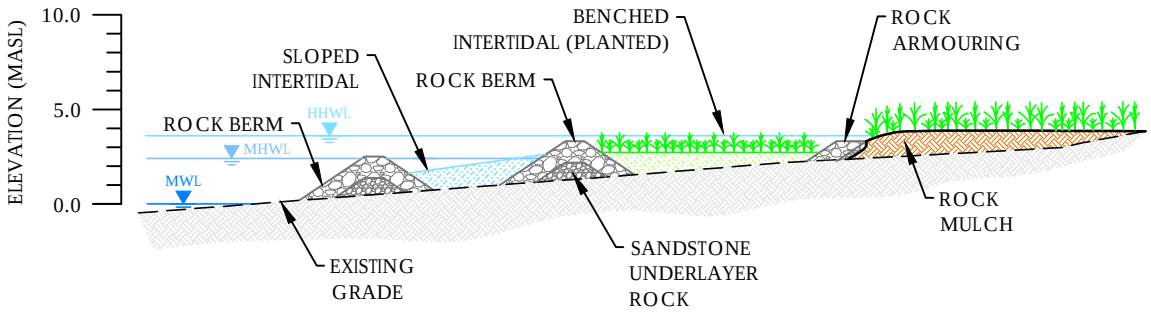

PROPOSED BENCHED SHORELINE HABITAT

SCALE: NOT TO SCALE

Legend

Proposed Marine Habitat Compensation Site

DRAFT
NOT FOR CONSTRUCTION

Pacific NorthWest LNG

Marine Habitat Offsetting
Site C

Sources: Base map provided by Microsoft Bing Imagery

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DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-858	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 10

ORIGINAL SHEET - ANSI A

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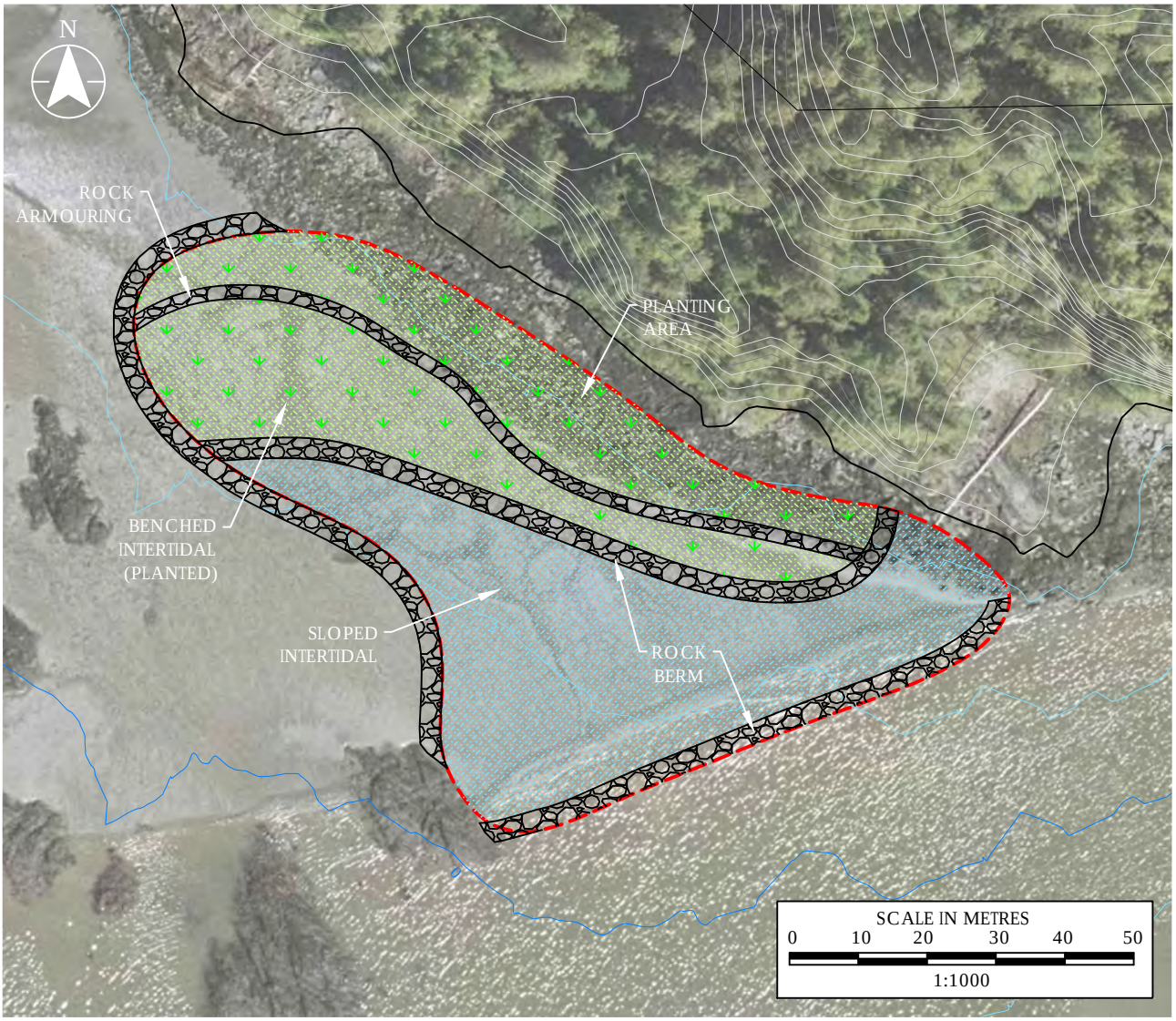

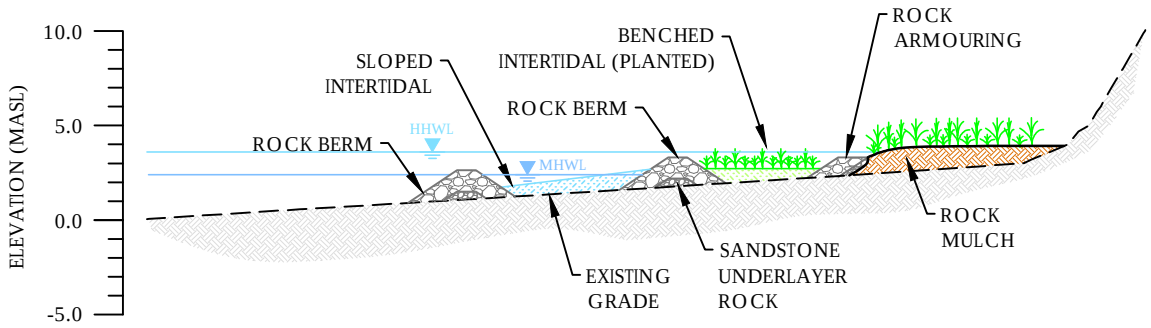

PROPOSED BENCHED SHORELINE HABITAT

SCALE: NOT TO SCALE

Legend

Proposed Marine Habitat Compensation Site

DRAFT
NOT FOR CONSTRUCTION

Pacific NorthWest LNG

Marine Habitat Offsetting
Site D

Sources: Base map provided by Microsoft Bing Imagery

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DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-859	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 11

ORIGINAL SHEET - ANSI A

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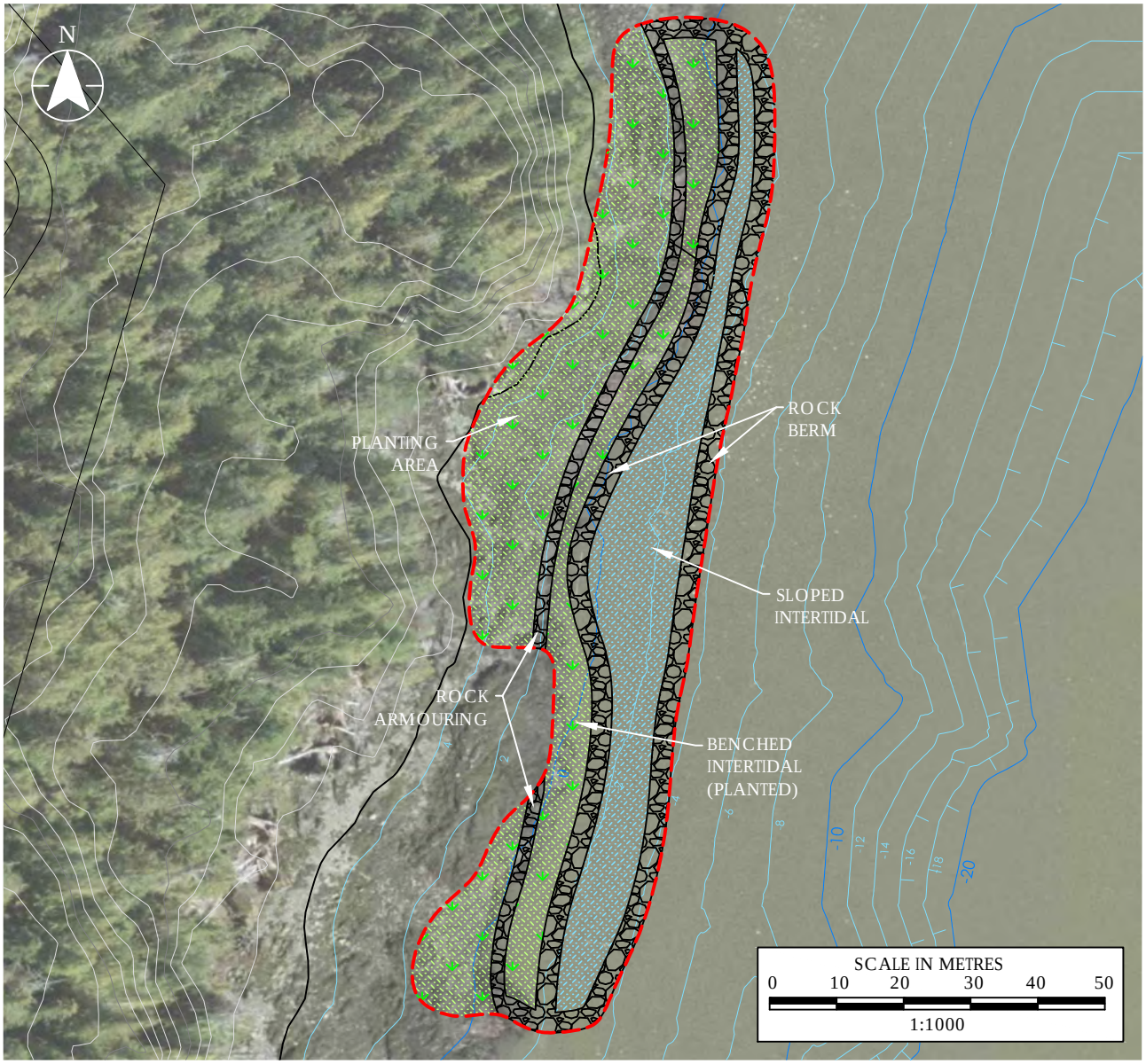

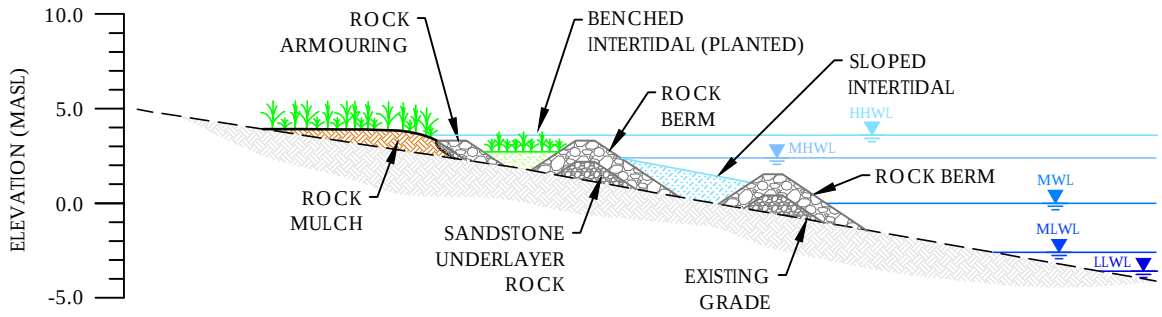

PROPOSED BENCHED SHORELINE HABITAT

SCALE: NOT TO SCALE

Legend

Proposed Marine Habitat Compensation Site

DRAFT
NOT FOR CONSTRUCTION

Pacific NorthWest LNG

Marine Habitat Offsetting
Site E

Sources: Base map provided by Microsoft Bing Imagery

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DATE: 27-OCT-14	PROJECTION: UTM - ZONE 9
FIGURE ID: 123110537-860	DATUM: NAD 83
DRAWN BY: G. HUYNH	CHECKED BY: M. PROUDFOOT

PREPARED BY: Stantec

PREPARED FOR: Pacific NorthWest LNG

FIGURE NO: 12

ORIGINAL SHEET - ANSI A

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Figures
December 12, 2014

Figure 1 Project Description

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Figures
December 12, 2014

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Figure 4 Past and Recent Studies

Figure 5 Predicted Habitat Impacts

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